

Directive 080

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Well Logging

Contents

1	Introduction	2
1.1	Background.....	2
1.2	Purpose of This Directive.....	3
1.3	AER Requirements	4
1.4	What's New in This Edition	4
1.5	Rules Pertinent to Well Logging	4
2	General Requirements	4
3	Logging of the Surface Casing Interval	5
3.1	Issue	5
3.2	Regulatory Objective	5
3.3	Requirements.....	5
3.3.1	Single-Well Pad	5
3.3.2	Multiwell Pad	5
4	Logging of Vertical and Deviated Wells.....	6
4.1	Issue	6
4.2	Regulatory Objective	6
4.3	Requirements.....	6
4.3.1	Single-well Pad.....	6
4.3.2	Multiwell Pad	6
4.3.3	Acceptable Well Logs to Determine Lithology, Fluid, and Porosity.....	7
4.3.4	Coalbed Methane and Southeastern Alberta Shallow Gas Wells.....	7
4.3.5	Observation Wells	8

4.3.6	Substitution of Acceptable Well Log Types	8
5	Logging of Horizontal Wells	8
5.1	Issue	8
5.2	Regulatory Objective	9
5.3	Requirements	9
6	Waivers and Notification of Incomplete Well Logging	9
6.1	Waivers for Technical or Operational Circumstances	9
6.2	Waivers Based on Pre-existing Offset Well Log Data	10
7	Reporting and Submission of Well Logs	10
7.1	Accuracy of Information	10
7.2	Submission of Well Logs	11
7.3	File Naming Convention for LAS and Raster Well Logs	11
7.4	Submission of Raster Well Logs	12
7.4.1	Header Data	12
7.4.2	Raster Well Log Format (TIFF or PDF)	12
7.5	Submission of LAS Well Logs	13
7.5.1	Format	13
7.5.2	Mandatory Data	13

Figures

Figure 1.	Vertical or deviated single well	14
Figure 2.	Vertical or deviated multiwell pad	15
Figure 3.	Horizontal single well	16
Figure 4.	Horizontal multiwell pad	17
Figure 5.	Multiwell pad with horizontal and vertical or deviated wells	18

1 Introduction

1.1 Background

Well logging is a process in which specialty tools are run down a borehole to take recordings at various depths of physical or chemical properties of the rocks and fluids penetrated or encountered by drilling the well. Wireline logs are created by lowering these specialty tools into a hole drilled with a rotary or percussion drilling rig. Measurement-while-drilling (MWD) logs and logging-while-drilling (LWD) logs are created by taking similar measurements while the well is actively being drilled. Cased-hole logs, which are run after the well is cased, are used to assess the current

state of the reservoir; to check the mechanical integrity of the casing, tubing, or cement; and to monitor fluid flow.

The wellbore data provided from well logging are used for quantitative and qualitative analysis of the rocks and fluids traversed by the log. These data can then be used to determine the petrophysical properties and reservoir properties of those rocks and fluids.

1.2 Purpose of This Directive

This directive sets out the requirements of the Alberta Energy Regulator (AER) for well logging.

These requirements

- ensure that sufficient well log data are taken at the wellbore to
 - map and characterize the strata behind surface casing to assist all parties in the evaluation of any potential effects from oil, gas, or geothermal activities on aquifers,
 - confirm the completion/production intervals of the well,
 - map and assess the resource potential of the strata penetrated by the well, and
 - determine reservoir parameters of the completed/producing intervals to estimate resources and reserves; and
- describe the formats in which well log data must be reported and submitted to the AER.

This directive does not change

- the casing integrity logging requirements set out in [Directive 056: Energy Development Applications and Schedules](#), which details the minimum casing test requirements for re-entering an existing wellbore;
- the wellbore integrity logging requirements set out in [Directive 051: Injection and Disposal Wells – Well Classifications, Completions, Logging, and Testing Requirements](#), which details the wellbore design, wellbore integrity logging, operational monitoring, and reporting requirements of any well used for injection; or
- the cement evaluation logging requirements or plug logging requirements set out in [Directive 020: Well Abandonment](#).

Section 3 of this directive describes surface casing logging requirements for multiwell pads.

