Prepared in cooperation with the U.S. Environmental Protection Agency

Geophysical Logs of Selected Test Wells at the Diaz Chemical Superfund Site in Holley, New York

Open-File Report 2007-1081

U.S. Department of the Interior
U.S. Geological Survey

Cover photo. The Diaz Chemical Superfund Site in Holley, New York

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By David A.V. Eckhardt and J. Alton Anderson

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U.S. Geological Survey, Reston, Virginia 2007

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Conversion Factors and Datum

Multiply	By	To obtain
	Length	
inch (in.)	2.54	centimeter (cm)
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
acre (ac)	4,047	square meter (m^2)
acre (ac)	0.4047	hectare (ha)
	Volume	
gallon (gal)	3.785	liter (L)
	Flow rate	
gallon per minute (gal/min)	0.06309	liter per second (L/s)
	Transmissivity*	
foot squared per day (ft^2/d)	0.09290	meter squared per day (m^2/d)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

°F=(1.8×°C)+32

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88).
Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).
Altitude, as used in this report, refers to distance above the vertical datum.
*Transmissivity: The standard unit for transmissivity is cubic foot per day per square foot times foot of aquifer thickness [(ft^3/d)/ft^2]ft. In this report, the mathematically reduced form, foot squared per day (ft^2/d), is used for convenience.
Fluid conductivity (specific conductance) is given in microSiemens per centimeter at 25 degrees Celsius (μS/cm at 25 °C).

Geophysical Logs of Selected Test Wells at the Diaz Chemical Superfund Site in Holley, New York

By David A.V. Eckhardt and J. Alton Anderson

Abstract

In June and July 2006, geophysical logs were collected and analyzed along with rock-core samples to define the bedrock stratigraphy and flow zones penetrated by four test wells at the Diaz Chemical Superfund site at Holley in eastern Orleans County, New York. The work was completed as a preliminary part of the investigation of contamination by organic compounds in the shale, mudstone, and sandstone bedrock. The geophysical logs included natural-gamma, caliper, borehole image, fluid properties, and flowmeter data. The orientation of fractures in the boreholes was inferred from the log data and summarized in stereo and tadpole plots; the transmissivity and hydraulic head was also determined for fracture zones that were observed to be hydraulically active through the flowmeter logs. The data are intended in part for use in the remediation of the site.

Introduction

Volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs) have been detected in ground water sampled at the Diaz Chemical Superfund site in the Village of Holley in Orleans County, N.Y. (fig. 1). The area was declared a Superfund site by the U.S. Environmental Protection Agency (USEPA) and listed on the National Priorities List (*http://www.epa.gov/superfund/sites/npl/npl.htm*) in 2004.

In June and July 2006, the U.S. Geological Survey (USGS) and the USEPA collected advanced borehole-geophysical logs from four test wells as a preliminary part of the investigation of VOC and SVOC contamination in the bedrock aquifer that underlies the site. The USGS analyzed the geophysical logs along with core samples and outcrops of the bedrock to define the rock fractures and flow zones penetrated by the wells. This report describes the geophysical methods and presents the borehole logs collected during the study. The logs are available upon request in .wcl (WellCAD, version 4.1) format, which allows the logs to be viewed in a tabular form or displayed and printed at user-specified vertical scales.

Study Area

The Diaz Chemical Superfund site occupies about 6 acres in the Village of Holley in eastern Orleans County, New York (fig. 1). The area is within the Lake Ontario Plain physiographic region and lies between the cities of Rochester to the east and Buffalo to the west. The site and its history are described by Lockheed Martin Technology Services (2005), New York State (2002), and Haley & Aldrich of New York, Inc. (2000).

The local topography consists of relatively flat terrain that is transected by a 40-ft deep ravine to the east of the site. The site is underlain by unconsolidated lacustrine silt and clay with some interbedded sand. The unconsolidated deposits range in thickness from 10 to 35 ft and overlie the

Queenston shale of upper Ordovician age. The Queenston shale consists of shales and subordinate fine-grained sandstones devoid of fossils (Brett and others, 1994; Goodman, 2005). At the site, the Queenston shale consists of mudstone with some thin-bedded sandstone. The shallow bedrock near its contact with the unconsolidated deposits is weathered into red clay. The deeper non-weathered rock is dense and has a low permeability. The mudstone and sandstone layers are relatively flat lying, and the main hydraulic permeability is likely along nearly-horizontal bedding planes; some sets of moderate- to high-angle fractures may also be hydraulically active. The site is directly adjacent to the Clarendon-Linden fault system, which is a series of north-striking, east-dipping normal faults in western New York (Fakundiny and Myers, 1978; Cannon and Noll, 2004).

