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Project name:
Project 1007 East Metro Drinking Water

Project ref:
60618753

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Date:
August 19, 2020

Memo

Subject: Appendix B - Geophysical Summary Memo (Beta Sites 3, 4, 5, and 6)

AECOM has prepared this memo to summarize the geophysical logging activities that were completed in FY20. All geophysical logging services and geophysical data interpretations were provided by the Minnesota Geological Survey (MGS). Logging activities were conducted as needed between November 2019 and May 2020.

1. Background

The Beta Site Drilling Event (Drilling Event) is a corridor-wide, phased drilling investigation that involves the installation of bedrock monitoring wells (MW) in select areas referred to herein as “Beta Sites” along the Project 1007 Corridor (**Figure B-1a** and **B-1b**). The general Project 1007 Corridor area includes:

- The Tri-Lakes Area, including Lake Olson, Lake Jane, and Lake De Montreville;
- Raleigh Creek from Hadley Avenue downstream to its confluence with Project 1007 at Tablyn Park;
- Downstream of Tablyn Park to Eagle Point Lake located in Lake Elmo Park Reserve;
- Eagle Point Lake and throughout its connection to Lake Elmo;
- Lake Elmo to Horseshoe Lake;
- Downstream of Horseshoe Lake toward the West Lakeland Storage sites (north, middle, and south ponds) to the I-94 Rest Area Pond; and
- At the Project 1007 discharge point at the St. Croix River.

To-date, a total of 12 bedrock monitoring wells have been installed at eight (8) Beta Sites across the Project 1007 Corridor. This memo is limited to the wells installed at Beta Sites 3, 4, 5, and 6. Geophysical logging activities completed in May 2020-June 2020 will be included in future deliverables.

2. Beta Site Logging Activities

A total of seven (7) monitoring wells were installed at four (4) Beta Sites along the Project 1007 Corridor from November 11, 2019 through January 16, 2020. Beta Sites 3, 4, and 5 are located within the Lake Elmo Park Reserve at 1515 Keats Ave N,

Lake Elmo, MN 55042 (**Figure B-1a**). Beta Site 6 is located on the Royal Golf Club Property located at 11455 20th St N, Lake Elmo, MN 55042 (**Figure B-1b**).

A total of five (5) new monitoring wells were installed at four (4) additional Beta Sites along the Project 1007 Corridor from May 26, 2020 through June 29, 2020. Geophysical results from these additional wells will be included in subsequent reports.

3. Geophysical Instruments and Methods

All instruments used to collect geophysical data were obtained by the MGS from Century Geophysical, LLC. Data were collected in the field by a qualified geoscientist and interpreted by a licensed geologist from the MGS. At least one or more geophysical tools were used to collect data in each borehole, as appropriate. A summary of geophysical tools used in each well is provided on **Table B-1**.

The purpose of each tool is described in manufacturer specification sheets provided by MGS (**Attachment B-1**) and is briefly summarized below:

Borehole Diameter

- 9074 Three Arm Caliper - The three-arm caliper tool was used to measure the diameter of a borehole and can be used in both open and cased holes.

Lithologic Contacts

- 9014 Natural Gamma, Spontaneous Potential (SP), Resistivity Logging Tool - This tool simultaneously records natural gamma, SP, and resistivity measurements to identify the lithologic contacts between bedrock formations. The tool has a slim design that can be used in wells with as small as a 2-inch diameter with either a steel or plastic casing.
- 8144 Series Multi-Parameter E-Logging Tool - The Multi-parameter E-Log tool can collect up to ten (10) different parameters, but was primarily used to collect natural gamma, SP, and resistivity measurements. The tool collects the same data as the 9014 tool with greater efficiency and was the preferred tool.

Flow

- 9722 Electromagnetic (E-M) Flowmeter - The E-M Flowmeter tool was used to measure ambient vertical fluid movement in a borehole. This tool can measure parameters such as flow, fluid resistivity, and temperature.

In conjunction with geophysical logging, downhole video logging was conducted by MGS for Beta Sites 3, 4, and 5 to verify lithologic contacts observed in the gamma log and to note relevant borehole features such as cavities and fractures and groundwater flow direction. Video logging for Beta Site 6 was conducted by a state-approved subcontractor and reviewed by MGS to note similar borehole features.

4. Passive Seismic Sounding

AECOM also retained MGS to complete passive seismic surveys in Lake Elmo Park Reserve to better constrain the inferred location of the buried bedrock valley and better position the proposed Beta Site (number 13) near or in the deepest portion of the valley. Data were collected in the field by a licensed geologist and interpreted by a geophysicist from the MGS. The location of each survey station is shown on **Figure B-2**.

A TROMINO-brand, high-sensitivity seismometer that records background seismic noise was used to collect a passive measurement at each station. Low-frequency seismic noise is constantly present within the Earth and generates local resonances, like micro-tremors, that can be detected by the seismometer. As a result, those waves can be used to provide a robust estimate of the depth to bedrock at a station in a relatively rapid, non-intrusive manner using a seismic method called Horizontal-to-Vertical Spectral Ratio (HVSR) (Chandler and Lively 2014).

A total of 12 measurements were collected in February 2020 and an additional five (5) measurements were collected in April 2020 (**Table B-2**). A summary of the passive seismic station locations and survey dates is provided below.

Date(s) of Surveys	Number of Stations	Station Location(s)
February 11, 2020	3	Lake Elmo Park Reserve, Small Lake Elmo peninsula
February 24, 2020	9	Lake Elmo Park Reserve, Between Keats Ave N and Lake Elmo and east of Brown's Pond
April 27, 2020	5	Lake Elmo Park Reserve, east of Brown's Pond

After the data were collected in the field, seismic peaks were evaluated, and the quality of each measurement was rated by the geophysicist. Peaks rated as "good" or "excellent" provided the highest level of confidence in the depth to bedrock estimates. Some limitations in the collection of passive seismic data include surficial disturbances such as foot traffic, site maintenance vehicles, and other recreational activities occurring near the seismic stations, as well as wind conditions that exceed 10 miles per hour (mph).

5. Summary of Geophysical Data

The information included in this Borehole Geophysical Summary Memo is intended to provide a summary of geophysical logging activities that were completed by MGS after the installation of monitoring wells.

Beta Sites 3-6

Detailed video observations, raw data logs, and a summary of measurements collected from each borehole at all four Beta Sites are provided in **Attachment B-2**. A summary of notable borehole features that were observed by MGS during the collection of geophysical data from Beta Sites 3-6 is provided below.

5.1 Beta Site 3 Borehole Features

MW3A – In January of 2020, prior to the completion of MW3A, video, caliper, fluid resistivity, gamma, and spontaneous potential logging was conducted on the hole, which at the time was cased down to 84.5 ft bgs and terminated at 210 ft bgs. The fluid resistivity log indicates two changes in slope at about 85 and 90.5 ft bgs in the Shakopee Formation that may be related to flow in or out of the borehole. Particles in the video appear move downwards more quickly above and below 85 feet bgs which may indicate flow into the borehole at fractures observed at both of these depths. The fluid resistivity log also indicates a change in slope at about 186 to 195 ft bgs in the Oneota Formation; however, the video log quality is poor at this interval due to cloudiness in the borehole, so the video does not provide visual evidence of a fracture or other features that might explain the change in slope.

In May of 2020, MGS returned to MW3A and conducted video, caliper, fluid resistivity, gamma, spontaneous potential logging on the entire hole, which was open from 230 to 250 ft bgs. The video log indicates the presence of minor subvertical and bedding plane fractures at about 237 ft bgs in the Jordan Sandstone open borehole, though there were no obvious signs of flow in or out of the open borehole noted in the video logged under ambient conditions. Particles in the video appear to be slowly settling due to gravity after being dislodged/disrupted by the video logging tool. However, the fluid resistivity log shows a slight baseline shift at about 238 ft bgs, which appears to align with another very slight shift in the temperature log and is also near the thin fractures observed on the video log at 237 ft bgs. This may indicate the presence of two subtle but chemically distinct water sources in the borehole, with water possibly entering or exiting the hole at about 237-238 ft bgs, but any ambient flow was too slow to pick up on the video log.

MW3B – Minor vugs or macropores and bedding plane fractures were observed from the casing bottom at 110 ft bgs to 113 ft bgs in the Shakopee Formation open borehole. Numerous other vugs or macropores, bedding plane fractures, and minor subvertical fractures were observed between 115 ft bgs and 128 ft bgs. Borehole video, flowmeter data and fluid resistivity and temperature logs do not show any obvious signs of flow in or out of the borehole under ambient conditions.

5.2 Beta Site 4 Borehole Features

MW4A – Video log observations indicate the presence of several large cavities, horizontal fractures containing rubble/loose material between 95 ft bgs and 131 ft bgs, and iron staining along the wall of the Shakopee Formation open borehole. A large vertical fracture was observed around 145 ft bgs to 146.7 ft bgs with iron staining and may be related to the change of slope from 143.0 to 146.5 ft bgs as indicated by the fluid resistivity log. The iron staining observed in conjunction with the change in slope may indicate this fracture was or still is hydrologically active.

5.3 Beta Site 5 Borehole Features

MW5A – In December of 2019, prior to the completion of MW5A, video logging was conducted on the hole, which at the time was cased down to 70 ft bgs and terminated at 187 ft bgs. The video log indicates a very vuggy and rubbly Shakopee Formation open borehole with several bedding plane fractures. Notable bedding plane fractures which appeared to affect flow were observed at 118.5 ft bgs, and 128.9 ft bgs. In addition, a vertical fracture observed between 84.3 and 86.4 ft bgs and a cavity at about 123.9 ft bgs also appeared to affect flow within the open borehole. Within the Oneota Formation, a cavity was observed at about 151.1 ft bgs with flow moving out of the borehole into the cavity, and hydraulically significant bedding plane fractures were observed between 178 and 180 ft bgs. No geophysical tools were available at the time.

In May of 2020, MGS returned to MW5A and conducted video, caliper, fluid resistivity, gamma, spontaneous potential logging on the entire hole, which was open from 210 to 220 ft bgs. The video and caliper logs indicate a relatively smooth texture of the Jordan Sandstone in the open borehole, with the exception of larger void spaces at approximately 211 ft bgs and 211.7 ft bgs. A possible bedding plane fracture was also observed at approximately 211 ft bgs. Some portions of the borehole appear in the video to be weakly-cemented, as indicated by common disturbances of loose Jordan Sandstone material observed during video logging. There were no obvious signs of flow into or out of the open borehole in the video logs or fluid resistivity and temperature logs under ambient conditions.

MW5B – According to the video and caliper logs, vugs or macropores and substantial rubble were present in the Shakopee Formation open borehole between 110 ft bgs and 118 ft bgs. Several notable bedding plane fractures were also observed at 111.6 ft bgs, 114.0 ft bgs, 114.5 ft bgs, 115.0 ft bgs, and 117.3 ft bgs. There were no obvious signs of flow into or out of the open borehole in the video logged under ambient conditions; therefore, a flow measurement was not collected.

The fluid resistivity and temperature logs show a steady gradient/slope across the open borehole interval, indicating there are no discrete intervals where water enters or exits. With these data mind, there are no obvious signs of flow in or out of the open borehole under ambient conditions.

5.4 Beta Site 6 Borehole Features

MW6A – The fluid resistivity log shows a sharp deflection at approximately 175 ft bgs to 176 ft bgs, which may be indicative of a contact between two chemically-distinct sources of groundwater. Possible turbulent flow was observed in the video log at approximately 176 ft bgs, but this observation is inconclusive because water was injected into the borehole by the drillers to improve video quality during logging.

According to MGS, two equally-plausible scenarios of flow originating from 175 ft bgs to 176 ft bgs are possible given the fluid resistivity deflection, the video observations, and other collected data:

(1) The first scenario is very minor upflow in the Oneota of about 0.013 gal/min originating at about 175 ft bgs to 176 ft bgs and exiting near the casing bottom. It is important to also note that the fluid resistivity readings within this interval (~160-175.5 ft.) are very flat and consistent, which is often indicative of one chemically-distinct water source throughout that interval and lends support to this interpretation.

(2) The second possible scenario is very minor downflow in the Oneota of about -0.004 gal/min originating at about 175 ft bgs to 176 ft bgs and exiting at about 182 ft bgs. The fluid resistivity values along this stretch are variable and show a steady downward decrease in resistance.

Corrected station measurements also indicate very minor upflow in the Jordan of approximately 0.088 gal/min measured at about 184 ft bgs and exiting at about 182 ft bgs. Upflow at this rate may also be occurring below 184 ft bgs and to the bottom of the hole, but could not be accurately measured in this larger, more cavernous section of the borehole.

MW6B – A slight deflection in the flowmeter stations and trolling logs, as well as in the fluid resistivity and temperature logs suggest very minor downflow in the Oneota Formation of approximately -0.030 gallons per minute (gal/min) that likely originates from a fracture at 134.2 ft bgs to 134.5 ft bgs. This minor downflow appears to exit the borehole through a fracture at approximately 138.2 ft bgs, which is supported by the corrected flowmeter station measurements and video observations indicating turbulent flow and possible outflow of suspended particles.

Passive Seismic Survey Results

According to the passive seismic results, the buried bedrock valley within the Lake Elmo Park Reserve trends mostly south underneath Lake Elmo, trends slightly southwest beneath the small Lake Elmo peninsula, trends mostly south again, then trends farther southwest towards Brown's Pond before continuing south towards 10th St N.

The deepest areas of the buried bedrock valley were identified between Brown's Pond and Lake Elmo with depth to bedrock estimates ranging from 288.1 ft bgs (LE201) up to 317.8 ft bgs (LE303). A reasonably deep area was also identified within the small Lake Elmo peninsula with a depth to bedrock estimate of 285.4 ft bgs (LE-1-03), but the presence of extensive vegetation and several other limitations in site access prohibited the installation of wells.

The HVSR report generated from each survey station is provided in **Attachment B-3**.

6. References

Chandler, V.W. and Lively, R.S., 2014. *Evaluation of the Horizontal-to-Vertical Spectral Ratio (HVSR) Passive Seismic Method For Estimating the Thickness of Quaternary Deposits in Minnesota and Adjacent Parts of Wisconsin*. University of Minnesota, Open File Report 14-01.

Figures
Figure B-1a and B-1b – Beta Site Well Locations
Figure B-2 – Passive Seismic Stations

Tables
Table B-1 – Beta Site Geophysical Logging Summary
Table B-2 – Passive Seismic Stationing Summary

Attachments
Attachment B-1 – Geophysical Equipment Specifications
Attachment B-2 – Geophysical Logging Results
Attachment B-3 – Passive Seismic Results

APPENDIX B
FIGURES

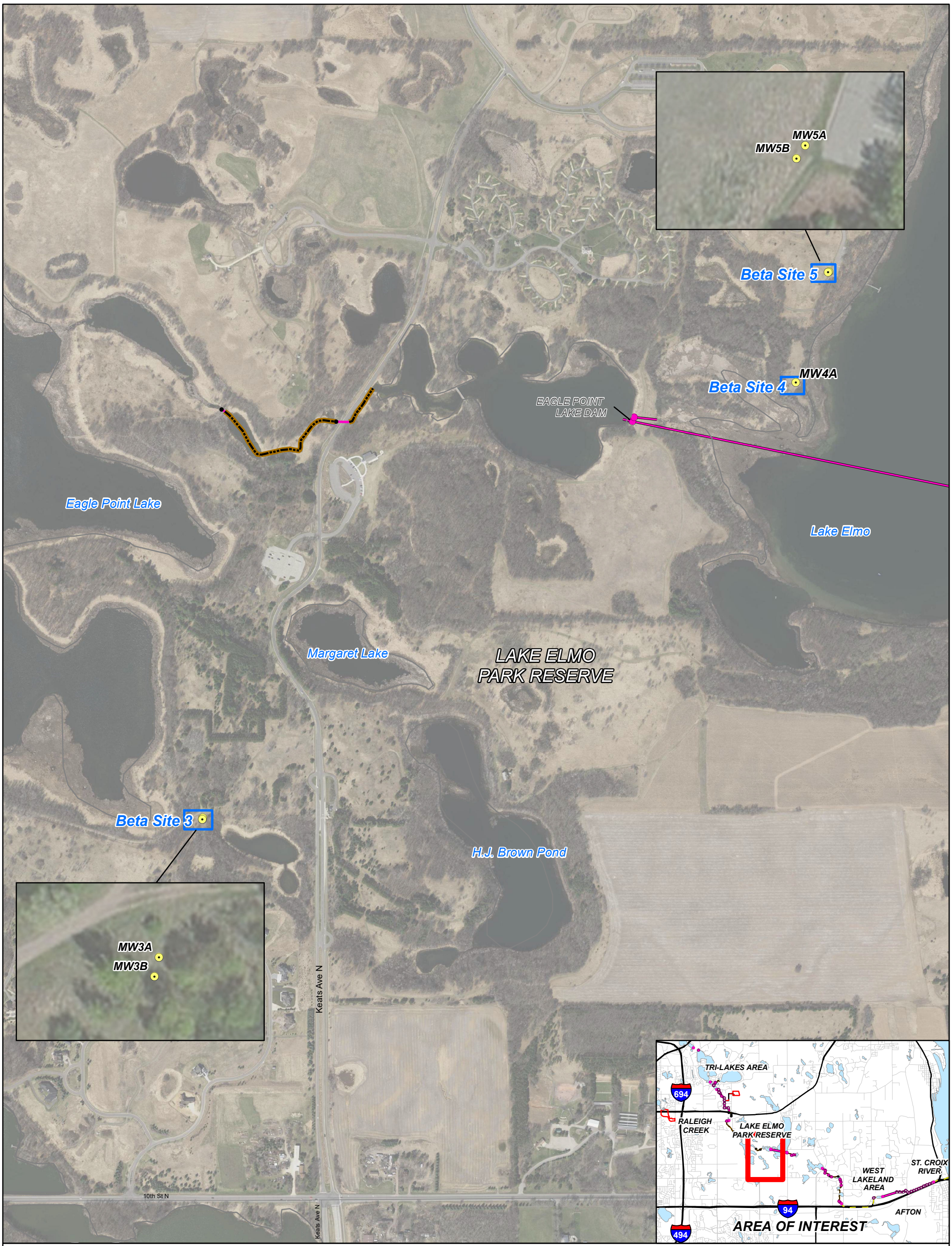

Figure B-1
Beta Sites 3, 4, and 5 Location Map, Geophysical Summary Memo
Six-Month Investigation Progress Report (November 11, 2019 - May 15, 2020)
Project 1007
Minnesota Pollution Control Agency

Project 1007 Structures

- Catch Basin
- Manhole
- Other Structure
- Channel
- Culvert
- Pipe
- Washington County Landfill connection
- MnDOT Pipeline
- Monitoring Well
- Beta Site

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N W E S

0 500 1,000 1,500 2,000 Feet

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User CommunityMnGeo 2016 Aerial Photograph 7-County; Other Sources: MDH, VBWD
AECOM Path: C:\Users\marie.santos\Desktop\Project 1007 OFFLINE\GIS temp\6-Month Investigation Progress Report\Figures\Figure 3-1a - Beta Sites 3,4,5 Location Map rev06192020.mxd Revised: 6/19/2020 By MGD

LAKE ELMO
PARK RESERVE

EAGLE POINT
LAKE DAM

LE207
LE209
LE208
LE-1-01
LE-1-02
LE-1-03
LE302
LE301
LE305
LE304
LE303
LE206
LE205
LE204
LE203
LE202
LE201

Eagle Point Lake
Lake Elmo
Margaret Lake
H.J. Brown Pond
Keats Ave N

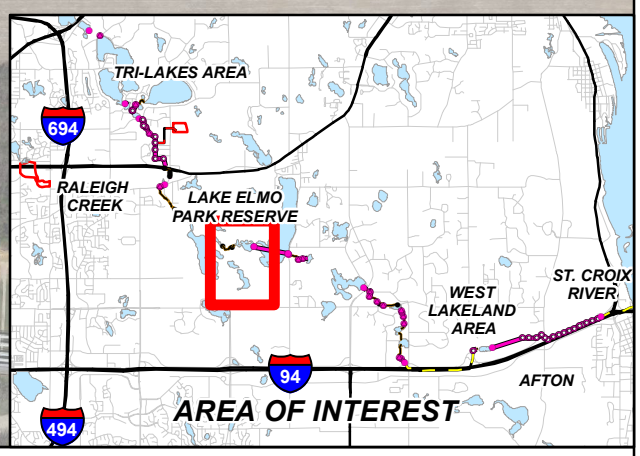

Figure B-2
Passive Seismic Stations,
Geophysical Summary Memo
Six-Month Investigation Progress Report
(November 11, 2019 - May 15, 2020)
Project 1007
Minnesota Pollution Control Agency

Project 1007 Structures

- Catch Basin
- Manhole
- Other Structure
- Channel
- Culvert
- Pipe
- Washington County Landfill connection
- MnDOT Pipeline

Passive Seismic Stations

- February 2020
- April 2020

AECOM

Service Layer Credits: MnGeo 2016 Aerial Photograph 7-County; Other Sources: MDH, VBWD
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APPENDIX B
TABLES

Table B-1
Beta Site Geophysical Logging Summary
Six-Month Investigation Progress Report (November 11, 2019 - May 15, 2020)
Project 1007
Minnesota Pollution Control Agency

Beta Site	Well Name	MWI Unique ID	Easting (1)	Northing (1)	Ground Elevation (2)	Gamma	Borehole Depth to Bottom (feet)	Gamma Log Bottom (feet)	Caliper	Multi-Parameter E-Log	Flowmeter	Video	Stratigraphy Source	Aquifer
3	MW3A	847052	507372.86	4979696.86	910.508	X	250	248.77*	X	X		MGS	Well Construction Log	Jordan
3	MW3B	847053	507372.01	4979693.32	910.379	X	130	128.43	X	X	X	MGS	Well Construction Log	Shakopee
4	MW4A	847054	508614.01	4980608.11	890.06	X	160	151.44	X	X		MGS	Well Construction Log	Oneota
5	MW5A	847056	508682.95	4980840.19	908.045	X	220	218.44	X	X		MGS	Well Construction Log	Jordan
5	MW5B	847057	508681.37	4980837.84	907.861	X	120	117.83	X	X		MGS	Well Construction Log	Shakopee
6	MW6A	847058	509410.8	4980133.29	890.464	X	210	187.42	X		X	Traut	Well Construction Log	Jordan
6	MW6B	847059	509412.93	4980132.12	890.534	X	150	138.56	X		X	NA	Well Construction Log	Oneota

Notes:
MWI = Minnesota Well Index
ft bgs = feet below ground surface
(1) Coordinates are reported in NAD 83, UTM 15N (meters)
(2) Ground elevation reported in NAV88 (feet)
* Gamma log bottom was initially measured at 203.38 feet but was later remeasured to acquire more coverage at depth
NA = not available

Table B-1
Beta Site Geophysical Logging Summary
Six-Month Investigation Progress Report (November 11, 2019 - May 15, 2020)
Project 1007
Minnesota Pollution Control Agency

Beta Site	Well Name	MWI Unique ID	Screen or Open Hole	Screen Top (ft bgs)	Screen Bottom (ft bgs)	Quat Top (ft bgs)	Quat Bottom (ft bgs)	First Bedrock (ft bgs)	First Bedrock Top (ft bgs)	First Bedrock Bottom (ft bgs)	Second Bedrock (ft bgs)	Second Bedrock Top (ft bgs)	Second Bedrock Bottom (ft bgs)	Third Bedrock (ft bgs)	Third Bedrock Top (ft bgs)	Third Bedrock Bottom (ft bgs)
3	MW3A	847052	20-foot open hole	230	250	0	74	Shakopee	74	170	Oneota	170	221	Jordan	221	250 (bottom of well, not unit)
3	MW3B	847053	20-foot open hole	110	130	0	79	Shakopee	79	130 (bottom of well, not unit)						
4	MW4A	847054	20-foot open hole	140	160	0	90	Shakopee	90	133	Oneota	133	160 (bottom of well, not unit)			
5	MW5A	847056	10-foot open hole	210	220	0	60	Shakopee	60	140	Oneota	140	203	Jordan	203	220 (bottom of well, not unit)
5	MW5B	847057	10-foot open hole	110	120	0	58	Shakopee	58	120 (bottom of well, not unit)						
6	MW6A	847058	7-foot telescoping screen	185	192	0	109.5	Shakopee	109.5	130	Oneota	130	182	Jordan	182	210 (bottom of well, not unit)
6	MW6B	847059	10-foot screen	140	150	0	132.5	Oneota	132.5	150 (bottom of well, not unit)						

Notes:
MWI = Minnesota Well Index
ft bgs = feet below ground surface
(1) Coordinates are reported in NAD 83, UTM 15N (meters)
(2) Ground elevation reported in NAV88 (feet)
* Gamma log bottom was initially measured at 203.38 feet but was later remeasured to acquire more coverage at depth
NA = not available

Table B-2
Passive Seismic Stationing Summary
Six-Month Investigation Progress Report (November 11, 2019 - May 15, 2020)
Project 1007
Minnesota Pollution Control Agency

Station ID	Date Acquired	Northing	Easting	Control Point	Surface Elevation (feet)	Depth to First Bedrock (feet)	Elevation of First Bedrock (feet)	Depth to Second Bedrock (feet)	Elevation of Second Bedrock (feet)
LE-1-01	2/11/2020	508387	4980316	-	900.00	239.65	660.35	78.42	821.58
LE-1-02	2/11/2020	508426	4980300	-	896.00	237.71	658.29	96.21	799.79
LE-1-03	2/11/2020	508467	4980256	-	886.00	285.39	600.61	130.94	755.06
LE201	2/24/2020	508018	4979727	-	898.00	288.09	609.91	210.10	687.90
LE202	2/24/2020	508566	4979718	-	934.00	139.34	794.66	293.62	640.38
LE203	2/24/2020	508455	4979732	-	938.00	154.80	783.20	280.13	657.87
LE204	2/24/2020	508353	4979717	-	940.00	181.62	758.38	280.13	659.87
LE205	2/24/2020	508245	4979728	-	946.00	162.26	783.74	275.05	670.95
LE206	2/24/2020	508149	4979742	-	945.00	263.03	681.97	109.01	835.99
LE207	2/24/2020	507703	4980467	CWI788508	912.00	74.38	837.62	249.79	662.21
LE208	2/24/2020	508108	4980394	-	904.00	78.42	825.58	317.77	586.23
LE209	2/24/2020	508324	4980478	-	901.00	79.22	821.78	317.77	583.23
LE301	4/27/2020	508235	4979830	-	914.68	314.56	600.12	207.05	707.63
LE302	4/27/2020	508242	4979880	-	910.67	314.56	596.11	243.62	667.05
LE303	4/27/2020	508199	4979798	-	907.18	317.77	589.41	263.03	644.15
LE304	4/27/2020	508111	4979783	-	907.78	263.03	644.75	170.39	737.39
LE305	4/27/2020	508029	4979812	-	902.52	180.44	722.08	296.45	606.07

Notes:
Coordinates are reported in NAD 83, UTM 15N (meters)

ATTACHMENT B-1
GEOPHYSICAL EQUIPMENT SPECIFICATIONS

CENTURY GEOPHYSICAL LLC.
PRODUCT DESCRIPTION

9074 Three Arm Caliper

Background Information
The 9074, 8074, 7074 and 6074 Three Arm Caliper logging tools, are a three-arm caliper configuration used to measure the diameter of the borehole. They can be used in both open and cased holes. Natural Gamma and the casing collar locator are optionally available. However, when configured with both the natural gamma and casing collar locator the tool is slightly longer.

Features

Properties Measured (see diagram)	Tool Specifications
1a. Natural Gamma: (optional) 2.2 x 10.16 cm (0.875 x 4.0 in.) NaI Scintillation Offset: 14.6 cm (5.76 in.) **1b. Casing Collar Locator: (optional)** Dual magnet and coil assembly Offset: 14.6 cm (5.76 in.) **2. Three Arm Caliper:** Short- or Long- arm configuration, motor operated Sensor Offset: Short-arm: 220.4 cm (86.8 in.) Long-arm: 241.0 cm (94.9 in.)	**Tool Length:** With Short-arms: 226 cm (89 in.) With Long-arms: 264 cm (104 in.) **Temperature:** 85 C (185 F) **Diameter:** 50.8 mm (2.0 in.) **Pressure:** 281 kg/cm^2 (4000 PSI) **Weight:** Short-arm: 18.5 kg (48 lbs.) Long-arm 20.8 kg (54 lbs.) **Logging Speed:** 9 m/min. (30 ft./min.) **Tool Voltage Required:** 56 VDC

Sensor Response Ranges

Sensor	Response Limits	Accuracy
Natural Gamma (NG)	0-400,000 API units	+/-5%
Casing Collar Locator (CCL)	+/- 50,000 CPS	NA
Short-Arm Caliper	5.1 to 76.2 cm (2 to 30 in)	+/-0.38 cm (0.15 in)
Long-Arm Caliper	5.1 to 113 cm (2 to 44.5 in)	+/-0.64 cm (0.25 in)

Tool Information

Item	Model #	Part #
Three Arm Caliper, with NG & Short Arms, without CCL	9074	298000A
Three Arm Caliper, with Short Arms, without NG and CCL	8074	298000B
Three Arm Caliper with CCL & Short Arms, without NG	7074	297000A
Three Arm Caliper with CCL & Short Arms, with NG	6074	298200A
Extensions to Long Arms	All	298009 (3 Req.)
Long Arm Center Shaft Extension	All	298010
Caliper Tip Balls	All	298008
Calibrator, Rings, 2	All	298001

CENTURY GEOPHYSICAL LLC.
PRODUCT DESCRIPTION

9144 Series E Logging Tool

Background Information

The Multi-Parameter E-Log tool is a multi-parameter resistivity tool primarily used for water well logging and monitoring wells. The tool records ten different parameters simultaneously in one pass of the borehole. The ten parameters are the following: natural gamma, spontaneous potential, single point resistance, 16 in. normal resistivity, 64 in. normal resistivity, 48 in. lateral resistivity, fluid resistivity, temperature, delta temperature, slant angle (tilt) and azimuth (bearing). Slant angle, bearing, and natural gamma are optional.

Features

Properties Measured (see diagram)		Tool Specifications
1. Natural Gamma: (optional) 2.5 x 10.2 cm (1.0 x 4.0 in.) NAI Scintillation Offset: 198.1cm (78.0 in.) **2. 64 in. Normal Resistivity:** Offset: 119.1 cm (42.96 in.) **3. 16 in. Normal Resistivity:** Offset: 170.1 cm (66.96 in.) **4. Fluid Resistivity:** Offset: 228.6 cm (90.0 in.) **5. Lateral Resistivity 48 in.** Offset: 139.6 cm (54.96 in.)	**6. Spontaneous Potential:** Offset: 27.7 cm (10.9 in.) **7. Single Point Resistance:** Offset: 190.5 cm (75.0 in.) **8. Temperature & Delta Temperature:** 0.074 C (0.007 F) resolution Offset: 236.2 cm (93.0 in.) **9. Slant Angle & Bearing: (optional)** 3-axis magnetometer and 2-axis inclinometer Offset: 200.6 cm (78.964 in.)	**Length:** 234.3 cm (92.25in.) **Temperature:** 70 C (158 F) **Diameter:** 53 mm (2.1 in.) **Pressure:** 281 kg/cm^2 (4000 PSI) **Weight:** 15 kg (33 lb.) **Logging Speed:** 9 m/min. (30 ft./min.) **Tool Voltage Required:** 36 VDC

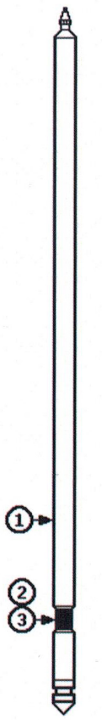
Sensor Response Ranges

Sensor	Response Limits	Accuracy
Natural Gamma (NG)	0-400,000 API units	+/-5%
16 in. (16N) & 64 in. Normal (64N) & Lateral Resistivity (LR)	0-2,000 ohm/meters	+/-5%
Spontaneous Potential (SP)	-400 - +400 mv	+/-5%
Temperature (TEMP)	0 C- 70 C (32 - 160 F)	+/-5%
Single Point Resistance (SPR)	0-2,000 ohms	+/-5%
Fluid Resistivity (FR)	0-100 ohm meters	+/-5%
X - Y Inclination (XYI)	0-45 degrees	+/-0.5 degrees
Azimuth (AZ)	0-360 degrees	+/-2 degrees

Tool Information

Item	Model #	Part #
Tool with 16N, 64N, LR, TEMP, SPR, FR (No Natural Gamma)	7144	336700A
Tool with NG, 16N, 64N, LR, TEMP, SPR, FR	8144	336700B
Magnetic Deviation Option and Same Parameters as 8044	9144	336700C
Deviation Calibration Test Stand		317430
SP/Resistivity Calibration Box		335230

9014 Natural Gamma, SP, Res Logging Tool



Background Information
The 9014 tool is a multi-parameter slim hole mining and hydrology tool that records natural gamma, SP, single-point resistance. With the tool's slim hole design, it can be used in 5.08 cm (2 in.) steel or plastic cased holes to record natural gamma for lithology. Even with its simple design, this tool records all three parameters simultaneously, without any merging or down logging required.

Features	
Properties Measured (see diagram)	**Tool Specifications**
1. Natural Gamma: 1.3 x 7.6 cm (0.5 x 3.0 in.) NAI Scintillation Offset: 276.8 cm (69.6 in.) **2. Spontaneous Potential** +/-0.1 ohm Resolution Offset: 204.2 cm (80.4 in.) **3. Single Point Resistance** +/-0.1 ohm Resolution Offset: 204.2 cm (80.4 in.)	**Length:** 137.2 cm (54 in.) **Temperature:** 75 C (167 F) **Diameter:** 47.6 mm (1.875 in.) **Pressure:** 281 kg/cc^2 (4000 PSI) **Weight:** 6.8 kg (15 lb.) **Logging Speed:** 9 m/min. (30 ft./min.) **Tool Voltage Required:** 30 VDC

Sensor Response Ranges		
Sensor	**Response Limits**	**Accuracy**
Natural Gamma	0 - 10,000 API units	+/-5%
Resistance	0 to 1500 ohms	+/-5%
Spontaneous Potential	-400 to 400 mv	+/- 10 mv

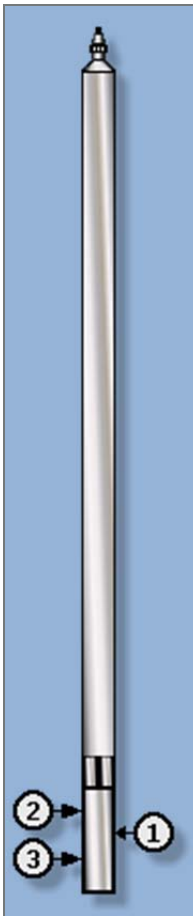
Phone: 918-838-9811
Fax: 918-838-1532

Century Geophysical, LLC
1223 S. 71st E. Ave.
Tulsa, OK 74112

sales@century-geo.com
www.century-geo.com

CENTURY GEOPHYSICAL LLC.
PRODUCT DESCRIPTION

9722 E-M Flowmeter



Background Information
The E-M Flowmeter tool is used in the environmental and hydrology industries to measure fluid movement in a borehole. The instrument measures flow rates using the principal of Faraday's Law of Induction. The downhole probe consists of an electromagnet and two electrodes located 180 degrees apart and 90 degrees to the magnetic field inside of a hollow cylinder. The voltage induced by a conductor moving at right angles through the magnetic field is directly proportional to the velocity of the conductor (water) through the field. The tool is capable of measuring low velocity flow rates down to less than 50 ml/min and increased flow rates to 40 liters/min, through the tool's 1 inch inside diameter sensor. When using the tool to measure low velocity flow rates a rubber skirt is attached to the outside of the sensor to block off the bore hole and force the fluid to pass through the 1 inch diameter opening inside the sensor coil. The Compu-View Software program is designed to allow the automatic collection of data at selected static stations in the borehole. When measuring faster flow rates the rubber skirt is typically removed and the tool is run in either the static station or dynamic mode. The tool has no moving parts.

