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west virginia department of environmental protection

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Office of Oil and Gas  
601 57th Street SE  
Charleston, WV 25304  
(304) 926-0450  
(304) 926-0452 fax

Earl Ray Tomblin, Governor  
Randy C. Huffman, Cabinet Secretary  
www.dep.wv.gov

## PERMIT MODIFICATION APPROVAL

November 02, 2015

ANTERO RESOURCES CORPORATION  
1615 WYNKOOP STREET  
DENVER, CO 80202

Re: Permit Modification Approval for API Number 8510179, Well #: JACKKNIFE UNIT 2H

### Move Surface Hole Location

Oil and Gas Operator:

The Office of Oil and Gas has reviewed the attached permit modification for the above referenced permit. The attached modification has been approved and well work may begin. Please be reminded that the oil and gas inspector is to be notified twenty-four (24) hours before permitted well work is commenced.

Please call James Martin at 304-926-0499, extension 1654 if you have any questions.

Sincerely,

A handwritten signature in black ink that reads "Gene Smith" followed by a flourish and the word "For".

Gene Smith  
Assistant Chief of Permitting  
Office of Oil and Gas

Promoting a healthy environment.

11/06/2015



October 21, 2015

Antero Resources  
1615 Wynkoop Street  
Denver, CO 80202  
Office 303.357.7310  
Fax 303.357.7315

West Virginia Department of Environmental Protection  
Office of Oil and Gas  
Attn: Mr. Taylor Brewer  
601 57<sup>th</sup> Street  
Charleston, WV 25304

Mr. Brewer:

Antero Resources Corporation (Antero) would like to submit the following permit modifications for two approved wells on the Buck Run pad. We are requesting to slightly change the surface hole locations of the Jackknife Unit 1H (API# 47-085-10178) and Jackknife Unit 2H (API# 47-085-10179). The location of the Buck Run pad will not change from what was originally approved, and there will be no additional disturbance associated with these requested modifications. Please note that there are no Coal Owners or Declarations on record with Ritchie County at this pad location; therefore, no notifications are required.

Attached you will find the following documents:

- REVISED Mylar Plats, which shows the new surface hole locations
- Form WW-6B – no change to approved casing plan

If you have any questions please feel free to contact me at (303) 357-7323.

Thank you in advance for your consideration.

Sincerely,

Ashlie Steele  
Permitting Supervisor  
Antero Resources Corporation

4708510179 MOD

Enclosures

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OCT 22 2015

WV Department of  
Environmental Protection

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WW-6B  
(04/15)

API# 47-085-10179 MODIFICATION  
API NO. 47- 085 - 10179  
OPERATOR WELL NO. Jackknife Unit 2H  
Well Pad Name: Buck Run Pad

STATE OF WEST VIRGINIA  
DEPARTMENT OF ENVIRONMENTAL PROTECTION, OFFICE OF OIL AND GAS  
WELL WORK PERMIT APPLICATION

1) Well Operator: Antero Resources Corporat 494488557 085 - Ritchie Clay Pennsboro 7.5'  
Operator ID County District Quadrangle

2) Operator's Well Number: Jackknife Unit 2H Well Pad Name: Buck Run Pad

3) Farm Name/Surface Owner: Stephen C. Jackson, et al Public Road Access: CR 74/9

4) Elevation, current ground: 1163' Elevation, proposed post-construction: 1127'

5) Well Type (a) Gas  Oil  Underground Storage

Other

(b)If Gas Shallow  Deep

Horizontal

6) Existing Pad: Yes or No No

7) Proposed Target Formation(s), Depth(s), Anticipated Thickness and Expected Pressure(s):  
Marcellus Shale: 6600' TVD, Anticipated Thickness- 75 feet, Associated Pressure- 2800#

8) Proposed Total Vertical Depth: 6600' TVD

9) Formation at Total Vertical Depth: Marcellus Shale

10) Proposed Total Measured Depth: 17,000' MD

11) Proposed Horizontal Leg Length: 9458'

12) Approximate Fresh Water Strata Depths: 115', 244', 462'

13) Method to Determine Fresh Water Depths: Offset well records. Depths have been adjusted according to surface elevations.