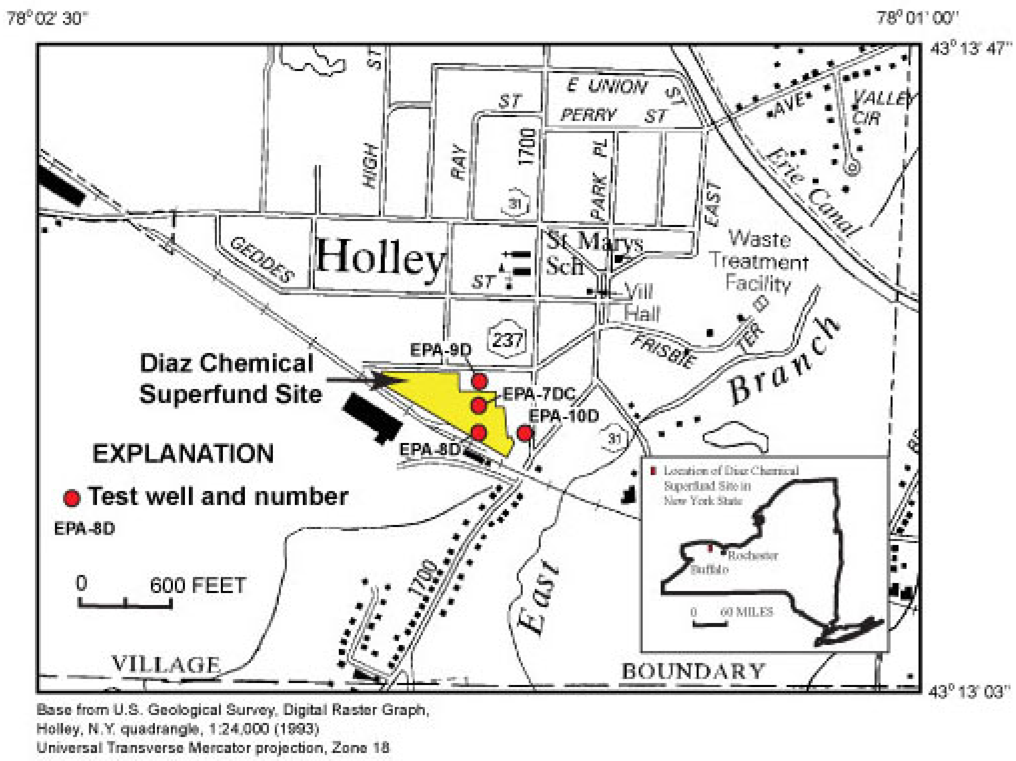

Figure 1. Map showing location of study area and wells that were logged at the Diaz Chemical Superfund Site, Holley, N.Y.

Description of Wells

Geophysical logs were collected from four test wells (locations shown in fig. 1). Construction and water-level information at the time of logging and the types of geophysical logs collected from the wells are given in table 1. Each well was constructed by the USEPA as a four-inch diameter test well with an open borehole below steel casing that terminated in bedrock. After completion of logging, each test well was converted to a two-inch monitor well with a grouted PVC casing and a screened, sand-packed interval.

Table 1. Well information and types of geophysical logs collected from test wells at the Diaz Chemical Superfund Site, Holley, New York

					Type of Log								
Well number	**Lat / Lon**	**Casing depth (ft)**	**Depth to bedrock (ft)**	**Well depth (ft)**	**Natural gamma**	**Mech cal**	**Acou cal**	**ATV**	**HPFM -amb**	**HPFM -pmp**	**HPFM -rec**	**Cond**	**Temp**
EPA-7DC	43 13 21.5 / 078 01 40.4	40	33	80	X	X	X	X	X		X	X	X
EPA-8D	43 13 19.8 / 078 01 39.7	30	24	80	X	X	X	X	X		X	X	X
EPA-9D	43 13 24.0 / 078 01 40.0	26	21	76	X	X						X	X
EPA-10D	43 13 20.1 / 078 01 35.9	19.5	12	79.5	X	X	X	X	X	X		X	X

<u>Explanation</u>

Lat / Lon, Latitude and longitude coordinates in degrees-minutes-seconds, North American Datum of 1983
Natural gamma, natural-gamma radiation in counts per second (cps)
Mech cal, mechanical three-arm caliper diameter in inches (in)
Acou cal, acoustic caliper borehole diameter in inches (in)
ATV, acoustic televiewer
HPFM, heat-pulse flowmeter in gallons per min (gal/min) [-amb, ambient conditions; -pmp, pumped conditions; -rec, recovery conditions]
Cond, fluid conductivity in microsiemens per centimeter (µS/cm)
Temp, fluid temperature in degrees Celsius (deg C)
Fracture stereo and strike/dip logs show azimuth (0-360 deg.) and dip angle (0-90 deg.) of fractures observed through the ATV logs; hydraulically active fractures (blue) or inactive fractures (gray) inferred through flowmeter logs

To access ground-water information in the National Water Information System (NWIS) through http://nwis.waterdata.usgs.gov/nwis, use the following 15-digit station identifiers:

EPA-7Dc, 431321078014001
EPA-8D, 431320078014001
EPA-9D, 431324078014001
EPA-10D, 431320078013601

Unstable borehole conditions in test well EPA-9D created collapse zones that prevented collection of acoustic televiewer and flow logs. Well yields less than 0.2 gal/min at EPA-7DC and EPA-8D prevented flow logs under steady pumped conditions; therefore, flow logs were completed during water-level recovery after pumping the wells. The measured flow rates were then normalized to represent a steady drawdown level. Pumped flow logs obtained at EPA-10D were collected at a steady pumping rate of 0.4 gal/min.