Features	
Properties Measured (see diagram)	Tool Specifications
1. Flowmeter: Electromagnetic Offset: 139.7 cm (55.0 in.) **2. Fluid Resistivity:** Offset: 139.7 cm (55.0 in.) **3. Temperature & Delta Temperature :** Offset: 139.7 cm (55.0 in.)	**Length:** 142 cm (56.0 in.) **Temperature:** 60 C (140 F) **Diameter:** 41.3 mm (1.625 in.) **Sensor Housing:** 50.8 mm (2.0 in.) **Weight:** (13.5 lbs.) **Tool Voltage Required:** 64 VDC **PRESSURE**: 2500PSI

Sensor Response Ranges

Sensor	Response Limits	Accuracy
Flowmeter (EMF)	50 ml./min. to 40 liters./min.	+/-20 ml/min. (High Gain)
Temperature (TEMP)	0 C to 60 C (32 to 140 F)	+/-5%
Fluid Resistivity (FR)	0-100 ohm meters	+/-5%

Tool Information

Item	Model #	Part #
Tool with EMF, TEMP, FR	9722	300500A
(included) 6.5 in. Diameter Flow Diverter Skirt (modifiable for use in hole from 3.75 in. to 6.25 in. diameter)		
(included) Centralizer		
(included) Weighted Section		

ATTACHMENT B-2
MW3A
GEOPHYSICAL LOGGING
RESULTS

Preliminary Flowmeter Summary and Results

Well Name: BS3
Unique Number: 847052
Date Logged: 1/8/2020

Note: This summary accompanies the video log, video log notes, caliper log, and multitool log.

The video log depths appear to be about 4.5-5 ft. deeper than the actual borehole depths based on the depth of the casing bottom recorded on the video while logging downwards and upwards. However, please note that the video log depths may increase with increasing depth in the borehole since the depth of the bottom of the hole appears to be about 10-11 ft. deeper than that measured by the driller and our other geophysical logging tools. It is possible these errors are due to cable stretching during video logging or possibly by a tool malfunction with the counter reel of the video logging rig.

The fluid resistivity log indicates a change in slope at about 85 ft. depth that may be related to flow in or out of the borehole. This depth roughly corresponds to about 88.4 ft. depth (uncorrected) in the video while logging down, and about 88.9 ft. depth (uncorrected) in the video while logging up. The video indicates slight turbulent flow around this interval and may also show flow into the borehole from the fracture at about 85 ft. and flow downwards. Suspended particles in the video through this interval appear to move downwards more quickly than above and below this interval. For this reason, the water may be exiting the borehole at the fracture at about 90.5 ft. depth, which corresponds to another change in the slope of the fluid resistivity log.

The fluid resistivity log also indicates a change in slope at the interval of about 186 to 195 ft. depth. This may also be related to flow in or out of the borehole at this interval. The borehole is very cloudy and the video log quality is poor along this interval, however, and does not provide any obvious evidence to support this interpretation.

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St. Paul, MN 55114
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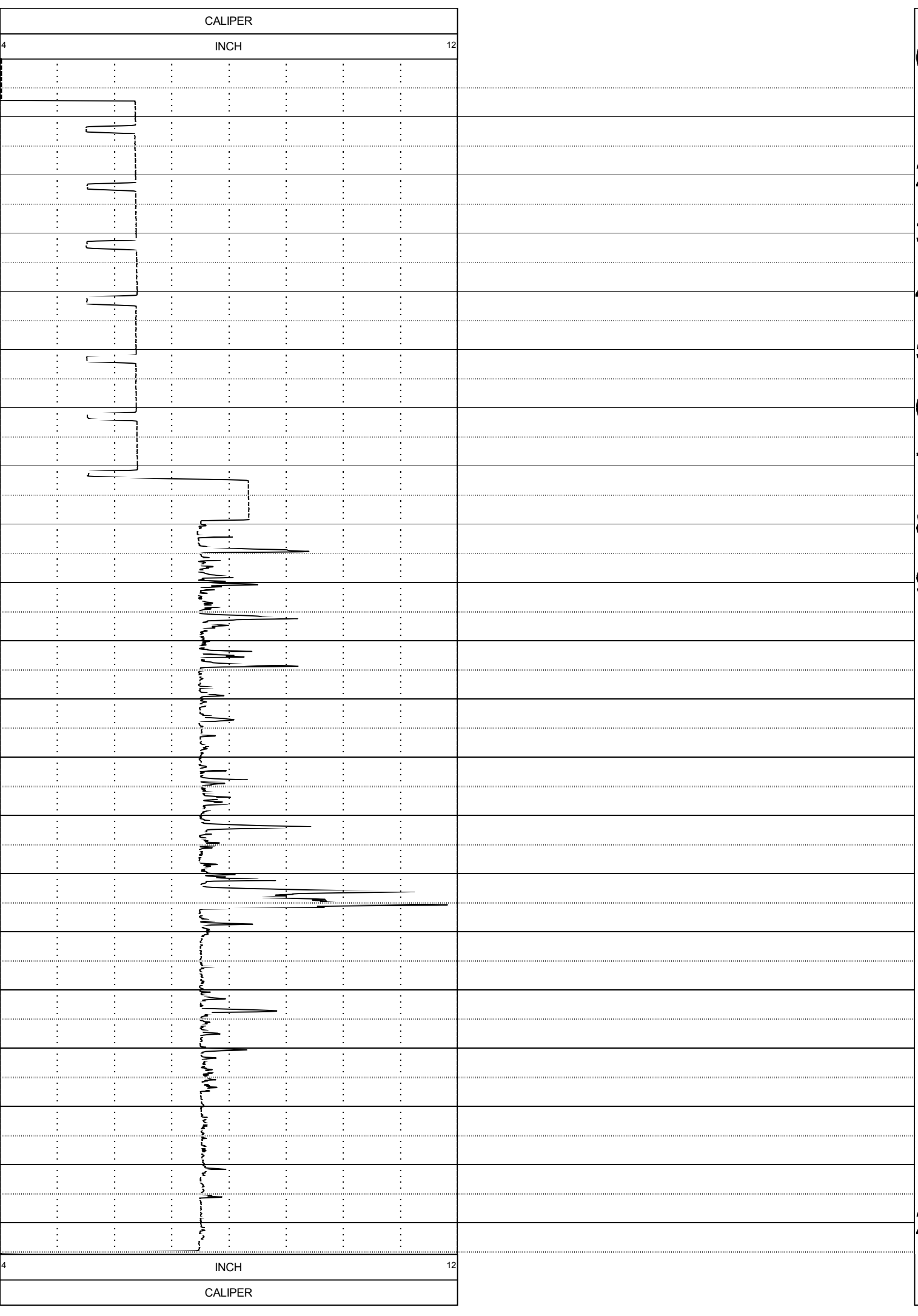
847052_CALIPER

NAME	: BS3			OTHER SERVICES:	
UNIQUE NUMBER	: 847052_CALIPER				
QUADRANGLE	: LAKE ELMO 102-B				
COUNTY	: WASHINGTON				
LOCATION/SUBSECTI:	ADCDDC				
SECTION	: 27	TOWNSHIP	: 29	RANGE	: 21
DATE	: 01/08/20	MGS CUTTINGS #	:		
CASING BOTTOM	: 80'			KB	:
LOG BOTTOM	: 205.35	LOG MEASURED FROM:	GL	DF	:
LOG TOP	: 0.09	DRL MEASURED FROM	:	GL	: 909 L1
CASING DIAMETER	: 6"	LOG RATE	: 30FPM		
CASING TYPE	: STEEL	FIELD OFFICE	: TRUCK		
CASING THICKNESS	:	RECORDED BY	: RETZLER		
BIT SIZE	: 4	BOREHOLE FLUID	: 0	FILE	: PROCESSED
MAGNETIC DECL.	: 0	RM	: 0	TYPE	: 8074A
MATRIX DENSITY	: 2.84	RM TEMPERATURE	: 0	LGDATE	: 01/08/20
NEUTRON MATRIX	: DOLOMITE	MATRIX DELTA T	: 44	LGTIME	: 09:54:
				THRESH	: 2500
SWL	: 16'				
REMARKS	:				



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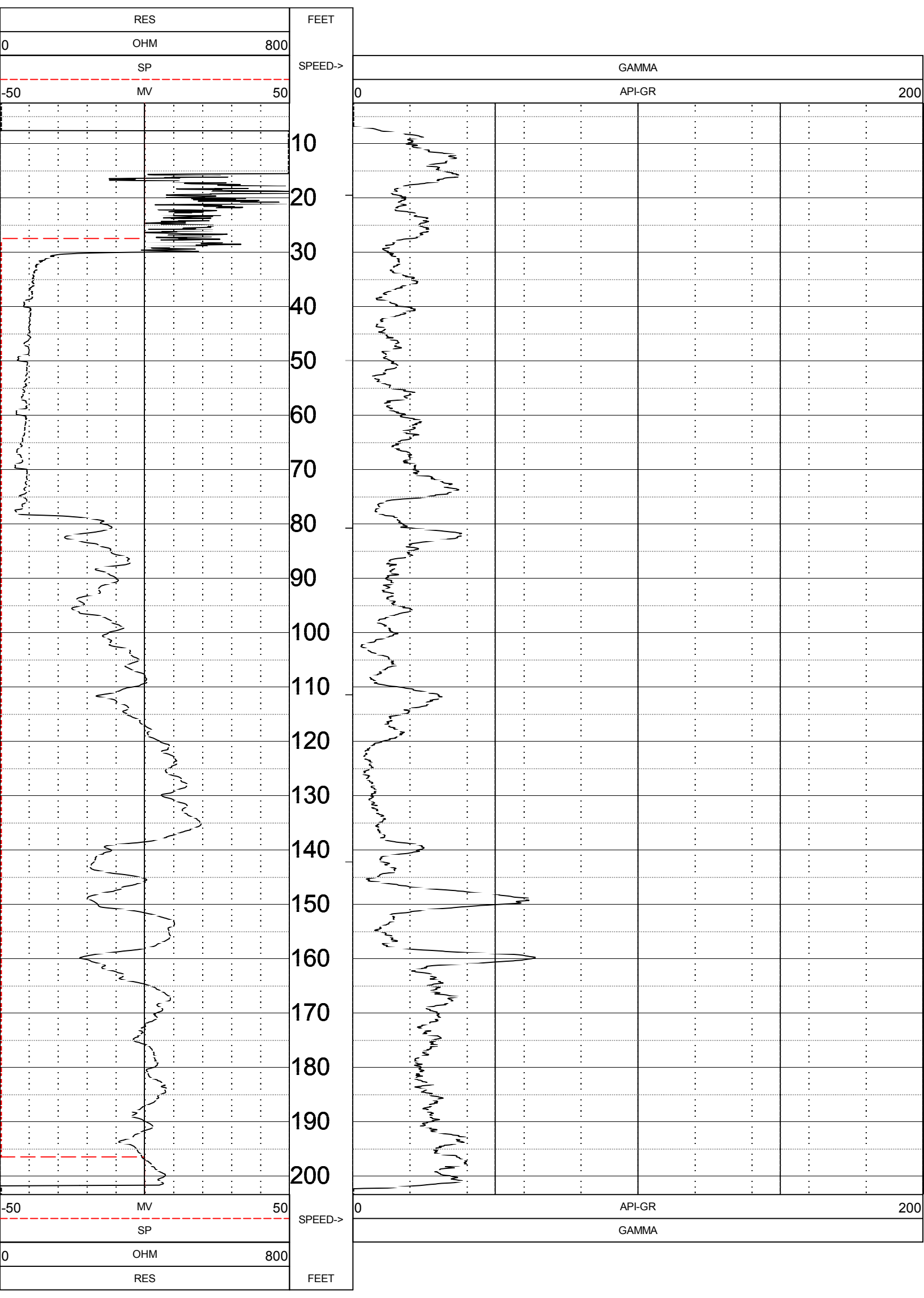
Dept. Phone: (612)626-2969

847052_GAMMA

NAME	: BS3			OTHER SERVICES:	
UNIQUE NUMBER	: 847052_GAMMA				
QUADRANGLE	: LAKE ELMO 102-B				
COUNTY	: WASHINGTON				
LOCATION/SUBSECTI:	ADCDDC				
SECTION	: 27	TOWNSHIP	: 29	RANGE	: 21
DATE	: 01/08/20	MGS CUTTINGS #	:		
CASING BOTTOM	: 80'			KB	:
LOG BOTTOM	: 203.38	LOG MEASURED FROM:	GL	DF	:
LOG TOP	: 2.60	DRL MEASURED FROM	:	GL	: 909 L1
CASING DIAMETER	: 6"	LOG RATE	: 30FPM		
CASING TYPE	: STEEL	FIELD OFFICE	: TRUCK		
CASING THICKNESS	:	RECORDED BY	: RETZLER		
BIT SIZE	: 4	BOREHOLE FLUID	: 0	FILE	: PROCESSED
MAGNETIC DECL.	: 0	RM	: 0	TYPE	: 8144A
MATRIX DENSITY	: 2.84	RM TEMPERATURE	: 0	LGDATE	: 01/08/20
NEUTRON MATRIX	: DOLOMITE	MATRIX DELTA T	: 44	LGTIME	: 10:16:
				THRESH	: 2500
SWL	: 16'				
REMARKS	: GAMMA FROM MULTI				



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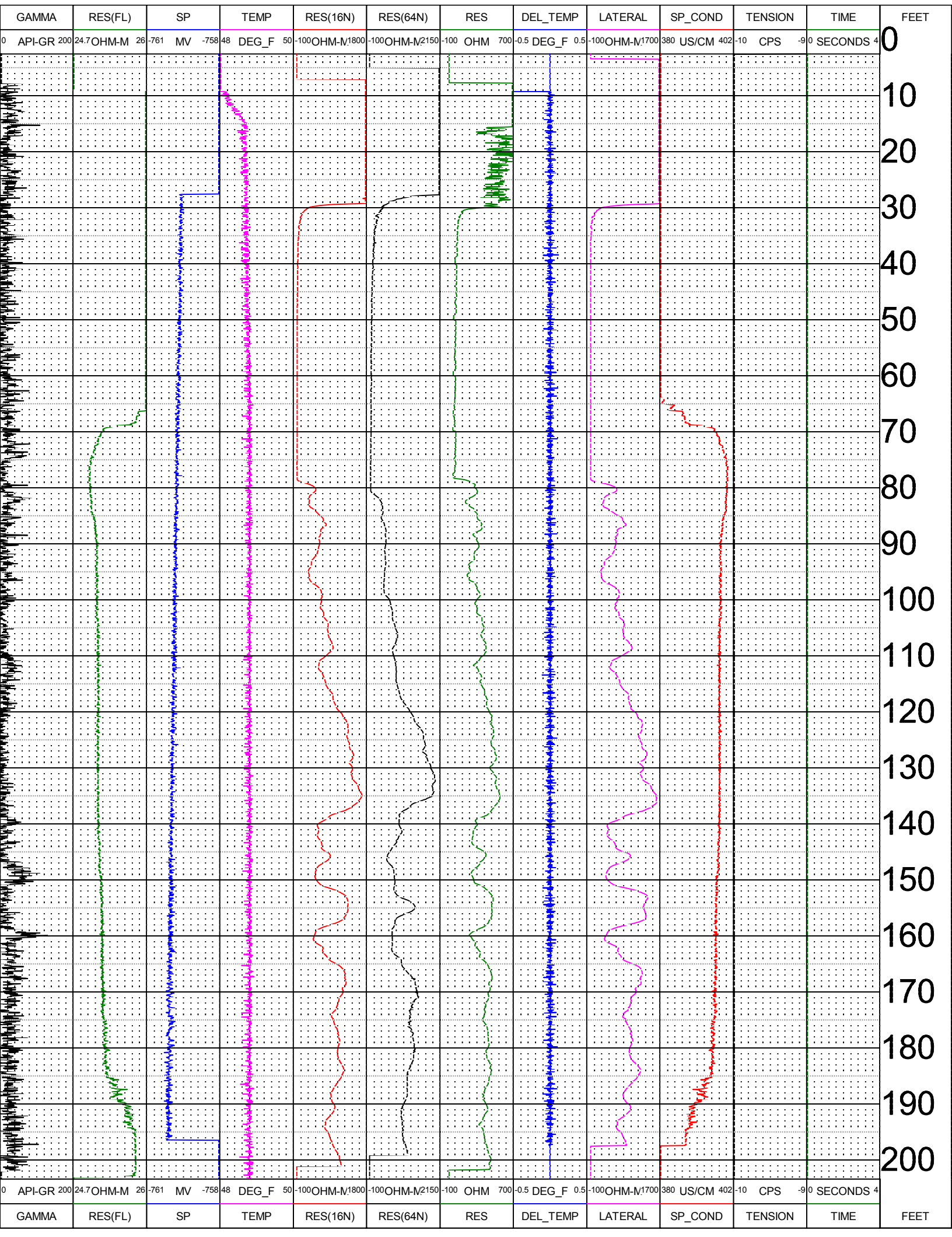
847052_MULTI

NAME	: BS3			OTHER SERVICES:	
UNIQUE NUMBER	: 847052_MULTI				
QUADRANGLE	: LAKE ELMO 102-B				
COUNTY	: WASHINGTON				
LOCATION/SUBSECTI:	ADCDDC				
SECTION	: 27	TOWNSHIP	: 29	RANGE	: 21
DATE	: 01/08/20	MGS CUTTINGS #	:		
CASING BOTTOM	: 80'			KB	:
LOG BOTTOM	: 203.38	LOG MEASURED FROM:	GL	DF	:
LOG TOP	: 2.60	DRL MEASURED FROM	:	GL	: 909 L1
CASING DIAMETER	: 6"	LOG RATE	: 30FPM		
CASING TYPE	: STEEL	FIELD OFFICE	: TRUCK		
CASING THICKNESS	:	RECORDED BY	: RETZLER		
BIT SIZE	: 4	BOREHOLE FLUID	: 0	FILE	: PROCESSED
MAGNETIC DECL.	: 0	RM	: 0	TYPE	: 8144A
MATRIX DENSITY	: 2.84	RM TEMPERATURE	: 0	LGDATE:	01/08/20
NEUTRON MATRIX	: DOLOMITE	MATRIX DELTA T	: 44	LGTIME	: 10:16:
				THRESH:	2500
SWL	: 16'				
REMARKS	:				



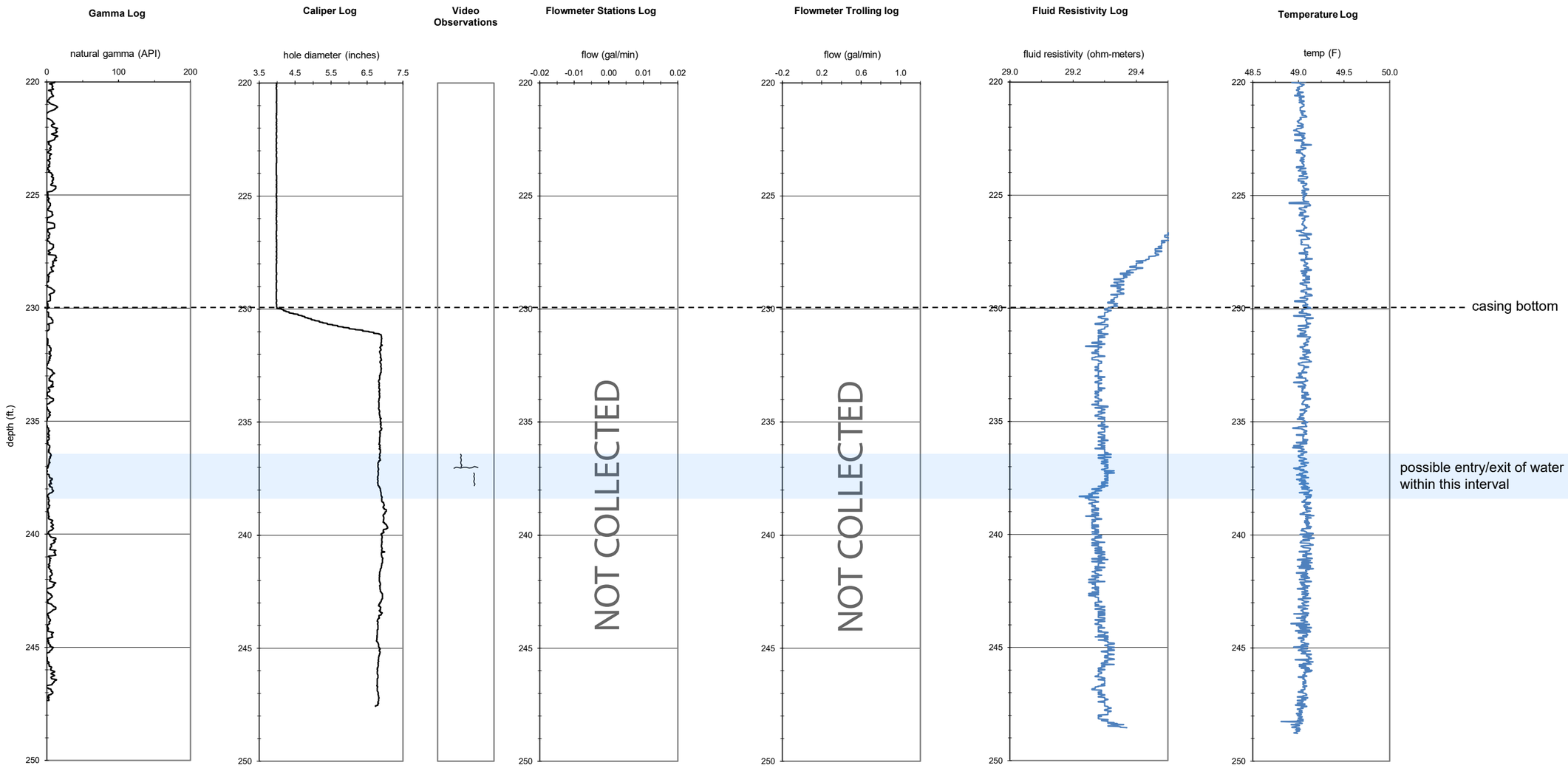
Well Name: BS3
Unique Number: 847052

VIDEO LOG OBSERVATIONS

Logged By: Retzler (MGS), Mayer (MGS)
Date: 1/8/2020
Note: Zeroed in sideview. Video depths do not match depths reported by the driller or measured in the caliper and multitool. The magnitude of the difference also appears to change with depth.

Depth (ft.):	Camera View:	Observations:
17.1	sideview	SWL
85.0	sideview	bottom of casing
88.0	downview	possible turbulent flow
146.9	downview	start of cloudier/murkier water
217.1	downview	bottom of hole, sandy bottom
208.0	sideview	thin fracture
202.8	sideview	fracture
186.9	sideview	group of thin fractures
173.8	sideview	thin fracture
166.1	sideview	vuggy fracture, thin fracture
165.8	sideview	thin fracture
160.8	sideview	group of thin fractures
158.5	sideview	particles indicate slight downflow or settling?
157.9	sideview	fracture and some loose material
157.4	sideview	fracture
154.8	sideview	rubbly zone with loose material
151.2	sideview	rubbly/cavernous
149.8	sideview	thin fracture
148.9	sideview	thin fracture
148.1	sideview	vuggy fracture zone
143.1	sideview	rubbly fracture zone
140.1	sideview	rubbly fracture zone
135.9	sideview	rubbly fracture zone
131.4	sideview	thin fracture
131	sideview	fracture rubbly zone
123.4	sideview	thin fracture
120.3	sideview	rubbly fracture
115.8	sideview	cavern
114.3	sideview	thin fracture
110.3	sideview	cavern
103.9	sideview	thin fracture
99.5	sideview	cavernous zone
95.4	sideview	loose rubbly zone and thin fracture
89.4	sideview	less downflow movement in particles; change in flow?
89	sideview	thin fracture; possible upflow
86.5	sideview	thin fracture
84.8	sideview	bottom of casing

Well Name: MW3A
Unique Number: 847052
T-R-S: T29 R21 Section 27 ADCDDC



Geology:
0-74 QUUU, Quaternary sediments
74-170 OPSH, Shakopee Formation
170-221 OPOD, Oneota Dolomite
221-250+ CJDN, Jordan Sandstone

KEY:
- subvertical fracture
- bedding plane fracture
- other vugs/macropores
- multitool log

NOTE: The original caliper log depth was off by about 1.1 ft. based on bottom of casing depth (which should be 230') and has been corrected on this figure. The video log footages are off by an additional 2.8 ft. and the observations shown on this figure take this into account. All other logs are unmodified.

Logged by Minnesota Geological Survey
5/15/2020
Multitool, Caliper, Video

Preliminary Flowmeter Summary and Results

Well Name: MW3A
Unique Number: 847052
Date Logged: 5/15/2020

Note: This summary accompanies the flowmeter results figure. Also, please note that the footages in the accompanying video log are off by an additional 2.8 feet based on the actual depth to bottom of casing (230 feet). Video observations shown on the results figure take this into account.

The video and caliper logs indicate a relatively smooth Jordan Sandstone borehole with only a few thin fractures at around 237'. There were no obvious signs of flow in or out of the open borehole noted in the video logged under ambient conditions. Particles in the video appear to be slowly settling due to gravity after being dislodged/disrupted by the video logging tool.

The fluid resistivity log shows a slight baseline shift at about 238' depth, which appears to align with another very slight shift in the temperature log. This is also near the thin fractures observed on the video log. This may indicate two subtly distinct (in chemistry) waters in the borehole, with water possibly entering or exiting the hole at about 237-238' depth, but with any ambient flow being too slow to pick up on the video log.

Well Name: MW3A
Unique Number: 847052

VIDEO LOG OBSERVATIONS

Logged By: Retzler (MGS), Mayer (MGS)
Date: 5/15/2020
Note: Zeroed in sideview. Video log footages appear to be off by ~2.9' based on casing bottom depth.

Depth (ft.):	Camera View:	Observations:
22.0	sideview	SWL
232.9	sideview	Bottom of casing
239.6	sideview	Thin fracture, horizontal
240.3	sideview	Vertical, thin fracture
250.4	sideview	Very murky/mucky
280.6	sideview	Bottom of hole

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847052_CALIPER

NAME	: MW3A			OTHER SERVICES:	
UNIQUE NUMBER	: 847052_CALIPER				
QUADRANGLE	: 102B				
COUNTY	: WASHINGTON				
LOCATION/SUBSECTI:	ADCDDC				
SECTION	: 27	TOWNSHIP	: 29	RANGE	: 21
DATE	: 05/15/20	MGS CUTTINGS #	:		
CASING BOTTOM	: 230'			KB	:
LOG BOTTOM	: 248.87	LOG MEASURED FROM:	GL	DF	:
LOG TOP	: 0.05	DRL MEASURED FROM:		GL	: 909 L1
CASING DIAMETER	: 4"	LOG RATE	: 30FPM		
CASING TYPE	: STEEL	FIELD OFFICE	: TRUCK		
CASING THICKNESS	:	RECORDED BY	: MAYER		
BIT SIZE	: 6	BOREHOLE FLUID	: 0	FILE	: PROCESSED
MAGNETIC DECL.	: 0	RM	: 0	TYPE	: 8074A
MATRIX DENSITY	: 2.84	RM TEMPERATURE	: 0	LGDATE:	05/15/20
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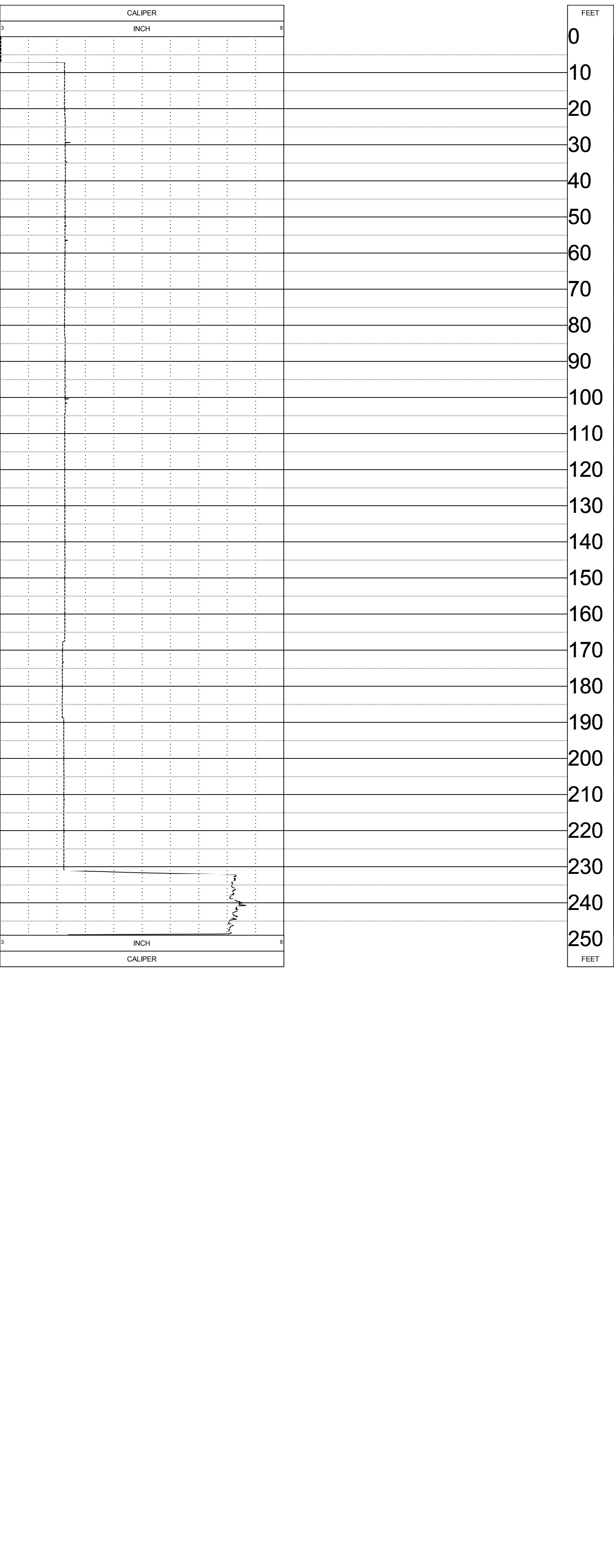
SWL	: 23'				
REMARKS	: PROJECT 1007				



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St. Paul, MN 55114
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847052_MULTIGAMMA

NAME	: MW3A			OTHER SERVICES:	
UNIQUE NUMBER	: 847052_MULTIGAMMA				
QUADRANGLE	: 102B				
COUNTY	: WASHINGTON				
LOCATION/SUBSECTI:	ADCDDC				
SECTION	: 27	TOWNSHIP	: 29	RANGE	: 21
DATE	: 05/15/20	MGS CUTTINGS #	:		
CASING BOTTOM	: 230'			KB	:
LOG BOTTOM	: 248.77	LOG MEASURED FROM:	GL	DF	:
LOG TOP	: 0.81	DRL MEASURED FROM	:	GL	: 909 L1
CASING DIAMETER	: 4"	LOG RATE	: 30FPM		
CASING TYPE	: STEEL	FIELD OFFICE	: TRUCK		
CASING THICKNESS	:	RECORDED BY	: MAYER		
BIT SIZE	: 6	BOREHOLE FLUID	: 0	FILE	: PROCESSED
MAGNETIC DECL.	: 0	RM	: 0	TYPE	: 8144A
MATRIX DENSITY	: 2.84	RM TEMPERATURE	: 0	LGDATE:	05/15/20
NEUTRON MATRIX	: DOLOMITE	MATRIX DELTA T	: 44	LGTIME	: 12:50:
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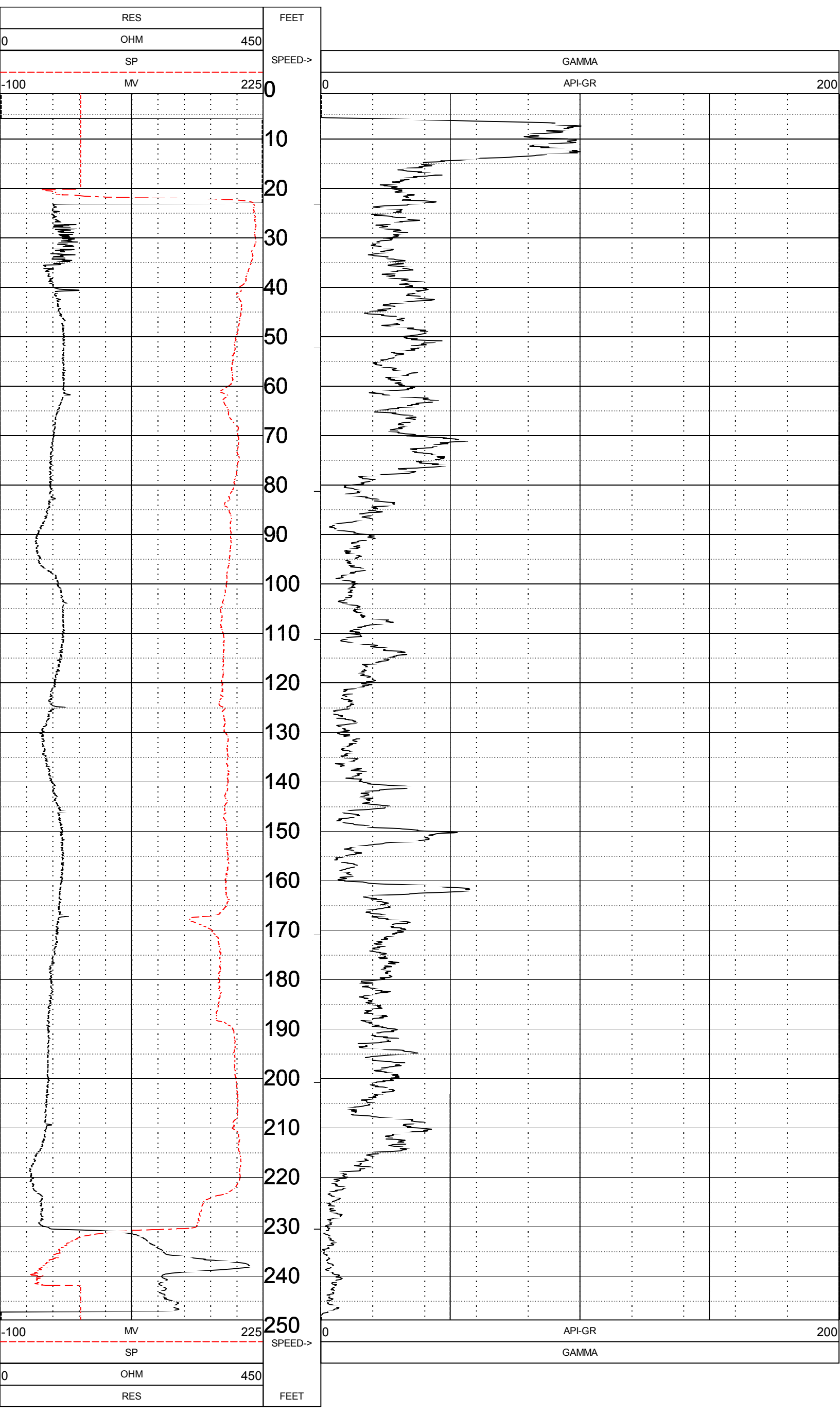
SWL	: 23'				
REMARKS	: PROJECT 1007				