14) Approximate Saltwater Depths: 532', 1149', 1794'

15) Approximate Coal Seam Depths: 420', 557', 757'

16) Approximate Depth to Possible Void (coal mine, karst, other): None Anticipated

17) Does Proposed well location contain coal seams directly overlying or adjacent to an active mine? Yes  No

(a) If Yes, provide Mine Info: Name: \_\_\_\_\_

Depth: \_\_\_\_\_

Seam: \_\_\_\_\_

Owner: \_\_\_\_\_

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WW-6B  
(04/15)

API# 47-085-10179 MODIFICATION  
 API NO. 47- 085 - 10179  
 OPERATOR WELL NO. Jackknife Unit 2H  
 Well Pad Name: Buck Run Pad

18)

**CASING AND TUBING PROGRAM**

<b>TYPE</b>	<b>Size (in)</b>	<b>New or Used</b>	<b>Grade</b>	<b>Weight per ft. (lb/ft)</b>	<b>FOOTAGE: For Drilling (ft)</b>	<b>INTERVALS: Left in Well (ft)</b>	<b>CEMENT: Fill-up (Cu. Ft.)/CTS</b>
Conductor	20"	New	H-40	94#	40'	40'	CTS, 38 Cu. Ft.
Fresh Water	13-3/8"	New	J-55/H-40	54.5#/48#	515'	515' *see #19	CTS, 715 Cu. Ft.
Coal	9-5/8"	New	J-55	36#	2465'	2465'	CTS, 1004 Cu. Ft.
Intermediate							
Production	5-1/2"	New	P-110	20#	17,000'	17,000'	CTS, 4278 Cu. Ft.
Tubing	2-3/8"	New	N-80	4.7#		7100'	
Liners							

<b>TYPE</b>	<b>Size (in)</b>	<b>Wellbore Diameter (in)</b>	<b>Wall Thickness (in)</b>	<b>Burst Pressure (psi)</b>	<b>Anticipated Max. Internal Pressure (psi)</b>	<b>Cement Type</b>	<b>Cement Yield (cu. ft./k)</b>
Conductor	30"	24"	0.438"	1530	50	Class A	1.18
Fresh Water	13-3/8"	17-1/2"	0.38"/0.33"	2730/1730	1000	Class A	1.18
Coal	9-5/8"	12-1/4"	0.352"	3520	1500	Class A	1.18
Intermediate							
Production	5-1/2"	8-3/4" & 8-1/2"	0.361"	12,630	2500	Lead-H/POZ & Tail - H	H/POZ-1.44 & H-1.8
Tubing	2-3/8"	4.778"	0.19"	11,200			
Liners							

**PACKERS**

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Kind:	N/A			
Sizes:	N/A			
Depths Set:	N/A			

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WW-6B  
(10/14)

API NO. 47-085 - 10179

OPERATOR WELL NO. Jackknife Unit 2HWell Pad Name: Buck Run Pad

19) Describe proposed well work, including the drilling and plugging back of any pilot hole:

Drill, perforate, fracture a new horizontal shallow well and complete Marcellus Shale.  
\*Antero will be air drilling the fresh water string which makes it difficult to determine when freshwater is encountered, therefore we have built in a buffer for the casing setting depth which helps to ensure that all fresh water zones are covered.

20) Describe fracturing/stimulating methods in detail, including anticipated max pressure and max rate:

Antero plans to pump Slickwater into the Marcellus Shale formation in order to ready the well for production. The fluid will be comprised of approximately 99 percent water and sand, with less than 1 percent special-purpose additives as shown in the attached "List of Anticipated Additives Used for Fracturing or Stimulating Well."