Description of Logs

The geophysical logs collected from the wells are presented in the appendix and include natural-gamma, caliper, borehole-image, fluid-conductivity and temperature, and heat-pulse-flowmeter data. The caliper logs were collected by mechanical and acoustical methods. Borehole-image logs were collected with an acoustic televiewer (ATV). Borehole-deviation logs were collected with three-axis fluxgate magnetometers and vertical inclinometers that are incorporated in the ATV probe. Fluid-property logs included fluid-conductance and temperature measurements of the borehole water. Flowmeter logs were collected by heat-pulse methods. The types and sources of geophysical logs collected in each well are listed in table 1. Applications of geophysical logs in ground-water studies are described by Williams and Lane (1998) and Keys (1990). The geophysical logs used in this investigation are described briefly below.

Natural-gamma logs measure the gamma radiation of the rock units penetrated by the borehole. Major gamma emitters are uranium, thorium, and daughter products of potassium-40. Sedimentary rocks with relatively high gamma radiation when compared to other lithologic units include shales, mudstones, bentonites, and other argillaceous units, as well as phosphate-rich zones. The gamma tool has a vertical resolution of 1 to 2 ft. Gamma logs collected in open boreholes and through steel casing may be used for lithologic identification and stratigraphic correlation.

Mechanical (mech) and acoustic (acou) caliper logs record the diameter of the borehole. Changes in borehole diameter are related to drilling and construction procedures and competency of lithologic units, fractures, and solution features. Mechanical-caliper logs were collected with a spring-loaded, three-arm averaging tool; acoustic-caliper logs were calculated from acoustic travel times collected with the ATV tool. Caliper logs were used in the delineation of fractures, solution features, and lithology, and to confirm well and casing depths and diameters.

Acoustic-televiewer (ATV) logs record a 360-degree magnetically oriented acoustic image of the borehole wall (Williams and Johnson, 2000). ATV logs can be collected in clear or murky water. Features with widths greater than 0.01 ft can be identified. Acoustic-televiewer logs were used to characterize bedding and lithology, fracture aperture and orientation, solution features, and borehole-wall rugosity.

Fluid-conductivity (Cond) logs record the electrical conductance of water in the borehole. Electrical conductance is directly related to the concentration of dissolved solids in the water. Slope changes in fluid-conductivity logs may indicate zones of inflow to or outflow from the borehole. Fluid-conductivity logs were used to delineate possible changes in borehole flow.

Temperature (Temp) logs record the temperature of air and water in the borehole. Temperature gradients that are smaller than the geothermal gradient may indicate intervals of borehole flow. Temperature logs were used to delineate the water level and possible changes in borehole flow.

Heat-pulse flowmeter (HPFM) logs record the direction and rate of vertical flow in the borehole. Vertical flow occurs in wells that penetrate more than one water-producing fracture zone under differing hydraulic head (water level). Flow in the borehole is from zones of higher head to zones of lower head. The HPFM (Hess, 1982) measures the traveltime of a thermal pulse between a set of upper and lower heat sensors (thermistors). The flow meter was used with flexible rubber diverters fitted to the nominal borehole diameter and has a measurement range of 0.01 to 1.5 gal/min in a stationary mode. Flow logs and fluid-property logs were obtained (when possible) under (1) steady-ambient (amb) conditions, and (2) steady-pumping (pmp) or transient-recovery (rec) conditions to provide a contrast of flow-rate gain or loss at discrete fracture zones with the boreholes (Paillet, 2000; 2001).

Flow-Zone logs for 3 of the 4 test wells are presented in the appendix and define the distribution and relative hydraulic head of fracture-flow zones penetrated by the boreholes (flow logs were not obtained at EPA-9D). Zones of inflow to and outflow from the borehole under ambient conditions were defined by the integrated analysis of the caliper, borehole-image, flowmeter, fluid-property logs, and water levels. The water levels measured during flow logging are composite head values that reflect the transmissivity-weighted average of the hydraulic heads of the flow zones open to the borehole (Bennett and others, 1982). Zones of inflow had heads higher than the composite water level, and zones of outflow had heads lower than the composite water level.

Transmissivity (*Trans*), in square feet per day (ft^2/d), and *water level*, in feet below land surface (ft-bls), of the flow zones were estimated by analysis of flowmeter data. Measured ambient and stressed flows were matched to simulated flows by trial and error adjustment of flow-zone transmissivity and water level (Paillet, 2000; 2001). Estimated ambient water-level values were based upon the hydrologic conditions at the time of logging.

Fracture Stereo and Strike/Dip (S/D) logs present the inferred strike and dip of fractures observed through the ATV logs. The dip azimuth (0 to 360 degrees) and the dip angle (0 to 90 degrees) are shown in tadpole plots and lower-hemisphere stereo-net diagrams. The blue symbols signify fracture zones that were observed to be hydraulically active through the flowmeter logs; the gray symbols signify fracture zones with no indication of flow.