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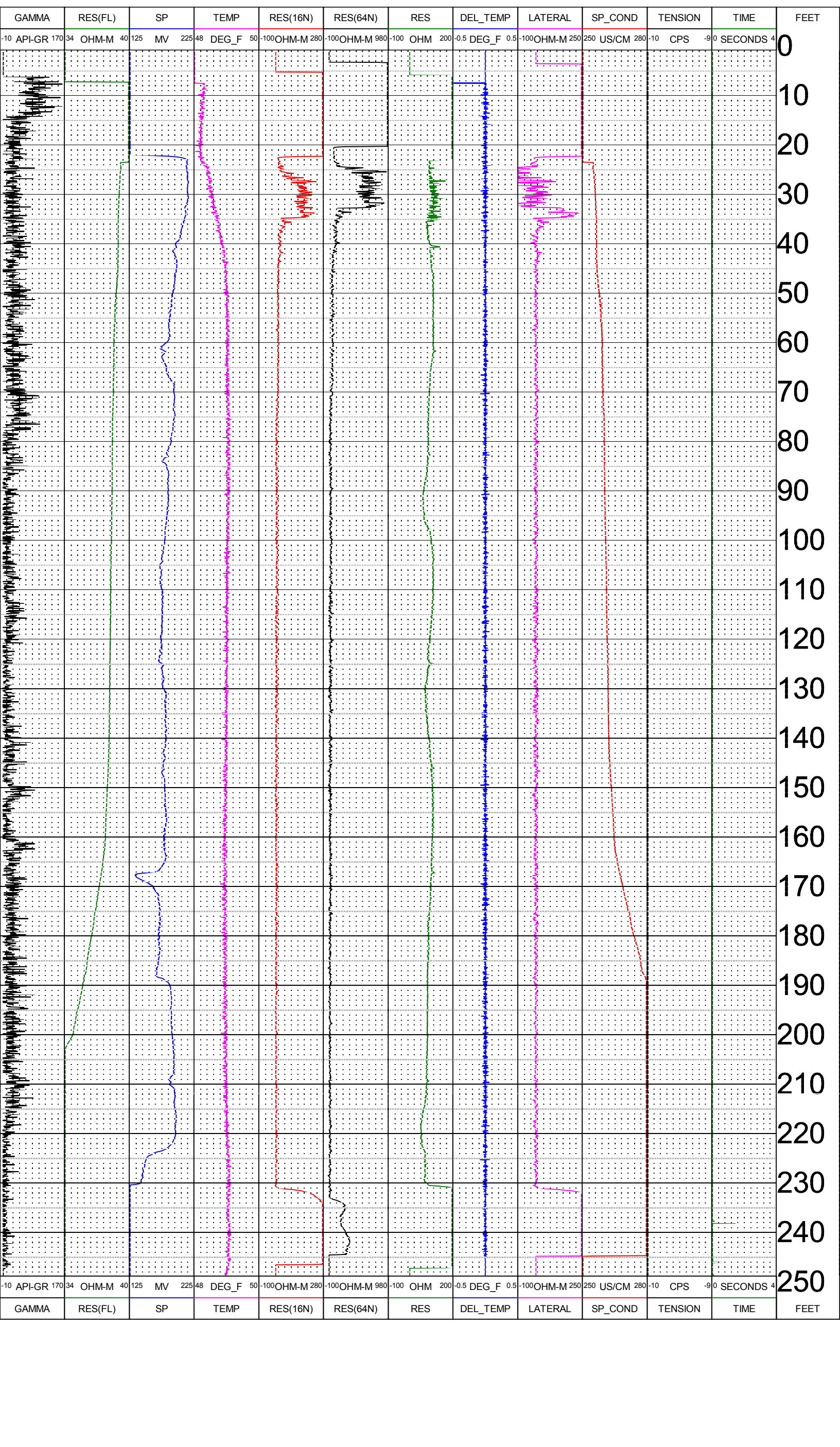
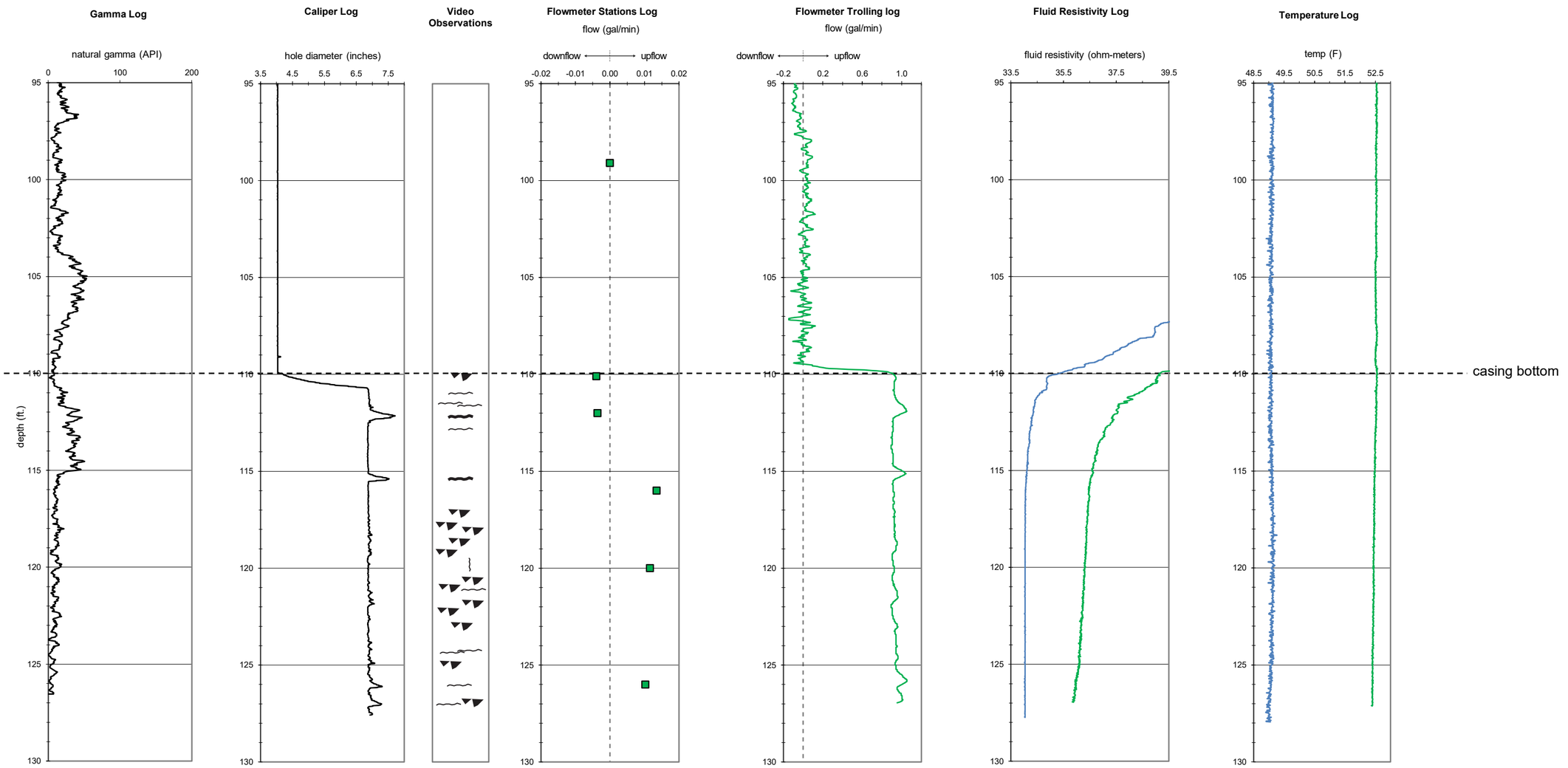
847052_MULTI

NAME	: MW3A			OTHER SERVICES:	
UNIQUE NUMBER	: 847052_MULTI				
QUADRANGLE	: 102B				
COUNTY	: WASHINGTON				
LOCATION/SUBSECTI:	ADCDDC				
SECTION	: 27	TOWNSHIP	: 29	RANGE	: 21
DATE	: 05/15/20	MGS CUTTINGS #	:		
CASING BOTTOM	: 230'			KB	:
LOG BOTTOM	: 248.77	LOG MEASURED FROM:	GL	DF	:
LOG TOP	: 0.81	DRL MEASURED FROM:		GL	: 909 L1
CASING DIAMETER	: 4"	LOG RATE	: 30FPM		
CASING TYPE	: STEEL	FIELD OFFICE	: TRUCK		
CASING THICKNESS	:	RECORDED BY	: MAYER		
BIT SIZE	: 6	BOREHOLE FLUID	: 0	FILE	: PROCESSED
MAGNETIC DECL.	: 0	RM	: 0	TYPE	: 8144A
MATRIX DENSITY	: 2.84	RM TEMPERATURE	: 0	LGDATE:	05/15/20
NEUTRON MATRIX	: DOLOMITE	MATRIX DELTA T	: 44	LGTIME :	12:50:
				THRESH:	2500
SWL	: 23'				
REMARKS	: PROJECT 1007				



Well Name: MW3B
Unique Number: 847053
T-R-S: T29 R21 Section 27 ADCDDC



Geology:
0-79 QUUU, Quaternary sediments
79-130+ OPSH, Shakopee Formation

KEY:
- subvertical fracture
- bedding plane fracture
- other vugs/macropores
- ambient station (flowmeter log)
- ambient trolling (flowmeter log)
- multitool log

NOTE: The original caliper log depth was off by about 0.8 ft. based on bottom of casing depth (which should be 110') and has been corrected on this figure. The video log footages are off by an additional 2.0 ft. and the observations shown on this figure take this into account. All other logs are unmodified.

Logged by Minnesota Geological Survey
5/15/2020
Multitool, Caliper, Ambient Flowmeter, Video

Preliminary Flowmeter Summary and Results

Well Name: MW3B
Unique Number: 847053
Date Logged: 5/15/2020

Note: This summary accompanies the flowmeter results figure. Also, please note that the footages in the accompanying video log are off by an additional 2.0 feet based on the actual depth to bottom of casing (110 feet). Video observations shown on the results figure take this into account.

The video and caliper logs indicate a number of thin bedding plane fractures at about 112.3', 115.4', 121.1', 124.4', 126.0', and 127.0'. The borehole also has a number of vugs throughout. There were no obvious signs of flow in or out of the open borehole noted in the video logged under ambient conditions. Particles in the video appear to be slowly settling due to gravity after being dislodged/disrupted by the video logging tool.

The biggest change in flow illustrated in the trolling flowmeter data occurs at the bottom of casing at a depth of about 110 feet. This is artificial and due to a sharp change in hole diameter from a 7" open hole to a 4" casing while logging upwards. The other smaller changes noted in the trolling flowmeter log align with changes in the borehole diameter at or near fractures (as noted in the caliper log) and are most likely due to poorer sealing of the 7" borehole with the 6" skirt during logging. After taking the previously mentioned factors into account, the trolling flowmeter log does not show any obvious signs of flow in or out of the open borehole under ambient conditions.

The stations flowmeter data seem to indicate slight upflow (0.010 gal/min) from the bottom of the borehole that exits somewhere between station #4 (116.0') and station #3 (112.0'); however, these data are misleading because these values are likely below what our flowmeter tool is capable of measuring and these values have been corrected based on ambient flow measurements taken within the 4" casing that do not accurately apply to "no flow" values in the much larger 7" open borehole. With this in mind, the stations flowmeter data also do not show any obvious signs of flow in or out of the open borehole under ambient conditions.

The fluid resistivity and temperature logs may record a slight change in slope at about 125' and deeper, particularly on the flowmeter fluid resistivity log and the multitool temperature log. However, this change is VERY small and occurs near the beginning of the upwards logging. Oftentimes the first 1 to 2 feet of recorded data at the start of logging are skewed.

Well Name: MW3B
Unique Number: 847053

VIDEO LOG OBSERVATIONS

Logged By: Mayer (MGS), Retzler (MGS)
Date: 5/15/2020
Note: Zeroed in sideview. Video log footages appear to be off by ~2.0' based on casing bottom depth.

Depth (ft.):	Camera View:	Observations:
16.1	downview	SWL
16.4	sideview	SWL
112.0	sideview	Bottom of casing; vuggy at top
114.3	sideview	BPF zone; thin
117.5	sideview	BPF
119.1	sideview	Vuggy
120.4	sideview	Vuggy
121.1	sideview	Vuggy
123.1	sideview	Thin BPF
126.4	sideview	Thin BPF zone
129.2	sideview	Rubbly BPF zone
129.5	downview	Bottom of hole

Well Name: MW3B
Unique Number: 847053

FLOW LOG STATION MEASUREMENTS

Logged By: Mayer (MGS) and Retzler (MGS)
Date: 5/15/2020
Flow Tool Skirt Diameter (in.): 6
Note: (+) flow values = upflow; (-) flow values = downflow
Corrected flow values are calculated using values measured in the casing (assumed to be zero).

Depth (ft.):	Flow (l/min)	Corrected Flow (l/min):	Comments:
99.1	-0.2620	0.0000	steady
110.1	-0.2740	-0.0150	steady
112.0	-0.2730	-0.0138	steady
116.0	-0.2210	0.0513	steady
120.0	-0.2270	0.0438	steady
126.0	-0.2310	0.0388	steady

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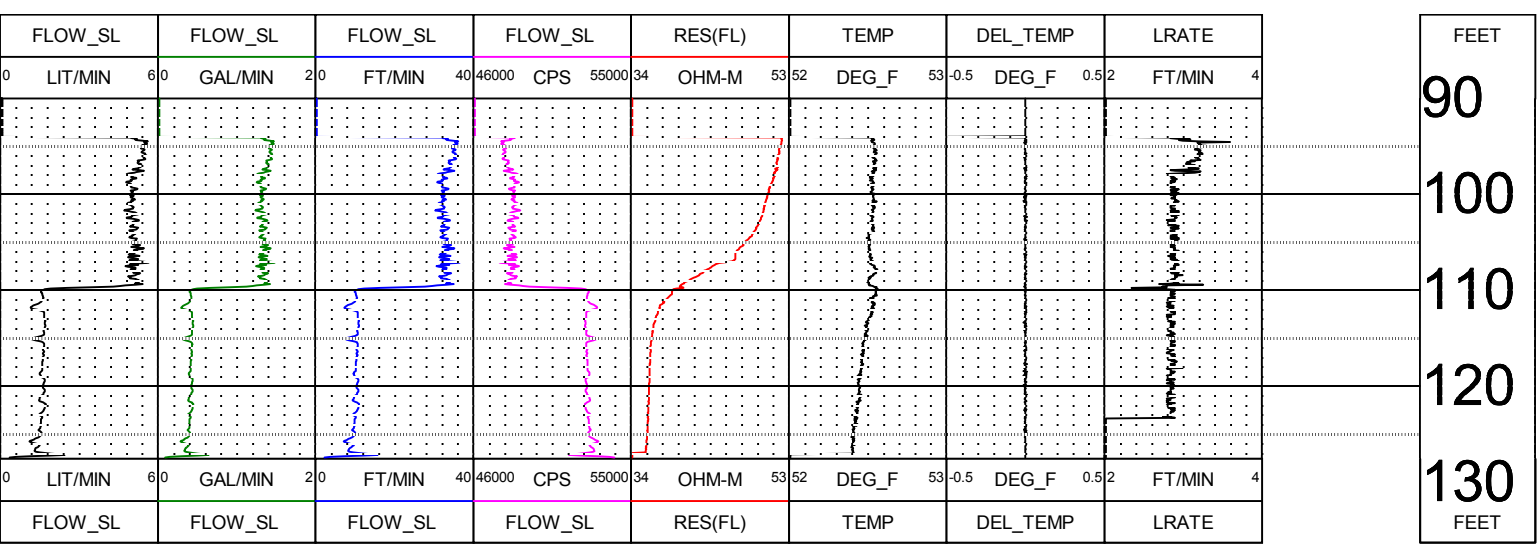
847053_AMBTROLL

NAME	: MW3B			OTHER SERVICES:	
UNIQUE NUMBER	: 847053_AMBTROLL				
QUADRANGLE	: 102B				
COUNTY	: WASHINGTON				
LOCATION/SUBSECTI	: ADCDDC				
SECTION	: 27	TOWNSHIP	: 29	RANGE	: 21
DATE	: 05/15/20	MGS CUTTINGS #	:		
CASING BOTTOM	: 110'			KB	:
LOG BOTTOM	: 127.46	LOG MEASURED FROM	: GL	DF	:
LOG TOP	: 90.04	DRL MEASURED FROM	:	GL	: 909 L1
CASING DIAMETER	: 4"	LOG RATE	: 3FPM		
CASING TYPE	: STEEL	FIELD OFFICE	: TRUCK		
CASING THICKNESS	:	RECORDED BY	: MAYER		
BIT SIZE	: 6	BOREHOLE FLUID	: 0	FILE	: PROCESSED
MAGNETIC DECL.	: 0	RM	: 0	TYPE	: 9721SL
MATRIX DENSITY	: 2.84	RM TEMPERATURE	: 0	LGDATE	: 05/15/20
NEUTRON MATRIX	: DOLOMITE	MATRIX DELTA T	: 44	LGTIME	: 10:39:
				THRESH	: 2500
SWL	: 16'				
REMARKS	: PROJECT 1007				

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS



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St. Paul, MN 55114
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847053_CALIPER

NAME	: MW3B			OTHER SERVICES:	
UNIQUE NUMBER	: 847053_CALIPER				
QUADRANGLE	: 102B				
COUNTY	: WASHINGTON				
LOCATION/SUBSECTI:	ADCDDC				
SECTION	: 27	TOWNSHIP	: 29	RANGE	: 21
DATE	: 05/15/20	MGS CUTTINGS #	:		
CASING BOTTOM	: 110'			KB	:
LOG BOTTOM	: 128.43	LOG MEASURED FROM:	GL	DF	:
LOG TOP	: -0.02	DRL MEASURED FROM	:	GL	: 909 L1
CASING DIAMETER	: 4"	LOG RATE	: 20FPM		
CASING TYPE	: STEEL	FIELD OFFICE	: TRUCK		
CASING THICKNESS	:	RECORDED BY	: RETZLER		
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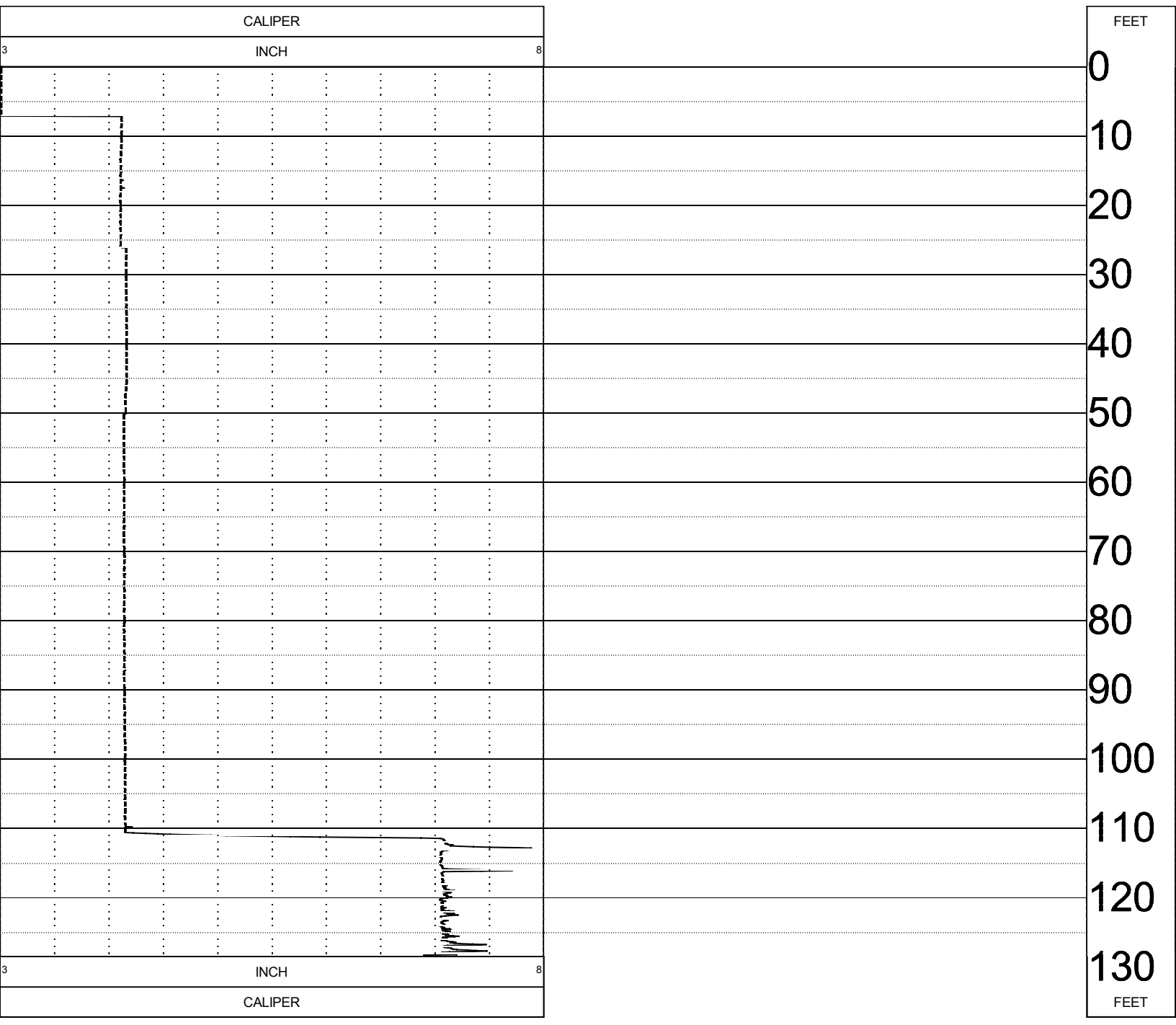
MATRIX DENSITY	: 2.84	RM TEMPERATURE	: 0	LGDATE	: 05/15/20
NEUTRON MATRIX	: DOLOMITE	MATRIX DELTA T	: 44	LGTIME	: 10:21:
				THRESH	: 2500
SWL	: 16'				
REMARKS	: PROJECT 1007				



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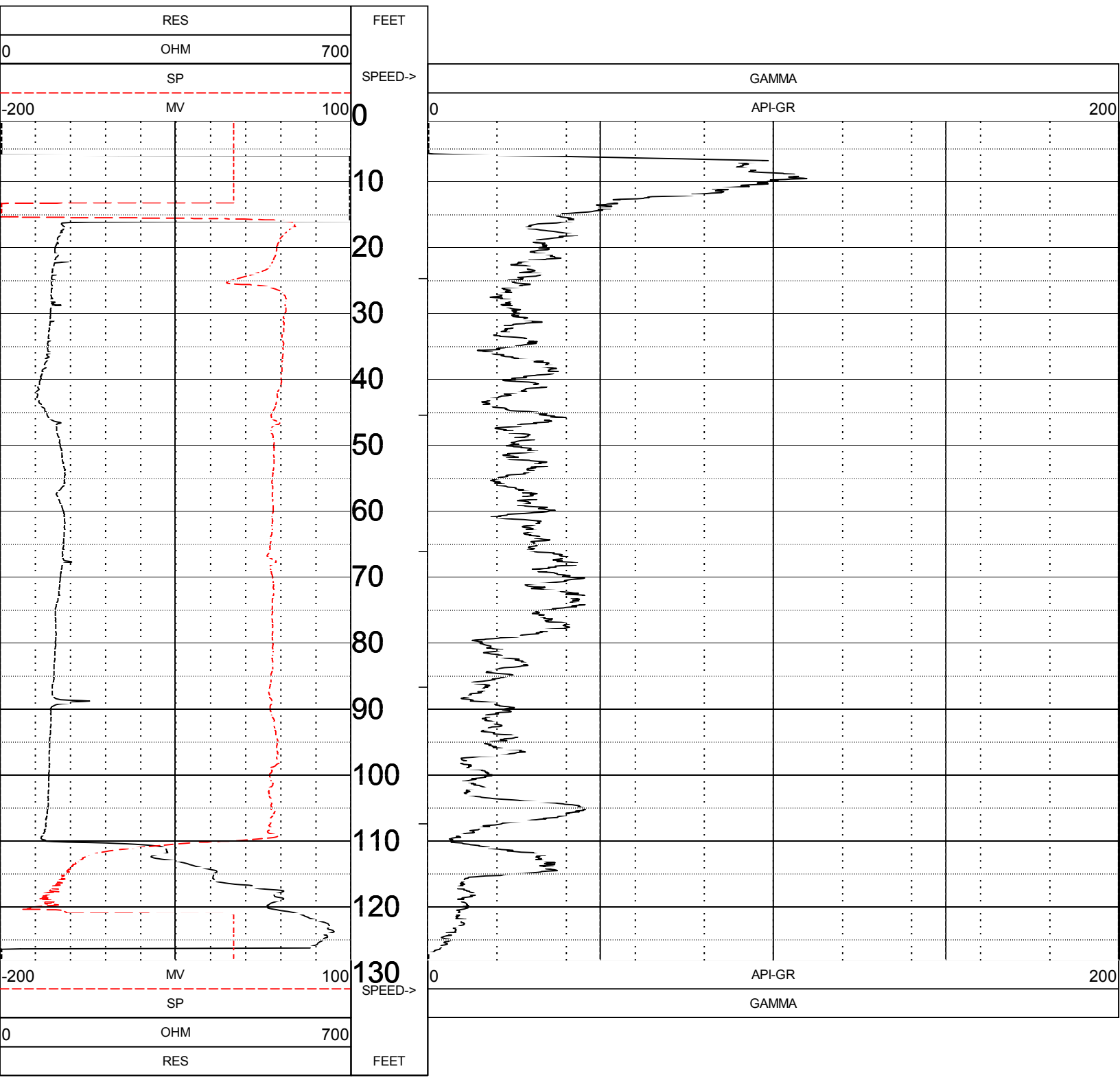
847053_MULTIGAMMA

NAME	: MW3B			OTHER SERVICES:	
UNIQUE NUMBER	: 847053_MULTIGAMMA				
QUADRANGLE	: 102B				
COUNTY	: WASHINGTON				
LOCATION/SUBSECTI:	ADCDDC				
SECTION	: 27	TOWNSHIP	: 29	RANGE	: 21
DATE	: 05/15/20	MGS CUTTINGS #	:		
CASING BOTTOM	: 110'			KB	:
LOG BOTTOM	: 127.96	LOG MEASURED FROM:	GL	DF	:
LOG TOP	: 0.90	DRL MEASURED FROM	:	GL	: 909 L1
CASING DIAMETER	: 4"	LOG RATE	: 20FPM		
CASING TYPE	: STEEL	FIELD OFFICE	: TRUCK		
CASING THICKNESS	:	RECORDED BY	: RETZLER		
BIT SIZE	: 6	BOREHOLE FLUID	: 0	FILE	: PROCESSED
MAGNETIC DECL.	: 0	RM	: 0	TYPE	: 8144A
MATRIX DENSITY	: 2.84	RM TEMPERATURE	: 0	LGDATE	: 05/15/20
NEUTRON MATRIX	: DOLOMITE	MATRIX DELTA T	: 44	LGTIME	: 10:06:
				THRESH	: 2500
SWL	: 16'				
REMARKS	: PROJECT 1007				



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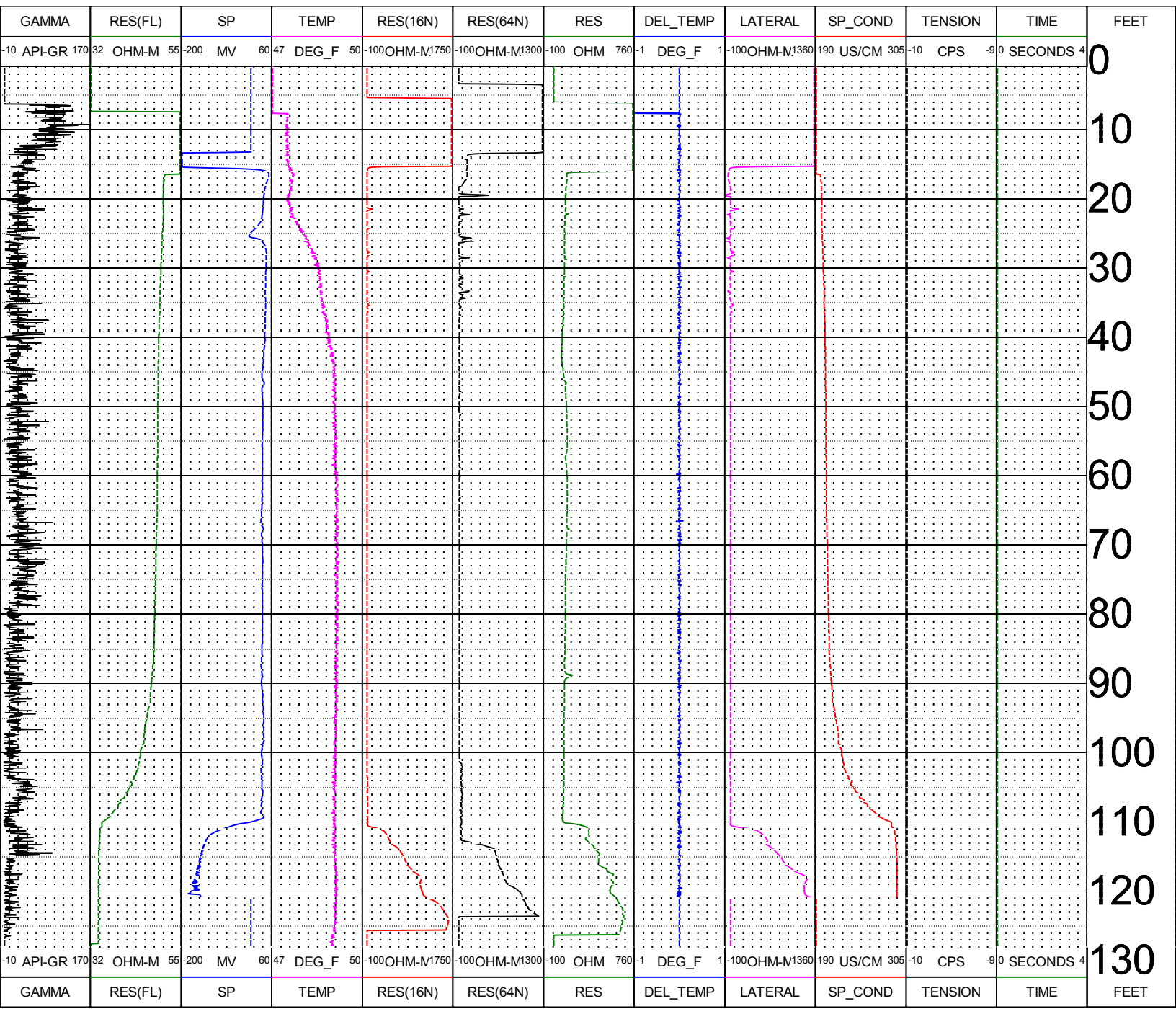
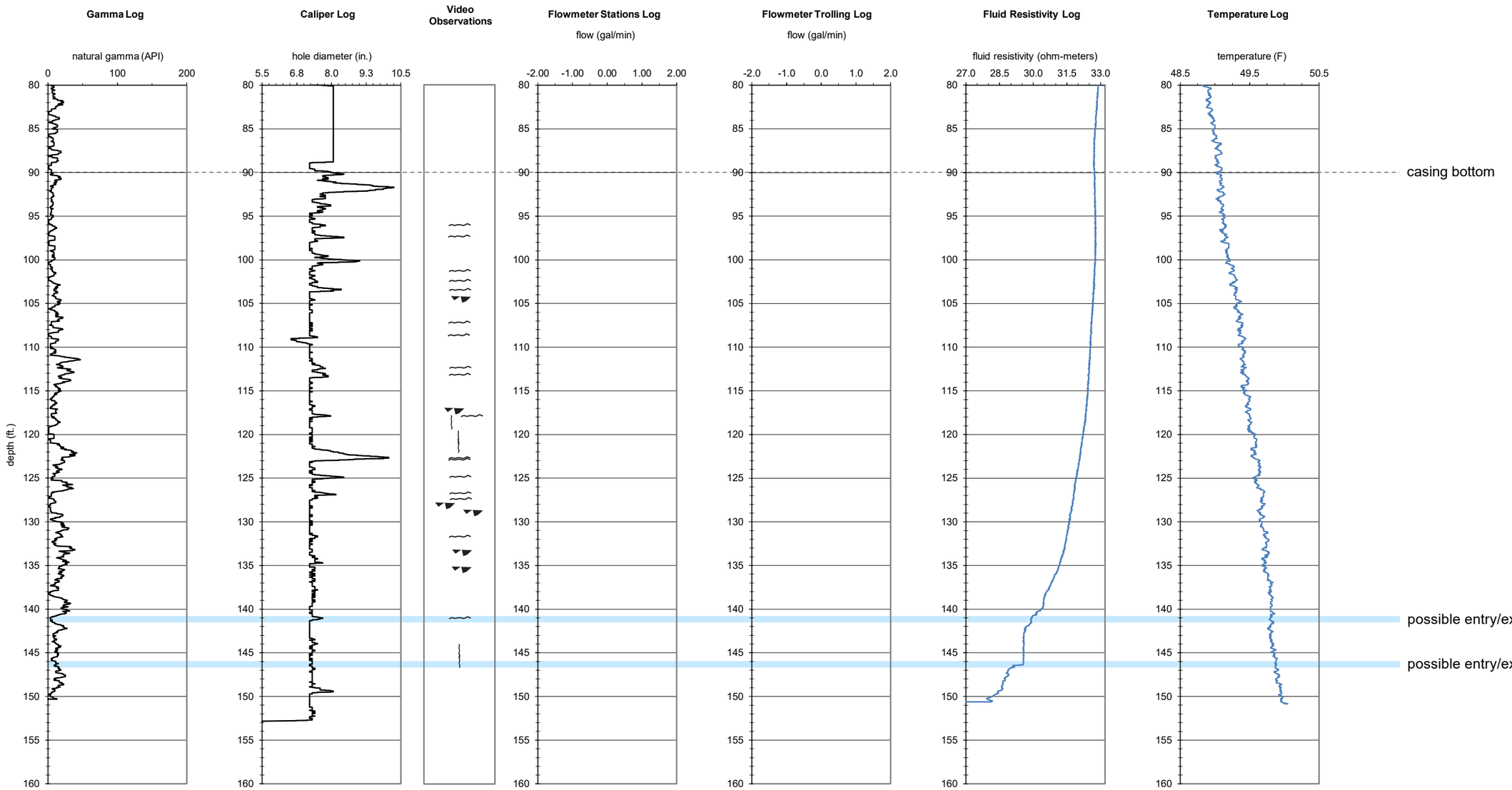
NAME	: MW3B			OTHER SERVICES:	
UNIQUE NUMBER	: 847053_MULTI				
QUADRANGLE	: 102B				
COUNTY	: WASHINGTON				
LOCATION/SUBSECTI:	ADCDDC				
SECTION	: 27	TOWNSHIP	: 29	RANGE	: 21
DATE	: 05/15/20	MGS CUTTINGS #	:		
CASING BOTTOM	: 110'			KB	:
LOG BOTTOM	: 127.96	LOG MEASURED FROM:	GL	DF	:
LOG TOP	: 0.90	DRL MEASURED FROM:		GL	: 909 L1
CASING DIAMETER	: 4"	LOG RATE	: 20FPM		
CASING TYPE	: STEEL	FIELD OFFICE	: TRUCK		
CASING THICKNESS	:	RECORDED BY	: RETZLER		
BIT SIZE	: 6	BOREHOLE FLUID	: 0	FILE	: PROCESSED
MAGNETIC DECL.	: 0	RM	: 0	TYPE	: 8144A
MATRIX DENSITY	: 2.84	RM TEMPERATURE	: 0	LGDATE:	05/15/20
NEUTRON MATRIX	: DOLOMITE	MATRIX DELTA T	: 44	LGTIME :	10:06:
				THRESH:	2500
SWL	: 16'				
REMARKS	: PROJECT 1007				



ATTACHMENT B-2
MW4A
GEOPHYSICAL LOGGING
RESULTS

Well Name: MW4A
Unique Number: 847054
T-R-S: T29 R21 Section 23 DCCDAA



Geology:
0-90 QUUU, Quaternary sediments
90-133 OPSH, Shakopee Formation
133-160+ OPOD, Oneota Dolomite

KEY:

- subvertical fracture
- bedding plane fracture (BPF)
- other vugs/macropores
- possible flow in/out of borehole
- flowmeter - ambient station
- flowmeter - injection/pumping station
- flowmeter - ambient trolling log
- flowmeter - injection/pumping trolling log
- multiparameter log

NOTE: The caliper log is off by about 0.91 ft. based on the reported depth to bottom of casing (90 ft.) and has been adjusted on this figure. The video log is off by about 1.0 ft. based on the reported depth to bottom of casing and the observation depths on this figure take that into account. Stratigraphic interpretation to the left is based on AECOM's drilling log data.

