# Log ASCII Standard (LAS) files for geophysical wireline well logs and their application to geologic cross sections through the central Appalachian basin

By Robert D. Crangle, Jr.

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# Log ASCII Standard (LAS) files for geophysical wire line well logs and their application to geologic cross sections through the central Appalachian basin

By Robert D. Crangle, Jr.[1]

## Introduction

The U.S. Geological Survey (USGS) uses geophysical wireline well logs for a variety of purposes, including stratigraphic correlation (Hettinger, 2001, Ryder, 2002), petroleum reservoir analyses (Nelson and Bird, 2005), aquifer studies (Balch, 1988), and synthetic seismic profiles (Kulander and Ryder, 2005). Commonly, well logs are easier to visualize, manipulate, and interpret when available in a digital format.

In recent geologic cross sections *E-E'* and *D-D'*, constructed through the central Appalachian basin (Ryder, Swezey, and others, in press; Ryder, Crangle, and others, in press), gamma ray well log traces and lithologic logs were used to correlate key stratigraphic intervals (Fig. 1). The stratigraphy and structure of the cross sections are illustrated through the use of graphical software applications (e.g., Adobe Illustrator). The gamma ray traces were digitized in Neuralog (proprietary software) from paper well logs and converted to a Log ASCII Standard (LAS) format. Once converted, the LAS files were transformed to images through an LAS-reader application (e.g., GeoGraphix Prizm) and then overlain in positions adjacent to well locations, used for stratigraphic control, on each cross section.

This report summarizes the procedures used to convert paper logs to a digital LAS format using a third-party software application, Neuralog. Included in this report are LAS files for sixteen wells used in geologic cross section *E-E'* (Table 1) and thirteen wells used in geologic cross section *D-D'* (Table 2).

### History of LAS files and Neuralog

Prior to the introduction of the LAS format, geophysical well-log data were recorded on magnetic tape and reviewed in a non-standardized binary format. In 1990, the Canadian Well Logging Society designed the LAS ASCII-type system for local Canadian markets to standardize the binary format used to digitize well logs. The simplicity and flexibility of the LAS ASCII-type encoding quickly led to its worldwide acceptance and use (personal communication, Kenneth Heslop, Canadian Well Logging Society, 10/17/2005). As shown in figure 2, the LAS format often begins with a header, followed by columns of values that

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describe specific measurements (e.g., gamma ray log in API radiation units) at given depths (Canadian Well Logging Society, 1990, *http://cwls.org/docs/LAS12_Standards.txt*).

The Neuralog software program (Neuralog, Inc., 1992), is an autovectorizing application used to create LAS files. The application is capable of generating an LAS file from a scanned well-log, imported as an image file (e.g., Tagged Image File Format) and digitized through a combination of an autovectorizing algorithm and user-defined manual edits. Once vectorized, Neuralog converts the digital image to an LAS file, which can then be used in a variety of other LAS-reader applications (e.g., GeoGraphix Prizm, Microsoft Excel, GeoTools QuickSyn, etc.). The conversion of a paper well log to a digital LAS file through Neuralog is quite useful, particularly for older logs where original digital data is limited or nonexistent.

## Procedures used to create LAS files

Gamma ray logs, used to construct geologic cross sections *E-E'* and *D-D'* (Fig. 1), were converted to LAS-format files through Neuralog. The LAS files, included in Tables 1 and 2, were created from scanned Tagged Image File Format (TIFF) files (Fig. 3) that were in turn converted to an LAS format (text file) via Neuralog. Once transformed to an LAS format, the file was accessible in an LAS viewer (e.g., GeoGraphix Prizm) where it was exported as a Windows Metafile format (WMF) image file. A graphical illustration application (e.g., Adobe Illustrator), was used to import the WMF file for further editing, which included scaling and placement (Fig. 4). Multiple quality-check verifications were made throughout the process to insure consistency between the original paper logs and the newly created digital logs.

Prior to the development of Neuralog, non-digital geophysical well logs were scanned, saved as TIFF files, manually traced in a graphical illustration application and placed within an appropriate stratigraphic cross-section illustration (e.g., Hettinger, 2001, Ryder 2002). This process produced vectorized, editable images, but no usable coordinates (e.g., X,Y data). With Neuralog, a more accurate and fully editable image, coupled with a trans-application digital data file, is achieved. The Neuralog vectorization process offers a significant savings in time and the resultant LAS data file may be used in a variety of other applications.

## Results and Conclusion

The autovectorization and LAS conversion of paper geophysical wireline well logs provides significant assistance in the correlation, creation, presentation, and digitization of geologic cross sections (Fig. 4). The integration of Neuralog, an LAS-file reader, and a graphical illustration application offers an effective and accurate process whereby non-digital paper well logs are converted to digital LAS files. These same procedures will be used to produce digital images of geophysical well logs for additional cross sections in the Appalachian basin and other localities.