Acknowledgments

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References Cited

Bennett, G.D., Kontis, A.L., and Larson, S.P., 1982, Representation of multiaquifer-well effects in three-dimensional ground-water flow simulation: Ground Water, v. 20, no. 3, p. 334-341.

Brett, C.E., Goodman, W.M., Loduca, S.T., and Lehmann, D.F., 1994, Ordovician and Silurian strata in the Genesee Valley area -- Sequences, cycles, and facies, *in* New York State Geological Association 66nd Annual Meeting Field Trip Guidebook: Rochester, N.Y., University of Rochester, p. 381-442.

Cannon, D.L. and Noll, M.R., 2004, Geochemical evidence for dolomitization along the Clarendon-Linden fault in western New York: Geological Society of America, Annual Meeting, November, 2004, Denver, Colo.

Fakundiny, R.H. and Myers, J.T., 1978, Structural instability features in the vicinity of the Clarendon-Linden fault system western New York and Lake Ontario: Advances in analysis of geotechnical instabilities, University Of Waterloo Press, SM Study No. 13, Paper 4, p. 121-171.

Goodman, W.M., 2005, Bedrock exposures in the lower Genesee River gorge – Their context within the stratigraphic framework for the Niagara region: Rochester, N.Y., Rochester Committee for Scientific Information, Bulletin 329, 30 p.

Haley & Aldrich of New York, Inc., 2000, Report on remedial investigation, Diaz Plant, Holley, New York, Site No. 837009, February 2000: Rochester, N.Y., 230 p.

Hess, A.E., 1982, A heat-pulse flowmeter for measuring low velocities in boreholes: U.S. Geological Survey Open-File Report 82-699, 44 p.
Keys, W.S., 1990, Borehole geophysics applied to ground-water investigations: U.S. Geological Survey Techniques of Water-Resources Investigations, book 2, chap. E2, p. 150.
Lockheed Martin Technology Services, 2005, Review of remedial investigations/feasibility studies, Diaz Superfund Site, Holley, New York, March 2005: Edison, N.J., 6 p.
New York State, 2002, Record of Decision, Diaz Chemical Corporation Site, Village of Holley, Orleans County, Site No. 8-37-009, March 2002: Albany, N.Y., Department of Environmental Conservation, 60 p.
Paillet, F.L., 2000, A field technique for estimating aquifer parameters using flow log data: Ground Water, v. 38, no. 4, pp. 510-521.
Paillet, F.L., 2001, Hydraulic head applications of flow logs in the study of heterogeneous aquifers: Ground Water, v. 39, no. 5, p. 667-675.
Williams, J.H. and Johnson, C.D., 2000, Borehole-wall imaging with acoustic and optical televiewers for fractured-bedrock aquifer investigations, *in* Proceedings of the 7th Minerals and Geotechnical Logging Symposium: Golden, Colo., Minerals and Geotechnical Logging Society, p. 43-53.
Williams, J.H. and Lane, J.W., 1998, Advances in borehole geophysics for ground-water investigations: U.S. Geological Survey Fact Sheet 002-98, 4 p.

Appendix

Geophysical logs of selected test wells at the Diaz Chemical Superfund site at Holley, N.Y.

