OMB No. 2040-0042 Approval Expires 4/30/2022

United States Environmental Protection Agency

Underground Injection Control
Permit Application for a Class II Well

(Collected under the authority of the Safe Drinking Water Act. Sections 1421, 1422, and 40 CFR Part 144)

For Official Use Only

Date Received

Permit Number

Read Attached Instructions Before Starting

I. Owner Name, Address, Phone Number and/or Email

Sanstone Development LLC.
557 Interstate Parkway
Bradford, Pa 16701
rjbwell@atlanticbb.net

II. Operator Name, Address, Phone Number and/or Email

III. Commercial Facility

- [ ] Yes
- [X] No

IV. Ownership

- [X] Private
- [ ] Federal
- [ ] State/Tribal/ Municipal

V. Permit Action Requested

- [X] New Permit
- [ ] Permit Renewal
- [ ] Modification
- [ ] Add Well to Area Permit
- [ ] Other

VI. SIC Code(s)

1311

VII. Indian Country

- [ ] Yes
- [X] No

VIII. Type of Permit (For multiple wells, use additional page(s) to provide the information requested for each additional well)

- [X] A. Individual
- [ ] B. Area

Number of Wells: 1

Well Field and/or Project Names: Project Name- Moody

IX. Class and Type of Well (see reverse)

A. Class	B. Type (enter code(s))	C. If type code is "X," explain.
2	R	

X. Well Status

- [ ] A. Operating — Date Injection Started
- [ ] B. Conversion — Date Well Constructed
- [X] C. Proposed

XI. Well Information

API Number: 37-083-53736

Permit (or EPA ID) Number:

Full Well Name: Moody Lot 5 #17

XII. Location of Well or, for Multiple Wells, Approximate Center of Field or Project

Locate well in two directions from nearest lines of quarter section and drilling unit

Surface Location

1/4 of 1/4 of Section Township Range

ft. from (N/S) Line of quarter section

ft. from (E/W) Line of quarter section.

Latitude: 41-54-34.3800

Longitude: -78-35-15.7000

XIII. Attachments

In addition to this form, complete Attachments A-U (as appropriate for the specific well class) on separate sheets. Submit complete information, as required in the instructions and list all attachments, maps or other figures, by the applicable letter.

XIV. Certification

I certify under the penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment. (Ref. 40 CFR § 144.32)

Name and Official Title *(Please Type or Print)*	Signature	Date Signed
R. James Barnes, Member		3/15/21

INSTRUCTIONS FOR FORM 7520-6 (CLASS II WELLS)

A permit application must be completed by all owners or operators of current or proposed Class I, II, and III wells, and some Class V injection wells subject to the requirement to obtain an Underground Injection Control (UIC) permit as described at 40 CFR 144.31 and others directed by a UIC official to apply for a UIC permit. Please note that the information needs vary by well class. These instructions are specific to Class III wells; other versions are available for other well classes. Please note that this form must be signed by a responsible entity as described at 40 CFR 144.32, even if the attachments are prepared by contractors or service companies. If the application covers multiple wells, use additional pages as necessary to provide all the requested information.

I. OWNER NAME, ADDRESS, PHONE AND/OR EMAIL: Enter the name and street address, city/town, state, and ZIP code of the owner of the well, well field, or company. Also provide an email address (if available) and/or a phone number.

II. OPERATOR NAME, ADDRESS, PHONE AND/OR EMAIL: Enter the name and street address, city/town, state, and ZIP code of the operator of well or well field; also provide an email address (if available) and/or a phone number. If the operator is the same as the owner, enter "same as owner."

III. COMMERCIAL FACILITY: Check the appropriate box to indicate the type of facility. A commercial facility is a single or multiple well facility that is specifically engaged in the business of injecting waste fluids generated by third party producers that is originated off-site and transported to the facility by truck for a fee or compensation.

IV. OWNERSHIP: Check the appropriate box to indicate whether the owner of the well/facility is a private, Federal, or State/Tribal/Municipal entity.

V. TYPE OF PERMIT ACTION REQUESTED: Check "new permit" if the well has never been subject to a UIC permit (e.g., for a newly constructed or converted well). Check "permit renewal" for an application associated with extending an expiring UIC permit. Check "modification" for an application to modify an existing permit that is not expiring. Check "add well to area permit" if additional wells are to be covered under an existing UIC area permit. Check "other," if needed and describe the situation.

VI. SIC CODES: List at least one and no more than four Standard Industrial Classification (SIC) Codes that best describe the nature of the business in order of priority. A list of SIC codes is available from the U.S. Department of Labor at https://www.osha.gov/pls/imis/sicsearch.html.

VII. INDIAN COUNTRY: Check yes if the well is located in Indian country. Indian country (as defined in 18 U.S.C. 1151) includes: all land within the limits of any Indian reservation under the jurisdiction of the U.S. government; all dependent Indian communities within the borders of the U.S.; and all Indian allotments, the Indian titles to which have not been extinguished.

VIII. TYPE OF PERMIT: Check "Individual" or "Area" to indicate the type of permit requested. Individual permits cover a single injection well, while area permits may cover more than one injection well. Note that area permits are issued at the discretion of the Director and that wells covered by an area permit must: be at one contiguous site, be under the control of one entity, and may not inject hazardous waste. If an area permit is requested, enter the ***number of wells*** to be included in the permit. In the case of a project or field that crosses State lines, it may be possible to consider an area permit if EPA has jurisdiction in all affected States (each such case will be considered individually). Also provide the ***name of the well field or project.***

IX. CLASS AND TYPE OF WELL: Enter the class (as defined in 40 CFR 144.6) and type of injection well for which a permit is requested. Use the most pertinent code selected from the table below. When selecting type "X", please explain in the space provided.

TABLE OF CLASS II WELL TYPES

A	Annular Disposal Well.
D	Produced Fluid Disposal Well.
H	Hydrocarbon Storage Well (excluding natural gas).
R	Enhanced Recovery Well.
X	Other Class II Wells (not included in Type "A," "D," "H," or "R").

X. WELL STATUS: Check ***Box A, Operating*** if the well currently operates as an injection well (e.g., if a permit renewal is requested or a permit is sought for an existing rule-authorized injection well). Check ***Box B, Conversion*** for an existing well not currently being utilized for injection that is proposed to be converted to an injection well. Check ***Box C, Proposed*** for an underground injection well not yet constructed or completed. Provide relevant dates if A or B are checked.

XI. WELL INFORMATION: Enter the ***API number*** (the number assigned by the local jurisdiction (usually a State Oil and Gas Agency) using the American Petroleum Institute standard numbering system). Enter the ***Permit or EPA ID number*** assigned to the injection well by the EPA or the permitting authority. If you do not have a number (e.g., for a new well), this will be provided by EPA or the permitting authority, and you can leave the field blank. Also enter the ***Full Name of the Well*** or project.

XII. LOCATION: For individual permit applications, in the fields provided, enter the location of the well using latitude and longitude and/or the Public Land Survey System. When using latitude and longitude, use decimal degrees to five or six places after the decimal, if possible; be sure to include a negative sign for the longitude of a well in the Western Hemisphere and a

negative sign for the latitude of a well in the Southern Hemisphere. When using the Public Land Survey System, fill in the complete township, range, and section to the nearest quarter-quarter section. A township is north or south of the baseline, and a range is east or west of the principal meridian (e.g., T12N, R34W). Also include the distance, in feet, from the nearest north or south line and nearest east or west line of the quarter-section. For area permit applications, provide the latitude and longitude of the approximate center of the area.

XIII. ATTACHMENTS: Specific instructions for completing the attachments are presented on pages 3 through 6. Place the permit or EPA ID number (or, if none has been assigned, other identifying information such as an API number or the project name) in the upper right hand corner of each page of the attachments.

XIV. CERTIFICATION: All permit applications must be signed by either: a responsible corporate officer for a corporation, by a general partner for a partnership, by the proprietor of a sole proprietorship, or by a principal executive or ranking elected official for a public agency, or a duly authorized representative of that person.

PAPERWORK REDUCTION ACT NOTICE: The public reporting and recordkeeping burden for this collection of information is estimated to average 61 hours per response for a Class II well permit application. Burden means the total time, effort, or financial resource expended by persons to generate, maintain, retain, or disclose or provide information to or for a Federal Agency. This includes the time needed to review instructions; develop, acquire, install, and utilize technology and systems for the purposes of collecting, validating, and verifying information, processing and maintaining information, and disclosing and providing information; adjust the existing ways to comply with any previously applicable instructions and requirements; train personnel to be able to respond to the collection of information; search data sources; complete and review the collection of information; and, transmit or otherwise disclose the information. An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. Send comments on the Agency's need for this information, the accuracy of the provided burden estimates, and any suggested methods for minimizing respondent burden, including the use of automated collection techniques to Director, Collection Strategies Division, U.S. Environmental Protection Agency (2822), 1200 Pennsylvania Ave., NW, Washington, DC 20460. Include the OMB control number in any correspondence. Do not send the completed forms to this address.

Instructions for Completing Attachments to Form 7520-6 (Class II Wells)

The Underground Injection Control (UIC) program, as promulgated under the Safe Drinking Water Act (SDWA), is designed to prevent injection activity from allowing the movement of fluid containing any contaminant into underground sources of drinking water (USDWs), if the presence of that contaminant may cause a violation of any primary drinking water regulation or may otherwise adversely affect the health of persons as found at Title 40 of the Code of Federal Regulations (40 CFR) section 144.12. Any applicant for a permit under this program shall have the burden of showing that their proposed construction, operation, maintenance, conversion, plugging, abandonment, and injection activity, does not endanger USDWs.

The attachments below have been constructed to provide applicants with clear expectations as to what information EPA needs to make a determination that an applicant's proposed activities will not endanger USDWs.

Pre-Application Coordination

Coordination between the UIC program and the permit applicant prior to submittal of the permit application is an important step for efficient and effective permitting. Early discussions will ensure that the applicant is aware of all the permit application requirements, including state specific requirements found at 40 CFR part 147. These discussions may also help the applicant plan how to invest time and resources needed to develop a comprehensive and complete permit application.

Applicants are encouraged to contact their EPA regional UIC program for a pre-application coordination meeting.

Note: If the owner or operator of *existing rule authorized Class II UIC well(s)* is required by the EPA to apply for a permit (40 CFR § 144.25), consult with EPA staff during the pre-application coordination for additional requirements that may apply.

When completing each attachment, please be sure to specify the units reported, e.g., of depth, pressure, temperature, etc.

Attachment A. Map(s) and Area of Review

Part I. Well Location(s)

For Individual Permits: If the surface location provided in the accompanying 7520-6 form does not adequately describe the well location (i.e., due to deviation, directional, or horizontal drilling), please describe the well's orientation and provide the top- and bottom-hole coordinates, as appropriate. If any monitoring wells are proposed as part of this permit application, provide coordinates for all monitoring wells.

For Area Permits (40 CFR § 144.33): Provide information similar to what is outlined above for individual permits for each well (existing or proposed) to be covered by this permit. In addition, provide a description of the proposed permitted area. At a minimum, this area should include all the proposed or existing wells known at the time of permit application submittal. For circular areas, this description should consist of a defined-radius from a singular point whose coordinates have been given. For polygonal areas, use a series of coordinates describing the vertices or corners of the area. Submit a Geographic Information System (GIS) file, if available.

Part II. Area of Review Size Determination (40 CFR § 146.6)

For All Permits. Give the method (fixed radius or equation) and, if appropriate, all calculations used to determine the size of the area of review (AOR). If you are uncertain as to which method to use, consult with your regional EPA office.

The AOR must be a minimum radius of one-fourth (1/4) mile from the well bore, including a well's lateral, or the proposed area permit boundary for area permits, unless the use of an equation is approved by the Director.

In addition, for Class II enhanced oil recovery well(s). The AOR will be at a minimum the larger of the following: one-fourth (1/4) mile radius or the distance to the nearest active producer in the production formation.

Part III. Map(s) (40 CFR §§ 144.31 & 146.24)

Submit a topographic map (or other map if a topographic map is unavailable) extending one mile beyond the facility property boundary showing:

- project injection well(s), well pad(s) and/or project area,
- applicable area of review,
- all outcrops of injection and confining formations,
- all surface water intake and discharge structures, and
- all hazardous waste treatment, storage, or disposal facilities.

Consult with your EPA regional office for the definition of the facility property boundary.

The information below does not apply to existing rule authorized Class II well(s).

Within the one-fourth (1/4) mile beyond the facility property boundary or the AOR, whichever is larger, the map will also show the:

- name and location of all production wells, injection wells, abandoned wells, dry holes, and all water wells, noting their types (public water system, domestic drinking water, stock, etc.),

- springs and surface bodies of water,
- mines (surface and subsurface) and quarries, and
- other pertinent surface features, including residences, schools, hospitals, and roads.

Only information of public record and pertinent information known to the applicant is required to be included on this map. Multiple maps may be needed to display this information clearly. If a certain feature is not present in the area covered, please state so definitively (e.g., *"There are no known outcrops of the confining formation in the mapped area."*).

Part IV, below does not apply to existing rule authorized Class II well(s).

Part IV. Area of Review Wells and Corrective Action Plans (40 CFR §§ 144.55 & 146.24)

Submit a tabulation of data and wellbore diagrams reasonably available from public records or otherwise known to the applicant on all wells within the AOR included on the map, which penetrate the proposed confining zone(s). Such information will include:

- well name, location and depth,
- well type,
- date well was drilled,
- well construction that includes casing and cement details, including demonstrated or calculated top of cement,
- cement bond logs (if available), and
- record of well completion and plugging (if applicable).

For such wells which are improperly sealed, completed, or abandoned, also submit a plan consisting of such steps or modifications as are necessary to prevent movement of fluid into USDWs.

Part V. Landowners Information (40 CFR § 144.31 and part 147)

Identify and submit a list with the names and addresses of all owners of record of land within one-fourth (1/4) mile of the facility property boundary. This requirement may be waived by the Regional Administrator if the site is in a populous area and the Regional Administrator determines that the requirement would be impracticable.

Consult with your regional EPA office, as additional state landowner notification requirements may apply (40 CFR part 147).

Attachment B. Geological and Geophysical Information

Part I. Geological Data (40 CFR § 146.24)

Provide the following information:

- geological data on all formations from the surface to the base of the injection well, identifying all USDWs and confining and injection zone(s). This data includes the lithologic description, geological name, thickness, depth, and total dissolved solids (TDS) concentrations from these formations (if known),
- source of information for the geologic data and formation TDS,
- porosity and permeability of injection formation (if available),
- geological cross-sections (if available) proximate to the injection well that includes the confining and injection zones. The cross-sections should illustrate the regional geologic setting and show the thickness and lateral continuity of the confining zone(s) through the area of review,
- within the AOR, identify known or suspected faults and fracture systems. If identified, provide proximity to the injection zone and the effect the fault/fracture system may have on the injection activities, and
- a history of seismic activity in the area and proximity to crystalline (i.e., granitic) basement.

Part II. Proposed Formation Testing Program (40 CFR § 146.22)

Provide a formation testing program to obtain data on:

- fluid pressure,
- estimated fracture pressure, and
- physical and chemical characteristics of the injection zone.

Attachment C. Well Construction/Conversion Information

Part I. Well Schematic Diagram (40 CFR § 146.24)

Provide a detailed proposed well schematic diagram that includes:

- identification of USDWs and confining and injection zones,
- casing and cementing details, including demonstrated or calculated top of cement,
- tubing and packer (if applicable),
- open hole or perforated intervals, and

- surface trace (if horizontal or deviated well).

For wells that are drilled and to be converted to an injection well, also provide the current well schematic diagram.

Part II. Well Construction or Conversion Procedures (40 CFR §§ 144.52, 146.22, & 146.24)

Provide detailed description of well construction or conversion procedures, that includes:

- proposed logs and other tests conducted during the drilling and construction of new well(s),
- proposed stimulation plan(s), if planned, and
- description of alarms and shut-down systems at the well (if applicable).

For wells that are drilled and to be converted to an injection well, also provide:

- well completion and cementing records, and
- previously run logs/tests.

Attachment D. Injection Operation and Monitoring Program (40 CFR §§ 146.23 & 146.24)

Submit the following information:

- flow diagram of fluid flow through the facility,
- contingency plan(s) to cope with well failure, so as to prevent migration of contaminating fluids into a USDW,
- drawing of the surface construction,
- locations of all monitoring devices (show on the map(s) referenced in section A.III. above), and
- description of sampling and monitoring devices to monitor the nature of the injected fluids, injection pressure, annulus pressure (if applicable), flowrate, and cumulative volume.

Hydrocarbon storage and enhanced recovery may be monitored on a field or project basis rather than on an individual well basis by manifold monitoring. If a manifold monitoring program is utilized, describe details of the monitoring program and how the program is comparable to individual well monitoring. Also, include on the map in section A.III.B, the distribution manifold applying injection fluid to all wells in the area, including location of all system monitoring locations.

Additionally, submit the following proposed operating data for each well in the individual or area permit:

- average and maximum daily rate and volume of fluids to be injected,
- average and maximum injection pressure,
- source(s) of injection fluids (including field and formation names),
- proposed annular fluid, and
- analysis of the chemical and physical characteristics of the injection fluid. At a minimum, this should include pH, specific gravity, TDS, and conductivity. Consult with the regional EPA office for additional guidance.

Attachment E. Plugging and Abandonment Plan (40 CFR §§ 144.31, 144.51 & 146.24)

Submit a plugging and abandonment (P&A) plan of the well on EPA Form 7520-19 along with a P&A diagram. The plan should include:

- type, and number of plugs to be used,
- placement of each plug including the elevation of top and bottom,
- type, grade, and quantity of cement to be used, and
- method of placement of the plugs.

Provide one or more cost estimates from an independent firm in the business of plugging and abandoning wells to conduct the work proposed in the P&A plan for EPA to contract plugging of the well. This is to ensure that EPA has adequate funding to plug the well(s) if the operator is unable to plug the well(s).

Consult with the regional EPA office for additional guidance on developing the P&A plan and cost estimate calculations.

Attachment F. Financial Assurance (40 CFR § 144.52)

Submit evidence of financial resources, such as a surety bond or financial statement, necessary for a third party to close, plug, or abandon the well in the event an owner or operator is unable to do so. The monetary amount is based on the P&A plan cost estimate provided in Attachment E.

Attachment G. Site Security and Manifest Requirements (Commercial Wells Only)

Provide a proposed site security plan. This could include fencing around the perimeter of the facility. Consult with the regional EPA office for additional guidance on manifest requirements.

Attachment H. Aquifer Exemptions (40 CFR §§ 144.7 & 146.4)

If an aquifer exemption (AE) is requested, submit the information required at 40 CFR § 144.7 and to demonstrate that the criteria found at 40 CFR § 146.4 are met. Consult with your regional EPA office for additional guidance.

Attachment I. Existing EPA Permits (40 CFR § 144.31)

Submit a listing of all permits or construction approvals received or applied for under any of the following programs:

- Hazardous Waste Management program under RCRA,
- UIC program under SDWA,
- NPDES program under CWA,
- Prevention of Significant Deterioration (PSD) program under the Clean Air Act,
- Nonattainment program under the Clean Air Act,
- National Emission Standards for Hazardous Pollutants (NESHAPS) preconstruction approval under the Clean Air Act.
- Ocean dumping permits under the Marine Protection Research and Sanctuaries Act,
- Dredge and fill permits under section 404 of CWA, and
- Other relevant environmental permits, including State permits.

Attachment J. Description of Business (40 CFR § 144.31)

Provide a brief description of the nature of the business.

Attachment K. Optional Additional Project Information (40 CFR § 144.4)

The following is a list of Federal laws that may apply prior to the issuance of permits. When any of these laws are applicable, EPA must ensure that they are followed. The optional additional information requested below will assist EPA in its analyses to satisfy these laws.

- The Wild and Scenic Rivers Act, 16 U.S.C. 1273 et seq.

  Identify any national wild and scenic river that may be impacted by the activities associated with the proposed project.

- The National Historic Preservation Act of 1966, 16 U.S.C. 470 et seq.

  Identify properties listed or eligible for listing in the National Register of Historic Places that may be affected by the activities associated with the proposed project. If previous historic and cultural resource survey(s) have been conducted, provide the results of the survey(s).

- The Endangered Species Act, 16 U.S.C. 1531 et seq.

  Identify any endangered or threatened species that may be affected by the activities associated with the proposed project. If a previous endangered or threatened species survey has been conducted, provide the results of the survey.

- The Coastal Zone Management Act, 16 U.S.C. 1451 et seq.

  Identify any coastal zones that may be affected by the activities associated with the proposed project.

ATTACHMENT A

MAP (S) AND AREA OF REVIEW

Map(s) and Area Review

Attached are three individual maps for the following Area Permit. The fixed radius method was applied to all three maps (quarter mile, quarter mile and 1 mile) for the purposed injection well. All springs, surface bodied or water and pertinent surface structures (none) have been identified on all maps.

Figure 1: Topographic map showing AOR: ¼ mile red circle

This map shows quarter mile circle in red. Well 17 is labeled inside the quarter mile red circle. All wells effected by the quarter mile AOR are listed on a separate paper listed as FIGURE 1 TABLE and are all active production wells. No other wells (abandoned, water, injection, dry holes, etc.) are present in the quarter mile AOR.

There is a unnamed tributary located in the southwest section of the quarter mile AOR. This is marked on Figure 1 map as unnamed tributary.

No pertinent surface features, Mines (surface or subsurface), quarries are present in the quarter mile AOR.

Figure 2: Topographic map showing AOR with ¼ mile extension

This map shows all wells within the quarter mile red circle. All wells within the quarter mile extension of the area of review. The wells located inside the blue circle to the red circle are all producing wells operated by Sandstone Development LLC except for 6 producing wells. These are owned by Minard Run Oil Co.

All surface land is owned by:

Landowners Information:
Headwaters Investment Corporation
3575 Piedmont Road
NE Building 151250
Atlanta, GA 30305

No pertinent surface features, Mines (surface or subsurface), quarries or water wells are present in the quarter mile extension of the AOR.

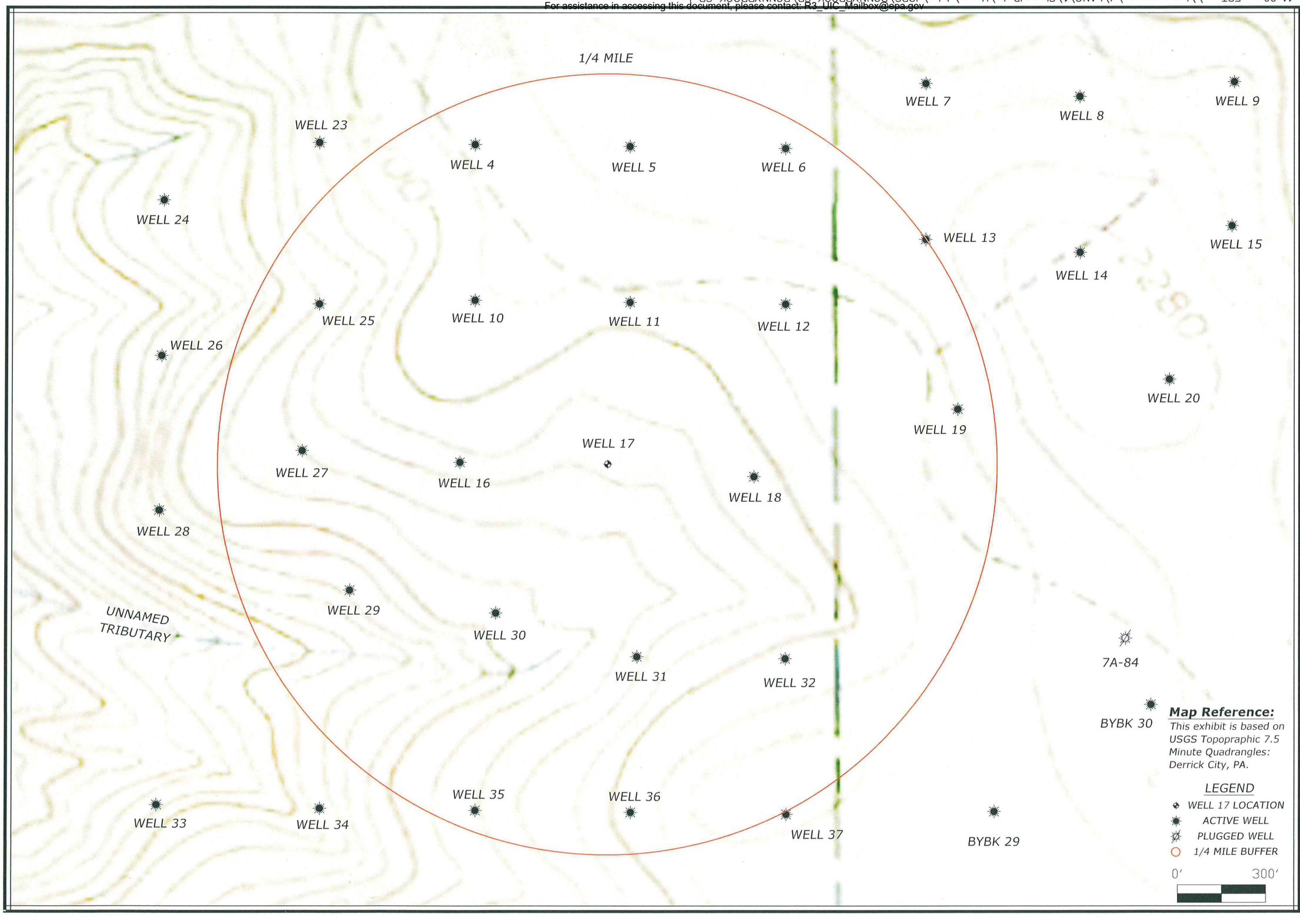
Figure 3: Topographic Map showing ¼ mile AOR with 1 mile extension

No outcrops of injection and confining formations present

No surface water intake, discharge structures, hazardous waste treatment storage or disposal facilities present.

FIGURE 2 TABLE

WELL NAME	API #	WELL #	DATE DRILLED	STATUS	CONDUCTOR	SURFACE CSG	CEMNET RETURN	TD
MOODY LOT 5	37-083-53723	4	1/22/2009	ACTIVE	31.5'	502'	YES	2150'
MOODY LOT 5	37-083-53724	5	1/8/2009	ACTIVE	31.5'	502'	YES	2150'
MOODY LOT 5	37-083-53725	6	1/22/2009	ACTIVE	31'	500'	NO	2160'
MOODY LOT 5	37-083-53729	10	1/13/2009	ACTIVE	31.5'	502'	YES	2156'
MOODY LOT 5	37-083-53730	11	1/27/2009	ACTIVE	31'	500'	NO	2160'
MOODY LOT 5	37-083-53731	12	1/26/2009	ACTIVE	31.2'	502'	NO	2150'
MOODY LOT 4	37-083-53732	13	12/17/2008	ACTIVE	31'	500'	YES	2160'
MOODY LOT 5	37-083-53735	16	2/11/2009	ACTIVE	43'	502'	NO	2150'
MOODY LOT 5	37-083-53736	17	2/6/2009	ACTIVE	44'	516'	YES	2150'
MOODY LOT 5	37-083-53737	18	1/29/2009	ACTIVE	62.6'	502'	YES	2150'
MOODY LOT 4	37-083-53738	19	12/10/2008	ACTIVE	31'	500'	NO	2190'
MOODY LOT 5	37-083-54300	25	10/19/2009	ACTIVE	32'	517'	NO	2127'
MOODY LOT 5	37-083-54302	27	10/22/2009	ACTIVE	32'	512'	NO	2127'
MOODY LOT 6	37-083-54304	29	11/9/2009	ACTIVE	32'	508'	NO	2034'
MOODY LOT 6	37-083-54305	30	10/29/2009	ACTIVE	32'	517'	YES	2074'
MOODY LOT 6	37-083-54306	31	10/26/2009	ACTIVE	32'	512'	YES	2100'
MOODY LOT 6	37-083-54307	32	11/17/2009	ACTIVE	32.2'	504'	YES	2214'
MOODY LOT 6	37-083-54310	35	10/12/2009	ACTIVE	32.4'	517'	YES	2110'
MOODY LOT 6	37-083-54311	36	10/20/2009	ACTIVE	32.3'	517'	NO	2120'
MOODY LOT 6	37-083-54312	37	11/11/2009	ACTIVE	32.1'	512'	YES	2214'



REV	DATE	DESCRIPTION	APPD

ANDREW S. ROSENBERGER
REGISTERED LAND SURVEYOR
PENNSYLVANIA AND NEW YORK
LANG SURVEYING LLC
1059 LAFFERTY LANE
BRADFORD, PA. 16701
PHONE: (814) 368-4139
EMAIL: langsurveyingllc@gmail.com
BOUNDARY, SUBDIVISION
TOPOGRAPHIC, OIL & GAS
WELL SURVEYS

DATE

DRAWING TITLE:
FIGURE 1
1/4 MILE BUFFER LOCATION MAP
MOODY WELL 17

CLIENT:
SANDSTONE DEVELOPMENT, LLC
BRADFORD TOWNSHIP McKEAN COUNTY
PENNSYLVANIA

DRAWN BY: DLC	DATE: 5/19/20
CHKD. BY: ASR	DATE:
APPD. BY:	DATE:
SCALE:	1" = 300'
ISSUE DATE:	
PROJECT #:	05282
DRAWING NUMBER:	05282.1

North

Oil Wells

1/2 MILE

1/4 MILE

WELL 17

Oil Wells

Tibbitts Hollow

Golf Course

Memorial

BRADFORD

PIPELINE

Oil Wells

Foster

Hollow

Pratt

Map Reference:
This exhibit is based on USGS Topopraphic 7.5 Minute Quadrangles: Derrick City, PA.

LEGEND
- WELL 17 LOCATION
- 1/4 MILE BUFFER
- 1/2 MILE BUFFER

0′ 1250′

REV	DATE	DESCRIPTION	APPD

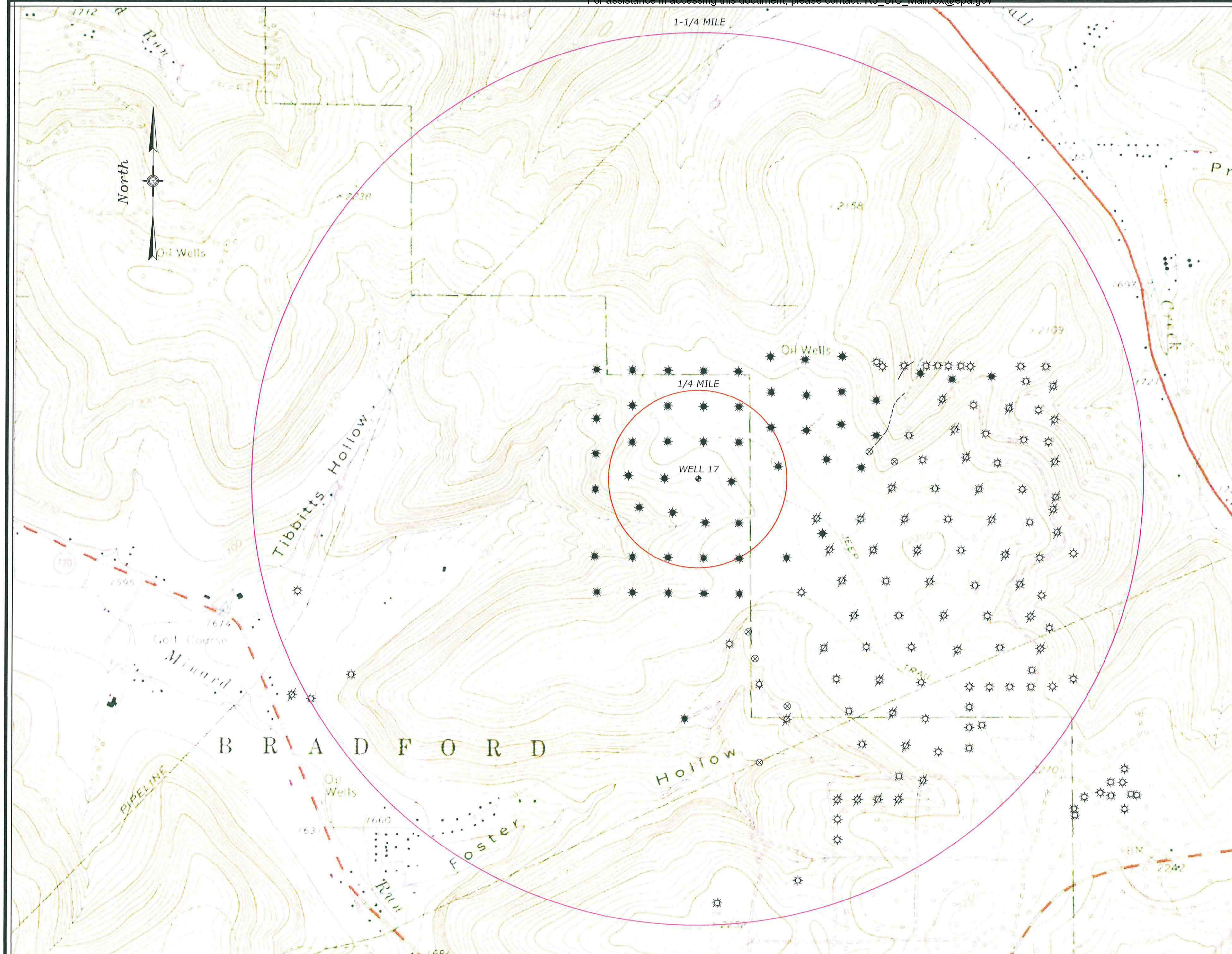
DATE

ANDREW S. ROSENBERGER
REGISTERED LAND SURVEYOR
PENNSYLVANIA AND NEW YORK
LANG SURVEYING LLC
1059 LAFFERTY LANE
BRADFORD, PA. 16701
PHONE: (814) 368-4139
EMAIL: langsurveyingllc@gmail.com
BOUNDARY, SUBDIVISION
TOPOGRAPHIC, OIL & GAS
WELL SURVEYS

DRAWING TITLE:
FIGURE 2
TOPOGRAPHIC LOCATION MAP
MOODY WELL 17

CLIENT:
SANDSTONE DEVELOPMENT, LLC
BRADFORD TOWNSHIP McKEAN COUNTY
PENNSYLVANIA

DRAWN BY: DLC	DATE: 5/19/20
CHKD. BY: ASR	DATE:
APPD. BY:	DATE:
SCALE:	1" = 1250'
ISSUE DATE:	
PROJECT #:	05282
DRAWING NUMBER:	05282.2



Map Reference:
This exhibit is based on USGS Topographic 7.5 Minute Quadrangles: Derrick City, PA.