Logged by Minnesota Geological Survey
12/17/2019
Multiparameter, caliper, and video logged.
Gamma log taken from multiparameter.

Well Name: MW4A
Unique Number: 847054

VIDEO LOG OBSERVATIONS

Logged By: Retzler (MGS), Cicha (MGS)
Date: 12/17/2019
Note: Zeroed in sideview.

Depth (ft.):	Camera View:	Observations:
1.3	sideview	SWL
91.0	sideview	bottom of 8" casing
153.1	downview	bottom of hole; drillers started adding water
146.7	sideview	vertical fracture with iron staining
145.0	sideview	vertical fracture (cont.) with iron staining
143.0	sideview	fracture; rubbly
142.1	sideview	vuggy
140.0	sideview	dolomitic precipitant
133.7	sideview	fracture
132.7	sideview	bedding
131.6	sideview	iron staining
129.9	sideview	fracture
129	sideview	cavern; fractures; rubbly
128.5	sideview	fracture zone
126.5	sideview	fracture zone
125.4	sideview	bedding
124.2	sideview	fractures; ledge
122.6	sideview	vertical fractures
119.4	sideview	fracture
118.2	sideview	vuggy
114.8	sideview	fracture
113.7	sideview	fracture zone; rubbly
113.4	sideview	color change; iron-stained to tan, gray
112.5	sideview	color change; tan, gray to iron-stained
110.4	sideview	rubbly, loose material
109.4	sideview	fracture
108.2	sideview	fracture
105.5	sideview	vuggy
104.7	sideview	fracture; ledge; loose material
103.5	sideview	fracture zone
102.4	sideview	fracture zone
101.3	sideview	rubbly
99	sideview	cavern
98.3	sideview	fracture zone
97.1	sideview	fracture zone
95.2	sideview	rubbly zone
93.2	sideview	rubbly zone

Depth (ft.):	Camera View:	Observations:
90.9	sideview	bottom of 8" casing

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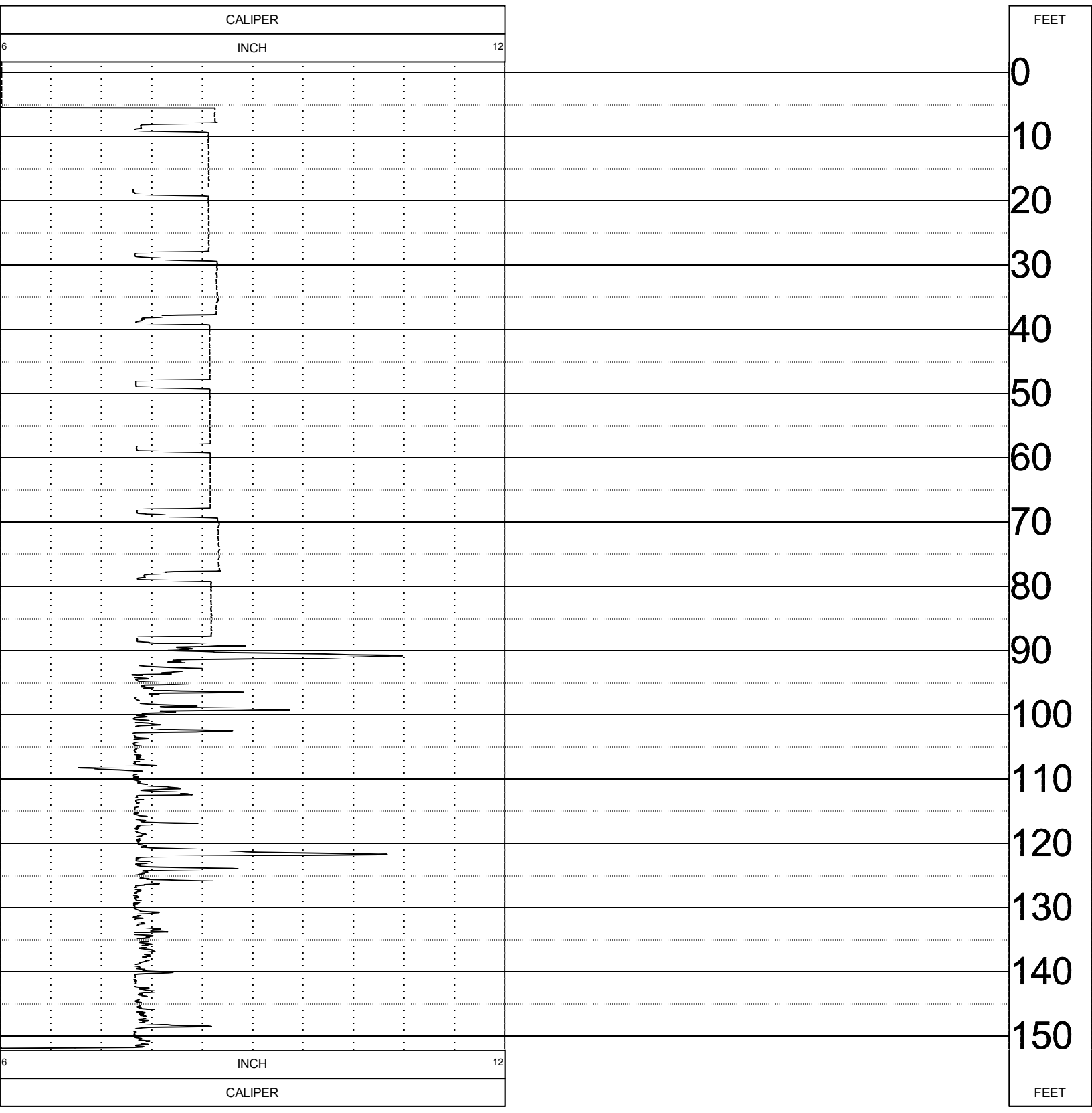
847054_CALIPER

NAME	: MW4A			OTHER SERVICES:	
UNIQUE NUMBER	: 847054_CALIPER				
QUADRANGLE	: LAKE ELMO 102-B				
COUNTY	: WASHINGTON				
LOCATION/SUBSECTI	: DCCDAA				
SECTION	: 23	TOWNSHIP	: 29	RANGE	: 21W
DATE	: 12/17/19	MGS CUTTINGS #	:		
CASING BOTTOM	: 90'			KB	:
LOG BOTTOM	: 152.04	LOG MEASURED FROM	: GL	DF	:
LOG TOP	: -1.63	DRL MEASURED FROM	:	GL	: 889.1 L1
CASING DIAMETER	: 8"	LOG RATE	: 30FPM		
CASING TYPE	: STEEL	FIELD OFFICE	: TRUCK		
CASING THICKNESS	:	RECORDED BY	: RETZLER		
BIT SIZE	: 4	BOREHOLE FLUID	: 0	FILE	: PROCESSED
MAGNETIC DECL.	: 0	RM	: 0	TYPE	: 8074A
MATRIX DENSITY	: 2.84	RM TEMPERATURE	: 0	LGDATE	: 12/17/19
NEUTRON MATRIX	: DOLOMITE	MATRIX DELTA T	: 44	LGTIME	: 10:14:
				THRESH	: 2500
SWL	: 1.3'				
REMARKS	: SWL FROM VIDEO				



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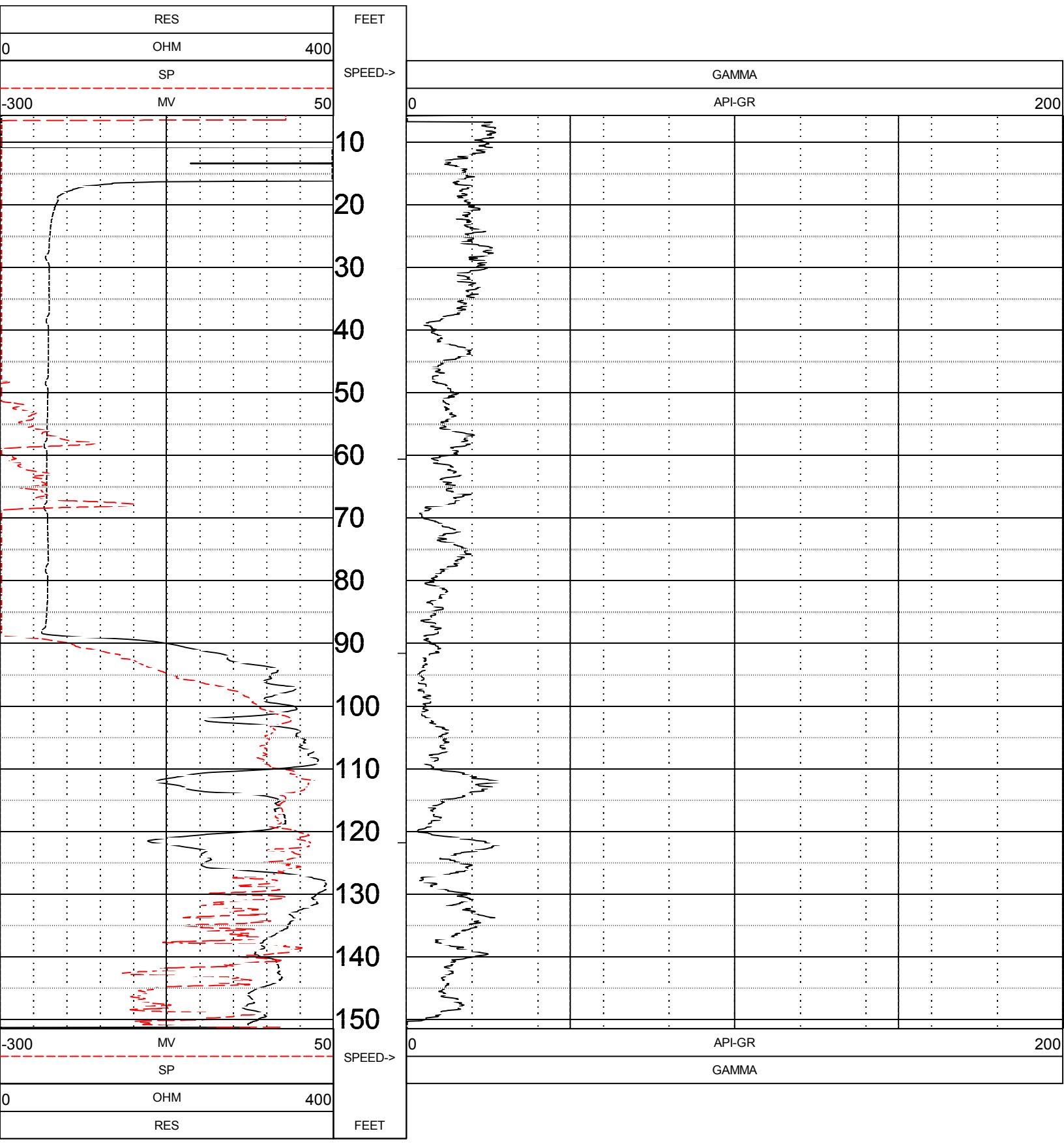
847054_GAMMA

NAME	: MW4A			OTHER SERVICES:	
UNIQUE NUMBER	: 847054_GAMMA				
QUADRANGLE	: LAKE ELMO 102-B				
COUNTY	: WASHINGTON				
LOCATION/SUBSECTI	: DCCDAA				
SECTION	: 23	TOWNSHIP	: 29	RANGE	: 21W
DATE	: 12/17/19	MGS CUTTINGS #	:		
CASING BOTTOM	: 90'			KB	:
LOG BOTTOM	: 151.44	LOG MEASURED FROM	: GL	DF	:
LOG TOP	: 5.69	DRL MEASURED FROM	:	GL	: 889.1 L1
CASING DIAMETER	: 8"	LOG RATE	: 30FPM		
CASING TYPE	: STEEL	FIELD OFFICE	: TRUCK		
CASING THICKNESS	:	RECORDED BY	: RETZLER		
BIT SIZE	: 4	BOREHOLE FLUID	: 0	FILE	: PROCESSED
MAGNETIC DECL.	: 0	RM	: 0	TYPE	: 9060A
MATRIX DENSITY	: 2.84	RM TEMPERATURE	: 0	LGDATE	: 12/17/19
NEUTRON MATRIX	: DOLOMITE	MATRIX DELTA T	: 44	LGTIME	: 09:44:
				THRESH	: 2500
SWL	: 1.3'				
REMARKS	: SWL FROM VIDEO				



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St. Paul, MN 55114
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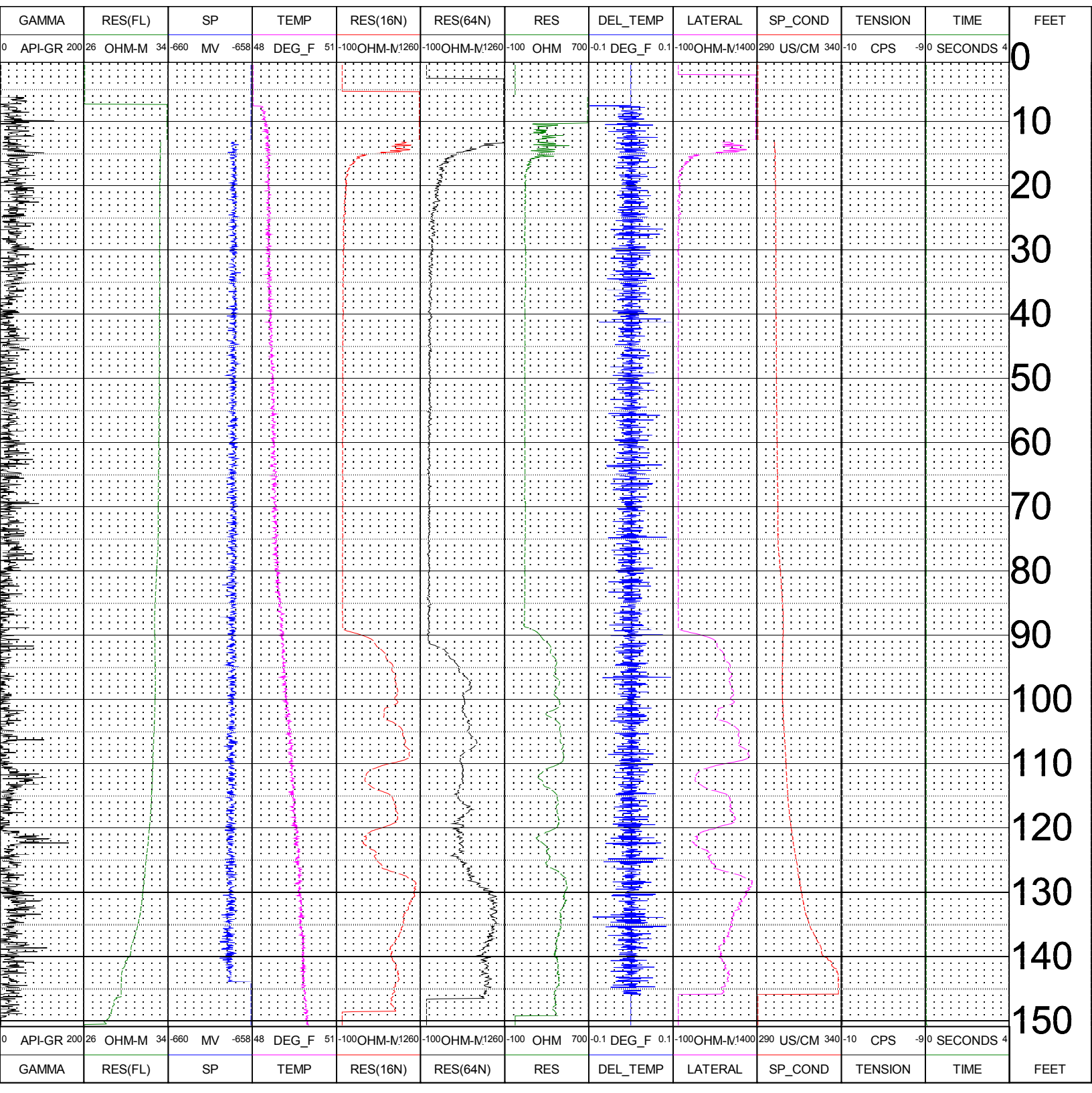
847054_MULTI

NAME	: MW4A			OTHER SERVICES:	
UNIQUE NUMBER	: 847054_MULTI				
QUADRANGLE	: LAKE ELMO 102-B				
COUNTY	: WASHINGTON				
LOCATION/SUBSECTI:	DCCDAA				
SECTION	: 23	TOWNSHIP	: 29	RANGE	: 21W
DATE	: 12/17/19	MGS CUTTINGS #	:		
CASING BOTTOM	: 90'			KB	:
LOG BOTTOM	: 150.84	LOG MEASURED FROM:	GL	DF	:
LOG TOP	: 0.84	DRL MEASURED FROM	:	GL	: 889.1 L1
CASING DIAMETER	: 8"	LOG RATE	: 30FPM		
CASING TYPE	: STEEL	FIELD OFFICE	: TRUCK		
CASING THICKNESS	:	RECORDED BY	: RETZLER		
BIT SIZE	: 4	BOREHOLE FLUID	: 0	FILE	: PROCESSED
MAGNETIC DECL.	: 0	RM	: 0	TYPE	: 8144A
MATRIX DENSITY	: 2.84	RM TEMPERATURE	: 0	LGDATE	: 12/17/19
NEUTRON MATRIX	: DOLOMITE	MATRIX DELTA T	: 44	LGTIME	: 09:59:
				THRESH	: 2500
SWL	: 1.3'				
REMARKS	: SWL FROM VIDEO				



Preliminary Flowmeter Summary and Results

Well Name: MW4A
Unique Number: 847054
Date Logged: 12/17/2019

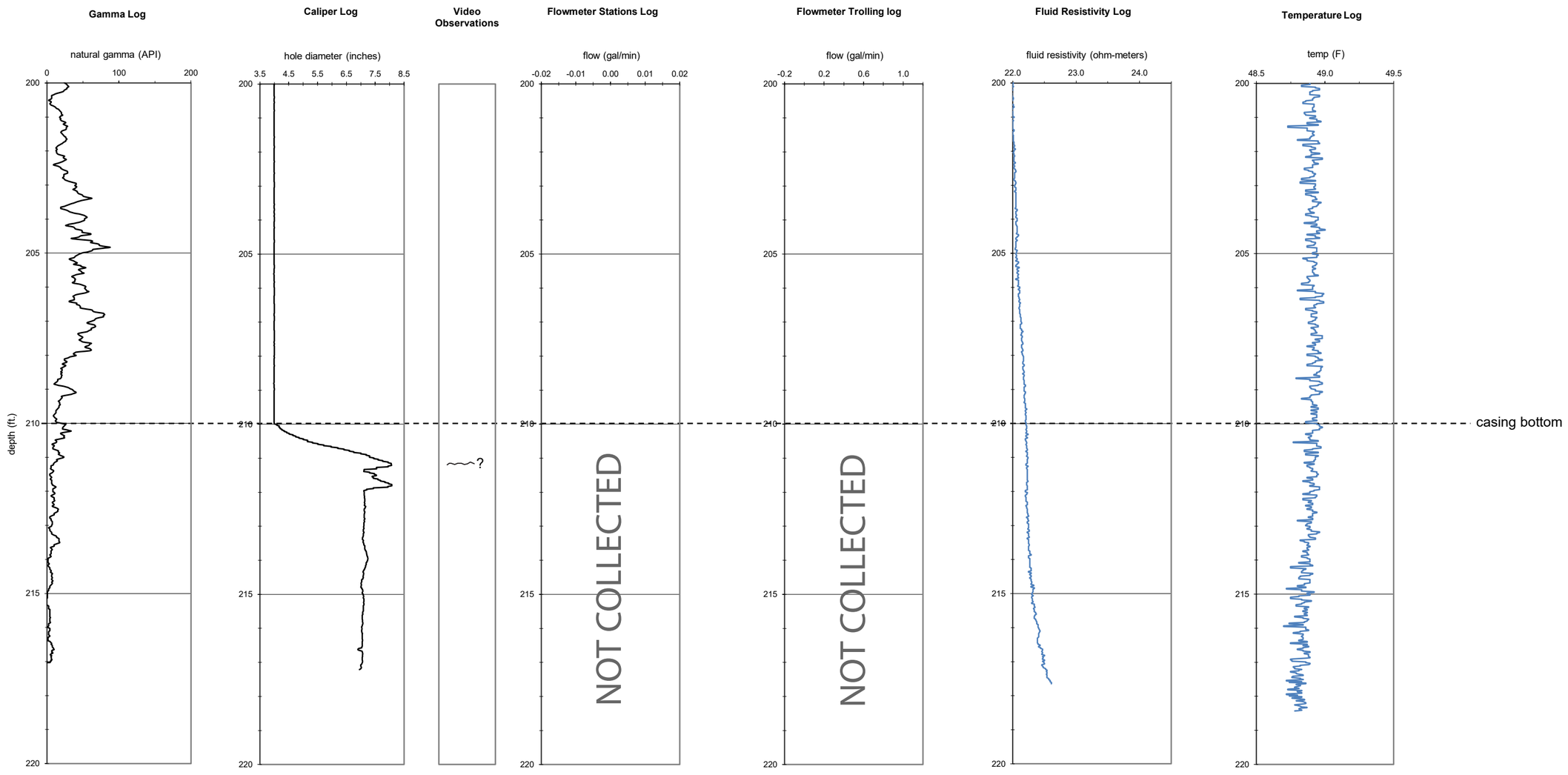
Note: This summary accompanies the video log, video log notes, gamma log, caliper log, and multitool log.

The fluid resistivity log shows a change in slope (to a flat-line reading) from about 143.0 to 146.5 ft. depth. This may be indicative of flow (either upflow or downflow) in this portion of the borehole; however, observations from the video log cannot confirm possible flow within this interval. The temperature log also does not show any sharp deflections at these depths. It is possible that these readings are extraneous due to the addition of water into the borehole while video logging and prior to logging with the multitool.

The video logging observations note a number of large cavities, horizontal fractures containing rubble/loose material, and iron staining along the borehole wall. Of note is a vertical fracture observed around 146.7 to 145.0 ft. depth with iron staining. This may be related to the possible interval of flow indicated in the fluid resistivity log. Iron staining along this fracture may indicate this fracture was or still is hydraulically active.

ATTACHMENT B-2
MW5A
GEOPHYSICAL LOGGING
RESULTS

Well Name: MW5A
Unique Number: 847056
T-R-S: T29 R21 Section 23 DCABDB



Geology:
0-60 QUUU, Quaternary sediments
60-140 OPSH, Shakopee Formation
140-203 OPOD, Oneota Dolomite
203-220+ CJDN, Jordan Sandstone

KEY:
- subvertical fracture
- bedding plane fracture
- other vugs/macropores
- multitool log

NOTE: The original caliper log depth was off by about 0.6 ft. based on bottom of casing depth (which should be 210') and has been corrected on this figure. The video log footages are off by an additional 3.0 ft. and the observations shown in this figure take this into account. All other logs are unmodified.

Logged by Minnesota Geological Survey
5/15/2020
Multitool, Caliper, Video

Preliminary Flowmeter Summary and Results

Well Name: MW5A
Unique Number: 847056
Date Logged: 5/15/2020

Note: This summary accompanies the flowmeter results figure. Also, please note that the footages in the accompanying video log are off by an additional 3.0 feet based on the actual depth to bottom of casing (210 feet). Video observations shown on the results figure take this into account.

The video and caliper logs indicate a fairly smooth Jordan Sandstone open borehole, with the exception of some larger void spaces at depths of about 211.0' and 211.7'. There may be a very thin bedding plane fracture at the larger void space at 211.0' depth. Some portions of the borehole appear to be weakly-cemented, indicated by loose Jordan Sandstone material falling during the video log. There were no obvious signs of flow in or out of the open borehole noted in the video logged under ambient conditions. Particles in the video appear to be slowly settling due to gravity after being dislodged/disrupted by the video logging tool.

The fluid resistivity and temperature logs show a steady gradient/slope across the open borehole interval, indicating there are no discrete intervals where water enters or exits.

With these data mind, there are no obvious signs of flow in or out of the open borehole under ambient conditions.

Well Name: MW5A
Unique Number: 847056

VIDEO LOG OBSERVATIONS

Logged By: Retzler (MGS), Mayer (MGS)
Date: 5/15/2020
Note: Zeroed in sideview. Video log footages appear to be off by ~3.0' based on casing bottom depth.
BPF = bedding plane fracture

Depth (ft.):	Camera View:	Observations:
19.9	sideview	SWL
213.0	sideview	Bottom of casing
214.4	sideview	Steady downflow; probably tool-induced
215.8	sideview	Block of sandstone fell; loose material
219.8	sideview	Bottom of hole; murky from falling material

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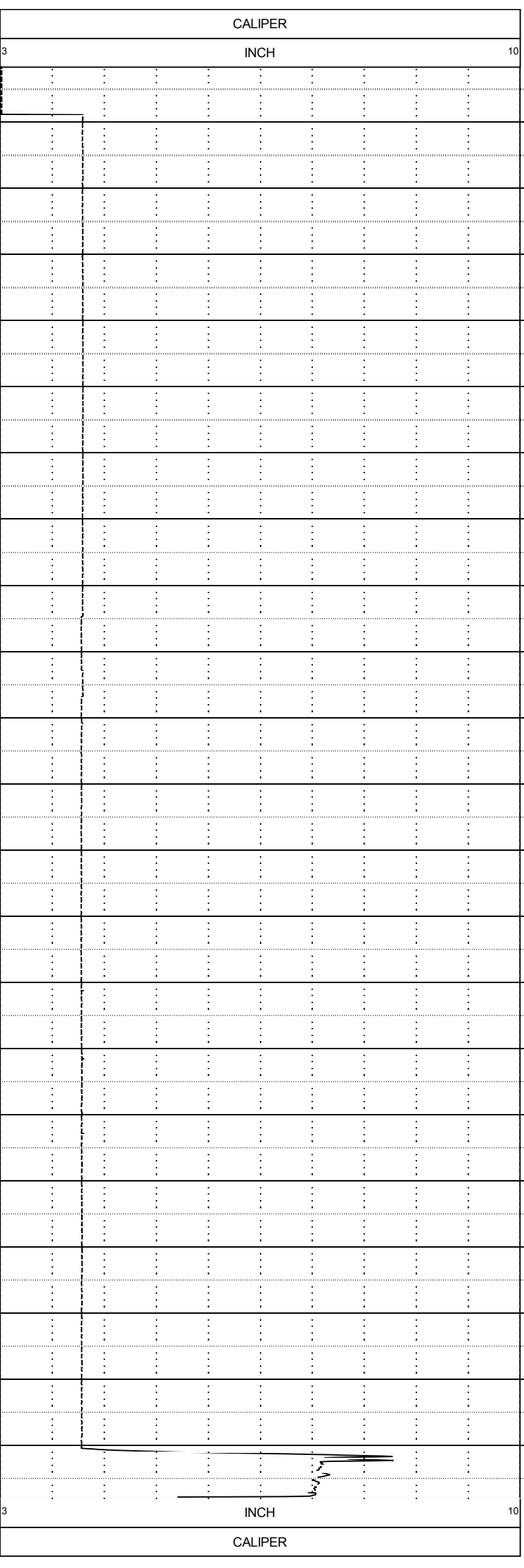
847056_CALIPER

NAME	: MW5A			OTHER SERVICES:	
UNIQUE NUMBER	: 847056_CALIPER				
QUADRANGLE	: 102B				
COUNTY	: WASHINGTON				
LOCATION/SUBSECTI:	DCABDB				
SECTION	: 23	TOWNSHIP	: 29	RANGE	: 21
DATE	: 05/15/20	MGS CUTTINGS #	:		
CASING BOTTOM	: 210'			KB	:
LOG BOTTOM	: 217.94	LOG MEASURED FROM:	GL	DF	:
LOG TOP	: 1.69	DRL MEASURED FROM:		GL	: 909 L1
CASING DIAMETER	: 4"	LOG RATE	: 30FPM		
CASING TYPE	: STEEL	FIELD OFFICE	: TRUCK		
CASING THICKNESS	:	RECORDED BY	: MAYER		
BIT SIZE	: 6	BOREHOLE FLUID	: 0	FILE	: PROCESSED
MAGNETIC DECL.	: 0	RM	: 0	TYPE	: 8074A
MATRIX DENSITY	: 2.84	RM TEMPERATURE	: 0	LGDATE:	05/15/20
NEUTRON MATRIX	: DOLOMITE	MATRIX DELTA T	: 44	LGTIME	: 14:28:
				THRESH:	2500
SWL	: 23'				
REMARKS	: PROJECT 1007				



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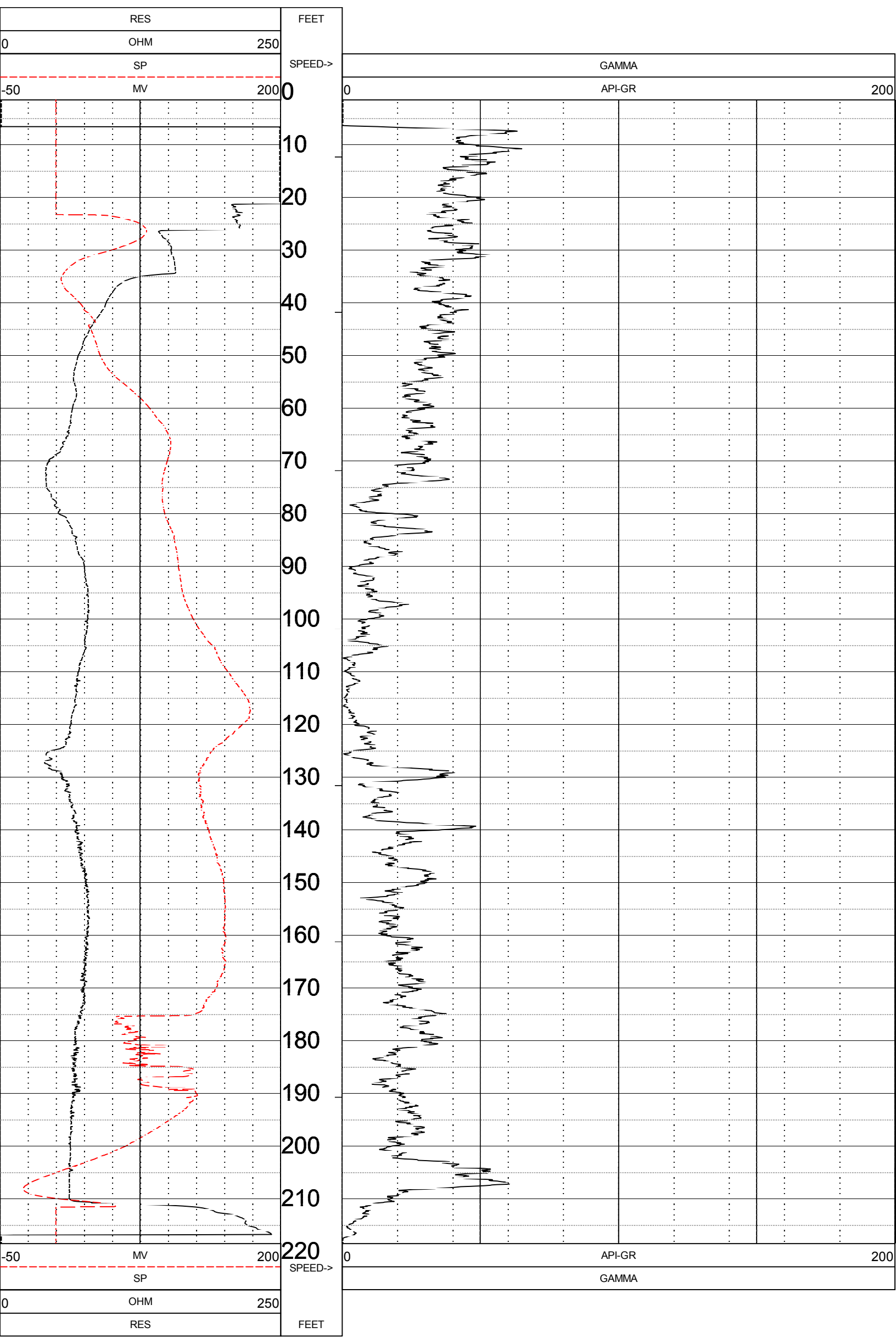
847056_MULTIGAMMA

NAME	: MW5A			OTHER SERVICES:	
UNIQUE NUMBER	: 847056_MULTIGAMMA				
QUADRANGLE	: 102B				
COUNTY	: WASHINGTON				
LOCATION/SUBSECTI:	DCABDB				
SECTION	: 23	TOWNSHIP	: 29	RANGE	: 21
DATE	: 05/15/20	MGS CUTTINGS #	:		
CASING BOTTOM	: 210'			KB	:
LOG BOTTOM	: 218.44	LOG MEASURED FROM:	GL	DF	:
LOG TOP	: 1.53	DRL MEASURED FROM	:	GL	: 909 L1
CASING DIAMETER	: 4"	LOG RATE	: 30FPM		
CASING TYPE	: STEEL	FIELD OFFICE	: TRUCK		
CASING THICKNESS	:	RECORDED BY	: MAYER		
BIT SIZE	: 6	BOREHOLE FLUID	: 0	FILE	: PROCESSED
MAGNETIC DECL.	: 0	RM	: 0	TYPE	: 8144A
MATRIX DENSITY	: 2.84	RM TEMPERATURE	: 0	LGDATE:	05/15/20
NEUTRON MATRIX	: DOLOMITE	MATRIX DELTA T	: 44	LGTIME	: 14:07:
				THRESH:	2500
SWL	: 23'				
REMARKS	: PROJECT 1007				