Section 4 sets out requirements for the logging of vertical and deviated wells on single- and multiwell pads, including coalbed methane (CBM), shallow gas, and observation wells.

Section 5 sets out requirements for the logging of horizontal wells on single- and multiwell pads.

Section 6 describes the circumstances under which requirement waivers may be processed.

Section 7 describes the requirements for the reporting and submission of well log data.

1.3 AER Requirements

Following AER requirements is mandatory for the responsible duty holder, as specified in legislation (e.g., licensee, operator, company, applicant, approval holder, or permit holder). The term “must” indicates a requirement, while terms such as “recommends” and “expects” indicate a recommended practice.

Each AER requirement is numbered.

Information on compliance and enforcement can be found on the AER website.

1.4 What's New in This Edition

This directive now also applies to geothermal resource development. References to the [Geothermal Resource Development Rules](#) (*GRDR*) have been added to sections 1.5, 2.1, 6, and 7.2.

1.5 Rules Pertinent to Well Logging

The [Oil and Gas Conservation Act](#), Part 5, section 10(1) and the [Geothermal Resource Development Act](#), section 26(1) provides the AER with the authority to set rules for well logging.

Sections 11.005 and 11.140 of the [Oil and Gas Conservation Rules](#) (*OGCR*) and sections 76 and 83 of the *GRDR* set out the rules pertinent to well logs.

Section 11.006 of the *OGCR* and section 77 of the *GRDR* enable the AER to require the licensee to obtain additional well logs beyond what is specified in this directive.

2 General Requirements

- 1) The licensee must submit to the AER a copy of all the well log data acquired at the well, as stipulated in the *OGCR*, section 11.005 or *GRDR*, section 76, whichever applies.

This requirement applies to all logs acquired at the well, regardless of whether or not the logs were required. This includes open-hole logs, cased-hole logs, borehole image logs, mud logs, strip logs, lithology logs, and hydrocarbon logs, as well as rate-of-penetration measurements, mud-gas detector readings, and cuttings descriptions.

See sections 7.2, 7.3, 7.4, and 7.5 of this directive for required file naming and submission formats.

- 2) To ensure data integrity, all well log data must be collected according to industry standards and the technically accepted logging rate published by the service provider.

3 Logging of the Surface Casing Interval

3.1 Issue

Nonsaline aquifers are an important natural resource. To ensure their protection, the AER has adopted a conservative and precautionary approach, which includes developing requirements for the logging of the surface casing interval.

3.2 Regulatory Objective

Appropriate well log data are available to be used in aquifer mapping and characterization.

3.3 Requirements

3.3.1 Single-Well Pad

- 3) Within the surface casing interval of a single well on a pad, a licensee must take an acceptable log to measure
 - a) gamma-ray response through casing from base of surface casing to surface and
 - b) neutron response through casing from base of surface casing to 25 m below surface.

3.3.2 Multiwell Pad

- 4) Within the surface casing interval for at least one well on each multiwell pad, a licensee must take an acceptable log to measure
 - a) gamma-ray response through casing from base of surface casing to surface and
 - b) neutron response through casing from base of surface casing to 25 m below surface.

For all other wells on the same pad, acquiring logs over the surface casing interval is not required.

Requirement 4 may be fulfilled by logging the surface casing interval from a vertical observation well (groundwater evaluation well or passive seismic well) on the same pad or surface facility lease if the following conditions are met:

- a) the vertical observation well is deeper than the surface casing interval for the producing wells on the pad, and
- b) the vertical observation well is licensed by the AER.

4 Logging of Vertical and Deviated Wells

4.1 Issue

To ensure orderly development, the AER needs to be able to confirm the completion intervals of producing formations, verify mineral rights ownership, and correctly correlate producing subsurface intervals. The AER must also be able to assess the resource potential and estimate resources and reserves for the province.

4.2 Regulatory Objective

Appropriate well log data are available for zone identification, correlation, and determination of reservoir and petrophysical parameters.

4.3 Requirements

4.3.1 Single-well Pad

- 5) For each vertical or deviated well on a single-well pad, the licensee must take an acceptable log, in accordance with section 4.3.3, to determine the lithology, fluid, and porosity of the strata from the total depth of the well to the base of surface casing and record all pertinent data (see figure 1).