LEGEND

- WELL 17 LOCATION
- ACTIVE WELL
- PLUGGED WELL
- OLD WELL
- 1/4 MILE BUFFER
- 1-1/4 MILE BUFFER
- SPRING

0′ 1400′

REV	DATE	DESCRIPTION	APPD

DATE

ANDREW S. ROSENBERGER
REGISTERED LAND SURVEYOR
PENNSYLVANIA AND NEW YORK

LANG SURVEYING LLC

1059 LAFFERTY LANE
BRADFORD, PA. 16701
PHONE: (814) 368-4139
EMAIL: langsurveyingllc@gmail.com

BOUNDARY, SUBDIVISION
TOPOGRAPHIC, OIL & GAS
WELL SURVEYS

DRAWING TITLE:
FIGURE 3
TOPOGRAPHIC LOCATION MAP
MOODY WELL 17

CLIENT:
SANDSTONE DEVELOPMENT, LLC
BRADFORD TOWNSHIP McKEAN COUNTY
PENNSYLVANIA

DRAWN BY: **DLC**	DATE: **5/19/20**
CHKD. BY: **ASR**	DATE:
APPD. BY:	DATE:
SCALE: **1" = 1400'**	
ISSUE DATE:	
PROJECT #: **05282**	
DRAWING NUMBER: 05282.3	

ATTACHMENT B

GEOLOICAL INFORMATION

Geological and Geophysical Information

Geological and geophysical information was obtained from each of the well drillers log, as well as cross reference by the well logs provided by PENNGOLD. Fresh water was encountered approximately 100-300ft from surface while drilling on air as noted in the drillers log. (Drillers and geophysical log copy attached)

The Bradford Third sand runs from approximately 1800-1900ft based on elevation differences. Net pay for the Bradford Third sand based on porosity and permeability is only approximately 30 feet. The Bradford Third sand history has proved to be a prolific oil producing sand in some areas. In other areas, the Bradford Third has provided to be a source of high volume brine producing sand. The area of review for Moody 17 has a mixture of both, oil and brine.

Injectivity Test Data

The 30 day Injectivity test data results are attached.

Fracturing Report

Moody Well 17 completion schedule and results are attached.

Earthquake Hazard in Pennsylvania

A report conducted by the ***Commonwealth of Pennsylvania Department of Conservation and Natural Resources Bureau of Topographic and Geologic Survey***, "Earthquake Hazard in Pennsylvania documents known epicenters found in Pennsylvania (page 8 of the report). A red "x" denotes the location of the area of review. Per the report, there are no documents cases where the epicenter of an earthquake was traced back to McKean County, Pennsylvania. On page 7 within the report, the author states, "The great majority of earthquakes occur along boundaries between tectonic plates. The reason for this is not completely clear, but it appears that stress levels are higher along plate boundaries, and that strain energy builds up more rapidly in those areas. Eastern North America, including Pennsylvania, today is far from the nearest plate boundary—the Mid-Atlantic Ridge, some 2,000 miles to the East." See attached.

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PAUL R. PLANTS
STEPHEN D. PLANTS

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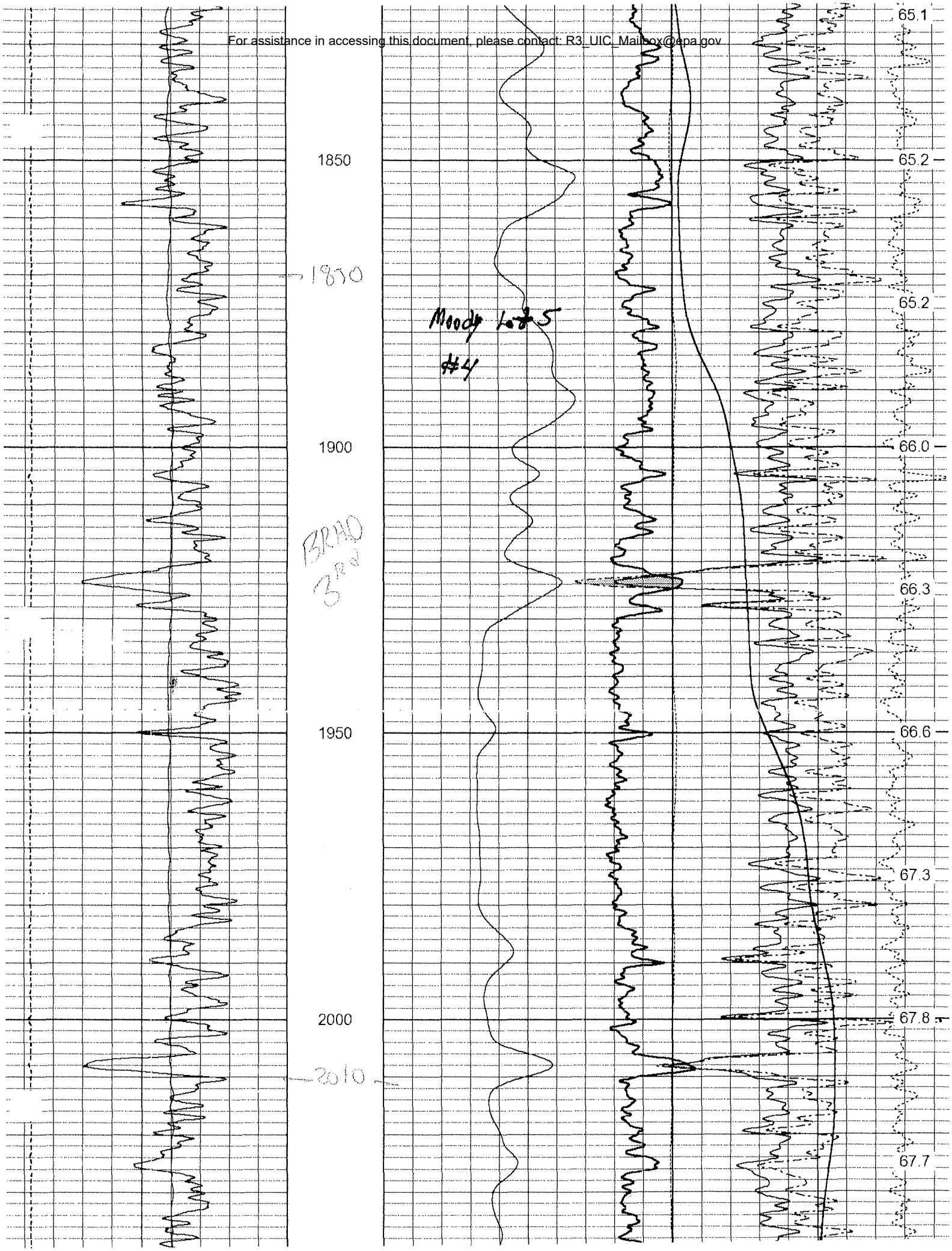
LAKE ERIE ENERGY PARTNERS
MOODY LOT 5 WELL #4
DRILLER'S LOG

SPUD DATE: 01/22/09
COMPLETION DATE: 01/23/09
SURFACE CASING SET @: 502'
SURFACE CASING SIZE: 7"

DATE CENTRALIZERS RUN: 01/22/09
CENTRALIZERS SET @: 470.8'; 314.8';252.4'
CEMENT RETURNS: 5 BBL.
AMOUNT OF CONDUCTOR: 31.5'
CONDUCTOR SIZE: 9 5/8"

0-8	ROCKS & DIRT
8-35	SANDSTONE
35-85	SHALE
85-120	SANDSTONE (FRESH WATER 5 GPM)
120-160	SHALE
160-185	SANDSTONE (FRESH WATER 10 GPM)
185-220	SHALE
220-260	SANDSTONE (FRESH WATER 10 GPM)
260-290	SHALE
290-360	SANDSTONE (FRESH WATER 10 GPM)
360-410	SHALE
410-460	RED ROCK
460-490	SHALE
490-530	RED ROCK
530-550	SHALE
550-590	RED ROCK
590-1420	SHALE & SANDSTONE
1420-1460	SAND (SMELL GAS)
1460-1490	SHALE
1490-1520	SAND (SMELL GAS)
1520-1560	SHALE
1560-1580	SAND (SMELL GAS, TAN COLOR SAND)
1580-1610	SHALE
1610-1640	SAND (SMELL GAS)
1640-1680	SHALE
1680-1720	SAND
1720-1760	SHALE
1760-1790	SAND
1790-1820	SHALE
1820-1845	SAND
1845-1890	SHALE
1890-1910	SAND
1910-1985	SHALE
1985-2010	SAND
2010-2050	SHALE
2050-2065	SAND
2065-2085	SHALE
2085-2095	SAND
2095-2150	SHALE
2150	T.D.



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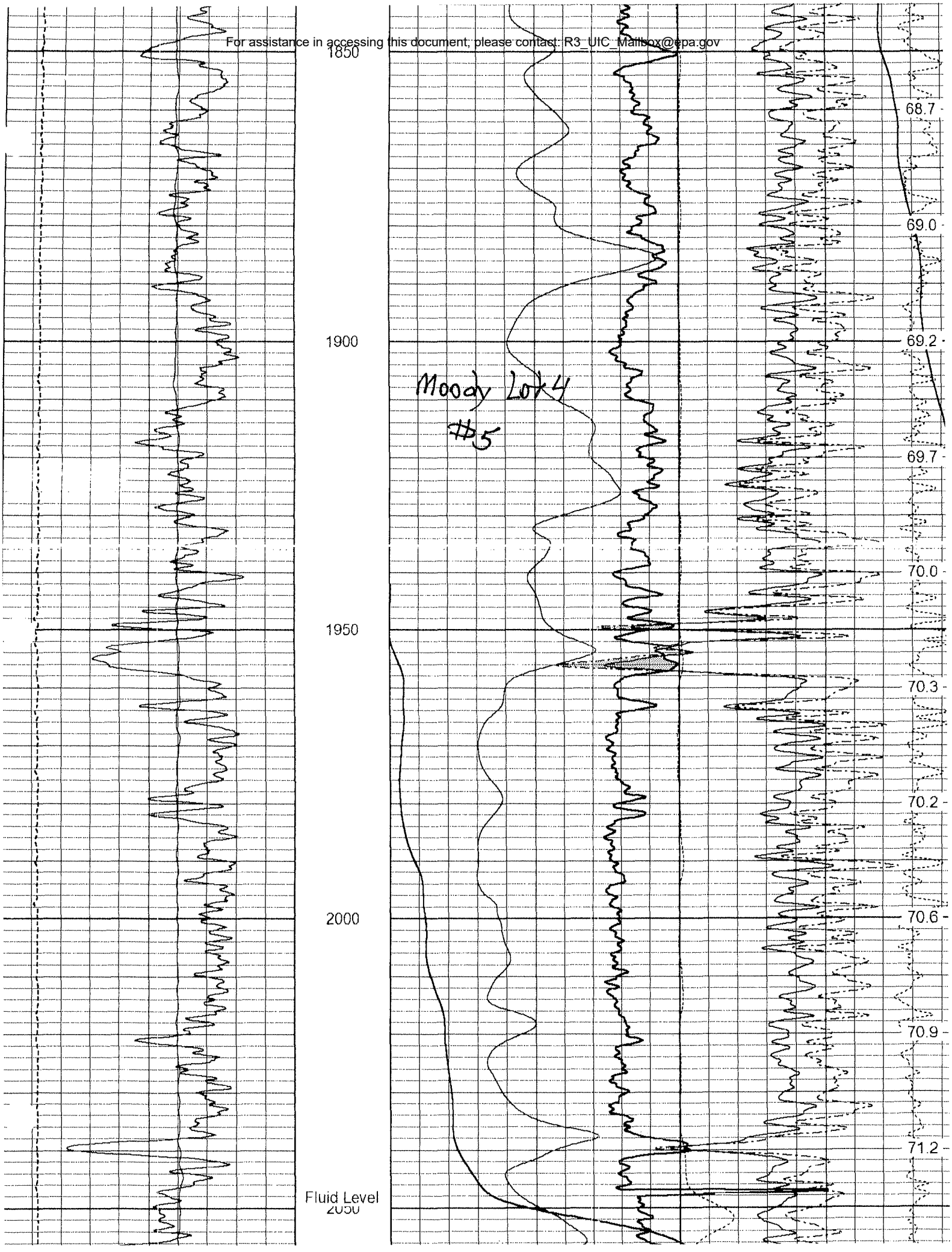
LAKE ERIE ENERGY PARTNERS
MOODY LOT 4 WELL #5
DRILLER'S LOG

SPUD DATE: 01/08/09
COMPLETION DATE: 01/12/09
SURFACE CASING SET @: 502'
SURFACE CASING SIZE: 7"

DATE CENTRALIZERS RUN: 01/09/09
CENTRALIZERS SET @: 470', 314', 252'
CEMENT RETURNS: 0 BBL.
AMOUNT OF CONDUCTOR: 31.5'
CONDUCTOR SIZE: 9 5/8"

0-15	ROCKS & DIRT
15-20	SAND
20-25	SANDSTONE
25-30	SAND
30-65	SHALE
65-85	SANDSTONE (FRESH WATER 10 GPM)
85-120	SHALE
120-165	SANDSTONE (FRESH WATER 15 GPM)
165-185	SHALE
185-260	SANDSTONE (FRESH WATER 25 GPM)
260-320	SHALE
320-365	SANDSTONE
365-395	RED ROCK
395-450	SHALE
450-530	RED ROCK
530-560	SHALE
560-585	RED ROCK
585-620	SHALE
620-650	RED ROCK
650-1395	SHALE & SANDSTONE
1395-1415	SAND (SMELL GAS)
1415-1440	SHALE
1440-1465	SAND (SMELL GAS)
1465-1550	SHALE
1550-1580	SAND (SMELL GAS)
1580-1620	SHALE
1620-1640	SAND (SMELL GAS, BROWN COLOR SAND)
1640-1785	SHALE
1785-1830	SAND
1830-1890	SHALE
1890-1920	SAND (SMELL GAS, BROWN COLOR SAND)
1920-2010	SHALE
2010-2030	SAND
2030-2060	SHALE
2060-2075	SAND
2075-2150	SHALE
2150	T.D.



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STEPHEN D. PLANTS

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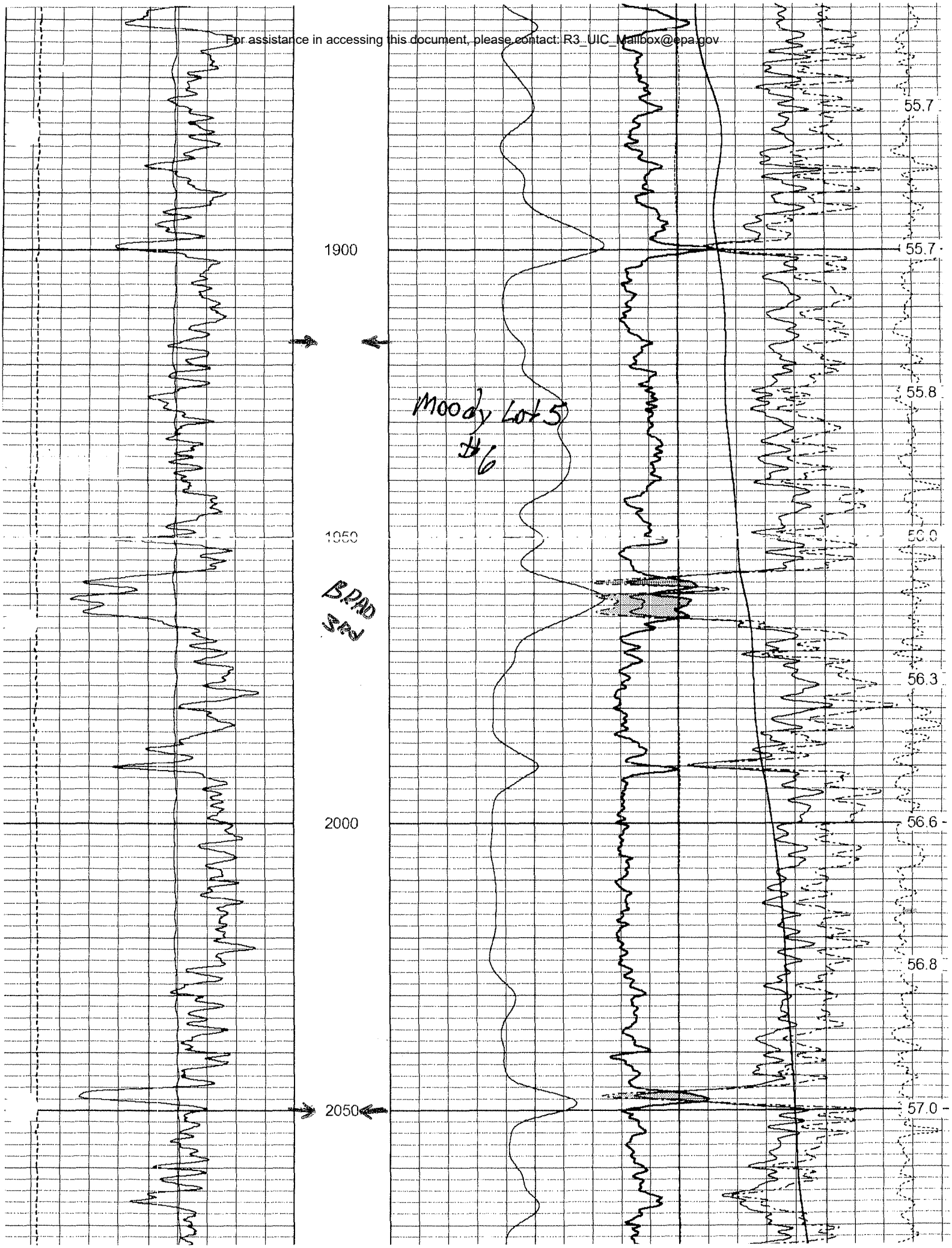
LAKE ERIE ENERGY PARTNERS
MOODY LOT 5 WELL #6
DRILLER'S LOG

SPUD DATE: 01/22/09
COMPLETION DATE: 01/26/09
SURFACE CASING SET @: 500'
SURFACE CASING SIZE: 7"

DATE CENTRALIZERS RUN: 01/23/09
CENTRALIZERS SET @: 405', 312', 218'
CEMENT RETURNS: 0 BBL.
AMOUNT OF CONDUCTOR: 31'
CONDUCTOR SIZE: 9 5/8"

0-5	ROCKS & DIRT
5-51	SANDSTONE
51-175	SHALE
175-200	SANDSTONE (FRESH WATER 25 GPM)
200-340	RED ROCK
340-370	SANDSTONE (FRESH WATER 25 GPM)
370-530	RED ROCK
530-1465	SHALE
1465-1490	SAND (SMELL GAS)
1490-1647	SHALE (SMELL GAS)
1647-1670	SAND (SMELL GAS)
1670-1820	SHALE
1820-1840	SAND (SMELL GAS)
1840-1940	SHALE
1940-1955	SAND (SMELL GAS, DARK COLOR SAND)
1955-1970	SHALE
1970-1985	SAND (SMELL GAS)
1985-2160	SHALE
2160	T.D.



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STEPHEN D. PLANTS

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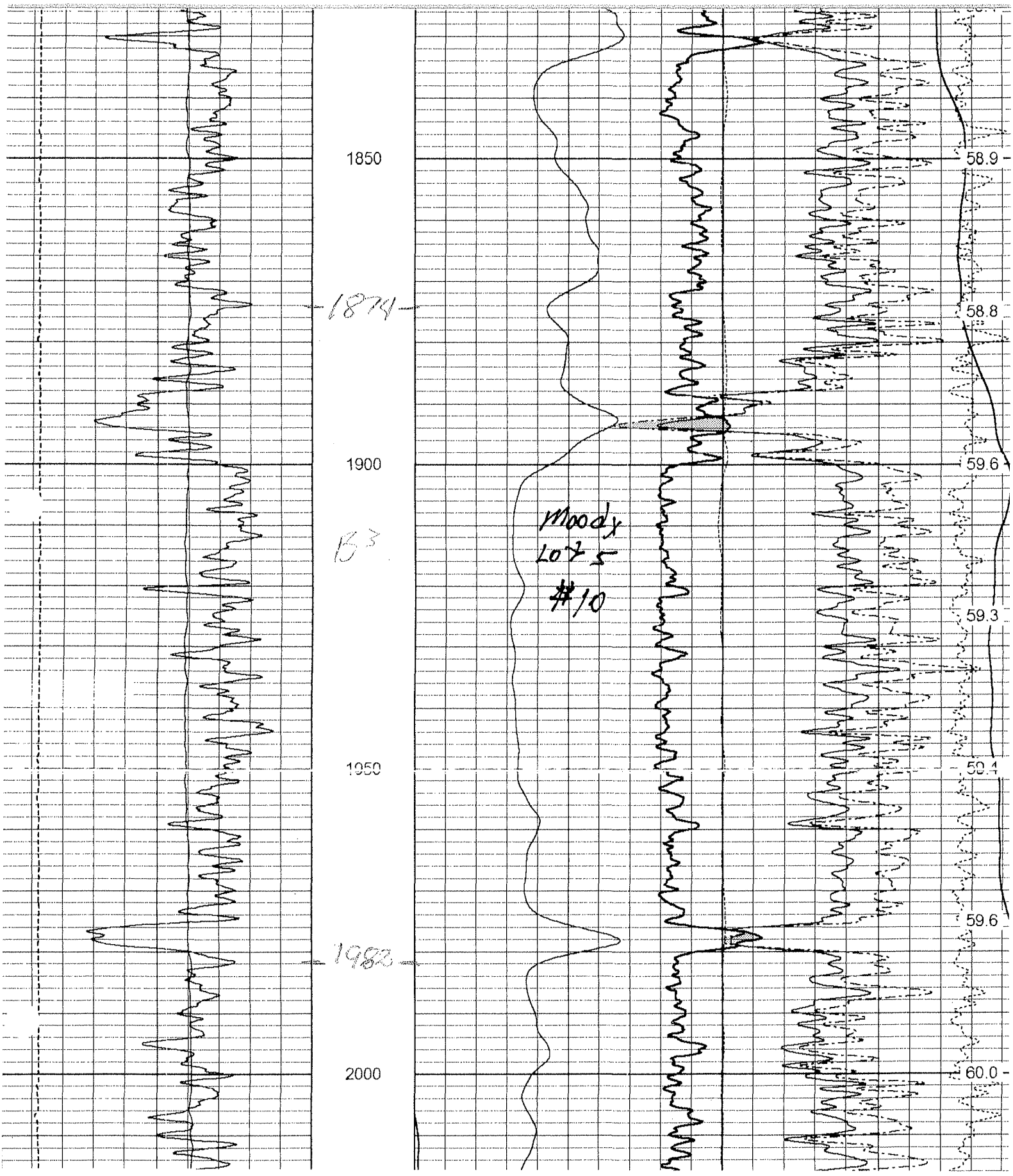
LAKE ERIE ENERGY PARTNERS
MOODY LOT 5 WELL # 10
DRILLER'S LOG

SPUD DATE: 01/13/09
COMPLETION DATE: 01/20/09
SURFACE CASING SET @: 502'
SURFACE CASING SIZE: 7"

DATE CENTRALIZERS RUN: 01/19/09
CENTRALIZERS SET @: 470.8'; 314.8';252.4'
CEMENT RETURNS: 3 BBL.
AMOUNT OF CONDUCTOR: 31.5'
CONDUCTOR SIZE: 9 5/8"

0-10	ROCKS & DIRT
10-35	SHALE
35-85	SANDSTONE
85-110	SHALE
110-125	SANDSTONE (FRESH WATER 5 GPM)
125-160	SHALE
160-185	SANDSTONE (FRESH WATER 15 GPM)
185-220	SHALE
220-260	SANDSTONE (FRESH WATER 25 GPM)
260-285	SHALE
285-320	SANDSTONE (FRESH WATER 30 GPM)
320-360	SHALE
360-420	RED ROCK
420-470	SHALE
470-520	RED ROCK
520-560	SHALE
560-580	RED ROCK
580-615	SHALE
615-630	RED ROCK
630-1290	SHALE & SANDSTONE
1290-1310	SAND
1310-1340	SHALE
1340-1365	SAND (SMELL GAS)
1365-1410	SHALE
1410-1430	SAND (SMELL GAS)
1430-1480	SHALE
1480-1530	SAND (SMELL GAS, LIGHT TAN COLOR SAND)
1530-1550	SHALE
1550-1620	SAND (SMELL GAS, LIGHT TAN COLOR SAND)
1620-1680	SHALE
1680-1730	SAND (SMELL GAS)
1730-1760	SHALE
1760-1785	SAND
1785-1830	SHALE
1830-1845	SAND (LIGHT TAN COLOR SAND)
1845-1890	SHALE
1890-1910	SAND
1910-1945	SHALE
1945-1980	SAND (SMELL GAS)
1980-1995	SHALE
1995-2015	SAND (BROWN COLOR SAND)
2015-2030	SHALE



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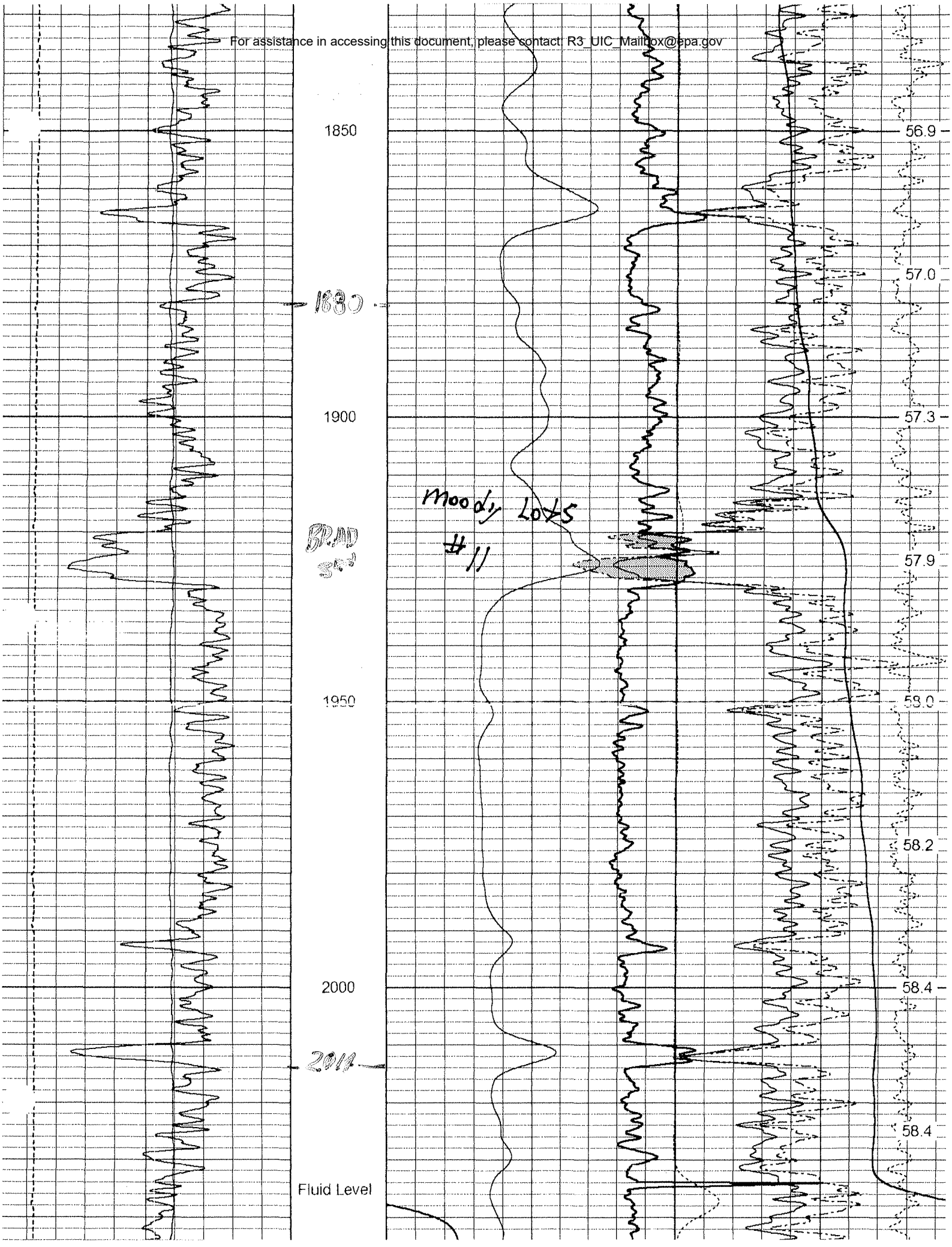
LAKE ERIE ENERGY PARTNERS
MOODY LOT 5 WELL #11
DRILLER'S LOG

SPUD DATE: 01/27/09
COMPLETION DATE: 01/30/09
SURFACE CASING SET @: 500'
SURFACE CASING SIZE: 7"

DATE CENTRALIZERS RUN: 01/28/09
CENTRALIZERS SET @: 405'; 312';218'
CEMENT RETURNS: 5 BBL.
AMOUNT OF CONDUCTOR: 31'
CONDUCTOR SIZE: 9 5/8"

0-5	ROCKS & DIRT
5-150	SHALE
150-180	SANDSTONE (FRESH WATER 15 GPM)
180-410	SHALE
410-445	SANDSTONE (FRESH WATER 15 GPM)
445-511	RED ROCK
511-1417	SHALE
1417-1427	SAND (SMELL GAS)
1427-1650	SHALE
1650-1670	SAND (SMELL GAS)
1670-1810	SHALE
1810-1827	SAND (SMELL GAS, DARK COLOR SAND)
1827-1947	SHALE
1947-1957	SAND (SMELL GAS, DARK COLOR SAND)
1957-1975	SHALE
1975-1990	SAND (SMELL GAS)
1990-2160	SHALE
2160	T.D.