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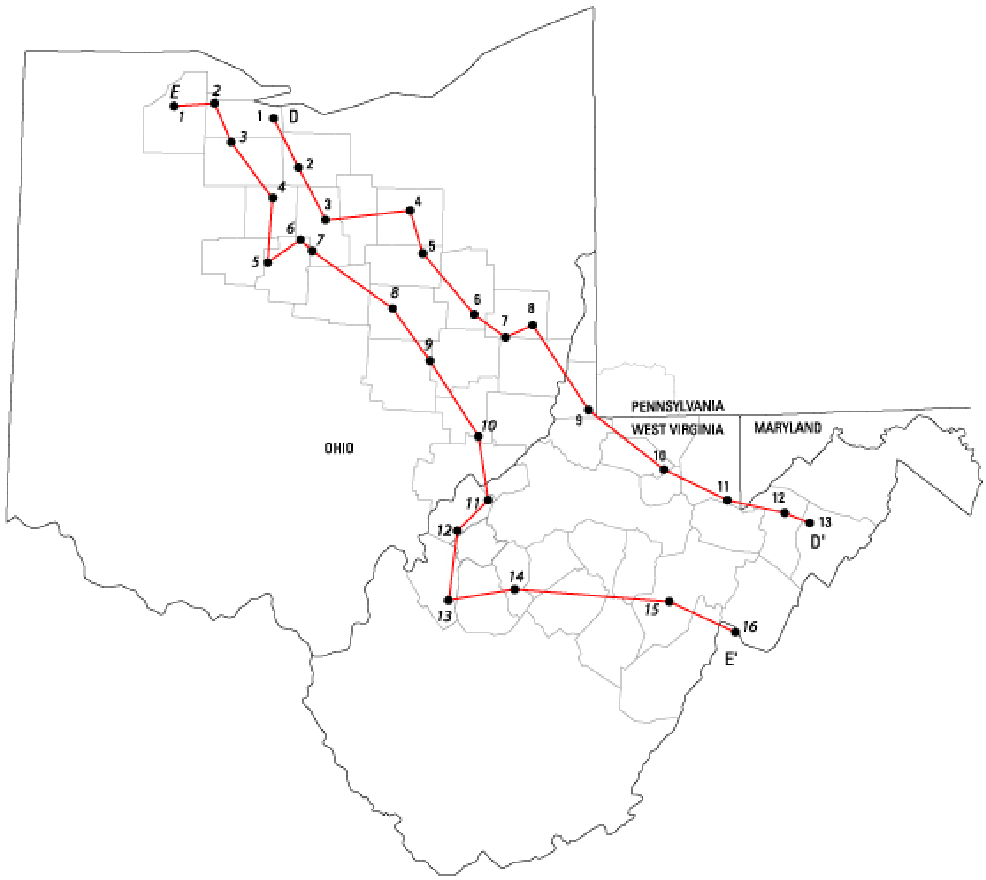


**Figure 1.** Location map for regional cross-sections *D-D'* and *E-E'* (red lines). Well locations represented as black dots, numbers correspond to well data listed in Tables 1 and 2.

```
~Version Information Block
      VERS.          2.00:    CWLS LOG ASCII STANDARD - VERSION 2.000000

      WRAP.           NO:     One Line Per Depth Step
     #
     ~Well Information Block
     #MNEM.UNIT               Data                 Information
     #----------   -----------------------------------------   ----------------
      STRT.FT                          0.0000:
      STOP.FT                       4900.0000:
      STEP.FT                          0.5000:
      NULL.                         -999.2500:
      COMP.                                   :    COMPANY
      WELL.                                   :    WELL
      FLD .                                   :    FIELD
      CNTY.                                   :    COUNTY
      STAT.                                   :    STATE
      CTRY.                                   :    COUNTRY
      SRVC.                                   :    SERVICE COMPANY
      DATE.                                   :    DATE
      API .                                   :    API NUMBER
      UWI .                                   :    UWI NUMBER
     #
     ~Curve Information Block
     #MNEM.UNIT      API CODE      Curve Description
     #----------    -------------   -------------------
      DEPT.FT                :  Depth in Feet
      GR  .GAPI              :  Gamma Ray
     ~A   DEPTH    GR
     120.500    117.200
       121.000    116.659
       121.500    116.113
       122.000    115.507
       122.500    116.460
       123.000    117.800
       123.500    118.816
       124.000    120.412
       124.500    121.232
       125.000    120.870
       125.500    120.082
       126.000    117.829
       126.500    114.186
       127.000    110.841
       127.500    107.667
       128.000    105.404
       128.500    105.983
       129.000    107.432
       129.500    107.165
       130.000    105.354
       130.500    103.670
       131.000    103.320
       131.500    102.851
       132.000    103.122
       132.500    105.247
       133.000    105.870
       133.500    105.277
       134.000    105.220
       134.500    103.633
       135.000    101.787
       135.500    101.037
       136.000     99.255
       136.500     97.193
       137.000     94.774
       137.500     91.366
       138.000     89.754
       138.500     89.344
       139.000     89.148
       139.500     90.939
       140.000     93.301
       140.500     95.354
```

**Figure 2.** Example of an LAS file of gamma ray data for the #1 Windbigler well, Morrow County, OH. Selected data from a depth range of 120.5 to 140.5 feet.