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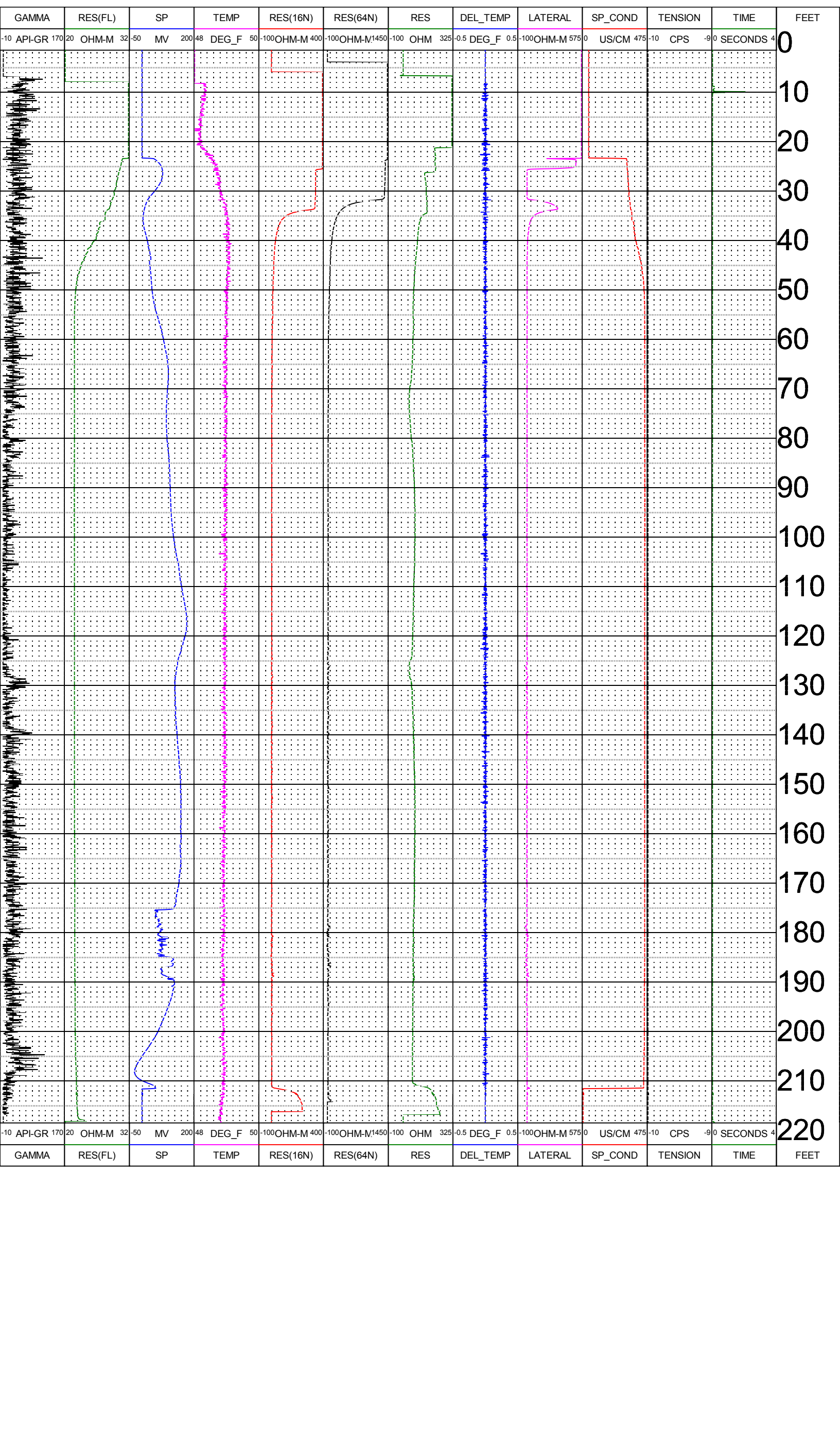
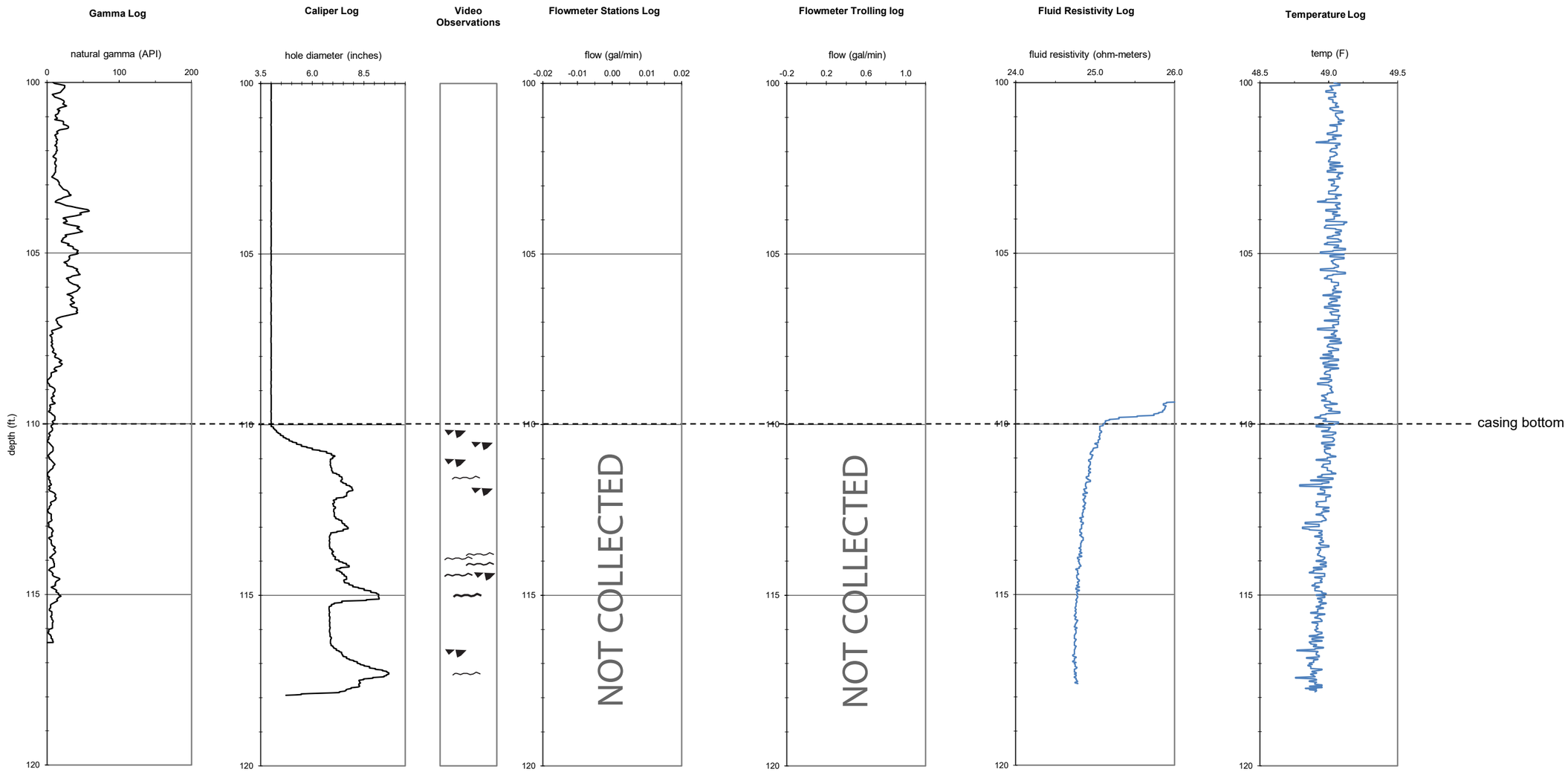
847056_MULTI

NAME	: MW5A			OTHER SERVICES:	
UNIQUE NUMBER	: 847056_MULTI				
QUADRANGLE	: 102B				
COUNTY	: WASHINGTON				
LOCATION/SUBSECTI:	DCABDB				
SECTION	: 23	TOWNSHIP	: 29	RANGE	: 21
DATE	: 05/15/20	MGS CUTTINGS #	:		
CASING BOTTOM	: 210'			KB	:
LOG BOTTOM	: 218.44	LOG MEASURED FROM:	GL	DF	:
LOG TOP	: 1.53	DRL MEASURED FROM:		GL	: 909 L1
CASING DIAMETER	: 4"	LOG RATE	: 30FPM		
CASING TYPE	: STEEL	FIELD OFFICE	: TRUCK		
CASING THICKNESS	:	RECORDED BY	: MAYER		
BIT SIZE	: 6	BOREHOLE FLUID	: 0	FILE	: PROCESSED
MAGNETIC DECL.	: 0	RM	: 0	TYPE	: 8144A
MATRIX DENSITY	: 2.84	RM TEMPERATURE	: 0	LGDATE:	05/15/20
NEUTRON MATRIX	: DOLOMITE	MATRIX DELTA T	: 44	LGTIME	: 14:07:
				THRESH:	2500
SWL	: 23'				
REMARKS	: PROJECT 1007				



ATTACHMENT B-2
MW5B
GEOPHYSICAL LOGGING
RESULTS

Well Name: MW5B
Unique Number: 847057
T-R-S: T29 R21 Section 23 DCABDB



Geology:
0-58 QUUU, Quaternary sediments
58-120+ OPSH, Shakopee Formation

KEY:
- subvertical fracture
- bedding plane fracture
- other vugs/macropores
- multitool log

NOTE: The video log footages are off by an additional 1.3 ft. and the observations shown on this figure take this into account. All other logs are unmodified.

Logged by Minnesota Geological Survey
5/15/2020
Multitool, Caliper, Video

Preliminary Flowmeter Summary and Results

Well Name: MW5B
Unique Number: 847057
Date Logged: 5/15/2020

Note: This summary accompanies the flowmeter results figure. Also, please note that the footages in the accompanying video log are off by an additional 1.3 feet based on the actual depth to bottom of casing (110 feet). Video observations shown on the results figure take this into account.

The video and caliper logs indicate a very vuggy and rubbly Shakopee Formation open borehole with several notable bedding plane fractures at depths of about 111.6', 114.0', 114.5', 115.0', and 117.3'. There were no obvious signs of flow in or out of the open borehole noted in the video logged under ambient conditions. Particles in the video appear to be slowly settling due to gravity after being dislodged/disrupted by the video logging tool.

The fluid resistivity and temperature logs show a steady gradient/slope across the open borehole interval, indicating there are no discrete intervals where water enters or exits

With these data mind, there are no obvious signs of flow in or out of the open borehole under ambient conditions.

Well Name: MW5B
Unique Number: 847057

VIDEO LOG OBSERVATIONS

Logged By: Retzler (MGS), Mayer (MGS)
Date: 5/15/2020
Note: Zeroed in sideview. Video log footages appear to be off by ~1.3' based on casing bottom depth.
BPF = bedding plane fracture

Depth (ft.):	Camera View:	Observations:
19.5	sideview	SWL
111.3	sideview	Bottom of casing
111.5	sideview	Vuggy
112.9	sideview	BPF and rubbly zone
114.2	sideview	Rubbly zone
115.1	sideview	Thin, rubbly BPF zone
115.4	sideview	Thin, rubbly BPF zone
115.7	sideview	Larger rubbly BPF zone
116.4	sideview	Ledgy, rubbly BPF zone
118.0	sideview	Thin, rubbly BPF zone
119.0	sideview	Bottom of hole

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Dept. Phone: (612)626-2969

847057_CALIPER

NAME	: MW5B			OTHER SERVICES:	
UNIQUE NUMBER	: 847057_CALIPER				
QUADRANGLE	: 102B				
COUNTY	: WASHINGTON				
LOCATION/SUBSECTI:	DCABDB				
SECTION	: 23	TOWNSHIP	: 29	RANGE	: 21
DATE	: 05/15/20	MGS CUTTINGS #	:		
CASING BOTTOM	: 110'			KB	:
LOG BOTTOM	: 117.93	LOG MEASURED FROM:	GL	DF	:
LOG TOP	: 0.05	DRL MEASURED FROM	:	GL	: 909 L1
CASING DIAMETER	: 4"	LOG RATE	: 30FPM		
CASING TYPE	: STEEL	FIELD OFFICE	: TRUCK		
CASING THICKNESS	:	RECORDED BY	: MAYER		
BIT SIZE	: 6	BOREHOLE FLUID	: 0	FILE	: PROCESSED
MAGNETIC DECL.	: 0	RM	: 0	TYPE	: 8074A
MATRIX DENSITY	: 2.84	RM TEMPERATURE	: 0	LGDATE:	05/15/20
NEUTRON MATRIX	: DOLOMITE	MATRIX DELTA T	: 44	LGTIME	: 15:02:
				THRESH:	2500
SWL	: 19'				
REMARKS	: PROJECT 1007				

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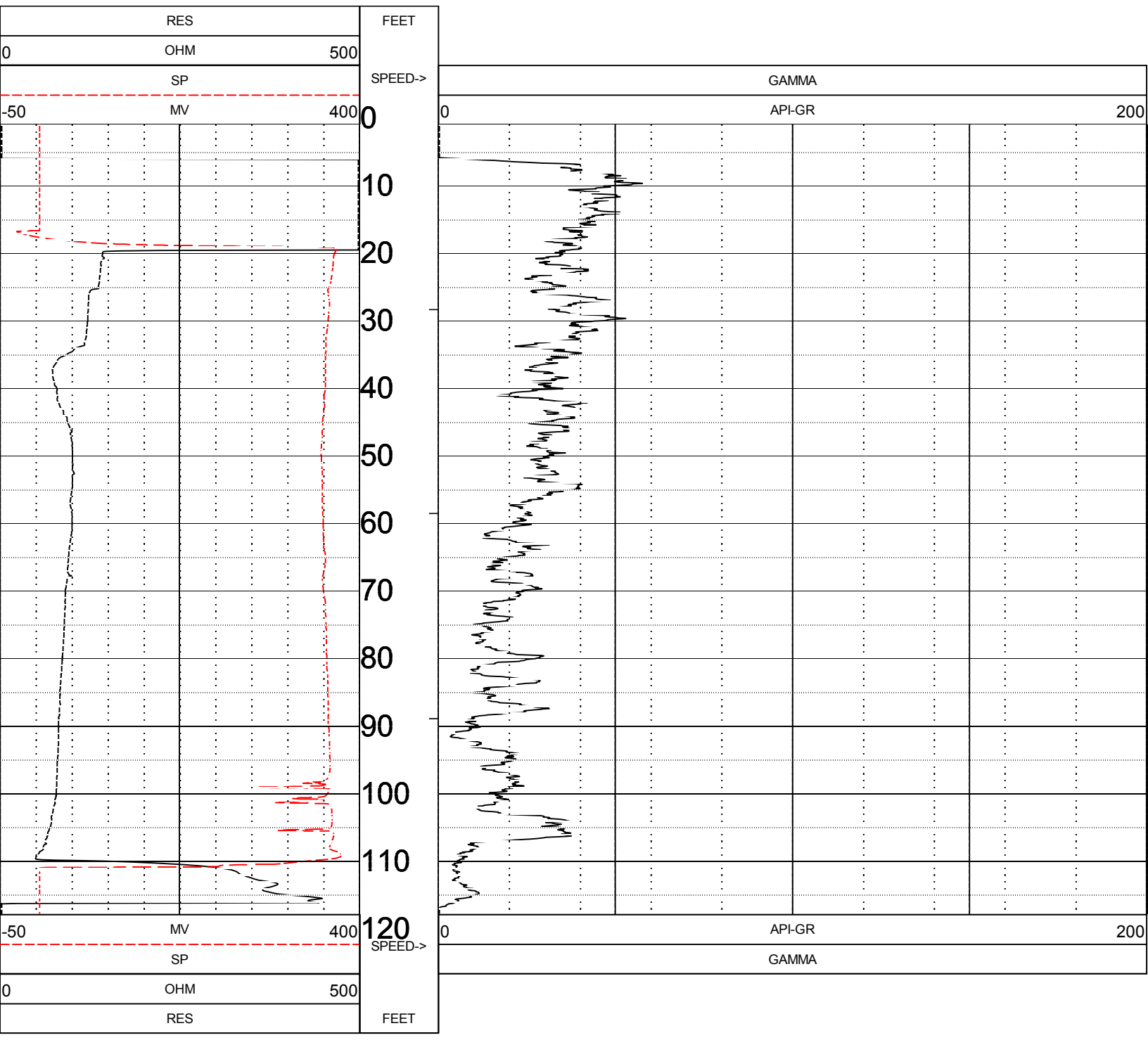
847057_MULTIGAMMA

NAME	: MW5B			OTHER SERVICES:	
UNIQUE NUMBER	: 847057_MULTIGAMMA				
QUADRANGLE	: 102B				
COUNTY	: WASHINGTON				
LOCATION/SUBSECTI:	DCABDB				
SECTION	: 23	TOWNSHIP	: 29	RANGE	: 21
DATE	: 05/15/20	MGS CUTTINGS #	:		
CASING BOTTOM	: 110'			KB	:
LOG BOTTOM	: 117.83	LOG MEASURED FROM:	GL	DF	:
LOG TOP	: 0.91	DRL MEASURED FROM	:	GL	: 909 L1
CASING DIAMETER	: 4"	LOG RATE	: 30FPM		
CASING TYPE	: STEEL	FIELD OFFICE	: TRUCK		
CASING THICKNESS	:	RECORDED BY	: MAYER		
BIT SIZE	: 6	BOREHOLE FLUID	: 0	FILE	: PROCESSED
MAGNETIC DECL.	: 0	RM	: 0	TYPE	: 8144A
MATRIX DENSITY	: 2.84	RM TEMPERATURE	: 0	LGDATE:	05/15/20
NEUTRON MATRIX	: DOLOMITE	MATRIX DELTA T	: 44	LGTIME	: 15:19:
				THRESH:	2500
SWL	: 19'				
REMARKS	: PROJECT 1007				



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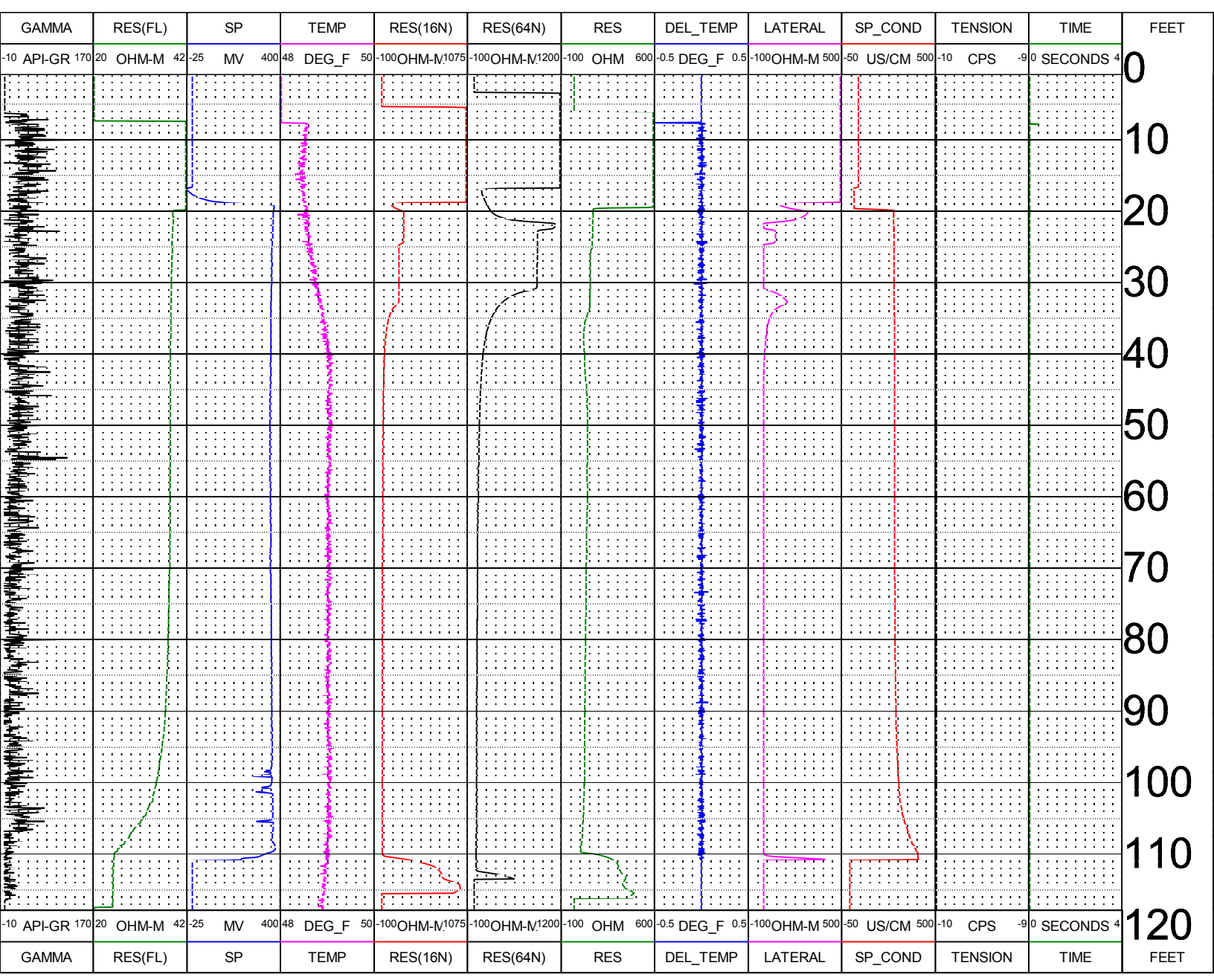
847057_MULTI

NAME	: MW5B			OTHER SERVICES:	
UNIQUE NUMBER	: 847057_MULTI				
QUADRANGLE	: 102B				
COUNTY	: WASHINGTON				
LOCATION/SUBSECTI:	DCABDB				
SECTION	: 23	TOWNSHIP	: 29	RANGE	: 21
DATE	: 05/15/20	MGS CUTTINGS #	:		
CASING BOTTOM	: 110'			KB	:
LOG BOTTOM	: 117.83	LOG MEASURED FROM:	GL	DF	:
LOG TOP	: 0.91	DRL MEASURED FROM:		GL	: 909 L1
CASING DIAMETER	: 4"	LOG RATE	: 30FPM		
CASING TYPE	: STEEL	FIELD OFFICE	: TRUCK		
CASING THICKNESS	:	RECORDED BY	: MAYER		
BIT SIZE	: 6	BOREHOLE FLUID	: 0	FILE	: PROCESSED
MAGNETIC DECL.	: 0	RM	: 0	TYPE	: 8144A
MATRIX DENSITY	: 2.84	RM TEMPERATURE	: 0	LGDATE:	05/15/20
NEUTRON MATRIX	: DOLOMITE	MATRIX DELTA T	: 44	LGTIME	: 15:19:
				THRESH:	2500
SWL	: 19'				
REMARKS	: PROJECT 1007				



ATTACHMENT B-2
MW6A
GEOPHYSICAL LOGGING
RESULTS

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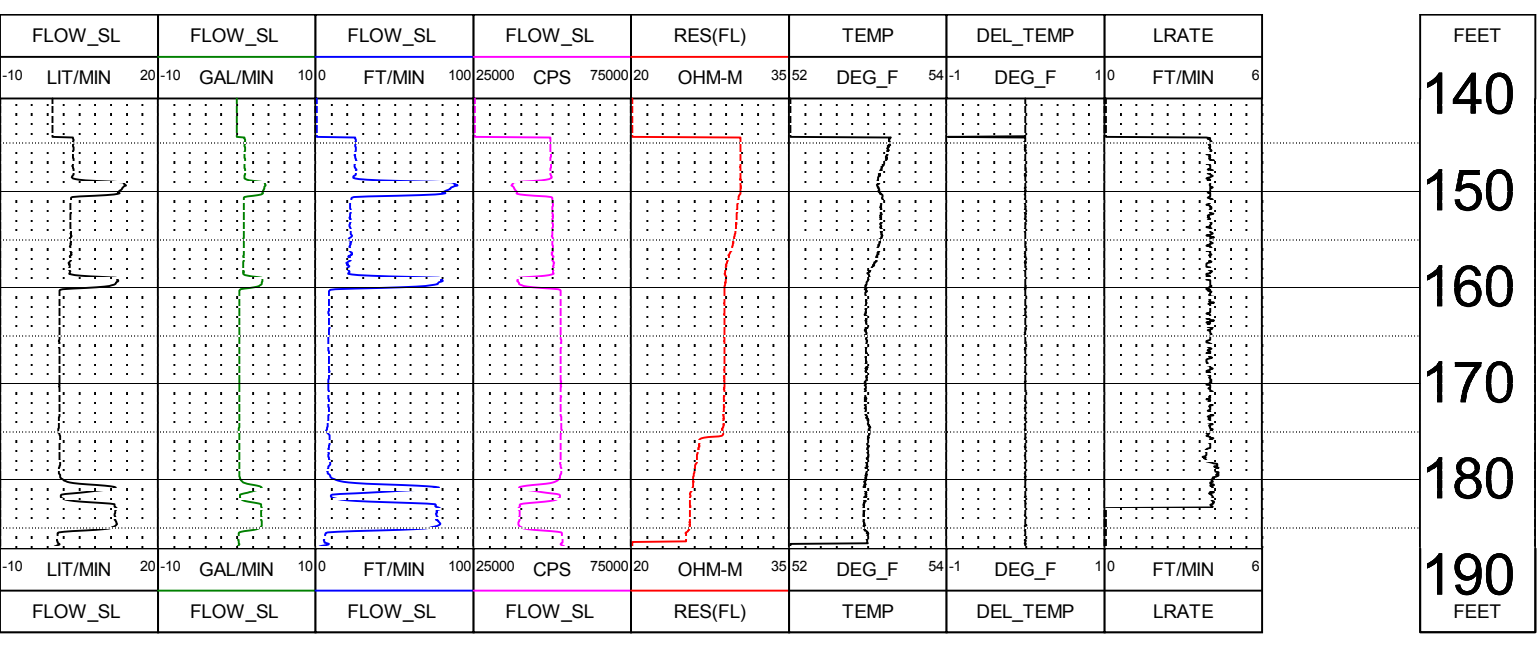
847058_AMBTROLL

NAME	: MW6A			OTHER SERVICES:	
UNIQUE NUMBER	: 847058_AMBTROLL				
QUADRANGLE	: 102B-LAKE ELMO				
COUNTY	: WASHINGTON				
LOCATION/SUBSECTI	: BBCDDD				
SECTION	: 25	TOWNSHIP	: 29	RANGE	: 21
DATE	: 11/15/19	MGS CUTTINGS #	:		
CASING BOTTOM	: 160			KB	:
LOG BOTTOM	: 187.08	LOG MEASURED FROM	:	DF	:
LOG TOP	: 140.34	DRL MEASURED FROM	:	GL	: 889 L1
CASING DIAMETER	: 6	LOG RATE	: 4 FPM		
CASING TYPE	:	FIELD OFFICE	: TRUCK		
CASING THICKNESS	: 0	RECORDED BY	: MAYER		
BIT SIZE	: 4	BOREHOLE FLUID	: 0	FILE	: PROCESSED
MAGNETIC DECL.	: 0	RM	: 0	TYPE	: 9721SL
MATRIX DENSITY	: 2.84	RM TEMPERATURE	: 0	LGDATE	: 11/15/19
NEUTRON MATRIX	: DOLOMITE	MATRIX DELTA T	: 44	LGTIME	: 10:47:
				THRESH	: 2500
SWL	: 8				
REMARKS	:				



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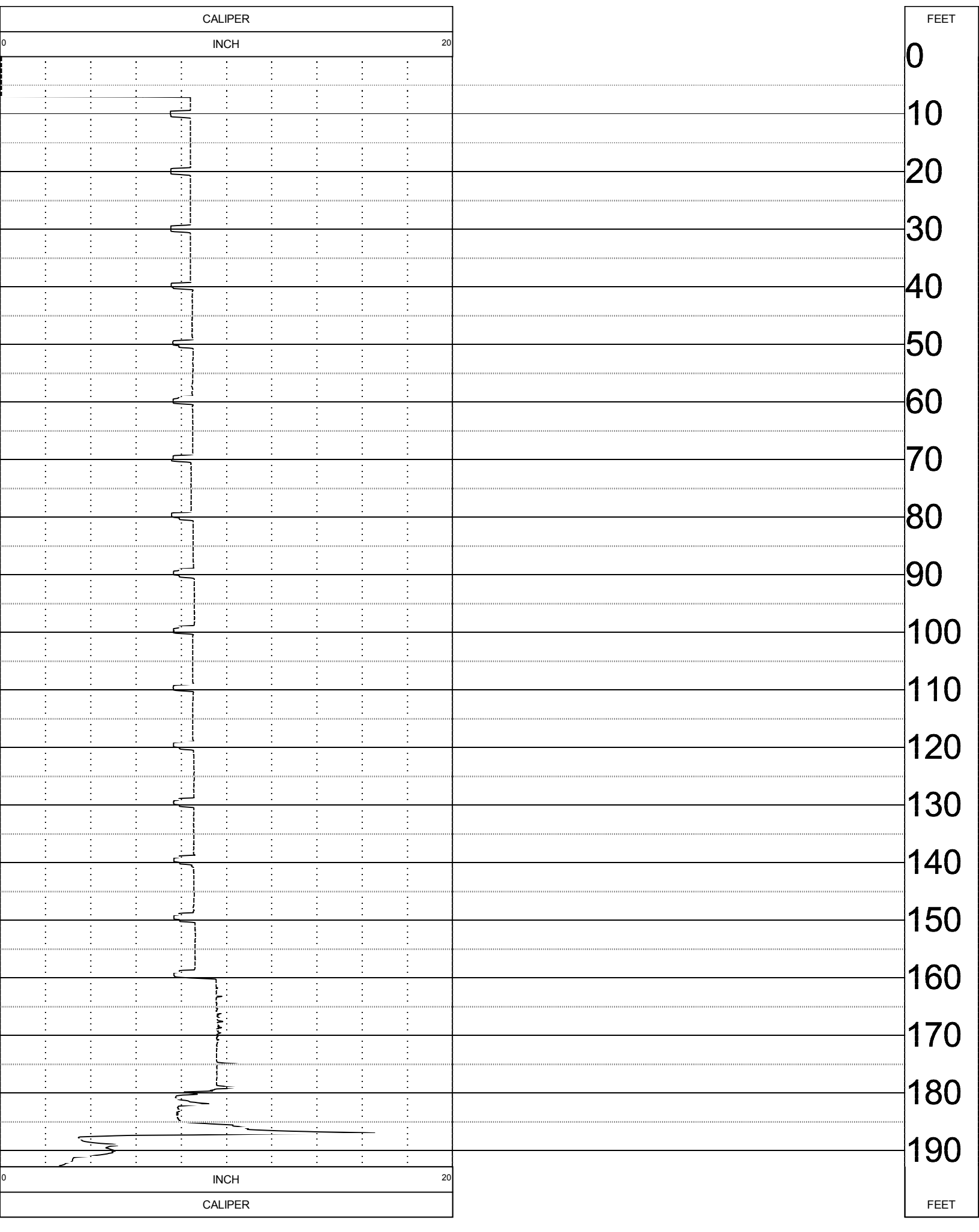
847058-CALIPER

NAME	: MW6A			OTHER SERVICES:	
UNIQUE NUMBER	: 847058-CALIPER				
QUADRANGLE	: 102B - LAKE ELMO				
COUNTY	: WASHINGTON				
LOCATION/SUBSECTI:	BBCDDD				
SECTION	: 29	TOWNSHIP	: 25	RANGE	: 21
DATE	: 11/15/19	MGS CUTTINGS #	:		
CASING BOTTOM	: 160			KB	:
LOG BOTTOM	: 192.75	LOG MEASURED FROM:		DF	:
LOG TOP	: 0.07	DRL MEASURED FROM:		GL	: 889L1
CASING DIAMETER	: 8	LOG RATE	: 30FPM		
CASING TYPE	:	FIELD OFFICE	: TRUCK		
CASING THICKNESS	: 0	RECORDED BY	: MAYER		
BIT SIZE	: 4	BOREHOLE FLUID	: 0	FILE	: PROCESSED
MAGNETIC DECL.	: 0	RM	: 0	TYPE	: 8074A
MATRIX DENSITY	: 2.84	RM TEMPERATURE	: 0	LGDATE:	11/15/19
NEUTRON MATRIX	: DOLOMITE	MATRIX DELTA T	: 44	LGTIME :	10:06:
				THRESH:	2500
SWL	: 8				
REMARKS	:				



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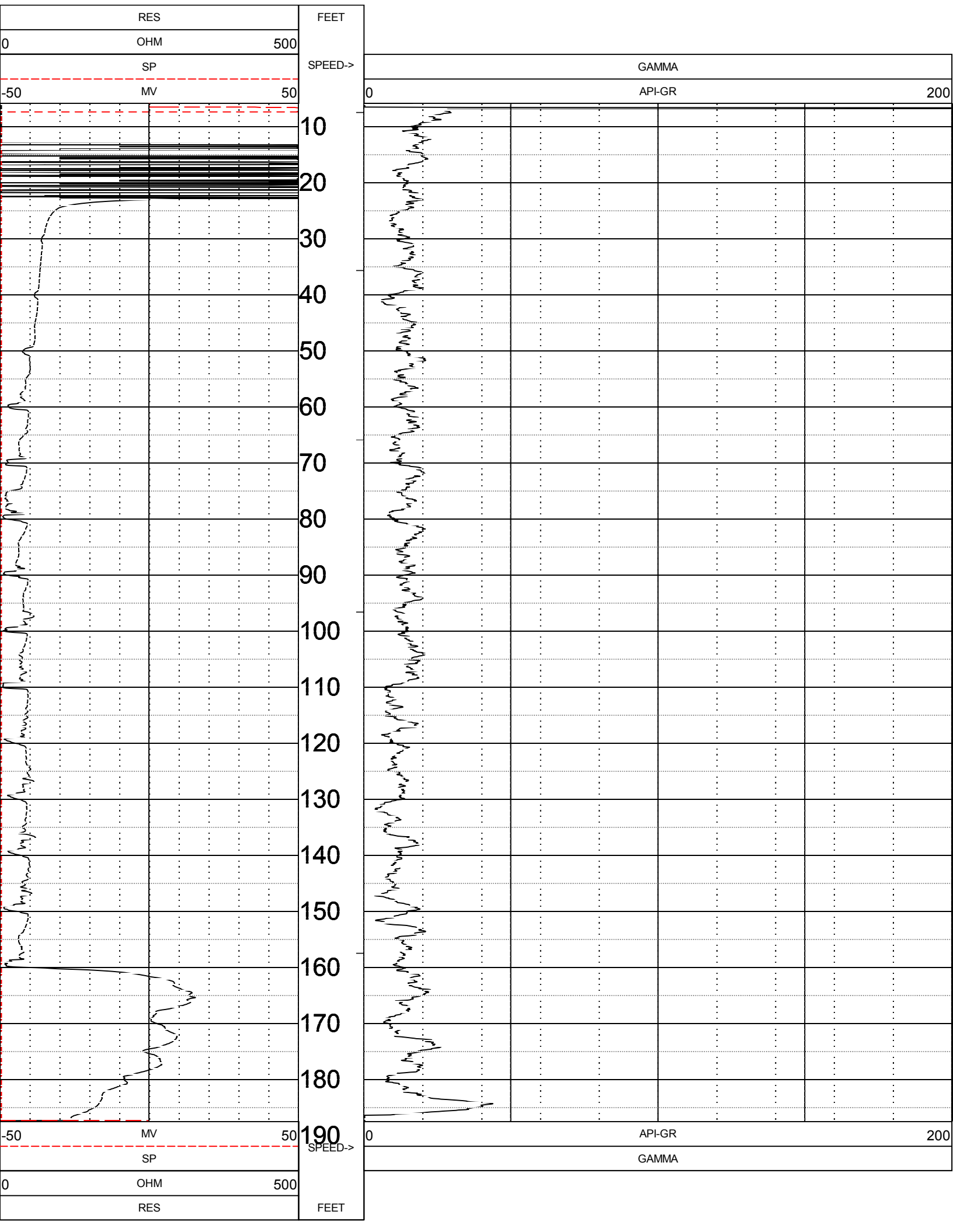
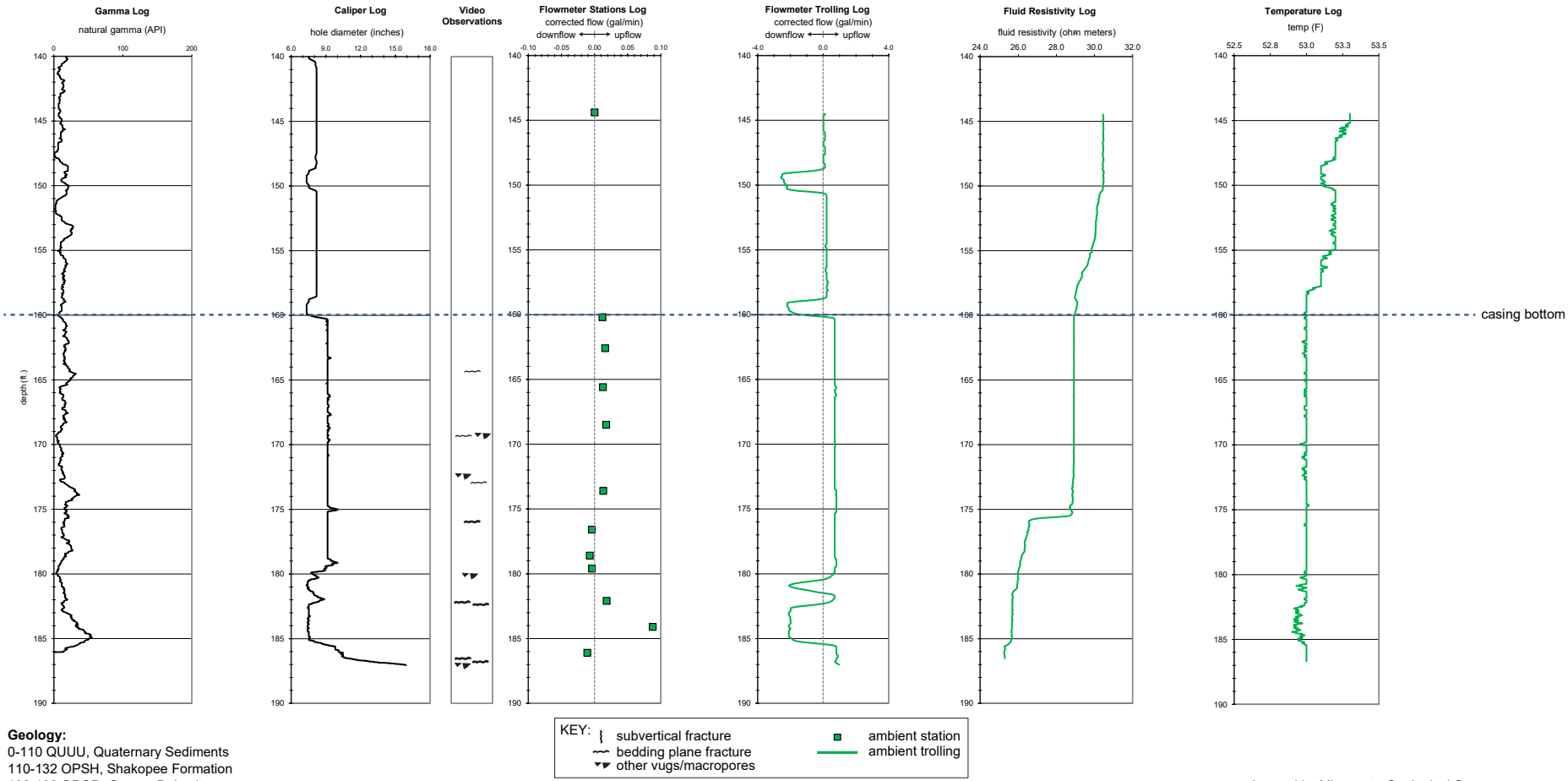
847058

NAME	: MW6A			OTHER SERVICES:	
UNIQUE NUMBER	: 847058				
QUADRANGLE	: 102B - LAKE ELMO				
COUNTY	: WASHINGTON				
LOCATION/SUBSECTI:	BBCDDD				
SECTION	: 25	TOWNSHIP	: 29	RANGE	: 21
DATE	: 11/15/19	MGS CUTTINGS #	:		
CASING BOTTOM	: 160			KB	:
LOG BOTTOM	: 187.42	LOG MEASURED FROM:		DF	:
LOG TOP	: 5.85	DRL MEASURED FROM:		GL	: 889L1
CASING DIAMETER	: 6	LOG RATE	: 30FPM		
CASING TYPE	:	FIELD OFFICE	: TRUCK		
CASING THICKNESS	: 0	RECORDED BY	: MAYER		
BIT SIZE	: 4	BOREHOLE FLUID	: 0	FILE	: PROCESSED
MAGNETIC DECL.	: 0	RM	: 0	TYPE	: 9060A
MATRIX DENSITY	: 2.84	RM TEMPERATURE	: 0	LGDATE:	11/15/19
NEUTRON MATRIX	: DOLOMITE	MATRIX DELTA T	: 44	LGTIME :	09:41:
				THRESH:	2500
SWL	:				
REMARKS	:				



Well Name: MW6A
Unique Number: 847058
T-R-S: T29 R21 Section 25



Geology:
0-110 QUUU, Quaternary Sediments
110-132 OPSH, Shakopee Formation
132-182 OPOD, Oneota Dolomite
182-187 CJDN, Jordan Sandstone

NOTE: The gamma log depths may be off, as it suggests the top of the Jordan may be at 186 ft. The pick of 182 ft. is used here based on core and drillers descriptions. The depths of all other logs appear to be correct and in agreement with each other. Also note that the flow values reported and graphed have been corrected to compensate for logging speed and average values measured within the casing (assumed to be no flow).