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STEPHEN D. PLANTS

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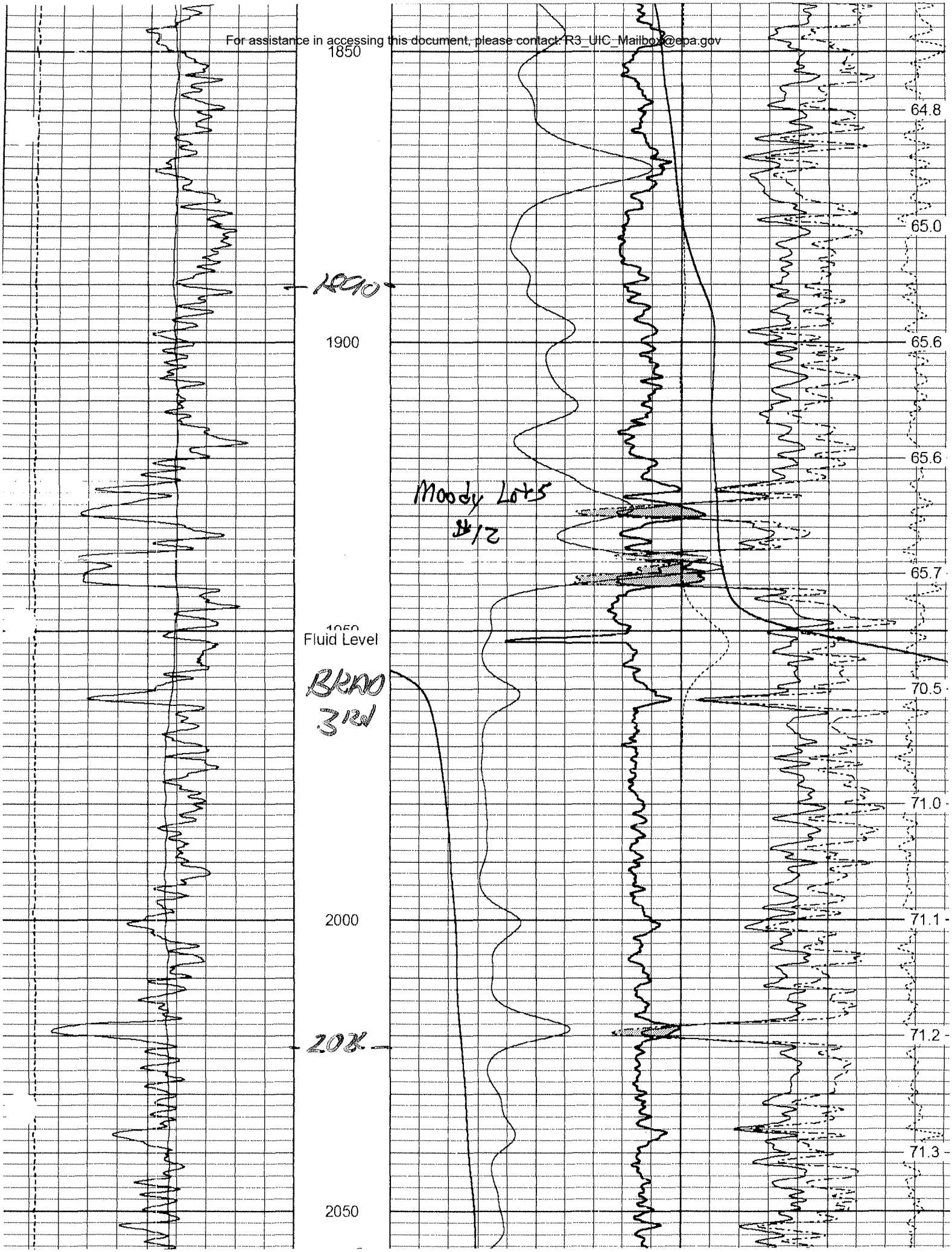
LAKE ERIE ENERGY PARTNERS
MOODY LOT 5 WELL #12
DRILLER'S LOG

SPUD DATE: 01/26/09
COMPLETION DATE: 01/28/09
SURFACE CASING SET @: 502'
SURFACE CASING SIZE: 7"

DATE CENTRALIZERS RUN: 01/27/09
CENTRALIZERS SET @: 470.8'; 314.8';252.4'
CEMENT RETURNS: 0 BBL.
AMOUNT OF CONDUCTOR: 31.2'
CONDUCTOR SIZE: 9 5/8"

0-12	ROCKS & DIRT
12-35	SHALE
35-85	SANDSTONE
85-110	SHALE
110-125	SANDSTONE (FRESH WATER 10 GPM)
125-165	SHALE
165-185	SANDSTONE (FRESH WATER 15 GPM)
185-240	SHALE
240-285	SANDSTONE (FRESH WATER 10 GPM)
285-310	SHALE
310-350	SANDSTONE (FRESH WATER 10 GPM)
350-390	SHALE
390-410	RED ROCK
410-440	SHALE
440-480	RED ROCK
480-510	SHALE
510-550	RED ROCK
550-580	SHALE
580-610	RED ROCK
610-1385	SHALE & SANDSTONE
1385-1440	SAND (SMELL GAS)
1440-1485	SHALE
1485-1525	SAND (SMELL GAS)
1525-1540	SHALE
1540-1580	SAND (SMELL GAS)
1580-1615	SHALE
1615-1645	SAND (SMELL GAS)
1645-1660	SHALE
1660-1690	SAND (SMELL GAS, BROWN COLOR SAND)
1690-1775	SHALE
1775-1810	SAND (SMELL GAS, TAN COLOR SAND)
1810-1850	SHALE
1850-1880	SAND
1880-1915	SHALE
1915-1930	SAND (TAN COLOR SAND)
1930-1980	SHALE
1980-2020	SAND
2020-2060	SHALE
2060-2085	SAND
2085-2150	SHALE
2150	T.D.



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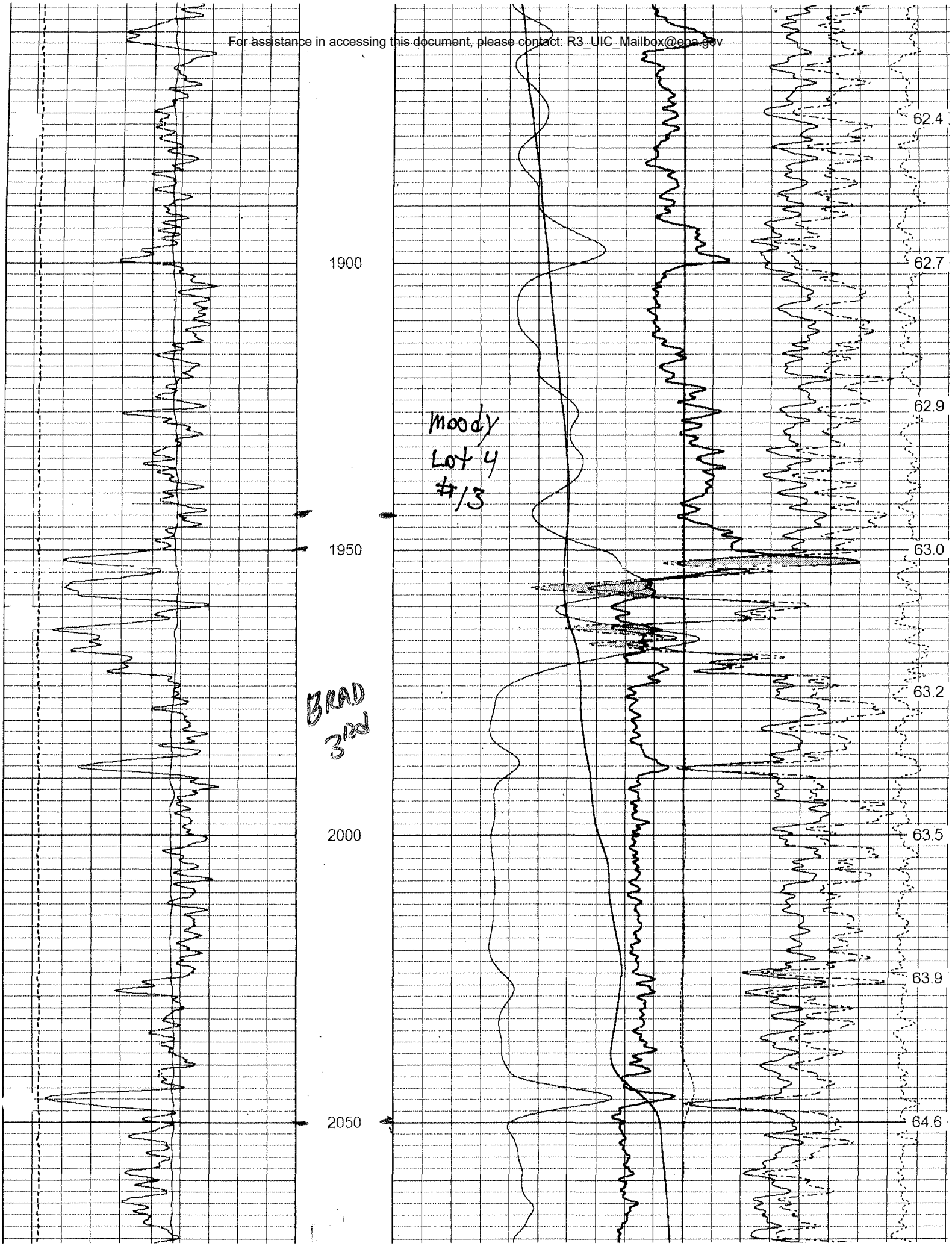
LAKE ERIE ENERGY PARTNERS
MOODY LOT 4 WELL #13
DRILLER'S LOG

SPUD DATE: 12/17/08
COMPLETION DATE: 12/19/08
SURFACE CASING SET @: 500'
SURFACE CASING SIZE: 7"

DATE CENTRALIZERS RUN: 12/18/08
CENTRALIZERS SET @: 405', 312', 218'
CEMENT RETURNS: 1 BBL.
AMOUNT OF CONDUCTOR: 31'
CONDUCTOR SIZE: 9 5/8"

0-5	TOPSOIL
5-10	SANDSTONE
10-25	RED ROCK
25-71	SHALE
71-81	SANDSTONE
81-390	SHALE (FRESH WATER 25 GPM)
390-410	RED ROCK
410-430	SHALE
430-475	RED ROCK
475-495	SHALE
495-510	RED ROCK (FRESH WATER 25-30 GPM)
510-1476	SHALE
1476-1492	SAND (SMELL GAS)
1492-1650	SHALE
1650-1670	SAND (SMELL GAS)
1670-1825	SHALE
1825-1845	SAND (SMELL GAS)
1845-1945	SHALE
1945-1956	SAND (SMELL GAS)
1956-1976	SHALE
1976-1985	SAND (SMELL GAS)
1985-2040	SHALE
2040-2047	SAND (SMELL GAS, DARK COLOR SAND)
2047-2160	SHALE
2160	T.D.



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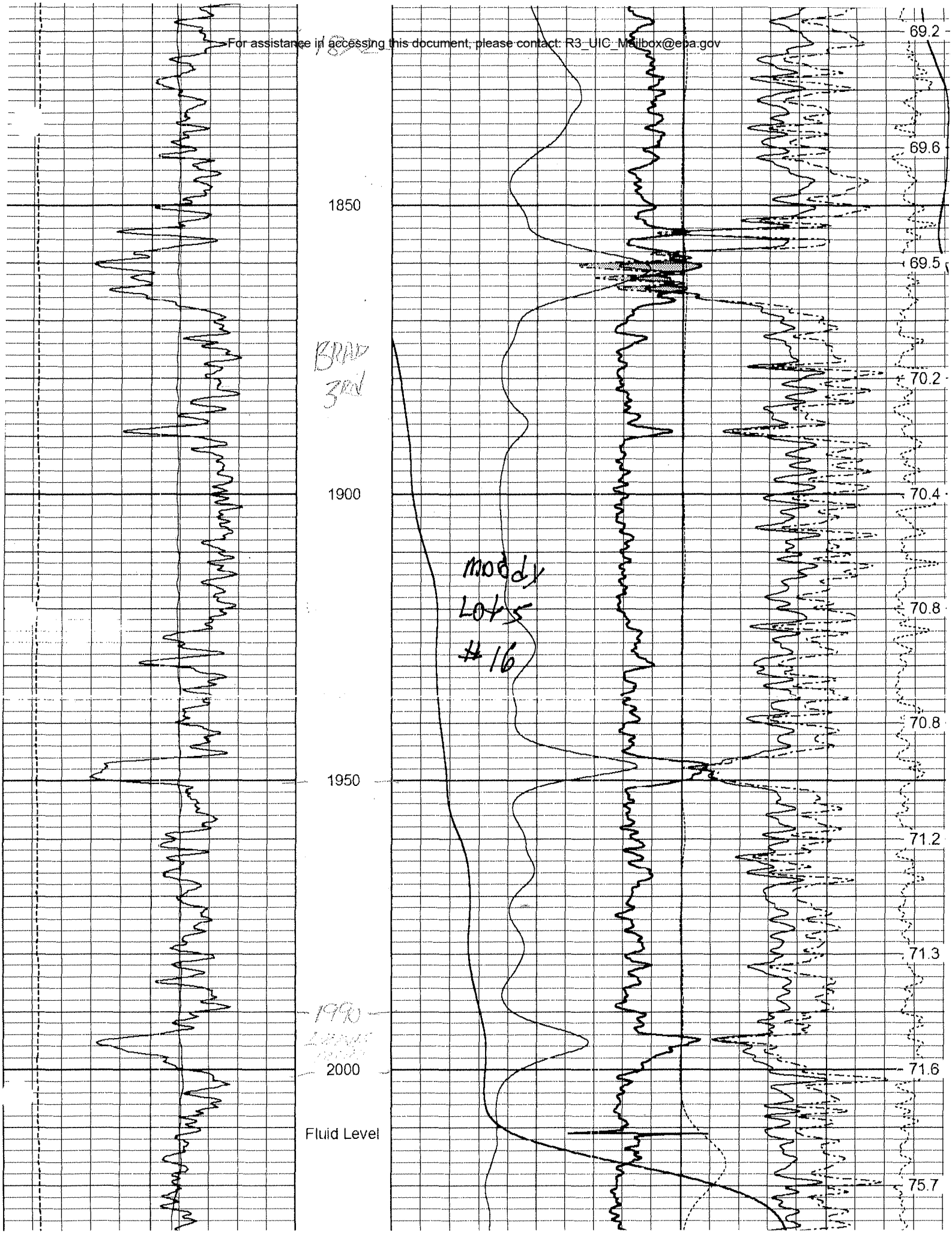
LAKE ERIE ENERGY PARTNERS
MOODY LOT 5 WELL #16
DRILLER'S LOG

SPUD DATE:. 02/11/09
COMPLETION DATE: 02/13/09
SURFACE CASING SET @: 502'
SURFACE CASING SIZE: 7"

DATE CENTRALIZERS RUN: 02/12/09
CENTRALIZERS SET @: 470.8'; 314.8'; 252.4'
CEMENT RETURNS: 0 BBL.
AMOUNT OF CONDUCTOR: 43'
CONDUCTOR SIZE: 9 5/8"

0-35	ROCKS & DIRT
35-85	SHALE
85-120	SANDSTONE (FRESH WATER 10 GPM)
120-160	SHALE
160-185	SANDSTONE (FRESH WATER 15 GPM)
185-250	SHALE
250-290	SANDSTONE (FRESH WATER 10 GPM)
290-310	SHALE
310-340	RED ROCK
340-360	SHALE
360-390	SANDSTONE (FRESH WATER 10 GPM)
390-410	SHALE
410-460	RED ROCK
460-520	SHALE
520-560	RED ROCK
560-620	SHALE
620-645	RED ROCK
645-1320	SHALE & SANDSTONE
1320-1340	SAND (SMELL GAS, TAN COLOR SAND)
1340-1370	SHALE
1370-1395	SAND (SMELL GAS, TAN COLOR SAND)
1395-1460	SHALE
1460-1485	SAND
1485-1495	SHALE
1495-1530	SAND
1530-1560	SHALE
1560-1620	SAND
1620-1680	SHALE
1680-1710	SAND
1710-1790	SHALE
1790-1850	SAND (TAN COLOR SAND)
1850-1940	SHALE
1940-1990	SAND (SMELL GAS, TAN COLOR SAND)
1990-2010	SHALE
2010-2025	SAND (TAN COLOR SAND)
2025-2050	SHALE
2050-2065	SAND
2065-2090	SHALE
2090-2105	SAND
2105-2150	SHALE
2150	T.D.



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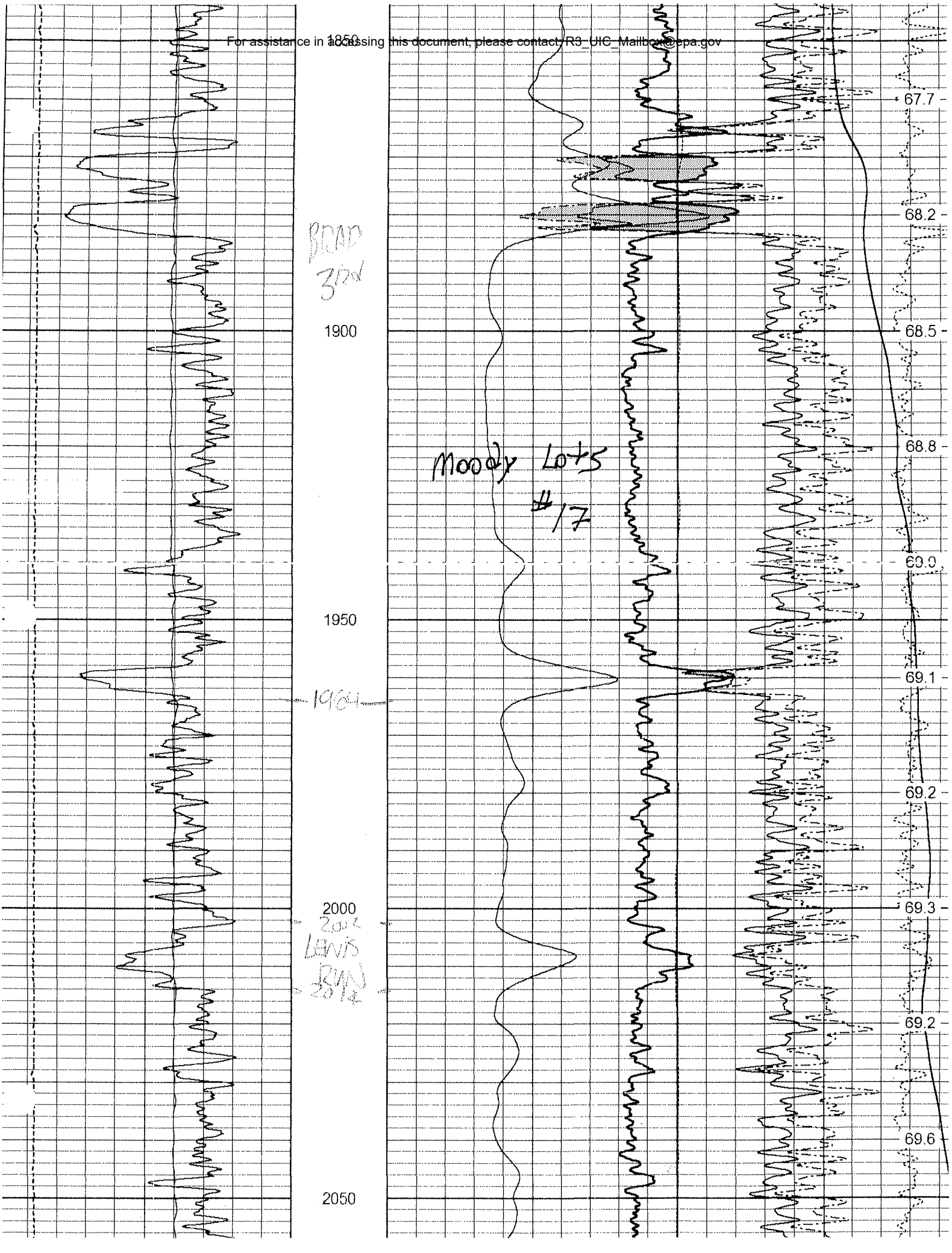
LAKE ERIE ENERGY PARTNERS
MOODY LOT 5 WELL #17
DRILLER'S LOG

SPUD DATE: 02/06/09
COMPLETION DATE: 02/10/09
SURFACE CASING SET @: 502'
SURFACE CASING SIZE: 7"

DATE CENTRALIZERS RUN: 02/06/09
CENTRALIZERS SET @: 470.8'; 314.8'; 252.4'
CEMENT RETURNS: 4 BBL.
AMOUNT OF CONDUCTOR: 44'
CONDUCTOR SIZE: 9 5/8"

0-35	ROCKS & DIRT
35-65	SANDSTONE
65-85	SHALE
85-120	SANDSTONE (FRESH WATER 10 GPM)
120-160	SHALE
160-185	SANDSTONE (FRESH WATER 15 GPM)
185-250	SHALE
250-285	SANDSTONE (FRESH WATER 10 GPM)
285-310	SHALE
310-360	SANDSTONE (FRESH WATER 10 GPM)
360-420	RED ROCK
420-460	SHALE
460-530	RED ROCK
530-610	SHALE
610-635	RED ROCK
635-1390	SHALE & SANDSTONE
1390-1430	SAND (SMELL GAS)
1430-1480	SHALE
1480-1530	SAND (SMELL GAS)
1530-1550	SHALE
1550-1585	SAND (TAN COLOR SAND)
1585-1610	SHALE
1610-1660	SAND (SMELL GAS)
1660-1740	SHALE
1740-1780	SAND (SMELL GAS)
1780-1810	SHALE
1810-1860	SAND (BROWN COLOR SAND)
1860-1885	SHALE
1885-1920	SAND (SMELL GAS)
1920-1980	SHALE
1980-2010	SAND (BROWN COLOR SAND)
2010-2040	SHALE
2040-2060	SAND (SMELL GAS)
2060-2070	SHALE
2070-2090	SAND (SMELL GAS)
2090-2150	SHALE
2150	T.D.



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STEPHEN D. PLANTS

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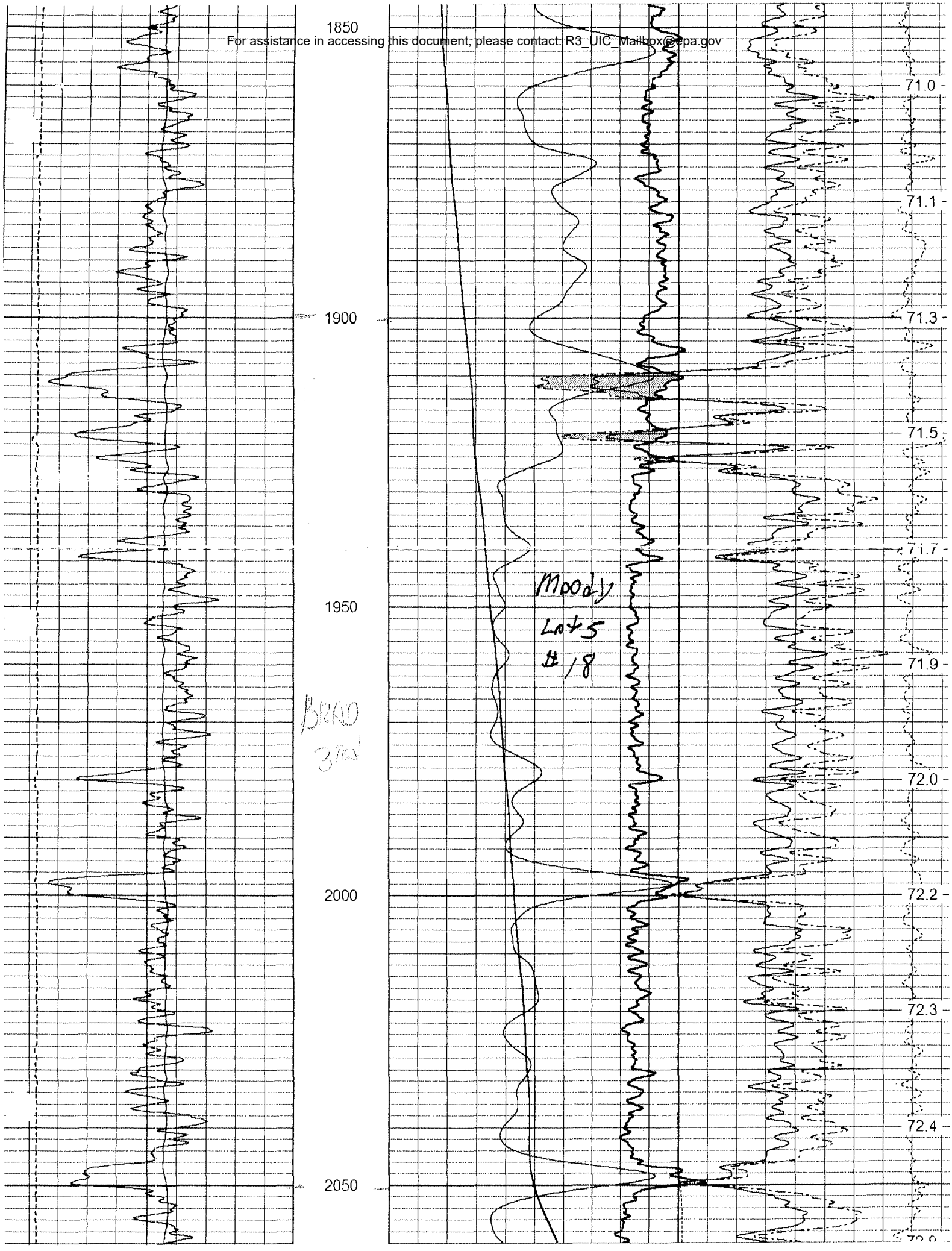
LAKE ERIE ENERGY PARTNERS
MOODY LOT 5 WELL #18
DRILLER'S LOG

SPUD DATE: 01/29/09
COMPLETION DATE: 02/05/09
SURFACE CASING SET @: 502'
SURFACE CASING SIZE: 7"

DATE CENTRALIZERS RUN: 01/30/09
CENTRALIZERS SET @: 470.8'; 314.8'; 252.4'
CEMENT RETURNS: 4 BBL.
AMOUNT OF CONDUCTOR: 62.6'
CONDUCTOR SIZE: 9 5/8"

0-15	ROCKS & DIRT
15-32	SHALE
32-45	ROCKS & GRAVEL
45-85	SHALE
85-120	SANDSTONE (FRESH WATER 2 GPM)
120-160	SHALE
160-185	SANDSTONE (FRESH WATER 5 GPM)
185-260	SHALE
260-290	SANDSTONE (FRESH WATER 10 GPM)
290-320	SHALE
320-360	SANDSTONE
360-395	RED ROCK
395-420	SHALE
420-480	RED ROCK
480-510	SHALE
510-525	RED ROCK
525-550	SHALE
550-575	RED ROCK
575-1390	SHALE & SANDSTONE
1390-1420	SAND
1420-1510	SHALE
1510-1535	SAND
1535-1565	SHALE
1565-1585	SAND
1585-1610	SHALE
1610-1640	SAND
1640-1665	SHALE
1665-1685	SAND
1685-1760	SHALE
1760-1820	SAND (SMELL GAS, DARK BROWN COLOR)
1820-1860	SHALE
1860-1910	SAND (SMELL GAS, DARK BROWN COLOR)
1910-1940	SHALE
1940-1980	SAND
1980-2010	SHALE
2010-2030	SAND
2030-2060	SHALE
2060-2085	SAND
2086-2150	SHALE
2150	T.D.



Plants & Goodwin INC. OIL & GAS FIELD SERVICES

PAUL R. PLANTS
STEPHEN D. PLANTS

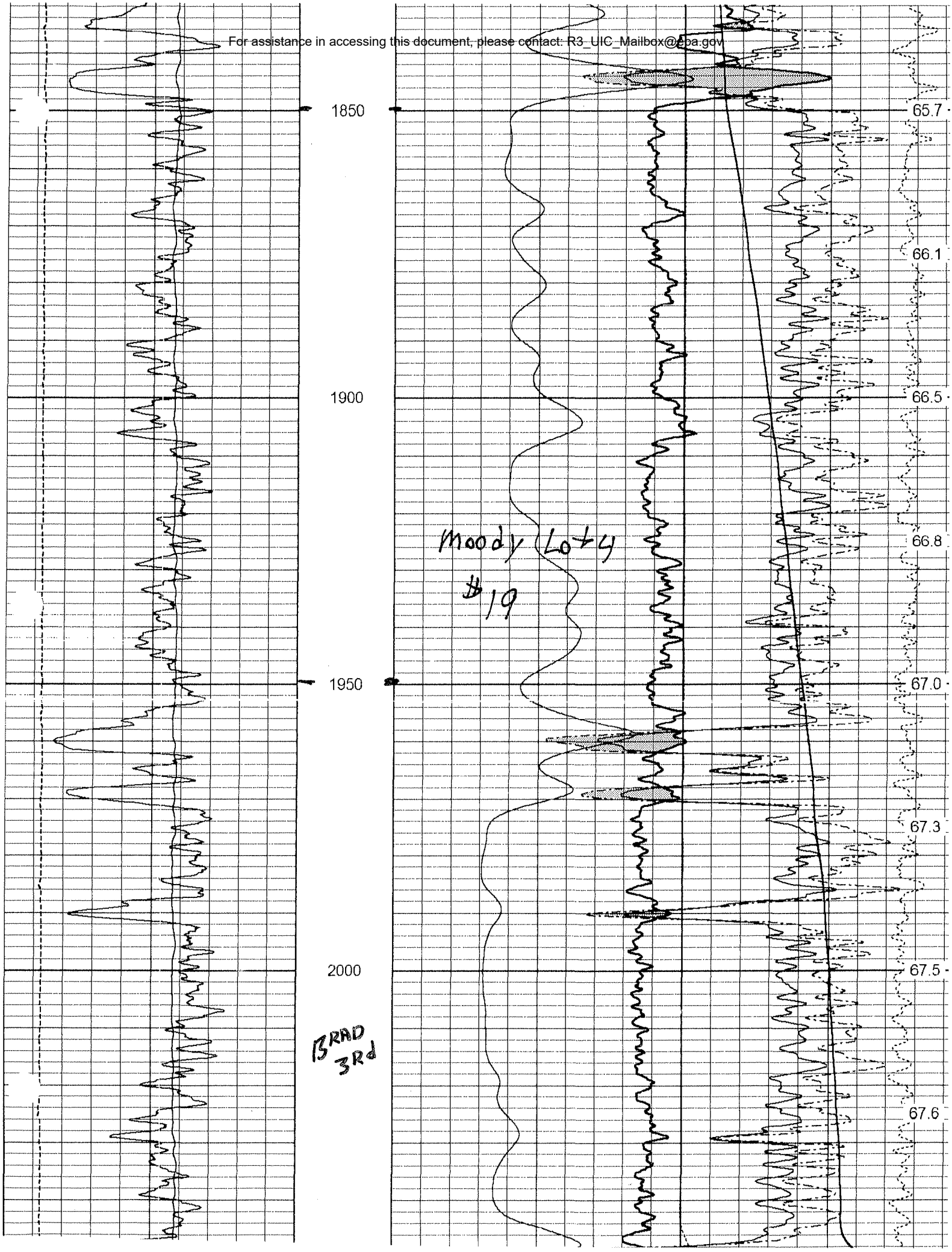
1034 ROUTE 44 • SHINGLEHOUSE, PA 16748 • (814) 697-6330 • (814) 697-7515 FAX

LAKE ERIE ENERGY PARTNERS
MOODY LOT 4 WELL #19
DRILLER'S LOG

SPUD DATE: 12/10/08
COMPLETION DATE: 12/16/08
SURFACE CASING SET @: 500'
SURFACE CASING SIZE: 7"

DATE CENTRALIZERS RUN: 12/11/08
CENTRALIZERS SET @: 405', 312', 218'
CEMENT RETURNS: 0 BBL.
AMOUNT OF CONDUCTOR: 31'
CONDUCTOR SIZE: 9 5/8"

0-10	TOPSOIL
10-25	SANDSTONE
25-46	SHALE
46-51	SANDSTONE
51-381	SHALE (FRESH WATER 20 GPM)
381-401	RED ROCK
401-446	SHALE
446-511	RED ROCK (FRESH WATER 20-25 GPM)
511-650	SHALE
650-685	RED ROCK
685-1850	SHALE
1850-1860	SAND (SMELL GAS)
1860-1950	SHALE
1950-1965	SAND (SMELL GAS, DARK COLOR SAND)
1965-1980	SHALE
1980-1995	SAND (SMELL GAS)
1995-2150	SHALE
2150-2165	SAND (SMELL GAS)
2165-2190	SHALE
2190	T.D.