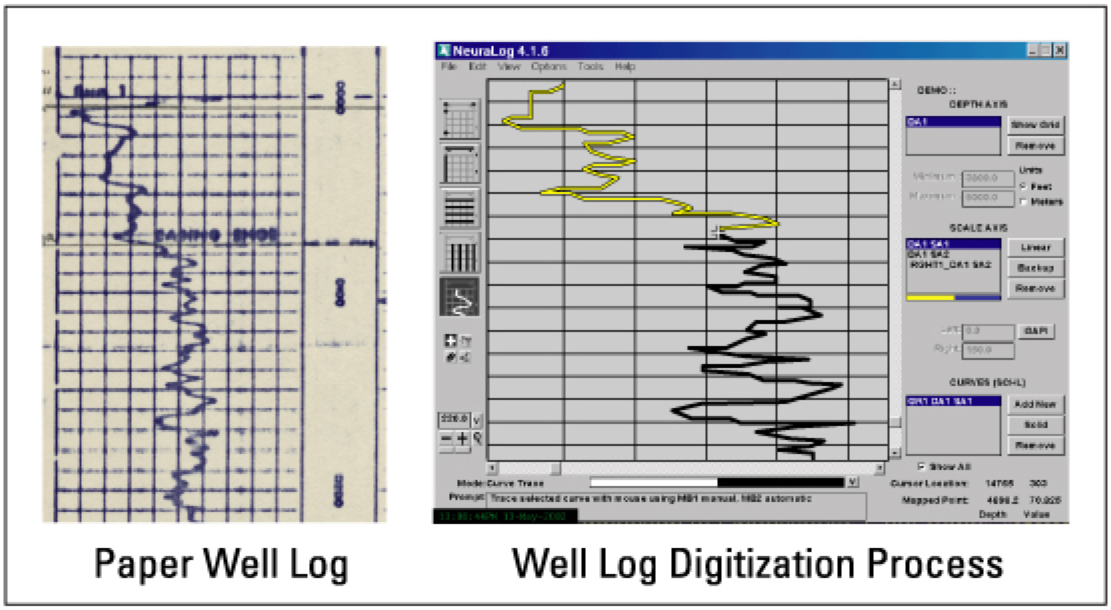


**Figure 3.** Selected segment of the Windbigler #1 gamma ray log used to define lithology and correlate stratigraphy. The image file (left) was imported into Neuralog where it was traced, digitized (right), and converted to an LAS file. The resulting LAS file (Fig. 2) was imported into GeoGraphix Prizm, where it was converted to a digital image, exported as a WMF image file, then imported into Adobe Illustrator and included as part of the geologic cross section *E-E'*. The resolution for this figure is compromised due to the original condition of the paper well log and the original native resolution of the Neuralog screen-capture.