Company USGS **Site ID** 431321078014001 **Station name** OI-21

Other ID EPA-7Dc **Date of log** 6/26-6/28/06 **Start time of log**

County/State Orleans/NY **Office/logging unit** TROY

Logging operator JAA **Observer** DAVE

Description of log-measuring point(LMP) LAND SURFACE

Height of LMP above/below LSD 0.0 **Altitude of LMP** 562.4FT

Log orientation MN **Mag declination** -11.2 **Logging direction**

Logging speed **Depth error after logging**

Logging probe manufacturer Mount Sopris

Logging probe model

Logging probe serial number

Description of calibration/standardization

Date of calibration/standardization

Standard(Low) **Response(Low)**

Standard(High) **Response(High)**

Borehole depth/diameter/type 80FT/4IN/OPEN HOLE

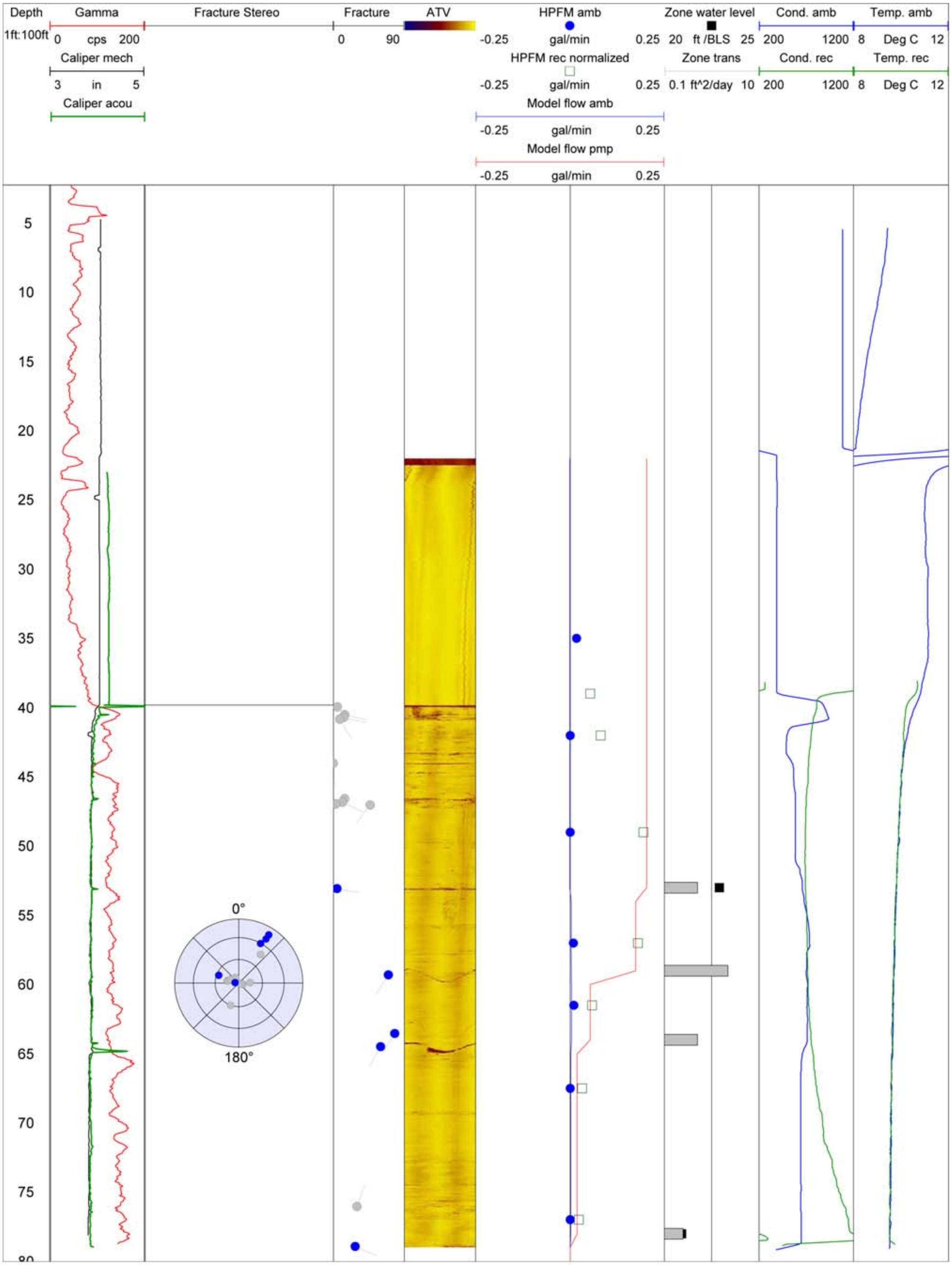
Casing depth/diameter/type 40FT/4IN/STEEL

Borehole fluid type WATER **Borehole fluid depth** 22.25 FT

Borehole fluid res/cond **Borehole fluid temp**

Hydrologic conditions AMBIENT/RECOVERY

Remarks stickup= -0.6ft, unable to reach steady state, pumped well to 32ft for recovery



Depth
1ft:100ft
Gamma
0 cps 200
Caliper mech
3 in 5
Caliper acou
Fracture Stereo
Fracture
0 90
ATV
HPFM amb
-0.25 gal/min 0.25
HPFM rec normalized
-0.25 gal/min 0.25
Model flow amb
-0.25 gal/min 0.25
Model flow pmp
-0.25 gal/min 0.25
Zone water level
20 ft /BLS 25
Zone trans
0.1 ft^2/day 10
Cond. amb
200 1200
Cond. rec
200 1200
Temp. amb
8 Deg C 12
Temp. rec
8 Deg C 12
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
0°
180°

