Appendix J

Opsitnick (2015): Reservoir quality of the Marcellus Shale Play in the Hill Unit 2H and 3H wells: Determining mineralogical and lithological properties

Reservoir Quality of the Marcellus Shale Play in the Hill Unit 2H and 3H Wells: Determining Mineralogical and Lithological Properties



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I hereby acknowledge that I have fulfilled my responsibilities, as defined by the Honor Code, and maintained the integrity of both myself and the college community as a whole.

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List of Acronyms and Abbreviations

PaGS- Pennsylvania Geological Survey

USGS- United States Geological Survey

XRD- X-ray Diffraction

MMBbl- Million Barrels

GR- Gamma Ray

PE- Photoelectric Effect

NP- Neutron Porosity

DP- Density Porosity

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ABSTRACT

The Marcellus Formation is a valuable shale gas resource in Pennsylvania. In the southwest region of the state (particularly Washington and Greene counties), shale gas drilling and hydraulic fracturing are common. Recently, two wells were drilled in Washington County by Antero Resources, the Hill Unit 2H (API# 37-125-23880) and the Hill Unit 3H (API# 37-125-23879). The purpose of this study was to examine the lithology and the mineralogy of the Marcellus Formation in the 2H and the 3H wells using rock cuttings samples and geophysical well log data. Rock cutting samples from the vertical and lateral portions of the two wells were collected and evaluated for mineralogical content using XRD analysis. In addition, both wells are compared for similarities in lithological compositions based on geophysical well log interpretation.

Ideal properties for the Marcellus Formation need to consist of greater than 40% quartz and carbonates, and less than 30% clays. The Marcellus shale in the 3H well is more abundant in quartz and carbonate content, in both the vertical and lateral portions, than the 2H well. In addition, the clay mineral content in the 3H well lies at, or below, 30% in lateral portion of the Marcellus shale. The 2H well contains greater than 40% clay minerals, less than 10% carbonates, and roughly 50% quartz. The mineral percentages of the vertical and lateral depths of both wells suggest that the 2H resides in the Upper Marcellus while the 3H resides in the Lower Marcellus.

A geophysical log was only available for the 3H well. However both wells were drilled on the same well pad. If both wells contain a similar mineralogy, then the location of each formation in the 2H well will be roughly the same as the 3H well. Both wells show a similar relationship between mineralogy and depth as well as a relationship between mineralogy and lateral depth. Based on geophysical log interpretation, the Marcellus shale in the 3H well lies roughly 7,815 feet below the ground surface. The Marcellus shale displays a high gamma ray curve as well as a low density porosity and neutron porosity curve. The photoelectric curve ranges between 3 and 4, indicating a shale bed. Although the 3H well lies within the preferred mineralogy range for quartz, clay minerals, and carbonates, more work needs to be performed to further assess the reservoir quality of both wells.

1.0 Introduction

1.1 History of Shale Gas in Pennsylvania

Pennsylvania has a long history of oil and gas exploration and production. In 1859, the oil and gas industry began in Titusville, when Colonel Edwin Drake drilled a well to 69.5 feet and struck oil (Harper, 1998). Following this well's completion, the industry improving the technologies and methods of drilling as they went (Harper, 1998). Over the decades, the industry drilled both oil and gas wells in much of western Pennsylvania. These wells produced from a myriad of reservoirs, although the most popular (and prolific) were shallow Upper Devonian Venango and Bradford Group sandstones, and deep Lower Devonian Oriskany Sandstone wells (Harper, 2008). In 1939, companies drilled down to the Oriskany sandstone and discovered large quantities of natural gas (Harper, 2008). The gas originated from the Marcellus Formation, an organic-rich shale that was tens to hundreds of feet above the Oriskany (Harper, 2008). In these early days of oil and gas development, the occurrence of natural gas in the Marcellus shale was assumed to be in "pockets" and that flows could not be sustained for any length of time (Harper, 2008).

Oil and gas development in Washington County started in 1881 (Carter, K.M., 2003). Production was mostly limited to conventional, shallow reservoirs in the Upper Devonian Venango Group sands, with some production from the Upper Devonian Murrysville Sandstone, Mississippian Burgoon Sandstone, the Pennsylvanian Conemaugh Group and the Pottsville Formation (PA*IRIS/WIS, accessed January, 2015). Although the Marcellus shale contained natural gas, it was not considered a viable reservoir rock due to its low porosity and permeability characteristics (Carter et al., 2011). In 2004, the Marcellus Formation became a target of drilling activity when Range Resources Corporation (Range) discovered the play after completing the Renz No. 1 well in Washington County (Carter et al., 2011). Since then, more than 500 Marcellus shale gas wells have been completed in Washington County (PA*IRIS/WIS, accessed January, 2015), and completing the Renz well, drilling activity associated with the Marcellus play has made southwestern Pennsylvania a hub for shale gas production (Carter et al, 2011).

1.2 Petroleum Systems

In a conventional hydrocarbon reservoir model, organic material matures in shale, a source rock for natural gas, and migrates to a porous and permeable reservoir rock (Cooney, 2013; Fig. 1). The reservoir is usually comprised of sandstone or limestone and sealed by an impermeable rock layer (Cooney, 2013). In contrast to this model, the unconventional reservoir model shows that the shale acts as a source, reservoir, trap, and seal in a petroleum system (Laughrey et al., 2014; Fig. 1).

Conventional petroleum systems consist of a source rock, such as an organic-rich shale bed, and a reservoir rock, such as a sandstone or a limestone bed (Harper and Kostelnik, accessed January, 2015; Fig. 1). Natural gas migrates from the source rock to the reservoir rock where it is stored in the pore spaces (Harper and Kostelnik, accessed January, 2015). A fault or unconformity overlies the source rock (Harper and Kostelnik, accessed January, 2015; Fig. 1). A sealant bed, such as a shale or a non-porous limestone bed, overlies faults and unconformities and thus provide a trap situation (Harper and Kostelnik, accessed January, 2015; Fig. 1). The trap keeps petroleum in the reservoir (Harper and Kostelnik, accessed January, 2015; Fig. 1). Organic shale reservoirs in a conventional petroleum system lie above the Tully Limestone and are Late Devonian age (Shultz, 2002). In an unconventional petroleum system, the organic shale bed acts as a source and reservoir rock, a trap, and a seal (Harper and Kostelnik, accessed January, 2015; Fig. 1). The shale reservoirs underlie the Tully Limestone and are Middle Devonian age and older (Shultz, 2002).



Figure 1: Diagram showing a conventional and an unconventional petroleum system. (Modified from USGS.gov).

1.3 A Significant Resource

The Marcellus Formation extends throughout New York, Pennsylvania, Ohio, West Virginia, Virginia, and eastern Kentucky (Fig. 2). Like most petroleum resources, the Marcellus formed either from continuous authigenic accumulations within Devonian black shale source rocks or within overlying and intertonguing Devonian siltstone and sandstone reservoirs (Milici and Swezy, 2006).

Pennsylvania has two core areas of Marcellus production, the northeast region and the southwest region. Drilling in northeastern Pennsylvania occurs in Bradford, Lycoming, Sullivan, Susquehanna, Tioga, and Wyoming counties (Harper and Kostelnik, accessed January, 2015; Fig. 2). Here, the Marcellus shale is thicker and contains a higher abundance of organic material (Harper and Kostelnik, accessed January, 2015; Fig. 2). In southwestern Pennsylvania, Marcellus production occurs in Allegheny, Armstrong, Beaver, Fayette, Greene, Indiana, Somerset, Washington, and Westmoreland counties (Harper and Kostelnik, accessed January, 2015; Fig. 2). Here, the Marcellus shale generally is less than 50 feet thick and contains a lower abundance in organic matter (Harper and Kostelnik, accessed January, 2015; Fig. 2). For this study, the focus is on Washington County.

Natural gas exploration began in Washington County, Pennsylvania in 1881 (Fig. 2). In 1885, the operators completed three wells that penetrated into Upper Devonian Venango Group sandstones rock units. These wells, however, produced oil instead of natural gas. The Gantz well was the first commercially productive oil well in Washington County. It produced roughly 50 barrels of oil per day from the Venango Group's Gantz sand. The Gordon well was drilled to a depth of 2,408 feet and produced 100 barrels of oil per day. The reservoir was a 16-feet-thick sandstone called the Gordon sand. As a result of the productivity from the Gordon well, there was an incentive for active oil exploration and development throughout Washington County. The Gabby well drilled to a depth of 2,608 feet and produced oil from the Gordon and Gantz sands after stimulation using nitroglycerin torpedoes (Carter, 2003).

Current drilling activity in Washington County is mostly unconventional and the targeted resource is the Marcellus shale. According the U.S. Geological Survey (USGS), the Marcellus play has a mean undiscovered, technically recoverable natural gas resource potential of 84,198 billion cubic feet (Bcf) and 3,379 million barrels (MMBbl) natural gas liquids (Coleman et al, 2011).



Figure 2: Extent of Devonian formations in the Appalachian basin. The red circles show the core areas of natural gas drilling in Pennsylvania while the X shows the location of Washington County (Modified from Milici and Swezey, 2006).

1.4 Statement of the Problem

Shale gas reservoirs often consist of complex lithological and mineralogical heterogeneities (Cooney, 2013). The amount of petroleum hydrocarbons that occur in Middle Devonian source rocks rely on two factors: 1) the amount of organic matter present in the rocks; and 2) the degree of conversion of the organic matter into petroleum (Harper and Laughrey, 1987). Variations in organic matter quantity in shale source rocks occur due to differences in depositional environments, whereas reservoir quality and production potential, characterized by thermal maturity assessments, may also be affected by shale mineralogy. Within the Marcellus Formation, mineralogy changes both vertically and laterally. These varying mineral compositions lead to differences in geochemical properties (Wang and Carr, 2013) and may affect the reservoir quality and production potential of the Marcellus shale. The industry is interested in the vertical and lateral change in mineralogy of the Marcellus shale, particularly the percentage of quartz, clays, and carbonates (Carter, et al. 2012). A higher abundance of quartz and carbonate content creates a more brittle formation, making the Marcellus shale more amenable to fracturing during stimulation (Cooney, 2013). The mineralogy differs in the Upper Marcellus and Lower Marcellus shale beds (Carter et al., 2011). The Lower Marcellus shale is the preferred shale bed (PA*IRIS/WIS, accessed January 2015).

1.5 Research Objective

The purpose of this study is to describe the mineralogical and lithological characteristics of the Marcellus shale in southwestern Pennsylvania, using geophysical well log data and rock cuttings samples associated with two wells in West Pike Run, Washington County.

2.0 REGIONAL GEOLOGY

The Marcellus Formation is a Devonian shale [415 – 355 Ma] that occurs in Canada,

Pennsylvania, West Virginia, eastern Ohio, New York, Maryland, Virginia, and Tennessee (Fig. 2). During the Devonian period, the Tioga ash fall was immediately followed by a rapid subsidence within the foreland basin (Shultz, 2002). Sea level rise resulted in the Kaskaskia sequence and inundated the Appalachian Basin (Prothero and Dott, 2012). This resulted in the deposition of light gray shale and organic-rich black shale (Shultz, 2002). The Middle Devonian epoch ended with the spread of the argillaceous Tully Limestone across much of the Appalachian Basin (Shultz, 2002).

2.1 Lithology and Lithostratigraphy

The Marcellus Formation was named in 1839 by James Hall after a black shale outcrop near the village of Marcellus, New York (Hall, J., 1839). The Marcellus lies at the base of the Hamilton Group which comprises the Tully limestone, Moscow Formation, Ludlowville Formation, and the Skaneateles Formation (Fig. 3, 4). The Tully is a micritic brown to dark brownish-gray, argillaceous limestone that ranges from 20 to 60 feet thick (Harper and Laughrey, 1987). It is an important stratigraphic marker that indicates the boundary between Upper and Middle Devonian formations (Fig. 4). Where present, the Moscow shale underlies the Tully (Fig. 3). Underlying the Moscow shale is the Ludlowville shale (Fig. 3). The Skaneateles shale is bounded between the Ludlowville shale and the Centerfield limestone (Fig. 3). The Marcellus Formation is a black shale ranging from 20 to 70 feet thick in southwestern Pennsylvania (Harper and Laughrey, 1987; Fig. 5). It is organic-rich and serves as the source rock for many reservoirs in the Appalachian Basin. Although the primary lithology of the Marcellus is black shale, it also

consists of dark gray, fissile, carbonaceous shale with locally abundant pyrite, and contains few fossils (Shultz, 2002). In much of Pennsylvania the Marcellus includes a thin limestone (the Cherry Valley or Purcell) roughly three feet thick (Fig. 4). The limestone has been used to divide the formation into two parts, the Upper Marcellus and Lower Marcellus. The dark gray shale and carbonaceous shale makes up the Upper Marcellus while the organic black shale makes up the Lower Marcellus. In this study, geophysical logs were interpreted to determine the lithostratigraphy of the Marcellus shale and overlying Middle Devonian formations.

2.2 Depositional Environments/Paleogeography/Tectonism

The Devonian foreland basin setting was preceded by a prolonged history of during multiple sedimentary basins evolving since the Late Precambrian. Beginning in the Vendian and Cambrian periods, southwestern Pennsylvania was composed of terrigenous, silisiclastic rocks (Prothero and Dott, 2010). Sea level rose during the Sauk transgression sequence during the Vendian and Early Cambrian periods (Prothero and Dott, 2010). This resulted in terrigenous passive margin development followed by a dominance of carbonate passive margin sedimentation (Prothero and Dott, 2010). During the Middle Ordovician, North America collided with an island arc, resulting in the Taconian orogeny and the development of a corresponding foreland basin with Ordovician siliclastic fill (Shultz, 2002).

Devonian foreland basin evolution was the product of collision between North America and the micro continent, Avalonia, causing the Acadian Orogeny and further uplift in what is now central Pennsylvania (Fig. 6; Prothero and Dott, 2010). Terrigenous sediment from the Acadian orogenic belt and organic material from the remains of marine flora and fauna accumulated in the adjacent foreland basin (Prothero and Dott, 2010; Fig. 7). The abundance of organic matter

led to the development of disaerobic and anaerobic conditions (Prothero and Dott, 2010). The accumulation of organic material and anoxic conditions were ideal in the formation of black shale (Fig. 7).





Figure 4: Well log of the Unit Hill 3H well showing the gamma ray curve (left) and the neutron porosity, density porosity, and photoelectric effect curve (right). The orange lines show groups of similar geophysical log signatures as well as the boundaries of individual formations.



Figure 5: Generalized geologic cross section of western Pennsylvania showing the thickness of the Marcellus and overlying formations. Note how the Marcellus thickens from west to east. (Modified from Harper, 1987).



Figure 6: Paleotectonic map showing north to south collisions of North America with Europe and Avalonia during the Devonian period. These collisions caused the Caledonian and Acadian orogenies. Note the approach of the African part of Gondwanaland from the south and a microcontinent from the north. (F: Florida, S: Spain, WE: Western Europe, I: Italy, G: Greenland, E: Europe.) (Modified from Prothero and Dott, 2010).



Figure 7: Paleogeographic map of the Devonian period showing the location of North America. Note the location of the Acadian Mountains in eastern North America. (Modified from americanroads.us).

3.0 METHODS

3.1 Geophysical Log Interpretation

Four well log curves aided in interpreting the lithology of the Hill Unit 3H well. These curves are the gamma ray (GR), neutron porosity (NP), density porosity (DP) and photoelectric effect (PE). The gamma ray index measures the natural radioactivity of geologic formations (Asquith and Krygowski, 2004). Rocks containing clay minerals (i.e. shales) tend to have higher GR readings because of the presence of potassium as well as thorium and uranium (Asquith and Krygowski, 2004; Fig. 4). High abundances of organic material are associated with shale while lower abundances correlate with sandstone or limestone rock units (Asquith and Krygowski, 2004; Fig. 4).

Density porosity measures the density of an entire rock formation. These measurements are recorded in grams per cubic centimeter. Density porosity curves evaluate shaly sand reservoirs and complex lithologies. Neutron porosity values measure the hydrogen concentration in a formation. The values vary depending on differences in lithology (e.g. sandstone, limestone, and dolomite) (Asquith and Krygowski, 2004; Fig. 4).

The photoelectric curve helps to determine if the lower gamma ray indices portray sandstone or limestone rock units (Asquith and Krygowski, 2004; Fig. 4). A PE curve of 2.5 indicates silica (e.g. sandstone), shale ranges between 3 and 4, and a curve near 5 indicates limestone (Asquith and Krygowski, 2004: Fig. 4). A geophysical well log was available for the Hill Unit 3H well (API# 37-125-23879), but not for the Hill Unit 2H well (API# 37-125-2388). As a result, lithological interpretations for the Hill Unit 2H well, drilled on the same well pad as the 3H well, are based upon the 3H geophysical log.

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3.2 Sample Preparation

Dry well cuttings samples donated to the Pennsylvania Geological Survey (PaGS) by Antero Resources were analyzed for this project (Fig. 8). Cuttings samples taken were from the vertical and lateral sections of the Hill Unit 2H (API# 37-125-23880) and the Hill Unit 3H (API# 37-125-23879) (Fig. 8). For the 2H well, samples for mineralogical analysis were collected and provided at 30 foot intervals by Antero Resources for the vertical portion. The shallowest sample provided by Antero started at 7,200 feet and ended at 8,100 feet below ground surface. For the 3H well, the vertical samples were also provided by Antero Resources and collected at intervals ranging from 10 to 30 feet. Approximately 3.0 grams were measured from each interval, unless sample volumes were limited. In these instances, however, some of the cutting samples were in smaller amounts, so only 2.0-2.5 grams were measured and collected. Overall, 26 samples from the vertical portion of the 2H well, 31 from the 3H well, 5 from the horizontal 2H, and 3 from the horizontal 3H were sampled and evaluated for this work, for a grand total of 65 samples.

Bulk mineralogy samples were ground with a mortar and pestle until they reached the consistency of talcum powder and placed in clean sample bags for transport to the Middletown office of the PaGS (Fig. 9).

3.3 Mineralogical Analysis

Standard X-ray powder diffraction (XRD) techniques were used to determine bulk mineralogy of each cuttings sample prepared for this work. The analyses were run by John Barnes using a PANalytical Empyrean X-ray diffractometer (Fig. 10). X-ray scanning was performed between November 18, 2014 and December 8, 2014. For this study, the Rietveld method was used to analyze the mineralogy of the rock cutting samples. The Rietveld considers the preferred orientation, cleavage and crystallinity of the minerals (Rietveld, 1967). Rietveld calculations were used to obtain a more reasonable estimate, rounded to the nearest tenth of a percent. In order to check for errors using the Rietveld method, the samples were first run automatically and then run manually.





Figure 9: Image of a PANalytical EMPYREAN X-ray diffraction machine. (Modified from http://www.panalytical.com/Empyrean.htm).

3.3 Possible Errors

3.3.1 Preferred Orientation

The preferred orientation of mineral grains, especially platy minerals, depends primarily on the grinding and method used to pack the samples into the sample holder (Chung, 1974). All samples for this study were ground to the equivalent of talcum powder. Each one was loaded into the sample holder using a method called back-packing where they are packed into a cavity, turned over in the device, and then removed from the bottom of the cavity. The surface exposed to the X-ray beam is the same surface as the bottom surface during sample packing. This makes a smoother surface and prevents pushing down on the X-rayed surface. If preferred orientation is not accounted for in the calculations, then higher percentages will result for minerals with perfect cleavage (i.e., muscovite) and lower for minerals with fractures (i.e., quartz) (Chung, 1974). By using the Rietveld calculations, the entire pattern for the mineral and not just the prominent peaks that are most affected by preferred orientation (Rietveld, 1967).

3.3.2 Sample Mixing

Grinding samples using a mortar and pestle mixes the clays, carbonates, and minerals. Inadequate mixing affects the bulk mineralogy results when a harder mineral over- or underrepresented based on whether large grains of it are present on the X-rayed surface. This also occurs when a harder mineral is buried under finer minerals (Chung, 1974; Barnes, personal communication, January 2015). According to John Barnes (personal communication, January 2015), the samples were adequately mixed; therefore, any errors pertaining to sample mixing should be considered minuscule.

3.3.3 Crystallinity

Crystallinity is another variable that can affect mineralogy, particularly when platy minerals are evaluated using RIR calculations (Chung, 1974). For muscovite there are many polytypes and when mixed in with chlorite, feldspar, and quartz, it is difficult to know which polytype is present (Chung, 1974). The results also differ depending on the polytype used for muscovite. When analyzing platy minerals, the Rietveld method was used to calculate their percentages (Chung, 1974). The results are less dependent on muscovite polytypes (Chung, 1974).

3.3.4 Three Repeated Sections

Three sample analyses were replicated for this study, all of which were from the vertical section of the 2H well. The intervals were at 7,200, 7,230 and 7,260 feet (appendices). This was done to see if there were any changes that needed to be incorporated to the affected results. Out of the three replicated samples, only one was changed intentionally. The X-ray optics was changed to reduce a high background that was appearing at the start of each scan. Any other changes pertained to the packing of each sample.

4.0 RESULTS

4.1 Lithostratigraphy

The Marcellus shale is a black organic-rich shale that ranges from 20-70 feet thick in southwestern Pennsylvania and greater than 150 feet in northwestern Pennsylvania (Harper and Kostelnik, accessed January, 2015). Based on the geophysical well log for the Hill Unit 3H (API# 37-125-23879), the top of the Marcellus starts at 7,765 feet below the ground surface and the base reaches a depth of 7,858 feet (Fig. 4). The Marcellus shale is 93 feet thick. This interval is characterized by low neutron and low density porosity values as well as high gamma ray readings (Fig. 4). The PE curve ranges between 3 and 4, indicating a shale bed (Fig. 4).

Well log data for the Hill Unit 2H well (API# 37-125-3880) was not available for this study. The interpreted location of the Marcellus shale in the 3H well can be applied to the 2H since both wells are on the same well pad. In addition, the Tully Limestone, Ludlowville Formation, Skaneateles Formation, Centerfield Limestone, and the Onondaga Limestone will have correspondingly similar depths.

4.2 Mineralogy

Mineralogical results for the 65 samples evaluated by this study are presented below. Full analytical results are provided in Appendices A, B, C, and D.

4.2.1 Vertical Sections

Based upon the bulk mineralogy results (Appendix A, C), the vertical portions of both Antero wells have a similar mineralogy. In addition, the data shows that mineralogy varies with depth (Fig. 10, 11). Average percent, range, and standard deviation values for both wells were

calculated. The percent averages for the 2H well are 40% quartz, 43% clay minerals, and 17% carbonates (Appendix A). For the vertical portion of the 3H well, the average percent of total mineralogy amounted to 45% quartz, 41% clay minerals, and 14% carbonates (Appendix C). Both wells contain a low abundance of carbonates and a high abundance of quartz and clay minerals (Fig. 11; Appendix A, C).