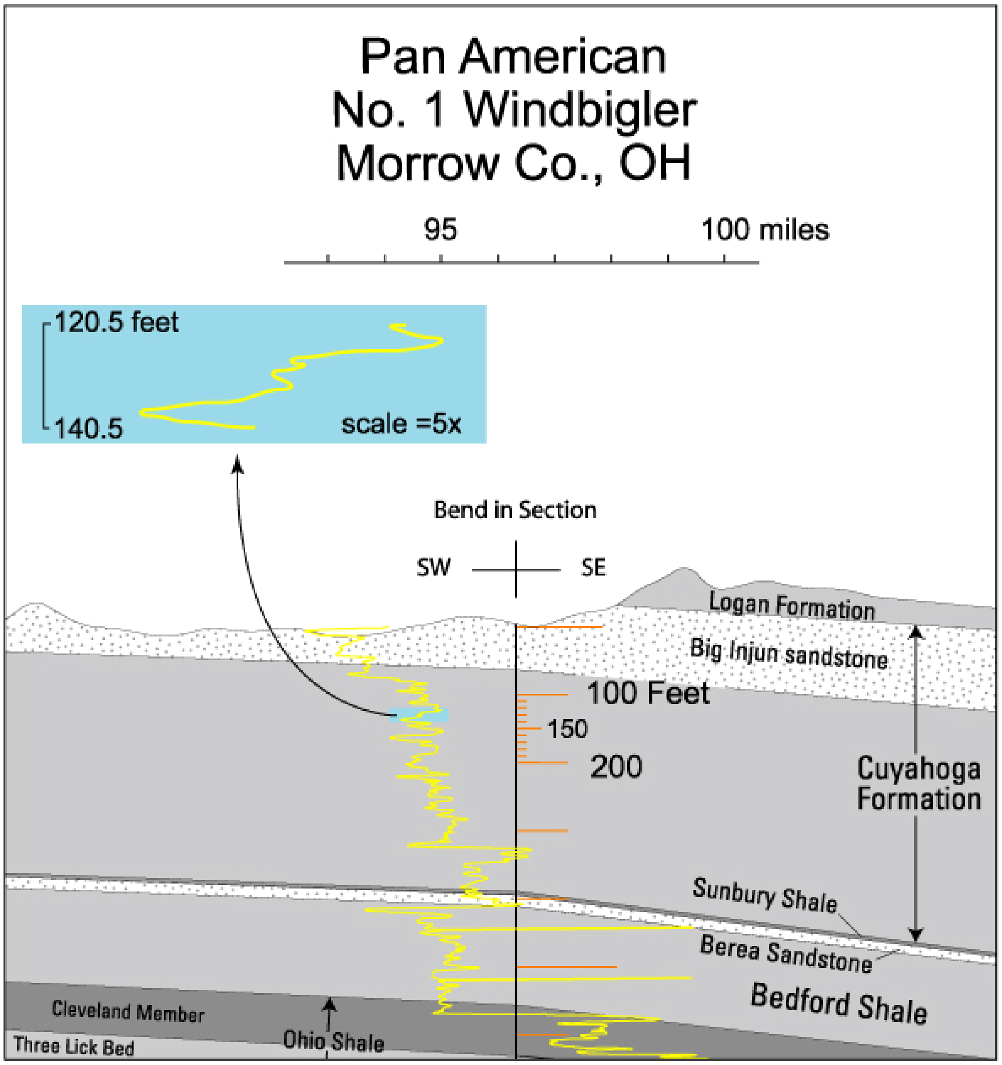


**Figure 4.** Selected segment of geologic cross section E-E' showing the location of the No. 1 Windbigler well and a digitized gamma ray log of the well (yellow). The area in blue corresponds to the data shown in figures 2 and 3.

**Table 1. Sixteen Log ASCII Standard (LAS) files for geologic cross section E-E' through the Appalachian basin from Wood County, Ohio, to Pendleton County, West Virginia**