Logged by Minnesota Geological Survey
11/15/2019
Gamma, Caliper, Ambient Flowmeter
Video by Traut; observed by MGS

Preliminary Flowmeter Summary and Results

Well Name: MW6A
Unique Number: 847058
Date Logged: 11/15/2019

Note: This summary accompanies the flowmeter results illustration.

The fluid resistivity log shows a sharp deflection between about 175-176 ft. depth. This likely indicates a contact between two chemically-distinct sources of water. Furthermore, we observed possible turbulent flow at about 176 ft. in the video, but these observations are inconclusive due to water being injected into the borehole during video logging. Nevertheless, two equally-plausible scenarios of flow originating from 175-176 ft. are possible given this fluid resistivity deflection, the video observation, and the other collected data:

The first scenario is very minor upflow in the Oneota of about 0.013 gal/min (as indicated by the corrected station measurements) originating at about 175-176 ft. depth and exiting near casing bottom. It is important to also note that the fluid resistivity readings within this interval (~160-175.5 ft.) are very flat and consistent, which is often indicative of one chemically-distinct water source throughout that interval and lends support to this interpretation.

The second possible scenario is very minor downflow in the Oneota of about -0.004 gal/min (as indicated by the corrected station measurements) originating at about 175-176 ft. depth and exiting at about 182 ft. The fluid resistivity values along this stretch are more varied, showing a steady decrease in resistance downward.

Please note that the corrected station measurements for both of the above scenarios (from 160 to 180 ft.) are very low and within the range of possible error given the true borehole diameter (9”), the diameter of the skirt used (8”), and the precision of the flowmeter tool.

Lastly, corrected station measurements also indicate very minor upflow in the Jordan of about 0.088 gal/min measured at about 184 ft. depth and exiting at about 182 ft. Upflow at this rate is also likely occurring below 184 ft. and to the bottom of the hole, but could not be accurately measured due to a poor seal around the flowmeter skirt in this larger, more cavernous part of the borehole. This upflow and exit point interpretation is also supported by the observations made during video logging.

Well Name: MW6A
Unique Number: 847058

VIDEO LOG OBSERVATIONS

Logged By: Traut; Observations by Retzler (MGS)
Date: 11/14/2019
Note: Traut camera was zeroed in sideview.

Depth (ft.):	Camera View:	Observations:
164.4	sideview	thin bedding plane fracture (BPF); vuggy; microbial; Hager City
169.4	sideview	thin BPFs and vugs
172.5	sideview	very vuggy
172.9	sideview	thin BPF
176	sideview	large BPF; turbulent; possible flow?
180.1	sideview	large vuggy zone; looks like Coon Valley
182.2	sideview	blocky, fractured zone; possible outflow?
182.5	sideview	BPF; possible outflow?
182.9	sideview	suspended particles flowing upwards
183.1	sideview	borehole opens up
186.7	sideview	BPF and cavern area
187.1	sideview	cavern area
187.6	sideview	cavern area; bottom of hole

Well Name: MW6A
Unique Number: 847058

FLOW LOG STATION MEASUREMENTS

Logged By: Mayer (MGS) and Steenberg (MGS)
Date: 11/15/2019
Flow Tool Skirt Diameter (in.): 8
Note: (+) flow values = upflow; (-) flow values = downflow
Corrected flow values are calculated using values measured in the casing (assumed to be zero).

Depth (ft.):	Flow (l/min)	Corrected Flow (l/min):	Comments:
144.4	-0.2528	0.0000	casing
160.2	-0.2166	0.0453	casing
162.6	-0.2041	0.0609	steady
165.6	-0.2149	0.0474	steady
168.5	-0.2001	0.0659	steady
173.6	-0.2131	0.0496	steady
176.6	-0.2648	-0.0150	steady
178.6	-0.2748	-0.0275	
179.6	-0.265	-0.0153	
182.1	-0.1977	0.0689	steady
184.1	0.0131	0.3324	
186.1	-0.2859	-0.0414	cavern

ATTACHMENT B-2
MW6B
GEOPHYSICAL LOGGING
RESULTS

Minnesota Geological Survey
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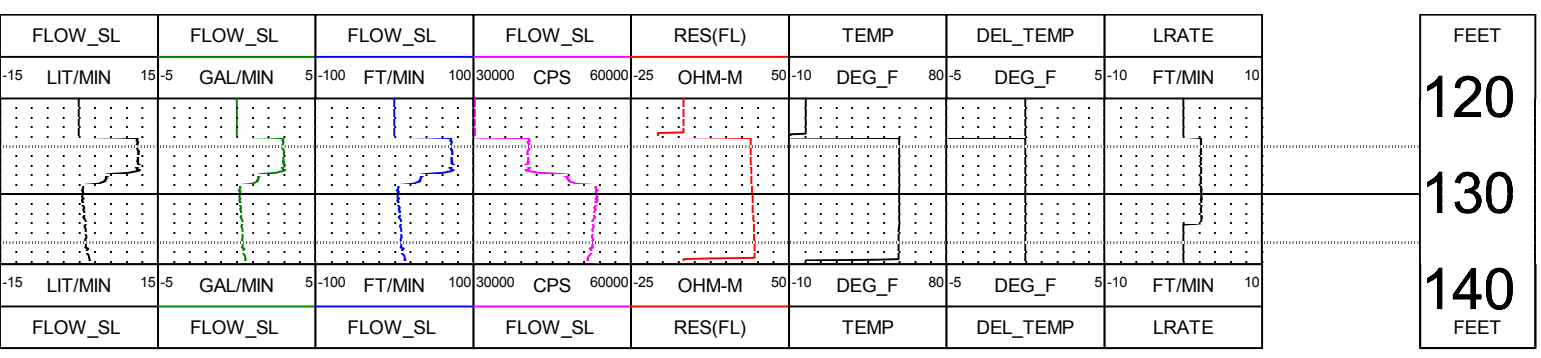
847059_AMBTROLL

NAME	: MW6B			OTHER SERVICES:	
UNIQUE NUMBER	: 847059_AMBTROLL				
QUADRANGLE	: 102B - LAKE ELMO				
COUNTY	: WASHINGTON				
LOCATION/SUBSECTI	: BBCDDD				
SECTION	: 25	TOWNSHIP	: 29	RANGE	: 21
DATE	: 11/21/19	MGS CUTTINGS #	:		
CASING BOTTOM	: 133			KB	:
LOG BOTTOM	: 137.19	LOG MEASURED FROM	:	DF	:
LOG TOP	: 120.02	DRL MEASURED FROM	:	GL	: 889L1
CASING DIAMETER	: 8X6	LOG RATE	: 4FPM		
CASING TYPE	:	FIELD OFFICE	: TRUCK		
CASING THICKNESS	: 0	RECORDED BY	: CICHA		
BIT SIZE	: 4	BOREHOLE FLUID	: 0	FILE	: PROCESSED
MAGNETIC DECL.	: 0	RM	: 0	TYPE	: 9721SL
MATRIX DENSITY	: 2.84	RM TEMPERATURE	: 0	LGDATE	: 11/21/19
NEUTRON MATRIX	: DOLOMITE	MATRIX DELTA T	: 44	LGTIME	: 10:18:
				THRESH	: 2500
SWL	: 9.8				
REMARKS	:				



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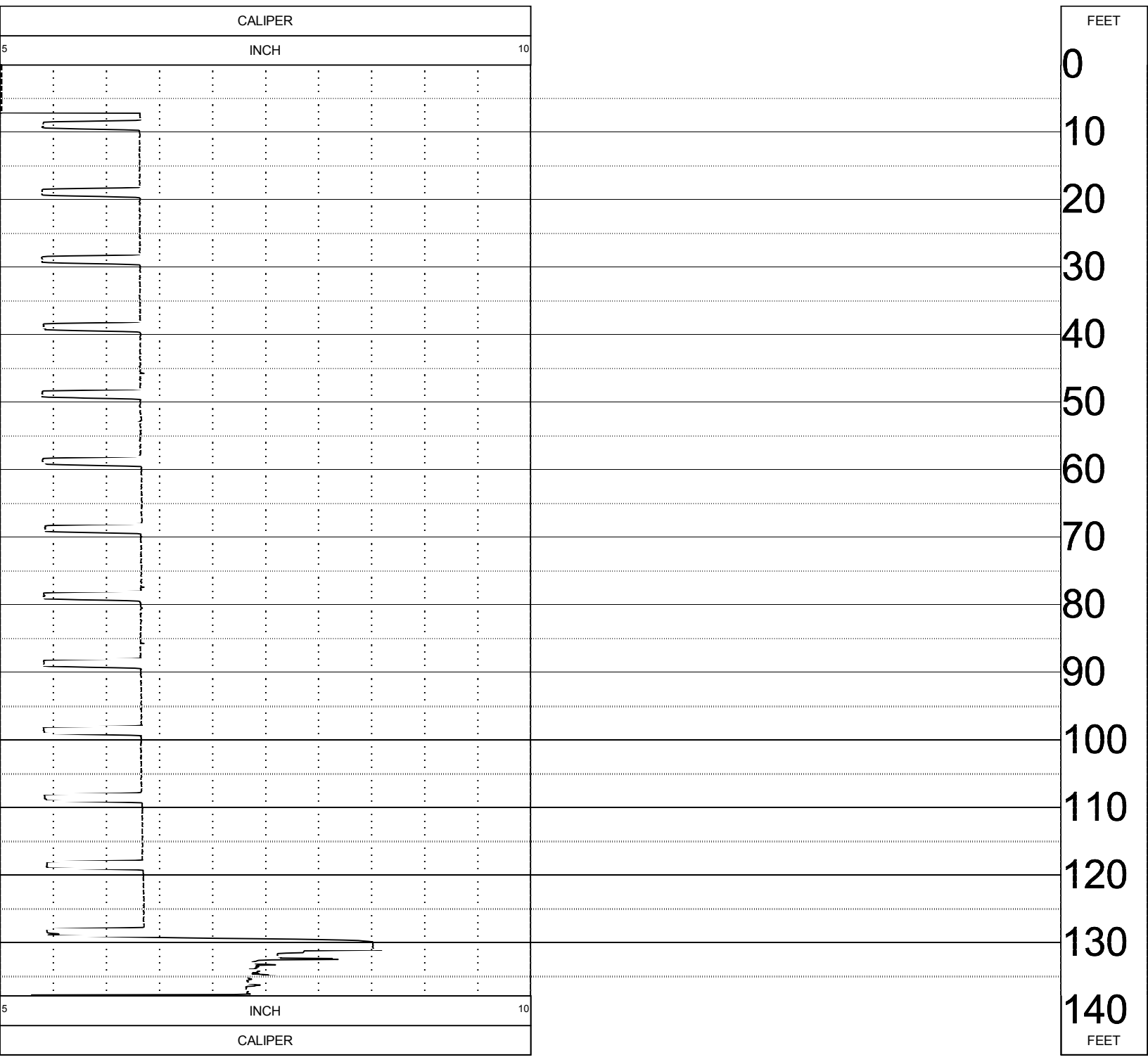
St. Paul, MN 55114
Dept. Phone: (612)626-2969

847059_CALIPER

NAME	: MW6B			OTHER SERVICES:	
UNIQUE NUMBER	: 847059_CALIPER				
QUADRANGLE	: 102B - LAKE ELMO				
COUNTY	: WASHINGTON				
LOCATION/SUBSECTI:	BBCDDD				
SECTION	: 25	TOWNSHIP	: 29	RANGE	: 21
DATE	: 11/21/19	MGS CUTTINGS #	:		
CASING BOTTOM	: 133			KB	:
LOG BOTTOM	: 137.83	LOG MEASURED FROM:		DF	:
LOG TOP	: 0.08	DRL MEASURED FROM:		GL	: 889L1
CASING DIAMETER	: 8X6	LOG RATE	: 30FPM		
CASING TYPE	:	FIELD OFFICE	: TRUCK		
CASING THICKNESS	: 0	RECORDED BY	: CICHA		
BIT SIZE	: 4	BOREHOLE FLUID	: 0	FILE	: PROCESSED
MAGNETIC DECL.	: 0	RM	: 0	TYPE	: 8074A
MATRIX DENSITY	: 2.84	RM TEMPERATURE	: 0	LGDATE	: 11/21/19
NEUTRON MATRIX	: DOLOMITE	MATRIX DELTA T	: 44	LGTIME	: 09:54:
				THRESH	: 2500
SWL	: 9.6				
REMARKS	:				



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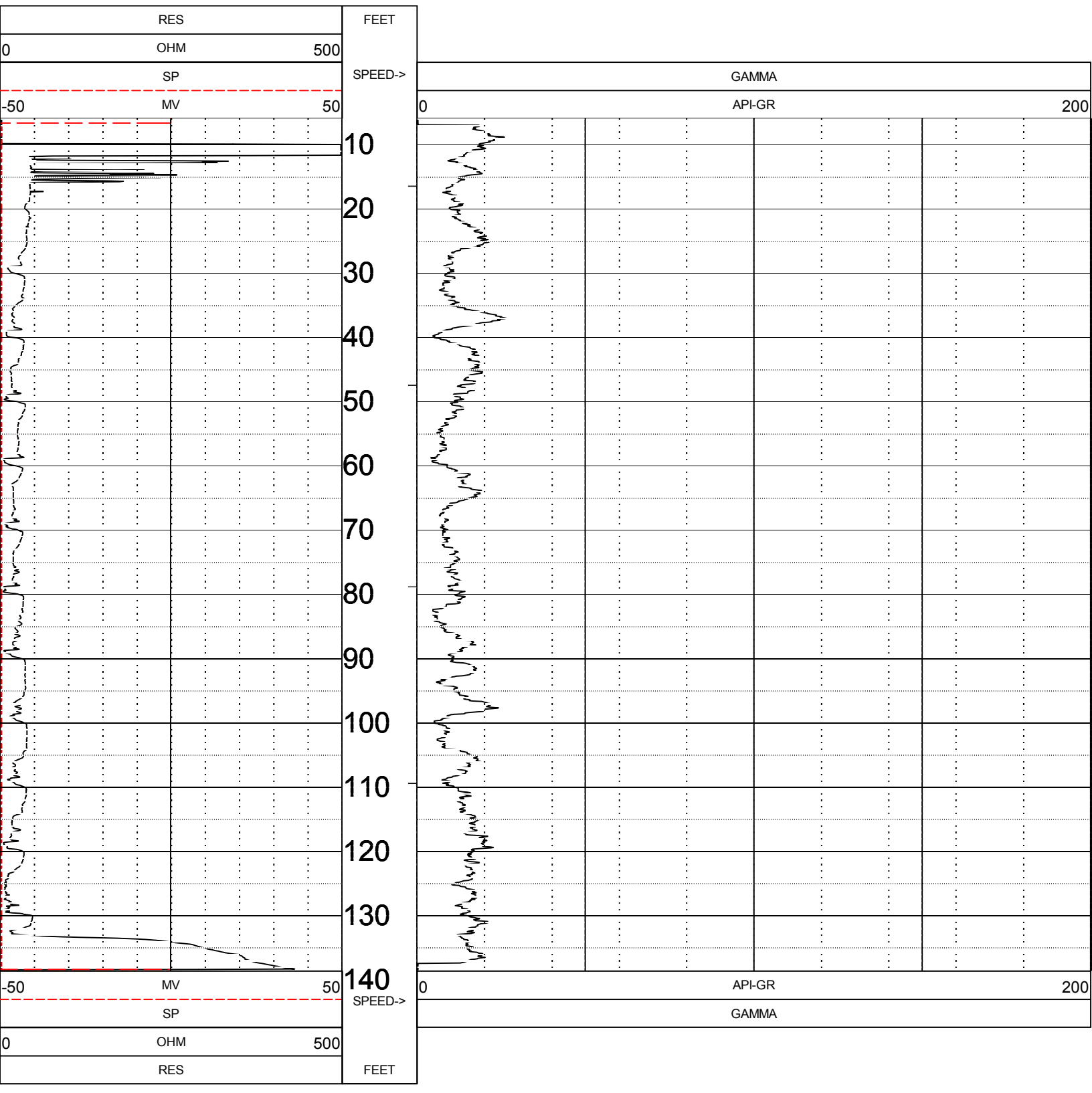
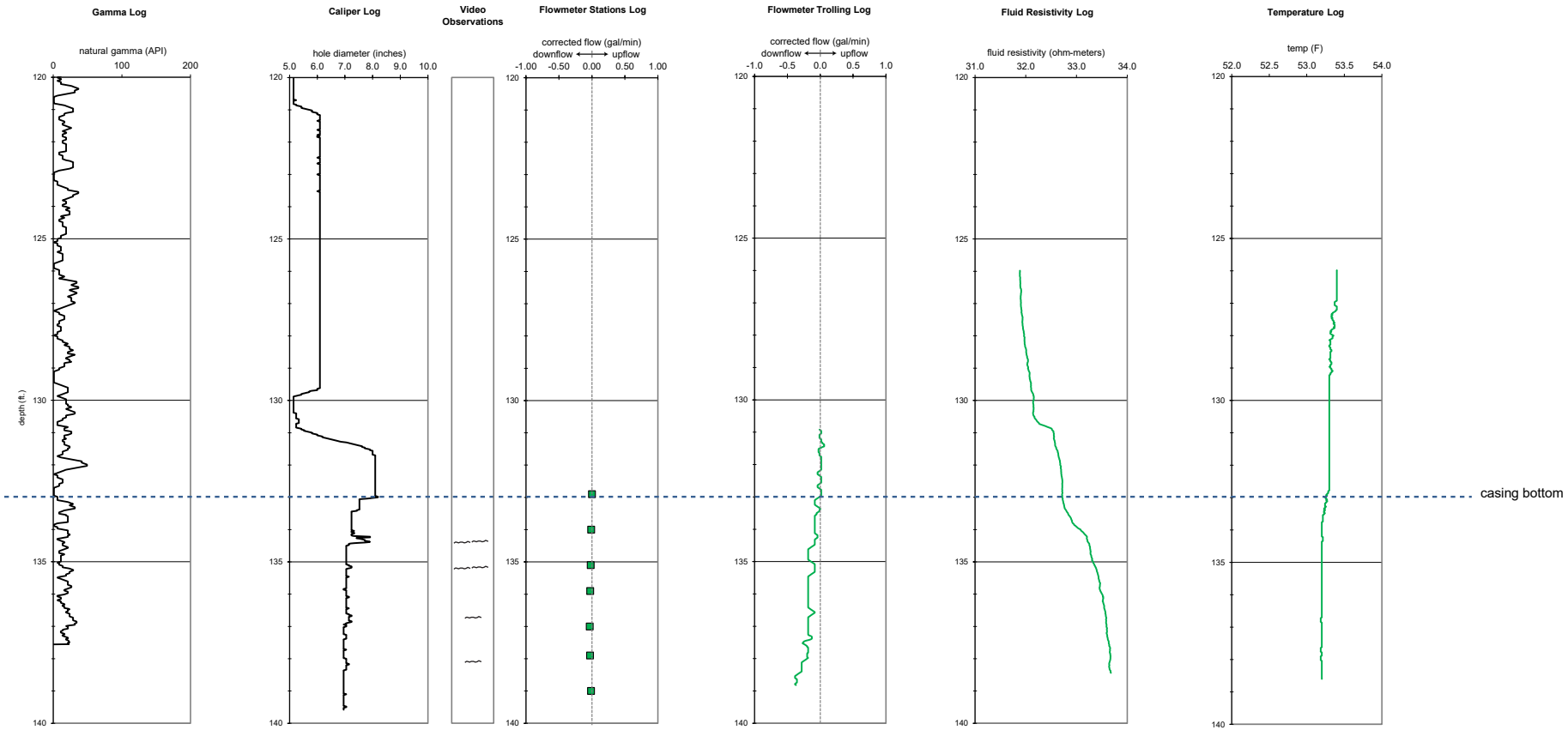
St. Paul, MN 55114
Dept. Phone: (612)626-2969

847059

NAME	: MW6B			OTHER SERVICES:	
UNIQUE NUMBER	: 847059				
QUADRANGLE	: 102B - LAKE ELMO				
COUNTY	: WASHINGTON				
LOCATION/SUBSECTI:	BBCDDD				
SECTION	: 25	TOWNSHIP	: 29	RANGE	: 21
DATE	: 11/21/19	MGS CUTTINGS #	:		
CASING BOTTOM	: 133			KB	:
LOG BOTTOM	: 138.56	LOG MEASURED FROM:		DF	:
LOG TOP	: 5.91	DRL MEASURED FROM:		GL	: 889L1
CASING DIAMETER	: 6	LOG RATE	: 30FPM		
CASING TYPE	:	FIELD OFFICE	: TRUCK		
CASING THICKNESS	: 0	RECORDED BY	: CICHA		
BIT SIZE	: 4	BOREHOLE FLUID	: 0	FILE	: PROCESSED
MAGNETIC DECL.	: 0	RM	: 0	TYPE	: 9060A
MATRIX DENSITY	: 2.84	RM TEMPERATURE	: 0	LGDATE:	11/21/19
NEUTRON MATRIX	: DOLOMITE	MATRIX DELTA T	: 44	LGTIME :	09:38:
				THRESH:	2500
SWL	: 9.6				
REMARKS	:				



Well Name: MW6B
Unique Number: 847059
T-R-S: T29 R21W Section 25



Geology:
0-133 QUUU, Quaternary sediments
133-138 OPOD, Oneota Dolomite

Logged by Minnesota Geological Survey
11/21/2019
Gamma, Caliper, Ambient Flowmeter, and Video

NOTE: The caliper, stations, trolling, fluid resistivity, and temperature log depths have been adjusted downwards 1.8 feet to match the bottom of 8" casing value reported by the driller and measured on the gamma log of 133 feet. The video log observation depths have also been corrected to better match with the caliper results. Also note, the flow values reported and graphed have been corrected to compensate for logging speed and average values measured within the casing (assumed to be no flow).

Preliminary Flowmeter Summary and Results

Well Name: MW6B
Unique Number: 847059
Date Logged: 11/21/2019

Note: This summary accompanies the flowmeter results illustration.

A slight deflection in the flowmeter stations and trolling logs, as well as in the fluid resistivity and temperature logs suggests very minor downflow in the Oneota of about -0.030 gal/min (as indicated by the corrected station measurements) originating from a fracture at about 134.2-134.5 ft. depth. This minor downflow appears to exit the borehole at a fracture around 138.2 ft. depth, as supported by the corrected flowmeter station measurements and video observations indicating turbulent flow and possible outflow of suspended particles. Note that the depths recorded in the video have been corrected to better correlate with depths reported by the driller and the other corrected logs. The depth of this observation in the raw video occurs at 139.9 ft.

Please also note that the corrected station measurements are very low and within the range of possible error given the precision of the flowmeter tool.

Well Name: MW6B
Unique Number: 847059

VIDEO LOG OBSERVATIONS

Logged By: Retzler (MGS), Cicha (MGS)
Date: 11/21/2019
Note: Zeroed in sideview.

Depth (ft.):	Camera View:	Observations:
9.6	sideview	SWL
135.8	sideview	bottom of 8"
141.2	downview	bottom of hole
139.9	sideview	fracture; turbulent flow?
138.3	sideview	fracture
137.2	sideview	fracture zone
136.6	sideview	fracture zone
135.7	sideview	bottom of 8"

Well Name: MW6B
Unique Number: 847059

FLOW LOG STATION MEASUREMENTS

Logged By: Retzler (MGS) and Cicha (MGS)
Date: 11/21/2019
Flow Tool Skirt Diameter (in.): 8
Note: (+) flow values = upflow; (-) flow values = downflow
Corrected flow values are calculated using values measured in the casing (assumed to be zero).

Depth (ft.):	Flow (l/min)	Corrected Flow (l/min):	Comments:
137.2	-0.3057	-0.0149	steady
136.1	-0.3475	-0.0287	steady
135.2	-0.3591	-0.0326	steady
134.1	-0.3380	-0.0256	steady
133.1	-0.3144	-0.0178	steady
132.2	-0.2982	-0.0124	steady
131.1	-0.2605	0.0000	casing; steady

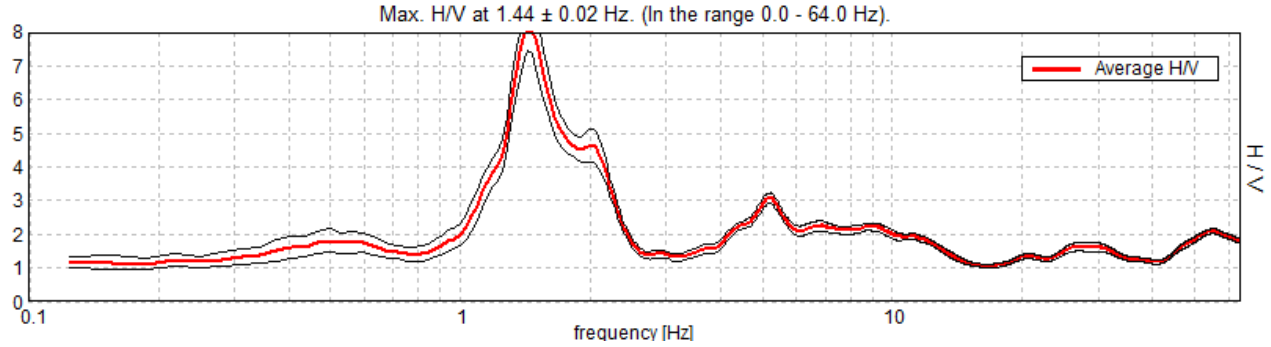
ATTACHMENT B-3
PASSIVE SEISMIC
RESULTS

LE304, LAKE ELMO 4_27_20

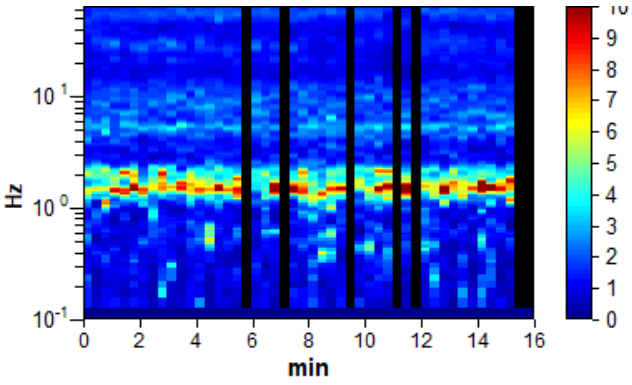
Instrument: TRZ-0082/01-10
Data format: 16 byte
Full scale [mV]: 51
Start recording: 27/04/20 12:45:05 End recording: 27/04/20 13:01:05
Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN
GPS data not available

Trace length: 0h16'00". Analyzed 85% trace (manual window selection)
Sampling rate: 128 Hz
Window size: 20 s
Smoothing type: Triangular window
Smoothing: 10%

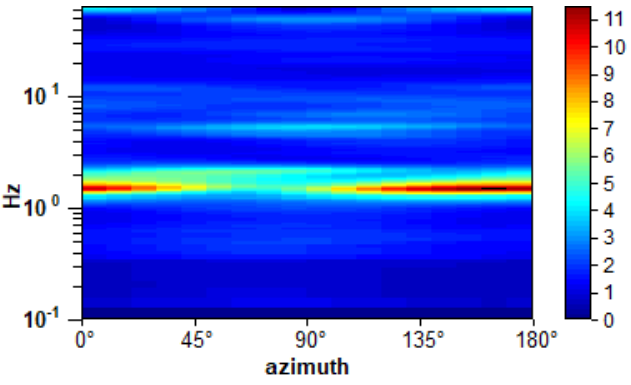
HORIZONTAL TO VERTICAL SPECTRAL RATIO



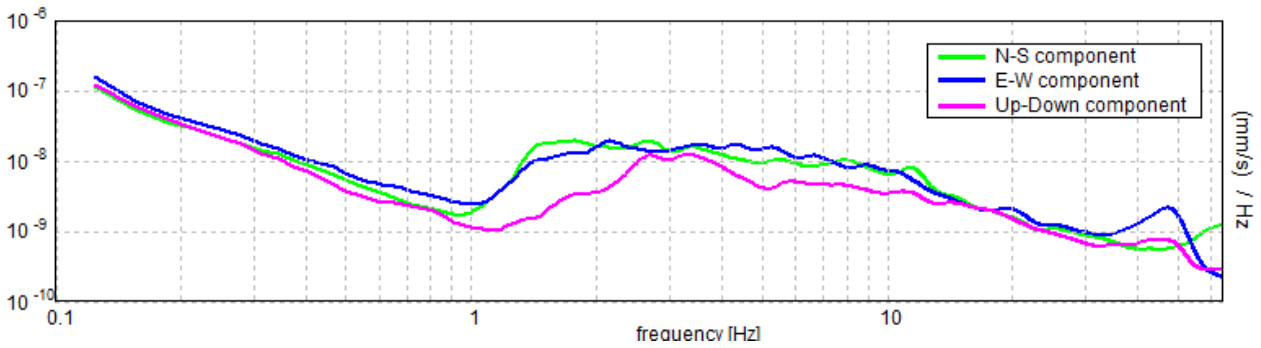
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the SESAME, 2005 guidelines. **Please read carefully the *Grilla* manual before interpreting the following tables**.]

Max. H/V at 1.44 ± 0.02 Hz (in the range 0.0 - 64.0 Hz).

Criteria for a reliable H/V curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	1.44 > 0.50	OK	
$n_c(f_0) > 200$	1178.8 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz **$\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz**	Exceeded 0 out of 70 times	OK	
Criteria for a clear H/V peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	1.219 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$	2.156 Hz	OK	
$A_0 > 2$	8.43 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0.01074| < 0.05	OK	
$\sigma_f < \varepsilon(f_0)$	0.01543 < 0.14375	OK	
$\sigma_A(f_0) < \theta(f_0)$	0.9744 < 1.78	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

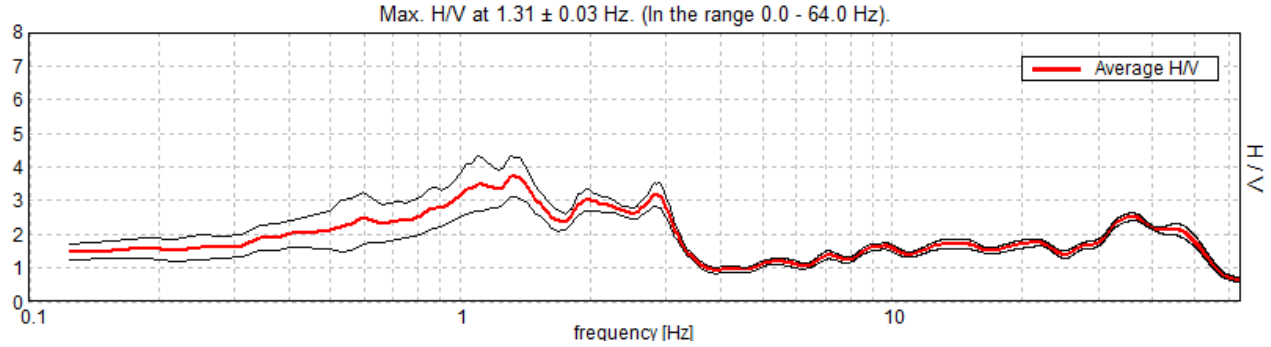
Threshold values for σ_f and $\sigma_A(f_0)$					
Freq. range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

LE305, LAKE ELMO 4_27_20

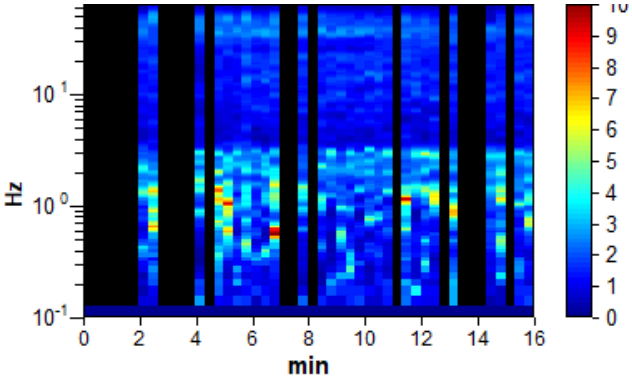
Instrument: TRZ-0082/01-10
Data format: 16 byte
Full scale [mV]: 51
Start recording: 27/04/20 13:07:28 End recording: 27/04/20 13:23:28
Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN
GPS data not available

Trace length: 0h16'00". Analyzed 58% trace (manual window selection)
Sampling rate: 128 Hz
Window size: 20 s
Smoothing type: Triangular window
Smoothing: 10%

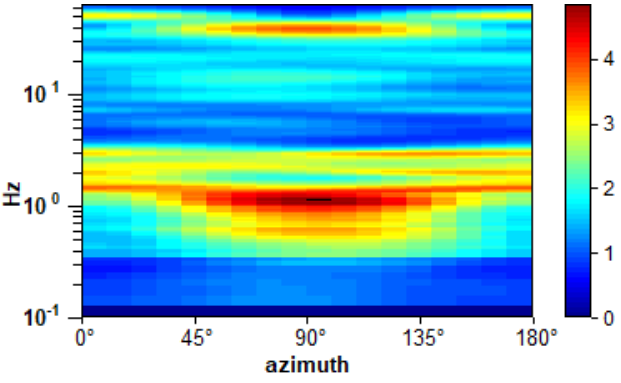
HORIZONTAL TO VERTICAL SPECTRAL RATIO



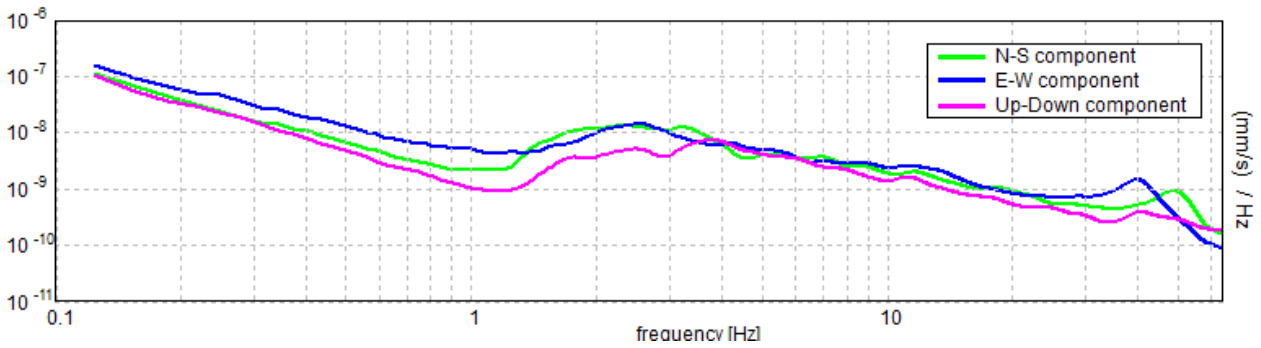
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the SESAME, 2005 guidelines. **Please read carefully the *Grilla* manual before interpreting the following tables**.]