Anticipated Max Pressure - 9300 lbs  
Anticipated Max Rate - 80 bpm

21) Total Area to be disturbed, including roads, stockpile area, pits, etc., (acres): 28.54 acres

22) Area to be disturbed for well pad only, less access road (acres): 10.27 acres

23) Describe centralizer placement for each casing string:

Conductor: no centralizers  
Surface Casing: one centralizer 10' above the float shoe, one on the insert float collar and one every 4th joint spaced up the hole to surface.  
Intermediate Casing: one centralizer above float joint, one centralizer 5' above float collar and one every 4th collar to surface.  
Production Casing: one centralizer at shoe joint and one every 3 joints to top of cement in intermediate casing.

24) Describe all cement additives associated with each cement type:

Conductor: no additives, Class A cement.  
Surface: Class A cement with 2-3% calcium chloride and 1/4 lb of flake  
Intermediate: Class A cement with 1/4 lb of flake, 5 gallons of clay treat  
Production: Lead cement- 50/50 Class H/Poz + 1.5% salt + 1% C-45 + 0.5% C-16a + 0.2% C-12 + 0.45% C-20 + 0.05% C-51  
Production: Tail cement- Class H + 45 PPS Calcium Carbonate + 1.0% FL-160 + 0.2% ACGB-47 + 0.05% ACSA-51 + 0.2% ACR-20

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25) Proposed borehole conditioning procedures:

Conductor: blowhole clean with air, run casing, 10 bbls fresh water.  
Surface: blowhole clean with air, trip to conductor shoe, trip to bottom, blowhole clean with air, trip out, run casing, circulate pipe capacity + 40 bbls fresh water followed by 25 bbls bentonite mud, 10 bbls fresh water spacer.  
Intermediate: blowhole clean with air, trip to surface casing shoe, trip to bottom, blowhole clean with air, trip out, run casing, circulate 40 bbls brine water followed by 10 bbls fresh water and 25 bbls bentonite mud, pump 10 bbls fresh water.  
Production: circulate with 14 lb/gal NaCl mud, trip to middle of lateral, circulate, pump high viscosity sweep, trip to base of curve, pump high viscosity sweep, trip to top of curve, trip to bottom, circulate, pump high viscosity sweep, trip out, run casing, circulate 10 bbls fresh water, pump 48 bbls barite pill, pump 10 bbls fresh water followed by 48 bbls mud flush and 10 bbls water.

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\*Note: Attach additional sheets as needed.