| Well # | File Name | Well Name | Location | API No. | Latitude | Longitude | TD (ft) | Date(s) of log run(s) | LAS Interval (ft) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | A_KM_ark_oil | Kin-Ark Oil Co. No.1 Carter | Center Township, Wood County, OH, Dunbridge, OH 7.5' quadrangle | 34-173-20237 | 41.415 | -83.609 | 2,821 | 1/11/1965 (Run 1, GR-N) | 0-2,800 |
| 2 | A_Kerbel_1 (LAS file from Ohio Geological Survey, http://www.ohiodnr.com/geosurvey/ogcim/petrol/dlg.htm) | Russell Maguire No.1 Paul Kerbel | Woodville Township, Sandusky County, OH, Elmore, OH 7.5' quadrangle | 34-143-20147 | 41.438 | -83.317 | 2,785 | 11/29/1965 (Run 1, GR-N) | 100.5-2,779.5 |
| 3 | A_M_and_B_Asphalt | Ohio Dept. of Nat. Resources M and B Asphalt Co. | Liberty Township, Seneca County, OH, Tiffin North, OH 7.5' quadrangle | 34-147-60840 | 41.226 | -83.199 | 2,870 | 1985 (Run 1, GR-N) | 0-2,850 |
| 4 | A_Leonhardt (LAS file from Ohio Geological Survey, http://www.ohiodnr.com/geosurvey/ogcim/petrol/dlg.htm) | HL Hawkins & HL Hawkins, Jr. No.1 VE Leonhardt | Chatfield Township, Crawford County, OH, Chatfield, OH 7.5' quadrangle | 34-033-20050 | 40.910 | -82.883 | 3,772 | 10/11/1965 (Run 1, GR-N) | 100-3,772 |
| 5 | A_Myers_A | United Producing Co No.3 Orrie Myers (O & E Myers) | Canaan Township, Morrow County, OH, Denmark, OH 7.5' quadrangle | 34-117-20012 | 40.571 | -82.920 | 4,100 | 7/16/1965 (Run 1) | 0-3,100 |
| 5 | A_Myers_B | United Producing Co No.3 Orrie Myers (O & E Myers) | Canaan Township, Morrow County, OH, Denmark, OH 7.5' quadrangle | 34-117-20012 | 40.571 | -82.920 | 4,100 | 7/26/1965 (Run 2) | 2,900-4,100 |
| 6 | A_Windbigler | Pan American Petroleum Corp. No.1 AC Windbigler | Troy Township, Morrow County, OH, Blooming Grove, OH 7.5' quadrangle | 34-117-20047 | 40.690 | -82.682 | 4,890 | 10/13/1962 (Run 1) 11/3/1962 (Run 2) | 0-4,100 |
| 7 | A_Palmer | Pan American No.1 J Palmer | Troy Township, Richland County, OH, Mansfield South, OH 7.5' quadrangle | 34-139-20289 | 40.648 | -82.590 | 4,775 | 2/28/1964 (Run 1, GR-N), 3/18/1964 (Run 2, GR-N) | 0-4,900 |
| 8 | A_Lee | Bob Tatum No.1 Edwin L Lee | Jefferson Township, Coshocton County, OH, Warsaw, OH 7.5' quadrangle | 34-031-22053 | 40.323 | -82.001 | 6,970 | 6/16/1971 (Run 1, FDC-GR) | 100-6,970 |
| 9 | A_Marshall | Lakeshore Pipeline No.1 WR Marshall | Adams Township, Guersey County, OH, Bloomfield, OH 7.5' quadrangle | 34-059-20782 | 40.037 | -81.720 | 8,602 | 4/17-18/1961 (Run 1, L-GR-N), 5/31/1961 (Run 2, L-GR-N) | 100-8,650 |
| 10 | A_Ullman (LAS file from Ohio Geological Survey, http://www.ohiodnr.com/geosurvey/ogcim/petrol/dlg.htm) | Amerada No.1 Robert Ullman | Elk Township, Noble County, OH, Dalzell, OH 7.5' quadrangle | 34-121-21278 | 39.611 | -81.347 | 11,442 | 8/16/1966 (Run 1, GR-N), 10/19/1966 (Run 2, FDC-GR), 12/9/1966 (Run 3, GR-N) | 0-11,450 |
| 11 | A_Hope_Power | Hope Natural Gas No.9634 Power Oil Co. | Walker District, Wood County, WV, Willow Island, WV 7.5' quadrangle | 47-107-00351 | 39.255 | -81.272 | 13,327 | 1/13-14/1955 (Run 3-GR) | 100-12,300 |
| 12 | A_Deem | Exxon Corporation No.1 Howard H Deem Et Ux | Steele District, Wood County, WV, Rockport, WV 7.5' quadrangle | 47-107-00756 | 39.081 | -81.508 | 13,266 | 10/13/1976 (Run 1,IGR), 10/28/1976 (Run 2, IGR), 11/22/1976 (Run 3, IGR), 11/29/1976 (Run 4, IGR) | 100-13,200 |
| 12 | A_Deem_B | Exxon Corporation No.1 Howard H Deem Et Ux | Steele District, Wood County, WV, Rockport, WV 7.5' quadrangle | 47-107-00756 | 39.081 | -81.508 | 13,266 | 10/13/1976 (Run 1,IGR), 10/28/1976 (Run 2, IGR), 11/22/1976 (Run 3, IGR), 11/29/1976 (Run 4, IGR) | 8,800-13,240 |
| 13 | A_McCoy | Exxon Corporation No.1 Walter McCoy Et Al | Washington District, Jackson County, WV, Kentuck, WV 7.5' quadrangle | 47-035-01366 | 38.731 | -81.569 | 17,675 | 4/21/1975 (Run 1, FDC-GR-N), 8/26/1975 (Run 2, FDC-GR-N) | 0-17,700 |
| 14 | A_Gainer_Lee | Exxon Corporation No.1 Gainer-Lee | Center District, Calhoun County, WV, Grantsville, WV 7.5' quadrangle | 47-013-02503 | 38.875 | -81.098 | 20,222 | 10/8/1973 (Run 1, IGR), 11/29/1973 (Run 1, FDC-GR), 1/13/1974 (Run 1, FDC-GR-N), 1/13/1974 (Run 2, FDC-GR), 2/10/1974 (Run 2, BCS-GR), | 0-20,250 |
| 14 | A_Gainer_Lee_B | Exxon Corporation No.1 Gainer-Lee | Center District, Calhoun County, WV, Grantsville, WV 7.5' quadrangle | 47-013-02503 | 38.875 | -81.098 | 20,222 | 3/2/1974 (Run 3, BCS-GR), 3/2/1974 (Run 3, FDC-GR), 5/4/1974 (Run 4, BCS-GR), 5/4/1974 (Run 4, FDC-GR), 1974 (Run 5, BCS-GR), 1974 (Run 5, FDC-GR) | 11,000-20,211 |
| 15 | A_W_VA_Med_Security_Prison_A | Hope Natural Gas No.10228 WV Board of Control | Huttonsville District, Randolph County, WV, Mill Creek, WV 7.5' quadrangle | 47-083-00103 | 38.707 | -79.969 | 13,121 | 5/8/1959 (Run 1, L-GR), 5/31/1959 (Run 2, GR) | 0-6,300 |
| 15 | A_W_VA_Med_Security_Prison_B | Hope Natural Gas No.10228 WV Board of Control | Huttonsville District, Randolph County, WV, Mill Creek, WV 7.5' quadrangle | 47-083-00103 | 38.707 | -79.969 | 13,121 | 11/17/1959 (Run 3, GR), 2/22/1960 (Run 2, L-GR-N) | 6,300-13,100 |
| 16 | A_Sponangle | United Fuel Gas Co. 8800-T No.1 Ray Sponaugle | Circleville District, Pendleton County, WV, Snowy Mtn, WV 7.5' quadrangle | 47-071-00006 | 38.548 | -79.513 | 13,000 | 7/15/1960 (Run 1, L-G, R-N) | 0-13,000 |