Max. H/V at 1.31 ± 0.03 Hz (in the range 0.0 - 64.0 Hz).

Criteria for a reliable H/V curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	1.31 > 0.50	OK	
$n_c(f_0) > 200$	735.0 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz **$\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz**	Exceeded 0 out of 64 times	OK	
Criteria for a clear H/V peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	0.313 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$	3.25 Hz	OK	
$A_0 > 2$	3.71 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0.0225| < 0.05	OK	
$\sigma_f < \varepsilon(f_0)$	0.02953 < 0.13125	OK	
$\sigma_A(f_0) < \theta(f_0)$	0.6056 < 1.78	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

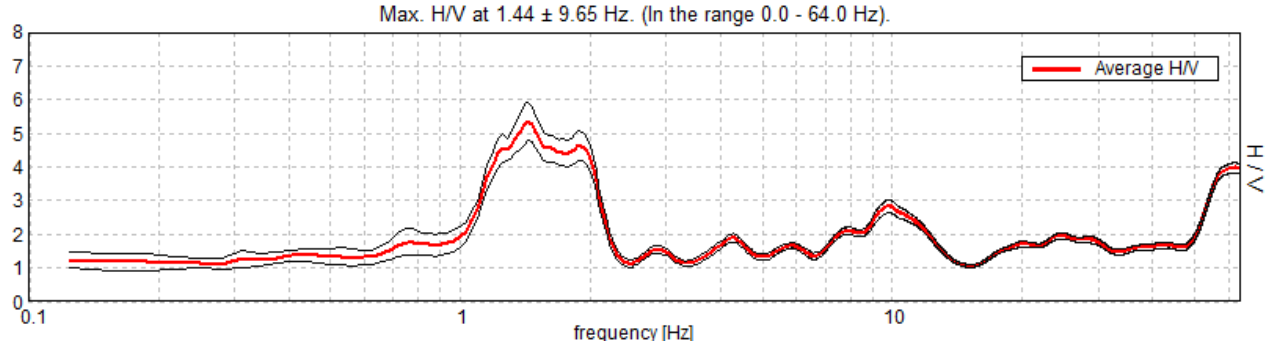
Threshold values for σ_f and $\sigma_A(f_0)$					
Freq. range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

LE303, LAKE ELMO 4_27_20

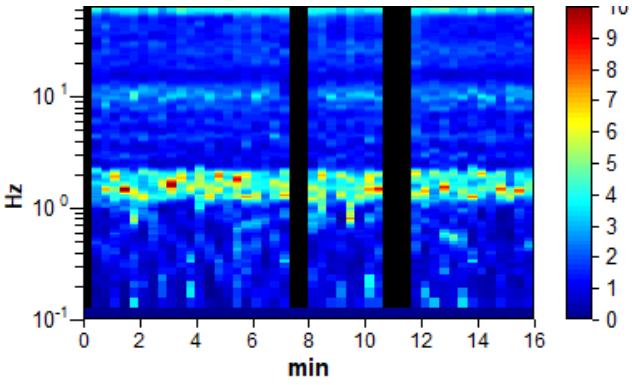
Instrument: TRZ-0082/01-10
Data format: 16 byte
Full scale [mV]: 51
Start recording: 27/04/20 12:21:33 End recording: 27/04/20 12:37:33
Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN
GPS data not available

Trace length: 0h16'00". Analyzed 88% trace (manual window selection)
Sampling rate: 128 Hz
Window size: 20 s
Smoothing type: Triangular window
Smoothing: 10%

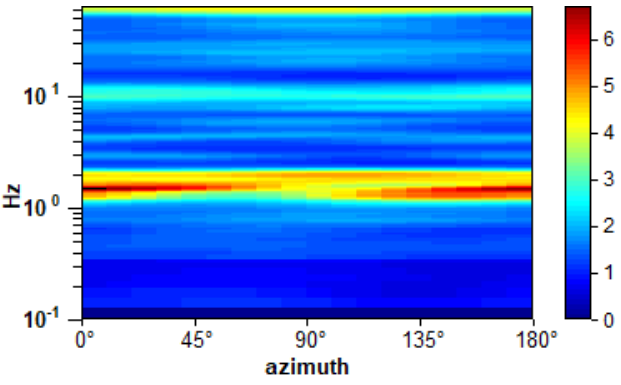
HORIZONTAL TO VERTICAL SPECTRAL RATIO



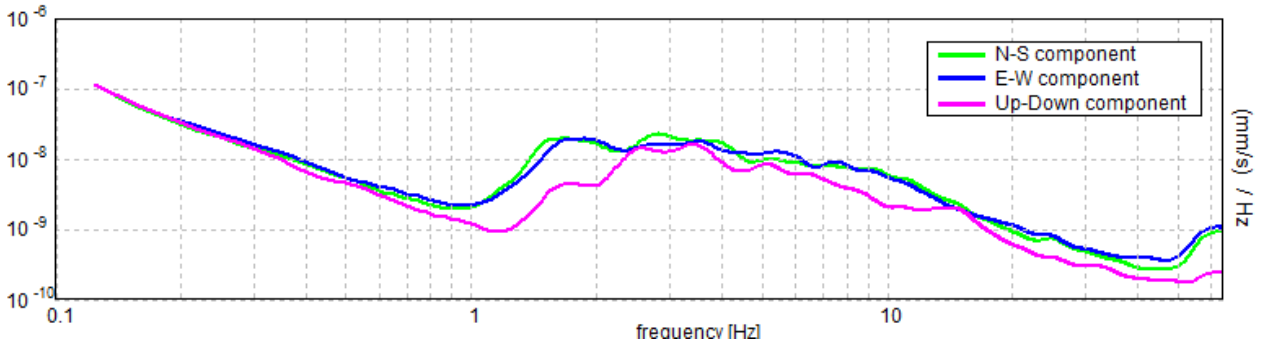
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the SESAME, 2005 guidelines. **Please read carefully the *Grilla* manual before interpreting the following tables**.]

Max. H/V at 1.44 ± 9.65 Hz (in the range 0.0 - 64.0 Hz).

Criteria for a reliable H/V curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	1.44 > 0.50	OK	
$n_c(f_0) > 200$	1207.5 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz **$\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz**	Exceeded 0 out of 70 times	OK	
Criteria for a clear H/V peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	1.063 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$	2.156 Hz	OK	
$A_0 > 2$	5.35 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|6.71221| < 0.05		NO
$\sigma_f < \varepsilon(f_0)$	9.6488 < 0.14375		NO
$\sigma_A(f_0) < \theta(f_0)$	0.5513 < 1.78	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

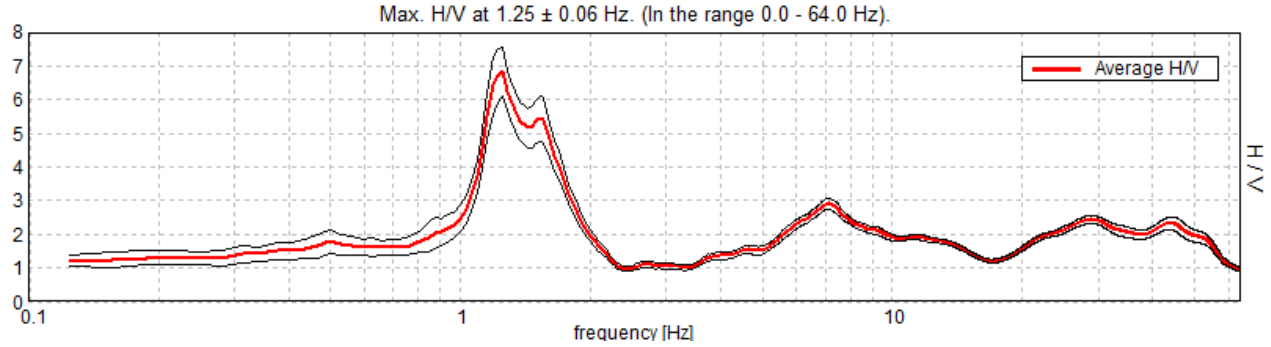
Threshold values for σ_f and $\sigma_A(f_0)$					
Freq. range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

LE302, LAKE ELMO 4_27_20

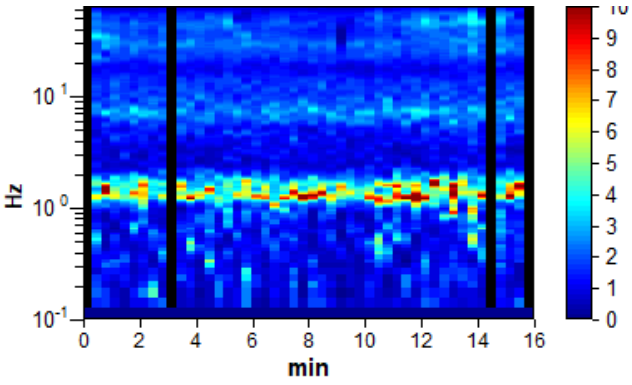
Instrument: TRZ-0082/01-10
Data format: 16 byte
Full scale [mV]: 51
Start recording: 27/04/20 11:59:05 End recording: 27/04/20 12:15:05
Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN
GPS data not available

Trace length: 0h16'00". Analyzed 92% trace (manual window selection)
Sampling rate: 128 Hz
Window size: 20 s
Smoothing type: Triangular window
Smoothing: 10%

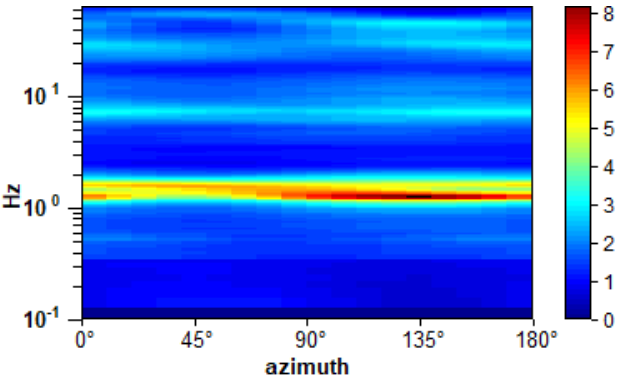
HORIZONTAL TO VERTICAL SPECTRAL RATIO



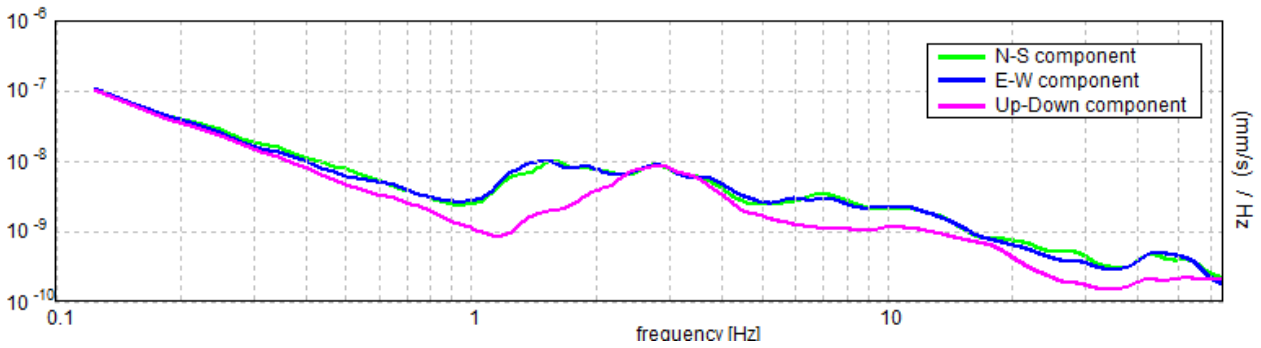
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the SESAME, 2005 guidelines. **Please read carefully the *Grilla* manual before interpreting the following tables**.]

Max. H/V at 1.25 ± 0.06 Hz (in the range 0.0 - 64.0 Hz).

Criteria for a reliable H/V curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	1.25 > 0.50	OK	
$n_c(f_0) > 200$	1100.0 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz **$\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz**	Exceeded 0 out of 61 times	OK	
Criteria for a clear H/V peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	1.063 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$	1.781 Hz	OK	
$A_0 > 2$	6.83 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0.04914| < 0.05	OK	
$\sigma_f < \varepsilon(f_0)$	0.06143 < 0.125	OK	
$\sigma_A(f_0) < \theta(f_0)$	0.7343 < 1.78	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

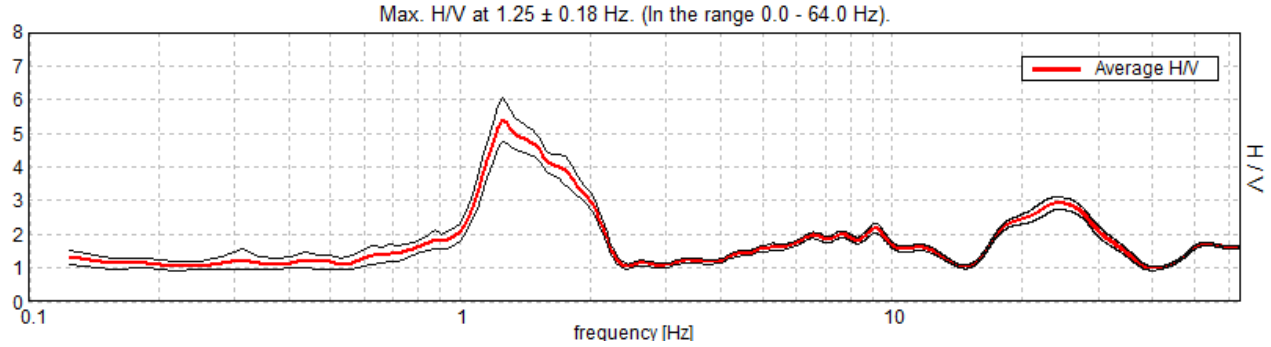
Threshold values for σ_f and $\sigma_A(f_0)$					
Freq. range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

LE301, LAKE ELMO 4_27_20

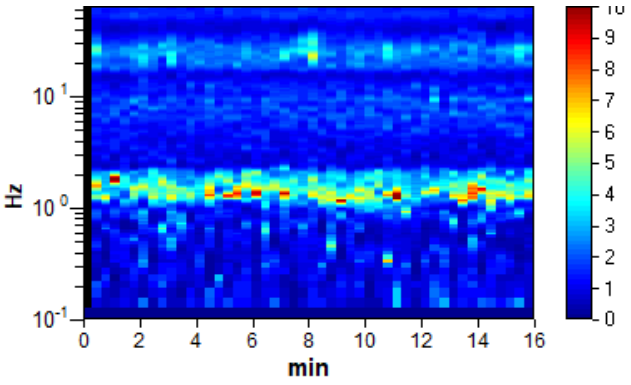
Instrument: TRZ-0082/01-10
Data format: 16 byte
Full scale [mV]: 51
Start recording: 27/04/20 11:35:19 End recording: 27/04/20 11:51:19
Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN
GPS data not available

Trace length: 0h16'00". Analyzed 98% trace (automatic window selection)
Sampling rate: 128 Hz
Window size: 20 s
Smoothing type: Triangular window
Smoothing: 10%

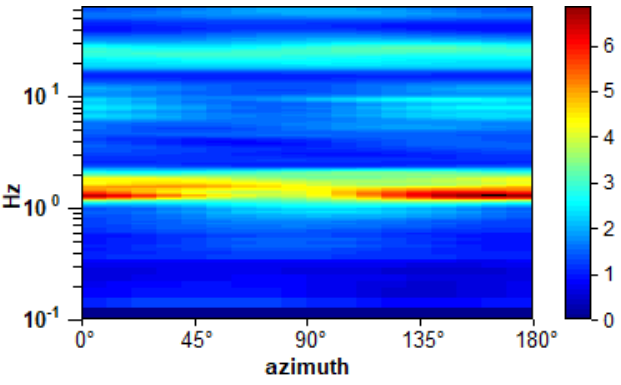
HORIZONTAL TO VERTICAL SPECTRAL RATIO



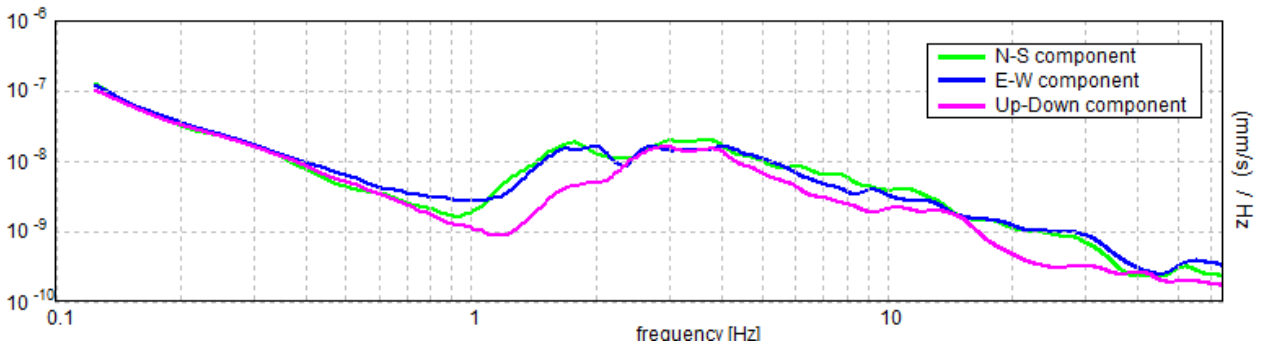
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the SESAME, 2005 guidelines. **Please read carefully the *Grilla* manual before interpreting the following tables**.]

Max. H/V at 1.25 ± 0.18 Hz (in the range 0.0 - 64.0 Hz).

Criteria for a reliable H/V curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	1.25 > 0.50	OK	
$n_c(f_0) > 200$	1175.0 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz **$\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz**	Exceeded 0 out of 61 times	OK	
Criteria for a clear H/V peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	1.031 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$	2.063 Hz	OK	
$A_0 > 2$	5.41 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0.14334| < 0.05		NO
$\sigma_f < \varepsilon(f_0)$	0.17917 < 0.125		NO
$\sigma_A(f_0) < \theta(f_0)$	0.6592 < 1.78	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

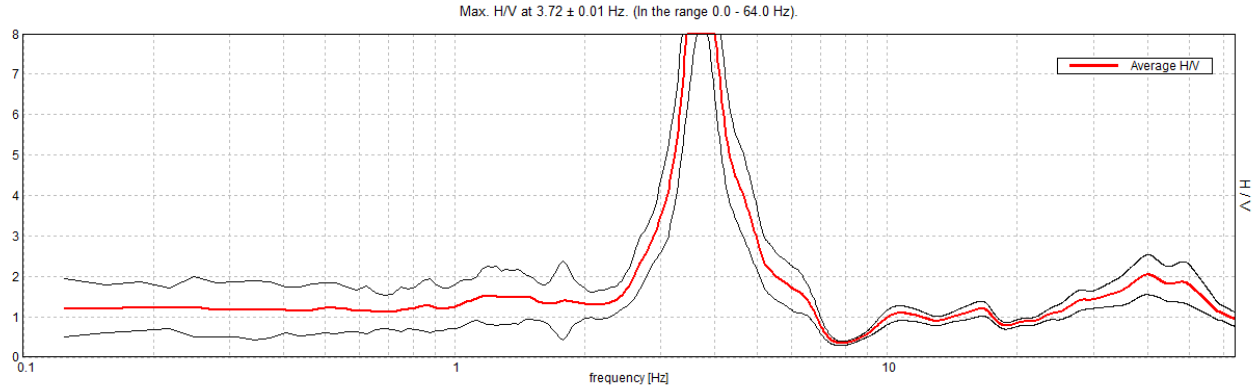
Threshold values for σ_f and $\sigma_A(f_0)$					
Freq. range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

LE209, folder LAKE_ELMO_2020_2, orig LE209

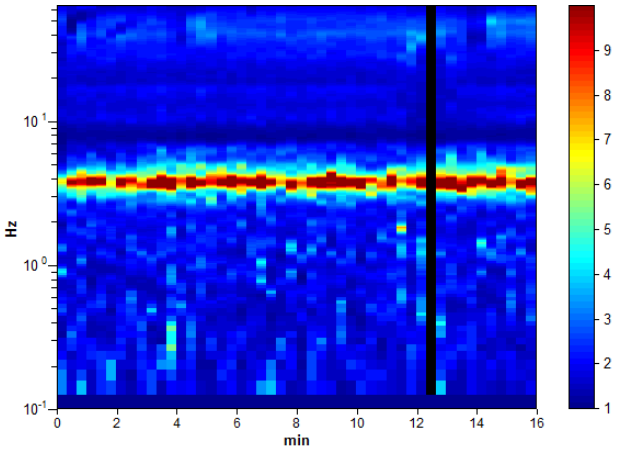
Instrument: TRZ-0082/01-10
Start recording: 24/02/20 13:22:41 End recording: 24/02/20 13:38:40
Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN
GPS data not available

Trace length: 0h16'00". Analyzed 98% trace (automatic window selection)
Sampling rate: 128 Hz
Window size: 20 s
Smoothing type: Triangular window
Smoothing: 10%

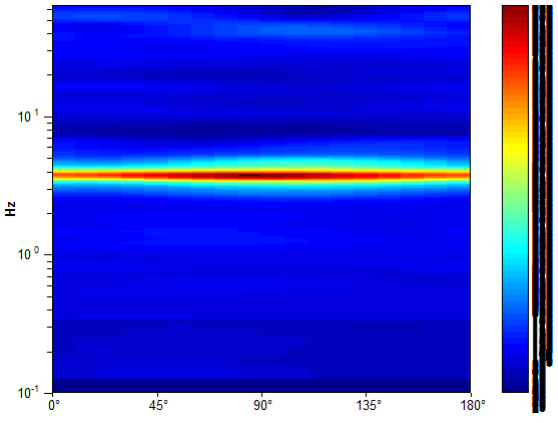
HORIZONTAL TO VERTICAL SPECTRAL RATIO



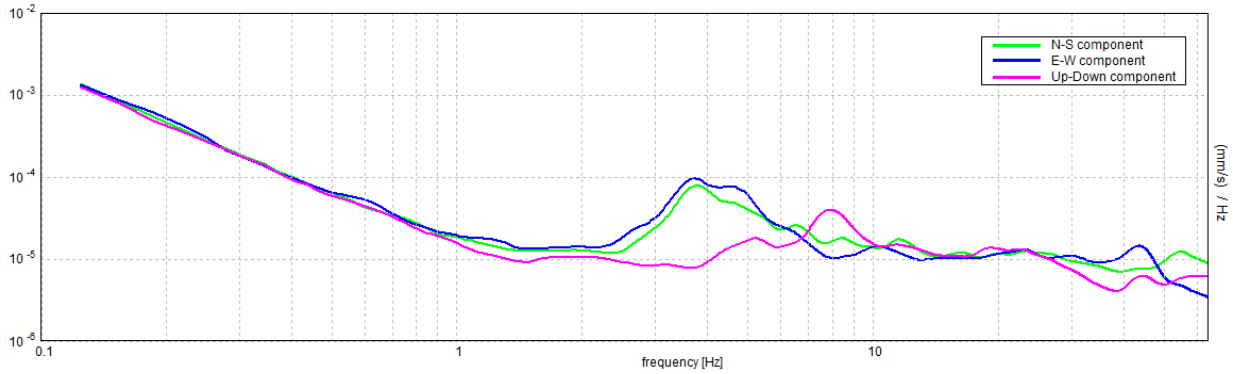
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the SESAME, 2005 guidelines. **Please read carefully the** *Grilla* **manual before interpreting the following tables**.]

Max. H/V at 3.72 ± 0.01 Hz (in the range 0.0 - 64.0 Hz).

Criteria for a reliable H/V curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	3.72 > 0.50	OK	
$n_c(f_0) > 200$	3495.6 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz **$\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz**	Exceeded 14 out of 180 times		NO
Criteria for a clear H/V peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	3.281 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$	4.25 Hz	OK	
$A_0 > 2$	11.21 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0.00093| < 0.05	OK	
$\sigma_f < \varepsilon(f_0)$	0.00345 < 0.18594	OK	
$\sigma_A(f_0) < \theta(f_0)$	1.2469 < 1.58	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

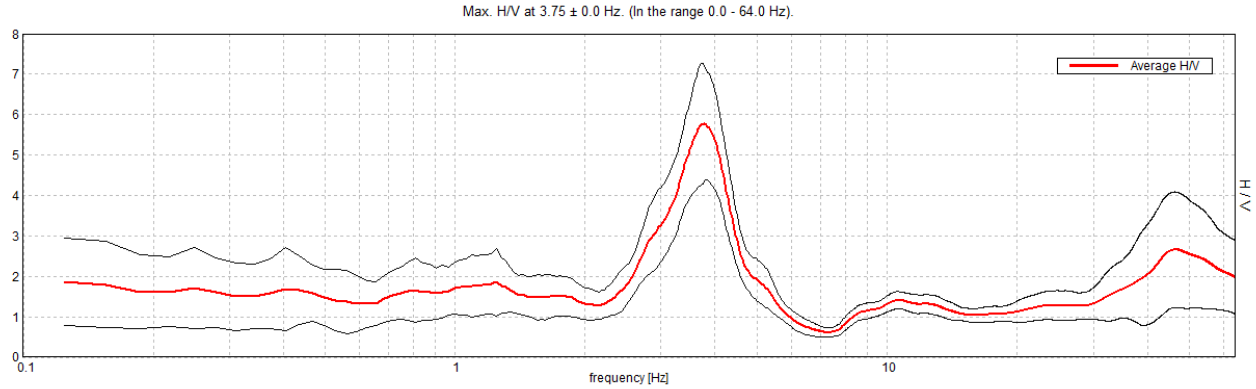
Threshold values for σ_f and $\sigma_A(f_0)$					
Freq. range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

LE208, folder LAKE_ELMO_2020_2, orig LE208

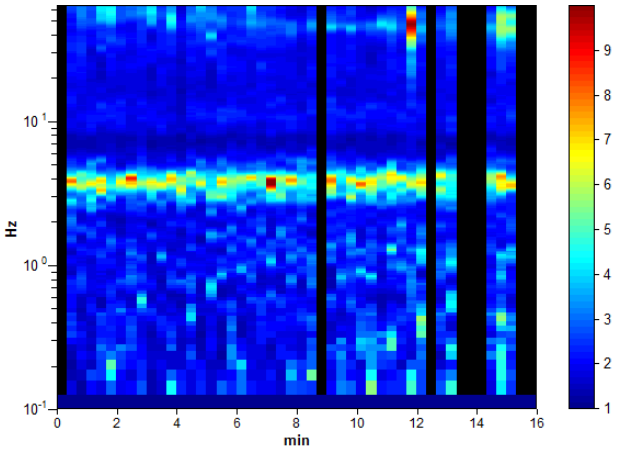
Instrument: TRZ-0082/01-10
Start recording: 24/02/20 12:55:19 End recording: 24/02/20 13:11:18
Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN
GPS data not available

Trace length: 0h16'00". Analyzed 83% trace (manual window selection)
Sampling rate: 128 Hz
Window size: 20 s
Smoothing type: Triangular window
Smoothing: 10%

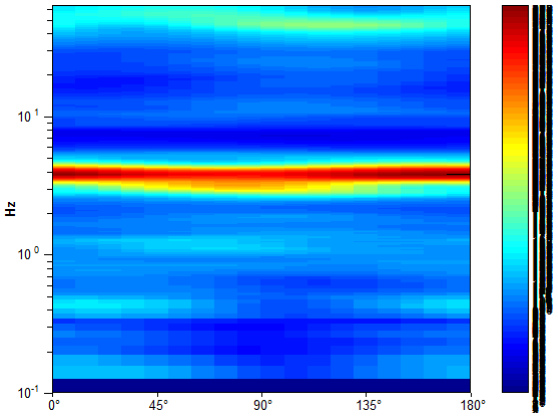
HORIZONTAL TO VERTICAL SPECTRAL RATIO



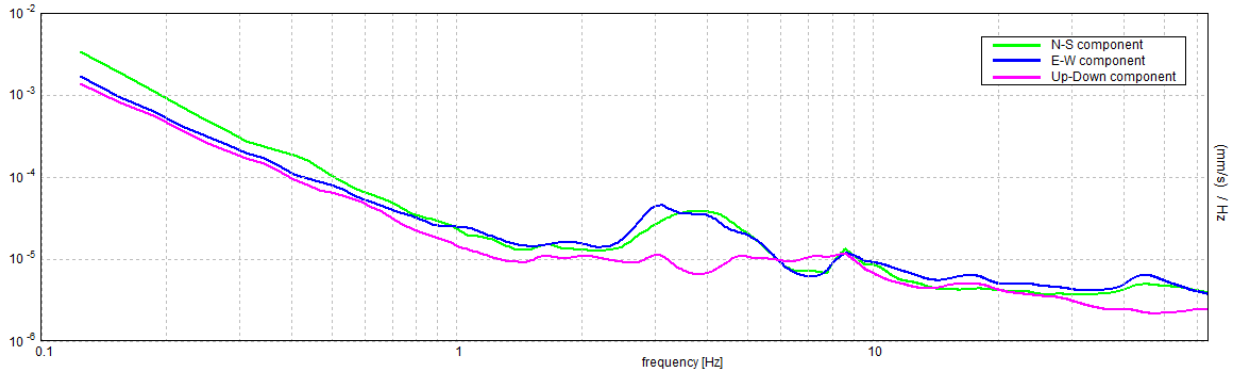
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the SESAME, 2005 guidelines. **Please read carefully the** *Grilla* **manual before interpreting the following tables**.]

Max. H/V at 3.75 ± 0.0 Hz (in the range 0.0 - 64.0 Hz).

Criteria for a reliable H/V curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	3.75 > 0.50	OK	
$n_c(f_0) > 200$	3000.0 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz **$\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz**	Exceeded 0 out of 181 times	OK	
Criteria for a clear H/V peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	2.813 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$	4.5 Hz	OK	
$A_0 > 2$	5.78 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0.00063| < 0.05	OK	
$\sigma_f < \varepsilon(f_0)$	0.00234 < 0.1875	OK	
$\sigma_A(f_0) < \theta(f_0)$	0.7271 < 1.58	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

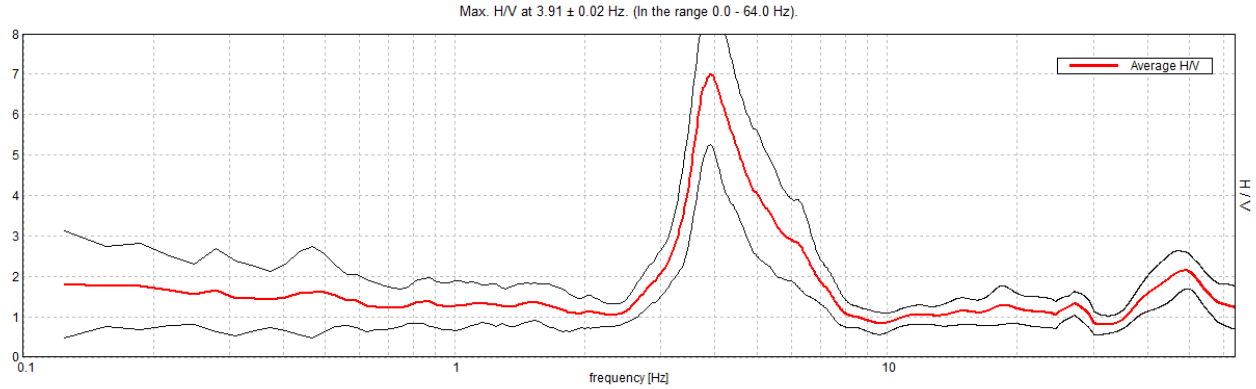
Threshold values for σ_f and $\sigma_A(f_0)$					
Freq. range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

LE207, folder LAKE_ELMO_2020_2, orig LE207

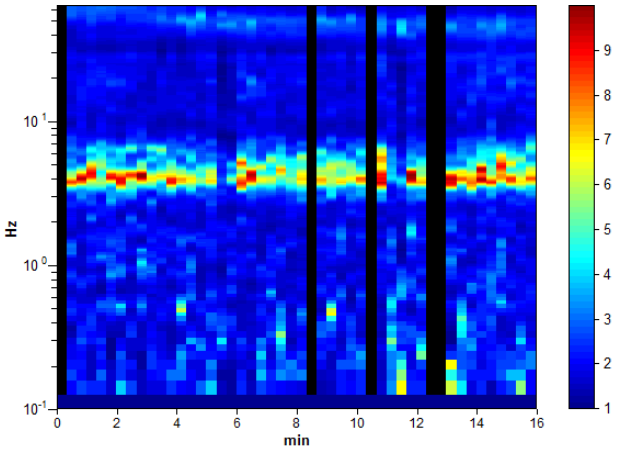
Instrument: TRZ-0082/01-10
Start recording: 24/02/20 12:28:09 End recording: 24/02/20 12:44:09
Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN
GPS data not available

Trace length: 0h16'00". Analyzed 90% trace (manual window selection)
Sampling rate: 128 Hz
Window size: 20 s
Smoothing type: Triangular window
Smoothing: 10%

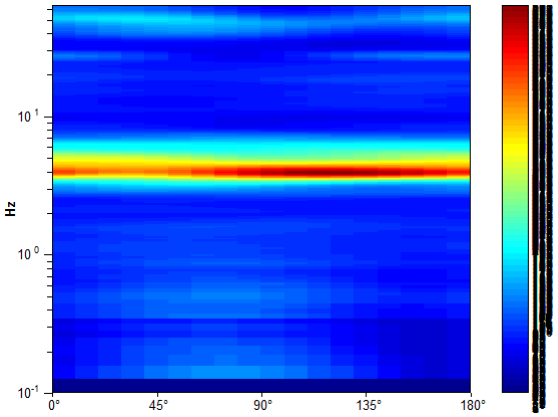
HORIZONTAL TO VERTICAL SPECTRAL RATIO



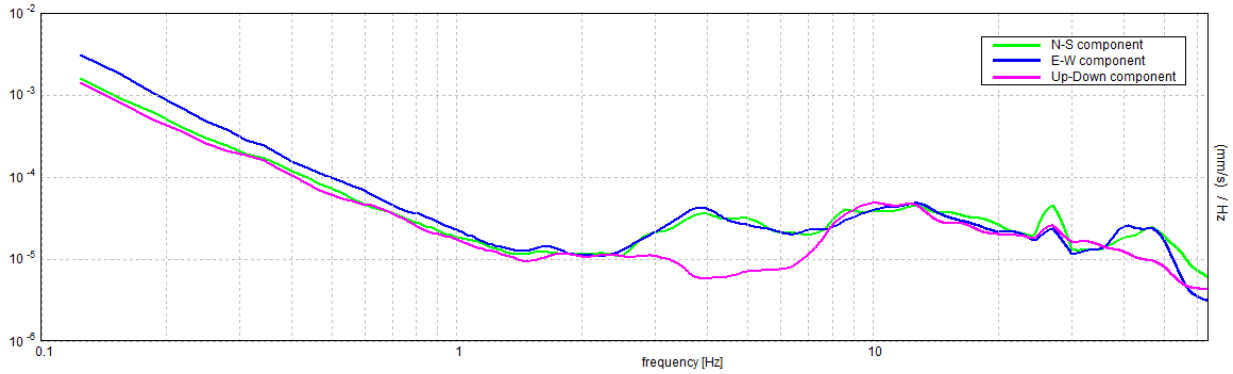
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the SESAME, 2005 guidelines. **Please read carefully the** *Grilla* **manual before interpreting the following tables**.]