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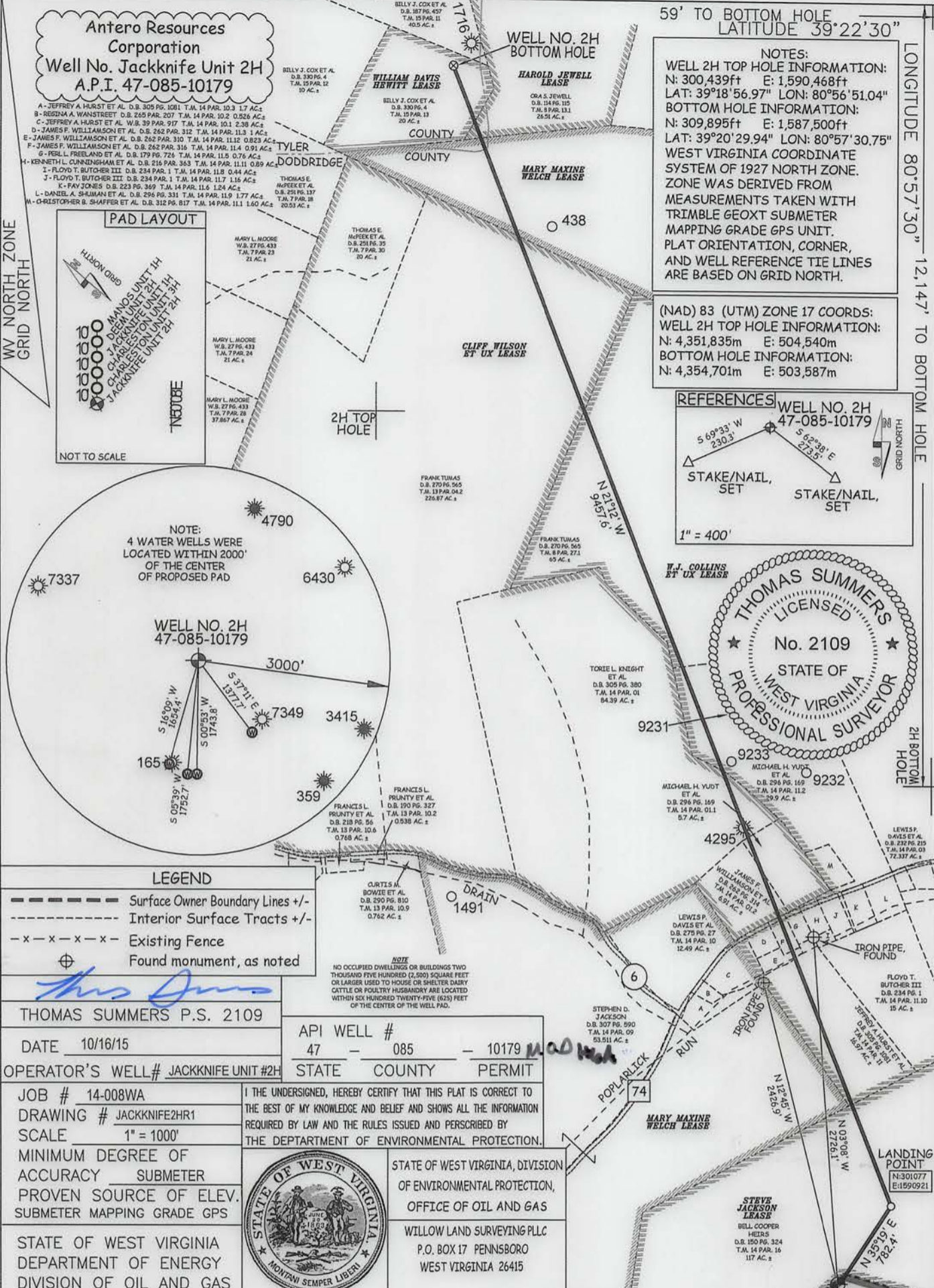
LATITUDE 39°20'00"

8,727'

59' TO BOTTOM HOLE  
LATITUDE 39°22'30"

LONGITUDE 80°57'30" 12,147' TO BOTTOM HOLE

6,378'  
LONGITUDE 80°55'00"



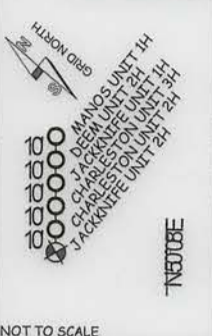
**Antero Resources Corporation**  
**Well No. Jackknife Unit 2H**  
**A.P.I. 47-085-10179**

**NOTES:**  
**WELL 2H TOP HOLE INFORMATION:**  
 N: 300,439ft E: 1,590,468ft  
 LAT: 39°18'56.97" LON: 80°56'51.04"  
**BOTTOM HOLE INFORMATION:**  
 N: 309,895ft E: 1,587,500ft  
 LAT: 39°20'29.94" LON: 80°57'30.75"  
 WEST VIRGINIA COORDINATE SYSTEM OF 1927 NORTH ZONE. ZONE WAS DERIVED FROM MEASUREMENTS TAKEN WITH TRIMBLE GEOXT SUBMETER MAPPING GRADE GPS UNIT. PLAT ORIENTATION, CORNER, AND WELL REFERENCE TIE LINES ARE BASED ON GRID NORTH.