4.2.2 Lateral Sections

The lateral portion of the 2H well displays an increase in quartz and clays with increasing measured depth (Fig. 12). The carbonate values, however, decrease with increasing measured depth (Fig. 12). Average values for quartz, clay minerals, and carbonates content are 36%, 43%, and 21% respectively (Appendix B). In the lateral portion of the 3H well, the abundance of quartz and clays decrease with increasing measured depth while the percentage of carbonates increases (Fig. 13). The calculated average percent of total mineralogy for quartz, clay minerals, and carbonates was 54%, 25%, and 21% respectively (Appendix D). There is also a relationship between mineral percentage and lateral depth (Fig. 13). These lateral section results suggest that the 2H well may be completed in the upper Marcellus horizon while the 3H well is in the lower Marcellus horizon.



Figure 10: Graph showing the tops of each formation and the base of the Huntersville Chert in the vertical 2H well. Note how the quartz carbonate, and clay mineral content varies with depth.



Figure 11: Graph showing the tops of the Tully Limestone through the Huntersville Chert in the vertical 3H well. Note how the quartz, carbonate, and clay mineral content varies with depth.



Figure 12: Graph showing the quartz, clay, and carbonate content in the lateral portion of the 2H well. Note how the samples at 7,600 feet are in the curve for this well. The mineralogy varies with lateral distance.


Figure 13: Quartz, clay, and carbonate content of the lateral 3H well. The quartz and carbonates increase while the clay mineral content decreases with lateral distance in the Marcellus shale.

4.2.3 Apatite

On mineralogy sample reported a large percentage (20%) of apatite. This sample was from 7,600 feet in the vertical portion of the Hill Unit 2H well (API# 37-125-23879) (Appendix A). This was the only detection of apatite reported for this study. When a high abundance of apatite shows up suddenly, it may indicate volcanic or sedimentary (phosphate) origins (Smith, personal communication 2015). According to Smith (personal communication, 2015), the apatite is a fossil bed.

5.0 DISCUSSION

5.1 Mineralogy

According to a study by Wang and Carr (2013), the three most important minerals to consider for evaluating natural gas shale reservoirs are quartz, clay minerals, and carbonates. Ideally for a productive reservoir, the quartz and carbonates amount need to be greater than 40% while the amount for clay minerals need to be less than 30% (Wang and Carr, 2013; Table 1). A Marcellus sample from 7,830 feet, analyzed for the Hill Unit 2H well (API# 37-125-23880) has a combined quartz and carbonates value above the 40% range, but the clay minerals value is above the 30% range (Appendix A). Similarly in the Hill Unit 3H (API# 37-125-23879), a Marcellus sample from 7,830 feet also shows a combined quartz and carbonates value above the 40% range (Appendix C). The sample taken at 7,850 feet is in the ideal mineral range. When comparing the lateral portions of both Antero wells, only one out of five cutting samples from the 2H and all three samples from the 3H well are within the ideal mineral range (Appendix B, D).

Overall mineralogy varies with depth, both vertically and laterally, within the Marcellus shale (Figs. 10-13). In the vertical portions of 2H and the 3H well, quartz, carbonate, and clay mineral content varies with depth in the Marcellus (Figs. 10, 11). According to Cooney (2013) an increase of quartz and carbonate content with depth, along with a commensurate decrease in clay mineral content with depth, promises greater petroleum reservoir potential. This increase allows for more brittle formations that may contain continuous free gas (Cooney, 2013) and certainly those that will respond well to hydraulic stimulation. Based upon the low clay mineral content and the higher quartz and carbonate contents, the 3H well is completed in the more promising hydrocarbon reservoir (Fig 13; Appendix D).

Table 1: Ideal Mineralogic Pr (Modified	roperties for Shale Gas Producing Reservoirs in Wang and Carr. 2013)
Mineral Type	Percenatage
Quartz and Carbonates	Greater than or equal to 40%
Clays	Less than or equal to 30%

5.2 Implications For Reservoir Quality

From the mineralogy and geophysical log data, the Hill Unit 3H will likely be more productive than the Hill Unit 2H well. The Marcellus shale within the vertical portion of the 2H well contains 50% quartz by weight, but more than 40% clay minerals and less than 10% carbonates (Fig. 10). With lateral distance, quartz and clay mineral content varies while carbonate content decreases (Fig. 12). In comparison, the 3H well consists of more than 55% quartz and carbonates, but more than 30% clay minerals at the top of the Marcellus Formation (Fig. 11). The lateral portion of the 3H well shows an increase in carbonate content while clay mineral and quartz content decrease with lateral distance (Fig. 13). The lack of clay minerals reduces the tendency for hydrocarbons to be adsorbed to clay mineral surfaces (Cooney, 2013). With a smaller percent of clay minerals in the 3H well, the fracing process will be more successful in this rock, which leads to better gas drainage and a more productive well.

6.0 CONCLUSIONS

Based on mineralogy and geophysical well log interpretations, the Marcellus Formation in the 3H well is the more viable natural gas reservoir. Both the vertical and lateral portions of the 2H and well and the 3H well do not have similar mineralogical characteristics in the Marcellus (Appendix A, B, C, and D). In the vertical 2H well, the clay mineral content is above 30%, but the combined quartz and carbonates content is above 40% (Appendix A). For the vertical 3H well, the combined percentage of quartz and carbonates content is greater than 40% while the clay mineral content is equal to 30% (Appendix C).

The lateral portion of the 3H has a favorable mineralogy and is interpreted to within the lower Marcellus horizon (Appendix D). Average percent values for quartz, carbonates, and clay mineral content were 54%, 62%, and 25% respectively (Appendix D). The mineralogy within the lateral portion of the 2H well is less favorable and resides in the upper Marcellus horizon (Appendix B). Average percent values in the lateral 2H are 36% quartz, 43% clay minerals, and 21% carbonates (Appendix B).

Since the Hill Unit 2H and 3H wells lie on the same well pad, it can be inferred that the Marcellus intervals are at corresponding similar vertical depths (Appendix E, F). For the two wells, mineralogy varies with depth both vertically and laterally (Figs. 10, 11, 12, 13). Although mineralogy plays a role in reservoir quality, more work needs to be done in order to fully assess the reservoir quality of this shale, namely through the studies of thermal maturity and total organic carbon content of the Marcellus shale in this area of southwestern Pennsylvania.

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Appendices

r			1	r	r	r	r	r	1					r	r	r		r						1	1	1					
TOT	DEDCENTAGE	LENCENTAGE	100	100	100	100	101	100	100	100	66	101	66	100	101	100	101	101	101	100	100	100	100	100	66	66	100	100	N/A	N/A	N/A
	VIINERALUUI	Total Carbonate+	0	0	0	2	2	2	2	0	6	14	11	57	73	46	44	18	4	4	7	3	6	L	15	14	74	24	17	73	22
		Total Clay	56	57	61	57	53	52	47	48	39	44	43	18	17	29	30	44	53	57	50	53	74	50	44	45	14	23	43	47	13
	FERCENT	Fotal Quartz+	44	43	39	41	46	46	51	52	51	43	45	25	11	25	27	39	44	39	43	44	50	43	40	40	12	53	40	42	11
	н +	Apatite '	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.												
	RBONAT	Dolomite	N.D.	N.D.	N.D.	1	N.D.	N.D.	N.D.	N.D.	N.D.	3	N.D.	N.D.	1	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	5	6			
GY	CAI	Calcite	N.D.	N.D.	N.D.	1	2	2	2	N.D.	6	11	11	57	72	46	44	18	4	4	7	3	9	7	15	14	69	18			
NERALC	Y	Chlorite	15	24	22	12	17	17	15	10	7	9	10	4	4	10	10	L	12	10	11	11	12	5	13	13	N.D.	4			
ENT OF MI	CLA	Muscovite	41	33	39	45	36	35	32	38	32	38	33	14	13	19	20	37	41	47	39	42	32	45	31	32	14	19	logy		
PERCE		Pyrite	N.D.	1	N.D.	1	1	1	1	1	1	1	1	N.D.	N.D.	N.D.	N.D.	2	1	N.D.	N.D.	N.D.	3	2	2	3	1	1	tal minera		viation
	QUARTZ+	Plagioclase	7	9	9	9	9	7	7	7	5	4	4	3	N.D.	1	2	4	8	4	5	5	5	4	4	4	N.D.	2	percent of to	Range	tandard Dev
		Quartz	37	36	33	34	39	38	43	44	45	38	40	22	11	24	25	33	35	35	38	39	42	37	34	33	11	50	Average I		S
1	Sampleu Interval		7200	7230	7260	7290	7320	7350	7380	7410	7440	7470	7500	7530	7560	7590	7620	7650	7680	7710	7740	7770	7800	7830	7860	7890	7980	8110			
	Formation Sampled		Not Listed	Tully Limestone	Tully Limestone	Ludlowville Formation	Centerfield Limestone	Skaneateles Formation	Marcellus Formation	Marcellus Formation	Marcellus Formation	Onondaga Formation	Huntersville Chert	Not Listed	Not Listed																

Appendix A: Vertical 2H Results

	IVLUL	DEDCENTACE	FERCEN LAUE	66	66	66	100	100	V/A	V/A	N/A
ylvania.	VINTED AT OCV	VIINERALUUI	Total Carbonate+	74	27	2	0	1	21	74	32
ounty, Pennsy			Total Clay	20	33	52	60	50	43	40	16
Washington C	DEDCENT	FERCENT	Total Quartz+	5	39	45	40	49	36	44	18
samples,		Е +	Apatite	20	N.D.	N.D.	N.D.	N.D.			
us cuttings		BONAT	Dolomite	N.D.	N.D.	N.D.	N.D.	N.D.			
I Marcell	GY	CAF	Calcite]	54	27	2	N.D.	1			
al 2H we	NERALO	Y	Chlorite	N.D.	N.D.	9	8	7	gy		
alysis, of later	ENT OF MIN	CLAY	Muscovite	20	33	46	52	43	total mineralo	e	eviation
XRD an	PERCI		Pyrite	N.D.	3	4	3	4	rcent of	Rang	indard D
ineralogy, by		QUARTZ+	Plagioclase	N.D.	3	4	4	3	Average pe		Stz
Μ			Quartz	5	33	37	33	42			
	Compad Internal	Jatinpieu Interval		7600	8620	9610	10600	11624			

Appendix B: Lateral 2H Results

	Mine	stalogy, t	y XRD anal	lysis, of v	vertical 3H w	vell Marce	Ilus cuttin	igs sample:	s, Washin	gton County, Pe	annsylvania.		
	Conned Internal			PERC	CENT OF M	1INERAL	OGY			DEDCENT	DE TOTAL	MINED ALOCY	TOTAL
Formation Sampled	(ft below surface)	-	QUARTZ +		CLA	١Y	CA	RBONAT	IE+	LENCENT	JF 101AL		DEPCENTAGE
	(IL DEIDW SULLACE)	Quartz	Plagioclase	Pyrite	Muscovite	Chlorite	Calcite	Dolomite	Apatite	Total Quartz+	Total Clay	Total Carbonate+	
Sonyea Formation	7220	36	4	1	30	19	11	N.D.	N.D.	41	49	11	101
Sonyea Formation	7250	39	4	4	28	19	7	N.D.	N.D.	47	47	7	101
Sonyea Formation	7280	38	5	2	31	19	6	N.D.	N.D.	45	50	6	101
Sonyea Formation	7310	36	4	2	34	20	5	N.D.	N.D.	42	54	5	101
Sonyea Formation	7340	41	4	1	30	19	5	N.D.	N.D.	46	49	5	100
Geneseo Formation	7370	43	4	N.D.	32	16	9	N.D.	N.D.	47	48	9	101
Geneseo Formation	7400	44	5	1	26	18	5	N.D.	N.D.	50	44	5	66
Geneseo Formation	7430	41	3	1	29	14	11	N.D.	N.D.	45	43	11	66
Geneseo Formation	7460	46	5	N.D.	26	12	11	N.D.	N.D.	51	38	11	100
Tully Limestone	7490	44	9	2	22	13	12	1	N.D.	52	35	13	100
Ludlowville Formation	7520	37	L	1	35	20	N.D.	N.D.	N.D.	45	55	0	100
Ludlowville Formation	7550	28	1	N.D.	14	10	48	N.D.	N.D.	29	24	48	101
Ludlowville Formation	7580	35	4	1	30	19	11	N.D.	N.D.	40	49	11	100
Ludlowville Formation	7610	41	9	N.D.	32	19	2	N.D.	N.D.	47	51	2	100
Ludlowville Formation	7640	40	6	N.D.	32	19	N.D.	N.D.	N.D.	49	51	0	100
Ludlowville Formation	7670	41	4	1	33	20	N.D.	N.D.	N.D.	46	53	0	66
Ludlowville Formation	0692	44	5	N.D.	29	20	2	N.D.	N.D.	49	49	2	100
Ludlowville Formation	7700	45	9	N.D.	28	19	1	N.D.	N.D.	51	47	1	66
Centerfield Limestone	7710	46	L	N.D.	24	20	4	N.D.	N.D.	53	44	4	101
Skaneateles Formation	7720	52	3	3	26	14	1	N.D.	N.D.	58	40	1	66
Skaneateles Formation	7730	47	9	3	27	15	2	N.D.	N.D.	56	42	2	100
Skaneateles Formation	7740	37	2	1	34	14	11	1	N.D.	40	48	12	100
Marcellus Formation	0770	33	3	3	29	12	20	N.D.	N.D.	39	41	20	100
Marcellus Formation	7790	34	2	3	26	11	23	1	N.D.	39	37	24	100
Marcellus Formation	7810	47	4	4	34	3	8	N.D.	N.D.	55	37	8	100
Marcellus Formation	7830	51	3	4	35	N.D.	7	N.D.	N.D.	58	35	7	100
Marcellus Formation	7850	28	N.D.	2	12	4	55	N.D.	N.D.	30	16	55	101
Marcellus Formation	7870	8	N.D.	1	16	N.D.	61	14	N.D.	6	16	75	100
Huntersville Chert	7890	5	N.D.	1	15	2	63	14	N.D.	9	17	77	100
Huntersville Chert	7910	86	N.D.	N.D.	7	N.D.	1	9	N.D.	86	7	7	100
Huntersville Chert	7930	43	2	1	30	11	13	N.D.	N.D.	46	41	13	100
		Average	percent of to	otal mine	sralogy					45	41	14	N/A
			Range							80	47	77	N/A
		-1	Standard De	viation						14	12	21	N/A

Appendix C: Vertical 3H Results

	IVTOT	DEDCENTACE	FERCEN LAUE	66	100	101	N/A	N/A	N/A
nsylvania.		MINENALUUI	Total Carbonate+	9	14	42	21	36	19
County, Pen		IL IUIAL	Total Clay	30	50	16	22	14	8
s, Washington (U TNADAAA	LENCENI C	Total Quartz+	63	57	43	54	20	10
gs sample		TE+	Apatite	N.D.	N.D.	N.D.			
vell cutting		RBONAT	Dolomite	N.D.	N.D.	N.D.			
arcellus v	УдУ	CA	Calcite	9	14	42			
ral 3H M	INERAL (Y	Chlorite	N.D.	N.D.	N.D.	llogy		
alysis, of late	ENT OF M	CLA	Muscovite	30	67	16	otal of minera	ge	Deviation
XRD an	PERC		Pyrite	9	8	4	percent to	Ran	tandard I
peralogy, by		QUARTZ+	Plagioclase	4	3	1	Average f		S
Mir			Quartz	53	46	38			
	Country Intomial	Jatend distance in AV		11010	12000	12990			

Appendix D: Lateral 3H Results



Appendix E: 2H Well Location Plat

5500-PM-OG0002 Rev. 9/2008

COMMONWEALTH OF PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL PROTECTION Oil and Gas Management Program WELL LOCATION PLAT (ATTACHMENT, if needed)



Applicant / Well Operator Name Well(Farm) Name DEP ID# Well# Serial # HILL UNIT 2H ANTERO RESOURCES 266637 Surface Owner or Water Purveyor Approximate Course and Owner, Lessee, or Operator of Name of Coal Seam Owned, Leased, or Operated with a Water Supply within 1,000 ft Distance to Water Supply Workable Coal Seam WILLIAM COTTLE 168 S. CALIFORNIA DRIVE S5'E 895' COALCENTER, PA. 15423 CHARLES O'DONNELL S25°E 920' (SPRING) 169 S. CALIFORNIA DRIVE COAL CENTER, PA. 15423 ROBERT HOMME ____ 2910 KERRY FOREST PARKWAY S30°E 990' SUITE D4-360 TALLAHASSEE, FL. 32309 THEODORE DEMICHELE 167 S. CALIFORNIA DRIVE S17°E 645' COAL CENTER, PA. 15423 JOSEPH VERNO S6'E 550' 157 S. CALIFORNIA DRIVE COALCENTER, PA. 15423 PAUL BECKA \$30°W 585' 147 S. CALIFORNIA DRIVE COAL CENTER, PA. 15423 MARY JANE RUSSELL \$42°W 740' 137 S. CALIFORNIA DRIVE COAL CENTER, PA. 15423 RECEIVED SEP 21 2009 THOMAS HAVRILESKO S52°W 990' 122 S. CALIFORNIA DRIVE DEP. SOUTHWEST REGION OIL & GAS COAL CENTER, PA. 15423 DAVID DILLON 153 S. CALIFORNIA DRIVE S22"W 415' COAL CENTER, PA. 15423







NOTE A American Datum Conversion NAD 27 to NAD 83 NADCON Program Version 2.11 	Output from NADCON f	or station	
AD 27 to NAD 83 NAD CON Program Version 2.11 Transformation #: 1 Region: Conus Latitude Longitude NAD 27 datum values: 40 05 17.4000 79 58 27.7100 NAD 83 datum values: 0.0 05 17.4003 79 58 26.89310 NAD 83 - NAD 27 shift values: 0.26133 -0.81680(mscs.) 8.060 -19.352 (msters) Nagnitude of total shift: 20.964(msters) Nagnitude of total shift: 20.964(msters)	North Amer	ican Datum Conversi	on
NADCON Program Version 2.11 Transformation #: 1 Region: Conus Latitude Longitude NAD 27 datum values: 40 05 17.40133 79 58 27.71000 NAD 83 datum values: 40 05 17.40133 79 58 26.8310 NAD 83 - NAD 27 shift values: 0.26133 -0.81690(secs.) 8.060 -13.352 (meters) Magnitude of total shift: 20.964(meters)	NAD	27 to NAD 83	125-23880
Transformation #: 1 Region: Conus Latitude Longitude ND 27 datum values: 40 05 17.14000 79 58 27.71000 ND 83 datum values: 40 05 17.40133 79 58 26.89310 ND 83 - NAD 27 shift values: 0.26133 -0.81690(secc.) 8.060 -19.352 (meters) Magnitude of total shift: 20.964(meters)	NADCON P	rogram Version 2.11	,
Transformation #: 1 Region: Conus Latitude Longitude ND 27 datum values: 40 05 17.40133 79 58 27.71000 ND 83 datum values: 40 05 17.40133 79 58 26.9310 ND 83 - NAD 27 shift values: 0.26133 -0.81690(secs.) 8.060 -19.352 (meters) Magnitude of total shift: 20.964(meters)			
Image: Second state			
Image: Second state sta			
Latitude Longitude NAD 27 datum values: 40 05 17.14000 79 58 27.7100 NAD 83 datum values: 40 05 17.40133 79 58 26.89310 NAD 83 - NAD 27 shift values: 0.26133 -0.81690(secs.) 8.060 -19.352 (meters) Magnitude of total shift: 20.964(meters)	Trans	formation #: 1	Region: Conus
NAD 27 datum values: 40 05 17.4000 79 58 27.71000 NAD 83 datum values: 40 05 17.40133 79 58 26.89310 NAD 83 - NAD 27 shift values: 0.26133 -0.81690(secs.) 8.060 -19.352 (meters) Magnitude of total shift: 20.964(meters)		Latitude	Longitude
NAD 83 datum values: 40 05 17.40133 79 58 26.89310 NAD 83 - NAD 27 shift values: 0.26133 -0.81690(secs.) 8.060 -19.352 (meters) Magnitude of total shift: 20.964(meters)	NAD 27 datum values:	40 05 17.14000	79 58 27.71000
NAD 83 - NAD 27 shift values: 8.060 -19.352 (meters) Magnitude of total shift: 20.964(meters) C C C C C C C C C C C C C	NAD 83 datum values:	40 05 17.40133	79 58 26.89310
8.060 -19.352 (meters) Magnitude of total shift: 20.964(meters)	NAD 83 - NAD 27 shift values:	0.26133	-0.81690(secs.)
Magnitude of total shift: 20.964 (meters)		8.060	-19.352 (meters)
The second secon	Magnitude of total shift:		20.964 (meters)
C COMPAGE SINCE PAGE			
	NIS HOME PAGE		

REVISE	OMMONWEALTH O R MENT OF ENVIRO Oil and Gas Mana WELL LOCATI (ATTACHMENT	F PENNSYLVANIA NMENTAL PROTECTION gement Program ON PLAT	DEP USE ONLY 125-23880
Applacant / Well Operator Name	DEP ID#	Well(Farm) Name HILL LINIT	Well# Serial#
ANTERO RESOURCES	266637	HILL ON I	2H
Surface Owner or Water Purveyor with a Water Supply within 1,000 ft. WILLIAM COTTLE	Distance to Water Supply	Owner, Lessee, or Operator of Workable Coal Seam	Owned, Leased, or Operated
168 S. CALIFORNIA DRIVE	S5°E 895'		
COAL CENTER, PA. 15423			
CHARLES O'DONNELL			BECEIVED
169 S. CALIFORNIA DRIVE	S25'E 920' (SPRING)		1120121122
COAL CENTER, PA. 15423			MAR 3 0 2010
ROBERT HOMME			DEP, SOUTHWEST REUN
2910 KERRY FOREST PARKWAY	S30°E 990'		OIL & GAO
SUITE D4-360			
TALLAHASSEE, FL. 32309			
THEODORE DEMICHELE			
167 S. CALIFORNIA DRIVE	\$17"E 645'		
COAL CENTER, PA. 15423			
JOS EPH VERNO			
157 S. CALIFORNIA DRIVE	S6°E 550'		
COAL CENTER, PA. 15423			
PAUL BECKA			
147 S. CALIFORNIA DRIVE	\$30°W 585'		
COAL CENTER, PA. 15423			
MADY JANE DIRCELL			
MART JANE RUSSELL	\$42°W 740'		
COAL CENTER BA 15422			
COAL GENTER, PA. 15425			
THOMAS HAVRILESKO			
122 S. CALIFORNIA DRIVE	S52°W 990'		
COAL CENTER, PA. 15423			
DAVID DILLON			
153 S. CALIFORNIA DRIVE	S22°W 415'		
COAL CENTER DA 15422			







Appendix F: 3H Well Location Plat

5500-PM-0G0002 Rev. 9/2008

COMMONWEALTH OF PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL PROTECTION Oil and Gas Management Program



WELL LOCATION PLAT

(ATTACHMENT, if needed)