4.3.2 Multiwell Pad

- 6) For at least one well on a multiwell pad, the licensee must take an acceptable log to determine the lithology, fluid, and porosity of the strata from the total depth of the well to the base of surface casing and record all pertinent data (see figure 2).
- 7) Log coverage specified in requirement 6 must be obtained over the full stratigraphic section penetrated by the wells on the pad (from the deepest formation to base of surface casing).
- 8) If an additional well is drilled from a previously existing pad and penetrates a deeper zone not previously logged, additional well logs must be taken of this zone to determine the lithology, fluid, and porosity of the strata.
- 9) For all remaining wells on the same pad, the licensee must, at a minimum, take an acceptable well log to measure the gamma ray of the strata from the total depth of the well to base of surface casing. The gamma-ray logs may be MWD, LWD, open hole, cased hole, or a combination thereof to determine the lithology of the strata from the total depth of the well to the base of surface casing; all pertinent data must be recorded.

The AER recommends that the licensee not leave the open-hole measurement of the lithology, fluid, and porosity to the last well on the pad due to the possibility of encountering unforeseeable technical or operational problems that could prevent acquiring these logs on the last well.

4.3.3 Acceptable Well Logs to Determine Lithology, Fluid, and Porosity

The AER considers the following to be acceptable well log types to determine the **lithology**¹ of the strata:

- gamma ray
- photoelectric
- elemental spectroscopy
- spontaneous potential

The AER considers the following to be acceptable well log types to determine the **fluid** of the strata:

- resistivity
- induction
- micro-image resistivity

The AER considers the following to be acceptable well log types to determine the **porosity** of the strata:

- bulk density
- density porosity
- neutron porosity
- sonic
- nuclear magnetic resonance

4.3.4 Coalbed Methane and Southeastern Alberta Shallow Gas Wells

For all CBM and southeastern Alberta shallow gas wells²

- within Development Entity No. 1³ under amended Order No. DE 2006-1 or
 - set out in Southeastern Alberta Commingling Order No. MU 7490⁴ and any succeeding orders,
- a combination of cased-hole gamma-ray, neutron-porosity, and sonic logs is acceptable for determining the lithology, fluid, and porosity of the strata.

¹ Lithology refers to the rock composition, texture, and zone.

² For this directive, “shallow gas well” refers to a gas well completed above the base of the Colorado Group.

³ Development Entity No. 1 applies to the strata between the top of the Edmonton Group and the base of the Belly River Group in the area outlined in appendix A of Development Entity Order No. DE 2006-1A, which is available on the AER website.

⁴ Commingling Order No. MU 7490, available on the AER website, applies to the strata between the top of the Edmonton Group and the base of the Colorado Group in the area of Alberta south of Township 31 and east of the 5th Meridian.

All other CBM and gas wells are subject to the same requirements as detailed in sections 4.3.1 and 4.3.2 of this directive.

4.3.5 Observation Wells

10) The licensee must take a well log to measure the gamma ray of the strata for each licensed observation well, including groundwater evaluation wells and passive seismic wells.

For shallow aquifer identification and characterization, the AER recommends that the licensee take additional downhole measurements to collect more detailed information on the lithology, fluid, permeability, and porosity of the strata of the surface casing interval, particularly in zones with aquifers that are local sources of drinking water, contribute to surface water, or could be affected by lease activities.

All unlicensed observation wells should also be logged.

4.3.6 Substitution of Acceptable Well Log Types

Acquiring alternative logs to those set out in section 4.3.3 to determine lithology, fluid, or porosity may be requested by application to the AER before planned well-logging operations for licensed wells. All requests for substitution of acceptable well log types are to be submitted by email to LoggingWaivers@aer.ca with the subject line “Request for Substitution of Acceptable Well Log Types.”

Applications for the substitution of acceptable well log types must be submitted 30 days before the planned start of the logging program or as soon as a well licence is obtained, whichever occurs later.

The well licence number and unique well identifier (UWI) must be provided at the time of the application for substitution of acceptable well log types.