**Scale, units, and depths for Gamma Ray logging runs:**

| Well No. | Scale and Units | Depths of Selected Logged Intervals | Casing Shoe Location(s) | Notes |
|---|---|---|---|---|
| 1 | 0-200 API units<br>200-400 backup scale | About 74 feet below Kelly Busing (KB) to Total Depth (TD) | | |
| 2 | 0-200 API units<br>200-400 backup scale | 100 feet below KB to TD | | |
| 3 | 0-200 API units | Ground level (GL) to TD | | |
| 4 | 0-200 API units<br>200-400 backup scale | 100 feet below KB to TD | | |
| 5 | 0-10 (no units, probably in micrograms of Radium equivalent per metric ton (μgm Ra-eq/ton)<br>10-20 backup scale | About 9 feet below KB to TD | 1,245 feet below KB | |
| 6 | 0-200 API units<br>200-400 backup scale | About 12 feet below KB to TD | 75 feet below KB | |
| 7 | 0-200 API units<br>200-400 backup scale | 100 feet below KB to TD | 810 feet below KB | |
| 8 | 0-200 API units<br>200-400 backup scale | 100 feet below KB to TD | 520 feet below KB | |
| 9 | 0-10 (μgm Ra-eq/ton?)<br>10-20 backup scale | 100 feet below KB to 4,790 feet | 1,395 feet below KB | |
| | 0-8 (μgm Ra-eq/ton?)<br>8-16 backup scale | 4,790 feet to TD | 4,790 feet below KB | |
| 10 | 0-200 API units<br>200-400 backup scale | About 13 feet below KB to TD | 116 feet below KB<br>2,006 feet below KB<br>6,891 feet below KB | |
| 11 | 0-10 μgm Ra-eq/ton | About 65 feet below KB to 12,330 feet | | |
| | | 12,330 feet to TD | | Spontaneous Potential log (milivolts) not shown |
| 12 | 0-200 API units<br>200-400 backup scale<br>(no scale change noted between logging runs) | logging run 2: 2,390 to 8,710 feet<br>logging run 3: 8,730 to 12,810 feet<br>logging run 4: 12,810 feet to TD | | |
| 13 | 0-150 API units 150-300 backup scale | About 28 feet below KB to TD | | |
| 14 | 0-120 API units | About 27 feet below KB to 2,643 feet | | |
| | 0-250 API units | 2,670 to 8,190 feet | | |
| | 0-200 API units | 8,190 to 10,850 feet | | |
| | 0-250 API units | 10,850 to 11,020 feet | | |
| | 0-150 API units | 11,020 feet to TD | | |
| 15 | 0-15 (μgm Ra-eq/ton?) | About 14 feet below KB to 6,300 feet | | |
| | 0-16 (μgm Ra-eq/ton?) | 6,300 feet to TD | | |
| 16 | 0-12.5 (μgm Ra-eq/ton?) | 100 feet below KB to TD | | |

**Table 2. Log ASCII Standard (LAS) files for geologic cross section D-D' through the Appalachian basin from Sandusky County, Ohio, to Hardy County, West Virginia**