Applicant / Well Operator Name	DEP ID#	Well(Farm) Name HILL UNIT	Well# Serial#
ANTERO RESOURCES	266637		Name of Coal Seam
with a Water Supply within 1,000 ft.	Distance to Water Supply	Workable Coal Seam	Owned, Leased, or Operated
WILLIAM COTTLE			
168 S. CALIFORNIA DRIVE	S5°E 905'		
COAL CENTER, PA. 15423			
CHARLES O'DONNELL			
169 S. CALIFORNIA DRIVE	S25°E 920' (SPRING)		
COAL CENTER, PA. 15423			
ROBERT HOMME			
2910 KERRY FOREST PARKWAY	S30"E 990'		
SUITE D4-360			
TALLAHASSEE, FL. 32309			
THEODORE DEMICHELE		a a tha an	
167 S. CALIFORNIA DRIVE	S17'E 655'		
COAL CENTER PA. 15423			· · · · · · · · · · · · · · · · · · ·
JOSEPH VERNO			
157 S. CALIFORNIA DRIVE	S6°E 560'		
COAL CENTER, PA. 15423			
PAUL BECKA			
147 S. CALIFORNIA DRIVE	S30'W 590'		
COAL CENTER, PA. 15423			
MARY JANE RUSSELL			
137 S. CALIFORNIA DRIVE	\$42°W 745'		
COAL CENTER, PA. 15423		RECEIVED	
		SEP 91 2000	
THOMAS HAVRILESKO		021 21 2003	
122 S. CALIFORNIA DRIVE	S52"W 990'	OIL & GAS	DN
COAL CENTER, PA. 15423			
DAVID DILLON			
153 S. CALIFORNIA DRIVE	S22"W 420'		
COAL CENTER, PA. 15423			





Ž	pen DEPARTNEN	nsylv	Ania	DEPART	MENT OF ENV	TH OF PENNSY IRONMENTAL NAGEMENT PI	LVANIA PROTECTION ROGRAM		Sute ID	DEP US	SE ONLY
Ame	- endec	ہ <i>۲</i>	w	ell Re	cord and	Comple	tion Rep	ort	Chent Hi		Subfacilli
Well Op Anter	erator Resource	es Anc	alachian Cor	n	DEP 10#	Wel API # (Po	mit / Reg) RO-00		Proje	ct Number	A
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Cal F Address	rac Well	Service	I 445	Ado	ress			Addres	s		
City Stal		1202	1440	Снў	• State – Zip			CITY - 3	Tate - Zıp -	~ · · · - ·	
Phone	293-2931			Pho	ne			Phone			

Appendix G: 2H Well Completion Report

Hill Unit 2H (API# 37-125-23880-00) Antero Resources Appalachian Corporation

Perfo	ration Rec	ord			Stimulatio	n Record			
Date	Interval P From	erforated To	Date	Interval Treated	Fiuld Type A	mount	Propp Type	ing Agent Amount	Average Injection Rate
7/30/2010	11328'	11560'	8/29/2010	Marcellus	Water/15% HCI	8616 bbl	Sand	175182#	59 bbl/min
9/2/2010	11003'	11235'	9/03/2010	Marcellus	Water/15% HCI	10076 bbl	Sand	145000#	49.5 bbl/mir
9/3/2010	10583'	10910'	9/03/2010	Marcellus	Water/15% HCI	9952 bbl	Sand	196180#	53 bbl/min
9/4/2010	9703'	10539	9/04/2010	Marcellus	Water/15% HCl	7487 bbl	Sand	191000#	51.5 bbl/mir
9/5/2010	9378'	9610'	9/04/2010	Marcellus	Water/15% HCI	8758 bbl	Sand	379700#	64 bbl/min
9/6/2010	8728'	9285'	9/05/2010	Marcellus	Water/15% HCI	9810 bbl	Sand	189560#	54.2 bbi/mir
9/7/2010	8078'	8635'	9/05/2010	Marcellus	Water/15% HCI	10441 bbl	Sand	369010#	69,1 bbi/mir
			9/06/2010	Marcellus	Water/15% HCI	9732 bbl	Sand	348380#	64.8 bbl/min
			9/07/2010	Marcellus	Water/15% HCI	8328 bbl	Sand	346360#	67.2 bbl/mir
			9/07/2010	Marcellus	Water/15% HCI	8515 bbl	Sand	381440#	70.5 bbl/min
			9/08/2010	Marcellus	Water/15% HCI	8241 bbl	Sand	380480#	70.2 bbi/mir

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OCT 2 1 2010 DEF, SOUTHWEST REGION OIL & GAS

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			,	Well R	eco	rd and	Comp	letion I	Repo	rt	Client Id			Su	bfacility id
Well Op Anter	erator D Resourc	es Appa	alachian C	Corp.	DE 2	266637	Well API# 37 <u>125-2</u>	(Permit / Reg) 3880-00			Pro	ject Nun	nber		Acres
Address 1625	17 th Street						Well Farm N Hill Unit	lame			'T	Well # 2H	,	Serial	#
City Denve	ər			Stat	Ô	Zip Code 80202	County	ashington		Munic	lpality	West	• Pike	Run	
Phone 303-3	57-7310		Ĩ	Fax 303-3	357-7	315	USGS 7.5 r	nin. quadrangle	e map						
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We	l Type	🛛 Ga	ns l] Oil		mbination	າ Oil & Gອ	s Tini	alelenia ection	l sele			165.91 F		
Drillin	g Method	R	tary - Air			tary - Mu	d		ble Too		<u>ப</u> ல	nraĝe	L		posal
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	Casi	ng and	Tubing		Ce Ce	ement retu Ement retu	irned on s irned on c	urface cas oal protect	ling? tive cas	ina?		s [Г	7 N/A
Hole Size	Pipe Size	Wt.	Thread / Weld	Amount i Well (ft)	1	<i>Materi:</i> Type	al Behind I and Amou	Pipe nt	Packe Typ	er/H e	ardwai Siz	re / Ce. e	ntraliz De	ters oth	Date
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17-1/2"	13-3/8*	48#	STC	485'	_	555	sx Class H								4/2/1
12-1/4"	9-5/8"	36"	LTC	1844'	_	670	sx Class H								4/4/1
					_	170	sx Class H		Cmt P	lug	30	0'	783	2'	4/16/1
8-1/2"	5-1/2"	20#	Buttress	11,624'	Lea	ad 1250 sx	, Tail 670 s	x Class H							5/10/1
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Brone	o Drilling	Compar	ny, Inc.		Scie	ntific Drilli	ng		Ň	me				·	
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Chapter to any contained in the point of	Completion Report has be	ien properiy	caseo and i d in the rer	uamantau II nit for thie w	accordan ell Lemi	ware that there	are significant penalti
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Antero Resources Corporation

Washington County Pennsylvania Hopkins Pad Hill Unit 2H - Slot 2 Directional Pilot Hill Unit 2H

Design: Directional Pilot Hill Unit 2H

Survey Completion Report

17 May, 2010



ANTERO			0016	Survey Com	pletion Repo	ationa. ort	1	5	Scientific Drilling
Company: A Project: V Site: H Well: H Wellbore: D Design: D	ntero Resou /ashington C opkins Pad ill Unit 2H irectional Pil irectional Pil	rces Corpora county Penns ot Hill Unit 21 ot Hill Unit 21	tion yivania i	Local C TVD Re MD Ref North R Survey Databas	to-ordinate Re ference: erence: leference: Caiculation M se:	ference: lethod:	Wəll Hill Uni 2H @ 1175 2H @ 1175. Grid Minimum Cu EDMOKC	It 2H - Slot 2 Oft Oft Irvature	
Project	Washingt	on County Pe	nnsylvania, SV	V Pennsylvania					
Map System: Geo Datum: Map Zone:	Universal T NAD 1927 Zone 17N (ransverse M - Eastern US 84 W to 78 V	ercator (US Su /)	rvey Fee System	n Datum:	-	Mean Sea L	evel	
Site	Hopkins F	ad, Pad Cen	ter			_			
Site Position: From: Position Uncertain	Map n ty:	0.0 ft	Northing: Easting: Slot Radiu	14,5 1,9 s:	59,794.17 _{ft} 27,276.73ft 0"	Latitud Longitu Grid Co	e; ide: onvergence:		40° 5' 17 317 N 79° 58' 27.850 W 0 66 °
Well Well Position Position Uncertair	Hill Unit 2F +N/-S +E/-W hty	1 - Slot 2, 0.0 ft 0.0 ft 0.0 ft	Northin Easting Wellher	g; ; ad Elevation;	14,559,776 3 1,927,287.7 1,175	94 ft 78 ft 0 ft	Latitude: Longitude: Ground Leve)I:	40° 5' 17 140 N 79° 58' 27 710 W 1,155.0ft
Wellbore	Directions	i Pilot Hill Un	it 2H					-	
Magnetics	Model I	Name	Sample Date	e Decl	ination (°)	6)ip Angle (°)	Field S	trength
	IGR	F200510	2009/07	/31	-9.02		67.8	2	53,163
Audit Notes: Version: Vertical Section: .	10	Depth	Phase: From (TVD) (ft) 0.0	ACTUAL +N/-8 (ft) 0 0	Ti ; +	ie On Dep E/-W (ft) 0.0	th:	0 0 Direction (*) 319 82	7
Survey Program - From (ft) 100 0 6,129 0	To (ft) 6,032.0 7,970.0	Date 207 Survey (Wi Survey #1 0 Survey #2 5	10/04/17 Silbore) Gyro (Directiona SDI MWD (Directiona	i Pllot Hill Unit : ctional Pilot Hill	Tool Name KPR-SR-SS SDI MWD		Description SDC Keeper SDI MWD/Ga	- surface ref s/s amma	IN 1 8 2010 JUTHANEST REGIO
Survey ;	<u> </u>								
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300.0 400.0 500.0 600.0 700.0 800.0 900.0 1,000.0		0.84 1 25 1 41 0.89	94.46 120.86 104 26	799.9 899 8 999.8	-1 -2 -2	: 0 :.8	16.7 18.6	-12.3 -14.1	0.63 0.61

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$\begin{array}{cccc} 4,000.0 & 0.37 \\ 4,100.0 & 1.75 \\ 4,200.0 & 0.30 \\ 4,300.0 & 0.34 \\ 4,400 & 0.38 \\ 4,500.0 & 0.39 \\ 4,600 & 0 & 0.42 \\ 4,700.0 & 0.28 \\ 4,800 & 0 & 0.30 \\ 4,900.0 & 1 & 00 \\ 5,000.0 & 0 & 0.33 \\ 5,100.0 & 0.35 \\ 5,200 & 0 & 0.28 \\ 5,300 & 0 & 0.72 \end{array}$		3,900.0	0.4	46
$\begin{array}{ccccc} 4,100.0 & 1 & 75 \\ 4,200.0 & 0 & 30 \\ 4,300.0 & 0.34 \\ 4,400 & 0 & .38 \\ 4,500.0 & 0.39 \\ 4,600 & 0 & 042 \\ 4,700.0 & 0.28 \\ 4,800 & 0 & 030 \\ 4,900.0 & 1 & 00 \\ 5,000.0 & 0 & 33 \\ 5,100.0 & 0.35 \\ 5,200 & 0 & .28 \\ 5,300 & 0 & .72 \\ \end{array}$		4,000.0	0.:	37
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54000 0.74		5,300 0 5 400 0	0. n	12 74

Scientific Drilling International

Local Co-ordinate Reference:

Survey Calculation Method:

N/S

(ft)

-32

-37

-4.2

-4.3

-42

-5.0

-59

-6.1

-6.6

-69

-7.1

-7.6

-77

-79

-8,9

-10.0

-11.3

-12.6

-13.3

-14.0

-14.7

-155

-16.4

-17.3

-18.1

-18.9

-197

-20 3

-21.1

-21.6

-23.2

-24 9

-25.4

-26.0

-26 6

-27 2

-27.7

-28.2

-28 5

-28 7

-29.2

-29.6

-30.2

-31.1

63 7

63 9

64.2

64 2

65 0

66 0

66.3

66 7

67 3

68 2



TVD Reference: **MD Reference:** North Reference:

Database:

1,099 8

1,199 8

1,299.8

1,399 8

1,499.8

1,5997

1,699.7

1,799.7

1,899.7

1,999 7

2,099.6

2,199.6

2,299.6

2,399 6

2,499.6

2,599.6

2,699.5

2.799.5

2,899.5

2,999.5

3,099 4

3,199 4

3,299.4

3,399 4

3,499.4

3,599 4

3,699 4

3,799 4

3,899.4

3,999 4

4,099 3

4,199 3

4,299.3

4,399 3

4,499 3

4,599.3

4,699.3

4,799.3

4,899.3

4,999.3

5,099.3

5,199 3

5.299 3

5,399.3

TVD

(ft)

(azimuth)

108.34

120 06

115 20

84.21

92.70

125.44

95 14

104 98

107 86

94.22

94 73

118.88

77 14

123 33

155.17

117.46

127.52

103.95

139.12

130.09

131 64

125 72

118.72

121 70

118.02

127.82

110.88

127 54

133 61

144.05

154.39

167.62

186.50

209.70

184 73

134.05

184 65

177.34

89.01

159,70

138 53

143 13

126 41

148 04



DLeg (°/100ft)

0.13

0.19

0 07

1 1 1

1.38

Well Hill Unit 2H - Slot 2

V. Sec

(ft)

-15.3

-16.4

-17 5

-187

-19.6

2H @ 1175 Oft 2H @ 1175 Oft

Grid Minimum Curvature

E/W

(ft)

19.9

21.1

22.0

23 9

25 5

EDMOKC

-21 1 1.40 26 8 -23.0 0.93 28.6 -24 1 0.15 30.1 315 -25.4 0 08 0 59 33 5 -26.9 -28 6 0 02 36.0 0.67 -30.3 38.0 1 00 -31.7 40.0 -33.1 1 08 42 0 0.50 43.0 -34.6 44.0 -36.0 0.63 46.1 -38.4 0.80 48.8 -41.1 0.72 50.5 -42.8 1.34 51.2 -43.8 0.17 -44.8 0.05 52.1 -46.1 0.30 53 1 -47 7 0.18 54.5 0.13 -49.3 56.0 0.07 -50.8 574 0.17 58.7 -52.4 0.27 59 9 -537 -55 0 024 61 1 REGION 0.38 62 0 -56.1 2010 62.5 -56.8 0.12 H 1530 111 15 0.17 63.3 -58 6 -60 3 ð 64.1 -60.8 yand 64.1 NN 63.9 -61.1

-61.4

-62.0

-62.6

-63.0

-63.7

-64 5

-65 1

-65.7

-66.5

-67.8

Page 3

COMPASS 5000.1 Build 41

to 35

0.32

0.04

1.04

0.94

0.13

0.07

0 46

0 27

ANTERO RESOURCES			Scientific Drill					
Company: Project: Site: Well: Wellbore: Design:	Antero Resour Washington G Hopkins Pad Hili Unit 2H Directional Pik Directional Pik	ces Co ounty P ot Hill U ot Hill U	rporation ennsylvania nit 2H nit 2H	Local Ço-o TVD Refere MD Refere North Refe Survey Cal Database:	rdinate Reference: once: nce; rence: culation Method:	Well Hill Unit 2 2H @ 1175.0f 2H @ 1175 0f Grid Minimum Curv EDMOKC	2H - Slot 2 t t rature	
Survey								
MD (ft)	inc (°)		Azi (azimuth) (°)	TVD (ft)	N/S (ft)	E/W (ft)	V. Sec (ft)	DLeg (°/100ft)
5,50	0.0	0 68	143.45	5,499.3	-32 2	68 9	-69 0	0.
5,60	00	0.63	150 54	5,599.3	-33 1	69 5	-70.1	0
5,70		0.69	135,50	5,699 3	-34.0	70.2	-71,3	0
5,80	0.0	0 64	129 93	5,799.3	-34.8	710	-72 4	0.
5,90	iu u	0.53	124.04	5,899 2	-35.4	71.8	-73,4	0.
6,00	0 0	0.88	110 33	5,999.2	-36.0	72.9	-74 5	0
6,03	2.0	0 72	120.47	6,031 2	-36 1	73.3	-74.9	Ū.
6,12	9.0	1.10	351.90	6,128.2	-35 5	73 7	-74 7	1.
6,19	3 0	1 80	330 10	6,192.2	-34 0	73.2	-73.2	1.
6,23	10	2 30	332.36	6,230.2	-32.9	72.5	-71.9	1
6.20	4.0	4.00	328 50	6 203 1	-20 0	70.9	20 F	
6.34	9 0	7.30	320 40	6,387.6	-23.3	700 65.2	C 00-	2.
6 45	4.0	9 70	320 70	6481 6	-22 4	58.2	-082	3.
6.57	9.0	12,10	318.10	6,574.8	21	14 F	-40.	2,
6.64	1.0	14 20	314.70	6,635.2	12.3	34 R	-2/ 2	Z.,
0,0-		47.00		0,000.2		04.0	-131	3.
6,73	0.0	17 30	315.40	6,726 6	30.5	16 6	12.6	3.
6,83	1 U	19.50	319.40	6,816 8	52.6	-36	42.5	2
6,92	00	22 70	320.70	6,905.4	78 8	-25 6	767	3.4
7,02	1.0	26 06	319.22	6,991 9	108.8	-50 8	115 9	3.9
7,11	4.0	28 70	320 30	7,074 5	141.5	-78 4	158.7	2.
7,20	90	31.60	318.90	7,156 6	177.8	-109,4	206.4	3.1
7,34	10	32 10	320.05	7,268 8	230 8	-154.6	276 1	0.0
7,43	50	30 42	318 94	7,349.1	267 9	-186 3	324.8	1:
7,52	8.0	29.52	318.86	7,429.7	302.9	-216.8	371.3	0.9
7,62	3.0	29 50	317.33	7,512 3	337.7	-248 1	418 1	0
7 71	8.0	29.07	317 50	7 505 9	371 0	-270 E	464 5	
7 70	99	28 72	317.00	7 888 0	8110	-219,0	464.5	04
330 001			51021	1,000.8	4013	-300.1	ə04.1	00
7 81	3.0	28.67	318.40	7.678 4	406 O	_910 9	510.9	~ ~
7,93	6.7	29 17	319 19	7.786.6	450.0	-340 7	5103	0.0
Onordo	na Taroet 2H	••	0.0.0	.,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	,00 0	-0-07	570.1	0:
7.94	0.0	29 18	319.21	7,789.6	452.2	-350 7	571 B	n 1
7,97	0 0	28 92	318 82	7,815 8	463 2	-360.3	586.3	10
Checked By			Ar	oproved By:	······		Date:	No.
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2010/05/17 10:20	:58AM			Page 4			COMPAS	S 5000 1 Build
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Antero Resources Corporation

Washington County Pennsylvania Hopkins Pad Hill Unit 2H - Slot 2 Horizontal Hill Unit 2H

Design: Horizontal Hill Unit 2H

Survey Completion Report

17 May, 2010



Company: A Project: W	Antero Resources Corporation Washington County Pennsylvania					Local Co-ordinate Reference: Well Hill Unit 2H - Si TVD Reference: 2H @ 1175.0ft				Scientific I	<u>Junu</u> g	
Well: H Well: H Wellbore: H Design: H	opkins Pad ill Unit 2H orizontal Hill U orizontal Hill U	init 2H Init 2H		M N S	MD Reference: 2H @ North Reference: Grid Survey Calculation Method: Minim Detabase			2H @ 1175 Grid Minimum Cu	1 @ 1175 Oft rid mimum Curvature			
Project	Washington	County Pen	nsylvania, SW	Pennsvlv	ania			EDWORC		··· ··· ········		
Map System: Geo Datum: Map Zone:	Universal Tra NAD 1927 - E Zone 17N (84	ansverse Mer Eastern US 4 W to 78 W)	cator (US Surv	ey Fee	System Datum: Mean Sea Level							
Site	Hopkins Pa	d, Pad Cente	r						· · · · · · · · · · · · · · · · · · ·			
Site Position; From: Position Uncertai	Map nty:	0 0 ft	Northing: Easting: Slot Radius	:	14,559, 1,927,	794.17 _{ft} 276.73ft 0"	Latituc Longit Grid C	le: ude: onvergence:		40° 5' 17 79° 58' 27 0 6	317 N 850 W	
Well	Hill Unit 2H	- Slot 2,]	
Well Position Position Uncertair	+N/-S +E/-W nty	0.0 ft 0 0 ft 0 0 ft	Northing Easting: Wellhead	: I Elevatio	n:	4,559,776.3 1,927,287 7 1,175	94 ft 78 ft .0 ft	Latitude: Longitude: Ground Leve):	40° 5' 17. 79° 58' 27. 1,155	140 N 710 W .0 ft	
Weilbore	Horizontal F	-lill Unit 2H								· · · · · · · · · · · · · · · · · · ·]	
Magnetics	Model Na	ame	Sample Date		Declina (°)	tion	I	Dip Angle (°)	Field St (n)	irength F)		
	IGRF2	200510	2009/07/3	31		-9 02		67.8	2	53,163		
Design Audit Notes: Version:	Horizontal H	ill Unit 2H	Phase:	ACT	UAL	т	ie On Der		7 3/1 0			
Vertical Section:		Depth F	rom (TVD)		+N/-S +E/-W Direc			Direction				
			(#) 0 0		(ft) 00	1	(ft) 0.0		(*) 337.50		S	
Survey Program		Date 2010	/05/17			-			· · · · · · · · · · · · · · · · · · ·	2010		
From (ft)	To (ft)	Survey (Well	bore)		To	ol Name		Description	-	1 30	HWES	
100 0 6,129 0 7,435 0	6,032 0 Survey #1 Gyro (Directional Pilot i- 7,341 0 Survey #2 SDI MWD (Directional F 11,624 0 MWD (Horizontal Hill Unit 2H)				illi Unit : KPR-SR-SS iliot Hilli SDI MWD SDI MWD			SDC Keeper - surface ref s/s SDI MWD/Gamma SDI MWD/Gamma		NUL	EP, SOUT	
Survey												
MD (ft)	inc (°)	Azi (az)	imuth) *)	TVD (ft)		N/S (ft)		E/W (ft)	V: Sec (ft)	DLeg (*/100ft)		
100.0).99	98.36	1	0.0	-().1	00	0.0 -04		0.00 0.99	
200.0	1	1 53	89.96	2	00.0	-() 3	3.0	-1 4		0 57	
400.0	1	1,13	92.43 92.79	3	99.9 99.9	-()3	5.3 7 1	-23		0 52	
500.0	1	.30	97.76	4	99.9	-().6	92	-4.1		0.72	
600.0	C	99	96 15	5	99 9	-(8	11.2	-5 0		0 31	
700.0 800 D	0).84 1 25	101.96	6	99 9 00 0	-1	.1	12 8	-5.9		0 18	
900.0	1	41	120 86	8	99.8 99.8	-2	.5 20	14.6 16 7	-68 -83	1	0.43 0.63	
)10/05/17 10 22 17A	M Page 2 COMPASS 500								COMPAS	SS 5000.1 Bu	ild 41	
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1+14 1.44 6 - 14 - 14 - 14												
ANTERO												
RESOLIRO	- 5											

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Scientific Drilling International Survey Completion Report