An application for the substitution of acceptable well log types may be approved if the application demonstrates that the requested alternative well-logging program can provide sufficient data to determine the lithology, fluid, and porosity of the strata.

5 Logging of Horizontal Wells

5.1 Issue

As part of ensuring orderly development, the AER needs to be able to confirm the completion intervals of producing formations, verify mineral rights ownership, and correctly correlate producing subsurface intervals. The AER also needs to be able to assess the resource potential and estimate resources and reserves for the province.

5.2 Regulatory Objective

Appropriate well log data are available for zone identification, correlation, and determination of reservoir and petrophysical parameters.

5.3 Requirements

11) For each horizontal well drilled from a single- or multiwell pad, regardless of the Lahee classification, the licensee must, at a minimum, take an acceptable well log to measure the gamma ray of the strata from the total depth of the well to the base of surface casing.

The gamma-ray measurements may be MWD, LWD, open hole, cased hole, or a combination thereof (see figures 3 and 4).

12) For multiwell pads in which one or more vertical or deviated wells and one or more horizontal wells are drilled, the vertical or deviated wells on the pad are subject to the requirements in section 4.3. All horizontal wells on the pad are subject to requirement 11 (see figure 5).

6 Waivers and Notification of Incomplete Well Logging

As outlined in the *OGCR*, section 11.140(3) and the *GRDR*, section 83(3), a licensee may apply for a substitution or relief from these well-logging requirements where special circumstances warrant.

6.1 Waivers for Technical or Operational Circumstances

13) The licensee must submit a notification of incomplete well logging through the designated information submission system if the planned well-logging program was not completed and either of the following conditions exist:

- a) A nonroutine abandonment has been approved for part of or the entire interval of strata that was not successfully logged.
- b) Logging tools were lost in the hole and could not be recovered.

The notification must be submitted to the AER within 24 hours of the nonroutine abandonment or loss of tools downhole.

The well licence number and a detailed explanation of why the planned well-logging program was not completed must be provided at the time of notification.

Upon receipt of the notification of incomplete well logging, the AER will grant a logging waiver. The licensee must keep all documentation to support the notification and, in the event of an AER audit, provide the AER with this documentation within 14 days of request.

- 14) If neither condition in requirement 13 is met, the licensee must submit a logging waiver request through the designated information submission system [DDS system](#) for approval. The request must include
- a) the well licence number,
 - b) the UWI, and
 - c) a detailed explanation for the request.

6.2 Waivers Based on Pre-existing Offset Well Log Data

- 15) To request a waiver based on the availability of pre-existing offset well log data that meet the criteria in section 4.3, the licensee must submit a logging waiver request through the designated information submission system for approval. The request must include
- a) the well licence number,
 - b) the UWI,
 - c) details about which well logs, if any, will be taken over which intervals for the subject well in place of the well logs required by this directive,
 - d) a discussion of the geological setting, distribution, heterogeneity, and continuity of the strata over the interval for which the logging waiver is requested, including a labelled cross-section of the subject location,
 - e) a labelled map that indicates which offset wells meet the criteria in section 4.3 and their distance to the subject well, and
 - f) a discussion of the suitability, quality, and age of the offset well logs with respect to the criteria in section 4.3.

To ensure a timely review, well-logging waiver requests should be submitted to the AER as soon as possible.

7 Reporting and Submission of Well Logs

7.1 Accuracy of Information

To support quality data processing and dissemination, the AER takes steps to validate the accuracy of the header data of all submitted well logs.

The licensee, however, is solely responsible for submitting complete and accurate information regarding the well licence number and UWI on the well log header or in the well information section. The AER is not responsible for inaccurate, incomplete, or incorrect information included in or submitted with the well log. The AER may make all or any portion of the information included

in the well log publicly available on the expiration of the statutory confidentiality status of the UWI that appears on the well log or summary report.

7.2 Submission of Well Logs

- 16) As stipulated in the *OGCR*, section 11.140(1) (b) and (c) and the *GRDR*, section 83(b) and (c), within one month of the rig release of the well, the licensee must submit to the AER a copy of all well logs acquired at the well. Any additional well logs taken after rig release must be submitted within one month of the run date.
- 17) The licensee must submit all Log ASCII Standard (LAS) and raster (TIFF or PDF) logs to the AER through the [designated information submission system](#).