Company USGS **Site ID** 431320078014001 **Station name** OI-22

Other ID EPA-8D **Date of log** 6/28/06 **Start time of log**

County/State Orleans/NY **Office/logging unit** TROY

Logging operator JAA **Observer** DAVE

Description of log-measuring point(LMP) LAND SURFACE

Height of LMP above/below LSD 0.0 **Altitude of LMP** 561.1

Log orientation MN **Mag declination** -11.2 **Logging direction**

Logging speed **Depth error after logging**

Logging probe manufacturer Mount Sopris

Logging probe model

Logging probe serial number

Description of calibration/standardization

Date of calibration/standardization

Standard(Low) **Response(Low)**

Standard(High) **Response(High)**

Borehole depth/diameter/type 80FT/4IN/OPEN HOLE

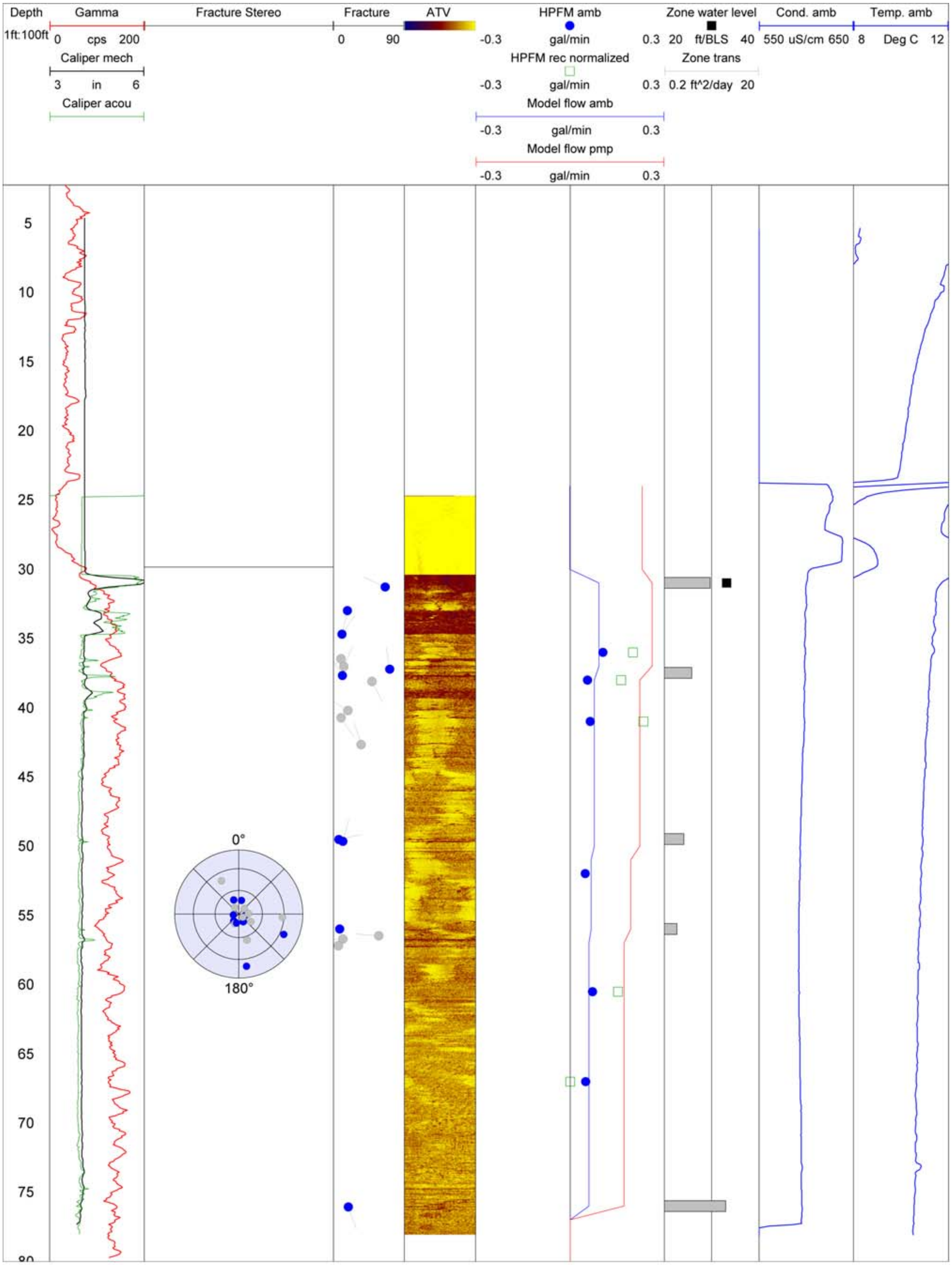
Casing depth/diameter/type 30FT/4IN/STEEL

Borehole fluid type WATER **Borehole fluid depth** 24.14FT

Borehole fluid res/cond **Borehole fluid temp**

Hydrologic conditions AMBIENT/RECOVERY

Remarks stickup= 0.0, unable to reach steady state, pumped well to 30ft for recovery



Depth
1ft:100ft
Gamma
0 cps 200
Caliper mech
3 in 6
Caliper acou
Fracture Stereo
Fracture
0 90
ATV
HPFM amb
-0.3 gal/min 0.3
HPFM rec normalized
-0.3 gal/min 0.3
Model flow amb
-0.3 gal/min 0.3
Model flow pmp
-0.3 gal/min 0.3
Zone water level
20 ft/BLS 40
Zone trans
0.2 ft^2/day 20
Cond. amb
550 uS/cm 650
Temp. amb
8 Deg C 12
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
0°
180°