Proje Site: Well: Wellb Desig	ore: jn:	Vashington County Hopkins Pad Hill Unit 2H Horizontal Hill Unit 2 Horizontal Hill Unit 2	Pennsylvania 2H 2H	TVD Refere MD Refere North Refe Survey Cal Database:	ence: nce: rence: culation Method:	2H @ 1175 Oft 2H @ 1175.Oft Grid Minimum Curv EDMOKC	ature	
Surve	ey							
	MD (ft)	inc (°)	Azi (azimuth) (°)	TVD (ft)	N/S (ft)	E/W (ft)	V. Sec (ft)	DLeg (°/100ft)
	1,000	0 08	9 104.26	999.8	-2.8	18 6	-97	0.6
	1,100	0 0.7	7 108 34	1,099 8	-3.2	19 9	-10 6	0.13
	1,200	0 06	5 120,06	1,199 8	-3.7	21.1	-11.5	0.1
	1,300	0 06	1 115 20	1,299 8	-4 2	22.0	-12 4	0.0
	1,400	0 1.5	9 84.21	1,399.8	-4 3	23 9	-13 2	1.1
	1 500	0 02	1 92 70	1 499 8	-4.2	25 5	-13.6	13
	1,000	0 15	7 125.44	1 599 7	-5.0	26.8	-14 9	1.4
	1,000	0 0.8	7 95.14	1 699 7	-5.9	28.6	-16 4	0.9
	1,700	. U.O	3 104 08	1 799.7	-6.1	30,1	-17 2	01
	1,000	0 00 0 00	n 107.86	1.899.7	-66	31.5	-18 1	0.0
	1,000			4 000 -	<u> </u>	99 F	10.0	
	2,000	0 1.4	2 94 22	1,999.7	-0.9	33.5	-19.2	00
	2,100	.0 1.4	4 9473	2,099 6	-/ 1	30.0	-205	0.0
	2,200	.0 0.9	9 118 88	2,199.0	-7.0	40.0	-210	10
	2,300	.0 1.4	9 77.14	2,299 0	-79	42.0	-23.4	1.0
	2,400	.0 09	4 123 33	2,399.0	-10	42.0	2011	
	2,500	.0 0.7	6 155 17	2,499.6	-8.9	43.0	-24.7	0.5
	2,600	0 10	3 117 46	2,599.6	-10 0	44 0	-26.1	06
	2,700	.0 1.7	9 127.52	2,699.5	-11 3	46.1	-28 1	0.8
	2,800	0 17	2 103 95	2,799 5	-126	48.8	-30.3	12
	2,900	.0 0.5	0 139 12	2,899 5	-13 3	50.5	-31.0	1.3
	3.000	.0 0.6	5 130.09	2,999.5	-14.0	51 2	-32.6	0.1
	3,100	0 06	0 131.64	3,099.4	-14.7	52 1	-33 5	0.0
	3,200	.0 0.	9 125.72	3,199 4	-15 5	53.1	-34 7	03
	3,300	.0 1.0	3 118 72	3,299 4	-16 4	54.5	-36 0	0.1
	3,400	0 0.9	1 121.70	3,399.4	-17.3	56.0	-37.4	0.1
	3 500	0 09	118.02	3,499,4	-18.1	57 4	-38.7	0.0
	3,000	0.000 0.000	9 127.82	3,599,4	-18 9	58.7	-40 0	01
	3 700	0 07	6 110.88	3,699 4	-19.7	59 9	-41 1	0.2
	3,800	0.0	3 127 54	3,799 4	-20 3	61 1	-42.2	0 2
	3,900	0 0.4	6 133 61	3,899 4	-21 1	62 0	-43.2	Z ^{0.3}
				2 000 4	_91 R	62.5	-43.9	
	4,000	.0 0.3	07 144-05 75 454-00	3,899.4 1 000 9	-210	63.3	-45 7	E E
	4,100	.0 1.7	0 104.39	4,055.3	-20 2	64.1	-47.5	ST 2
1	4,200	.0 0.3	SU 107 02	4,155 3	-25 4	64.1	-48.0	രല്പ്പ
ł	4,300	0 03	100.00 00 200.70	4,255 3	-26.0	63.9	-48.5	- Ā
1	4,400	.0 0.	205.10	4,000 0	20.0			<u> </u>
	4,500	0 03	184 73	4,499.3	-26.6	637	-490	æ
	4,600	0 04	12 134.05	4,599.3	-27.2	63.9	-496	۲. The second se
	4,700	.0 0.2	28 184.65	4,699 3	-27 7	64.2	-00.2	LL.
	4,800	0 0.3	30 177.34	4,799 3	-28 2	04.2	-0.00	11
1	4,900	0 1.0	0 89 01	4,899.3	-28.5	000	~01.Z	
	5,000	.0 0.3	33 159 70	4,999.3	-28.7	66 0	-51 8	01
1	5,100	.0 0 3	35 138.63	5,099.3	-29 2	66.3	-52.4	0.1
	5,200	0 02	28 143.13	5,199.3	-29 6	66.7	-52 9	0.0
	5,300	.0 0.3	72 126 41	5,299 3	-30 2	67 3	-53.7	0.
	5,400	.0 0.1	74 148 04	5,399 3	-31 1	68.2	-54.8	0.:

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ANTERO	

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Scientific Drilling International Survey Completion Report



Project: Site: Well: Wellbore: Design:	Washington County Hopkins Pad Hill Unit 2H Horizontal Hill Unit : Honzontal Hill Unit :	r Pennsylvania 2H 2H	TVD Refer MD Refere North Refe Survey Ca Database:	ence: once: erence: lculation Method:	2H @ 1175.01 2H @ 1175.01 Grid Minimum Cun EDMOKC	t t vature		
Survey								
MD (ft)	inc (°)	Azi (azimuth) (°)	TVD (ft)	N/S (ft)	E/W (ft)	V. Sec (ft)	ן (°/	OLeg (100ft)
5,5	00 0 0.6	8 143.45	5,499.3	-32.2	68.9	-56,1		0
5,6	0.0 0.6	3 150.54	5,599 3	-33.1	69.5	-57 2		0
5,7	000 06	9 135.50	5,699.3	-34.0	70 2	-58.3		0
5,8	000 06	4 129.93	5,799.3	-34.8	71 0	-59.3		0.0
5,9	000 0.5	3 124.04	5,899.2	-35 4	71 8	-60.2		0.1
6,0	00.0 0.8	8 110.33	5,999,2	-36 0	72.9	-61 1		0 :
6,0	32.0 0.7	2 120.47	6,031.2	-36.1	73 3	-61 5		0.6
6,1	29.0 1.1	0 351.90	6,128 2	-35.5	73.7	-61 0		1.5
6,1	93 0 1.8	0 330 10	6,192 2	-34.0	73.2	-59.4		1.3
6,2	310 23	0 332.36	6,230.2	-32 9	72 5	-58.1		1.3
6.2	940 40	0 328.50	6 293 1	-20 Q	70.8	-64 7		· ·
6.3	89.0 73	0 320.40	6 387 6	-23 3	65.2	-04.7		21
6.4	84.0 97	0 320 70	6,481.6	-11.5	56.3			21
6.5	79 0 12.1	0 318.10	6.574.8	2.1	44.5	-15.1		24
6,6	41.0 14.2	0 314.70	6,635.2	12.3	34.8	-2.0		3.6
6.7	260 173	0 915.40	6 706 6	00 E				
6,7	310 175	0 31540	6 9 16 9	30 5	10.0	218		32
0,0 A Q	260 227	0 32070	8 905 4	78.8	-0.0	500		2.0
7.0	210 260	6 31922	6 991 9	108.8	-20 0	120.0		3,4
7,1	14.0 28.7	0 320 30	7.074 5	141 5	-38.4	160.7		28
7.0		o 040.00	7450.0	477.0	101			2.
7,20	14.0 31.0	0 318.90	7,156.6	1/7 8	-109 4	206 1		3.1
7,34	410 J21	0 320,05	7,268.8	230 8	-154.6	272 4		0.6
7,4	30.0 30.4 39 0 50 50	2 310.94	7,349,1	207.9	-160.3	318 8	1	1.6
7,5	200 29.5	3 319.00	7,429.7	202.9	-210.0	302.6		0.9
T. B.	200 200	5 510,07	7,450,5	303.2	-2172	303.3		1.0
TUNY								
7,6	12.0 30 1	9 320.02	7,502.5	334 6	-244 0	402.5		10
7,64	40 3274	4 322 16	7,529 8	347 6	-254.5	418.6		8.7
7,6	60 34.9	2 322.28	7,556.4	361.7	-265.4	435 8		₹ ^{6.8}
7,70	180 37.0	8 322,75	7,582.3	376.6	-276 9	453.9	0	8 68
1,14	402	/ 323.47	7,607 3	392.6	-288 9	473.3	01	臣 10.0
7,77	71.0 44 3	7 324.76	7,630 2	409 5	-301 1	493,6	~	5.8.5
7,79	97.0 47.7	5 325 49	7,648.2	424.9	-311.8	511 9	æ	₩8.1
7,83	34.0 52.32	2 327 98	7,672 0	448.6	-327.3	539.7	Annual (E Q 3
7,84	110 53.2	2 328 42	7,676.2	453.3	-330 3	545.2	Ę	
Marcelli	US						=	ō,
7,86	6 0 56.4	5 329,91	7,690.6	470.9	-340.7	565.4		员13.8
7,89	3.0 59.96	3 331 63	7,704 8	490 9	-351.9	588.2		 14.0
7,89	95.9 60 28	8 331.71	7,706.3	493 1	-353.1	590 7		11.4
Landing	Pt 2H							
7,92	29 0 63.98	3 332.62	7,721.8	519.0	-366 8	619,9		11 4
7,96	68.19	9 332.86	7,734.7	545.0	-380.2	649.0		13,1
7,98	37.0 71.79	332 60	7,743 6	566 7	-391 4	673 3		13 8
8.02	4.0 73 76	3 332 84	7,754.6	598.1	-407.6	708.6		53
8.05	6.0 73.9	5 333 16	7 763 5	625 5	-421 5	739.2		1 1
8,05	56.0 73.9t	5 333 16	7,763 5	625 5	-421 5	739.2		1.

Company: Project: Washington County Pennsyvaria Hotochina Pad Best: Hotochina Pad Hotochina	ANTERO RESOURCES			Scier	itific Drilling Survey Comple	International tion Report		9 :	Scientific Drillin				
Survey ND Inc Act (azimuth) TVD N/S E/W V. Sec DLog 8,082.0 76.04 333.56 7.770.2 648.0 -432.8 764.3 8.1 8,1180 79.95 333.40 7.777.6 679.5 -448.5 779.4 105.2 8,176.0 82.99 333.61 7.785.9 730.8 -474.1 886.6 2.25 8,217.0 81.5 333.89 7.795.0 705.7 91.03 883.3 0.9 8,245.0 85.93 333.44 7.793.6 792.4 -564.2 1.049.9 2.8 8,367.0 89.50 335.70 7.796.6 878.1 -564.2 1.049.9 1.3 8,451.0 89.26 336.52 7.797.9 988.7 -564.2 1.049.8 0.0 8,557.0 90.30 335.67 7.797.4 988.7 -564.3 1.442.8 0.7 8,6410 89.23 336.82 7.797.4 1.422.9 -470.0	Company: Project: Site: Well: Wellbore: Design:	Antero Washi Hopkir Hill Un Horizo Horizo	Resources Con ngton County P is Pad it 2H ntal Hill Unit 2H ntal Hill Unit 2H	poration ennsylvania	Local Co-o TVD Refer MD Refere North Refe Survey Ca Database:	ordinate Reference: ence: nce: rence: lculation Method:	Well Hill Unit 2 2H @ 1175.0ft 2H @ 1175 0ft Grid Minimum Curv EDMOKC						
HD Inc Actication th (%) TVD N/S E/W V.Sec (%) D.Les (%) 8,082.0 76.04 333.56 7.770.2 648.0 -432.8 744.3 8.1 8,118.0 79.95 333.40 7.777.7 679.5 -448.5 794.4 10.8 8,176.0 82.99 333.81 7.782.5 700.8 -474.1 886.6 2.25 8,176.0 82.99 333.84 7.785.0 730.8 -474.1 886.6 2.55 8,245.0 85.90 333.94 7.795.0 815.7 -515.7 951.0 10.6 8,347.0 89.50 335.70 7.796.9 902.7 -565.2 1.046.9 1.3 8,435.0 89.94 335.870 7.797.9 988.7 -594.3 1.140.8 0.6 8,610 89.96 336.57 7.798.3 1.076.8 -632.7 1.239.8 1.140.8 8,610 89.47 336.63 7.797.1 1.249.8 -7064 <	Survey												
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b c,r100 b c,r000 r/1904 r/000 r/000 <thr 000<="" th=""> r/0000 r/00</thr>	8,176	0	82 99	333.61	7,785.9	730 8	-4/4.1	855 6	2.5				
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5,500,0 55,60,0 55,65,7 7,750,0 2,550,5 -1,77,6 2,659,5 0.3 10,075,0 89,97 338 17 7,798,3 2,479,0 -1,213 4 2,754,6 0.3 10,075,0 89,97 337,58 7,798,3 2,656,2 -1,248,5 2,848,6 0.2 10,254,0 90,20 337,53 7,797,8 2,654,1 -1,224,4 2,943,6 0.2 10,254,0 90,74 337,49 7,797,1 2,741,9 -1,320,8 3,038,6 0.4 10,548,0 88,69 337,96 7,796,9 2,828,9 -1,356,3 3,132,6 0.4 4 10,548,0 88,69 337,56 7,800,4 3,004,9 -1,424,4 3,427,6 0.5 <td< td=""><td>9,885</td><td>0</td><td>89.73</td><td>331.21</td><td>1,181.4 7 709 0</td><td>2,000 1</td><td>-1,141.0</td><td>2,004.0</td><td>0.3</td></td<>	9,885	0	89.73	331.21	1,181.4 7 709 0	2,000 1	-1,141.0	2,004.0	0.3				
10,075.0 89.97 338 17 7,798.3 2,479.0 -1,213.4 2,754.6 6 0.4 10,075.0 90.17 337.96 7,798.1 2,566.2 -1,248.5 2,848.6 0 0 0.4 0.169.0 90.17 337.96 7,798.1 2,566.2 -1,248.5 2,848.6 0 0.2 10,264.0 90.20 337.53 7,797.8 2,654.1 -1,284.4 2,943.6 0 0 0 4 4 4,943.6 0 0 0 0 0 303.6 0 0 4 4 4,943.6 0 0 0 0 0 3,038.6 0 0 4 </td <td>9,980</td> <td>.0</td> <td>99.00</td> <td>331,03</td> <td>1,190.0</td> <td>2,390 9</td> <td>-1,177 0</td> <td>2,008.0</td> <td></td>	9,980	.0	99.00	331,03	1,190.0	2,390 9	-1,177 0	2,008.0					
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$10,3590$ 90.74 337.49 $7,797.1$ $2,741.9$ $-1,320.8$ $3,038.6$ ∞ $50.836.5$ $10,453.0$ 89.50 338.02 $7,796.9$ $2,828.9$ $-1,356.3$ $3,132.6$ ∞ $50.856.3$ $10,548.0$ 88.69 337.96 $7,798.4$ $2,916.9$ $-1,391.9$ $3,227.6$ ∞ $50.856.3$ $10,643.0$ 88.86 337.65 $7,600.4$ $3,004.9$ $-1,427.8$ $3,322.6$ ∞ $50.836.3$ $10,738.0$ 89.16 337.51 $7,802.0$ $3,092.7$ $-1,464.0$ $3,417.5$ $0.336.26$ ∞ $3,512.5$ $0.556.3$ $10,833.0$ 89.36 337.08 $7,803.3$ $3,180.3$ $-1,500.7$ $3,512.5$ $0.556.3$ $10,928.0$ 89.33 336.50 $7,804.3$ $3,267.6$ $-1,538.1$ $3,607.5$ $0.66.367.5$ $11,022.0$ 89.60 336.33 $7,805.2$ $3,353.8$ $-1,575.8$ $3,701.5$ $0.371.5$ $11,117.0$ 89.83 336.46 $7,805.7$ $3,440.8$ $-1,613.8$ $3,796.5$ $0.29.65.3$ $11,211.0$ 89.96 336.36 $7,806.7$ $3,527.0$ $-1,651.4$ $3,890.5$ $0.99.65.4$ $11,400.0$ 87.65 336.79 $7,814.6$ $3,700.3$ $-1,726.4$ $4,079.3$ $0.88.64.21.36.66$ $11,494.0$ 87.01 337.29 $7,819.0$ $3,786.7$ $-1,763.0$ $4,173.1$ $0.88.64.21.36.66.76.76.76.76.76.76.76.76.76.76.76.76$	10,264	10	90.20	337 53	7,797.8	2,654.1	-1,284 4	2,943.6	07 80 80 80				
10,453.0 8950 338.02 $7,7969$ $2,8289$ $-1,356.3$ $3,132.6$ 54 $10,548.0$ 88.69 337.96 $7,798.4$ $2,916.9$ $-1,391.9$ $3,2276$ 56 $10,6430$ 8886 337.56 $7,8004$ $3,004.9$ $-1,427.8$ $3,322.6$ 56 $10,6430$ 8886 337.56 $7,8004$ $3,004.9$ $-1,427.8$ $3,322.6$ 56 $10,6330$ 89.16 337.51 $7,8020$ $3,092.7$ $-1,464.0$ $3,417.5$ 60.3 $10,833.0$ 89.36 337.06 $7,802.3$ $3,180.3$ $-1,5007$ $3,512.5$ 0.5 $10,928.0$ 89.33 336.50 $7,6043$ $3,2676$ $-1,538.1$ $3,607.5$ 0.6 $11,0220$ 89.60 33633 $7,805.2$ $3,3538$ $-1,575.8$ $3,7015$ 0.3 $11,1170$ 89.83 336.46 $7,8057$ $3,440.8$ $-1,613.8$ $3,7965$ 0.2 $11,2110$ 89.86 336.36 $7,8067$ $3,527.0$ $-1,651.4$ $3,8905$ 0.9 $11,306.0$ 8691 336.66 $7,8101$ $3,6140$ $-1,689.3$ $3,985.4$ 21 $11,494.0$ 87.01 337.29 $7,814.6$ $3,700.3$ $-1,726.4$ $4,079.3$ 0.8 $11,494.0$ 87.01 337.29 $7,819.0$ $3,786.7$ $-1,763.0$ $4,173.1$ 0.8	10,359	0	90 74	337 49	7,797 1	2,741 9	-1,320.8	3,038.6	ര ല്ല്				
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	10,453	3.0	89 50	338.02	7,796 9	2,828 9	-1,356.3	3,132.6	≩ 2 4				
$10,643.0$ 88.86 337.65 $7,800.4$ $3,004.9$ $-1,427.8$ $3,322.6$ \bigcirc \bigcirc \bigcirc 0.3 $10,738.0$ 89.16 337.51 $7,802.0$ $3,092.7$ $-1,464.0$ $3,417.5$ \bigcirc 0.3 $10,833.0$ 89.36 337.08 $7,803.3$ $3,180.3$ $-1,500.7$ $3,512.5$ \bigcirc 0.5 $10,928.0$ 89.33 336.50 $7,604.3$ $3,267.6$ $-1,538.1$ $3,607.5$ 0.6 $11,022.0$ 89.60 336.33 $7,805.2$ $3,353.8$ $-1,575.8$ $3,701.5$ 0.3 $11,117.0$ 89.83 336.46 $7,805.7$ $3,440.8$ $-1,613.8$ $3,796.5$ 0.2 $11,211.0$ 68.96 336.36 $7,806.7$ $3,527.0$ $-1,651.4$ $3,890.5$ 0.9 $11,306.0$ 86.91 336.66 $7,810.1$ $3,614.0$ $-1,689.3$ $3,995.4$ 2.1 $11,400.0$ 87.65 337.29 $7,818.0$ $3,786.7$ $-1,763.0$ $4,173.1$ 0.8 $11,494.0$ 87.01 337.29 $7,819.0$ $3,786.7$ $-1,763.0$ $4,173.1$ 0.8	10,548	3.0	88.69	337.96	7,798.4	2,916.9	-1,391.9	3,227 6	z 58				
10,738 0 89.16 337.51 7,802 0 3,092.7 -1,464.0 3,417.5 0.3 10,833.0 89.36 337.08 7,803.3 3,180.3 -1,500 7 3,512 5 0.5 10,928.0 89.33 336.50 7,804 3 3,267 6 -1,538.1 3,607.5 0.6 11,022 0 89.60 336 33 7,805.2 3,353 8 -1,575.8 3,701 5 0.3 11,117 0 89.83 336.46 7,805 7 3,440.8 -1,613.8 3,796 5 0.2 11,211 0 88.96 336.36 7,806 7 3,527.0 -1,651.4 3,890 5 0.9 11,306.0 86 91 336.66 7,810 1 3,614 0 -1,689.3 3,985 4 2 1 11,400 0 87 65 336.79 7,818.0 3,786.7 -1,763.0 4,173.1 0.8 11,494.0 87.01 337.29 7,818.0 3,786.7 -1,763.0 4,173.1 0.8	10,643	30	88 86	337.65	7,800 4	3,004.9	-1,427.8	3,322.6	2 8 0.3				
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11,022 0 89.60 336 33 7,805.2 3,353 8 -1,575.8 3,701 5 0.3 11,117 0 89.83 336.46 7,805 7 3,440.8 -1,613.8 3,796 5 0.2 11,211 0 88.96 336.36 7,806 7 3,527.0 -1,651.4 3,890 5 0.9 11,306.0 86 91 336.66 7,810 1 3,614 0 -1,689.3 3,985.4 21 11,400 0 87 65 336.79 7,814.6 3,700.3 -1,726.4 4,079.3 0.8 11,494.0 87.01 337.29 7,819.0 3,786.7 -1,763.0 4,173.1 0.8	10,928	0.0	89.33	336.50	7,804 3	3,267 6	-1,538.1	3,607.5	0.6				
11,117 0 89,83 336,46 7,805 7 3,440.8 -1,613.8 3,796 5 0.2 11,211 0 88,96 336,36 7,806 7 3,527.0 -1,651.4 3,890 5 0.9 11,306.0 86 91 336,66 7,810 1 3,614 0 -1,689.3 3,985.4 2.1 11,400 0 87 65 336.79 7,814.6 3,700.3 -1,726.4 4,079.3 0.8 11,494.0 87.01 337.29 7,819.0 3,786.7 -1,763.0 4,173.1 0.8	11 022	0	89.60	336 33	7,805,2	3.353 8	-1.575.8	3,701 5	0.3				
11,211 0 86.96 336.36 7,806 7 3,527.0 -1,651.4 3,990 5 0.9 11,206.0 86 91 336.66 7,810 1 3,614 0 -1,689.3 3,985.4 2.1 11,400 0 87 65 336.79 7,814.6 3,700.3 -1,726.4 4,079.3 0.8 11,494.0 87.01 337.29 7,819.0 3,786.7 -1,763.0 4,173.1 0.8	11 117	0	89.83	336.46	7.805 7	3,440.8	-1.613.8	3.796 5	0.2				
11,306.0 86 91 336.66 7,810 1 3,614 0 -1,689.3 3,985.4 21 11,400 0 87 65 336.79 7,814.6 3,700.3 -1,726.4 4,079.3 0.8 11,494.0 87.01 337.29 7,819.0 3,786.7 -1,763.0 4,173.1 0.8	11 911	õ	88.96	336.36	7.806 7	3,527.0	-1,651.4	3.890 5	09				
11,400 0 87 65 336.79 7,814.6 3,700.3 -1,726.4 4,079.3 0.8 11,494.0 87.01 337.29 7,819.0 3,786.7 -1,763.0 4,173.1 0.8	11,304	1.0	86.00	336 66	7.810 1	3,614 0	-1,689.3	3.985.4	21				
11,494.0 87.01 337.29 7,819.0 3,786.7 -1,763.0 4,173.1 0.8	11,400	0	87 65	336.79	7.814.6	3,700.3	-1,726.4	4,079.3	0.8				
	11 4 94	.0	87 01	337.29	7.819.0	3,786.7	-1,763.0	4.173.1	0.8				
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ANTERO	XCES.			So	ientific Surv	c Drilling ey Comple	International tion Report	I		cientific Drilli
Compar Project: Site: Well: Wellbor Design:	e:	Antero Ro Washingi Hopkins I Hill Unit 2 Horizonta Horizonta	esources Con ton County P Pad 2H al Hill Unit 2H al Hill Unit 2H	rporation ennsylvania		Local Co- TVD Refer MD Refere North Refe Survey Ca Database:	ordinate Reference: ence: nce: prence: lculation Method:	Well Hill Unit 2 2H @ 1175 0f 2H @ 1175 0f Grid Minimum Cun EDMOKC	2H - Slot 2 t t vature	
Survey I	MD (ft) 11,575 11,624 erminus	0 0 TGT Hill	Inc (*) 87 28 87 28 Unit 2H	Azi (azimuth) (°) 337.24 337.24	T\ (f	/D *) 7,823.0 7,825.3	N/8 (ft) 3,861.3 3,906 5	E/W (ft) -1,794.2 -1,813 2	V. Sec (ft) 4,254 0 4,303 0	DLeg (°/100ft) 0 3 0 0
Design .	Annotat Me	ions assured Depth (ft) 7,529 0 7,841.0	Vertical Depth (ft) 7,430. 7,676	Loc +N/-3 (ft) 5 303 2 453	al Coordii .2 3	nates +E/-W (ft) -217 2 -330.3	Comment Tully Marcellus			
Checke	ed By:				Approv	ed By:			Date:	
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010/05/17	10.22:1	7.AM				Page 6			COMPASS	5000 1 Build 4
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\sim	DEMANDER	- LATERSWEET	N N	Vell Re	cor	d and	Compl	etion F	Report	Clie	ent kl		Sut	ofacility kig
Well Ope	rator Resource	es Appal	achian C	orp.	DEP 26	^{1D#} 66637	Well API#(F 37 <u>125-23</u>	/ermit / Reg) 880-00	201A/E	<u>и —</u>	Project	t Number		Acres
Address 1625	7 th Street				_ <u>_</u>	- ·····	Well Farm Na Hill Unit	me			W	ଶା# 2H	Serial	#
City Denve				State CC		ip Code 80202	County	shington	м	unicipal	W	est Pike	Run	
Phone 303-3	57-7310			Fax 303-35	57-73 [,]	15	USGS 7.5 m Californ	in. quadrangk Ia	e map	• .				
Check	all that apply	r. ⊠.(i Original Wel	Record	🗋 Orig	inal Com	pletion Report		ended Well	Record	1 🗆	Amende	d Compl	etion Report
	1995 (sv. 46) 1995 (sv. 46)		William I.		Y		(ରାହା)	Anisis e entre	gitalita hita	1.0.0) 0	p i si s	. ALUDAN		5 (a. 69 st 29
Wel	I Type Method	Ga M Ro	s 🗌		Cor	nbinatio arv M	n Oil & Gas ud		ection	L	j Stora	age		sposal
Date Dril	ing Started 3/29/2010		Date Drillin 5/	Completed	3100	Surface E	levation 1196' ft	Tota	Depth - Dril 11.624	ler MD	ft.	Total De	pth - Log .583' N	ger #D ft.
	Casi	ng and	Tubing		Cer	ment ret	urned on su	inface cas	sing?	107 X	Yes		lo Io [
Hole	Dine Sine	14/4	Thread /	Amount in		Mater	ai Behind F	lipe	Packer	/ Har	dware	/ Centra	lizers	Date
24"	20"	133#	STC	40'	1	10 ^p	9 sx Class H	<u>n</u>	1 1920		0120			3/30/10
7-1/2*	13-3/8"	48#	STC	485'	<u> </u>	55	5 sx Class H							4/2/10
2-1/4"	9-5/8"	36"	LTC	1844'		67	0 sx Class H					·		4/4/10
3-1/2"	5-1/2"	20#	Buttress	11.624'	Lea	17 Id 1250 s	0 sx Class H	x Class H	Cmt Pl	ug	300		832	5/10/10
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	Pertorati	Interval P	erforated					F	luid	P	roppin	g Agen	, A	werage
Dat	Ð	From	То	Dat	le l	Interv	al Treated	Type Amou		mount Type		<u>e Amount Inje</u>		ction Rate
								SEP 2	<mark>3 2010</mark>			IN 1 9	2010	
							DE	SOUTHW	EST REGIO	NC	DEP.	BOUTHW	EST REC	3ION
Natural ()pen Flow		· _ ·			Nat	ural Rock		I		н	OIL &		Davs
After Tre Flow	atment Open					Afte	r Treatment x Pressure				_/	lours	~	Days
Well S	Service Co	ompani	es Provi	de the name,	, addre: Name	ss, and pl	hone number (of all well se	rvice comp	anies li ame	nvoived	. <u>~</u> ξ	CEI	VED
Bror Address 162	ICO Drilling	Compa Ave	any, Inc.		Scie Address 421	South F	ruung Eadle Lane			ddress	Den	SEP	142	
City - Su Edn	ie - Zip iond, OK 7	3013			City - St Okla	ate - Zip ahoma (City, OK 73	128	c	ity - Sta	e-Zipc	of Enviro	mental	×
Phone 405	562-4128			1	Phone 405	-787-36	63		P	hone		~	istrict O	mce (
							-1-							