7.3 File Naming Convention for LAS and Raster Well Logs

18) All submitted well logs must follow the file naming convention below:

- Information blocks are separated by an underscore “_”.
- WL is used for the data type.
- The file name is unique. Use the other information block to ensure that the file name is unique.

Example: TIFF file name

Data type	Licence #	UWI	Other information	File extension
WL	0123456	00-13-20-045-12W4-02	Mud Log	.tif

Example: LAS file name

Data type	Licence #	UWI	Other information	File extension
WL	0123456	00-13-20-045-12W4-02	Main Pass	.las

Example: PDF file name

Data type	Licence #	UWI	Other information	File extension
WL	0123456	00-13-20-045-12W4-02	Strip Log	.pdf

- 19) If the well log is a replacement log submitted in response to a letter of noncompliance from the AER, immediately after the UWI in the file name, the submitter must provide the AER reference number cited in the letter.

Example: Replacement file name

Data type	–	Licence #	–	UWI	–	Other information	File extension (.las, .tif, or .pdf)
WL	–	0123456	–	00-13-20-045-12W4-02	–	R123	.tif

- 20) If the well log is a revision to a log submitted previously, include “revised” in the other information block.

Example: Revised well log file name

Data type	–	Licence #	–	UWI	–	Other information	File extension (.las, .tif, or .pdf)
WL	–	0123456	–	00-13-20-045-12W4-02	–	revised	.tif

7.4 Submission of Raster Well Logs

7.4.1 Header Data

- 21) The well log header on the raster well log must contain the following:

- a) log name or logging tool description,
- b) complete UWI, including the applicable location exception code and drilling event sequence,
- c) valid licence number matching the UWI,
- d) log run date,
- e) logged intervals (bottom and top) that match the drill leg, and
- f) ground elevation or kelly bushing elevation.

7.4.2 Raster Well Log Format (TIFF or PDF)

- 22) The submitted black-and-white (B&W) or colour raster well log must meet the following format requirements for both TIFF and PDF, unless otherwise specified:

- a) Canadian Well Logging Society (CWLS) B&W TIFF standard dated September 28, 2004, and issued in *InSite CWLS Newsletter*, December 2004,
- b) CCITT Group 4 TIFF containing all tags required for a baseline TIFF,
- c) CCITT T6 Group 4 or LZW7 compression (TIFF only),

- d) lossless compression (PDF),
- e) opens in standard viewers such as Windows Picture and Fax Viewer (TIFF) or the current version of Adobe Acrobat (PDF),
- f) minimum resolution of 200 dpi,
- g) if colour, 256 colour palette,
- h) contained in one single file,
- i) continuous pagination, and
- j) no tiling.

7.5 Submission of LAS Well Logs

7.5.1 Format

23) The submitted LAS well log must

- a) be in CWLS LAS 2.0 or newer format with the depth curve being the first curve listed in the ~C section and the depth data being the first column in the ~A section,
- b) include in the depth mnemonic the API code of 001 for measured depth or 960 for true vertical depth,
- c) be tested to ensure that it passes CWLS certify, and
- d) have a .las file extension (file extension .exe is not acceptable).

7.5.2 Mandatory Data

24) The LAS well log must have the following information correctly encoded in the ~Well Information Section of the LAS file:

- a) complete UWI, including the applicable location exception and drilling event sequence (the UWI must exist in the AER's systems),
- b) valid licence number that must exist in the AER's systems and must match the UWI,
- c) log run date, and
- d) ground elevation and/or kelly bushing elevation.