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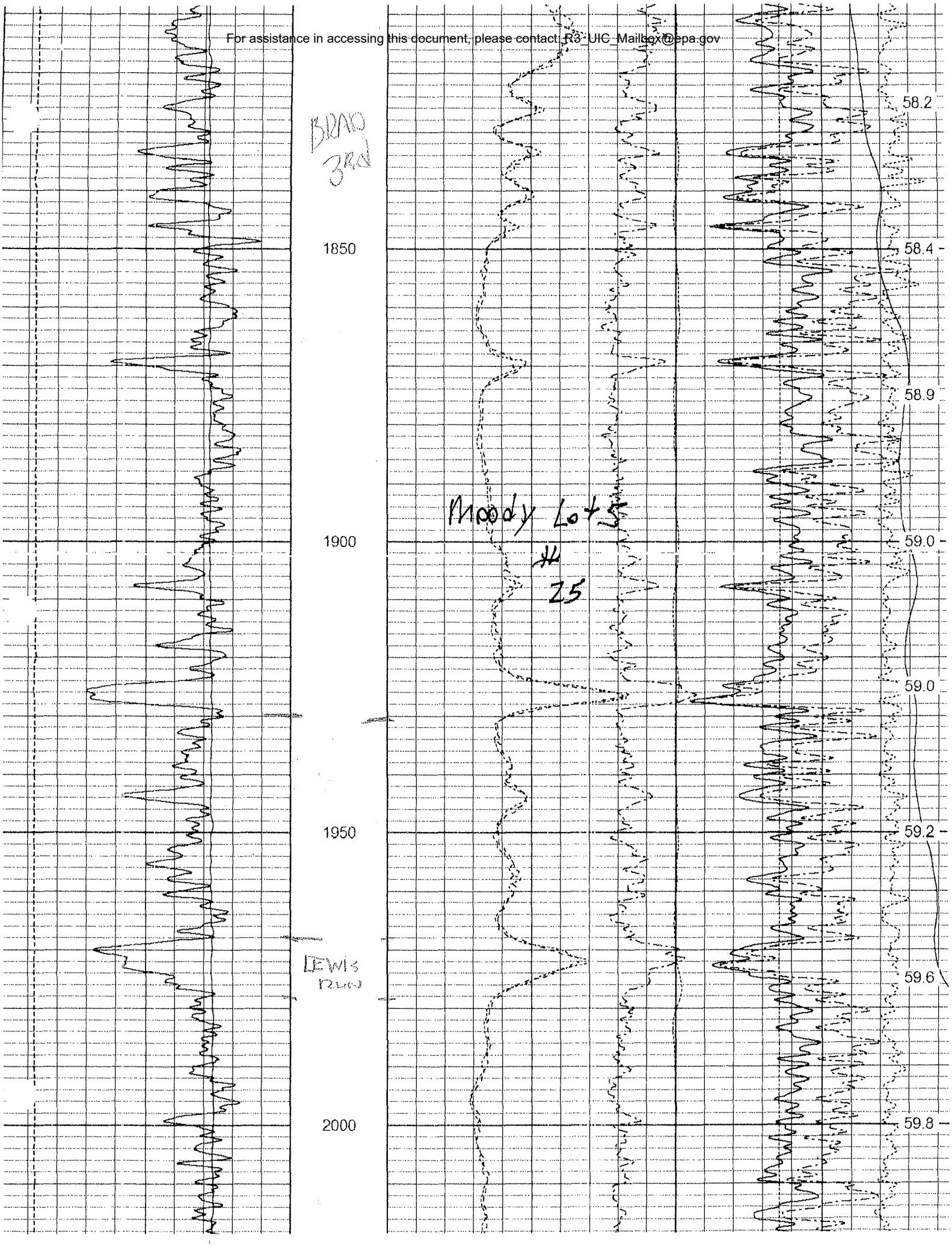
LAKE ERIE ENERGY PARTNERS
MOODY LOT #5 WELL #25
DRILLER'S LOG

SPUD DATE: 10/19/09
COMPLETION DATE: 10/21/09
SURFACE CASING SET @: 517'
SURFACE CASING SIZE: 7"

DATE CENTRALIZERS RUN: 10/20/09
CENTRALIZERS SET @: 420'; 323'; 226'
CEMENT RETURNS: 0 BBL.
AMOUNT OF CONDUCTOR: 32'
CONDUCTOR SIZE: 9 5/8"

0-10	ROCKS & DIRT
10-15	RED ROCK
15-70	SHALE
70-76	SANDSTONE
76-96	SHALE
96-101	SANDSTONE
101-140	SHALE
140-150	SANDSTONE (FRESH WATER 10 GPM)
150-260	SHALE
260-275	RED ROCK
275-1345	SHALE
1345-1360	SAND (SMELL GAS)
1360-1530	SHALE
1530-1540	SAND (SMELL GAS)
1540-1705	SHALE
1705-1720	SAND (SMELL GAS)
1720-1915	SHALE
1915-1930	SAND (SMELL GAS)
1930-2127	SHALE
2127	T.D.

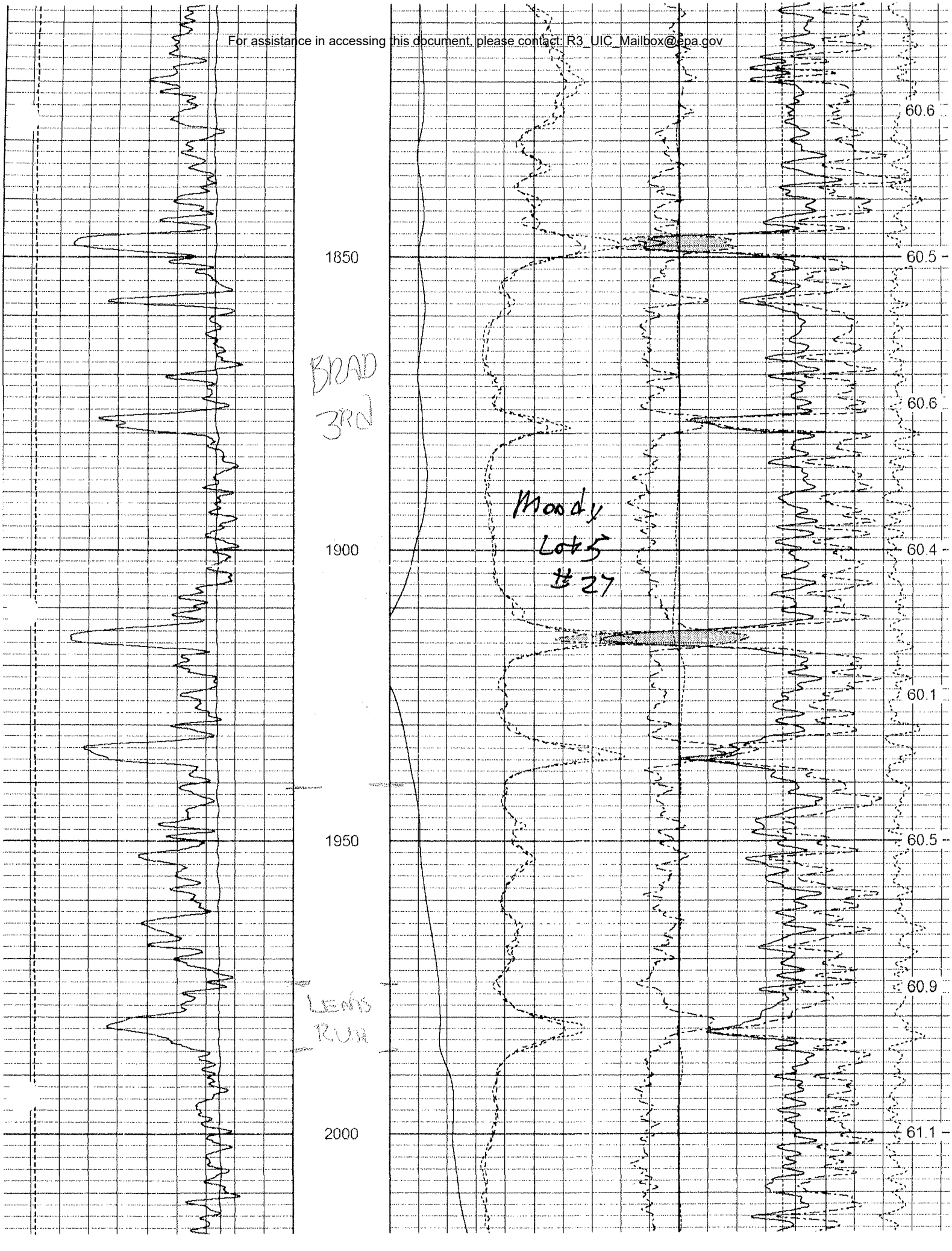


LAKE ERIE ENERGY PARTNERS
MOODY LOT 5 WELL #27
DRILLER'S LOG

SPUD DATE: 10/22/09
COMPLETION DATE: 10/27/09
SURFACE CASING SET @: 512'
SURFACE CASING SIZE: 7"

DATE CENTRALIZERS RUN: 10/26/09
CENTRALIZERS SET @: 421'; 331'; 210'
CEMENT RETURNS: 0 BBL.
AMOUNT OF CONDUCTOR: 32'
CONDUCTOR SIZE: 9 5/8"

0-10	ROCKS & DIRT
10-25	RED ROCK
25-42	SHALE
42-50	SANDSTONE (FRESH WATER 2 GPM)
50-76	SHALE
76-92	SANDSTONE
92-166	SHALE
166-176	SANDSTONE (FRESH WATER 15 GPM)
176-360	SHALE
360-430	RED ROCK
430-1375	SHALE
1375-1390	SAND (SMELL GAS)
1390-1540	SHALE
1540-1555	SAND (SMELL GAS)
1555-1705	SHALE
1705-1725	SAND (SMELL GAS)
1725-1830	SHALE
1830-1855	SAND (SMELL GAS, DARK COLOR SAND)
1855-1905	SHALE
1905-1915	SAND (SMELL GAS, DARK COLOR SAND)
1915-1930	SHALE
1930-1940	SAND (SMELL GAS)
1940-2127	SHALE
2127	T.D.



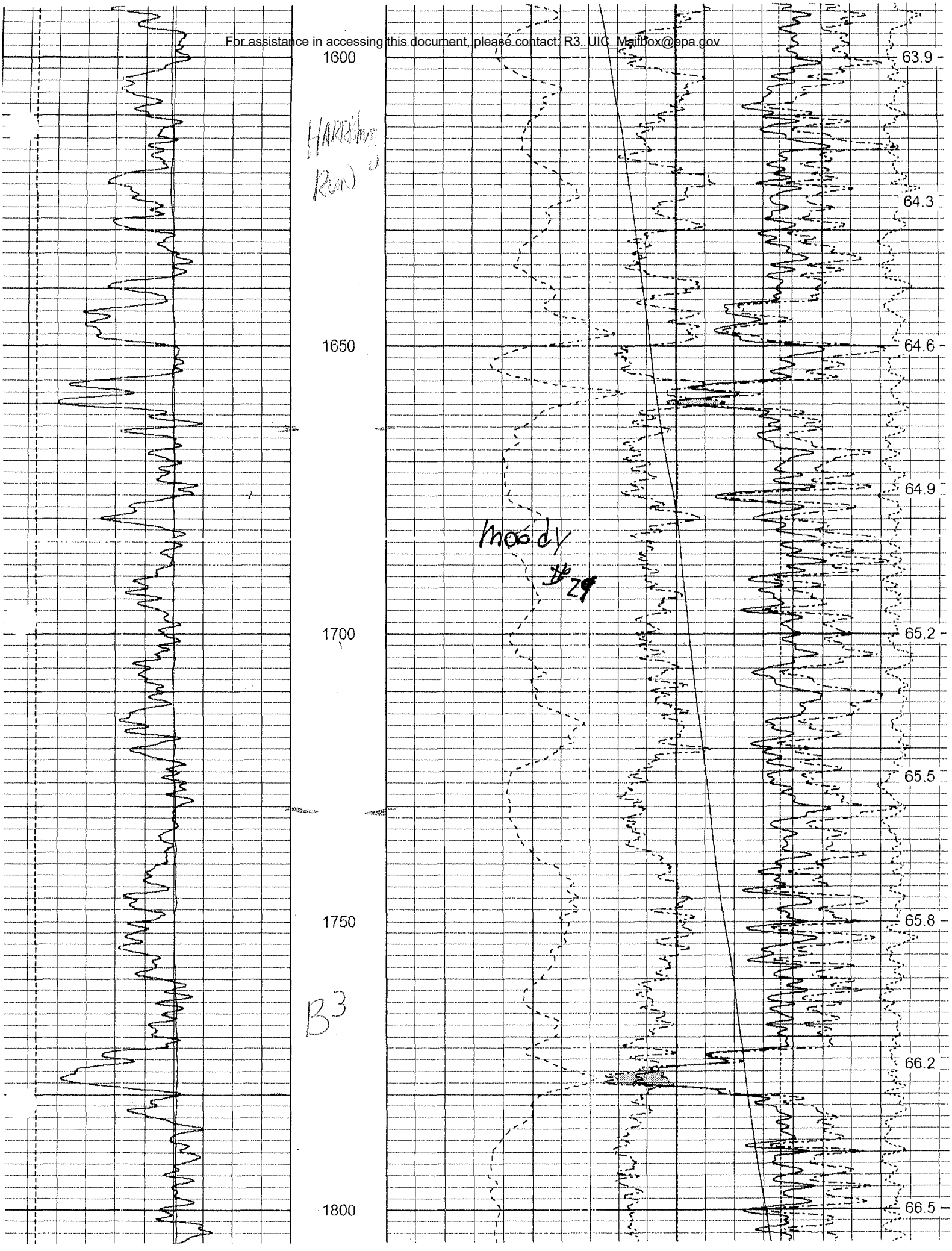
LAKE ERIE ENERGY PARTNERS
WELL #29
DRILLER'S LOG

SPUD DATE: 11/09/09
COMPLETION DATE: 11/12/09
SURFACE CASING SET @: 508'
SURFACE CASING SIZE: 7"

DATE CENTRALIZERS RUN: 11/10/09
CENTRALIZERS SET @: 411'; 314'; 217'
CEMENT RETURNS: 0 BBL.
AMOUNT OF CONDUCTOR: 32'
CONDUCTOR SIZE: 9 5/8"

0-10	ROCKS & DIRT
10-25	SANDSTONE
25-70	SHALE
70-76	SANDSTONE
76-80	SHALE
80-90	SANDSTONE (FRESH WATER 15 GPM)
990-286	SHALE
286-300	RED ROCK
300-330	SHALE
330-345	RED ROCK
345-1295	SHALE
1295-1310	SAND (SMELL GAS)
1310-1470	SHALE
1470-1490	SAND (SMELL GAS)
1490-1635	SHALE
1635-1655	SAND (SMELL GAS)
1655-1705	SHALE
1705-1710	SAND (SMELL GAS)
1710-1765	SHALE
1765-1785	SAND (SMELL GAS, DARK COLOR SAND)
1785-2034	SHALE (SALT WATER @ 1830')
2034	T.D.

NOTE: WELL WAS DRILLED FROM 1830' TO 2034' WITH 6 1/8" TRICONE BIT DUE TO SALT WATER AT 1830'.

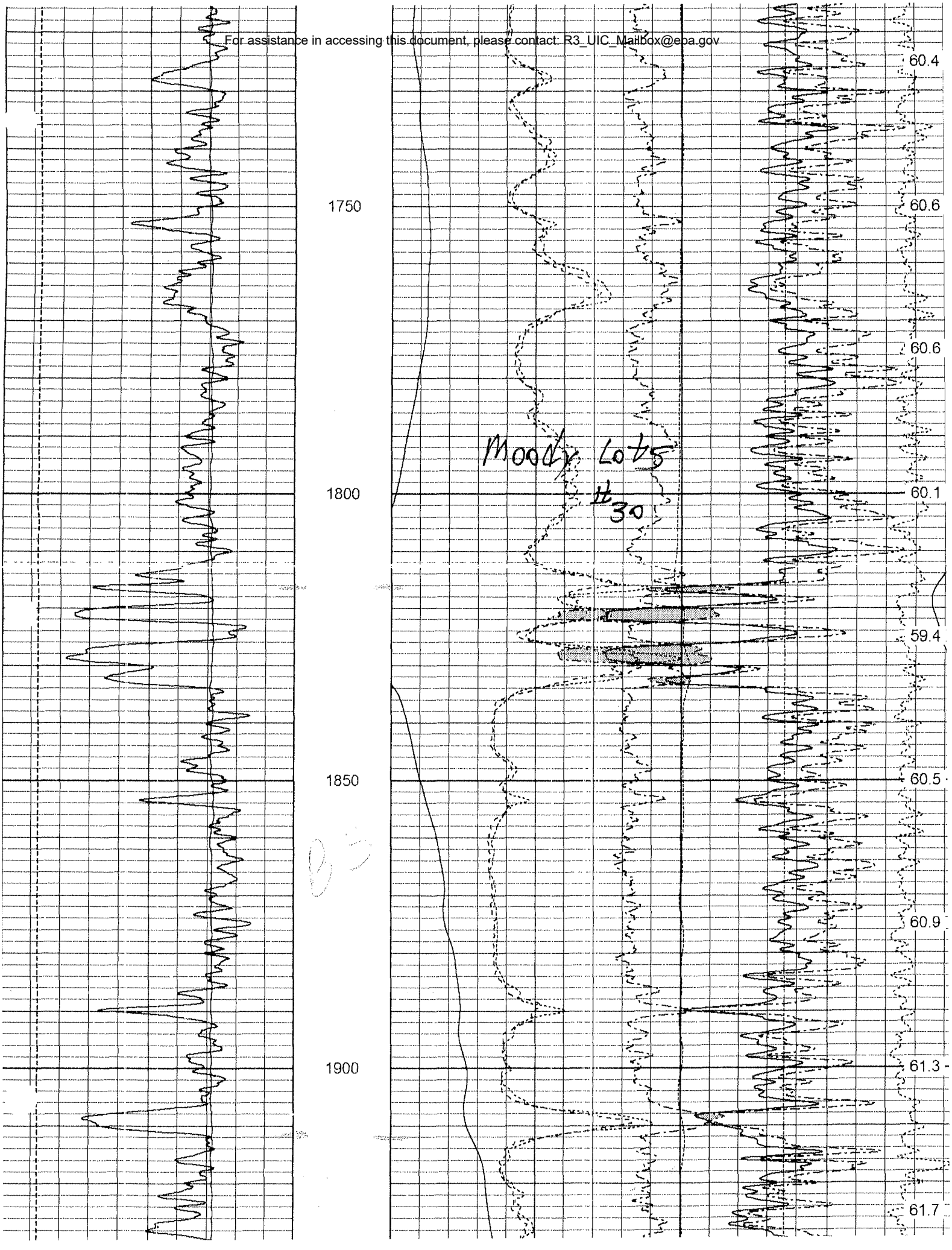


LAKE ERIE ENERGY PARTNERS
MOODY LOT 5 WELL #30
DRILLER'S LOG

SPUD DATE: 10/29/09
COMPLETION DATE: 11/04/09
SURFACE CASING SET @: 517'
SURFACE CASING SIZE: 7"

DATE CENTRALIZERS RUN: 11/03/09
CENTRALIZERS SET @: 420'; 323'; 226'
CEMENT RETURNS: 11 BBL.
AMOUNT OF CONDUCTOR: 32'
CONDUCTOR SIZE: 9 5/8"

0-10	ROCKS & DIRT
10-15	SANDSTONE (FRESH WATER 2 GPM)
15-25	RED ROCK
25-145	SHALE
145-165	SANDSTONE (FRESH WATER 10 GPM)
165-286	SHALE
286-316	RED ROCK
316-346	SHALE
346-390	RED ROCK
390-520	SHALE
520-560	RED ROCK
560-640	SHALE
640-650	SAND (SMELL GAS)
650-1340	SHALE
1340-1360	SAND (SMELL GAS)
1360-1516	SHALE
1516-1532	SAND (SMELL GAS, DARK COLOR SAND)
1532-1806	SHALE
1806-1832	SAND (SMELL GAS, DARK COLOR SAND)
1832-1900	SHALE
1900-1915	SAND (SMELL GAS, DARK COLOR SAND)
1915-2067	SHALE
2067	T.D.

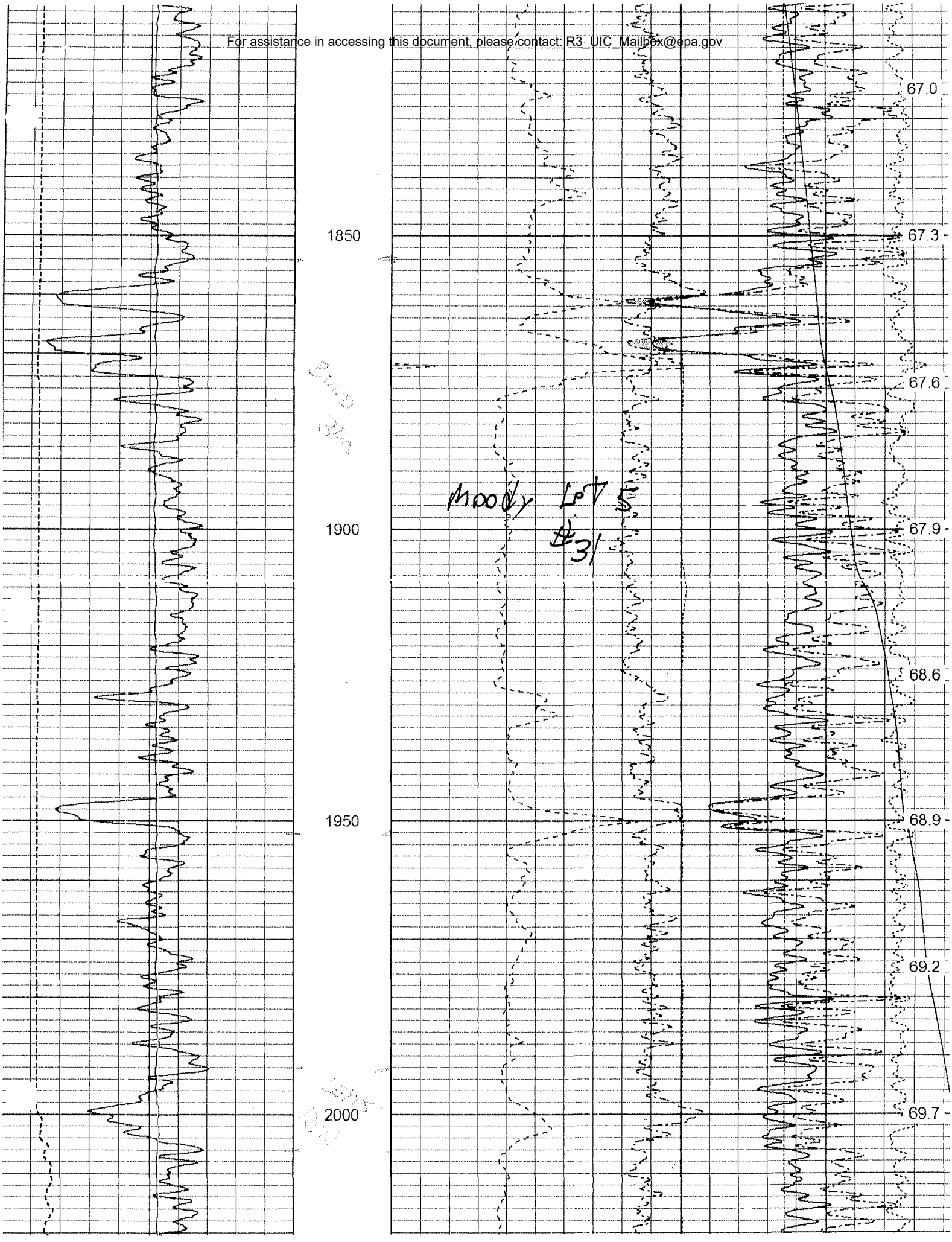


LAKE ERIE ENERGY PARTNERS
MOODY LOT 5 WELL #31
DRILLER'S LOG

SPUD DATE: 10/26/09
COMPLETION DATE: 10/29/09
SURFACE CASING SET @: 512'
SURFACE CASING SIZE: 7"

DATE CENTRALIZERS RUN: 10/27/09
CENTRALIZERS SET @: 452'; 331'; 181'
CEMENT RETURNS: 7 BBL.
AMOUNT OF CONDUCTOR: 32'
CONDUCTOR SIZE: 9 5/8"

0-20	ROCKS & DIRT
20-35	SHALE
35-65	SANDSTONE (FRESH WATER 5 GPM)
65-85	SHALE
85-120	SANDSTONE (FRESH WATER 10 GPM)
120-180	SHALE
180-260	SANDSTONE (FRESH WATER 20 GPM)
260-290	SHALE
290-330	SANDSTONE (FRESH WATER 25 GPM)
330-365	RED ROCK
365-395	SHALE
395-420	RED ROCK
420-460	SANDSTONE
460-535	RED ROCK
535-580	SHALE
580-615	RED ROCK
615-1382	SHALE & SANDSTONE
1382-1410	SAND (SMELL GAS, TAN COLOR SAND)
1410-1490	SHALE
1490-1530	SAND (SMELL GAS)
1530-1550	SHALE
1550-1565	SAND (SMELL GAS, TAN COLOR SAND)
1565-1575	SHALE
1575-1620	SAND (SMELL GAS, BROWN COLOR SAND)
1620-1710	SHALE
1710-1745	SAND (SMELL GAS)
1745-1790	SHALE
1790-1830	SAND (SAND IS WET, INJECT WATER)
1830-1860	SHALE
1860-1890	SAND (TAN COLOR SAND)
1890-1915	SHALE
1915-1935	SAND
1935-1980	SHALE
1980-2010	SAND
2010-2100	SHALE
2100	T.D.

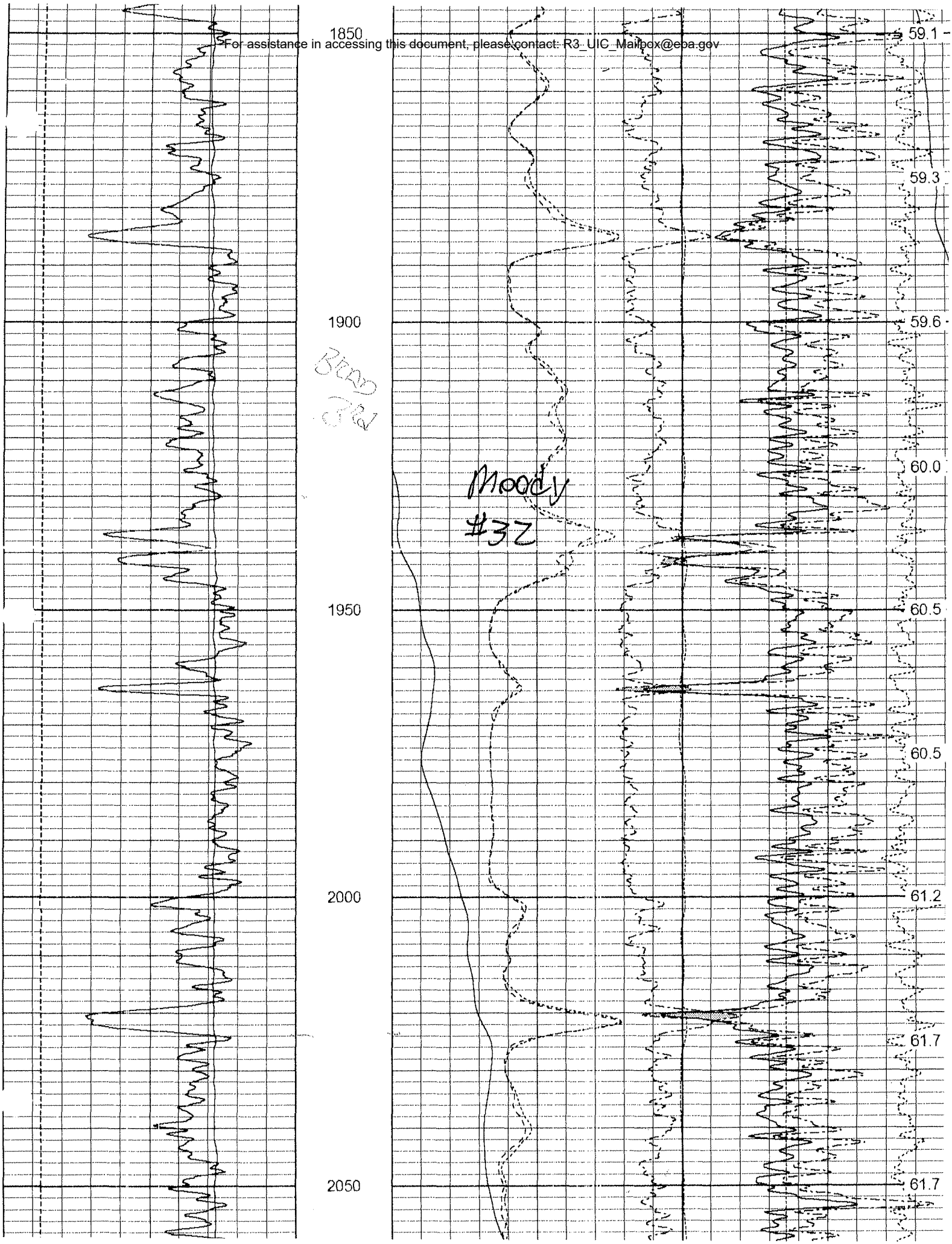


LAKE ERIE ENERGY PARTNERS
WELL #32
DRILLER'S LOG

SPUD DATE: 11/17/09
COMPLETION DATE: 11/19/09
SURFACE CASING SET @: 504'
SURFACE CASING SIZE: 7"

DATE CENTRALIZERS RUN: 11/18/09
CENTRALIZERS SET @: 440'; 282'; 123'
CEMENT RETURNS: 9 BBL.
AMOUNT OF CONDUCTOR: 32.2'
CONDUCTOR SIZE: 9 5/8"

0-8	ROCKS & DIRT
8-45	SANDSTONE
45-65	SHALE
65-85	SANDSTONE (FRESH WATER 15 GPM)
85-120	SHALE
120-165	SANDSTONE (FRESH WATER 5 GPM)
165-250	SHALE
250-285	SANDSTONE (FRESH WATER 5 GPM)
285-325	SHALE
325-360	SANDSTONE (FRESH WATER 5 GPM)
360-390	SHALE
390-425	RED ROCK
425-460	SHALE
460-520	RED ROCK
520-550	SHALE
550-585	RED ROCK
585-615	SHALE
615-635	RED ROCK
635-1415	SHALE & SANDSTONE
1415-1425	SAND (SMELL GAS, TAN COLOR SAND)
1425-1445	SHALE
1445-1480	SAND (SMELL GAS, TAN COLOR SAND)
1480-1560	SHALE
1560-1580	SAND
1580-1630	SHALE
1630-1685	SAND (SMELL GAS, TAN COLOR SAND)
1685-1790	SHALE
1790-1835	SAND (SMELL GAS)
1835-1880	SHALE
1880-1910	SAND (TAN COLOR SAND)
1910-1940	SHALE
1940-1970	SAND (TAN COLOR SAND)
1970-2010	SHALE
2010-2025	SAND (TAN COLOR SAND)
2025-2040	SHALE
2040-2060	SAND (SMELL GAS)
2060-2214	SHALE
2214	T.D.