**(NAD) 83 (UTM) ZONE 17 COORDS:**  
**WELL 2H TOP HOLE INFORMATION:**  
 N: 4,351,835m E: 504,540m  
**BOTTOM HOLE INFORMATION:**  
 N: 4,354,701m E: 503,587m

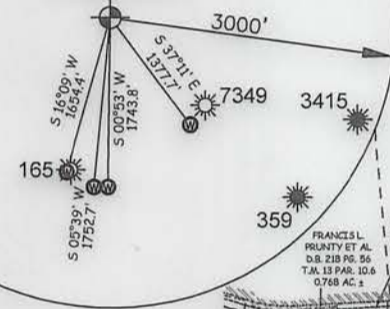


**PAD LAYOUT**



**NOTE:**  
 4 WATER WELLS WERE LOCATED WITHIN 2000' OF THE CENTER OF PROPOSED PAD

**WELL NO. 2H**  
**47-085-10179**



**LEGEND**

- Surface Owner Boundary Lines +/-
- - - Interior Surface Tracts +/-
- x - x - x - Existing Fence
- ⊕ Found monument, as noted

THOMAS SUMMERS P.S. 2109

DATE 10/16/15

OPERATOR'S WELL# JACKKNIFE UNIT #2H

API WELL # 47 - 085 - 10179  
 STATE COUNTY PERMIT

JOB # 14-008WA  
 DRAWING # JACKKNIFE2HR1  
 SCALE 1" = 1000'  
 MINIMUM DEGREE OF ACCURACY SUBMETER  
 PROVEN SOURCE OF ELEV. SUBMETER MAPPING GRADE GPS

I THE UNDERSIGNED, HEREBY CERTIFY THAT THIS PLAT IS CORRECT TO THE BEST OF MY KNOWLEDGE AND BELIEF AND SHOWS ALL THE INFORMATION REQUIRED BY LAW AND THE RULES ISSUED AND PERSCRIBED BY THE DEPARTMENT OF ENVIRONMENTAL PROTECTION.



STATE OF WEST VIRGINIA, DIVISION OF ENVIRONMENTAL PROTECTION, OFFICE OF OIL AND GAS  
 WILLOW LAND SURVEYING PLLC  
 P.O. BOX 17 PENNSBORO WEST VIRGINIA 26415

STATE OF WEST VIRGINIA DEPARTMENT OF ENERGY DIVISION OF OIL AND GAS

WELL TYPE: OIL GAS X LIQUID INJECTION WASTE DISPOSAL  
 (IF "GAS") PRODUCTION X STORAGE DEEP SHALLOW X  
 LOCATION: ELEVATION 1,163' ORIGINAL - 1,127' AS BUILT WATERSHED NORTH FORK HUGHES RIVER  
 QUADRANGLE PENNSBORO 7.5' DISTRICT CLAY COUNTY RITCHIE

SURFACE OWNER STEPHEN C. JACKSON ET AL ACREAGE 40.835 ACRES +/-  
 OIL & GAS ROYALTY OWNER HARVEY WEIGLE HEIRS; STEVE JACKSON; W.J. COLLINS ET UX; CLIFF WILSON ET UX; MARY MAXINE WELCH; HAROLD JEWELL; WILLIAM DAVIS HEWITT LEASE ACREAGE 51 ACRES±; 117 ACRES±; 576 ACRES±; 413 ACRES±; 76.43 ACRES±; 26.5 ACRES±; 20 ACRES±  
 PROPOSED WORK: DRILL X CONVERT DRILL DEEPER REDRILL FRACTURE OR STIMULATE X PLUG OFF OLD FORMATION PERFORATE NEW FORMATION X  
 OTHER PHYSICAL CHANGE IN WELL (SPECIFY) MOD-SHL  
 PLUG & ABANDON CLEAN OUT & REPLUG ESTIMATED DEPTH 6,600' TVD 17,000' MD  
 TARGET FORMATION MARCELLUS  
 WELL OPERATOR ANTERO RESOURCES CORP. DESIGNATED AGENT DIANNA STAMPER  
 ADDRESS 1615 WYNKOOP STREET ADDRESS 5400 D BIG TYLER ROAD  
 DENVER, CO 80202 CHARLESTON, WV 25313

11/06/2015