| Well # | File Name | Well Name | Location | API No. | Latitude | Longitude | TD (ft) | LAS Interval (ft) |
|---|---|---|---|---|---|---|---|---|
| 1 | Haff_GRNeutron.las | East Ohio Gas Company No. 1-2171 Haff, V & I | TownsendTownship, Sandusky Co., OH<br>Clyde, OH 7.5' Quadrangle | 34-143-20077 | 41.371 | -82.907 | 3,123 | 0-3,200 |
| 2 | Wheeler_GR.las | Pure Oil Company No. 1 Wheeler, I.M. | GreenfieldTownship, Huron Co., OH<br>Willard, OH 7.5' Quadrangle | 34-077-20025 | 41.106 | -82.704 | 3,865 | 100-3,900 |
| 3 | Empire_Reeves.las | Empire Reeves Steel No. D-1 Empire Reeves Steel Division | MadisonTownship, Richland Co., OH<br>Mansfield North, OH 7.5' Quadrangle | 34-139-20448 | 40.779 | -82.519 | 5,085 | 0-5,100 |
| 4 | Drake.las | Great Lakes Gas Corporation No. 1 Drake, Alonzo, Jr. | WayneTownship, Wayne Co., OH<br>Wooster, OH 7.5' Quadrangle | 34-169-21419 | 40.860 | -81.906 | 6,897 | 100-6,870 |
| 5 | Troyer_first_part.las | Parker & Chapman No. 1 Dan E Troyer | SaltcreekTownship, Holmes Co., OH<br>Fredericksburg, OH 7.5' Quadrangle | 34-075-21283 | 40.657 | -81.772 | 7,369 | 100-7,000 |
| 5 | No_1_Troyer_last_300.las | Parker & Chapman No. 1 Dan E Troyer | SaltcreekTownship, Holmes Co., OH<br>Fredericksburg, OH 7.5' Quadrangle | 34-075-21283 | 40.657 | -81.772 | 7,369 | 7,000-7,350 |
| 6 | HuebnerGR.las | Stocker & Sitler, Inc. No. 2 (1-2669) Huebner | RushTownship, Tuscarawas Co., OH<br>Gnadenhutton, OH 7.5' Quadrangle | 34-157-21030 | 40.304 | -81.425 | 8,227 | 100-8,250 |
| 7 | Zechman_A.las | Red Hill Development No. 1 Zechman, Thomas | MoorefieldTownship, Harrison Co., OH<br>Piedmont, OH 7.5' Quadrangle | 34-067-20737 | 40.195 | -81.197 | 10,625 | 6,395-10,596 |
| 7 | Zechman_B.las | Red Hill Development No. 1 Zechman, Thomas | MoorefieldTownship, Harrison Co., OH<br>Piedmont, OH 7.5' Quadrangle | 34-067-20737 | 40.195 | -81.197 | 10,625 | 800-6,500 |
| 8 | Birney_A.LAS | McCormick Sanford E No. 1 Birney, Roy | GreenTownship, Harrison Co., OH<br>Cadiz, OH 7.5' Quadrangle | 34-067-20103 | 40.262 | -80.966 | 10,181 | 72-10,204 |
| 8 | Birney_B.las | McCormick Sanford E No. 1 Birney, Roy | GreenTownship, Harrison Co., OH<br>Cadiz, OH 7.5' Quadrangle | 34-067-20103 | 40.262 | -80.966 | 10,181 | 8,900-10,050 |
| 9 | Burley1.las | Sanford E McCormick No. 1 John Burley | Liberty District, Marshall Co., WV<br>Cameron, WV 7.5' Quadrangle | 47-051-00539 | 39.762 | -80.530 | 16,512 | 50-10,500 |
| 9 | Burley2.las | Sanford E McCormick No. 1 John Burley | Liberty District, Marshall Co., WV<br>Cameron, WV 7.5' Quadrangle | 47-051-00539 | 39.762 | -80.530 | 16,512 | 10,500-14,500 |
| 9 | Burley3.las | Sanford E McCormick No. 1 John Burley | Liberty District, Marshall Co., WV<br>Cameron, WV 7.5' Quadrangle | 47-051-00539 | 39.762 | -80.530 | 16,512 | 14,500-16,500 |
| 10 | Finch_A.las | Phillips Petroleum Co. No. A-1 (A-1251) R.R. Finch | Winfield District, Marion Co., WV<br>Fairmont East, WV 7.5' Quadrangle | 47-049-00244 | 39.432 | -80.012 | 17,111 | 0-10,500 |
| 10 | Finch_B.las | Phillips Petroleum Co. No. A-1 (A-1251) R.R. Finch | Winfield District, Marion Co., WV<br>Fairmont East, WV 7.5' Quadrangle | 47-049-00244 | 39.432 | -80.012 | 17,111 | 10,000-12,100 |
| 10 | Finch_C.las | Phillips Petroleum Co. No. A-1 (A-1251) R.R. Finch | Winfield District, Marion Co., WV<br>Fairmont East, WV 7.5' Quadrangle | 47-049-00244 | 39.432 | -80.012 | 17,111 | 12,100-14,900 |
| 10 | Finch_D.las | Phillips Petroleum Co. No. A-1 (A-1251) R.R. Finch | Winfield District, Marion Co., WV<br>Fairmont East, WV 7.5' Quadrangle | 47-049-00244 | 39.432 | -80.012 | 17,111 | 14,800-16,000 |
| 10 | Finch_E.las | Phillips Petroleum Co. No. A-1 (A-1251) R.R. Finch | Winfield District, Marion Co., WV<br>Fairmont East, WV 7.5' Quadrangle | 47-049-00244 | 39.432 | -80.012 | 17,111 | 15,900-17,000 |
| 10 | Finch_F.las | Phillips Petroleum Co. No. A-1 (A-1251) R.R. Finch | Winfield District, Marion Co., WV<br>Fairmont East, WV 7.5' Quadrangle | 47-049-00244 | 39.432 | -80.012 | 17,111 | 16,900-17,100 |
| 11 | Q-1_A.las | Columbia Fuel Corp. No. USA Q-1, GW-1466 Monogahela National Forest | Union District, Preston Co., WV<br>Lead Mine, WV 7.5' Quadrangle | 47-077-00119 | 39.238 | -79.573 | 9,910 | 0-7,550 |
| 11 | Q-1_B.las | Columbia Fuel Corp. No. USA Q-1, GW-1466 Monogahela National Forest | Union District, Preston Co., WV<br>Lead Mine, WV 7.5' Quadrangle | 47-077-00119 | 39.238 | -79.573 | 9,910 | 7,700-10,000 |
| 11 | Q-1_GR_D_final.las | Columbia Fuel Corp. No. USA Q-1, GW-1466 Monogahela National Forest | Union District, Preston Co., WV<br>Lead Mine, WV 7.5' Quadrangle | 47-077-00119 | 39.238 | -79.573 | 9,910 | 0-9,910 |
| 12 | greenland_GR.las | Shell Oil Co. (Consolidated Gas Supply Corp.) No. 1 Greenland Lodge, Inc. | Union District, Grant Co., WV<br>Greenland Gap, WV 7.5' Quadrangle | 47-023-00002 | 39.195 | -79.142 | 16,075 | 50-13,000 |
| 13 | Bean_A.las | Exxon Corporation No. 1 Charles H. Bean, et al. | Moorefield District, Hardy Co., WV<br>Old Fields, WV 7.5' Quadrangle | 47-031-00021 | 39.138 | -78.990 | 16,075 | 100-5,300 |
| 13 | Bean_B.las | Exxon Corporation No. 1 Charles H. Bean, et al. | Moorefield District, Hardy Co., WV<br>Old Fields, WV 7.5' Quadrangle | 47-031-00021 | 39.138 | -78.990 | 16,075 | 5,300-10,450 |
| 13 | Bean_C.las | Exxon Corporation No. 1 Charles H. Bean, et al. | Moorefield District, Hardy Co., WV<br>Old Fields, WV 7.5' Quadrangle | 47-031-00021 | 39.138 | -78.990 | 16,075 | 10,450-16,050 |