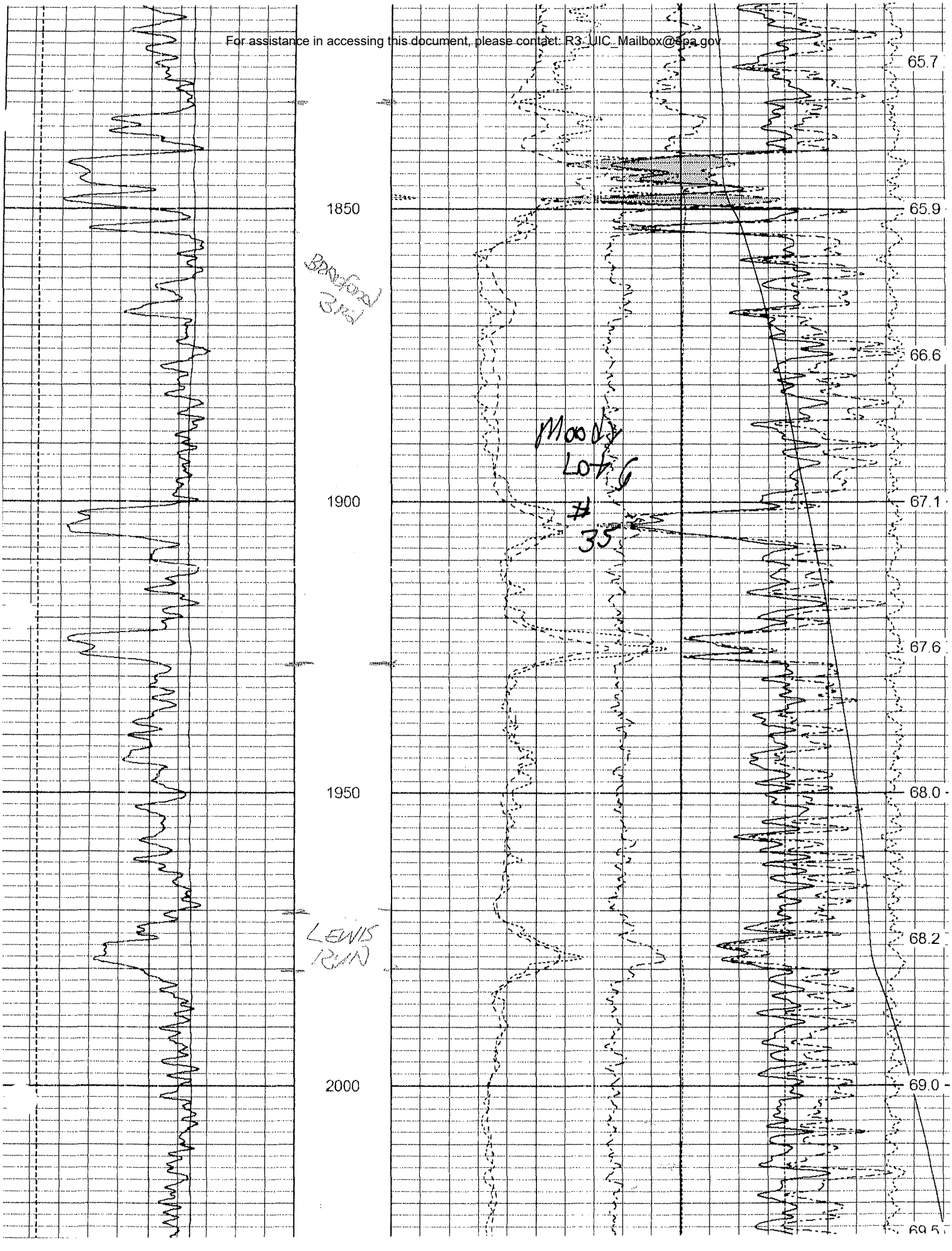


LAKE ERIE ENERGY PARTNERS
MOODY LOT #6 WELL #35
DRILLER'S LOG

SPUD DATE: 10/12/09
COMPLETION DATE: 10/19/09
SURFACE CASING SET @: 517'
SURFACE CASING SIZE: 7"

DATE CENTRALIZERS RUN: 10/13/09
CENTRALIZERS SET @: 452'; 290'; 129'
CEMENT RETURNS: 5 BBL.
AMOUNT OF CONDUCTOR: 32.4'
CONDUCTOR SIZE: 9 5/8"

0-18	ROCKS & DIRT
18-35	SHALE
35-60	SANDSTONE
60-85	SHALE
85-120	SANDSTONE (FRESH WATER 10 GPM)
120-160	SHALE
160-185	SANDSTONE (FRESH WATER 15 GPM)
185-240	SHALE
240-280	SANDSTONE (FRESH WATER 20 GPM)
280-310	SHALE
310-360	SANDSTONE (FRESH WATER 25 GPM)
360-380	SHALE
380-420	RED ROCK
420-460	SANDSTONE
460-495	RED ROCK
495-540	SHALE
540-570	RED ROCK
570-1320	SANDSTONE & SHALE
1320-1380	SAND (SMELL GAS)
1380-1460	SHALE
1460-1485	SAND (SMELL GAS, BROWN COLOR SAND)
1485-1525	SHALE
1525-1565	SAND (TAN COLOR SAND)
1565-1620	SHALE
1620-1680	SAND
1680-1710	SHALE
1710-1760	SAND (SMELL GAS, SAND IS WET, PULL DRILL STEEL & PUT TRICONE BIT ON)
1760-1830	SHALE
1830-1860	SAND (BROWN COLOR SAND)
1860-1890	SHALE
1980-1920	SAND (SMELL GAS)
1920-1960	SHALE
1960-2010	SAND (SMELL GAS)
2010-2050	SHALE
2050-2065	SAND (SMELL GAS)
2065-2110	SHALE
2110	T.D.

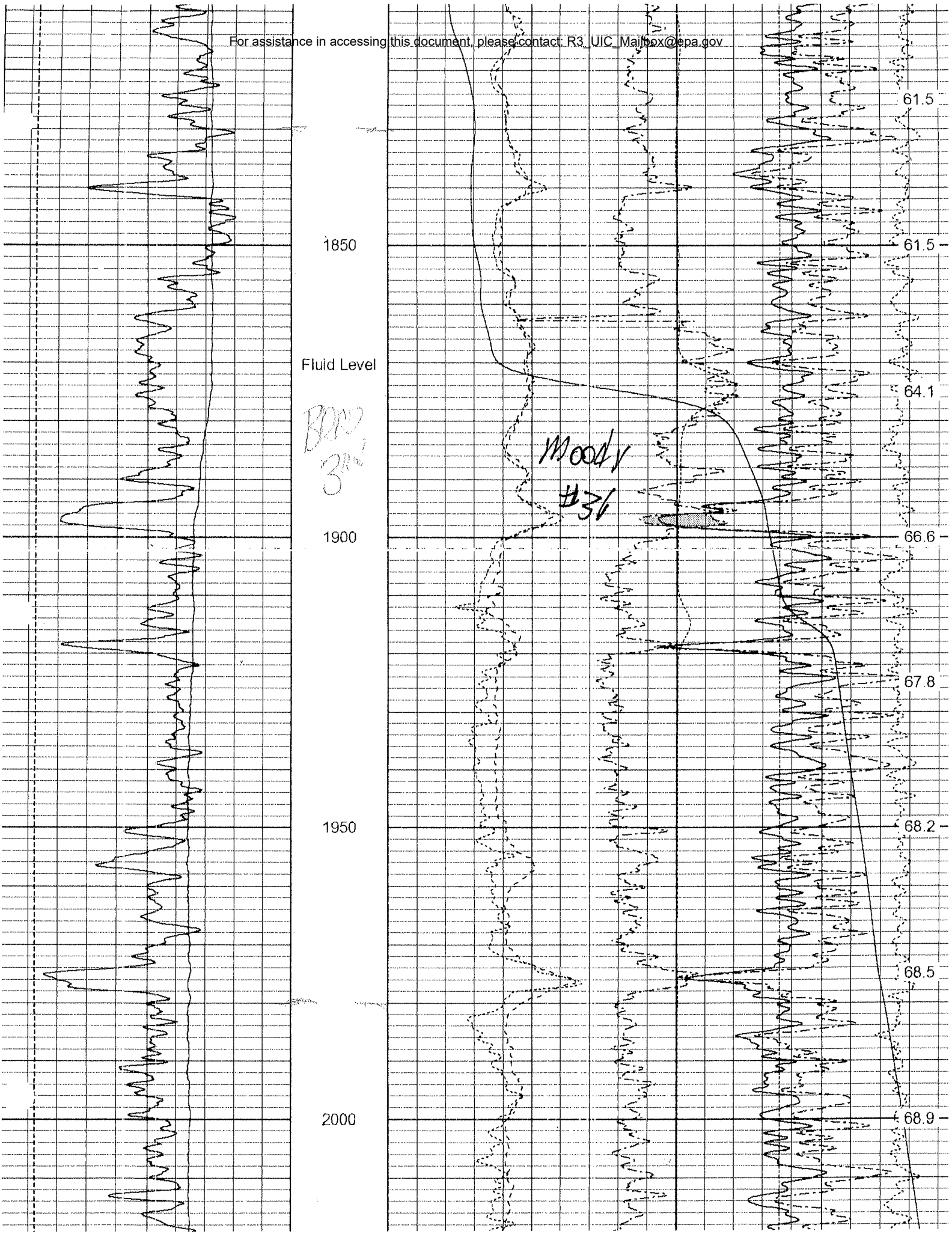


LAKE ERIE ENERGY PARTNERS
MOODY WELL #36
DRILLER'S LOG

SPUD DATE: 10/20/09
COMPLETION DATE: 10/27/09
SURFACE CASING SET @: 517'
SURFACE CASING SIZE: 7"

DATE CENTRALIZERS RUN: 10/21/09
CENTRALIZERS SET @: 452'; 290'; 129'
CEMENT RETURNS: 0 BBL.
AMOUNT OF CONDUCTOR: 32.3'
CONDUCTOR SIZE: 9 5/8"

0-26	ROCKS & DIRT
26-65	SHALE
65-85	SANDSTONE (FRESH WATER 10 GPM)
85-120	SHALE
120-165	SANDSTONE (FRESH WATER 15 GPM)
165-190	SHALE
190-220	SANDSTONE (FRESH WATER 10 GPM)
220-250	SHALE
250-280	SANDSTONE (FRESH WATER 5 GPM)
280-325	SHALE
325-370	RED ROCK
370-425	SHALE
425-490	RED ROCK
490-535	SHALE
535-615	RED ROCK
615-1370	SANDSTONE & SHALE
1370-1395	SAND (SMELL GAS)
1395-1415	SHALE
1415-1435	SAND (SMELL GAS)
1435-1515	SHALE
1515-1560	SAND (SMELL GAS, TAN COLOR SAND)
1560-1595	SHALE
1595-1620	SAND (SMELL GAS)
1620-1745	SHALE
1745-1830	SAND (SMELL GAS)
1830-1890	SHALE
1890-1930	SAND (SMELL GAS, BROWN COLOR SAND)
1930-1965	SHALE
1965-1985	SAND (SMELL GAS, BROWN COLOR SAND)
1985-2010	SHALE
2010-2030	SAND (BROWN COLOR SAND)
2030-2120	SHALE
2120	T.D.

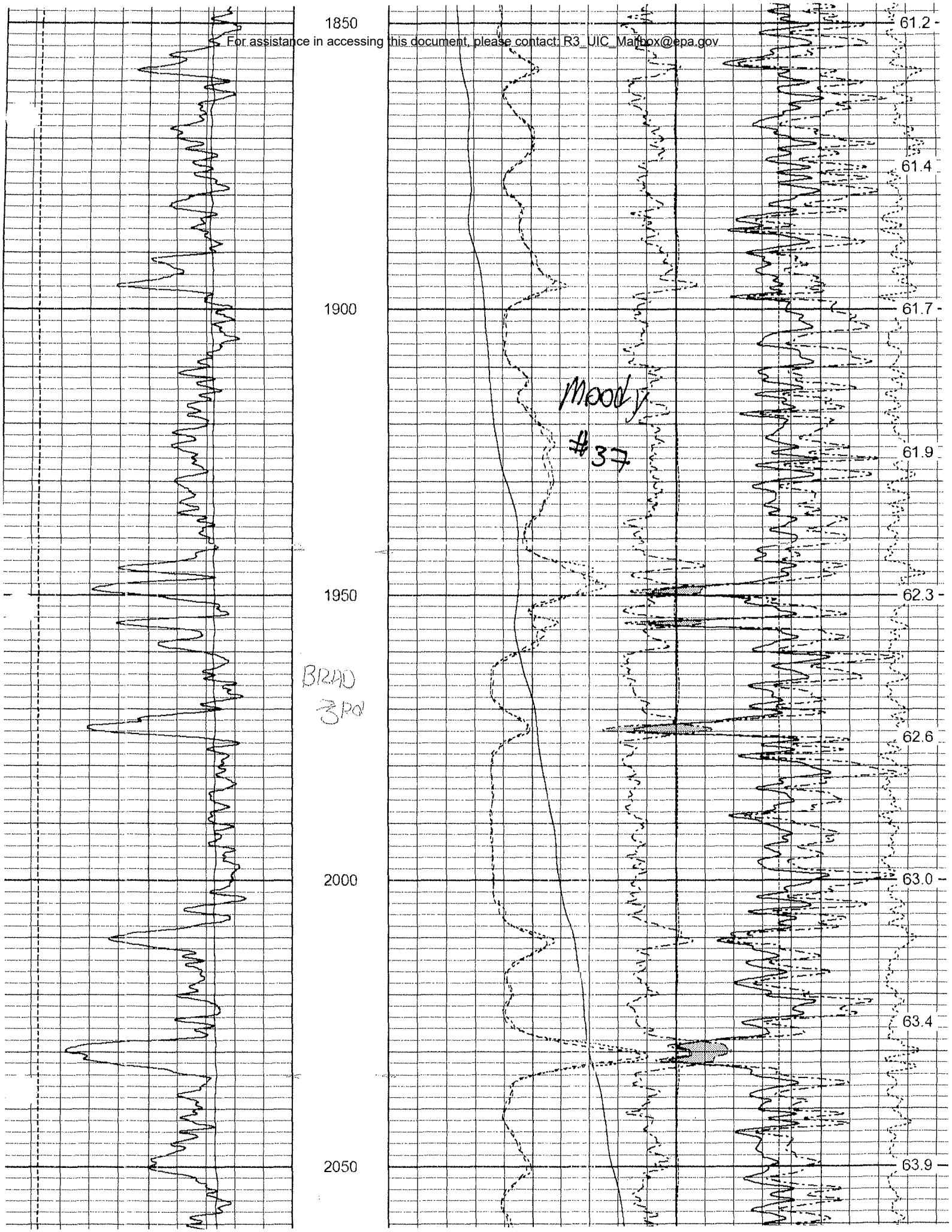


LAKE ERIE ENERGY PARTNERS
WELL #37
DRILLER'S LOG

SPUD DATE: 11/11/09
COMPLETION DATE: 11/16/09
SURFACE CASING SET @: 512'
SURFACE CASING SIZE: 7"

DATE CENTRALIZERS RUN: 11/12/09
CENTRALIZERS SET @: 451'; 290'; 129'
CEMENT RETURNS: 5 BBL.
AMOUNT OF CONDUCTOR: 32.1'
CONDUCTOR SIZE: 9 5/8"

0-15	ROCKS & DIRT
15-42	SANDSTONE
42-44	COAL
44-65	SHALE
65-85	SANDSTONE (FRESH WATER 10 GPM)
85-165	SHALE
165-185	SANDSTONE (FRESH WATER 5 GPM)
185-250	SHALE
250-280	SANDSTONE (FRESH WATER 5 GPM)
280-310	SHALE
310-350	SANDSTONE (FRESH WATER 5 GPM)
350-390	SHALE
390-420	RED ROCK
420-460	SHALE
460-530	RED ROCK
530-560	SHALE
560-585	RED ROCK
585-620	SHALE
620-645	RED ROCK
645-1430	SHALE
1430-1480	SAND (SMELL GAS)
1480-1495	SHALE
1495-1560	SAND (SMELL GAS)
1560-1580	SHALE
1580-1620	SAND
1620-1645	SHALE
1645-1680	SAND (SMELL GAS)
1680-1785	SHALE
1785-1860	SAND (SMELL GAS, TAN COLOR SAND)
1860-1935	SHALE
1935-1970	SAND (SMELL GAS, TAN COLOR SAND)
1970-2005	SHALE
2005-2015	SAND (SMELL GAS, TAN COLOR SAND)
2015-2035	SHALE
2035-2055	SAND (SMELL GAS)
2055-2110	SHALE
2110-2125	SAND (SMELL GAS)
2125-2214	SHALE
2214	T.D.



INJECTIVITY TEST DATA FOR WELL 17 MOODY LEASE

DATE	TIME	CSG	TBG	TOTAL BBLS	RATE BBL/DAY	COMMENTS
10/20/2020	8:30	8	10	0	0	SET UP PUMP AND START PUMPING
	9:00	8	0	0	900	DICHARGE PRESS. 100 PSI
	9:30	10	0		935	DICHARGE PRESS. 100 PSI
	9:45	10	0			#3 PLUNGER LEAKING SHUT DOWN
	10:00	10	VAC			TBG ON VACUUM
	10:30	10	VAC			HAVING PROBLEM WITH ALTRONIC GAUGE
	11:30	10	VAC		320	
	15:00	10	VAC	100	300	
	15:30	10	VAC	115	330	
	22:00	10	VAC	175	303	SHUT IN
10/21/2020	7:00	10	VAC	175		OPEN TBG VLV
	12:30	10	VAC	235		BBL/DAY NOT READING ON GAUGE
	15:30	10	VAC	263		SHUT IN
10/22/2020	7:00	10	VAC	336	300	TOTALIZER FIXED
	9:00	10	VAC	363	330	
	11:00	8	VAC	391		
	13:00	8	VAC	417		
	14:20	8	VAC	430	219	SHUT IN WELL
10/23/2020	7:15	10	VAC	430	360	
	11:15	10	VAC	481	209	
	12:15	10	VAC	491	191	
	2:15	8	VAC	505	173	
	3:15	8	VAC	513	173	SHUT IN WELL
10/24/2020	7:15	10	VAC	513	335	OPEN TBG VLV
	12:15	10	VAC	562	150	SHUT IN WELL
10/25/2020	7:00	10	VAC	562	336	OPEN TBG VLV
	12:00	10	VAC	608	137	SHUT IN WELL
10/26/2020	8:30	8	VAC	608	314	OPEN TBG VLV
	16:30	8	VAC	665	114	SHUT IN WELL
10/27/2020	7:00	8	VAC	665	311	OPEN TBG VLV
	15:30	7	3" VAC	719	103	INSTALL NEW GAUGES ON TBG & CSG, SI
10/28/2020	7:30	7	25"	719	314	OPEN TBG VLV
	15:30	7	2 PSI	77	94	SHUT IN WELL
10/29/2020	8:00	7	25"	719	313	OPEN TBG VLV
	16:00	7	2 PSI	820	87	SHUT IN WELL
10/30/2020	7:00	7	25"	820	313	OPEN TBG VLV
	15:30	7	2 psi	868	81	SHUT IN WELL
10/31/2020	7:00	7	23"	868	314	OPEN TBG VLV
	14:15	7	2 PSI	910	79	SHUT IN WELL
11/1/2020	6:00	7	25"	910	311	OPEN TBG VLV
	17:00	7	0	964	71	SHUT IN WELL
11/2/2020	6:00	7	23"	964	313	OPEN TBG VLV
	16:00	7	3 PSI	1009	69	SHUT IN
11/3/2020	6:00	7	23"	1009	316	OPEN TBG VLV
	16:00	7	0	1054	64	SHUT IN WELL

11/4/2020	7:00	7	25"	1054	316	OPEN TBG VLV
	16:00	7	2 PSI	1095	62	SHUT IN WELL
11/5/2020	6:30	7	25"	1095	317	OPEN TBG VLV
	16:30	7	2 PSI	1138	61	SHUT IN WELL
11/6/2020	6:16	7	25"	1138	319	OPEN TBG VLV
	16:15	7	2 PSI	1178	40	SHUT IN WELL
11/7/2020	5:30	7	24"	1178	318	OPEN TBG VLV
	15:30	6	0	1217	54	SHUT IN WELL
11/8/2020	16:45	7	25"	1217	360	OPEN TBG VLV
11/9/2020	6:30	7	0	1268	45	
	15:30	6	0	1285	41	SHUT IN WELL
11/10/2020	6:30	7	25"	1285	358	OPEN TBG VLV
	16:30	7	0	1321	43	SHUT IN WELL
11/11/2020	6:30	7	25"	1321	355	OPEN TBG VLV
	12:00	7	0	1347	44	TRY PUMPING DOWN TBG WITH DITCH PUMP
						TOTALIZER QUIT WORKING, SHUT IN TBG
11/12/2020	9:00	7	25"	1347	0	TRY PUMPING DOWN TBG WITH TRIPLEX PUMP
						#3 PLUNGER STILL LEAKING, SHUT BACK IN
						WAITING FOR PARTS FOR TOTALIZER
11/16/2029	3:00	7	25"	1347	0	OPEN TBG VLV
11/17/2020	7:30	7	1 PSI	1428	38	
11/18/2020	7:00	7	2 PSI	1465	37	
11/19/2020	7:00	7	1 PSI	1501	36	
11/20/2020	7:00	7	1 PSI	1536	34	
11/21/2020	7:00	7	1 PSI	1573	33	
11/22/2020	7:00	7	1 PSI	1604	31	SHUT IN TEST COMPLETED

Lake Erie Energy Partners, LLC

Well Completion Schedule & Results

Well Name:	Moody Lot 5 #17	**API ID**	37-083-53736	**Comp. Date**	5/8/2009
Casing Size:	7" O.D.	**Csg. Depth (ft)**	516	**Start Pump**	6:15 AM
Total Well Depth (ft.)	2157	**Log Meas. From**	Top of 7" collar	**Finish Pump**	10:45 AM
Total Sand (sks.)	640	**Max. Rate (BPM)**	18	**Weather**	Cool/Cloudy
Est Tbg. TD (ft.)	2021	**Service Rig**	Plants & Goodwin	**Frac Service Co.**	Curtis

SCHEDULE						RESULTS					
Stage	**Zone**	**Double Notch**	**Notch Depth (ft)**	**Adjusted Notch Depth (ft)**	**Sand (sks)**	**Break Down (PSI)**	**Avg. Rate (BPM)**	**Avg Pres. (PSI)**	**Total H2O (gl)**	**ISIP**	**Comments**
1	Watsonville		1352.5		50	PI 1300	17	1600	111	1050	
2	Bradford 2nd		1563.5		50	2100	17	1800	115	1100	
3	Bradford 2nd	**DN**	1573.5		80	4000	17	1800	150	1150	
4	Bradford 2nd	**DN**	1577.5		80	2500	17	2000	150	1150	
5	Bradford 2nd	**DN**	1581.5		70	1700	17	2100	138	1200	
6	Harrisburg Run	**DN**	1754.0		80	1700	17	2000	153	1250	
7	Bradford 3rd		1865.5								
8	Bradford 3rd	**DN**	1872.5		80	3200	17	2400	157	1300	
9	Bradford 3rd	**DN**	1880.5		100	2600	14	2800	225	1350	

Lake Erie Energy Partners, LLC

Well Completion Schedule & Results

Well Name:	Moody Lot 5 #17	**API ID**	37-083-53736	**Comp. Date**	5/8/2009
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SCHEDULE

RESULTS

Stage	Zone	Double Notch	Notch Depth (ft)	Adjusted Notch Depth (ft)	Sand (sks)	Break Down (PSI)	Avg. Rate (BPM)	Avg Pres. (PSI)	Total H2O (gl)	ISIP	Comments
10	Bradford 3rd	**DN**	1961.0		50	3500	15	2500	124	1400	

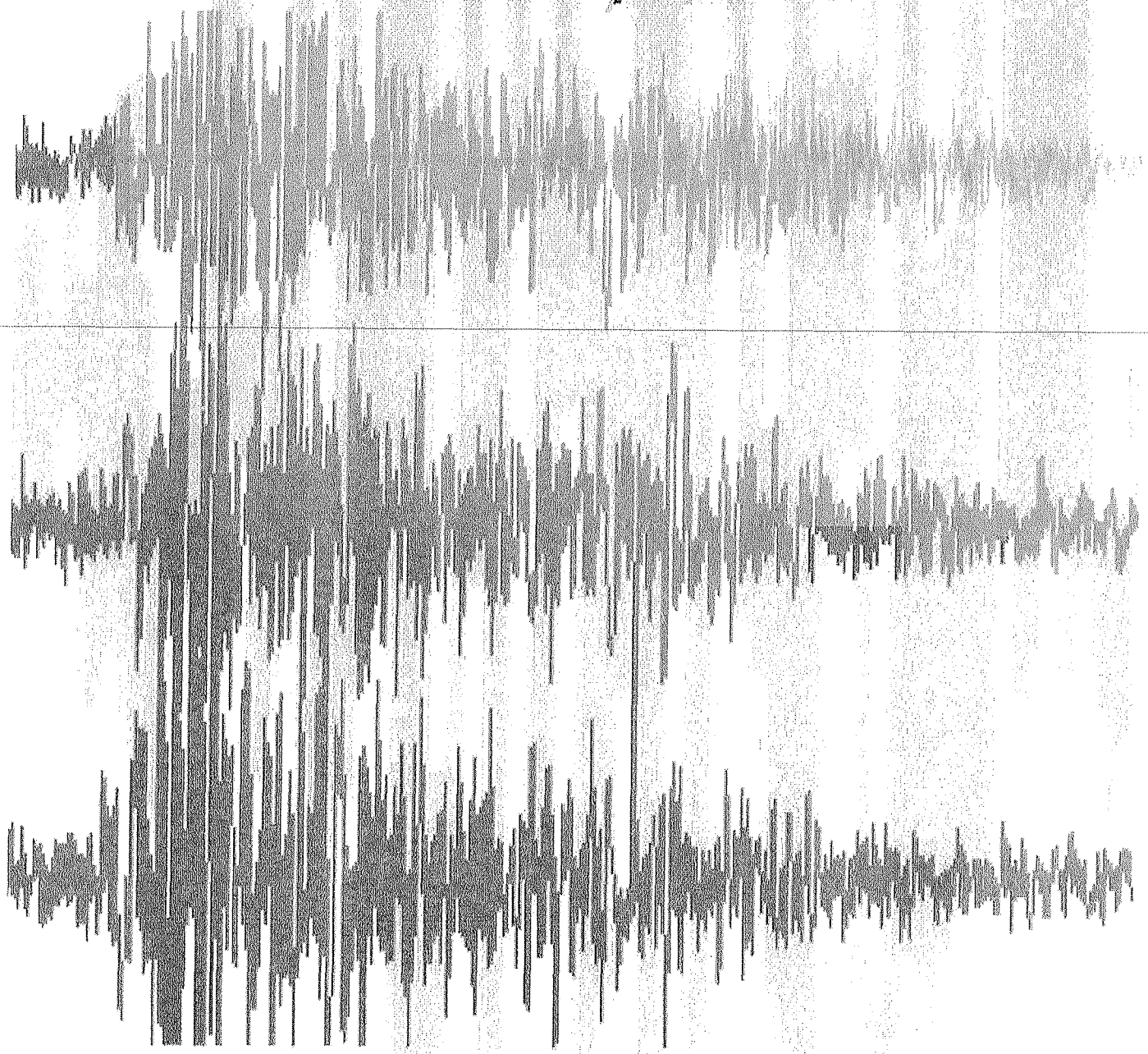
Comments: Deleted Stage #7

Note: *16 BPM Max in highlighted zones

Well Name: Moody Lot 5 #17 **API ID** 37-083-53736

Educational Series 10

Earthquake Hazard in Pennsylvania



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DEPARTMENT OF
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First Edition, June 1989
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Third Printing, Slightly Revised, June 2006
Fourth Printing, June 2007

ON THE COVER: A seismograph recording (in purple-blue) of a Richter magnitude 5.3 earthquake that had an epicenter near Au Sable Forks, N. Y. It includes all three components of ground motion: vertical (top), north-south (middle) and east-west (bottom). Recorded at Millersville University, Millersville, Pa., on April 20, 2002.

Educational Series 10

Earthquake Hazard in Pennsylvania

by Charles K. Scharnberger
Millersville University

PENNSYLVANIA GEOLOGICAL SURVEY
FOURTH SERIES
HARRISBURG
2003

Contents

Earthquake Hazard in Pennsylvania

by
Charles K. Scharnberger

Introduction

Compared to other states, especially California and Alaska, Pennsylvania is relatively free of earthquake activity. Even considering only the eastern half of North America, Pennsylvania has experienced fewer and milder earthquakes than most other states or Canadian provinces. Nevertheless, earthquakes do occur in our commonwealth, and Pennsylvania may be subject to the effects of earthquakes that have epicenters located outside our borders. Therefore, it is worth considering how much hazard earthquakes present to Pennsylvanians.

What Is an Earthquake?

Earthquakes occur when there is a sudden release of stored energy from a portion of a fault plane within the earth. Faults are fractures in the lithosphere—the rather brittle outer layer of the solid earth. Energy in the form of *strain*, small elastic distortion of the lithosphere, accumulates over a period of time due to *stress* acting on the rock of the lithosphere. The origin of this stress is believed by most geophysicists to be slow convective motion, driven by heat energy, which occurs below the lithosphere in the mantle. One consequence of this convection is the fragmentation of the lithosphere into tectonic plates, and the slow movement of these plates relative to each other. Much of our understanding of earthquakes, as well as other geologic phenomena such as volcanic eruptions and mountain building, is based on this theory of *plate tectonics*.

The rock of the lithosphere can accommodate only so much strain energy. Eventually, the rock must fracture. When this happens, strain is relieved, the stress level drops, some energy is converted into heat, some movement (slip) occurs along the plane of fracture (the fault plane), and some energy is radiated away from the area of fracture in the form of elastic waves—called *seismic waves*—which travel through the earth or along the surface of the earth. The arrival of these seismic waves at a point on the surface causes rapid and complex motions of the ground. This is what we feel as an earthquake. Once a

fault has formed as the result of an initial fracture, earthquakes are likely to recur along the same fault, because this plane is now a zone of weakness in the lithosphere.

Figure 1 shows the relationship of a fault plane to the origin point of the seismic waves (called the *hypocenter* or *focus* of the earthquake) and the *epicenter*, the point on the surface of the earth directly above the hypocenter. Note that, unless the attitude of the fault plane is vertical, the epicenter will be located some distance from the trace of the fault along the surface of the earth.

Earthquake Magnitude

Seismic waves are detected and measured by seismographs. The energies of earthquakes are compared on the basis of their magnitudes, a concept first defined in the 1930s by Charles Richter of the California Institute of Technology. Richter wished to have a single number to describe an earthquake, independent of the distance from the epicenter at which the earthquake waves were recorded. The system he devised is commonly called the *Richter Scale*, a term that

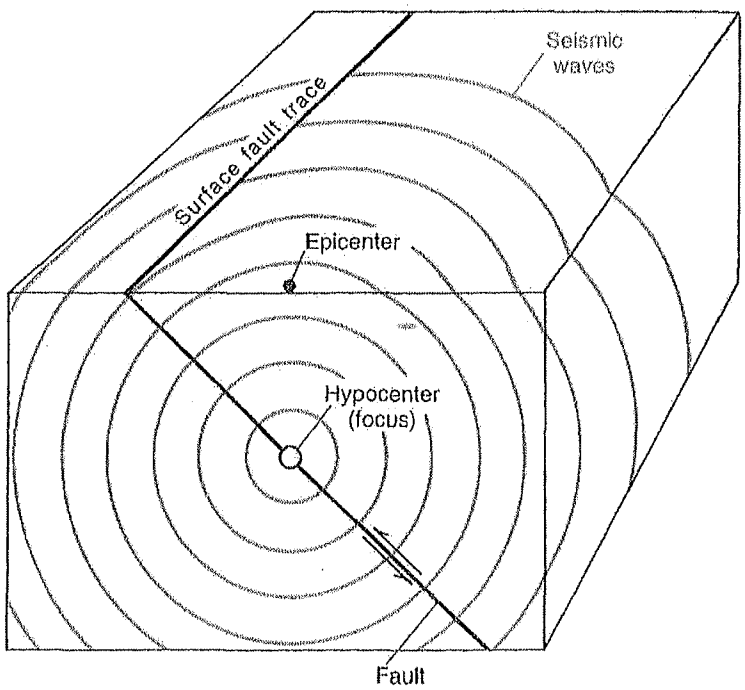

Figure 1. Relationships among the fault plane, the fault trace on the surface of the earth, the earthquake hypocenter (focus), the epicenter, fault slip (arrows), and seismic waves. (Based on Plummer, C. C., and McGeary, David, Physical geology, 4th ed., Wm. C. Brown Publishers, Figure 16.2, p. 345. Copyright © 1988. Reproduced with permission of The McGraw-Hill Companies.)

frequently leads to the mistaken impression that there is a kind of physical instrument—a scale similar to those used to measure weights—to which the term applies. In fact, the Richter Scale—Richter himself preferred to call it the *magnitude scale*—is a scale of numbers that expresses the relative sizes of earthquakes. The numbers of the magnitude scale are logarithms, that is, numbers that express powers of 10. As originally defined by Richter on the basis of California earthquakes recorded locally on a particular type of seismograph, the magnitude represented the maximum amount of ground movement at a distance of 100 kilometers (62 miles) from the epicenter of an earthquake. Each whole number on the scale represented a tenfold difference in this amplitude of ground motion.

As the concept of magnitude came to be used worldwide and had to be calculated from many different types of seismographs, new ways of defining the magnitude were introduced, so that today several different magnitude numbers might be found for the same earthquake. Thus, magnitudes are useful mostly for comparing earthquakes (the purpose Richter had in mind), rather than for finding the actual energy of an earthquake with more than rough precision.

There is no upper or lower limit to the Richter Scale, but as a matter of historical fact, no magnitude greater than about 9.5 has ever been calculated for an earthquake. Earthquakes in eastern North America seldom have magnitudes greater than 5.

Earthquake Intensity

Before the development of the magnitude scale, earthquakes were compared on the basis of *intensity*. Today, intensity values are an important supplement to the magnitudes because intensity is a semiquantitative expression of the effects caused by an earthquake. These may be effects on people, on man-made structures, or on natural features of the landscape. Intensities are determined after the earthquake on the basis of field observations made by trained personnel, or from survey forms filled out by persons who experienced the earthquake. The U.S. Geological Survey (USGS) uses reports sent in by postmasters and compiles intensity data by postal ZIP code.

Obviously, intensity is not a single number for a particular earthquake, but varies from place to place. Usually, the intensity is greatest in the immediate vicinity of the epicenter and decreases with increasing distance from the epicenter. However, many factors affect intensity; among them are topography, type and thickness of soil, direction from the epicenter relative to regional rock structure, and type of

bedrock. The greatest intensities are commonly caused by landslides or other modes of ground failure induced by the seismic waves rather than by the direct effects of seismic shaking.

In the United States, intensities are expressed in terms of the *Modified Mercalli scale.* This scale was first proposed in Italy by Giuseppi Mercalli in the early 1900s and was modified in 1931 by the American seismologists H. O. Wood and F. Neumann (for this reason, it is also called the Wood-Neumann scale). Table 1 is an abridged version of the Modified Mercalli scale; Roman numerals are usually used to avoid confusion with earthquake magnitude.