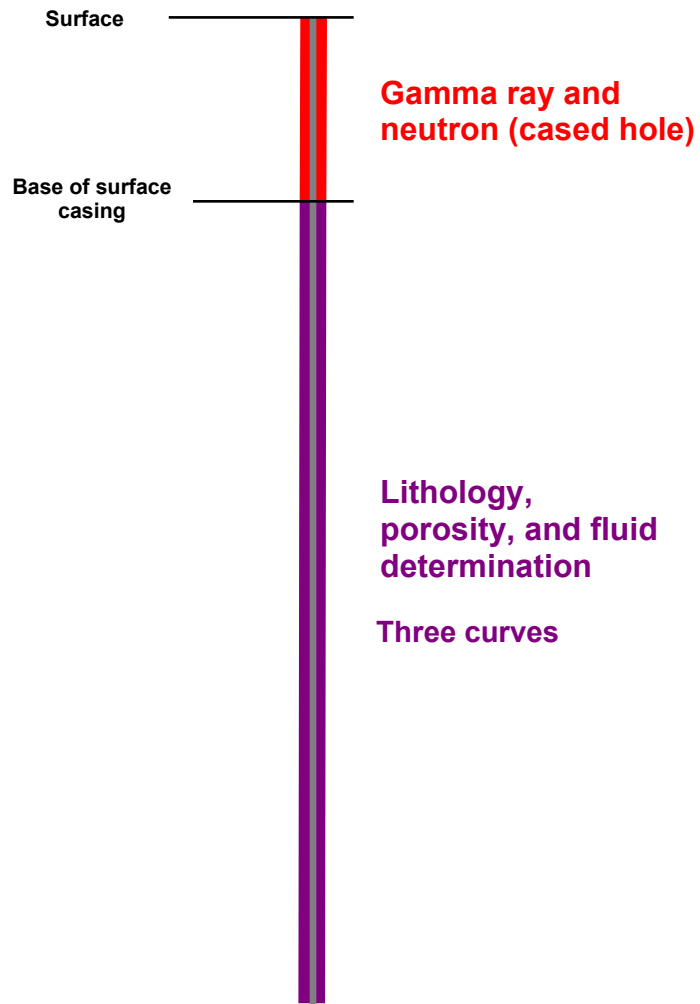


Figure 1. Vertical or deviated single well

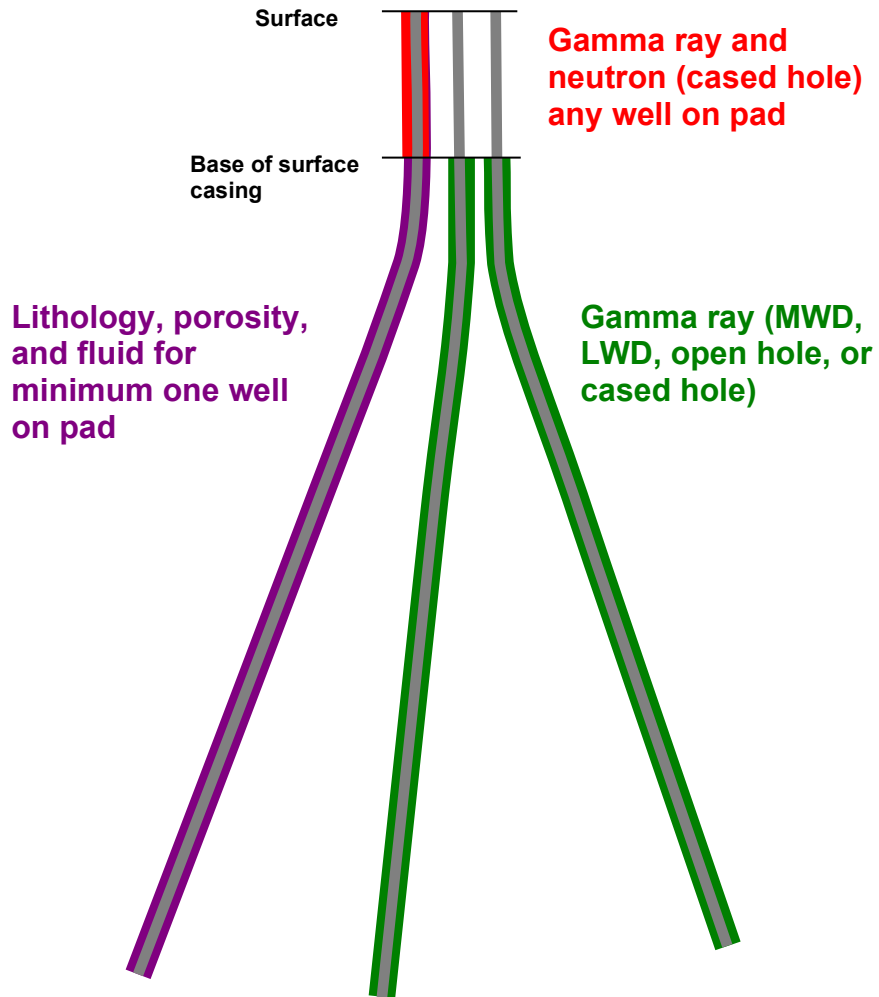