		LOG OF	FORMA	TIONS	Well API#	: 37- <u>125</u> - <u>23880-00</u>
(If you wil	l need more sp I	ace than this pa	ge, please pho	tocopy the blar	k form before filling i	(in.)
Formation Name or Type	Top	Bottom	Gas at	Oil at	Water at	
Sand and Shale (TVD)	7227'	7506'	(Teet)	(teet)	(fresh / brine; ft.)	Source of Data
Shale	7506	7520'				MWD Gamma Ray
Limestone	7520	7500				MWD Gamma Ray
Sand and Shale	7500	7000				MWD Gamma Ray
Shale	7000	7810				MWD Gamma Ray
Limestone	7010	7969.				MWD Gamma Ray
Linestone	1909.	8019	1			Mudlogging/Lithologi
Horizontal Marcellus Top	7841'	MD				Sample Description
TD (Measured Depth)		11624'				
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				SEP 23	2010	PEOION
			[•	DEP	SOUTHWEST HEGIOT
	F	Í	DE	P. SOUTHWES	THEOION	OIL & Gro
l			1	OIL&G	~	
do hereby certify to the best Completion Report has been	of my know	ledge, inform	nation and b	ellef that the	e well identified	on this Well Record a
Chapter 78 and any conditions submitting false information, inc	contained i contained i	n the permit ossibility of f	for this well ine and imp	l. I am awa risonment.	with the require re that there are	ements of 25 Pa. Co significant penalties f
Wall Sparshor's Managemer					DEP USF	ONLY
ashlii Mihalcin	Deter		Revie	wood by:	4	9/20/m
Permit Representative	Date: 6/15/20)10	Comm	nents:		1-11-1
			<u> </u>		······································	

	DEPARTMENT OF ENVIRON	MENTAL PROTECTION	OIL	AND GAS MANAGEMENT P	ROGRAM	/	Site ID Primary Fac 1			
Ame	nded	W	ell Rec	ord and Comple	tion Re	port	Client Id		Subfacility ld	
Well Operate Antero R Address	esources App	balachian Corr	<u>></u>	DEP ID# Well API # (Pe 266637 37 <u>125-238</u> Well Farm Nan	rmit / Reg) 79-00 ie		Project	Number	Acres	
City Denver			State CO	Zip Code County 80202 Was	hington	Muna	cipality W	3H /est Pike F	Run	
Phone 303-357-	7310	Fax	303-357-	7315 USGS 7 5 min Californi	quadrangle ma 3	эp				
Check all 1	that apply [] Original Well R	acord 🔯	Original Completion Report	Amend	ed Well Re	cord 🔲	Amended C	ompletion Report	
			W	alleracord)	socomple	te the so	enoratione	ations of	heidek (Georgi 2))	
Well T	ype 🔲 🤇	Bas □O	4C	Combination Oil & Gas	🗌 Inject	ion	Stora	ge 🗋	Disposal	
Drilling N Date Dniling	Method F Started	Rotary – Air Date Drilling Co	ompleted	Rotary – Mud Surface Elevation ft	Cable	e Tool pth - Driller	ft	Total Depth	- Logger ft	
	Casing an	d Tubing		Cement returned on sur	face casing	y? a caeing?				
Hole		Thread / A	mount in	Material Behind Pi		Packer / F	lardware /	Centralize	ers Date	
Size Pi	ipe Size Wt	Weld	<u>/Vell (ft)</u>	Type and Amount		Type	Size	Dep	th Run	
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			MARC	OM THE MIONTRIE	120 RTR					
P	erforation Re	cord	and the second s		Stimulatio	n-Recor	d			
Data	Interval	Perforated	Data	Internal Tracted	Flui Type	id Amount	Proppin Type	g Agent	Average	
Dára	Please see	Attachment	Date	Please see Attachment	Type	Anount	туре	Amount	injection Rate	
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Natural Oper	n Flow			Natural Rock Pressure			Hou	ns	Days	
Natural Oper After Treatme Flow	n Flow ent Open			Natural Rock Pressure After Treatment Rock Pressure			- Hou Hou	irs	Days Days	
Natural Oper After Treatm Flow Well Ser	ent Open vice Compar	ies Provide ti	ie name, add	Natural Rock Pressure After Treatment Rock Pressure dress, and phone number of a	all well service	companie	Hou Hou s involved	irs	Days Days	
Natural Oper After Treatm Flow Well Ser Name Cal Fra Address	ent Open vice Compar	lies Provide ti ps Corp	1e name, add	Natural Rock Pressure After Treatment Rock Pressure dress, and phone number of a ess	all well service	companie Name Xddrass	Hou Hou s involved	ITS	Days Days	
Natural Oper After Treatme Flow Well Ser Name Cal Fra Address 717 171 City - State Denver	ent Open vice Compar to Well Servic th Street, Suit ² p , CO 80202	lies Provide ti es Corp e 1445	1e name, add Name Addri City	Natural Rock Pressure After Treatment Rock Pressure dress, and phone number of a ess State – Zip	all well service	Companie Name Xddras City - S	Hou Hou s involved s =	ITS ITS	Days Days	

Hill Unit 3H (API# 37-125-23879-00) Antero Resources Appalachian Corporation

Perfo	ration Red	cord			Stimulatio	n Record			
Date	Interval P From	Perforated To	Date	Interval Treated	Fluid Type At	nount	Propp Type	<i>ing Agent</i> Amount	Average Injection Rate
7/30/2010	12708	12940'	8/26/2010	Marcellus	Water/15% HCI	6313 bbl	Sand	1694#	12.7 bbl/min
8/27/2010	12054'	12613'	8/27/2010	Marcellus	Water/15% HCI	10081 bbl	Sand	111000#	62.8 bbl/min
8/28/2010	11400'	11959'	8/28/2010	Marcellus	Water/15% HCI	9567 bbl	Sand	384300#	70 bbl/min
8/29/2010	10746'	11305'	8/28/2010	Marcellus	Water/15% HCI	8861 bbl	Sand	286285#	64.3 bbl/min
8/30/2010	10092'	10651'	8/29/2010	Marcellus	Water/15% HC!	9010 bbl	Sand	276920#	68 bbl/min
9/2/2010	9765'	9997'	8/29/2010	Marcellus	Water/15% HCI	7313 bbl	Sand	350025#	55.6 bbl/min
9/4/2010	9438'	9670'	8/30/2010	Marcellus	Water/15% HCl	8790 bbl	Sand	368100#	64.8 bbl/min
9/5/2010	9111'	9343'	8/30/2010	Marcellus	Water/15% HCI	8730 bbl	Sand	385160#	55.9 bbl/min
9/6/2010	8457'	9016'	8/30/2010	Marcellus	Water/15% HCI	6870 bbl	Sand	10000#	62 3 bbl/min
9/7/2010	8130'	8362'	9/04/2010	Marcellus	Water/15% HCI	9659 bbl	Sand	391200#	61.8 bbl/min
			9/05/2010	Marcellus	Water/15% HCI	8992 bbl	Sand	312330#	58.5 bbl/min
	~		9/06/2010	Marcellus	Water/15% HCI	10255 bbl	Sand	115480#	55 bbi/min
			9/06/2010	Marcellus	Water/15% HCI	9220 bbl	Sand	377940#	69.7 bbl/min
h #-		<u> </u>	9/07/2010	Marcellus	Water/15% HCI	8463 bbl	Sand	381630#	70.2 bbl/min
			9/08/2010	Marcellus	Water/15% HCI	7840 bbl	Sand	384060#	68.8 bbl/min

OCT 2 1 2010 DEP, SOUTHWEST REGION OIL & GAS

ANTERO RESOURCES		'\		Scienti Sui	fic Drilli vey Repor	ng Internat t Geographi	c c	6	Scientific Drillin
Company: Project: Site: Well: Wellbore: Design:	Antero Resources Corporation Washington County Pennsylvania Hopkins Pad Hill Unit 3H Horizontal Hill Unit 3H Horizontal Hill Unit 3H				Local C TVD Rei MD Refe North R Survey (Databas	o-ordinate Refer ference: erence: eference: Calculation Metf e;	rence: We WE WE Grid nod: Min ED	II Hill Unit 3H - Slot 3 ELL @ 1196 Oft (Original \ ELL @ 1196 Oft (Original \ J Imum Curvature MOKC	Vell Elev) Vell Elev)
Survey			-						
Measured Depth (ft)	Inclination (°)	Azimuth (°)	Vertical Depth (ft)	+N/-S (ft)	+E/-W (ft)	Map Northing (ft)	Map Easting (ft)	Latitude	Longitude
10,654 (87 01	336 71	7,809 5	3,323 6	-826 6	14,563,128 86	1,926,451	97 40° 5' 50 374 N	79° 58' 37 970 W
10,844 (86 91	336 45	7,818 9	3,410 5	-864 6 -902 8	14,563,215 81	1,926,413	98 40° 5' 51 238 N	79° 58' 38 446 W
10,938 0	86 30	336 44	7,824 5	3,583 4	-940 3	14,563,388 68	1,926,338	30 40° 5' 52 955 N	79° 58' 39 395 W
11,032 (86 34	335 97	7,830 5	3,669 2	-978 1	14,563,474 51	1,926,300	45 40° 5' 53 808 N	79° 58' 39 869 W
11,127 0	60 47 86 20	336 28	7,836 5	3,726 7 3,755 9	-1,003 8 -1,018 7	14,563,531 94	1,926,274	84 40° 5' 54 378 N	79° 58' 40 190 W
11,190 0	86 81	336 69	7,840 4	3,813 5	-1,041 8	14,563.618 80	1,926,201	52 40° 5° 54 668 N 83 40° 5' 55 241 N	79° 58' 40 352 W
11,221 0	86 64	336 92	7,842 2	3,842 0	-1,054 0	14,563,647 25	1,926,224	64 40° 5' 55 524 N	79° 58' 40 819 W
11,316 0	87 21	337 26	7,847 3	3,929 4	-1,090 9	14,563,734 63	1,926,187	71 40° 5' 56 392 N	79° 58' 41 282 W
11,505 0	87 45	337 12	7,855.3	4,017.0	-1,127.2 -1,163.2	14,563,822 32	1,926,151	41 40° 5' 57 263 N	79° 58' 41 736 W
11,578 0	88 62	337 64	7,857 8	4,171 1	-1,191 3	14,563,976 40	1,926,087	33 40° 5' 58 793 N	79° 58' 42 538 W
11,600 0	88 92	337 33	7,858 3	4,191 4	-1,199 7	14,563,996 72	1,926,078	91 40° 5' 58 995 N	79° 58' 42 643 W
11,757 0	89 40	337 20	7.861 0	4,278 1 4.336 1	-1,236.2	14,564,083 34	1,926,042,	44 40° 5' 59 855 N	79° 58' 43 100 W
11,789 0	89 87	337 19	7,861 2	4,365 6	-1,273 1	14,564,170 87	1,926,005	53 40°6'0725 N	79° 58' 43 407 W
11,884 0	89 29	335 12	7,861 9	4,452 5	-1,311 5	14,564,257 75	1,925,967	13 40° 6' 1 588 N	79° 58' 44 043 W
11,947 0	91 21	335 27	7,862.0	4,480 5	-1,324.6	14,564,285 82	1,925,953	98 40° 6' 1 867 N	79° 58' 44 209 W
11,978 0	91 98	335 17	7,860 8	4,537 7	-1,351 1	14,564,342 95	1,925,940	44 40°6'2'155 N 45 40°6'2'434 N	79° 58' 44 379 W
12,010 0	92 12	335 29	7,859 7	4,566,7	-1,364 5	14,564,371 98	1,925,914	05 40° 6' 2 723 N	79° 58' 44 710 W
12,041 0	92 18 91 85	335 27	7,858 5	4,594 8	-1,377 5	14,564,400 12	1,925,901	10 40° 6' 3 003 N	79° 58' 44 872 W
12,104 0	90 70	335 73	7,856 7	4,652 2	-1,403 6	14,564,457 43	1,925,874 9	78 40°6'3291 N 99 40°6'3572 N	79° 58' 45 039 W
12,136 0	90 66	335 49	7,856 3	4,681 3	-1,416 8	14,564,486 57	1,925,861	78 40° 6' 3 862 N	79° 58' 45 366 W
12,167 0	90 60 90 48	335 71	7,856 0	4,7095	-1,429 6	14,564,514 80	1,925,848 9	97 40° 6' 4 142 N	79° 58' 45 526 W
12,262 0	90 47	336 10	7,855 1	4,796 2	-1,468 6	14,564,601 43	1,925,835 /	78 40°6'4 432 N 99 40°6'5 003 N	79° 58' 45 692 W
12,325 0	89 70	335 80	7,855 0	4,853 7	-1,494 3	14,564,658 96	1,925,784 3	32 40° 6' 5 574 N	79° 58' 46 337 W
12,357.0	89 26	334 74	7,855 3	4,882 8	-1,507 7	14,564,688 02	1,925,770 9	93 40° 6' 5 863 N	79° 58' 46 505 W
12,451 0	90 40	335 42	7,855 8	4,968 1	-1,547 0	14,564,716 13	1,925,757 8	15 40° 6' 6 142 N 31 40° 6' 6 712 N	79° 58' 46 669 W
12,483 0	90 81	335 97	7,855 5	4,997 3	-1,560 2	14,564,802 56	1,925,718 4	40° 6' 7 001 N	79° 58' 47 164 W
12,546.0	91 11 90 40	335 70	7,854 4	5,054 8	-1,585 9	14,564,860 04	1,925,692 6	6 40° 6' 7 572 N	79° 58' 47 487 W
12,734 0	88 99	334 29	7,853 7	5,140 2	-1.665 5	14,565,030 35	1,925,653 4	0 40°6'8421N	79° 58' 47 980 W
12,829 0	90 00	334 62	7,854 5	5,310 8	-1,706 5	14,565,116 06	1,925,572 1	4 40° 6' 10 117 N	79° 58' 49 001 W
12,923 0 13,003 0 TGT HII	88 93 88 93 I Unit 3H	335 50 335 50	7,855 4 7,856 9	5,396 0 5,468 8	-1,746 1 -1,779 3	14,565,201 29 14,565,274 08	1,925,532 5 1,925,499 3	60 40° 6' 10 964 N 3 40° 6' 11 687 N	79° 58' 49 498 W 79° 58' 49 915 W
urvev Annot	tions								
	Measured	Vertical	L	ocal Coordi	nates				
	Jepin (ft)	Uepth (ft)	+N/-	5	+E/-W	Commont			
	7,710 0	7.595 0	(19	618 9	243.6	Marcellue			
	7,860 0	7,670 5		740 3	199 4	Onondaga		 .	
hecked By	:			Appro	ved By:	· · · · · · · · · · · · · · · · · · ·		Date:	
31/10 2 53 10	бРМ				Page	4		COMPA	ASS 5000 1 Build 41

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Well Op Anter	erator o Resol	rces App	alachian (:orn	DEP ID	#	Well API#((Perm	It / Reg)			Pn	oject Nu	mber		Acres
Address 1625	17 th Stre	et			2000		Well Farm N Hill Unif	lame	<u></u>			1	Well #	<u> </u>	Serial I	¥
City Denve	er			State	Zip C	Code 202	County	ashi	naton		Muni	clpality	Moe	Diko E	 2	
Phone 303.3	57 7210			Fax 303_34	7_7216		USGS 7.5 m	nin, qu	adrangle	e map	ļ		1105			
Check	all that a	oply: 🔯	Original We	Il Record	Origina	il Comp	Califorr etion Report	niat	□ Ame	anded V	Veil Re	cord		1ended C	omnie	ation Re
		****			/i		动船等						L		ompie	
We	ІІ Туре	⊠ G	as [] 01] Comb	ination	Oil & Ga	S	🗌 Inje	ection		□s	orage] Dis	posal
Drillin	g Metho	d 🛛 R	otary - Air		Rotar	y – Mu	d		🗍 Ca	ble To	ool		¥_			
	1/25/20	10	3/	29/2010			<u>1165'</u> fi	t.	Total	Depth – 13,00	Driller)3' MI	<u>)</u> ft.	T	tal Depth 800	- Logg)3' M	^{ar} Dft.
	Ca	ising and	Tubing		Ceme Ceme	ent retu ent retu	rned on si rned on c	urfa oal r	ce cas protect	ing? tive ca	isina?)S)S	X No X No	Г	1 N/A
Hole Size	Pipe Si	wt.	Thread / Weld	Amount in	· · ·	Materia	Behind P	Plpe		Pac	ker / H	lardwa	re / C	entralizo	ers	Da
24"	20"	133#	STC	40'		26 sa	cks Class I	<u>н.</u> Н		<u>י ו</u>	pe	512	20	Dep	<u>m</u>	Ru 1/25
7-1/2*	13-3/8	48#	STC	479'		530 s	acks Class	н				<u> </u>				2/12
2-1/4*	9-5/8"	36"	LTC	1834'		635 s	acks Class	A								2/15/
						165 si	acks Class	н		Cmt	Plug	30)0'	7507	r.	2/28/
-1/2"	5-1/2"	20#	Buttress	13003'	Lead 1	290 sa	cks, Tail 86	i0 Cla	ass H			<u> </u>				3/27
						d. epi			Życie							
	Perfor	ation Rec	ord					Sti	<u>mulat</u>	ion R	acord	: 				
Dat	θ	Interval P From	erforated To	Date	, 1	nterval	Treated	Т	Flu ype	uld Am	ount	<i>Ргорр</i> Туре	Ing A An	gent nount	Av Inject	erage lion R
		·														
										·				RECE	IVF	ח
		_	·····			·				·····				AAY 1	0 20	
												[DEP. SI		₩_ <u>4</u> ₩ ~~:	10
atural O	nen Flow						18-1							OIL & G	ias Ias	EGIOI
ter Tres	atment One					Pressu	re	:					Hours			D
ow		·				Rock F	ressure						Hours			D
veil S		ompanie	es Provid	e the name, a	iddress, a	ind phor	e number of	fall w	ell serv	ice con	panles Name	involve	d.			
BLOU		ng Compa	iny, Inc.	5A	Weathe	rford V	Vireline Se	ervic	es		Sci	entific	Drillin	g		
dress	7 IN. M8	<u>y AVƏ.</u>			//7 N.	Kiver /	venue				421	South	i Eagl	e Lane		
1621 ty - Stat		73013			y - State		0450				City - 3	iain Tib	-			