Earthquakes Beyond Pennsylvania

Historically, large earthquakes have occurred in three regions of eastern North America: (1) the Mississippi Valley, especially near the town of New Madrid, Mo.; (2) the St. Lawrence Valley; and (3) Charleston, S. C.

New Madrid, Missouri

Three great earthquakes struck the vicinity of New Madrid in December 1811, January 1812, and February 1812. Although there were no seismographs to record these events, each earthquake in the series is estimated to have had a magnitude in excess of 7. These earthquakes were felt in western Pennsylvania, but no damage is known to have occurred there (Abdypoor and Bischke, 1982; all other references to the effects of large historic earthquakes in Pennsylvania are from this source). It is unlikely that future New Madrid earthquakes would be any greater than those of 1811–12, so Pennsylvanians probably do not have to worry about a threat from that quarter.

The St. Lawrence Region

One of the largest earthquakes in eastern North America occurred on February 28, 1925, and had an epicenter in the La Malbaie-Charlevoix region of Quebec. This earthquake had a magnitude near 7. Earthquakes having magnitudes estimated to have exceeded 6.5 occurred in the same region in 1663 and 1870 (Johnston and others, 1994; most magnitudes given in this section are from this source). At least a dozen earthquakes strong enough to be felt in Pennsylvania have originated in the St. Lawrence Seismic Zone since the time of European settlement, the most recent on November 25, 1988. Earthquake activity in Ontario, western New York, northwestern Pennsyl-

Table 1. ***The Modified Mercalli Scale of 1931 (Abridged Version)***

I. Not felt except by a very few under especially favorable circumstances.

II. Felt only by a few persons at rest, especially on the upper floors of buildings. Delicately suspended objects may swing.

III. Felt quite noticeably indoors, especially on the upper floors of buildings, but many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibration is like the passing of a truck. Duration is estimated.

IV. During the day felt indoors by many, outdoors by few. At night some are awakened. Dishes, windows, and doors are disturbed; walls make a creaking sound. Sensation is like a heavy truck striking a building. Standing motor cars are rocked noticeably.

V. Felt by nearly everyone; many are awakened. Some dishes, windows, etc., are broken; a few instances of cracked plaster occur; unstable objects are overturned. Disturbance of trees, poles, and other tall objects is sometimes noticed. Pendulum clocks may stop.

VI. Felt by all; many are frightened and run outdoors. Some heavy furniture is moved; a few instances of fallen plaster or damaged chimneys occur. Damage is slight.

VII. Everybody runs outdoors. Damage is *negligible* in buildings of good design and construction; *slight* to *moderate* in well-built ordinary structures; *considerable* in poorly built or badly designed structures. Some chimneys are broken. Noticed by persons driving motor cars.

VIII. Damage is *slight* in specially designed structures; *considerable* in ordinary substantial buildings, with partial collapse; *great* in poorly built structures. Panel walls are thrown out of frame structures. Chimneys, factory stacks, columns, walls, and monuments fall; heavy furniture is overturned. Sand and mud are ejected from the ground in small amounts. Changes occur in well water. Persons driving motor cars are disturbed.

IX. Damage is *considerable* in specially designed structures; well-designed frame structures are thrown out of plumb; damage is *great* in substantial buildings, with partial collapse. Buildings are shifted off their foundations. Ground is cracked conspicuously. Underground pipes are broken.

X. Some well-built wooden structures are destroyed; most masonry and frame structures are destroyed along with their foundations. Ground is badly cracked. Rails are bent. Considerable landslides occur on river banks and steep slopes. Sand and mud are shifted. Water is splashed (slopped) over banks.

XI. Few, if any, masonry structures remain standing. Bridges are destroyed. Broad fissures occur in the ground. Underground pipelines are completely out of service. Earth slumps and land slips occur in soft ground. Rails are bent greatly.

XII. Damage is total. Waves are seen on the ground surface. Lines of sight and level are distorted. Objects are thrown upward into the air.

vania, and eastern Ohio may represent a westward extension of this zone. An earthquake of unknown magnitude with an epicenter near Attica, N. Y., is reported to have cracked walls in Sayre (Bradford County), Pa., on August 12, 1929. On November 1, 1935, an earthquake with an epicenter near Timiskaming, Ontario (northwest of the St. Lawrence Seismic Zone proper), and an estimated magnitude of 6.4, was felt with intensity IV in northwestern Pennsylvania and, at lower intensities, throughout the commonwealth. The lower St. Lawrence region is too far away for even a large future earthquake to be likely to cause damage in Pennsylvania. If an earthquake having a magnitude of 6 or greater were to occur on the western extension of the St. Lawrence Seismic Zone, however, at least moderate damage might be expected in one or more of the counties of Pennsylvania's "northern tier."

Charleston, South Carolina

Charleston was the site of the largest historic earthquake to have struck the eastern seaboard of the United States, and one of the 10 largest earthquakes to occur anywhere in the world away from an active tectonic plate margin. The earthquake on August 31, 1886, had a magnitude estimated to have been around 7.5. Intensity reached X on the Modified Mercalli scale, and the city of Charleston was heavily damaged. Although this earthquake was felt in most of Pennsylvania, intensity here did not exceed IV, so a recurrence of the great Charleston earthquake would pose little hazard to Pennsylvanians.

Other East Coast Areas

Eastern Massachusetts experienced strong earthquake shocks in 1658, 1727, 1755, and 1925. The largest of these was the earthquake of November 18, 1755, which had an estimated magnitude of about 6.3. The epicenter is generally thought to have been offshore of Cape Ann, north of Boston, although the exact location is uncertain. This earthquake was felt with intensities of IV and V in eastern Pennsylvania. Intensity as high as VI might be expected from a magnitude 7 earthquake originating in the vicinity of Boston.

Southeastern New York and northern New Jersey have been the sites of moderate earthquakes. Two of these events, in 1737 and 1884, produced intensities as high as VII in New York City and were felt at intensity IV in eastern Pennsylvania. If an earthquake of magnitude 6 or greater were to occur in this area, it is likely that damage would result in the easternmost counties of Pennsylvania.

Earthquakes in Pennsylvania

Figure 2 shows the locations of historic epicenters in Pennsylvania; a list of Pennsylvania earthquakes by county is given in Table 2. Ambiguities always exist in lists of earthquakes, and no two lists for the same region are likely to agree in every detail. Some events identified as earthquakes in some lists may, in fact, have been something else—blasting in the course of mining operations, for example. Table 2 includes only those events that the author considers to be earthquakes with a high degree of certainty. Aftershocks—smaller earthquakes following a larger one in approximately the same location—are listed only if they occurred more than a year after the main shock; otherwise they are mentioned in the "Remarks" column. Earthquakes that can be considered foreshocks of larger events have been listed separately from their main shocks only if they occurred months to years earlier. It is likely that some earthquakes having magnitudes less than 3, other than aftershocks, have occurred in Pennsylvania but were not detected by seismographs or recognized as earthquakes and reported by persons who felt them. It is also possible that evidence for some earthquakes that occurred prior to the mid-twentieth century has not yet been discovered in historical documents. For example, the entire earthquake history of Lancaster County prior to 1885 was unknown to the scientific community until Armbruster and Seeber (1987) published the results of their search of newspapers and other archives.

Earthquakes having magnitudes greater than 5 can occur in Pennsylvania, as demonstrated by the earthquake of September 25, 1998 (Armbruster and others, 1998) (Table 2, Crawford County). Southeastern Pennsylvania, the state's most seismically active region, is not known to have experienced an earthquake with magnitude greater than 4.7, but the historical record goes back only about 200 years. No obvious reason exists to conclude that an earthquake of magnitude between 5 and 6 could not occur there also. An earthquake with magnitude greater than 6 is much less likely, but the fact that such large earthquakes have occurred elsewhere in the East means that this possibility cannot be ruled out entirely for Pennsylvania.

What is the Level of Earthquake Hazard in Pennsylvania?

Geologic History and Faults

The great majority of earthquakes occur along boundaries between tectonic plates. The reason for this is not completely clear, but it appears

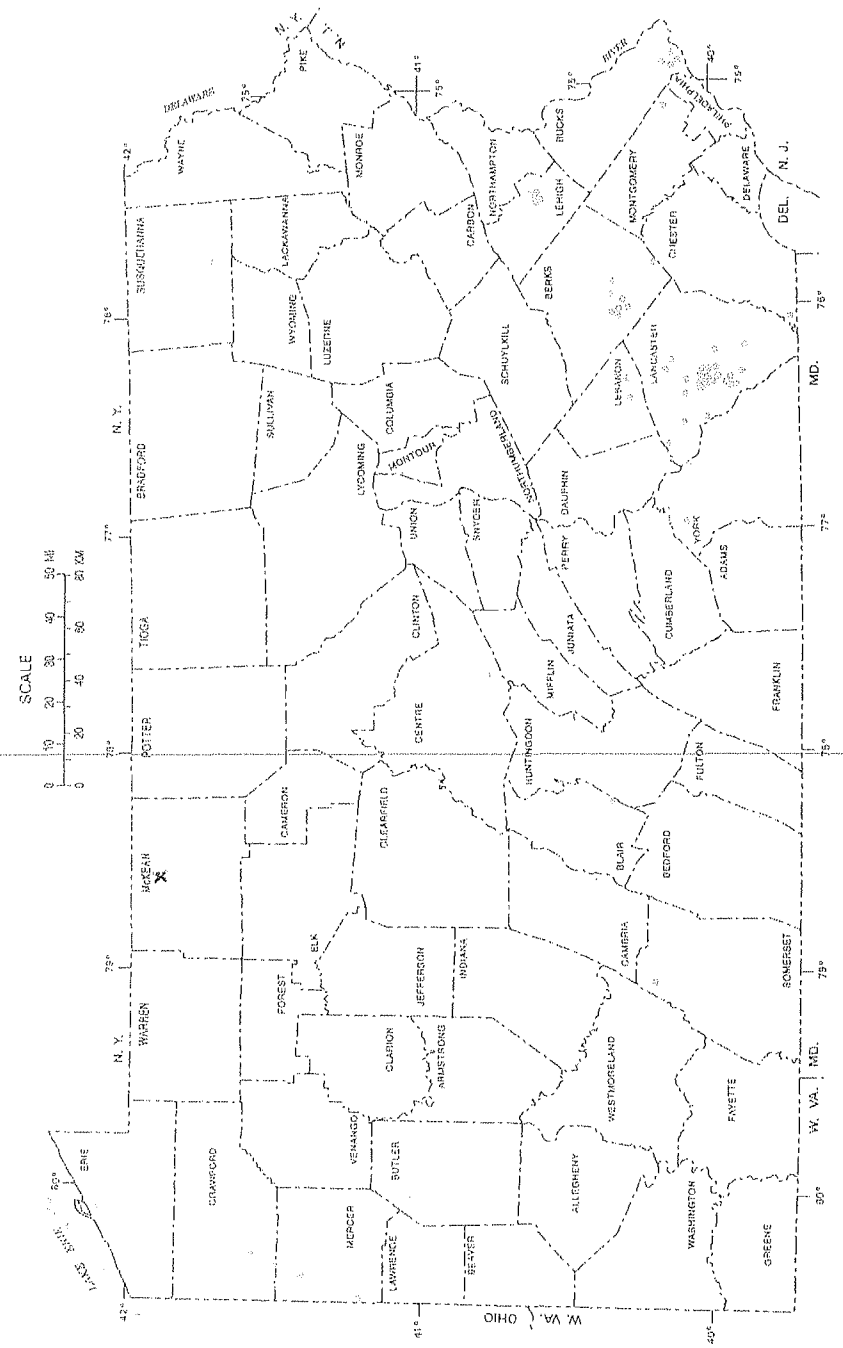

Figure 2. Locations of historic earthquake epicenters in Pennsylvania. Many locations are approximate. Pre-twentieth-century earthquakes felt in Philadelphia are not shown because their epicenter locations are unknown.

Table 2. *Selected Earthquakes in Pennsylvania Through March 2006*

Date (local time)		Where strongly felt	Magnitude	Remarks
		ADAMS COUNTY		
May 26,	1994		2.8	
		BERKS COUNTY		
Nov. 21,	1777	Unknown	Unknown	
May 28,	1906	Geigertown	Unknown	
June 8,	1937	Reading	Unknown	
Jan. 7,	1954	Sinking Spring	3.2 (est.)	Aftershocks for 1 year
June 25,	1972	Wyomissing	Unknown	Start of series of small earthquakes lasting a few days
Aug. 12,	1973	Wyomissing	Unknown	
May 10,	1993	Spring Twp.	2.8	
Jan. 15,	1994	Spring Twp.	4.0, 4.6	Two events about 1 hour apart. Long aftershock sequence into the late 1990s
Oct. 28,	1996	Wyomissing	2.5	May be delayed aftershock of Jan. 15, 1994, earthquake
		BLAIR COUNTY		
July 15,	1938	Clover Creek	3.2 (est.)	
		BUCKS COUNTY		
Dec. 27,	1961	Bristol-Levittown	Unknown	Epicenter may have been in New Jersey
Nov. 14,	1981	Bristol-Levittown	Unknown	Epicenter may have been in New Jersey
Apr. 12,	1982	Bristol-Levittown	2.5	Epicenter may have been in New Jersey
May 12,	1982	Bristol-Levittown	2.5	Epicenter may have been in New Jersey
May 12,	1982		2.4	
May 10,	1984		2.2	
Feb. 2,	1989		Unknown	
		CENTRE COUNTY		
Mar. 25,	1937		Unknown	
Aug. 15,	1991	Centre Hall	3.0	
		CHESTER COUNTY		
Dec. 17,	1752		3.6	
Jan. 25,	1821	New London	3.1	
Oct. 17,	1996	Nottingham	2.3	Epicenter may have been in Maryland
		CRAWFORD COUNTY		
Sept. 15,	1852	Meadville	Unknown	
Apr. 14,	1985	Conneaut Lake	3.2	
Sept. 25,	1998	Jamestown (Mercer Co.)	5.2	Largest known Pennsylvania earthquake; many aftershocks
		ERIE COUNTY		
Nov. 1,	1870	Erie	3.5	
Sept. 26,	1921	Erie	2.9	
Feb. 16,	1930	Erie	2.9	
Oct. 29,	1934	Erie	3.2 (est.)	Strongest aftershock felt at Albion on Nov. 5
Dec. 17,	1990	Erie	2.5	
Aug. 30,	1998	Erie	2.1	
Oct. 30,	1999	Erie	2.5	
		FAYETTE COUNTY		
Dec. 8,	1896	Dunbar	3.8	
Oct. 8,	1965	Connellsville	3.3	
		FRANKLIN COUNTY		
Mar. 19,	1880	Chambersburg	3.5	Epicenter may have been in Maryland

Table 2. *Continued.*

Date (local time)		Where strongly felt	Magnitude	Remarks
		LACKAWANNA COUNTY		
Sept. 27,	1940	Unknown	Unknown	May be mining-related event
		LANCASTER COUNTY		
Dec. 17,	1752	Lancaster	3.6 (est.)	Epicenter may have been in Chester County
Jan. 11,	1798	Lancaster	Unknown	
Nov. 20,	1800	Lititz	3.9 (est.)	
Jan. 27,	1801	Lancaster	Unknown	
Mar. 19,	1818	Lancaster	Unknown	
Aug. 21,	1820	Mt. Joy	3.4 (est.)	
May 4,	1822	Lancaster	Unknown	
May 1,	1825	Millersville	3.1	Reported from "Millerstown," which was the name of present-day Millersville in 1825
Sept. 5,	1829	Lancaster	Unknown	
Feb. 5,	1834	Marticville	3.8 (est.)	
Jan. 20,	1861	Lancaster	3.5	
Sept. 17,	1865	Willow Street	Unknown	
Nov. 7,	1866	Lancaster	Unknown	
Mar. 8,	1885	Lancaster	Unknown	
Sept. 26,	1886	Elizabethtown	Unknown	
Mar. 8,	1889	Conestoga	4.1 (est.)	
May 6,	1892	Terre Hill	Unknown	
Dec. 7,	1972	Lititz	3.5 (est.)	
July 16,	1978	Conestoga	3.1	
Oct. 6,	1978	Manheim Twp.	3.0	
Apr. 22,	1984	Marticville	4.1	Magnitude 3 foreshock 4 days earlier; many aftershocks
Sept. 19,	1984	Lancaster	Unknown	
May 2,	1986	Conestoga	2.6	May be delayed aftershock of Apr. 22, 1984, earthquake
Mar. 11,	1995	East Petersburg	2.0, 2.4	Two events about 1 hour apart
Nov. 14,	1997	Lititz	3.0	
Oct. 5,	2000	Conestoga	2.3	May be delayed aftershock of Apr. 22, 1984, earthquake
		LEBANON COUNTY		
Jan. 15,	1885	Schaefferstown	2.7 (est.)	
May 12,	1964	Cornwall	3.2 (est.)	
		LEHIGH COUNTY		
May 31,	1884	Allentown	2.9 (est.)	
May 31,	1908	Allentown	3.1 (est.)	
June 22,	1928	Allentown	2.4 (est.)	
Nov. 23,	1951	Allentown	3.3 (est.)	
Sept. 14,	1961	Allentown	Unknown	
		LUZERNE COUNTY		
Feb. 24,	2000		2.3	
		MERCER COUNTY		
Aug. 17,	1873	Sharon	Unknown	Epicenter may have been in Ohio
Dec. 11,	1890	Greenville	2.9	
Aug. 26,	1936	Greenville	2.9	
		MONROE COUNTY		
Oct. 24,	1942	Stroudsburg	3.4	Epicenter may have been in New Jersey
		MONTGOMERY COUNTY		
Mar. 5,	1980	Abington	3.5	Strongest of a series of 6 earthquakes over 9 days felt in Montgomery and lower Bucks Counties

Table 2. *Continued.*

Date (local time)		Where strongly felt	Magnitude	Remarks
		PHILADELPHIA AREA[1]		
Dec. 18,	1737			
Nov. 27,	1755			
Mar. 23,	1758			
Mar. 22,	1763			
Oct. 13,	1763			
Oct. 30,	1763			
Apr. 25,	1772			
Nov. 22–23,	1777			
Nov. 29,	1780			
Mar. 17,	1800			
Nov. 29,	1800			
Nov. 12,	1801			
Dec. 8–9,	1811			
Dec. 16,	1811			
Jan. 8,	1817			
Aug. 17,	1840			
Nov. 11 and 14,	1840			
June 17,	1871			
Mar. 25,	1879			
		SOMERSET COUNTY		
Feb. 3,	1982	Jennerstown	2.6	
		SULLIVAN COUNTY		
Oct. 28,	1946	Unknown	Unknown	May be mining-related event
		SUSQUEHANNA COUNTY		
Aug. 14,	1982	Hop Bottom	Unknown	
		TIOGA COUNTY		
Dec. 16,	1869	Tioga	3.1	
Dec. 14,	1990	Tioga	3.0	
		WARREN COUNTY		
July 8,	1995	Warren	2.4	
		YORK COUNTY		
June 16,	1997	Dillsburg	2.4	

[1]Earthquakes whose epicenters are unknown and that were felt in Philadelphia.

that stress levels are higher along plate boundaries, and that strain energy builds up more rapidly in those areas. Eastern North America, including Pennsylvania, today is far from the nearest plate boundary—the Mid-Atlantic Ridge, some 2,000 miles to the east. Nevertheless, the eastern states and eastern provinces of Canada do experience a moderate level of earthquake activity, including occasional earthquakes with magnitudes greater than 6 that are capable of producing significant damage. Seismicity in the East may be related to what happened here about 200 million years ago. At that time, the supercontinent called Pangaea broke up and the Atlantic Ocean began to form. This event, called *rifting* by geologists, produced many faults, and some of these faults may be experiencing reactivation by the present-day

stress, which is squeezing eastern North America in a roughly east-west direction. Johnston and others (1994) found that nearly 70 percent of earthquakes with magnitudes of at least 6 in so-called stable continental regions occur in areas that experienced rifting sometime during the past 200 million years.

It might seem, then, that a straightforward approach to earthquake hazard evaluation in the East would be to locate all the faults, or at least those that are 200 million years old or younger. Unfortunately, this approach does not work very well because it is impossible to demonstrate that any particular fault is active, even when earthquake epicenters are located in the vicinity of the fault's surface trace. Actual displacement of the earth's surface along a fault line during an earthquake is extremely rare in the East. Complicating the problem is the fact that the vast majority of mapped faults in our region have no seismicity at all associated with them. Therefore, simply knowing where the faults are tells us little, if anything, about earthquake hazard.

Despite the difficulty of identifying specific faults that are responsible for earthquakes in the East, regions of perisistent earthquake activity have been delineated and named. An example in Pennsylvania is the Lancaster Seismic Zone (Armbruster and Seeber, 1987), which encompasses all seismicity in Lancaster, York, Lebanon, and Berks Counties. As indicated in Table 2, this is the most active seismic zone in Pennsylvania.

A Probabilistic Approach

It appears that the best guides to seismic hazard in Pennsylvania and elsewhere in the East are the earthquakes themselves. The earthquake history of a region can be the basis for conducting a probabilistic earthquake-hazard analysis.

As part of the National Earthquake Hazard Reduction Program, seismologists working for the USGS have used earthquake history to estimate the probabilities of earthquakes of various magnitudes occurring in various locations over a given period of time. They have produced a series of maps that show the results as ground-motion hazard maps. These maps have been designed to be useful for the determination of building codes. Usually, 50 years is the time frame considered because that is what architects and structural engineers take to be the useful lifetime of a new building. The expected decrease in intensity with distance from the epicenter is also taken into consideration to arrive at an estimate of the probability that certain levels of ground shaking will be experienced at any given location.

The expected level of ground shaking is expressed in terms of some measure of ground acceleration or velocity, such as the peak hori-

zontal ground acceleration (the largest acceleration recorded during an earthquake). These terms are used because building codes are written to indicate how much horizontal force a building should be able to withstand during an earthquake. Table 3 gives the levels of peak acceleration and the *roughly* equivalent values of earthquake intensity on the Modified Mercalli scale. Figure 3 shows contours of peak horizontal ground acceleration having a 2 percent probability of being experienced in any 50-year period, as calculated by USGS seismologists. The contour values are percentages of the acceleration due to gravity (g), which is 9.8 meters/second/second, or 32 feet/second/second. The original map on which Figure 3 is based, as well as other seismic-hazard maps, may be viewed on the USGS web site at http://eqhazmaps.usgs.gov/.

Table 3. ***Approximate Correlation of Peak Horizontal Ground Acceleration (PHGA) with Modified Mercalli Intensity (MMI)***

PHGA (percent of g, acceleration due to gravity)	MMI
<6	<VI
6–8	VI
8–16	VII
16–32	VIII
>32	IX+

The Pennsylvania Department of Environmental Protection requires that structures built in areas that can expect peak horizontal ground acceleration to exceed 10 percent g with a probability of 10 percent in 250 years (which is equivalent to 2 percent probability in 50 years) incorporate specific seismic safety design features.

Conclusion

Two of the areas that have generated the largest historical earthquakes in eastern North America—New Madrid, Mo., and Charleston, S. C.—are too far away for earthquakes having epicenters there to cause damage in Pennsylvania, although earthquakes occurring in those areas that have magnitudes near 7 would be felt in Pennsylvania. Eastern Massachusetts is closer, and a magnitude 7 earthquake there could produce intensity VI effects in northeastern Pennsylvania.

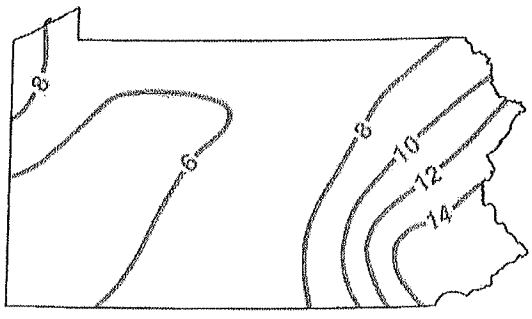

Figure 3. An earthquake-hazard map for Pennsylvania. The contours represent earthquake ground motions that have a 2 percent probability of being experienced in 50 years. The numbers are percentages of g, the acceleration due to gravity. See Table 3 for approximate corresponding values of Modified Mercalli intensity. From Frankel and others (2002).

Similar intensities might be expected in north-central and northwestern Pennsylvania from earthquakes that have epicenters in the western part of the St. Lawrence zone. The possibility that a magnitude 7 earthquake could occur having an epicenter near New York City cannot be completely discounted, and such an earthquake could produce significant damage (intensity VIII) in eastern Pennsylvania.

Pennsylvanians probably will continue to feel small earthquakes generated on local faults, although the exact identity of those faults is likely to remain elusive. A large local earthquake, one with magnitude greater than 6, though unlikely, is not impossible. A probabilistic analysis that takes into consideration the threat from earthquakes both outside and inside Pennsylvania's borders indicates a relatively low level of earthquake hazard in our commonwealth. Nevertheless, some precautions might be in order. These include contingency planning by emergency management agencies and emergency response services; incorporation of at least moderate earthquake resistance into the design of new buildings and other engineered structures, such as bridges and pipelines; and individual preparedness that would include having on hand a flashlight, battery-powered radio, water and food supply, and first-aid kit—as one might prepare for the possibility of a disaster of any sort. Further information about how to prepare for earthquakes and other emergencies may be obtained from the Southeastern Pennsylvania Chapter of the American Red Cross, 23rd and Chestnut Streets, Philadelphia, PA 19103, or from their web site at http://www.redcross-philly.org.

References

Abdypoor, Gladees, and Bischke, R. E., 1982, Earthquakes felt in the state of Pennsylvania; with emphasis on earthquakes felt in Philadelphia, Pa. and surrounding areas: Philadelphia, Temple University Department of Geology, 354 p.

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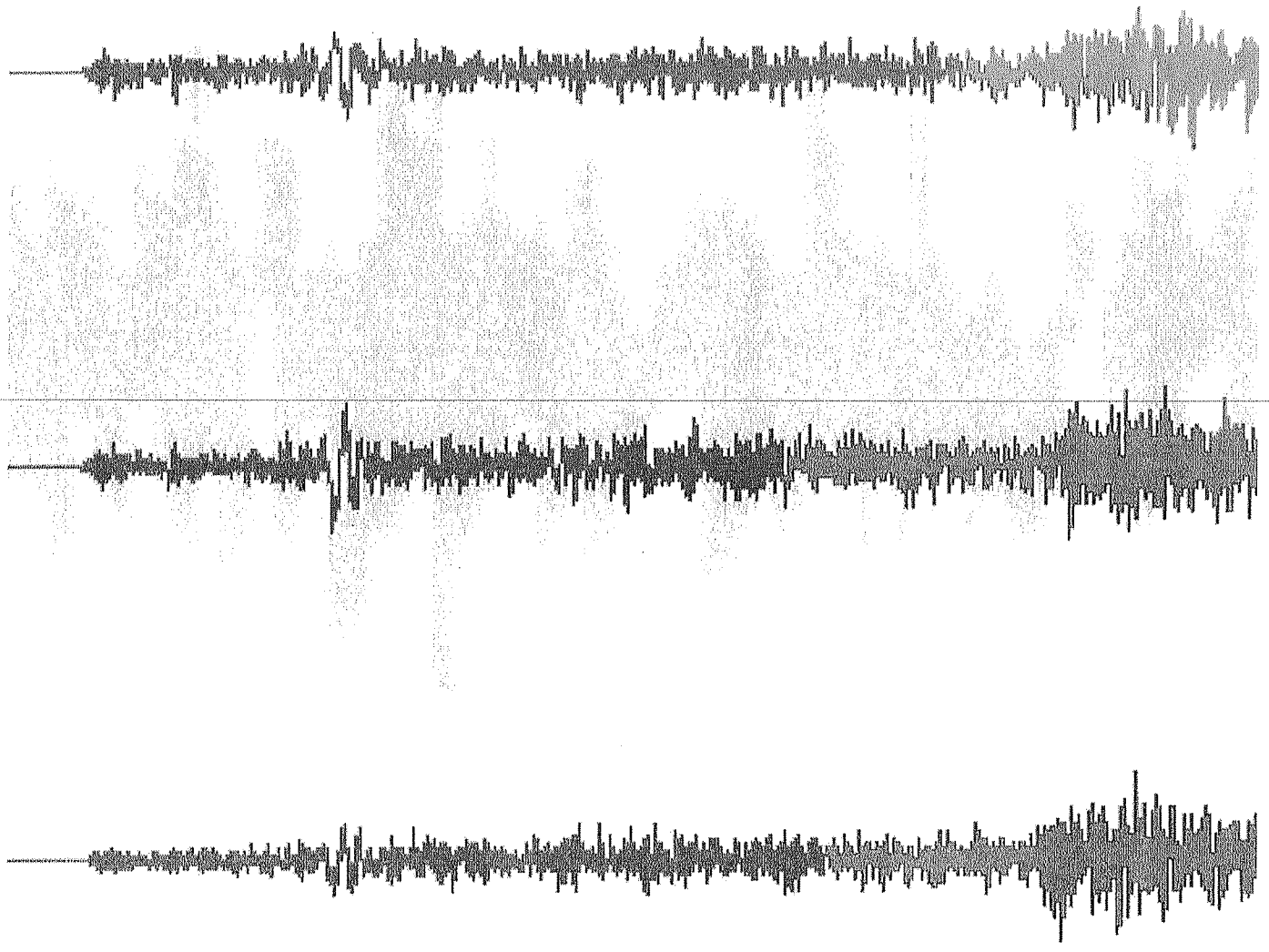
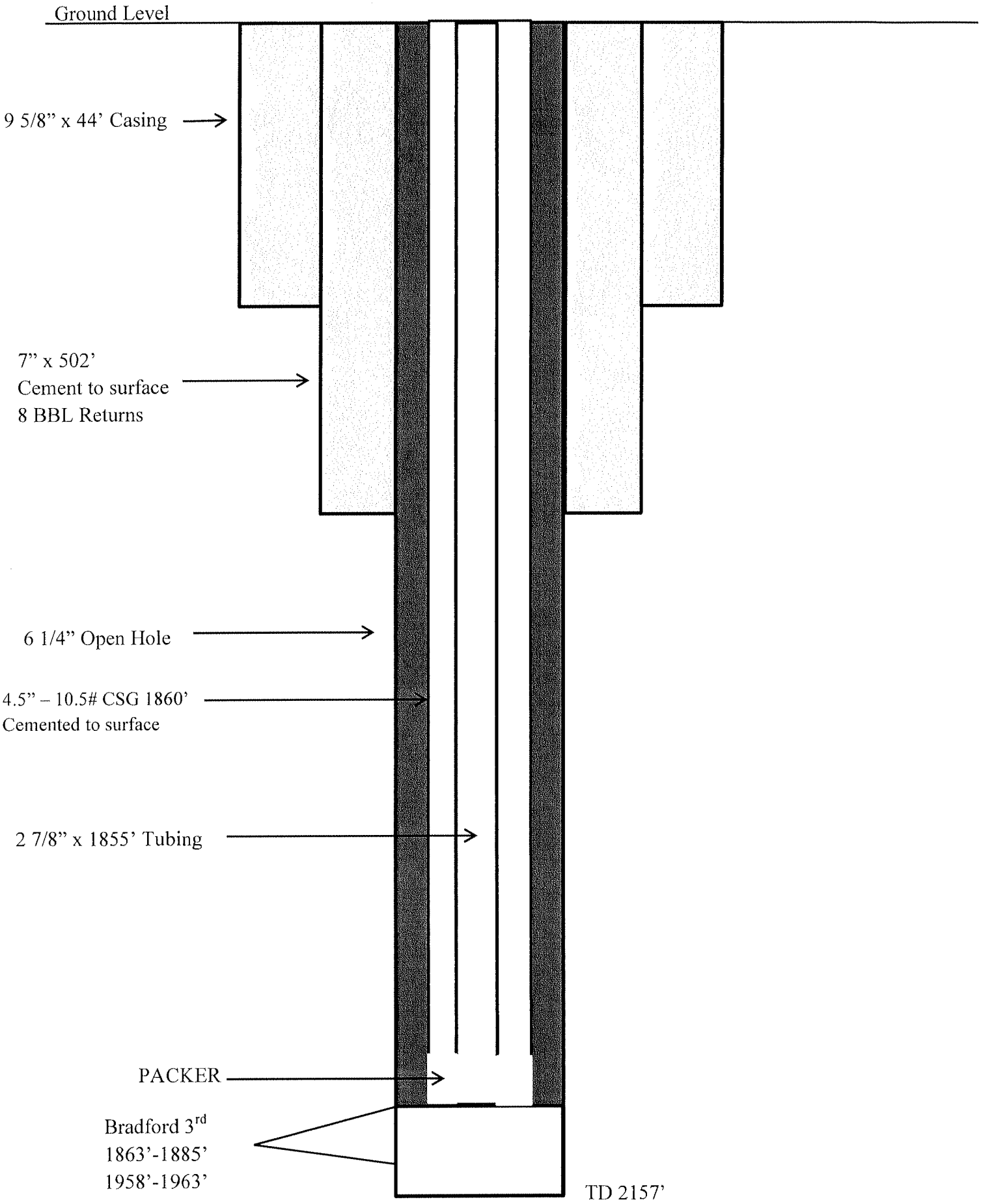


ATTACHMENT C

WELL CONSTRUCTION

CONVERSION INFORMATION

Well Schematic Diagram Moody Well 17



Well Conversion Procedures

1. Move in service rig and release packer, remove 2-7/8" tbg and packer.
2. Set bridge plug at 1860' with wireline unit.
3. Run 1860' of 4.5" -10.5# casing with cement shoe and 12 centralizers spaced approximately 150' apart.
4. Cement 4.5" casing from 1860' to surface with 187 sks of Class A common cement. Displace cement plug with 30 bbls of water and shut-in. Wait on cement overnight to cure.
5. Move in wireline unit to run bond log from bottom of 4.5" to surface.
6. Rig up to drill out wooden plug and bridge plug. Flush hole to TD 2150'. Remove work string from well bore.
7. Rig up to re-run 2-7/8" tubing with 4.5" packer to be set at 1855'. Prior to setting packer, we will load annular space with condition fluid.
8. Install well head and rig up to perform MIT tests.