Scale, units, and depths for Gamma Ray logging runs. Abbreviations: API, American Petroleum Institute; KB, Kelly bushing; TD, total depth

| Well No. | Scale and Units | Depths of Selected Logged Intervals | Casing Shoe Location(s) |
|---|---|---|---|
| 1 | 0-12 micro Roentgens / hour (μR/hr) | 10 feet below Kelly Bushing (KB) to Total depth (TD) | |
| 2 | 0-200 API units<br>200-400 backup scale | 100 feet below KB to TD | 473 feet below KB |
| 3 | 0-200 API units | About 7 feet below KB to TD | |
| 4 | 0-200 API units<br>200-400 backup scale | 100 feet below KB to TD | 3,615 feet below KB |
| 5 | 0-200 API units<br>200-400 backup scale | 100 feet below KB to TD | 1,220 feet below KB |
| 6 | 0-200 API units<br>200-400 backup scale | 100 feet below KB to TD | 1,420 feet below KB |
| 7 | 0-200 API units | 828 feet below KB to TD | 6,416 feet below KB |
| 8 | 0-200 API units<br>200-400 backup scale | 60 feet below KB to TD | 1,590 feet below KB |
| 9 | 0-250 API units<br>0-250 API units<br>0-250 API units<br>Units not listed (probably 0-250 API units) | 80 feet below KB to 3,870 feet<br>3,870 feet below KB to 10,505 feet<br>10,505 feet below KB to 14,475 feet<br>10,505 feet below KB to TD | 100 feet below KB<br>3,903 feet below KB<br>10,505 feet below KB |
| 10 | 0-150 API units<br>0-200 API units<br>0-150 API units<br>0-200 API units<br>0-150 API units | KB to 990 feet<br>990 feet below KB to 7,455 feet<br>7,455 feet below KB to 7,502 feet<br>7,502 feet below KB to 12,075 feet<br>12,075 feet below KB to TD | 993 feet below KB |
| 11 | 0-150 API units<br>150-300 backup scale<br>0-200 API units | KB to 7,710 feet<br><br>7,710 feet below KB to TD | 1,215 feet below KB<br>4,925 feet below KB |
| 12 | 0-200 API units<br>0-150 API units<br>0-200 API units | 50 feet below KB to 480 feet<br>480 feet below KB to 10,021 feet<br>10,021 feet below KB to TD | 336 feet below KB<br>5,255 feet below KB |
| 13 | 0-200 API units<br>Units not listed (probably 0-250 API units)<br>0-200 API units | 100 feet below KB to 1,490 feet<br>1,490 feet below KB to 5,920 feet<br>5,920 feet below KB to TD | <br><br>6,000 feet below KB |