Appendix H: 3H Well Completion Report

	!	LOG OF	FORMA	TIONS	Well API#:	37- <u>125-23879-00</u>
(If you w	ill need more spa	ce than this pa	ge, please phot	locopy the blank	form before filling it	in.)
	Top	Bottom	Gas at	Oil at	Water at	
Formation Name or Type	(feet)	(feet)	(feet)	(feet)	(fresh / brine; ft.)	Source of Data
Sand (all tops in TVD)	1815'	1871'		į i		Geophysical Log
Shale	1871'	1920'				Geophysical Log
Sand	1920'	1948'	1	: 		Geophysical Log
Shale	1948'	1958'				Geophysical Log
Sand	1958'	2037'	i	1		Geophysical Log
Sand and Shale	2037'	2282'	1	1		Geophysical Log
Sand	2282'	2300'				Geophysical Log
Shale	2300'	2330'	ł	l ŧ		Geophysical Log
Sand	2330'	2359'				Geophysical Log
Shale	2359'	2363'	1			Geophysical Log
Sand and Shale	2363'	2442'				Geophysical Log
Shale	2442'	2507'	1			Geophysical Log
Sand and Shale	2507'	2573'	1 1			Geophysical Log
Sand and Shale	2573'	2790'	1	l		Geophysical Log
Shale	2790'	2887'		1	1	Geophysical Log
Sand	2887'	2895'			1	Geophysical Log
Shale	2895'	2902'	1			Geophysical Log
Sand	2902'	2907'	l	1		Geophysical Log
Shale	2907'	3296'		1		Geophysical Log
Sand and Shale	3296'	3590'			1	Geophysical Log
Sand	3590'	3606'	1			Geophysical Log
Shale	3606'	3702'				Geophysical Log
Sand and Shale	3702'	3943'	I	I	1	Geophysical Log
Shale	3943'	4118'	1			Geophysical Log
Sand and Shale	4118'	i 4343'	1	1	1	Geophysical Log
Shale	4343'	4587'		1		Geophysical Log
Sand and Shale	4587'	4622'				Geophysical Log
Shale	4622'	4753'	1		1	Geophysical Log
Sand and Shale	4753'	4840'				Geophysical Log
Shale	4840'	5080'	Í	; REC	CEIVED	Geophysical Log
Sand and Shale	5080'	5160'			1	Geophysical Log
Shale	5160	5366'	5 4 1	MAY	192010	Geophysical Log
Sand	5366'	5371'	1	DED SAM	1	Geophysical Log
Shale	5371'	5429'		UEP, SOUTH	WEST HEGION	Geophysical Log
Sand and Shale	5429'	5581	1	, 01	4 GAS	Geophysical Log
Shale	5581'	6159'	1	1	l	Geophysical Log
Sand and Shale	¦ 6159'	6178'	1		•	Geophysical Log
Shale	6178'	6636'	i	1		Geophysical Log
Lontinued on 2" Page	st of my know	l vledae info	rmation and	belief that t	he well identifier	I on this Well Record a
Completion Report has bee	on properly c	ased and o	cemented in	accordance	with the requirer that there a	irements of 25 Pa. Co
submitting false information,	including the	possibility c	of fine and in	prisonment.		i o ogninount pondulos i
Well Operator's Signature					DEP USE	ONLY
John mahal	ein		Rev	/iewed by:		Date:
Title	Date:		Cor	nments:		
Permit Representative	5/5/20					
			-			
			- 2 -			

ANTERO RESOURCES		;	, *	, Sur	vey Repo	ort - Geograp	hic			Scientific Drilling
Company: A Project: Site: Well: H Wellbore: H Design: H	Antero Ri Washingt Hopkins I Hill Unit 3 Horizonta Horizonta	esources C on County Pad IH II Hill Unit 3 II Hill Unit 3	orporation Pennsylvar H	าเล	Local TVD R MD Re North Survey Databa	Co-ordinate Re eference: iference: Reference: / Calculation M ase:	ference:	Well H WELL WELL Grid Minimu EDMO	ill Unit 3H - Slot 3 @ 1196 Oft (Origina @ 1196 Oft (Origina @ Curvature KC	al Well Elev) al Well Elev)
Project	Wash	angton Cou	nty Penns	/Ivania, SW Per	nsylvania					
Map System: Geo Datum: Map Zone:	Univer NAD 1 Zone 1	sal Transve 927 - Easte 7N (84 W t	erse Merca Irn US o 78 W)	tor (US Survey	Fee Syste	em Datum;		Mean	Sea Level	
Site	Hopk	ins Pad, Pa	d Center				-			
Site Position: From: Position Uncerta	Ma Inty:	ap 0 	0 ft	Northing: Easting: Slot Radius:	14,: 1,:	559,794 17 ft 927,276 73 ft 0 "	Latitud Longitu Grid Co	e: ide: onvergen	ice:	40° 5' 17 317 N 79° 58' 27 850 W 0 66 °
Well	Hill Ur	nit 3H - Slot	3							·
Well Position	+N/-S +E/-W inty		00ft 00ft 00ft	Northing: Easting: Wellhead Ei	evation:	14,559,8052 1,927,2786 1,196	27 ft 50 ft 0 ft	Latitud Longitu Ground	e: Ide: I Level:	40° 5' 17 427 N 79° 58' 27 824 W 1 170 0 ft
Wellhore	Horiz	ontal Hill II	n# 914							
Magnetics	Ma	dal Nama			_					-
magnetics	MC	dei Name	5	imple Date	De	clination (°))ip Angle (°)	Fiel	d Strength (nT)
		IGRF20	10	02/09/10		-9 08			67 74	53,130
Design Audit Notes: Version: Vertical Section:	Horizo	ontal Hill Un	it 3H Jepth Fro	Phase: m (TVD)	ACTUAL	т s +	le On Dep F/-W	th:	Direction	7,187 0
			. (ft)	00	(ft)	00	(ft) 00		(°) 3	36 12
From	То	Dat	e 03/31/1	U					,	
(ft) 50 0 4,112 0 7,246 0	(ft) 4, 7, 13,	Surv 090 0 Surve 187 0 Surve 003 0 Surve	ey (Wellbo ey #1 Gyro ey #2 MWE ey #1 MWE	re) (Directional Pilo) (Directional Pilo) (Horizontal Hill	at Hill Unit : lot Hill Unit I Unit 3H)	Tool Name GYD-GC-SS SDI MWD SDI MWD		Descrip Gyroda SDI MV SDI MV	p tion ta gyro single shots VD/Gamma VD/Gamma	
Survey										
Measured Depth Incl (ft)	ination . (°)	Azimuth (°)	Vertical Depth (ft)	+N/-S (ft)	+E/-W (ft)	Map Northing (ft)	Ma East (ft	ip ling)	Latitude	Longitude
7,187 0 7,246 0 7,278 0 7,310 0 7,342 0 7,373 0 7,405 0 7,405 0 7,437 0 7,468 0 7,499 0	12 10 11 95 11 87 12 66 14 78 17 67 20 61 23 59 27 24 30 95	37 70 37 50 28 75 15 57 0 08 348 23 341 60 337 87 335 33 333 82	7,144 (7,202 (7,233 (7,264 (7,295 7 7,325 (7,325 7 7,355 7 7,355 7 7,355 7 7,355 7 7,355 7	3 405 3 415 0 420 5 420 5 426 8 434 2 434 2 442 8 452 9 464 2 476 4 490 0 490 0	307 2 314 7 318 3 320 8 321 8 320 8 318 0 313 8 308 5 302 1	14,560,210 5 14,560,220 2 14,560,232 0 14,560,232 0 14,560,232 0 14,560,238 1 14,560,248 0 14,560,269 4 14,560,269 4 14,560,281 6 14,560,295 2	3 1,927, 7 1,927, 3 1,927, 5 1,927, 1 1,927, 1 1,927, 3 1,927, 3 1,927, 3 1,927, 5 1,927, 5 1,927, 5 1,927, 5 1,927, 5 1,927, 5 1,927,	585 79 593 29 596 89 599 41 600 36 599 41 596 64 592 45 587 15 580 67	40° 5′ 2′ 398 N 40° 5′ 2′ 493 N 40° 5′ 2′ 547 N 40° 5′ 2′ 1699 N 40° 5′ 2′ 1683 N 40° 5′ 2′ 1683 N 40° 5′ 2′ 1868 N 40° 5′ 2′ 1980 N 40° 5′ 22 101 N 40° 5′ 22 236 N	79° 58' 23 811 W 79° 58' 23 713 W 79° 58' 23 685 W 79° 58' 23 682 W 79° 58' 23 619 W 79° 58' 23 619 W 79° 58' 23 630 W 79° 58' 23 644 W 79° 58' 23 716 W 79° 58' 23 782 W 79° 58' 23 864 W
	-									

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		.1	<i>4</i> .6	Surv	ev Report	Geographic		- MA	Scientific Drill
RESOURCES		1.	5.0	à	-,				CONCLUME DAM
Company:	Antero Re	, sources Co	rporation		Local Co	o-ordinate Refere	nce: Well H	ll Unit 3H - Slot 3	
Project:	Washingto	on County P	ennsylvania		TVD Ref	erence:	WELL	@ 1196 Oft (Original W	ell Elev)
Site:	Hopkins P	ad			MD Refe	rence:	WELL	② 1196 Oft (Original W	eli Elev)
Well: Wellbore:	Horizontal	⊐ Hull Hout 3H			Survey (nerence: Calculation Methr	di Minimu	m Curvature	
Design:	Horizontal	Hill Unit 3H	I		Databas	e:	EDMO	(C	
Survey									
Measured			Vertical			Мар	Мар		
Depth	Inclination	Azimuth	Depth	+N/-S	+E/-W	Northing	Easting	1 - 474 1 -	l a sa situ da
(11)	(*)	(*)	(11)	(π)	(ft)	(11)	(1)	Latitude	Longitude
7,531 0	34 40	333 50	7,467 3	505 5	294 4	14,560,310 74	1,927,573 00	40° 5' 22 390 N	79° 58' 23 960
7,563 0	38 16	333 29	7,493 1	522 4	285 9	14,560,327.66	1,927,564 52	40° 5' 22 558 N	79" 58 24 06
7,595 0	41 59	335 13	7,5177	560 F	2/0/	14,560,346 01	1,927,505 34	40 5 22 741 N 40° 5' 22 937 N	79° 58' 24 30'
7,6270	46 73	336 36	7,550 7	569 7	263 1	14,560,374 97	1.927.541 72	40° 5' 23 028 N	79° 58' 24 35
Landing	Pt 3H	00000	1,000 /				.,		
7,658 0	48.72	337 78	7,562 1	581 3	258 2	14,560,386 57	1,927,536 82	40° 5' 23 144 N	79° 58' 24 41
7,690 0	51 35	339 09	7,582 7	604 1	249 2	14,560,409 37	1,927,527 81	40° 5' 23 370 N	79° 58' 24 52
7,710 0	52 95	339 14	7,595 0	618 9	243 6	14,560,424 13	1,927,522 18	40° 5' 23 517 N	79° 58' 24 59
Marcell	us		7 004 5	0074	040.4	44 500 400 00	4 007 540 04	408 EL 03 E08 N	709 501 04 60
7,721 0	53 83	339 16	7,601 5	6271	240 4	14,000,432 38	1,927,519 04	40° 5' 23 596 N 40° 5' 23 843 N	79 00 24 03
7,7530	57 20	339 43	7,6190	677.2	221.3	14,560,482,52	1,927,499 88	40° 5' 24 096 N	79° 58' 24 87
7,7050	62 38	340 57	7.651 3	702 8	212 0	14.560.508 03	1,927,490 60	40° 5' 24 349 N	79° 58' 24 99
7,848 0	64 98	341 82	7,665 5	729 9	202 8	14,560,535 18	1,927,481 36	40° 5' 24 619 N	79° 58' 25 10
7,860 0	65 84	342 12	7,670 5	740 3	199 4	14,560,545 56	1,927,477 98	40° 5' 24 722 N	79° 58' 25 14
Ononda	iga								
7,880 0	67 27	342 61	7,678 4	757 8	193 8	14,560,563 04	1,927,472 43	40° 5' 24 895 N	79° 58' 25 21'
7,912 0	68 97	343 01	7,690 4	786 1	185 1	14,550,591 41	1,927,463 65	40° 5° 25 177 N 40° 5' 25 461 N	79' 58' 25 32
7,944 0	71 21	343 15	7 712 5	843.6	167.6	14,560,648,88	1,927,446 24	40° 5' 25 747 N	79° 58' 25 54
8.008.0	73 64	342 74	7,722 1	872 8	158 7	14,560,678 04	1,927,437 30	40° 5' 26 036 N	79° 58' 25 65
8,040 0	76 24	342 70	7,730 4	902 3	149 5	14,560,707 55	1,927,428 12	40° 5' 26 329 N	79° 58' 25 76
8,072 0	78 70	342 79	7,737 4	932 1	140 3	14,560,737 38	1,927,418 85	40° 5' 26 625 N	79° 58' 25 88
8,104 0	81 28	342 66	7,742 9	962 2	130 9	14,560,767 47	1,927,409 50	40° 5' 26 923 N	79° 58' 25 99
8,1360	85 21	342 43	7,7407	1030.0	121 4	14,000,797 78	1,927,399,90	40 5 27 224 N 40° 5' 27 694 N	79 58 26 11
8 282 0	87.05	338 19	7 753 7	1 129 8	72.4	14,560,935 09	1,927,350 98	40° 5' 28 587 N	79° 58' 26 72
8,346.0	88 90	338 83	7,756 0	1,189 3	49 0	14,560,994 60	1,927,327 55	40° 5' 29 178 N	79° 58' 27 01
8,378 0	89 06	338 96	7,756 5	1,219 2	37 4	14,561,024 45	1,927,316 03	40° 5' 29 474 N	79° 58' 27 16
8,473 0	89 43	339 08	7,757 8	1,307 9	34	14,561,113 14	1,927,282 02	40° 5' 30 355 N	79° 58' 27 58
8,569 0	88 89	337 32	7,759 2	1,397 0	-32 2	14,561,202 26	1,927,246 37	40° 5' 31 240 N	79° 58' 28 03
8,664 0	88 32	337 13	7,761 5	1,484 6	-690	14,561,289 83	1,927,209 61	40° 5' 32 109 N	70" 58' 28 45
8,7590	88 93	337 80	7765 2	1,572.3	-105 4	14,501,577 55	1,927,17321	40° 5' 33 856 N	79° 58' 29 38
8,804 U 8,950 0	89 20	337 79	7,766.3	1 749 5	-176.5	14,561,554 81	1,927,102 12	40° 5' 34 741 N	79" 58' 29 83
9,046 0	89 26	338 64	7.767.5	1,838 7	-212 1	14,561,643 94	1,927,066 50	40° 5' 35 626 N	79° 58' 30 28
9,141 0	89 50	338 82	7,768 5	1,927 2	-246 6	14,561,732 47	1,927,032 04	40° 5' 36 505 N	79° 58' 30 71
9,235 0	90 20	339 06	7,768 8	2,014 9	-280 3	14,561,820 19	1,926,998 26	40° 5' 37 376 N	79° 58' 31 13
9,328 0	88 96	337 88	7,769 4	2,101 4	-314 5	14,561,906 69	1,926,964 13	40° 5' 38 235 N	79° 58' 31 55
9,423 0	88 42	337 59	7,7716	2,1893	-3505	14,001,994 59	1,920,928 15	40 0 39 108 N 40° 5' 30 078 N	79 58 32 00
9,5180	88 76 88 76	337 10	77763	2,2709	-307 1	14,562 168 80	1.926.855.02	40° 5' 40 838 N	79° 58' 32 92
97070	88 99	337 44	7,778.2	2,451 2	-460 2	14,562.256 44	1,926,818 39	40° 5' 41 709 N	79° 58' 33 38
9.802 0	89 46	337 31	7,779 5	2,538 8	-496 B	14,562,344 12	1,926,781 85	40° 5' 42 579 N	79° 58' 33 84
9,897 0	89 83	338 01	7,780 1	2,626 7	-532 9	14,562,431 98	1,926,745 74	40° 5' 43 452 N	79° 58' 34 29
9,992 0	89 43	337 88	7,780 7	2,714 8	-568 5	14,562,520 03	1,926,710 07	40° 5' 44 326 N	79° 58' 34 73
10,087 0	89 09	336 98	7,781 9	2,802 5	-605 0	14,562,607 75	1,926,673 61	40° 5' 45 198 N	79" 58' 35 19
10,119 0	87 92	337 27	7,7827	2,8319	-6174	14,562,637 22	1,920,001 1/	40 0 40 490 N 40° 5' 46 069 N	19 00 00 00 70° 58' 25 66
10,182 0	87 48	33/ 55	77877	2,090 1	-0410	14,002,090 34	1,920,037 00	40° 5' 46 644 N	79° 58' 35 9
10,240 0	87 75	337 61	7,788 8	2,976 7	-677.9	14,562,781 97	1,926.600 68	40° 5' 46 928 N	79° 58' 36 10
10.371 0	86 54	336 77	7,793 6	3,064 2	-714 7	14,562,869 42	1,926,563 90	40° 5' 47 797 N	79° 58' 36 56
10,465 0	86 84	336 22	7,799 0	3,150 2	-752 1	14,562,955 48	1,926,526 47	40° 5' 48 652 N	79° 58' 37 03
10.560 0	86 74	337 03	7 804 3	3 237 3	700 8	14 563 042 55	1 926 488 84	40° 5' 49 517 N	79° 58' 37 50

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		LOG OF	FORMA	TIONS	Well API#	: 37- <u>125-23879-00</u>
(If you will	need more spa	ce than this pa	ge, please pho	tocopy the blai	nk form before filling l	
Familian Managar Tana	Тор	Bottom	Gas at	Oil at	Water at	Pourse of Data
Sand and Shale	(1661) 6636'	(feet) 6640'	(1001)	(1661)	(πesn / brine; π.)	Geophysical Log
Shale	6640'	7000'				Geophysical Log
Sand and Shale	7000'	7207			1	Geophysical Log
Shale	7207'	7212'				Geophysical Log
Sand and Shale	7212'	7401'				Geophysical Log
Shale	7401'	7420'				Geophysical Log
Limestone	7420'	7468'				Geophysical Log
Sand and Shale	7468'	7659'				Geophysical Log
Shale	7659'	7808'				Geophysical Log
Limestone	7808'	7822'				Geophysical Log
Chert	7822			ŧ		Geophysical Log
Linizatel Mercellus Ter	7045	МР				Geophysical Log
TD (Measured Depth)	7830	13003'				Geophysical Log
			-			
				3		
					RE	CEIVED
						v 1 9 2010
					WP	1
					DEP, SO	UTHWEST REGION
						<u></u>
I do hereby certify to the best Completion Report has been Chapter 78 and any condition submitting felse information in	of my know properly c contained	vledge, infor ased and c in the perm	mation and emented in it for this w fine and im	belief that accordance ell. I am a prisonment	the well identified be with the requi ware that there a	d on this Well Record an irements of 25 Pa. Cod ire significant penalties fo
Wat De este a objetie o					DEP USE	
asplit Schaler	\sim		Rev	lewed by:		Date:
Title: Permit Representative	Date: 5/5/20		Cor	nments:		
			<u> </u>	· · · · · ·		
			- 2 -			

30.1 Scientific Drilling International Survey Report Scientific Drilling Company: Antero Resources Corporation Local Co-ordinate Reference: Well Hill Unit 3H - Slot 3 Project: Washington County Pennsylvania WELL @ 1196 Oft (Original Well Elev) **TVD Reference:** Site: Hopkins Pad MD Reference: WELL @ 1196 Oft (Original Well Elev) Weil: Hill Unit 3H North Reference: Grid Wellbore: Directional Pilot Hill Unit 3H Survey Calculation Method: Minimum Curvature Design: Directional Pilot Hill Unit 3H Database: EDMOKC Survey Measured Vertical Depth Dogleg Rate (°/100ft) Vertical Build Turn Depth (ft) Inclination Azimuth Section (ft) +N/-S +E/-W Rate Rate (°/100ft) (°) (°) (ft) (ft) (ft) (°/100ft) 5,001 0 8 00 31 30 4,993 2 764 105 2 123 8 1 28 -1 26 -1 26 5,095 0 9 30 30 80 5.086 1 88 5 112 5 137 9 1 39 1 38 -0 53 5,285 0 9 90 35 00 5,273 4 115 1 129 7 169 5 049 0 32 2 21 5,476 0 8 70 27 20 5,461 9 141 4 145.7 200 2 0 91 -0 63 -4 08 5,663 0 9 00 31 60 5,646 7 166 4 159 8 228 7 040 0 16 2 35 5.854 0 9 60 32 30 5,835 2 192 6 176 2 259 5 0 32 0 31 0 37 6,045 0 9 00 30 60 6,023 7 218 9 192 3 290.3 0.35 -0 31 -0 89 6,233 0 10 40 31 00 6.209 0 246 1 208 5 321 8 075 074 0 21 6,424 0 10 40 31 00 6,396 8 275 7 226 3 356 1 0.00 0.00 0 00 6,614 0 10 50 28 80 6,583 7 305 5 243 5 390 4 0 22 0 05 -1 16 6,805 0 12 10 33 00 6,771 0 337 6 262 7 427 6 0 94 0 84 2 20 6,997 0 12 40 31 30 6,958 6 372 1 284.4 468 2 0 24 0 16 -0 89 7,187 0 12 10 37 70 7,144 3 405 3 307 2 508 5 073 -0 16 3 37 11 10 7,283 0 36 70 7,238 3 420 6 318 9 527 8 1 06 -1 04 -1 04 7,378 0 10 30 34 60 7.3317 434 9 329 2 545 4 0 94 -0 84 -2 21 7,568 0 8 90 32 20 7.519 0 461 4 346 6 577 0 0 77 -074 -1 26 7,710 0 8 90 32 20 7,659 3 480 0 358 3 599 0 0 00 0.00 0.00 Marcellus 8 90 7,752 7 32 20 7,701 5 485 6 361 9 605 5 0 00 0 00 0 00 Onondoga Target 3H 7,860 0 8 90 32 20 7.807 5 499 6 370 7 622 1 0 00 0 00 0 00 Onondaga 8,005 0 8 90 32 20 7,950 8 5186 382 7 644 5 0 00 0 00 0.00 Survey Annotations Measured Vertical Local Coordinates Depth (ft) Depth (ft) +N/-S +E/-W (ft) (ft) Comment 7,710 0 7,860 0 480 0 499 6 7,659 3 358 3 Marcellus 7,807 5 370 7 Onondaga _ _ _ _ _ ł Checked By: Approved By: Date: 03/31/10 2 18 04PM Page 3 COMPASS 5000 1 Build 41