Figure 2. Vertical or deviated multiwell pad

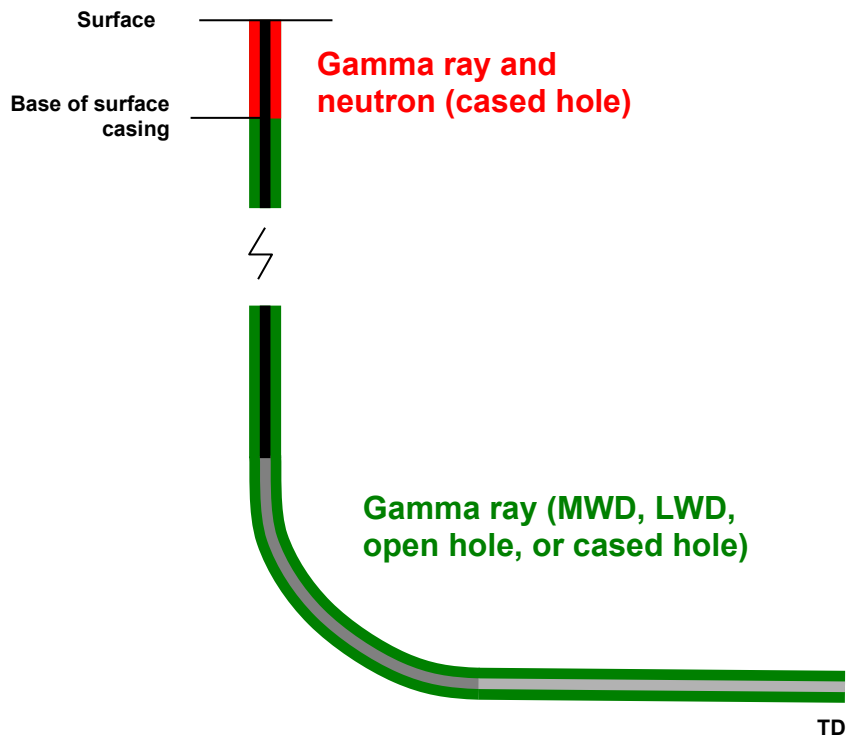


Figure 3. Horizontal single well

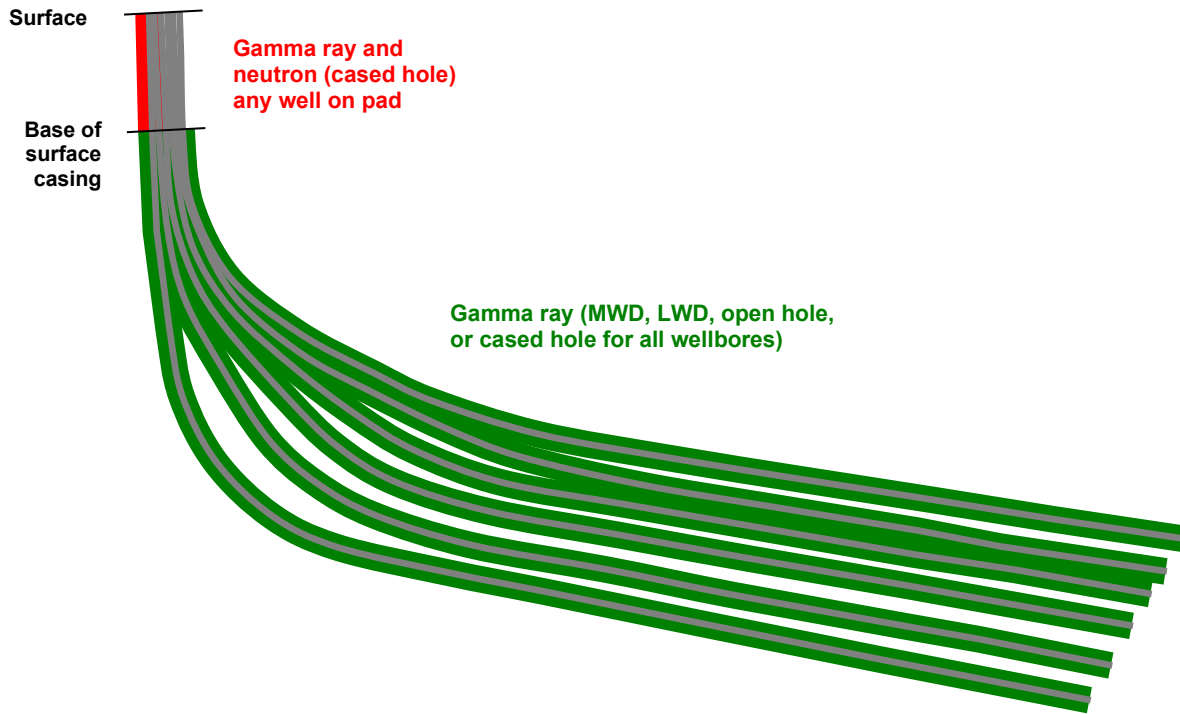