Cementing Calculations

1358'—6.25" open hole = 139.33ft^3
502'--- 7" casing = 61.60 ft^3
Total cubic feet = 200.93

200.93 / 1.18ft ^{3} per sks = 170.28 sks

170.28 sks x 1.1(10% excess) = 187.31 sks

See Attachment B Drillers log and Geophysical log for well completion and cementing records on Moody Well 17.

ATTACHMENT D

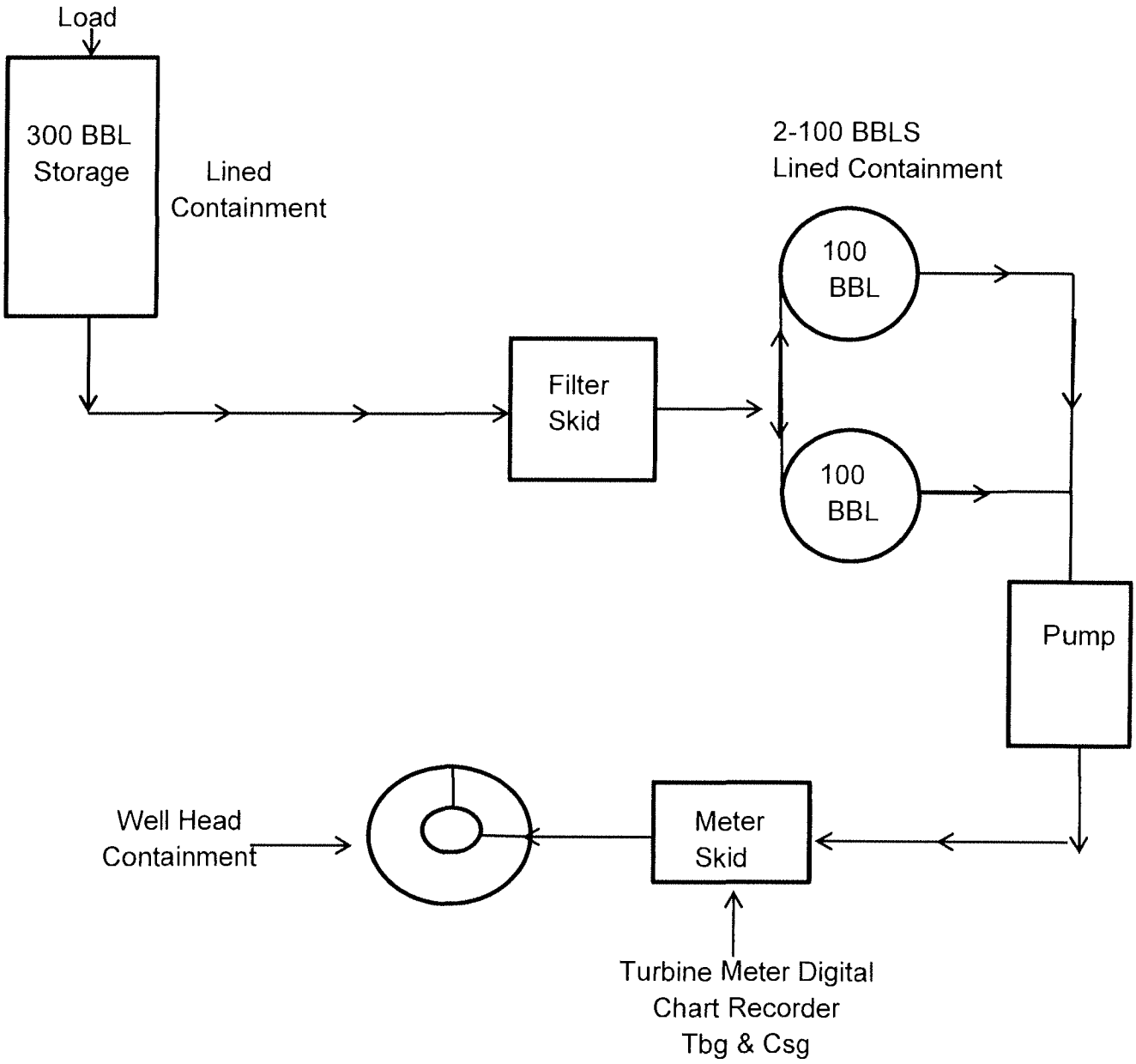
INJECTION OPERATION

AND

MONITORING PROGRAM

Injection Operation and Monitoring Program

FLOW/SURFACE DIAGRAM



CONTINGENCY PLAN

- All tanks will be placed in lined dyke
- A lined containment area will be placed around well head
- If pump is needed High- Low controls will be installed to kill pump if pressures become too high or too low. As well as High-Low flow rates.
- Pressure gauges will be installed on both Tbg & Csg
- Chart recorders installed to chart Csg & Tbg
  Pressures 24 hr/day- 7 days/week
- 4 ½ cement to surface
- Relief Valve set to max pressure and plumbed to holding tanks
- Altronic Digital Flow recorder to collect daily and total volume from ½ turbine meter
- Average of 40 BBLs/day rate with a maximum of 100 BBLs/day
- Based on the injection test Tbg will be on vacuum with maximum pressure being 1200psig
- Fluids will be collected from Moody and Andrus-McDowell project
- See attached SG from Microbac Laboratories and Produced Water Analysis from White Oak Laboratory.

MICROBAC

Microbac Laboratories Inc., Pittsburgh Division

CERTIFICATE OF ANALYSIS

0064040

Sandstone Development LLC

Jim Barnes
557 Interstate Parkway
Bradford, PA 16701

Project Name: Brine Wells

Project / PO Number: N/A
Received: 06/26/2020
Reported: 07/08/2020

Analytical Testing Parameters

Client Sample ID: Moody
Sample Matrix: Aqueous
Lab Sample ID: 0064040-01

Collected By: Customer
Collection Date: 06/24/2020 9:00

Analyses Subcontracted to: Microbac Laboratories Inc., - Marietta, OH

Inorganics Total	Result	RL	Units	Dilution	Note	Prepared	Analyzed	Analyst
SM 2710 F-2011								
Specific Gravity	**1.08**		g/mL	1	Y	07/07/20 0753	07/07/20 0915	JRH

Definitions

g/mL: Grams per Milliliter
Y: This analyte is not on the laboratory's current scope of accreditation.

Project Requested Certification(s)

Microbac Laboratories Inc., - Marietta, OH
68-01670 — PA Department of Environmental Protection

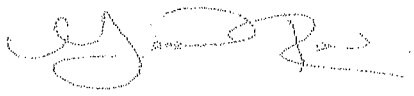
Microbac Laboratories Inc., Pittsburgh Division
02-00257 — PA Department of Environmental Protection
PADEP Accreditation by Rule

Report Comments

Samples were received in proper condition and the reported results conform to applicable accreditation standard unless otherwise noted.

The data and information on this, and other accompanying documents, represents only the sample(s) analyzed. This report is incomplete unless all pages indicated in the footnote are present and an authorized signature is included. ***The services were provided under and subject to Microbac's standard terms and conditions which can be located and reviewed at <https://www.microbac.com/standard-terms-conditions>.***

Reviewed and Approved By:



Yesenia Rosa
Customer Relationship Coordinator
Reported: 07/08/2020 18:11

MICROBAC
Pittsburgh Division
100 Marshall Drive Warrendale, PA 15086
724.772.0610

CHAIN OF CUSTODY RECORD

Number
Instructions on back

Lab Report Address
Client Name: Sandstone Development LLC
Address: 557 Interstate Parkway
City, State, Zip: Bradford PA 16701
Contact: Jim Barnes
Telephone No.: 814-598-4852
Send Report via: [] Mail [] Fax [] e-mail (address)

Invoice Address
Client Name: same
Address:
City, State, Zip: rjowell@atlanticbb.net
Contact:
Telephone No.:
Send Invoice via: [] Mail [] Fax [] e-mail (address)

Turnaround Time
[] Routine (5 to 7 business days)
[] RUSH* (notify lab)
(needed by)
Report Type
[]Results Only []Level 1 []Level 2 []Level3 []Level 4 []EDD

TO BE COMPLETED BY MICROBAC
Temperature Upon Receipt (°C)
Therm ID
Holding Time 26.4 °C (5.0 °C)
Samples Received on Ice? Yes No N/A
Custody Seals Intact? Yes No N/A

Project: Brine Wells
Location:
PO No.:
Compliance Monitoring? [] Yes
Sampled by (PRINT):
Sampler Signature:
Sampler Phone No.:

* Matrix Types: Soil/Solid (S), Sludge, Oil, Wipe, Drinking Water (DW), Groundwater (GW), Surface Water (SW), Waste Water (WW), Other (specify)
** Preservative Types: (1) HNO3, (2) H2SO4, (3) HCl, (4) NaOH, (5) Zinc Acetate, (6) Methanol, (7) Sodium Bisulfate, (8) Sodium Thiosulfate, (9) Hexane, (U) Unpreserved

REQUESTED ANALYSIS

Lab ID	Client Sample ID	Date Collected	Time Collected	No. of Containers	Matrix	Grab / Comp	Preservative Types **	Specific Gravity
1	Moody	6/24	9:00	1	brine	G	4	X
2	Morrison	6/24	10:00	1	brine	G	4	X

Sandstone Development LLC
PM: Yesenia Rosa
0064040

Possible Hazard Identification [] Hazardous [] Non-Hazardous [] Radioactive
Comments
Client supplied Containers CMV 6-25-2020

Sample Disposition [] Dispose as appropriate [] Return [] Archive

Relinquished By (signature)	Date/Time	Received By (signature)	Date/Time
[signature]	6/25/20 13:25	[signature]	6-25-2020 1325
[signature]	6-26-2020 1100	[signature]	6/26/2020 1100
[signature]	6/26/2020 1340	[signature]	6/26/20 1340

rev.12/26/2017

Page of

WHITE OAK
LABORATORY

2997 Ridgway Johnsonburg Road
Ridgway PA 15853 (814) 772-5927
www.whiteoaklaboratory.com
PA DEP Lab ID 24-05897

REPORT OF LABORATORY ANALYSIS

Client:	Sandstone Development	Sample Collector:	Mason Stark
Project Manager / Contact:	Jim Barnes	Matrix:	NPW
Address:	557 Interstate Parkway	Date/Time Received:	2/3/2021 9:40
	Bradford, PA 16701		

White Oak Laboratory Sample ID: 21B0008-1B
Client Sample ID: Sandstone Development
Sample Date & Time: 2/3/2021 8:15

Analyte	Method	Result	Quantitation Limit	Units	Date of Analysis	Time of Analysis	Analyst Initials	Qualifers
Bromide	EPA 300.0 Rev. 2.1	505	50	mg/L	2/8/2021	16:44	AC	
Chloride	EPA 300.0 Rev. 2.1	49,800	10,000	mg/L	2/8/2021	17:39	AC	
Sulfate	EPA 300.0 Rev. 2.1	< 500	500	mg/L	2/8/2021	16:44	AC	
pH	SM4500-H+B -2011	6.68	0.1	pH at 11.7°C	2/3/2021	10:07	AC	A7

Notes:

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Ridgway PA 15853 (814) 772-5927
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PA DEP Lab ID 24-05897

REPORT OF LABORATORY ANALYSIS

Client:	Sandstone Development	Sample Collector:	Mason Stark
Project Manager / Contact:	Jim Barnes	Matrix:	NPW
Address:	557 Interstate Parkway	Date/Time Received:	2/3/2021 9:40
	Bradford, PA 16701		

White Oak Laboratory Sample ID: 21B0008-1C
Client Sample ID: Sandstone Development
Sample Date & Time: 2/3/2021 8:15

Analyte	Method	Result	Quantitation Limit	Units	Date of Analysis	Time of Analysis	Analyst Initials	Qualifers
Total Dissolved Solids	SM 2540C-2011	89,700	2,500	mg/L	2/8/2021	17:15	LG	
Total Suspended Solids	SM 2540D-2011	81	5	mg/L	2/8/2021	17:15	LG	

Notes:

WHITE OAK
LABORATORY

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Ridgway PA 15853 (814) 772-5927
www.whiteoaklaboratory.com
PA DEP Lab ID 24-05897

REPORT OF LABORATORY ANALYSIS

Client:	Sandstone Development	Sample Collector:	Mason Stark
Project Manager / Contact:	Jim Barnes	Matrix:	NPW
Address:	557 Interstate Parkway	Date/Time Received:	2/3/2021 9:40
	Bradford, PA 16701		

White Oak Laboratory Sample ID: 21B0008-7D
Client Sample ID: Sandstone Development
Sample Date & Time: 2/3/2021 8:15

Analyte	Method	Result	Quantitation Limit	Units	Date of Analysis	Time of Analysis	Analyst Initials	Qualifers
Chemical Oxygen Demand	SM 5220D-2011	861	125	mg/L	2/5/2021	15:54	AC	

Notes:

Pace Analytical Services, LLC
1638 Roseytown Road - Suites 2,3,4
Greensburg, PA 15601
(724)850-5600

PROJECT NARRATIVE

Project: 21B0008 (Brine)
Pace Project No.: 30404987

Method: EPA 900.0
Description: 900.0 Gross Alpha/Beta
Client: White Oak Laboratory LLC
Date: February 26, 2021

General Information:
1 sample was analyzed for EPA 900.0 by Pace Analytical Services Greensburg. All samples were received in acceptable condition with any exceptions noted below or on the chain-of custody and/or the sample condition upon receipt form (SCUR) attached at the end of this report.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

Method Blank:
All analytes were below the report limit in the method blank, where applicable, with any exceptions noted below.

Laboratory Control Spike:
All laboratory control spike compounds were within QC limits with any exceptions noted below.

Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

Additional Comments:

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Greensburg, PA 15601
(724)850-5600

PROJECT NARRATIVE

Project: 21B0008 (Brine)
Pace Project No.: 30404987

Method: **EPA 903.1**
Description: 903.1 Radium 226
Client: White Oak Laboratory LLC
Date: February 26, 2021

General Information:
1 sample was analyzed for EPA 903.1 by Pace Analytical Services Greensburg. All samples were received in acceptable condition with any exceptions noted below or on the chain-of custody and/or the sample condition upon receipt form (SCUR) attached at the end of this report.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

Method Blank:
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Laboratory Control Spike:
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Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

Additional Comments:

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Greensburg, PA 15601
(724)850-5600

PROJECT NARRATIVE

Project: 21B0008 (Brine)
Pace Project No.: 30404987

Method: **EPA 904.0**
Description: 904.0 Radium 228
Client: White Oak Laboratory LLC
Date: February 26, 2021

General Information:
1 sample was analyzed for EPA 904.0 by Pace Analytical Services Greensburg. All samples were received in acceptable condition with any exceptions noted below or on the chain-of custody and/or the sample condition upon receipt form (SCUR) attached at the end of this report.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

Method Blank:
All analytes were below the report limit in the method blank, where applicable, with any exceptions noted below.

Laboratory Control Spike:
All laboratory control spike compounds were within QC limits with any exceptions noted below.

Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

Additional Comments:

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Greensburg, PA 15601
(724)850-5600

PROJECT NARRATIVE

Project: 21B0008 (Brine)
Pace Project No.: 30404987

Method: **ASTM D5174-97**
Description: D517497 Total Uranium KPA
Client: White Oak Laboratory LLC
Date: February 26, 2021

General Information:
1 sample was analyzed for ASTM D5174-97 by Pace Analytical Services Greensburg. All samples were received in acceptable condition with any exceptions noted below or on the chain-of custody and/or the sample condition upon receipt form (SCUR) attached at the end of this report.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

Method Blank:
All analytes were below the report limit in the method blank, where applicable, with any exceptions noted below.

Laboratory Control Spike:
All laboratory control spike compounds were within QC limits with any exceptions noted below.

Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

Additional Comments:

This data package has been reviewed for quality and completeness and is approved for release.

Pace Analytical Services, LLC
1638 Roseytown Road - Suites 2,3,4
Greensburg, PA 15601
(724)850-5600

ANALYTICAL RESULTS - RADIOCHEMISTRY

Project: 21B0008 (Brine)
Pace Project No.: 30404987

Sample: 21B00O8 (Brine) **Lab ID: 30404987001** Collected: 02/03/21 08:15 Received: 02/05/21 10:15 Matrix: Water
PWS: Site ID: Sample Type:

Parameters	Method	Act ± Unc (MDC) Carr Trac	Units	Analyzed	CAS No.	Qual
	Pace Analytical Services - Greensburg					
Gross Alpha	EPA 900.0	**-154 ± 382 (814) C:NA T:NA**	pCi/L	02/15/21 18:14	12587-46-1	
	Pace Analytical Services - Greensburg					
Radium-226	EPA 903.1	**17.7 ± 6.55 (5.68) C:NA T:93%**	pCi/L	02/22/21 15:20	13982-63-3	
	Pace Analytical Services - Greensburg					
Radium-228	EPA 904.0	**18.3 ± 5.69 (7.53) C:68% T:83%**	pCi/L	02/22/21 14:56	15262-20-1	
	Pace Analytical Services - Greensburg					
Total Uranium	ASTM D5174-97	**1.82 ± 0.100 (26.200) C:NA T:NA**	ug/L	02/25/21 14:10	7440-61-1	

REPORT OF LABORATORY ANALYSIS

Pace Analytical Services, LLC
1638 Roseytown Road - Suites 2,3,4
Greensburg, PA 15601
(724)850-5600

QUALITY CONTROL - RADIOCHEMISTRY

Project: 21B0008 (Brine)
Pace Project No.: 30404987

QC Batch: 435383
QC Batch Method: EPA 903.1
Analysis Method: EPA 903.1
Analysis Description: 903.1 Radium-226
Laboratory: Pace Analytical Services - Greensburg
Associated Lab Samples: 30404987001

METHOD BLANK: 2101787 Matrix: Water
Associated Lab Samples: 30404987001

Parameter	Act ± Unc (MDC) Carr Trac	Units	Analyzed	Qualifiers
Radium-226	0.160 ± 0.422 (0.753) C:NA T:91%	pCi/L	02/22/21 14:54	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

REPORT OF LABORATORY ANALYSIS

Pace Analytical Services, LLC
1638 Roseytown Road - Suites 2,3,4
Greensburg, PA 15601
(724)850-5600

QUALITY CONTROL - RADIOCHEMISTRY

Project: 21B0008 (Brine)
Pace Project No.: 30404987

QC Batch: 434520
QC Batch Method: EPA 900.0
Analysis Method: EPA 900.0
Analysis Description: 900.0 Gross Alpha/Beta
Laboratory: Pace Analytical Services - Greensburg
Associated Lab Samples: 30404987001

METHOD BLANK: 2098127 Matrix: Water
Associated Lab Samples: 30404987001

Parameter	Act ± Unc (MDC) Carr Trac	Units	Analyzed	Qualifiers
Gross Alpha	0.189 ± 0.531 (1.31) C:NA T:NA	pCi/L	02/15/21 12:17	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

REPORT OF LABORATORY ANALYSIS

Pace Analytical Services, LLC
1638 Roseytown Road - Suites 2,3,4
Greensburg, PA 15601
(724)850-5600

QUALITY CONTROL - RADIOCHEMISTRY

Project: 21B0008 (Brine)
Pace Project No.: 30404987

QC Batch: 434524
QC Batch Method: ASTM D5174-97
Analysis Method: ASTM D5174-97
Analysis Description: D5174.97 Total Uranium KPA
Laboratory: Pace Analytical Services - Greensburg
Associated Lab Samples: 30404987001

METHOD BLANK: 2098131 Matrix: Water
Associated Lab Samples: 30404987001

Parameter	Act ± Unc (MDC) Carr Trac	Units	Analyzed	Qualifiers
Total Uranium	0.027 ± 0.001 (0.262) C:NA T:NA	ug/L	02/22/21 12:52	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

REPORT OF LABORATORY ANALYSIS

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Greensburg, PA 15601
(724)850-5600

QUALITY CONTROL - RADIOCHEMISTRY

Project: 21B0008 (Brine)
Pace Project No.: 30404987

QC Batch: 435384
QC Batch Method: EPA 904.0
Analysis Method: EPA 904.0
Analysis Description: 904.0 Radium 228
Laboratory: Pace Analytical Services - Greensburg
Associated Lab Samples: 30404987001

METHOD BLANK: 2101789
Matrix: Water
Associated Lab Samples: 30404987001

Parameter	Act ± Unc (MDC) Carr Trac	Units	Analyzed	Qualifiers
Radium-228	-0.166 ± 0.298 (0.732) C:80% T:81%	pCi/L	02/22/21 14:52	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

REPORT OF LABORATORY ANALYSIS

Pace Analytical Services, LLC
1638 Roseytown Road - Suites 2,3,4
Greensburg, PA 15601
(724)850-5600

QUALIFIERS

Project: 21B0008 (Brine)
Pace Project No.: 30404987

DEFINITIONS

DF - Dilution Factor, if reported, represents the factor applied to the reported data due to dilution of the sample aliquot.

ND - Not Detected at or above adjusted reporting limit.

TNTC - Too Numerous To Count

J - Estimated concentration above the adjusted method detection limit and below the adjusted reporting limit.

MDL - Adjusted Method Detection Limit.

PQL - Practical Quantitation Limit.

RL - Reporting Limit - The lowest concentration value that meets project requirements for quantitative data with known precision and bias for a specific analyte in a specific matrix.

S - Surrogate

1,2-Diphenylhydrazine decomposes to and cannot be separated from Azobenzene using Method 8270. The result for each analyte is a combined concentration.

Consistent with EPA guidelines, unrounded data are displayed and have been used to calculate % recovery and RPD values.

LCS(D) - Laboratory Control Sample (Duplicate)

MS(D) - Matrix Spike (Duplicate)

DUP - Sample Duplicate

RPD - Relative Percent Difference

NC - Not Calculable.

SG - Silica Gel - Clean-Up

U - Indicates the compound was analyzed for, but not detected.

N-Nitrosodiphenylamine decomposes and cannot be separated from Diphenylamine using Method 8270. The result reported for each analyte is a combined concentration.

Act - Activity

Unc - Uncertainty: For Safe Drinking Water Act (SDWA) analyses, the reported Unc. Is the calculated Count Uncertainty (95% confidence interval) using a coverage factor of 1.96. For all other matrices (non-SDWA), the reported Unc. is the calculated Expanded Uncertainty (aka Combined Standard Uncertainty, CSU), reported at the 95% confidence interval using a coverage factor of 1.96.

Gamma Spec: The Unc. reported for all gamma-spectroscopy analyses (EPA 901.1), is the calculated Expanded Uncertainty (CSU) at the 95.4% confidence interval, using a coverage factor of 2.0.

(MDC) - Minimum Detectable Concentration

Trac - Tracer Recovery (%)

Carr - Carrier Recovery (%)

Pace Analytical is TNI accredited. Contact your Pace PM for the current list of accredited analytes.

TNI - The NELAC Institute.

REPORT OF LABORATORY ANALYSIS

Pace Analytical Services, LLC
1638 Roseytown Road - Suites 2,3,4
Greensburg, PA 15601
(724)850-5600

QUALITY CONTROL DATA CROSS REFERENCE TABLE

Project: 21B0008 (Brine)
Pace Project No.: 30404987

Lab ID	Sample ID	QC Batch Method	QC Batch	Analytical Method	Analytical Batch
30404987001	**21B0008 (Brine)**	EPA 900.0	434520		
30404987001	**21B0008 (Brine)**	EPA 903.1	435383		
30404987001	**21B0008 (Brine)**	EPA 904.0	435384		
30404987001	**21B0008 (Brine)**	ASTM D5174-97	434524		

CHAIN-OF-CUSTODY / Analytical Request Document

For Assistance Processing This Document, please contact: R3_UIC_Mailbox@epa.gov

Pace Analytical

Chain-of-Custody is a LEGAL DOCUMENT - Complete all relevent fields

LAB USE ONLY - Affix Workorder/Login Label Here or List Pace Workorder Number Here

MTJL Log-in Number Here

WO# : 30404987

30404987

ALL SHADED AR

Company: White Oak Laboratory	Billing Information: Same
Address: 2997 Ridgway Johnsonburg Road, Ridgway PA 15853	
Report To: Lauren Geer	Email To: accounts@whiteoaklaboratory.com
Copy To: —	Site Collection Info/Address: —
Customer Project Name/Number: 21B0008 (Brine)	State: PA / County/City: Elk / Time Zone Collected: [ ] PT [ ] MT [ ] CT [X] ET
Phone: 814-772-5927 Email: accounts@whiteoaklaboratory.com	Site/Facility ID #: — / Compliance Monitoring? [ ] Yes [X] No
Collected By (print): Client	Purchase Order #: — / Quote #: — / DW PWS ID #: — / DW Location Code: —
Collected By (signature): Client	Turnaround Date Required: — / Immediately Packed on Ice: [ ] Yes [X] No
Sample Disposal: [X] Dispose as appropriate [ ] Return [ ] Archive: ____ [ ] Hold: ____	Rush: [ ] Same Day [ ] Next Day [ ] 2 Day [ ] 3 Day [ ] 4 Day [ ] 5 Day (Expedite Charges Apply) / Field Filtered (if applicable): [ ] Yes [X] No / Analysis: ____

* Matrix Codes (Insert in Matrix box below): Drinking Water (DW), Ground Water (GW), Wastewater (WW), Product (P), Soil/Solid (SL), Oil (OL), Wipe (WP), Air (AR), Tissue (TS), Bioassay (B), Vapor (V), Other (OT)

Container Preservative Type **: 1

** Preservative Types: (1) nitric acid, (2) sulfuric acid, (3) [illegible], (6) methanol, (7) sodium bisulfate, (8) sodium thiosulfate, [illegible], (C) ammonium hydroxide, (D) TSP, (U) Unpreserved, (O) Other ____

Analyses: Brine RADS: Gross Alpha, Radium 226, Radium 228, Uranium

Lab Profile/Line:

Lab Sample Receipt Checklist:

Custody Seals Present/Intact	Y	N	(NA)
Custody Signatures Present	(Y)	N	NA
Collector Signature Present	Y	(N)	NA
Bottles Intact	(Y)	N	NA
Correct Bottles	(Y)	N	NA
Sufficient Volume	(Y)	N	NA
Samples Received on Ice	Y	(N)	NA
VOA - Headspace Acceptable	Y	N	(NA)
USDA Regulated Soils	Y	N	(NA)
Samples in Holding Time	(Y)	N	NA
Residual Chlorine Present	Y	N	(NA)
Cl Strips: ____			
Sample pH Acceptable	(Y)	N	NA
pH Strips: 10D1101			
Sulfide Present	Y	N	(NA)
Lead Acetate Strips: ____			

LAB USE ONLY:
Lab Sample # / Comments:

Customer Sample ID	Matrix *	Comp / Grab	Collected (or Composite Start) Date	Collected (or Composite Start) Time	Composite End Date	Composite End Time	Res Cl	# of Ctns	Brine RADS: Gross Alpha, Radium 226, Radium 228, Uranium	Lab Sample # / Comments
21B0008 (Brine)	WW	G	2-3-21	0815				3	X	001

Cyn/HPNC

Customer Remarks / Special Conditions / Possible Hazards:

Type of Ice Used: Wet Blue Dry (None)

Packing Material Used: Packing Popcorn

Radchem sample(s) screened (<500 cpm): 0 N NA

SHORT HOLDS PRESENT (<72 hours): Y N (N/A)

Lab Tracking #:

Samples received via: FEDEX UPS Client Courier Pace Courier — 7728 1520 3740

Lab Sample Temperature Info:
Temp Blank Received: Y N (NA)
Therm ID#: ____
Cooler 1 Temp Upon Receipt: ____ oC
Cooler 1 Therm Corr. Factor: ____ oC
Cooler 1 Corrected Temp: ____ oC
Comments: Cpm 2-8-21

Trip Blank Received: Y N (NA)
HCL MeOH TSP Other

Non Conformance(s): (YES) / NO — Page: ____ of: ____

Relinquished by/Company: (Signature)	Date/Time:	Received by/Company: (Signature)	Date/Time:
[illegible] Geer WOL	2-3-21 1752	Pace	2-5-21 1015
Relinquished by/Company: (Signature)	Date/Time:	Received by/Company: (Signature)	Date/Time:
Relinquished by/Company: (Signature)	Date/Time:	Received by/Company: (Signature)	Date/Time:

MTJL LAB USE ONLY
Table #:
Acctnum:
Template:
Prelogin:
PM:
PB:

Pace Analytical®

Pace Greensburg Lab -Sample Container Count

30404987

Client White Oak Lab

Profile Number 13983

Site 21BD008 (BRINE)

Notes

Sample Line Item	Matrix	AG1H	AG1S	AG1T	AG2U	AG3S	AG3U	AG5U	AG5T	BG1U	BG2U	BP1N	BP1U	BP2S	BP2U	BP3C	BP3N	BP3S	BP3U	DG9S	GCUB	VG9H	VG9T	VG9U	VOAK	WGFU	WGKU	ZPLC	
1	WT											3																	
2																													
3																													
4																													
5																													
6																													
7																													
8																													
9																													
10																													
11																													
12																													

Container Codes

Glass

GJN	1 Gallon Jug with HNO3	DG9S	40mL amber VOA vial H2SO4
AG5U	100mL amber glass unprserved	VG9U	40mL clear VOA vial
AG5T	100mL amber glass Na Thiosulfate	VG9T	40mL clear VOA vial Na Thiosul
GJN	1 Gallon Jug	VG9H	40mL clear VOA vial HCl
AG1S	1L amber glass H2SO4	JGFU	4oz amber wide jar
AG1H	1L amber glass HCl	WGFU	4oz wide jar unpreserved
AG1T	1L amber glass Na Thiosulfate	BG2U	500mL clear glass unpreserved
BG1U	1L clear glass unpreserved	AG2U	500mL amber glass unpreserve
AG3S	250mL amber glass H2SO4	WGKU	8oz wide jar unpreserved
AG3U	250mL amber glass unpreserved		

Plastic / Misc.

GCUB	1 Gallon Cubitainer
12GN	1/2 Gallon Cubitainer
SP5T	120mL Coliform Na Thiosulfate
BP1N	1L plastic HNO3
BP1U	1L plastic unpreserved
BP3S	250mL plastic H2SO4
BP3N	250mL plastic HNO3
BP3U	250mL plastic unpreserved
BP3C	250ml plastic NAOH
BP2S	500mL plastic H2SO4
BP2U	500mL plastic unpreserved

EZI	5g Encore
VOAK	Kit for Volatile Solid
I	Wipe/Swab
ZPLC	Ziploc Bag

WT	Water
SL	Solid
OL	Non-aqueous liquid
WP	Wipe

WHITE OAK LABORATORY

238 Ridgway Johnsonburg Road, Ridgway, PA 15853
Phone: (814) 772-5927 Fax: (814) 772-5927
Email: info@whiteoaklaboratory.com
Website: www.whiteoaklaboratory.com

Chain of Custody / Request for Analysis

This chain of custody is a legal document, fill document completely. All writing must be legible, and in blue or black ink. For samples that do not meet sample acceptance criteria, contact laboratory management for further instructions.