Antero Resources Corporation

Washington County Pennsylvania Hopkins Pad Hill Unit 3H - Slot 3

Horizontal Hill Unit 3H

Survey: Survey #1 MWD

Standard Survey Report

31 March, 2010

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Antero Resources Corporation

Washington County Pennsylvania Hopkins Pad Hill Unit 3H - Slot 3

Directional Pilot Hill Unit 3H

Design: Directional Pilot Hill Unit 3H

Survey Report - Geographic

31 March, 2010



ANTERO RESOURCES	,	44	ا مالایا اس با ا	Scientifi Surv	ey Report	Geographic	ional `		Scientific Drilling
Company: Project: Site: Well: Wellbore: Design:	Antero Res Washingtor Hopkins Pa Hill Unit 3H Directional Directional	ources Cor n County Po Id Pilot Hill Ui Pilot Hill Ui	poration ennsylvania nit 3H nit 3H		Local Co TVD Refe MD Refer North Re Survey C Database	-ordinate Refer erence: rence: ference: :alculation Meth a:	ence: Well WEL Grid nod: Minir EDM	Hill Unit 3H - Slot 3 L @ 1196 Oft (Origina L @ 1196.0ft (Origina num Curvature IOKC	ıl Well Elev) Il Well Elev)
Project	Washir	ngton Cour	ty Pennsylva	nia, SW Pen	nsylvania				
Map System: Geo Datum: Map Zone:	Univers NAD 19 Zone 17	al Transver 27 - Easter N (84 W to	se Mercator (n US 78 W)	US Survey F	ee System	Datum:	Mea	ın Sea Level	
Site	Hopkin	is Pad, Pad	I Center						
Site Position: From: Position Uncert	Map ainty:	00	Nor Eas ft Slot	thing: ting: t Radius:	14,55 1,92	9,794 17 ft 7,276 73 ft 0 "	Latitude: Longitude: Grid Converg	ence:	40° 5' 17 317 N 79° 58' 27 850 W 0 66 °
Well	Hill Uni	t 3H - Slot	3			· · · · · ·			
Well Position Position Uncert	+N/-S +E/-W ainty		00ft 1 00ft 1 00ft 1	Northing: Easting: Weilhead Eli	evation:	14,559,805 27 1,927,278 60 1,196 0	ft Latit ft Long ft Grou	ude: jitude: ind Level:	40° 5' 17 427 N 79° 58' 27 824 W 1,170 0 ft
Wellbore	Direct	ional Pilot I	fill Unit 3H						
Magnetics	Мо	del Name	Sam	ple Date	Deci	Ination	Dip An	gle Fie	eld Strength
		IGRF201	0	07/30/09		-9 07	()	67 79	53,195
Design Audit Notes:	Direction	onal Pilot H	lill Unit 3H Ph		ACTUAL	Tie	On Depth:		0.0
Vertical Section		I	Depth From ((ft)	(TVD)	+N/-5 (ft)	3 +E (/-W ft)	Direction (°)	
				00		0 0	00		36 28
Survey Program	 1	Dat	e 03/31/10						
From (ft) 50 4.112	To (ft) 0 4,1 0 8,1	Surv 090 0 Surv 005 0 Surv	ey (Wellbore ey #1 Gyro (D ey #2 MWD (I) Virectional Pil Directional P	lot Hill Unit : ilot Hill Unit	Tool Name GYD-GC-SS SDI MWD	Des Gyr SD	scription odata gyro single sho I MWD/Gamma	ots
Survey			· · · <u> </u>					······································	
Measured Depth In (ft)	clination	Azimuth (°)	Verticai Depth (ft)	+N/-S (ft)	+E/-W (ft)	Map Northing (ft)	Map Easting (ft)	Latitude	Longitude
0 0 50 0 100 0 200 0 250 0 300 0 350 0 400 0	0 00 0 13 0 41 0 55 0 70 0 68 0 62 0 52 0 59 0 53	0 00 42 98 84 96 94 16 90 55 90 37 89 73 66 55 47 94 47 42	0 0 50 0 100 0 150 0 200 0 250 0 300 0 350 0 400 0 450 0	00 00 01 01 01 01 02 04 08	00 00 03 07 12 18 24 29 33 36	14,559,805 27 14,559,805 32 14,559,805 37 14,559,805 37 14,559,805 35 14,559,805 35 14,559,805 35 14,559,805 44 14,559,805 70 14,559,806 03	1,927,278 1,927,278 1,927,278 1,927,279 1,927,279 1,927,280 1,927,280 1,927,281 1,927,281 1,927,282	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	N 79° 58' 27 824 W N 79° 58' 27 823 W N 79° 58' 27 823 W N 79° 58' 27 821 W N 79° 58' 27 808 W N 79° 58' 27 808 W N 79° 58' 27 808 W N 79° 58' 27 703 W N 79° 58' 27 793 W N 79° 58' 27 787 W N 79° 58' 27 787 W N 79° 58' 27 782 W N 79° 58' 27 778 W
500.0	0.56	54 16	500 <u>0</u>	11	4.0	14,559,806 33	1,927,282	59 40° 5' 17 437	N <u>79° 58' 27 77</u> 2 W
)3/31/10 2 52 15	PM				Pag	je 2		C	OMPASS 5000 1 Build 4

ANTERO RESOJRCES		· · ·	t and The second	Scientii	vey Repo	ing Internat ort Geographi	tional c			Scientific Drillin
Company: Project: Site: Well: Wellbore: Design:	Antero Ro Washingt Hopkins F Hill Unit 3 Directiona Directiona	esources Co on County F Pad H al Pilot Hill U al Pilot Hill U	prporation Pennsylvania Init 3H Init 3H		Local TVD R MD Re North I Survey Databa	Co-ordinate Refe eference: ference: Reference: r Calculation Meti ise:	Well Hi WELL Grid Minimu EDMOI	III Unit 3H - Slot 3 @ 1196 0ft (Original @ 1196 0ft (Original m Curvature KC	Well Elev) Well Elev)	
Survey			-							
Measured Depth (ft)	Inclination (°)	Azimuth (°)	Vertical Depth (ft)	+N/-S (ft)	+E/-W (ft)	Map Northing (ft)	Ma Eas (f	ap ting t)	Latitude	Longitude
550 0	0 53	59 98	550 0	13	4 4	14,559,806 59	1,927	282 99	40° 5' 17 440 N	79° 58' 27 767 V
600 0	0.52	64 00 70 77	600 0 650 0	15	48	14,559,806 80	1,927	283 40	40° 5' 17 442 N	79° 58' 27 762 V
700 0	0 46	64 91	700 0	19	52	14,059,806 98	1,927,	283 81	40° 5' 17 443 N	79° 58' 27 757 W
750 0	0 40	74 92	750 0	20	60	14,559,807 27	1,927	284 56	40° 5' 17 445 N	79° 58' 27 751 W
800 0	0 44	74 80	800 0	21	63	14,559,807 36	1,927,	284 91	40° 5' 17 447 N	79° 58' 27 742 W
900 0	0 35	74 20	900 n	22	67	14,559,807 46	1,927	285 26	40° 5' 17 448 N	79° 58' 27 738 W
950 0	0 41	83 51	950 0	23	73	14,559,807 61	1,927	285 89	40° 5' 17 449 N 40° 5' 17 449 N	79° 58' 27 734 W
1,000 0	0 39	85 84	1,000 0	24	76	14,559,807 65	1,927	286 23	40° 5' 17 450 N	79° 58' 27 725 W
1,000 0	0.61	87 46	1,050 0	24	80	14,559,807 66	1,927,	286 64	40° 5' 17 450 N	79° 58' 27 720 W
1,150 0	0 69	83 30	1,150 0	25	91	14,559,807 68	1,927,	287 14	40° 5' 17 450 N	79° 58' 27 714 W
1,200 0	0 49	110 36	1,200 0	24	96	14,559,807 69	1,927	288 21	40° 5' 17 450 N	79° 58' 27 706 W
1,250 0	0.53	108 43	1,250 0	23	10 0	14,559,807 54	1,927,	288 63	40° 5' 17 448 N	79° 58' 27 695 W
1,350 0	0 69	95 75	1,349 9	20	105	14,559,807.40	1,927,	289 05	40° 5' 17 447 N	79° 58' 27 689 W
1,400 0	0 65	94 02	1,399 9	20	115	14,559,807 25	1,927	290 14	40° 5' 17 445 N	79° 58' 27 683 W
1,450 0	0.69	95 70	1,449 9	19	12 1	14,559,807 20	1,927,	290 72	40° 5' 17 445 N	79° 58' 27 668 W
1,550 0	0 66	94 86	1,499 9	18	12 /	14,559,807 12	1,927,	291 30	40° 5' 17 444 N	79° 58' 27 660 W
1,600 0	0 66	87 42	1,599 9	18	13 8	14,559,807 03	1,927,	292 44	40° 5' 17 443 N	79° 58' 27 653 W 79° 58' 27 645 W
1,650 0	073	85 93	1,649 9	18	14 4	14,559,807 07	1,927,	293 05	40° 5' 17 443 N	79° 58' 27 638 W
1,750 0	074	88 55	1,699.9	18	151	14,559,807 11	1,927,2	293 69	40° 5' 17 443 N	79° 58' 27 629 W
1,800 0	0 96	85 14	1,799 9	19	16 5	14,559,807 17	1.927.2	294 35	40° 5' 17 444 N 40° 5' 17 444 N	79° 58' 27 621 W
1,850 0	0 98	83 23	1,849 9	20	17 4	14,559,807 26	1,927,2	95 95	40° 5' 17 445 N	79° 58' 27 600 W
1,950 0	1 19	80 58	1,899.9	21	18 2	14,559,807 38	1,927,2	96 82	40° 5' 17 446 N	79° 58' 27 589 W
2,000 0	1 37	86 89	1,999 9	23	203	14,559,807 60	1,927,2	98.89	40° 5' 17 447 N 40° 5' 17 448 N	79° 58' 27 577 W
2,050 0	1 40	93 13	2,049 9	23	21 5	14,559,807 60	1,927,3	00 10	40° 5' 17 448 N	79° 58' 27 547 W
2,100 0	1 39	97 80	2,099 8	22	22 7	14,559,807 48	1,927,3	01 31	40° 5' 17 446 N	79° 58' 27 531 W
2,200 0	1 22	105 16	2,199.8	18	23 8	14,559,807 29	1,927,3	02 44	40° 5' 17 444 N	79° 58' 27 517 W
2,250 0	1 31	104 82	2,249 8	15	26 0	14,559,806 76	1,927,3	04 56	40° 5' 17 439 N	79° 58' 27 503 W
2,300 0	1 33	102 32	2,299 8	12	27 1	14,559,806 49	1,927,3	05 68	40° 5' 17 436 N	79° 58' 27 475 W
2,400 0	1 24	117 34	2,399 8	05	28 2 29 2	14,559,806 21	1,927,3	0679 0782	40° 5' 17 433 N	79° 58' 27 461 W
2,450 0	1 28	118 89	2,449 8	00	30 2	14,559,805 28	1,927,3	08 79	40° 5' 17 424 N	79° 58' 27 448 W
2,500 0 2,550 0	1 29	118 53	2,499 7	-05	31 2	14,559,804 74	1,927,3	09 78	40° 5' 17 418 N	79° 58' 27 423 W
2,600 0	1 36	120 16	2,5497	-11 -17	32.2	14,559,804 17	1,927,3	10 82	40° 5' 17 413 N	79° 58' 27 409 W
2,650 0	1 25	124 10	2,649 7	-23	34 3	14,559,802 97	1,927.3	12 85	40° 5' 17 407 N 40° 5' 17 400 N	79° 58' 27 396 W
2,700 0	1 40	123 65	2,699 7	-29	35 2	14,559,802 33	1,927,3	13 81	40° 5' 17 394 N	79° 58' 27 371 W
2,800 0	1 17	123 63	2,799 7	-36	362	14,559,801 64	1,927,3	14 83	40° 5' 17 387 N	79° 58' 27 358 W
2,850 0	1 00	133 54	2,849 7	-48	37 9	14,559,800 43	1,927,3	1076 1650	40° 5' 17 381 N 40° 5' 17 375 N	79° 58' 27 346 W
2,900 0	1 02	131 73	2,899 6	-54	38 6	14,559,799 83	1,927,3	17 15	40° 5' 17 369 N	79° 58' 27 329 W
2,950 0 3,000 0	U 98 () 88	121 65 111 65	2,949 6	-60	39 2	14,559,799 31	1,927,3	17 85	40° 5' 17 364 N	79° 58' 27 320 W
3,050 0	1 01	117 39	3,049 6	-03	40 0 40 7	14,559,798 94	1,927,3	18 57 19 32	40° 5' 17 360 N	79° 58' 27 310 W
3,100 0	1 04	115 80	3,099 6	-71	41 5	14,559,798 20	1,927.3	20 12	40° 5' 17 356 N	79° 58' 27 301 W
3,150 0	0.90	115 14	3,149 6	-74	42 3	14,559,797 84	1,927,3	20 88	40° 5' 17 349 N	79° 58' 27 281 W
3,200 0	0.89	116 77	3,1996 3,2406	-78	430	14,559,797 49	1,927,32	21 58	40° 5' 17 345 N	79° 58' 27 272 W

Site: Well:

Survey

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Scientific Drilling International Survey Report - Geographic

Database:



Antero Resources Corporation Company: Project: Washington County Pennsylvania Hopkins Pad Hill Unit 3H Wellbore: Directional Pilot Hill Unit 3H Directional Pilot Hill Unit 3H Design:

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Local Co-ordinate Reference: TVD Reference: MD Reference: North Reference: Survey Calculation Method:

Well Hill Unit 3H - Slot 3 WELL @ 1196 0ft (Original Well Elev) WELL @ 1196.0ft (Original Well Elev) Grid

Minimum Curvature EDMOKC

Depth In (ft)	clination (°)	Azimuth (°)	Depth (ft)	+N/-S (ft)	+E/-W (ft)	Northing (ft)	Easting (ft)	Latitude	Longitude
0 000 0	1.00	115 27	3 200 4	-86	44 5	14 559 796 72	1 927 323 10	40° 5' 17 337 N	79° 58' 27
3,300 0	100	113 37	3,2990	-00	45.2	14 550 706 23	1 027 323 04	40° 5' 17 334 N	79° 58' 27
3,350 0	105	11472	3,349 0	-09	40.0	14,009,190 00	1,027,020 04	40° 6' 17 220 N	70° 58' 27
3,400 0	1 02	118 67	3,399.6	-93	46 1	14,559,795 92	1,927,324 74	40 0 17 020 N	70% 50 27
3,450 0	0 9 9	114 97	3,449 6	-97	46 9	14,559,795 53	1,927,325 52	40° 5 17 325 N	79 00 27
3,500 0	0 99	118 80	3,499 6	-10 1	47 7	14,559,795 14	1,927,326 29	40° 5' 17 321 N	79-06-27
3,550 0	0 95	115 39	3,549 5	-10 5	48 4	14,559,794 75	1,927,327 05	40° 5' 17 318 N	79* 58 27
3,600 0	0 83	117 89	3,599 5	-10 9	49 1	14,559,794 41	1,927,327 74	40° 5' 17 314 N	79° 58' 27
3,650.0	0 84	113 87	3,649 5	-11 2	49 8	14,559,794 09	1,927,328 40	40° 5' 17 311 N	79° 58' 27
3 700 0	0 76	118 14	3.699 5	-115	50 4	14,559,793 78	1,927,329 02	40° 5' 17 308 N	79° 58' 27
3,750.0	0 78	111 18	3,749.5	-11 8	510	14,559,793 50	1,927,329 63	40° 5' 17 305 N	79° 58' 27
3,800,0	0.89	121 19	3 799 5	-12 1	517	14.559.793 18	1,927,330 28	40° 5' 17 302 N	79° 58' 27
3,0000	0.76	125 50	3 849 5	-125	52.3	14 559 792 79	1,927,330,89	40° 5' 17 298 N	79° 58' 27
3,650 0	070	123 30	3,040 5	-12.0	52.8	14 559 792 36	1 927 331 39	40° 5' 17 293 N	79° 58' 27
3,900 0	077	134 70	3,035 3	12.0	63.3	14 550 701 88	1 927 331 89	40° 5' 17 289 N	79° 58' 27
3,950.0	081	132 39	3,949 5	10.4	69.0	14,553,751 00	1 027 332 45	40° 5' 17 285 N	79° 58' 27
4,000 0	0.79	120.05	3,999.5	-138	228	14,000,101 41	1 007 222 40	40° 5' 17 281 N	70° 58' 27
4,050 0	0 81	128 25	4,049 5	-14 2	54 4	14,009,/91.08	1,921,333 03	40 0 17 201 N	70° 58' 07
4,090 0	078	147 61	4,089 5	-14 6	54 8	14,559,790 67	1,927,333 40	40 0 1/2//N	70 50 27
4,112 0	0 41	153 35	4,1 1 1 5	-14 8	54 9	14,559,790 48	1,927,333 51	40° 5' 17 275 N	19 56 21
4,177 0	1 20	13 40	4,176 5	-14 3	55 2	14,559,790 93	1,927,333 77	40° 5' 17 279 N	79° 58' 27
4,239 0	3 10	14 30	4,238 4	-12 1	55 7	14,559,793 19	1,927,334 34	40° 5' 17 301 N	79° 58' 27
4 335 0	5 30	11 50	4.334 2	-5 2	57 3	14,559,800 05	1,927,335 86	40° 5' 17 369 N	79° 58' 27
4 431 0	5 70	23.60	4,429 7	35	60 1	14,559,808 76	1,927,338 66	40° 5' 17 455 N	79° 58' 27
4,4010	7 80	27 50	4 525 1	13.6	65 0	14.559.818 91	1,927,343 57	40° 5' 17 554 N	79° 58' 26
4,527 0	0 20	34.00	4 6 1 9 0	25.7	72 2	14,559,830 99	1.927.350 84	40° 5' 17 673 N	79° 58' 26
4,022 0	3 30	39 70	4,0100	38.6	80.0	14 559 843 88	1 927 359 49	40° 5' 17 799 N	79° 58' 26
4,7170	9 50	3370	4,7127	64.3	077	14,550,860,60	1 927 376 26	40° 5' 18 052 N	79° 58' 26
4,906 0	920	32 50	4,099 2	704 3	105 2	14,000,000 00	1 027 383 77	40° 5' 18 170 N	79° 58' 26
5,001 0	8 00	31 30	4,993 2	704	100 2	14,000,001 00	1,027,000 77	40° 5' 19 290 N	79° 58' 26
5,095 0	9 30	30 80	5,086 1	665	112.0	14,009,093 //	1,927,391.00	40 5 10 200 N	70 50 20
5,285 0	9 90	35 00	5,273 4	115 1	1297	14,559,920 33	1,927,408 29	40° 5° 16 550 N	79 08 20
5,476 0	8 70	27 20	5,461 9	141 4	145 7	14,559,946 63	1,927,424 31	40° 5° 18 808 N	79 06 20
5,663 0	9 00	31 60	5,646 7	166 4	159 8	14,559,971 67	1,927,438 44	40° 5' 19 054 N	79" 58 25
5.854 0	9 60	32 30	5,835 2	192 6	176 2	14,559,997 86	1,927,454 78	40° 5' 19 311 N	79° 58' 25
6.045.0	9 00	30 60	6.023 7	218 9	192 3	14,560,024 18	1,927,470 90	40° 5' 19 569 N	79° 58' 25
6 233 0	10.40	31.00	6,209.0	246 1	208 5	14,560,051 38	1,927,487 12	40° 5' 19 836 N	79° 58' 25
6,2000	10 40	31.00	6 396 8	275.7	226.3	14,560,080 94	1,927,504 88	40° 5' 20 126 N	79° 58' 24
0,424 0	10 40	29 80	6 583 7	305.5	243.5	14 560 110 81	1,927,522,05	40° 5' 20 419 N	79° 58' 24
0,014 0	10.50	20 00	0,0007	227.6	762 7	14 560 142 85	1 927 541 34	40° 5' 20 734 N	79° 58' 24
6,805 0	12 10	33 00	0,7710	272 1	202 /	14,560,177,34	1 927 563 01	40° 5' 21 072 N	79° 58' 24
6,997 0	12 40	31 30	0,958 6	3/21	204 4	14 560 010 50	1 007 585 70	40° 5' 21 308 N	79' 58' 27
7,187 0	12 10	37 70	7,144 3	405 3	3072	14,000,210 00	1,927,000 /8	40° 5' 24 540 M	70° 50' 20
7,283 0	11 10	36 70	7,238 3	420 6	318 9	14,000,225 90	1,927,597 40	40 0 21 349 N	70 50 20
7,378 0	10 30	34 60	7,331 7	434 9	329 2	14,560,240 22	1,927,607 75	40° 5' 2'1 689 N	19 00 20
7,568 0	8 90	32 20	7,519 0	461 4	346 6	14,560,266 64	1,927,625 23	40° 5' 21 948 N	79" 58' 23
7,710 0	8 90	32 20	7,659 3	480 0	358 3	14,560,285 23	1,927,636 94	40° 5' 22 131 N	79° 58' 23
Marcollu	e								
7 752 7	800	32 20	7 701 5	485.6	361.9	14,560,290 83	1,927,640 46	40° 5' 22 185 N	79° 58' 23
1,1021	0.90	52 20	1,1010	100 0					
Onondog	ja Target i	311	7 007 5	400.0	270 7	14 560 304 97	1 027 6/0 20	40° 5' 22 323 N	79° 58' 22
7,860 0	8 90	32 20	7,807 5	499 6	3/0/	14,500,504 07	1,527,045.50	40 0 22 020 14	70 00 21
Onondag	a								
8.005 0	890	32 20	7,950 8	518 6	382 7	14,560,323 85	1,927,661 26	40° 5' 22 509 N	79° 58' 22
s 8 ga Tarç ga 8 ga 8	90 90 90 90	32 20 32 20 3H 32 20 32 20 32 20	7,659 3 7,701 5 7,807 5 7,950 8	480 0 485 6 499 6 518 6	361 9 370 7 382 7	14,560,290 83 14,560,304 87 14,560,323 85	1,927,640 46 1,927,649 30 1,927,661 26	40° 5' 22 185 N 40° 5' 22 323 N 40° 5' 22 509 N	79° 58' 23 79° 58' 22 79° 58' 22 79° 58' 22

ANTERO RESOURCES Project: Site: Well: Wellbore: Design:	Antero Res Washingtor Hopkins Pa Hill Unit 3H Directional Directional	ources Corporati 1 County Pennsyl d Pilot Hill Unit 3H Pilot Hill Unit 3H	nar Surve on vania	Local Co-or TVD Referen MD Referen North Refer Survey Calc Database:	Geographic dinate Reference: nce: ence: ence: ulation Method;	Well Hill Unit 3H - Slot 3 WELL @ 1196 Oft (Orginal Well Elev) WELL @ 1196 Oft (Original Well Elev) Grid Minimum Curvature EDMOKC	ing
Design Anno	tations Measured Depth (ft) 7,710 0 7,860 0	Vertica! Depth (ft) 7,659 3 7,807 5	Local Coord +N/-S (ft) 480 0 499 6	inates +E/-W (ft) 358 3 370 7	Comment Marcellus Onondaga		
Checked B	y:		Approv	/ed By:		Date:	
				• •			
							·
<u> </u>		<u> </u>		···· ·			