Figure 4. Horizontal multiwell pad

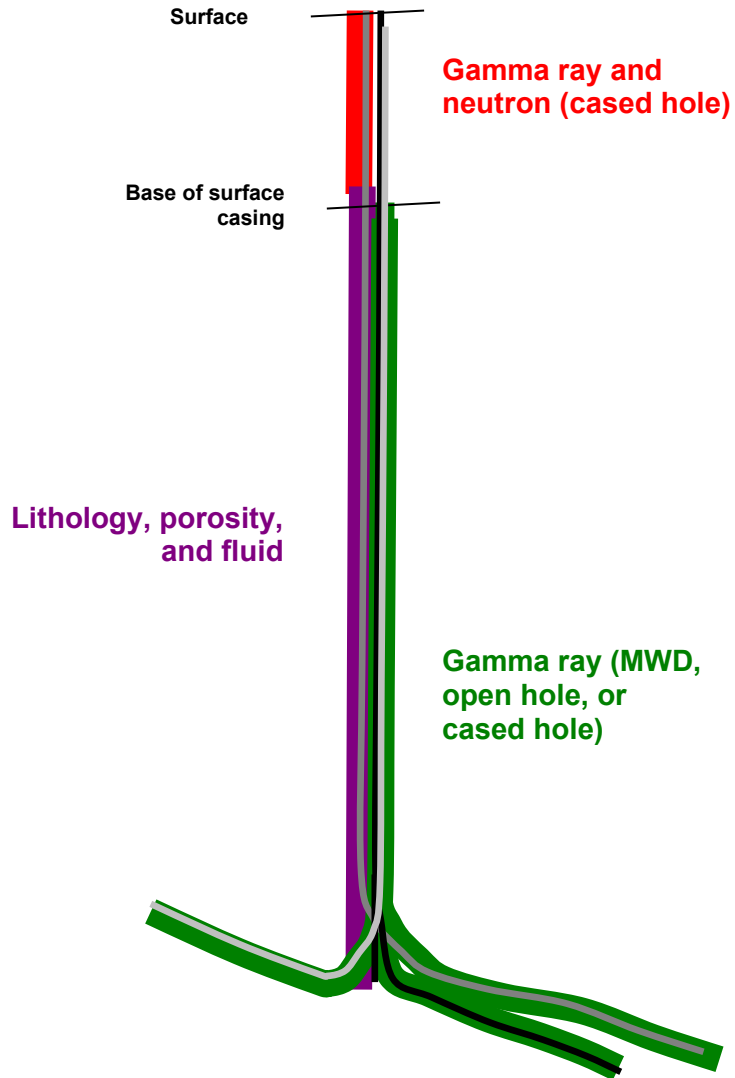


Figure 5. Multiwell pad with horizontal and vertical or deviated wells