Company USGS **Site ID** 431324078014001 **Station name** OI-23

Other ID EPA-9D **Date of log** 6/27/06 **Start time of log**

County/State Orleans/NY **Office/logging unit** TROY

Logging operator JAA **Observer** DAVE

Description of log-measuring point(LMP) LAND SURFACE

Height of LMP above/below LSD 0.0 **Altitude of LMP** 558.2FT

Log orientation MN **Mag declination** -11.2 **Logging direction**

Logging speed **Depth error after logging**

Logging probe manufacturer Mount Sopris

Logging probe model

Logging probe serial number

Description of calibration/standardization

Date of calibration/standardization

Standard(Low) **Response(Low)**

Standard(High) **Response(High)**

Borehole depth/diameter/type 76FT/4IN/OPEN HOLE

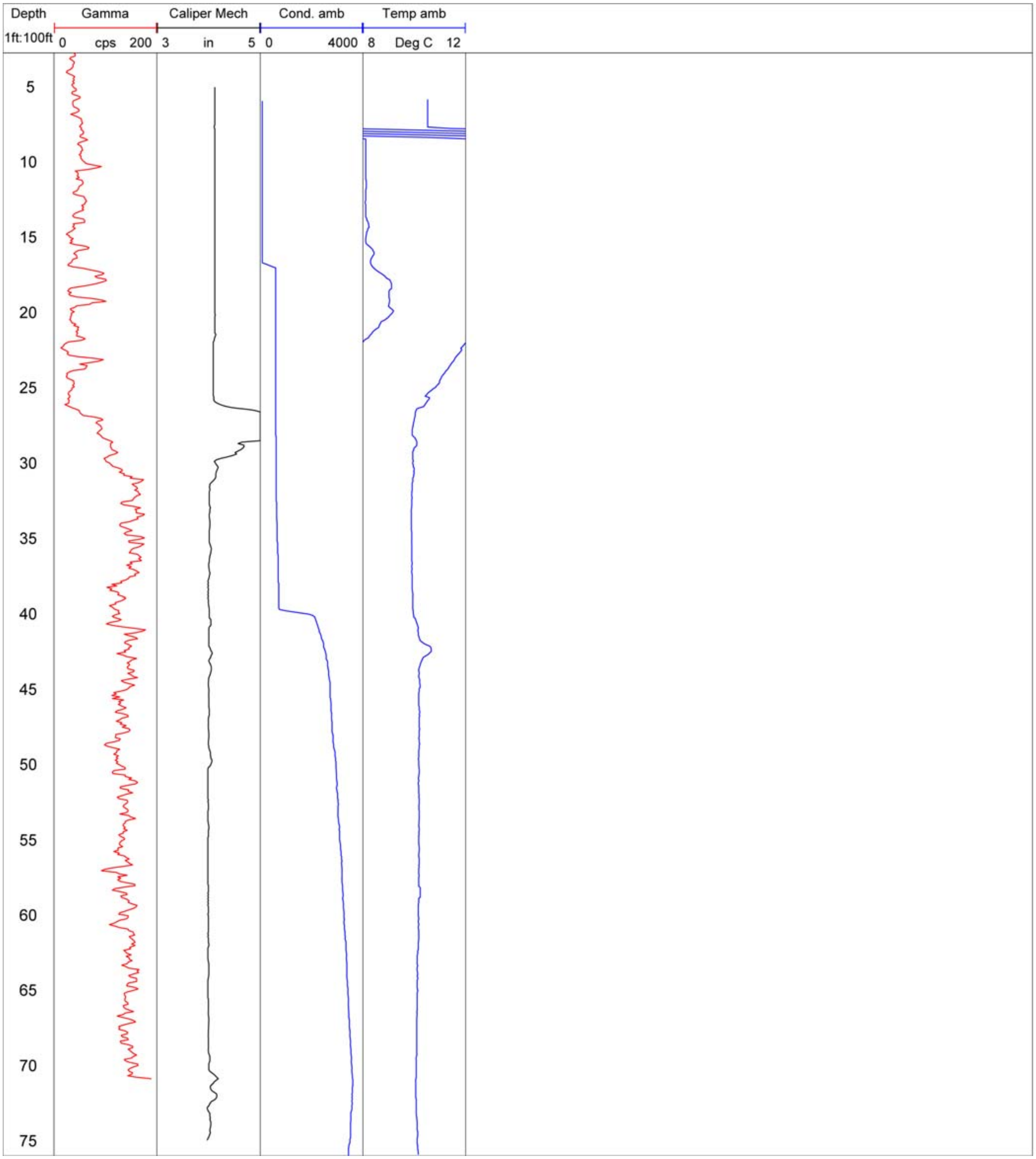
Casing depth/diameter/type 26FT/4IN/STEEL

Borehole fluid type WATER **Borehole fluid depth** 17.81 FT

Borehole fluid res/cond **Borehole fluid temp**

Hydrologic conditions AMBIENT

Remarks stickup= -0.5, blockage at 40 ft, unable to collect HPFM and ATV


Depth
Gamma
Caliper Mech
Cond. amb
Temp amb
1ft:100ft
0 cps 200
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8 Deg C 12
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Company USGS **Site ID** 431320078013601 **Station name** OI-24