Client	Sandstone Development	Contact Person	Jim Barnes	Samples for Compliance? [X] Yes [ ] No	[ ] Standard TAT
Mailing Address	557 Interstate Parkway	Phone Number	814 772 6423	Agency: Ridgway Borough	[ ] Rush TAT - Manager Approval Required
Physical Address	Bradford, Pa. 16701	Fax Number		PWSID#	Date Required
Additional Info		Email	wastewatertreatment@ridgwayborough.com	Sanitarian County	Final Report & Invoice. [ ] Email [ ] Fax [ ] Mail

For assistance in accessing this document, please contact: R3_UIC_Mailbox@epa.gov

Key: Preservative Codes**	
#1: Thermal	#5: HCl
#2: $Na_2S_2O_3$	#6: HNO_3
#3: NaOH/ ZnAct	#7: H_2SO_4
#4: NaOH	#8: Other (Specify)

Client Sample ID:	Date Collected:	Time Collected:	Matrix: Drinking Water	Matrix: Waste Water	Matrix: Solid	Matrix: Other	Sample Info: Preservative Code** (see left)	Sample Info: Grab (G) or Composite (C)	Sample Info: # of containers	Sample Info: Total Volume (mL)	Analysis Requested: TCLP (11) Metals	Bromide, Chloride, Sulfate, pH	Total Dissolved Solids, Total Suspended Solids	Ammonia, COD	Barium, Strontium	Gross Alpha, Radium 226, Radium 228, Uranium				Bottle ID (Lab Use Only)	Comments/ Field Data:
				X			1	G	1	500	X									1A	
				X			1	G	1	500		X								1B	
				X			1	G	1	1L			X							1C	
Sandstone D.	2/3/21	8:15 AM		X			7	G	1	500				X						7D	
				X			6	G	1	500					X					6E	
				X			6	G	3	3L						X				6F, 6G, 6H	

Sample Collector Name (Print): Mason Stark Sample Collector Signature: M Stark Position/Company: Ridgway Borough

Relinquished By: M Stark	Date/Time: 2-3-21 09:40	→	Received By:	Date/Time:	On Ice? (Y/N)
Relinquished By:	Date/Time:	→	Received By:	Date/Time:	On Ice? (Y/N)
Relinquished By:	Date/Time:	→	Received By:	Date/Time:	On Ice? (Y/N)
Relinquished By:	Date/Time:	→	Received at Lab By:	Date/Time: 2/3/2021 09:40	On Ice? (Y/N)

SHADED AREA FOR LABORATORY USE ONLY:

Thermometer ID: IR-01	In Hold Time?	[✓]Yes	[ ]No	[ ]N/A	Custody Seal Intact?	[ ]Yes	[ ]No	[✓]N/A	Notes:
Observed Temp °C: 7.4	Ice Present ?	[✓]Yes	[ ]No	[ ]N/A	Correct Bottle?	[✓]Yes	[ ]No	[ ]N/A	
Corrected Temp °C 7.5	Bottles Intact?	[✓]Yes	[ ]No	[ ]N/A	Client Contacted?	[ ]Yes	[ ]No	[✓]N/A	
Date & Time: 2/3/2021 09:41	Headspace?	[ ]Yes	[ ]No	[✓]N/A	In Temperature?	[ ]Yes	[ ]No	[✓]Cooldown	
Employee: AC	Laboratory ID #	21B0008							

WHITE OAK LABORATORY

Laboratory ID # 21B0008

Client: Sandstone Development

Receiver: [signature]

Date/Time of Checks: 2/3/2021 09:41

1) Check All That Apply

- ☐ PWS
- ☐ NPDES/Compliance
- ☐ Dept. of Health
- ☐ RUSH
- ☐ Other: _____

pH paper lot # 231018

Bottle #	pH
1A	6
1B	6
1C	6
7D	1
6E	1
6F	1
6G	1
6H	1

2) Was the CoC completed properly?

- ☑ YES
- ☐ NO If no, explain below

3) Were sample label(s) completed properly?

- ☑ YES
- NO If no, explain below

4) Do any samples have short hold time (< 48 hours?)

- ☑ YES If yes, list below & NOTIFY LABORATORY ANALYSTS!
- ☐ NO

pH

4) Do any analytes require subcontracting?

- ☑ YES If yes, list below
- ☐ NO

metals, ammonia, Rads

5) Method of Delivery

☐ Lab Courier ☐ US Mail ☐ UPS ☐ FedEx ☑ Hand Delivery ☐ Other

Notes:

ATTACHMENT E

PLUGGING

AND

ABANDONMENT PLAN

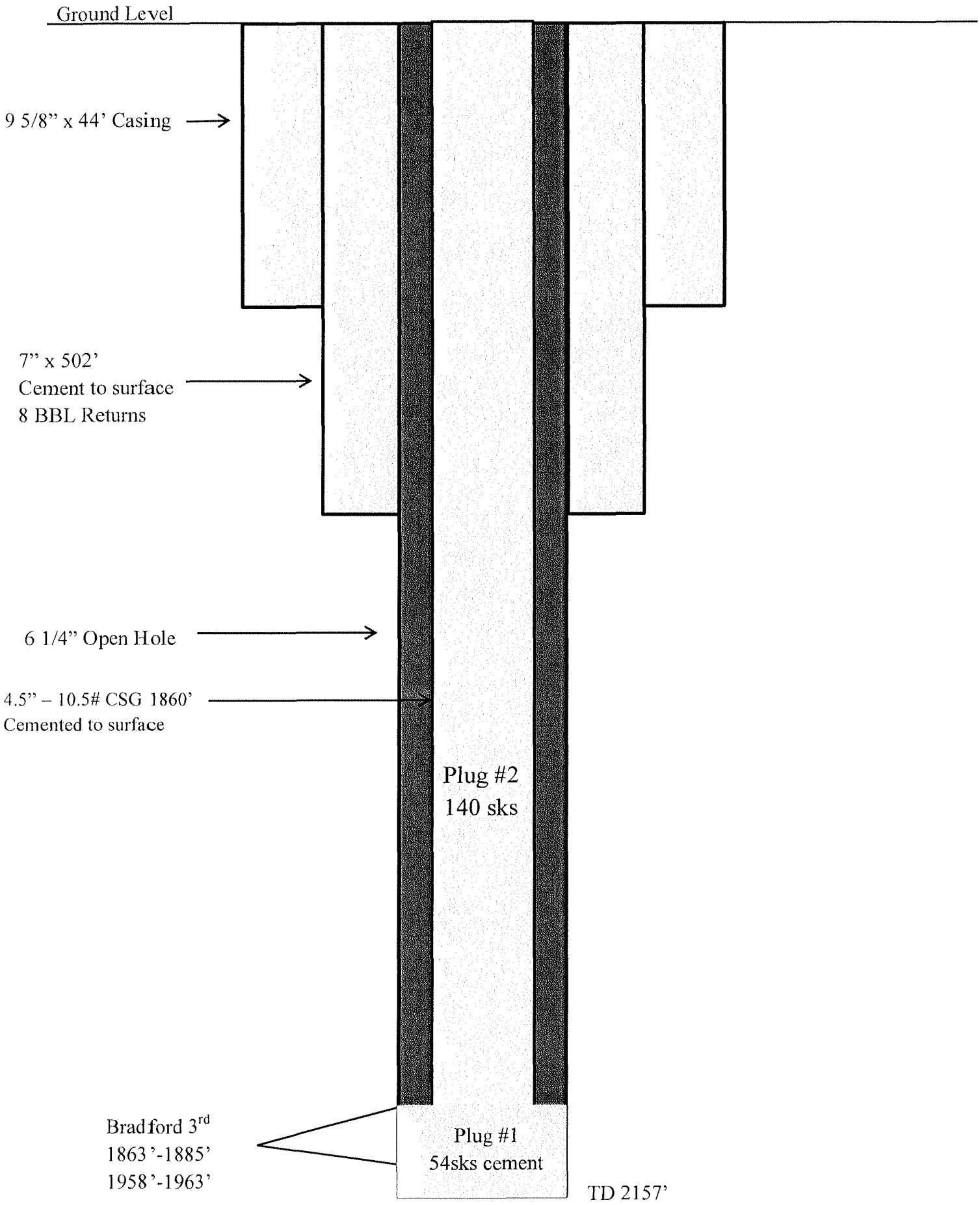
Plugging and Abandonment Plan

In the event that the Moody Lot 5 #17 well has to be plugged the following plan will be improvised.

The 2 7/8" tbg and packer will be removed. A solid cement plug will be put from total depth of 2150' to the inside of the 4 1/2" casing to 1850'. This plug will be a 54sks of Class A common cement and with WOC of 8hrs. After the WOC time, the plug will be tagged to verify depth of 1850'. Plug number 2 will be from 1850' to surface inside the 4 ½" casing. The 2nd plug will be 140sks of Class A common cement.

The 7" casing and 4 1/2" are already cemented to surface. Therefore, all annular spaces are filled completely with cement.

Plugging Diagram Moody Well 17



OMB No. 2040-0042 Approval Expires 4/30/2022

United States Environmental Protection Agency

EPA

WELL REWORK RECORD, PLUGGING AND ABANDONMENT PLAN, OR PLUGGING AND ABANDONMENT AFFIDAVIT

Name and Address, Phone Number and/or Email of Permittee

Sandstone Development LLC.
557 Interstate Parkway
Bradford, PA 16701
(814)368-9570
rjbwell@atlanticbb.net

Permit or EPA ID Number	API Number	Full Well Name
	37-083-53736-00	Moody Lot 5 #17

State	County
PA	McKean

Locate well in two directions from nearest lines of quarter section and drilling unit

Surface Location

1/4 of ____ 1/4 of Section 7 Township BRD Range ____

____ ft. from (N/S) ____ Line of quarter section

____ ft. from (E/W) ____ Line of quarter section.

Latitude 41-54-34.3800

Longitude -78-35-15.7000

Well Class	Timing of Action (pick one)	Type of Action (pick one)
☐ Class I ☑ Class II ☐ Class III ☐ Class V	☐ Notice Prior to Work Date Expected to Commence ____ ☐ Report After Work Date Work Ended ____	☐ Well Rework ☑ Plugging and Abandonment ☐ Conversion to a Non-Injection Well

Provide a narrative description of the work planned to be performed, or that was performed. Use additional pages as necessary. See instructions.

See attached plugging and abandonment plan

Certification

I certify under the penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment. (Ref. 40 CFR § 144.32)

Name and Official Title *(Please type or print)*	Signature	Date Signed
R. James Barnes, Member		3/15/21

Autumn Ridge Energy, LLC
11000 Painesville-Warren Road
Painesville, OH 44077
(440) 667-3381

2/2/2021

Sandstone Development LLC.
557 Interstate Parkway
Bradford, Pa 16701

Estimated plugging rates for Moody Lot 5 #17 injection well:

Service Rig Time: 16 hours @ $165.00 per/hr = $2,640.00
194sks Class A Common Cement @ $15.00 per/sks = $2,910.00

For estimated total of: $5,550.00

Any additional questions please feel free to call.

Sincerely,

Jesse

ATTACHMENT F

FINANCIAL ASSURANCE

THE PIONEER BANK of McKean County

HAMLIN BANK AND TRUST COMPANY
Established 1863
TRUST DEPARTMENT

March 10, 2021

US EPA Region 3

c/o James Bennett
1650 Arch Street
Philadelphia, PA 19103-2029

RE: Trust #881; Sandstone Development LLC T/U/A

Greetings Mr. Bennett,

Please find enclosed the proper documentation to show that as of March 9, 2021, Sandstone Development LLC currently holds a Standby Trust Agreement with the Trust Department of Hamlin Bank and Trust Company. This Standby Trust Agreement holds Hamlin Bank Certificate of Deposit #113273077 in the amount of $5,550.00.

The schedule to report this holding to the US EPA Region 3 and also to Sandstone Development LLC is April 1, 2021, then every April thereafter. If there are any questions or concerns, please call our department at (814) 887-5555. We can also receive email at trust@hamlinbank.com. Thank you for your time and have a nice day.

Sincerely,

Crystal VanGorder
Trust Operations

Encl.
CC: R. James Barnes, Sandstone Development LLC

STANDBY TRUST AGREEMENT

U.S. Environmental Protection Agency
Underground Injection Control
Financial Responsibility Requirement

THIS TRUST AGREEMENT (the "Agreement") is entered into as of March 9, 2021 by and between Sandstone Development LLC, owner or operator, a proprietorship corporation / partnership / association / proprietorship (the "Grantor"), and Hamlin Bank and Trust Company (the "Trustee"), a Financial corporation/financial institution.

Whereas, the United States Environmental Protection Agency ("EPA"), an agency of the United States Government, has established certain regulations applicable to the Grantor, requiring that an owner or operator of an injection well shall provide assurance that funds will be available when needed for plugging and abandonment of the injection well or wells,

Whereas, the Grantor has elected to establish a trust to provide all or part of such financial assurance for the facility or facilities identified herein, and

Whereas, the Grantor, acting through its duly authorized officers, has selected the Trustee to be the trustee under this Agreement, and the Trustee is willing to act as trustee,

NOW THEREFORE, the Grantor and the Trustee agree as follows:

Section 1. Definitions. As used in this Agreement: (a) The term "Grantor" means the owner or operator who enters into this Agreement and any successors or assigns of the Grantor. (b) The term " Trustee" means the Trustee who enters into this Agreement and any successor Trustee. (c) Facility or activity means any "underground injection well" or any other facility or activity that is subject to regulation under the Underground Injection Control Program.

Section 2. Identification of Facilities and Cost Estimates. This Agreement pertains to the facilities and cost estimates identified on attached Schedule A.

Section 3. Establishment of Fund. The Grantor and the Trustee hereby establish a trust fund (the "Fund") for the purpose of assuring compliance with the plugging and abandonment requirements established by EPA for the facilities identified on Schedule A. The Underground Injection Control regulations which govern the authorization to inject include a requirement for such financial assurance that the well or wells shall be plugged and abandoned at the time designated by EPA. The Grantor and the Trustee acknowledge that the Fund and all expenditures from the Fund shall be to fulfill the legal obligations of the Grantor under such regulations, and not any obligation of EPA. The Grantor and the Trustee intend that no third party have access to the Fund except as herein provided. The Fund is established initially as consisting of the property, which is acceptable to the Trustee, described in Schedule B attached hereto. Such property and any other property subsequently transferred to the Trustee is referred

to as the Fund, together with all earnings and profits thereon, less any payments or distributions made by the Trustee pursuant to this Agreement. The Fund shall be held by the Trustee, IN TRUST, as hereinafter provided. The Trustee shall not be responsible, nor shall it undertake any responsibility, for the amount or adequacy of any additional payments necessary to discharge any liabilities of the Grantor established by EPA, nor shall the Trustee have any duty to collect such additional amounts from the Grantor.

Section 4. Payment for Plugging and Abandonment. The Trustee shall make payments from the Fund only for the costs of plugging and abandonment ("P&A") of the injection wells covered by this Agreement and the associated P&A Plan, only after EPA has advised the Trustee that work has been completed under the P&A Plan that complies with 40 C.F.R. § 144.28 and/or § 144.52. The Trustee shall not refund to the Grantor any amounts from the Fund unless and until EPA has advised the Trustee that the P&A Plan has been successfully completed. The Trustee shall not release any funds to the Grantor that are necessary to cover liability for any injection wells covered by this Agreement that remain unplugged.

Section 5. Payments Comprising the Fund. Payments made to the Trustee for the Fund shall consist of cash or securities acceptable to the Trustee.

Section 6. Trustee Management. The Trustee shall invest and reinvest the principal and income of the Fund and keep the Fund invested as a single fund, without distinction between principal and income, in accordance with general investment policies and guidelines which the Grantor may communicate in writing to the Trustee from time to time, subject, however, to the provisions of this Section. In investing, reinvesting, exchanging, selling, and managing the Fund, the Trustee shall discharge his duties with respect to the trust fund solely in the interest of the beneficiary and with the care, skill, prudence, and diligence under the circumstances then prevailing which persons of prudence, acting in a like capacity and familiar with such matters, would use in the conduct of an enterprise of a like character and with like aims; *except that:*

(i) Securities or other obligations of the Grantor, or any other owner or operator of the facilities, or any of their affiliates as defined in the Investment Company Act of 1940, as amended, 15 U.S.C. 80a-2.(a), shall not be acquired or held, unless they are securities or other obligations of the Federal or a State government;

(ii) The Trustee is authorized to invest the Fund in time or demand deposits of the Trustee, to the extent insured by an agency of the Federal or State government; and

(iii) The Trustee is authorized to hold cash awaiting investment or distribution uninvested for a reasonable time and without liability for the payment of interest thereon.

Section 7. Commingling and Investment. The Trustee is expressly authorized in its discretion:
(a) To transfer from time to time any or all of the assets of the Fund to any common, commingled, or collective trust fund created by the Trustee in which the Fund is eligible to participate, subject to all of the provisions thereof, to be commingled with the assets of other

trusts participating therein; and (b) To purchase shares in any investment company registered under the Investment Company Act of 1940, 15 U. S. C. 80a-1 *et seq.*, including one which may be created, managed, underwritten, or to which investment advice is rendered or the shares of which are sold by the Trustee. The Trustee may vote shares in its discretion.

Section 8. Express Powers of Trustee. Without in any way limiting the powers and discretions conferred upon the Trustee by the other provisions of this Agreement or by law, the Trustee is expressly authorized and empowered: (a) To sell, exchange, convey, transfer, or otherwise dispose of any property held by it, by public or private sale. No person dealing with the Trustee shall be bound to see to the application of the purchase money or to inquire into the validity or expediency of any such sale or other disposition; (b) To make, execute, acknowledge, and deliver any and all documents of transfer and conveyance and any and all other instruments that may be necessary or appropriate to carry out the powers herein granted; (c) To register any securities held in the Fund in its own name or in the name of a nominee and to hold any security in bearer form or in book entry, or to combine certificates representing such securities with certificates of the same issue held by the Trustee in other fiduciary capacities, or to deposit or arrange for the deposit of such securities in a qualified central depository even though, when so deposited, such securities may be merged and held in bulk in the name of the nominee of such depositary with other securities deposited therein by another person, or to deposit or arrange for the deposit of any securities issued by the United States Government, or any agency or instrumentality thereof, with a Federal Reserve bank, but the books and records of the Trustee shall at all times show that all such securities are part of the Fund; (d) To deposit any cash in the Fund in interest-bearing accounts maintained or savings certificates issued by the Trustee, in its separate corporate capacity, or in any other banking institution affiliated with the Trustee, to the extent insured by an agency of the Federal or State government; and (e) To compromise or otherwise adjust all claims in favor of or against the Fund.

Section 9. Taxes and Expenses. All taxes of any kind that may be assessed or levied against or in respect of the Fund and all brokerage commissions incurred by the Fund shall be paid from the Fund. All other expenses incurred by the Trustee in connection with the administration of this Trust, including fees for legal services rendered to the Trustee, the compensation of the Trustee to the extent not paid directly by the Grantor, and all other proper charges and disbursements of the Trustee shall be paid from the Fund.

Section 10. Annual Valuation. The Trustee shall annually, at least 30 days prior to the anniversary date of establishment of the Fund, furnish to the Grantor and to the appropriate EPA Regional Administrator a statement confirming the value of the Trust. Any securities in the Fund shall be valued at market value as of no more than 60 days prior to the anniversary date of establishment of the Fund. The failure of the Grantor to object in writing to the Trustee within 90 days after the statement has been furnished to the Grantor and the EPA Regional Administrator shall constitute a conclusively binding assent by the Grantor, barring the Grantor from asserting any claim or liability against the Trustee with respect to matters disclosed in the statement.

Section 11. Advice of Counsel. The Trustee may from time to time consult with counsel, who may be counsel to the Grantor, with respect to any question arising as to the construction of this

Agreement of any action to be taken hereunder. The Trustee shall be fully protected, to the extent permitted by law, in acting upon the advice of counsel.

Section 12. Trustee Compensation. The Trustee shall be entitled to reasonable compensation for its services as agreed upon in writing from time to time with the Grantor.

Section 13. Successor Trustee. The Trustee may resign or the Grantor may replace the Trustee, but such resignation or replacement shall not be effective until the Grantor has appointed a successor trustee and this successor accepts the appointment. The successor trustee shall have the same powers and duties as those conferred upon the Trustee hereunder. Upon the successor trustee's acceptance of the appointment, the Trustee shall assign, transfer, and pay over to the successor trustee the funds and properties then constituting the Fund. If for any reason the Grantor cannot or does not act in the event of the resignation of the Trustee, the Trustee may apply to a court of competent jurisdiction for the appointment of a successor trustee or for instructions. The successor trustee shall specify the date on which it assumes administration of the trust in a writing sent to the Grantor, the EPA Regional Administrator, and the present Trustee by certified mail 10 days before such change becomes effective. Any expenses incurred by the Trustee as a result of any of the acts contemplated by this Section shall be paid as provided in Section 9.

Section 14. Instructions to the Trustee. All orders, requests, and instructions by the Grantor to the Trustee shall be in writing, signed by such persons as are designated in the attached Exhibit A or such other designees as the Grantor may designate by amendment to Exhibit A. The Trustee shall be fully protected in acting without inquiry in accordance with the Grantor's orders, requests, and instructions. All orders, requests, and instructions by the EPA Regional Administrator to the Trustee shall be in writing, signed by the EPA Regional Administrators of the Regions in which the facilities are located, or their designees, and the Trustee shall act and shall be fully protected in acting in accordance with such orders, requests, and instructions. The Trustee shall have the right to assume, in the absence of written notice to the contrary, that no event constituting a change or a termination of the authority of any person to act on behalf of the Grantor or EPA hereunder has occurred. The Trustee shall have no duty to act in the absence of such orders, requests, and instructions from the Grantor and/or EPA, except as provided for herein.

Section 15. Notice of Nonpayment. The Trustee shall notify the Grantor and the appropriate EPA Regional Administrator, by certified mail within 10 days following the expiration of the 30-day period after the anniversary of the establishment of the Trust, if no payment is received from the Grantor during that period. After the pay-in period is completed, the Trustee shall not be required to send a notice of nonpayment.

Section 16. Amendment of Agreement. This Agreement may be amended by an instrument in writing executed by the Grantor, the Trustee, and the appropriate EPA Regional

Administrator, or by the Trustee and the appropriate EPA Regional Administrator if the Grantor ceases to exist.

Section 17. Irrevocability and Termination. Subject to the right of the parties to amend this Agreement as provided in Section 16, this Trust shall be irrevocable and shall continue until terminated at the written agreement of the Grantor, the Trustee, and the EPA Regional Administrator, or by the Trustee and the EPA Regional Administrator if the Grantor ceases to exist. Upon termination of the Trust, all remaining trust property, less final trust administration expenses, shall be delivered to the Grantor.

Section 18. Immunity and Indemnification. The Trustee shall not incur personal liability of any nature in connection with any act or omission, made in good faith, in the administration of this Trust, or in carrying out any directions by the Grantor or the EPA Regional Administrator issued in accordance with this Agreement. The Trustee shall be indemnified and saved harmless by the Grantor or from the Trust Fund, or both, from and against any personal liability to which the Trustee may be subjected by reason of any act or conduct in its official capacity, including all expenses reasonably incurred in its defense in the event the Grantor fails to provide such defense.

Section 19. Choice of Law. This Agreement shall be administered, construed, and enforced according to the laws of the State of Pennsylvania.

Section 20. Interpretation. As used in this Agreement, words in the singular include the plural and words in the plural include the singular. The descriptive headings for each Section of this Agreement shall not affect the interpretation or the legal efficacy of this Agreement.

IN WITNESS WHEREOF the parties have caused this Agreement to be executed by their respective representatives duly authorized and their seals to be hereunto affixed and attested as of the date first above written.

GRANTOR

Sandstone Development LLC

By: James Barnes
[Print name]

Its: Managing Member
[Title]

Attest:

Its: Managing Member
[Title]

[SEAL]

Before me came the individual whose identity I confirmed as James Barnes, and whose true signature is set forth above; wherefor have I set my hand and seal this 9 day of March, 2021.

Notary Public

COMMONWEALTH OF PENNSYLVANIA
NOTARIAL SEAL
Mischelle G. Heffner, Notary Public
Smethport Boro, McKean County
My Commission Expires Aug. 27, 2021
MEMBER, PENNSYLVANIA ASSOCIATION OF NOTARIES

TRUSTEE

Hamlin Bank and Trust Company

By: Jeanmarie McClure
[Print name]

Its: Trust Officer
[Title]

Attest:

Its: Trust Officer
[Title]

[SEAL]

Before me came the individual whose identity I confirmed as Jeanmarie McClure, and whose true signature is set forth above; wherefor have I set my hand and seal this 9 day of March, 2021.

Notary Public

COMMONWEALTH OF PENNSYLVANIA
NOTARIAL SEAL
Mischelle G. Heffner, Notary Public
Smethport Boro, McKean County
My Commission Expires Aug. 27, 2021
MEMBER, PENNSYLVANIA ASSOCIATION OF NOTARIES

SCHEDULE A

Identification of Facilities and Cost Estimates

Schedule A is referenced in the standby trust agreement dated 3/10/21 by and between Sandstone Development LLC, the Grantor and
(Name of owner or operator)
Hamlin Bank and Trust Company, the Trustee.
(Name of trustee)

EPA identification number	PAS2R420BMCK
Name of facility	Moody Lot 5 #17
Address of facility	Lat. 41-54-34.3800 Lon -78-35-15.7000
Current plugging and abandonment cost estimate	$ 5,550.00
Date of estimate	2/2/21
EPA identification number	
Name of facility	
Address of facility	
Current plugging and abandonment cost estimate	
Date of estimate	

CERTIFICATE OF ACKNOWLEDGMENT

FOR

STANDBY TRUST FUND AGREEMENT

STATE OF Pennsylvania

COUNTY OF McKean

On this 9 day of March, 20 21, before me personally came

James Barnes to me known, who, being by me duly sworn, did depose
(Owner or Operator)

and say that he/she resides at 557 Interstate Pkwy Bradford, PA 16701,
(Address)

That he/she is Managing Member of Sandstone Development LLC,
(Title) (Corporation)

the corporation described in and which executed the above instrument; that he/she knows the seal of said corporation; that the seal affixed to such instrument in such corporate seal; that it was so affixed by order of the Board of Directors of said corporation, and that he/she signed his/her name thereto by like order.

Michelle McGhee
(Notary Public)

COMMONWEALTH OF PENNSYLVANIA
NOTARIAL SEAL
Mischelle G. Heffner, Notary Public
Smethport Boro, McKean County
My Commission Expires Aug. 27, 2021
MEMBER, PENNSYLVANIA ASSOCIATION OF NOTARIES

[Seal]

Autumn Ridge Energy, LLC
11000 Painesville-Warren Road
Painesville, OH 44077
(440) 667-3381

2/2/2021

Sandstone Development LLC.
557 Interstate Parkway
Bradford, Pa 16701

Estimated plugging rates for Moody Lot 5 #17 injection well:

Service Rig Time: 16 hours @ $165.00 per/hr = $2,640.00
194sks Class A Common Cement @ $15.00 per/sks = $2,910.00

For estimated total of: $5,550.00

Any additional questions please feel free to call.

Sincerely,

Jesse

TIME CERTIFICATE OF DEPOSIT
NOT NEGOTIABLE - NOT SUBJECT TO CHECK

132 73077

THIS CERTIFICATE EVIDENCES A DEPOSIT IN THE NAME(S) OF: Sandstone Development LLC/U/A

Certificate Number

Account Number

Date March 9, 2021

IN THE AMOUNT OF DOLLARS $ 5,550.00

TERM, MATURITY AND DESCRIPTION: This certificate has a term of 30 Months. It will (first) mature on Sept. 9, 2023.
The minimum balance is $ 1,000.00

INTEREST: Your deposit will earn interest at the rate of .80 % per year to the first maturity date. We calculate interest using the actual/365 days per year method. We will compound interest (accrue interest on interest) Semi-Annually.
We will pay interest To the Trust Dept.

UNLESS WE TELL YOU OTHERWISE IN A SEPARATE DOCUMENT, INTEREST WILL NOT ACCRUE ON THIS DEPOSIT AFTER FINAL MATURITY.

RENEWALS: [X] If checked, we will automatically renew this certificate on each succeeding maturity date. Each renewal term will be the same as the original term, beginning on the maturity date. We will not automatically renew this certificate (1) if you tell us not to do so, in writing, on or before the next maturity date, or (2) if you present this certificate to us for payment (or other disposition) on or within 10 calendar days after the maturity date if it has a term of more than 31 days, and one calendar day if it has a term of seven to 31 days.

SINGLE MATURITY: [ ] If checked, we will not automatically renew this certificate. It will mature once on the maturity date.

HAMLIN BANK AND TRUST COMPANY

BY [signature]

PERSONAL ACCOUNTS: You have requested and intend the type of account marked below:
[ ] Individual
[ ] Joint Account - With Survivorship
[ ] Joint Account - No Survivorship
[ ] Trust - Separate Agreement Dated
[ ]

[ ] Pay-On-Death or [ ] Revocable Trust Designation as defined ... (beneficiaries named below)

REVOCABLE TRUST OR PAY-ON-DEATH ACCOUNT BENEFICIARIES

NONPERSONAL ACCOUNTS: Depositor is a
[ ] Partnership [ ] Corporation
[X] LLC
Authorization dated

The NUMBER OF ENDORSEMENTS needed for withdrawal or any other purpose is:

T.I.N.: 56-2517570
SOCIAL SECURITY OR EMPLOYER'S I.D. NUMBER - A correct taxpayer identification number is required for almost every type of account. A certification of this number is also required and is contained on the first copy of this certificate.

BACKUP WITHHOLDING - A certification that you are not subject to backup withholding is necessary for almost all accounts (except for persons who are exempt altogether). This certification is contained on the first copy of this form. Failure to provide this certification when required will cause us to withhold the percentage allowed under the Internal Revenue Code or the Internal Revenue Service. Providing a false certification can result in serious federal penalties.

ENDORSEMENTS - SIGN ONLY WHEN YOU REQUEST WITHDRAWAL

X

X

X

READ OTHER SIDE FOR ADDITIONAL TERMS

ATTACHMENT J

DISCRIPTION OF BUSINESS

Description of Business

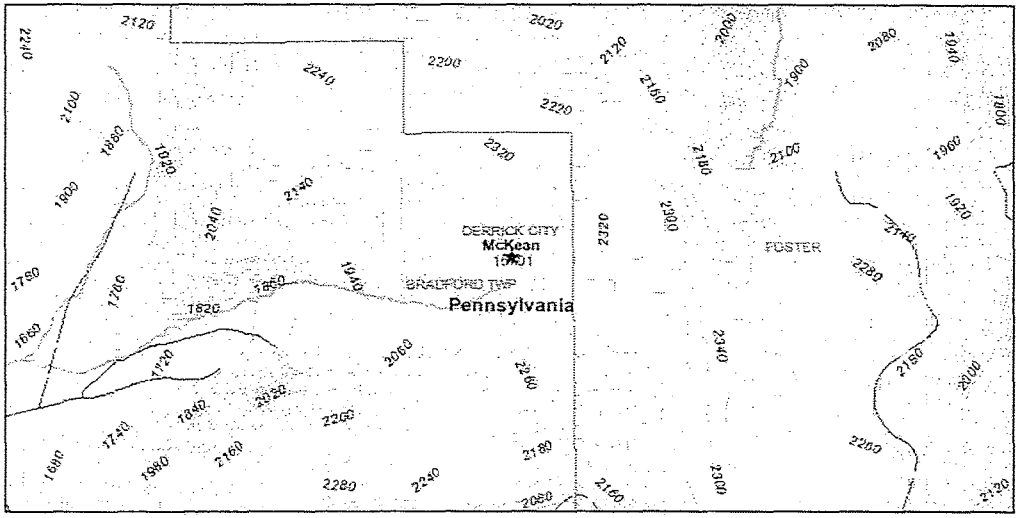
Sandstone Development is a privately held Exploration and Production Company established in 2005 and is engaged in developing oil and natural gas resource in the Application region of Northwestern Pennsylvania and Southwest New York. Sandstone Development acquired its assets from private lease holds.

ATTACHMENT K

OPTIONAL ADDITIONAL PROJECT INFORMATION

PNDI Project Environmental Review Receipt
Project Search ID: 20080617146003
Project Name: LAKE ERIE ENERGY PARTNERS MOODY LOT 5 WELL 17
Date: 6/17/2008 3:37:15 PM

Project Location



Location Accuracy

Project locations are assumed to be both precise and accurate for the purposes of environmental review. The creator/owner of the Project Review Receipt is solely responsible for the project location and thus the correctness of the Project Review Receipt content.

0 Known Impacts

Under the Following Agencies' Jurisdiction: None

Project Name: LAKE ERIE ENERGY PARTNERS MOODY LOT 5 WELL 17
On Behalf Of: Self
Project Search ID: 20080617146003
Date: 6/17/2008 3:37:10 PM
# of Potential Impacts: 0
Jurisdictional Agency:
Project Category: Mining,Oil or Gas (including roads and pipelines),New Well
Project Location
Decimal Degrees: 41.90955 N, -78.587694 W
Degrees Minutes Seconds: 41° 54' 34.38" N, 78° 35' 15.70" W
Lambert: -159988.12414250, 1060607.98142302 ft
ZIP Code: 16701
County: McKean
Township/Municipality: BRADFORD TWP
USGS 7.5 Minute Quadrangle ID: 82
Quadrangle Name: DERRICK CITY
Project Area: N/A

 APPLICANT INITIALS: _____