Antero Resources Corporation Washington County Pennsylvania Hopkins Pad

Hill Unit 3H - Slot 3

Horizontal Hill Unit 3H

Survey: Survey #1 MWD

Survey Report - Geographic

31 March, 2010





Antero Resources Corporation Washington County Pennsylvania Hopkins Pad

Hill Unit 3H - Slot 3

Directional Pilot Hill Unit 3H

Survey: Survey #2 MWD

Standard Survey Report

31 March, 2010

RECEIVED

MAY 1 9 2010 DEP, SOUTHWEST REGION OIL & GAS



ANTERO RESOURCES		۰,	`	Survey	Report			9	Scientific Drilling
Company: Ar Project: W Site: Ho Well: Hii Wellbore: Di	itero Resource ashington Cour pkins Pad I Unit 3H rectional Pilot I	s Corporation nty Pennsylvar -till Unit 3H	hia	Local Co TVD Refe MD Refe North Re Survey C	-ordinate Re erence: rence: ference: alculation M	ference:	Well Hill Unit 3 WELL @ 1196 WELL @ 1196 Grid Minimum Curv	H - Slot 3 i Oft (Original W i Oft (Original W ature	/ell Elev) /ell Elev)
Design: Di	rectional Pilot I	Hill Unit 3H		Database	9:		EDMOKC		
Project	Washington	County Penns	ylvania, SW Per	nsyivanla	·				
Map System: Geo Datum: Map Zone:	Universal Trai NAD 1927 - E Zone 17N (84	nsverse Merca astern US W to 78 W)	tor (US Survey I	Fee System) Datum:		Mean Sea Lev	/el	
Site	Hopkins Pad	, Pad Center							
Site Position: From: Position Uncertair	Map ity:	00 ft	Northing: Easting: Slot Radius:	14,55 1,92	9,794 17 ft 7,276 73 ft 0 "	Latitude: Longitud Grid Con	e: vergence:		40° 5' 17 317 N 79° 58' 27 850 W 0 66 °
	Hill Unit 3H -	Slot 3							
Well Position	+N/-S	0 O ft	Northing:		14,559,805	27 ft	Latitude:		40° 5' 17 427 N
Position Uncertair	+E/-W	00ft 00ft	Easting: Wellhead E	levation:	1,927,278 (1,196	60 ft 3 0 ft	Longitude: Ground Level		79° 58' 27 824 W 1,170 0 ft
Wellbore	Directional F	Pilot Hill Unit 3	Н						
Magnetics	Model Na	ame S	ample Date	Deci	lination	Di	p Angle (°)	Field (Strength nT)
	IGR	F2010	07/30/09		-9 07		67 79	·	53,195
Design	Directional F	Pilot Hill Unit 3	4				(
Audit Notes: Version:	10		Phase:	ACTUAL		Tie On Dept	h:		00
Vertical Section:		Depth Fr	om (TVD)	+N/-S (ff)	3	+E/-W (ft)	ſ	Direction (°)	
			00		0 0	00		36	3 28
Survey Program		Date 03/31/	/10						
From (ft)	To (ft)	Survey (Weill	oore)		Tool Name		Description		
50 0 4,112 0	4,090 0 8,005 0	Survey #1 Gyr Survey #2 MW	ro (Directional Pr /D (Directional P	ilot Hill Unit (Pilot Hill Unit	GYD-GC-SS SDI MWD		Gyrodata gyn SDI MWD/Ga	o single shots imma	
Survey									
Measured Depth (ft)	Inclination (°)	Azimuth (°)	Vertical Depth (ft)	+N/-S (ft)	+E/-W (ft)	Vertical Section (ft)	Dogleg Rate (°/100ft)	Build Rate (°/100ft)	Turn Rate (°/100ft)
4,090 0	0 78	147 61	4,089 5 4 111 5	-14 6 -14 8	54 8 54 9	20 7 20 6	0 00	0 00 -1 68	0 00 26 09
4,177 0	1 20	13 40	4,176 5	-14 3	55 2	21 1	2 36	1 22	-215 31
4,239 0	3 10	14 30	4,238 4	-12 1	55 7	23 2	3 06	306	1 45
4,335 0	5 30	עס דיד	4,004 2	-02	0/0	231	2 50	223	-2 72
4,431 0	5 70	23 60	4,429 7	35	60 1 65 0	384 404	128 224	0 42 2 10	12 60 4 06
4,527 0	7 80 9 30	27 50 34 00	4,619 0	257	72 2	63 5	1 88	1 58	6 84
4,717 0	9 50	33 70	4,7127	38 6	80 9	79 0	0 22	0 21	-0 32
4,906 0	9 20	32 50	4,899 2	64 3	97 7	109 6	0 19	-0 16	-003
								~~~	

ANTERO		'u [*] '		Survey	Report			1	Scientific Drilling		
Company:	Antero Resource	es Comoration			o.ordinete 7	oforener					
Project:	Washington Cou	inty Pennsylva	nia	TVD Re	o-orainate R eference:	eterence:	Well Hill Unit 3H - Slot 3 WELL @ 1196 Oft (Orioinal Well Flev)				
Site:	Hopkins Pad			MD Ref	erence:		WELL @ 119	6 Oft (Original	Well Elev)		
Wellbore:	Horizontal Hill U	nit 3H		North Reference: Grid Survey Calculation Method: Minimum Curvature							
Design:	-torizontal Hill U	nit 3H		Databa	se:	,	EDMOKC	valuie			
Project	Washington	County Penns	sylvania, SW Pen	nsylvania	~~						
Map System: Geo Datum: Map Zone:	Universal Tra NAD 1927 - E Zone 17N (84	insverse Merci Eastern US I W to 78 W)	ator (US Survey F	ec Syste	m Datum: ्		Mean Sea Le	evel			
Site	Hopkins Pad	d, Pad Center									
Site Position:			Northing:	14,5	i59,794 17 ft	Latitude			40° 5' 17 317 N		
From: Position Uncerta	Map intv:	00 #	Easting: Slot Radius:	1,9	27,276 73 ft	Longitu Grid Co	de:		79° 58' 27 850 W		
			- <u></u> -				Ivergence.				
Well	Hill Unit 3H -	Slot 3									
Well Position	+N/-S	00ft	Northing:		14,559,805	27 ft	Latitude:		40° 5' 17 427 N		
Position Uncerta	inty	00ft	Wellhead Ele	avation:	1,19	50 ft	Congitude: Ground Level	k	79" 58" 27 824 W 1,170 0 ft i		
Wellbore	Horizontal H	Hill Unit 3H									
Magnetics	Model Na	sme S	Sample Date	Dec	lination (°)	D	ip Angle (°)	Field	Strength (nT)		
	IGR	F2010	02/09/10		-9 08		67 74	1	53,130		
Design	Horizontal H	III Unit 3H									
Audit Notes:											
Version:	10		Phase:	ACTUAL		Tie On Depi	h:		7,187 0		
vertical Section:		Depth Fr (i	om (TVD) t)	+N/- (ft)	S	+E/-W (ft)	1	Direction (°)			
			0 0		00	00		336	6 12		
Erom	То	Date 03/31/	10								
(ft)	(ft)	Survey (Wellb	iore)		Tool Name		Description				
50 0	4,090 0	Survey #1 Gyr	o (Directional Pilo	ot Hill Unit :	GYD-GC-SS		Gyrodata gyro	o single shots			
4,112 0 7,246 0	7,187 0 13,003 0	Survey #2 MM Survey #1 MM	D (Directional Pil D (Horizontal Hill	ot Hill Unit Unit 3H)	SDI MWD SDI MWD		SDI MWD/Ge SDI MWD/Ge	umma Imma			
Survey											
Measured Depth (ft)	Inclination (°)	Azimuth (°)	Vertical Depth (ft)	+N/-S (ft)	+E/-W (ft)	Vertical Section (ft)	Dogleg Rate (°/100ft)	Build Rate (°/100ft)	Turn Rate (°/100ft)		
7,187 0	12 10	37 70	7,144 3	405 3	307 2	246 2	0 00	0 00	0 00		
7,246 0	11 95	37.50	7,202 0	415 0 420 5	314 7	252 1	0 26	-0 25	-0 34		
7,310 0	12 66	15 57	7,264 6	426 8	320 8	∡55 7 260 4	5 to 4 9 0 7	-0 25 2 47	-27 34 -41 19		
7,342 0	14 78	0 08	7,295 7	434 2	321 8	266 8	13 20	6 63	-48 41		
7,373 0 7 405 0	17 67	348 23	7,325 5	442 8	320 8	275 0	14 13	9 32	-38 23		
7,437 0	23 59	337 87	7,385 3	402 9 464 2	318 0	285 4 297 4	11 41 10 29	919 931	-2072 -1166		
7,468 0	27 24	335 33	7,413 3	476 4	308 5	310 7	12 29	11 77	-8 19		
/31/10 2 22 05PN	1			Pag	ge 2			COMF	PASS 5000 1 Build 41		

ANTERO RESOURCES	54) -	, t.p.t ,	Scienti	Survey I	g Interna Report	ational	Scientific Drilling				
Company: Project: Site: Well: Wellbore:	Antero Resources Washington Cour Hopkins Pad Hill Unit 3H Horizontal Hill Ur	s Corporation hty Pennsylvan	ia	Local Co TVD Refe MD Refe North Re Survey C	-ordinate Re Frence: rence: ference: alculation M	ference: lethod:	Well Hill Unit 3H - Slot 3 WELL @ 1196 Oft (Original Well Elev) WELL @ 1196 Oft (Original Well Elev) Grid Mananum Canzature				
Design:	Horizontal Hill Un	nt 3H		Database	*		EDMOKC				
Survey											
Measure Depth (ft)	id Inclination (°)	Azimuth (°)	Vertical Depth (ft)	+N/-S (ft)	+E/-W (ft)	Vertical Section (ft)	Dogleg Rate (°/100ft)	Build Rate (°/100ft)	Turn Rate (°/100ft)		
7,49	90 3095	333 82	7,440 4	490 0	302 1	325 8	12 20	11 97	-4 87		
7.53	10 34 40	333 50	7,467 3	505 5	294 4	343 0	10 79	10 78	-1 00		
7,56	30 3816	333 29	7,493 1	522 4	285 9	361 9	11 76	11 75	-0 66		
7,59	50 4159	333 56	7,517 7	540 7	276 7	382 4	10 73	10 72	0 84		
7,62	70 4511	335 13	7,541 0	560 5	267 2	404 4	11 50	11 00	4 91		
7,64 Landir	10 4673 IgPt3H	336 36	7,550 7	569 7	263 1	414 4	13 21	11 59	8 83		
7.65	80 4872	337 78	7,562 1	581 3	258 2	427 0	13 21	11 69	8 32		
7,69	00 5135	339 09	7,582 7	604 1	249 2	451 5	8 80	8 22	4 09		
7,72	10 5383	339 16	7,601 5	627 1	240 4	476 1	8 00	8 00	0 23		
7,75	30 57 20	338 89	7,619 6	651 7	231 0	502 4	10 55	10 53	-0 84		
7,78	50 5991	339 43	7,636 3	677 2	221 3	529 r	8 59	δ4/ 7.07	109		
7,81	60 62 38	340 57	7,651 3	702.8	212 0	500 0	) 0.09 9.85	/ 9/ 813	3 00		
7,84	80 64 98	341 82	7,665 5	(29 9 757 8	202 0	- 000 a 614 4	750	7 16	247		
7,88	00 6/2/	342 01	7,0704	/ D/ O 786 1	185 1	643 9	544	5 31	1 25		
7,94	40 6947	343 22	7,701 7	814 8	176 4	673 6	1 68	1 56	0 66		
7,97	60 71 21	343 15	7,712 5	843 6	167 6	703 5	5 44	5 44	-0 22		
8,00	80 7364	342 74	7,722 1	872 8	158 7	733 8	769	/ 59	-1 28		
8,04	00 7624	342 70	7,730 4	902.3	149 5	/04 0 705 F	i 013 769	7 69	-013		
8,07	20 /ช/ບ 40 8128	342 78	7 742 9	962.2	130 9	826 8	807	8 06	-0 41		
0,10	40 0120	3-72 00	1,1720	OUL L			,		-		
8,13	60 8521	342 43	7,746 7	992 5	121 4	858 4	12 30	12 28	-0 72		
8,18	60 <b>88 09</b>	341 09	7,749 6	1,039 9	105 7	908 1	635	5 76	-2 68		
8,28	20 87 05	338 19	7,753 7	1,129 8	72 4	1,003 8	321	-108	-3 02		
8,34	60 8890	338 83	7,756 0	1,1893	490	1,0077	7 064	2 09 0 50	0.41		
8,37	20 9909	220.90	1,150 5	1,2132	51 4	1,000 /	0.04	0.00	• • •		
8,47	30 8943	339 08	7,757 8	1,307 9	34	1,194 8	5 041	0 39	0 13		
8,56	90 8889	337 32	7,759 2	1,397 0	-32 2	1,290 4	192	-0 56	-1 83		
8,66	40 88 32	337 13	7,761 5	1,484 6	-69 0	1,385 4	1 0.63	-0 60	-0 20		
8,75 8.85	90 8893 40 8940	337 80 338 50	7,763 8 7,765 2	1,572 3 1,660 4	-105 4 -140 7	1,480 3 1,575 3	3 095 3 089	0 49	0 74		
8.95	00 8929	337 79	7,766 3	1,749 5	-176 5	1,671 :	2 075	-0 11	-0 74		
9,04	60 8926	338 64	7,767 5	1,838 7	-212 1	1,767	1 0.89	-0 03	0 89		
9,14	10 89 50	338 82	7,768 5	1,927 2	-246 6	1,862 (	) 0.32	0 25	0 19		
9,23	50 90 20	339 06	7,768 8	2,014 9	-280 3	1,955 \$	) 079	0 74	0 26		
9,32	80 88 96	337 88	7,769 4	2,101 4	-314 5	2,048	3 184	-1 33	-1 27		
9,42	30 88 42	337 59	7,771 6	2,189.3	-350 5	2,143	3 065	-057	-0.31		
9,51	80 8856	337 07	7,774 1	2,276.9	-387 1	2,230	7 025	0.21	0 13		
9,61	20 8876	33/19	7,7703	2,303 5	-423 0	2,332	6 036	0.24	0.26		
9,70	70 8899 20 8946	337 44	7 779 5	2,431 2	-400 2	2,522	5 0.51	0 49	-0 14		
0,00 9,00	70 8983	338.01	7,780 1	2.626 7	-532 9	2,617	6 0.83	0 39	0 74		
									10400 F000 4 Duda		

ANTERO RESOLIRCES	، ۱		Scient	Survey	ng Interr / Report	ational		9	Scientific Drilling	
Company: Project: Site: Well: Wellbore: Design:	Antero Resourc Washington Cou Hopkins Pad Hill Unit 3H Horizontal Hill U Horizontal Hill U	es Corporation unty Pennsylva nit 3H nit 3H	nia	Local C TVD Re MD Ref North R Survey Databas	o-ordinate R ference: erence: eference: Calculation M se:	eference: lethod:	Well Hill Unit 3H - Slot 3 WELL @ 1196 0ft (Original Well Elev) WELL @ 1196 0ft (Original Well Elev) Grid Minimum Curvature EDMOKC			
Survey										
Measure Depth (ft)	d Inclination (°)	Azimuth (°)	Vertical Depth (ft)	+N/-S (ft)	+E/-W (ft)	Vertical Section (ft)	Dogleg Rate (°/100ft)	Build Rate (°/100ft)	Turn Rate (°/100ft)	
9,992	0 8943	337 88	7,780 7	2,714 8	-568 5	2,712 5	0 4 4	-0.42	-0.14	
10,087	0 89.09	336 98	7,781 9	2,802 5	-605 0	2,807.5	1 01	-0 36	-0 95	
10,119	U 87 92	337 27	7,782 7	2,831 9	-617 4	2,839 5	3 77	-3 66	0 91	
10,182	υ 8748	337 56	7,785 3	2,890 1	-641 6	2,902 4	0 84	-0 70	0 46	
10.245	0 88.05	336 93	7 787 7	2 9/8 1	SSE O	3 065 C	4.6-			
10,276	0 87 75	337 61	7 788 9	2,340 1	-000 9	2,965 3	1 35	0 90	-1 00	
10,371	0 86 54	336 77	7,793.6	3 064 2	-0//9	2,996 3	2 40	-0 97	2 19	
10,465	0 86.84	336 22	7,799.0	3,150.2	-7147	3,0912	1 55	-1 27	-0 88	
10,560	0 86 74	337 03	7,804 3	3,237 3	-789 R	3,100 0	U 10/ 0.9/2	0 32	-0 59	
			-			0,2100	000	-011	085	
10,654	0 87 01	336 71	7,809 5	3,323 6	-826 6	3,373 7	0 45	0 29	-0.34	
10,749	0 87 31	336 09	7,814 2	3,410 5	-864 6	3,468 6	0 72	0 32	-0 65	
10,844	0 86 91	336 45	7,818 9	3,497 4	-902 8	3,563 5	0 57	-0 42	0 38	
11 032	0 8630	336 44	7,824 5	3,583 4	-940 3	3,657 3	0 65	-0 65	-0 01	
11,032	0 00 34	335.81	7,830.5	3,669 2	-978 1	3,751 1	0 50	0 04	-0 50	
11,095	0 86 47	335.96	7 834 5	3 726 7	-1 002 9	2 014 0				
11,127	0 86 20	336 28	7,836 5	3 755 9	-1,003.8	3,0140	0 21	0 21	-0 02	
11,190	0 86 81	336 69	7.840 4	3 813 5	-1 041 8	3,040 9	1 17	-0.84	100	
11,221	0 86 64	336 92	7,842 2	3,842.0	-1.054.0	3,000 0	1 17	097	0 65	
11,316	0 87 21	337 26	7,847 3	3,929 4	-1,090 9	4,034 6	0 70	0 60	0 36	
11,411	0 87 78	337 77	7,851 4	4,017 0	-1,127 2	4,129 5	0 80	0.60	0.54	
11,505	0, 8745	337 12	7,855 3	4,103 8	-1,163 2	4,223 4	0 77	-0 35	-0.69	
11,578	0 88.62	337 64	7,857 8	4,171 1	-1,191 3	4,296 3	1 75	1 60	071	
11,600	0 88 92	337 33	7,858 3	4,191 4	-1,199 7	4,318 3	196	1 36	-1 41	
11,094	0 88.92	337 01	7,860 1	4,278 1	-1,236 2	4,412 3	0 34	0 00	-0 34	
11,757	0 89.40	337 20	7 861 0	4 336 1	-1 260 7	4 475 0	0.00			
11,789	0 89 87	337 19	7,861 2	4,365 6	-1.273 1	4 507 2	1 47	076	0 30	
11,884	0 89 29	335 12	7,861 9	4,452 5	-1,311 5	4,602.2	1 47 2 26	147	-0.03	
11,915	90 13	334 67	7,862 0	4,480 5	-1,324 6	4.633 2	2 20	-001	-2 10	
11,947	9121	335 27	7,861 7	4,509 5	-1,338 2	4,665 2	3 86	3 38	188	
11.070		00	<b>-</b>							
11,9780	y 91.98	335 17	7,860 8	4,537 7	-1,351 1	4,696 2	2 50	2 48	-0 32	
12,0101	/ 92.12 ) 03.49	335 29	7,8597	4,566 7	-1,364 5	4,728 2	0 58	0 44	0 38	
12,041 (	> ⊎∠ib ) 0.1.₽≂	335 53	7,0585	4,594 8	-1,377 5	4,759 2	0 20	0 19	-0 06	
12.104 (	90 70	335 73	78587	4,0239	-1,390 8	4,7911	1 29	-1 03	0 78	
			1,0001	7,0JZ Z	-1,403 0	4,022 1	3 77	-3 71	0 68	
12,136 (	90 66	335 49	7,856 3	4,681 3	-1,416 8	4.854 1	0.76	-0 13	-0.75	
12,167 (	90 60	335 71	7,856 0	4,709 5	-1,429 6	4,885 1	0 74	-0 19	071	
12,199 (	90 48	335 58	7,855 7	4,738 7	-1,442 8	4,917 1	0 55	-0.38	-0.41	
12,262 (	90 47	336 10	7,855 1	4,796 2	-1,468 6	4,980 1	0 83	-0 02	0 83	
12,325 (	89 70	335 80	7,855 0	4,853 7	-1,494 3	5,043 1	1 31	-1 22	-0 48	
12,357 0	89 26	334 74	7,855 3	4,882 8	-1,507 7	5,075 1	3 59	-1 38	-3 31	
12,388 0	89 36	335 35	7,855 7	4,910 9	-1,520 7	5,106 1	1 99	0 32	1 97	
12,451 0	90 40	335 42	7,855 8	4,968 1	-1,547 0	5,169 1	1 65	1 65	0 11	
12,483 0	90 81	335 97	7,855 5	4,997 3	-1,560 2	5,201 1	2 14	1 28	1 72	
12,546 0	91 11	335 70	7,854 4	5,054 8	-1,585 9	5,264 1	0 64	0 48	-0 43	

ANTERO RESOURCES		· · · · · ·	fic Drilling International Survey Report						
Company: Project: Site: Well: Wellbore: Design:	Antero Resources Corporation Washington County Pennsylvania Hopkins Pad Hill Unit 3H Horizontal Hill Unit 3H Horizontal Hill Unit 3H			Local Co-ordinate Reference: TVD Reference: MD Reference: North Reference: Survey Calculation Method: Database:			Well Hill Unit 3H - Slot 3 WELL @ 1196 0ft (Original Well Elev) WELL @ 1196 0ft (Original Well Elev) Grid Minimum Curvature EDMOKC		
Survey Measure Depth (ft)	d inclination (°)	Azimuth	Vertical Depth (ft)	+N/-S (ft)	+E/-W (ft)	Vertical Section (ft)	Dogleg Rate (°/100ft)	Build Rate (°/100ft)	Turn Rate (°/100ft)
12,640 12,734 12,829 12,923 13,003 TGT Hil	0 90 40 0 88 99 0 90.00 0 88 93 0 88 93 Unit 3H	334 93 334 29 334 62 335 50 335 50	7,853 2 7,853 7 7,854 5 7,855 4 7,855 4 7,856 9	5,140 2 6,225 1 5,310 8 5,396 0 5,468 8	-1,625 2 -1,665 5 -1,706 5 -1,746 1 -1,779 3	5,358 1 5,452 0 5,547 0 5,641 0 5,720 9	1 11 1 65 1 12 1 47 0 00	-0 76 -1 50 1 06 -1 14 0 00	-0 82 -0 68 0 35 0 94 0 00
Checked By:			App	roved By:				Date:	
			,						
03/31/10 2 22 05	PM			Pa	ge 5	_		COL	MPASS 5000 1 Build