Other ID EPA-10D **Date of log** 7/05/06 **Start time of log**

County/State Orleans/NY **Office/logging unit** TROY

Logging operator JAA **Observer** DAVE

Description of log-measuring point(LMP) LAND SURFACE

Height of LMP above/below LSD 0.0 **Altitude of LMP** 537.7

Log orientation MN **Mag declination** -11.2 **Logging direction**

Logging speed **Depth error after logging**

Logging probe manufacturer Mount Sopris

Logging probe model

Logging probe serial number

Description of calibration/standardization

Date of calibration/standardization

Standard(Low) **Response(Low)**

Standard(High) **Response(High)**

Borehole depth/diameter/type 79.5FT/4IN/OPEN HOLE

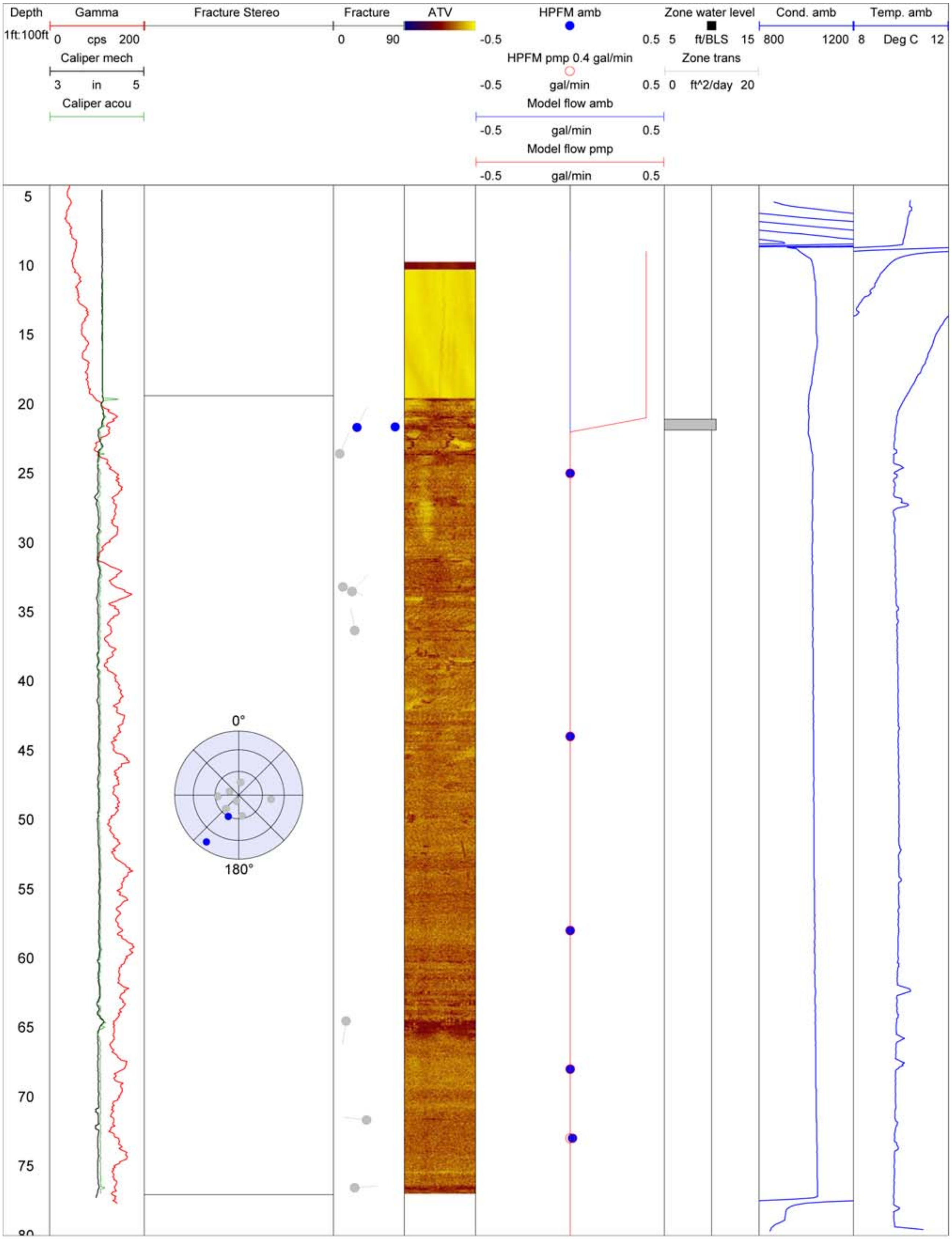
Casing depth/diameter/type 19.5FT/4IN/STEEL

Borehole fluid type WATER **Borehole fluid depth** 9.44 FT

Borehole fluid res/cond **Borehole fluid temp**

Hydrologic conditions AMBIENT / Pumping rate 0.4 gal/min

Remarks stickup= -0.6ft, pumping drawdown was 7.9 ft



Depth
1ft:100ft
Gamma
0 cps 200
Caliper mech
3 in 5
Caliper acou
Fracture Stereo
Fracture
0 90
ATV
HPFM amb
-0.5 0.5
HPFM pmp 0.4 gal/min
-0.5 gal/min 0.5
Model flow amb
-0.5 gal/min 0.5
Model flow pmp
-0.5 gal/min 0.5
Zone water level
5 ft/BLS 15
Zone trans
0 ft^2/day 20
Cond. amb
800 1200
Temp. amb
8 Deg C 12
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