Max. H/V at 3.91 ± 0.02 Hz (in the range 0.0 - 64.0 Hz).

Criteria for a reliable H/V curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	3.91 > 0.50	OK	
$n_c(f_0) > 200$	3359.4 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz **$\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz**	Exceeded 0 out of 188 times	OK	
Criteria for a clear H/V peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	3.344 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$	5.406 Hz	OK	
$A_0 > 2$	7.00 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0.00248| < 0.05	OK	
$\sigma_f < \varepsilon(f_0)$	0.0097 < 0.19531	OK	
$\sigma_A(f_0) < \theta(f_0)$	0.8525 < 1.58	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

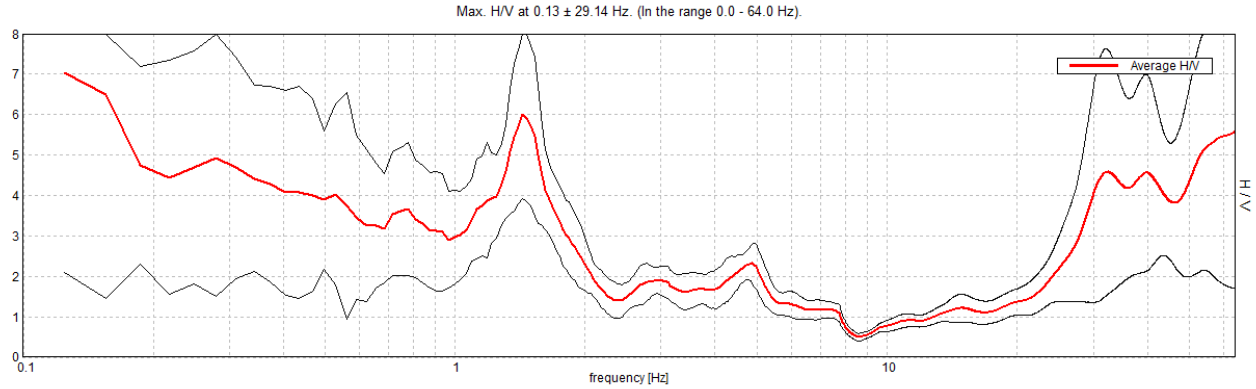
Threshold values for σ_f and $\sigma_A(f_0)$					
Freq. range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

LE206, folder LAKE_ELMO_2020_2, orig LE206

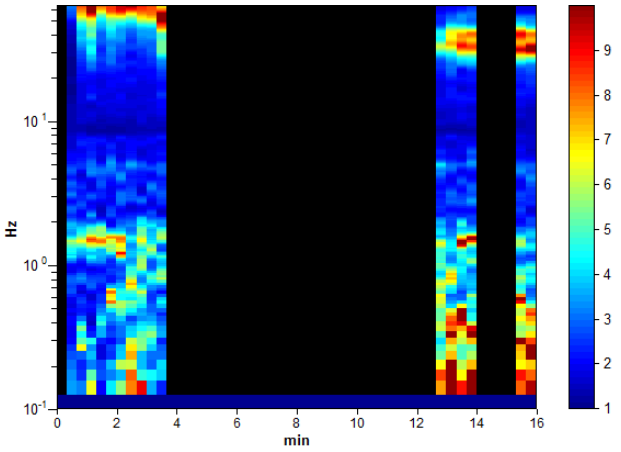
Instrument: TRZ-0082/01-10
Start recording: 24/02/20 11:24:16 End recording: 24/02/20 11:40:15
Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN
GPS data not available

Trace length: 0h16'00". Analyzed 33% trace (manual window selection)
Sampling rate: 128 Hz
Window size: 20 s
Smoothing type: Triangular window
Smoothing: 10%

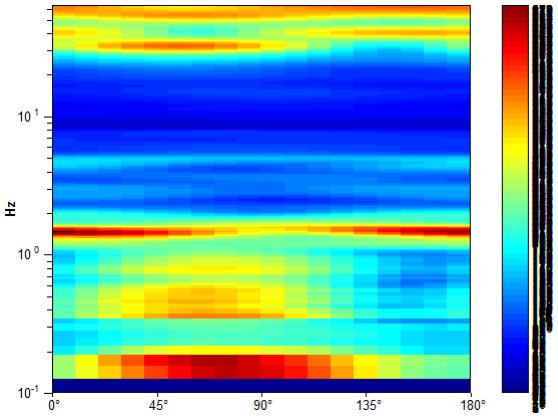
HORIZONTAL TO VERTICAL SPECTRAL RATIO



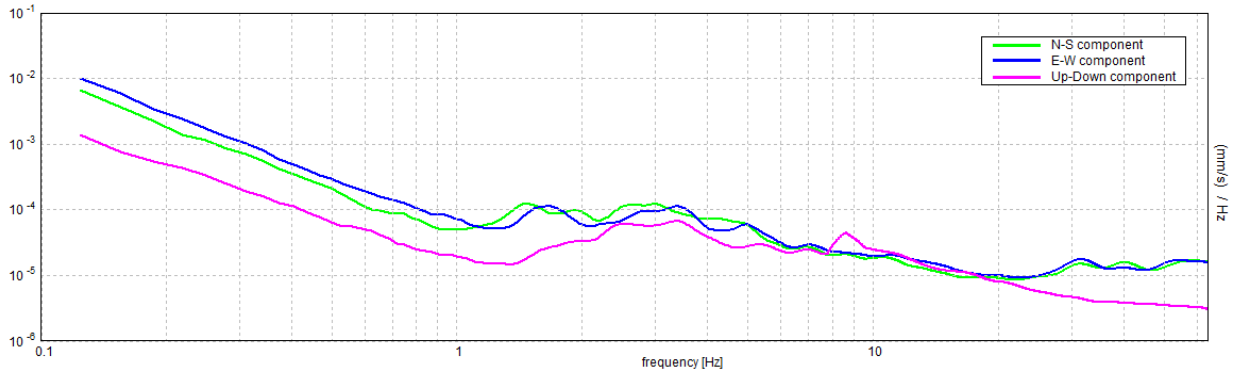
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the SESAME, 2005 guidelines. **Please read carefully the** *Grilla* **manual before interpreting the following tables**.]

Max. H/V at 0.13 ± 29.14 Hz (in the range 0.0 - 64.0 Hz).

Criteria for a reliable H/V curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	0.13 > 0.50		**NO**
$n_c(f_0) > 200$	40.0 > 200		**NO**
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz **$\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz**	Exceeded 2 out of 7 times		**NO**
Criteria for a clear H/V peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	0.094 Hz	**OK**	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$			**NO**
$A_0 > 2$	7.02 > 2	**OK**	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|105.8769| < 0.05		**NO**
$\sigma_f < \varepsilon(f_0)$	13.23462 < 0.03125		**NO**
$\sigma_A(f_0) < \theta(f_0)$	2.2437 < 3.0	**OK**	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

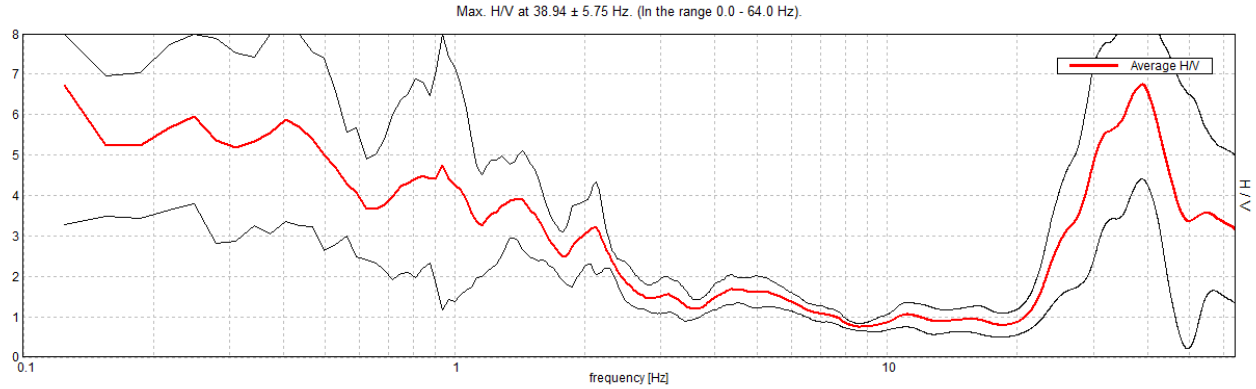
Threshold values for σ_f and $\sigma_A(f_0)$					
Freq. range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

LE205, folder LAKE_ELMO_2020_2, orig LE205

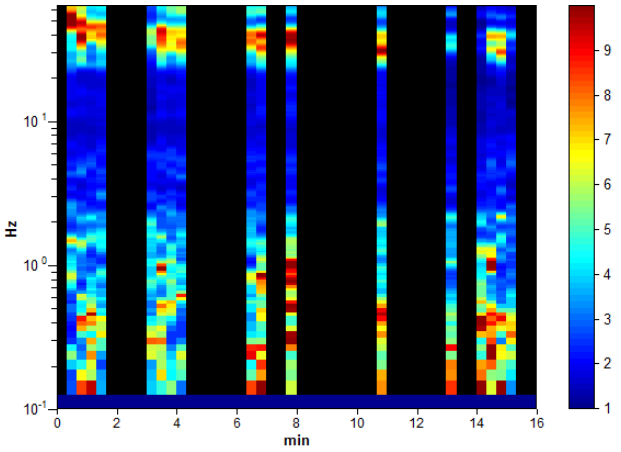
Instrument: TRZ-0082/01-10
Start recording: 24/02/20 11:02:07 End recording: 24/02/20 11:18:07
Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN
GPS data not available

Trace length: 0h16'00". Analyzed 35% trace (manual window selection)
Sampling rate: 128 Hz
Window size: 20 s
Smoothing type: Triangular window
Smoothing: 10%

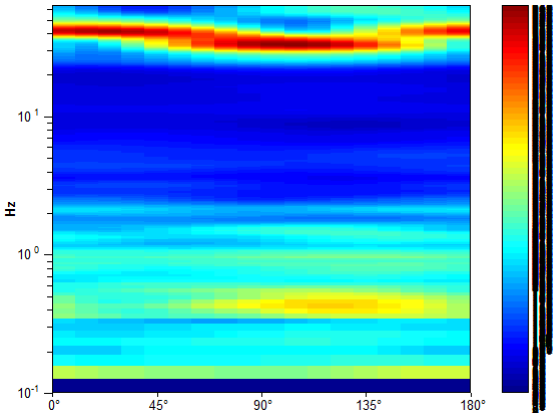
HORIZONTAL TO VERTICAL SPECTRAL RATIO



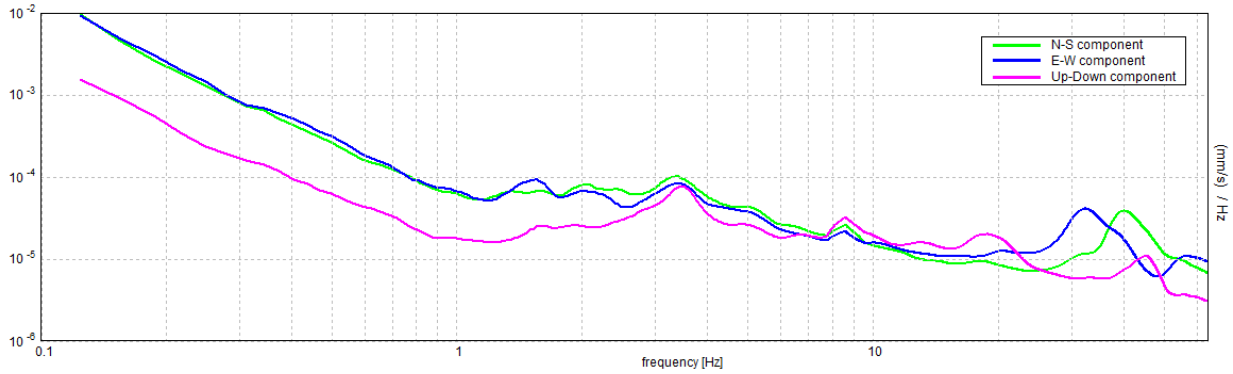
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the SESAME, 2005 guidelines. **Please read carefully the** *Grilla* **manual before interpreting the following tables**.]

Max. H/V at 38.94 ± 5.75 Hz (in the range 0.0 - 64.0 Hz).

Criteria for a reliable H/V curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	38.94 > 0.50	OK	
$n_c(f_0) > 200$	13238.8 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz **$\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz**	Exceeded 856 out of 1426 times		NO
Criteria for a clear H/V peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	27.25 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$	49.563 Hz	OK	
$A_0 > 2$	6.74 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0.06754| < 0.05		NO
$\sigma_f < \varepsilon(f_0)$	2.62967 < 1.94688		NO
$\sigma_A(f_0) < \theta(f_0)$	1.0697 < 1.58	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

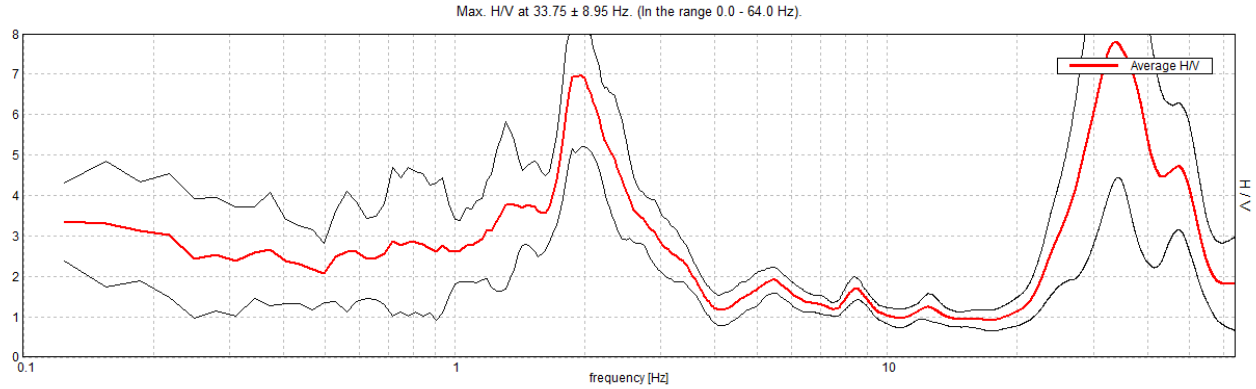
Threshold values for σ_f and $\sigma_A(f_0)$					
Freq. range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

LE204, folder LAKE_ELMO_2020_2, orig LE204 US

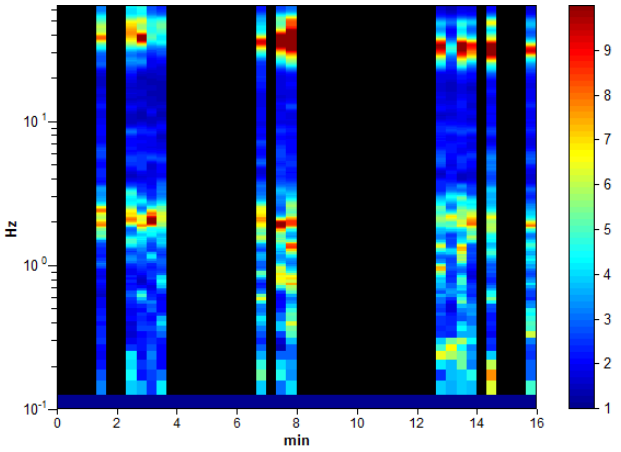
Instrument: TRZ-0082/01-10
Start recording: 24/02/20 10:38:59 End recording: 24/02/20 10:54:59
Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN
GPS data not available

Trace length: 0h16'00". Analyzed 29% trace (manual window selection)
Sampling rate: 128 Hz
Window size: 20 s
Smoothing type: Triangular window
Smoothing: 10%

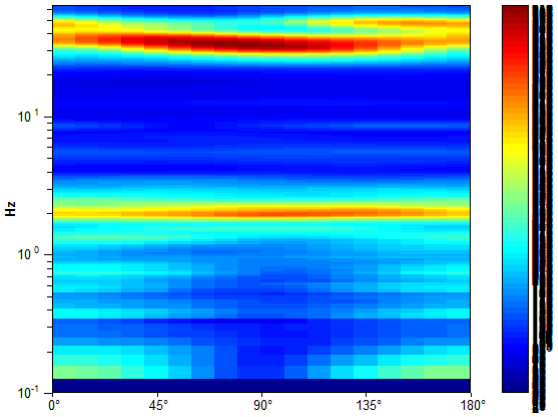
HORIZONTAL TO VERTICAL SPECTRAL RATIO



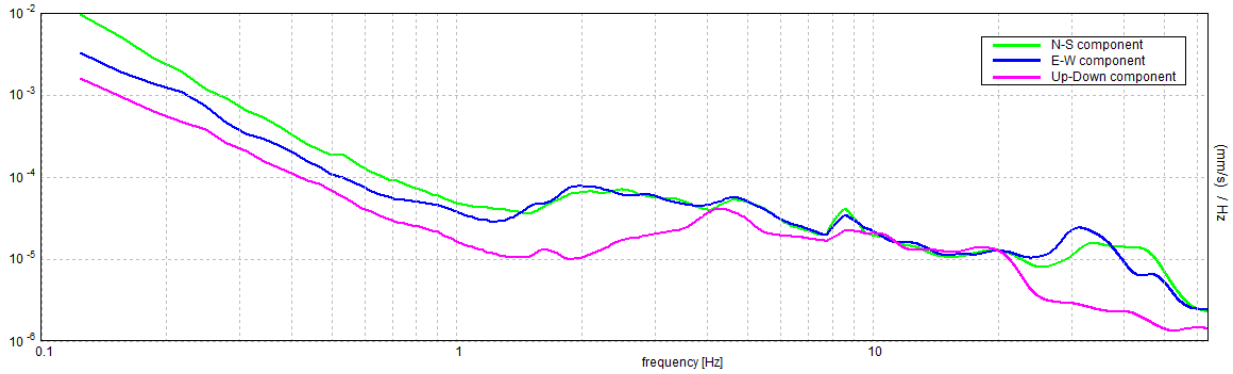
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the SESAME, 2005 guidelines. **Please read carefully the** *Grilla* **manual before interpreting the following tables**.]

Max. H/V at 33.75 ± 8.95 Hz (in the range 0.0 - 64.0 Hz).

Criteria for a reliable H/V curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	33.75 > 0.50	OK	
$n_c(f_0) > 200$	9450.0 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz **$\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz**	Exceeded 531 out of 1509 times		NO
Criteria for a clear H/V peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	26.813 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$	50.875 Hz	OK	
$A_0 > 2$	7.79 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0.11826| < 0.05		NO
$\sigma_f < \varepsilon(f_0)$	3.99131 < 1.6875		NO
$\sigma_A(f_0) < \theta(f_0)$	1.5094 < 1.58	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

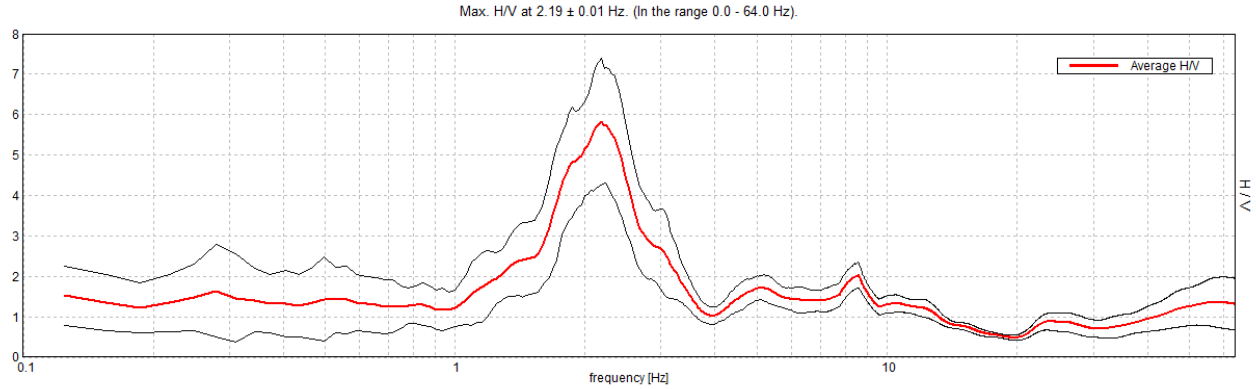
Threshold values for σ_f and $\sigma_A(f_0)$					
Freq. range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

LE203, folder LAKE_ELMO_2020_2, LE203 US

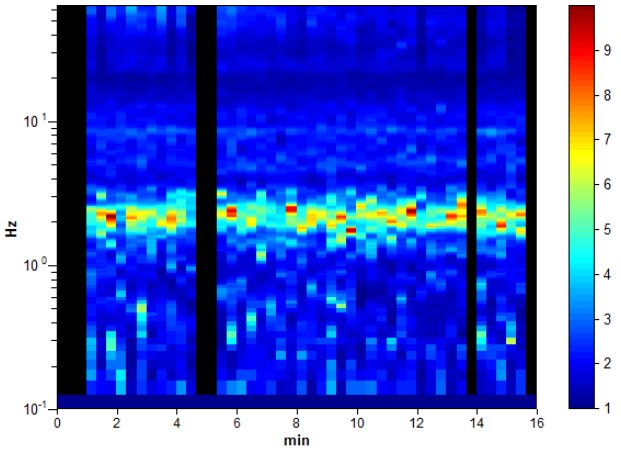
Instrument: TRZ-0082/01-10
Start recording: 24/02/20 10:16:14 End recording: 24/02/20 10:32:14
Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN
GPS data not available

Trace length: 0h16'00". Analyzed 85% trace (manual window selection)
Sampling rate: 128 Hz
Window size: 20 s
Smoothing type: Triangular window
Smoothing: 10%

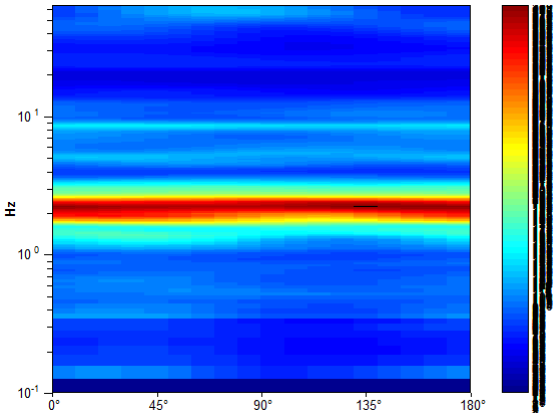
HORIZONTAL TO VERTICAL SPECTRAL RATIO



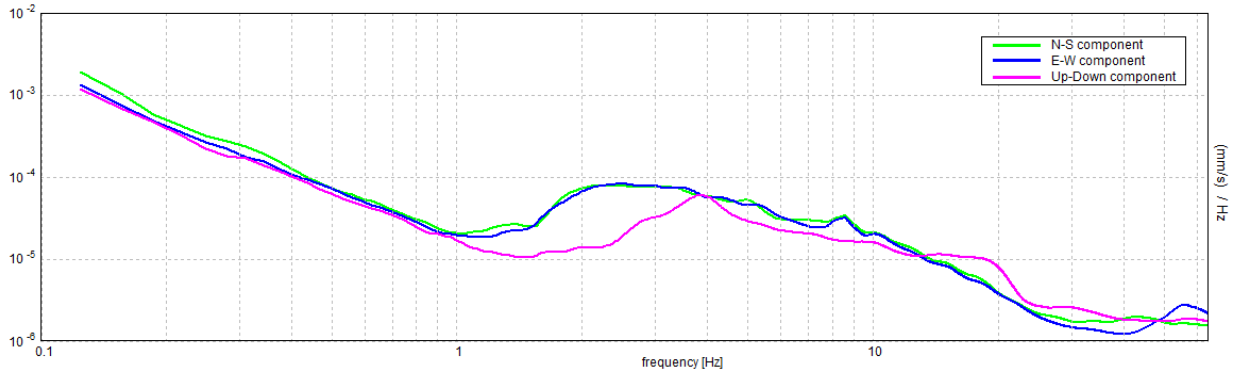
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the SESAME, 2005 guidelines. **Please read carefully the** *Grilla* **manual before interpreting the following tables**.]

Max. H/V at 2.19 ± 0.01 Hz (in the range 0.0 - 64.0 Hz).

Criteria for a reliable H/V curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	2.19 > 0.50	OK	
$n_c(f_0) > 200$	1793.8 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz **$\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz**	Exceeded 0 out of 106 times	OK	
Criteria for a clear H/V peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	1.594 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$	2.813 Hz	OK	
$A_0 > 2$	5.83 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0.00298| < 0.05	OK	
$\sigma_f < \varepsilon(f_0)$	0.00651 < 0.10938	OK	
$\sigma_A(f_0) < \theta(f_0)$	0.7648 < 1.58	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

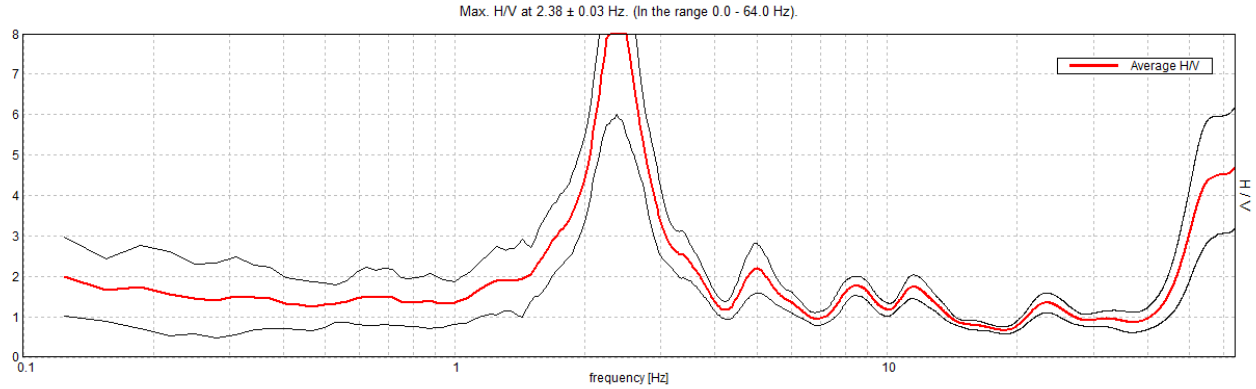
Threshold values for σ_f and $\sigma_A(f_0)$					
Freq. range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

LE202, folder LAKE_ELMO_2020_2, orig LE202 US

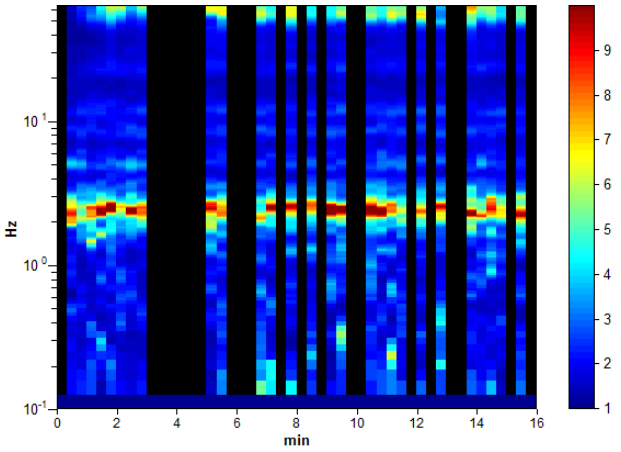
Instrument: TRZ-0082/01-10
Start recording: 24/02/20 09:51:10 End recording: 24/02/20 10:07:10
Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN
GPS data not available

Trace length: 0h16'00". Analyzed 56% trace (manual window selection)
Sampling rate: 128 Hz
Window size: 20 s
Smoothing type: Triangular window
Smoothing: 10%

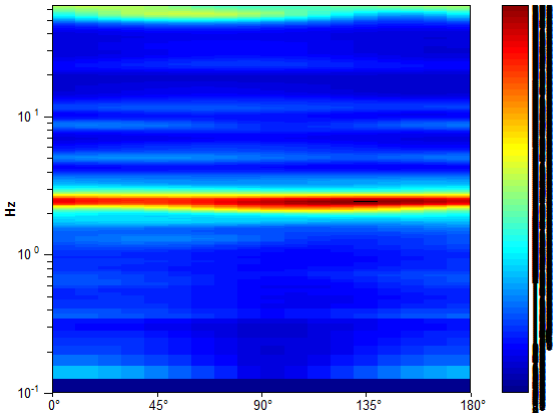
HORIZONTAL TO VERTICAL SPECTRAL RATIO



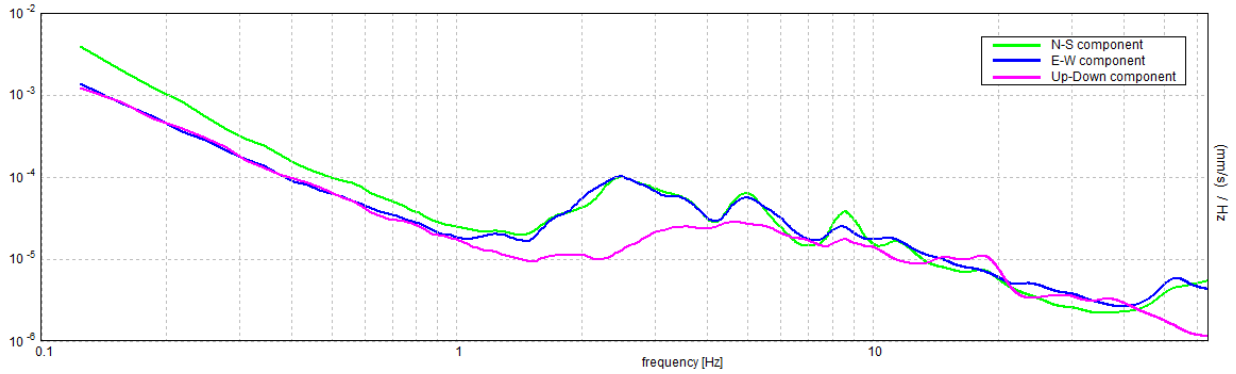
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the SESAME, 2005 guidelines. **Please read carefully the** *Grilla* **manual before interpreting the following tables**.]

Max. H/V at 2.38 ± 0.03 Hz (in the range 0.0 - 64.0 Hz).

Criteria for a reliable H/V curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	2.38 > 0.50	OK	
$n_c(f_0) > 200$	1282.5 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz **$\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz**	Exceeded 11 out of 115 times		NO
Criteria for a clear H/V peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	1.969 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$	2.844 Hz	OK	
$A_0 > 2$	8.71 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0.00624| < 0.05	OK	
$\sigma_f < \varepsilon(f_0)$	0.01482 < 0.11875	OK	
$\sigma_A(f_0) < \theta(f_0)$	1.2952 < 1.58	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

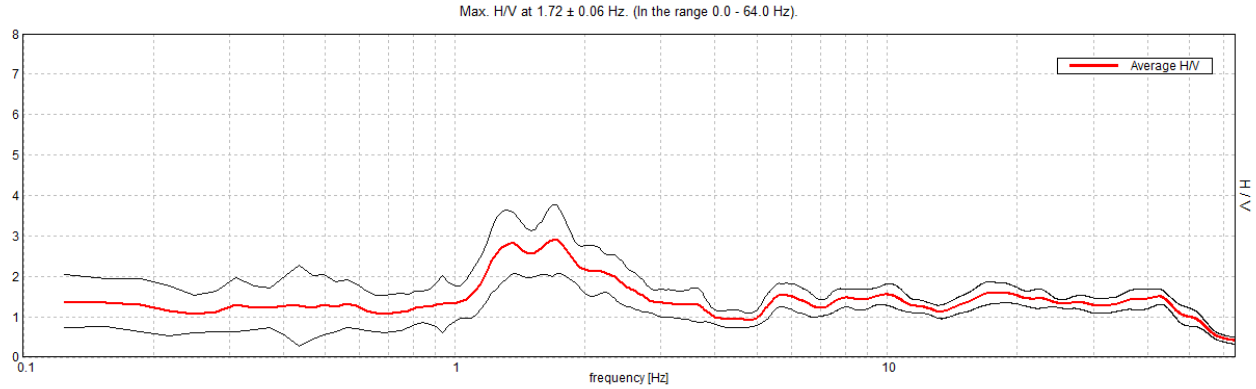
Threshold values for σ_f and $\sigma_A(f_0)$					
Freq. range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

LE201, folder LAKE_ELMO_2020_2, orig LE201 US

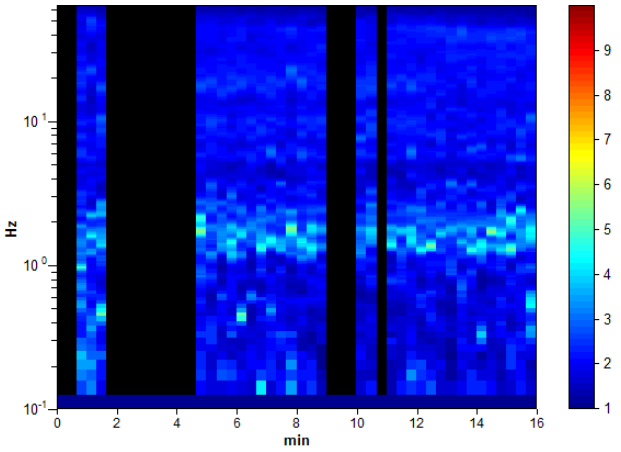
Instrument: TRZ-0082/01-10
Start recording: 24/02/20 09:14:08 End recording: 24/02/20 09:30:08
Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN
GPS data not available

Trace length: 0h16'00". Analyzed 69% trace (manual window selection)
Sampling rate: 128 Hz
Window size: 20 s
Smoothing type: Triangular window
Smoothing: 10%

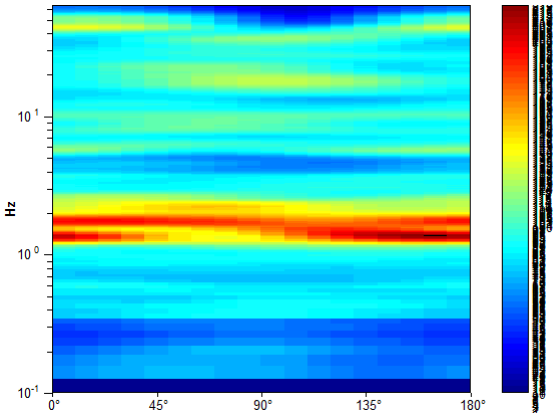
HORIZONTAL TO VERTICAL SPECTRAL RATIO



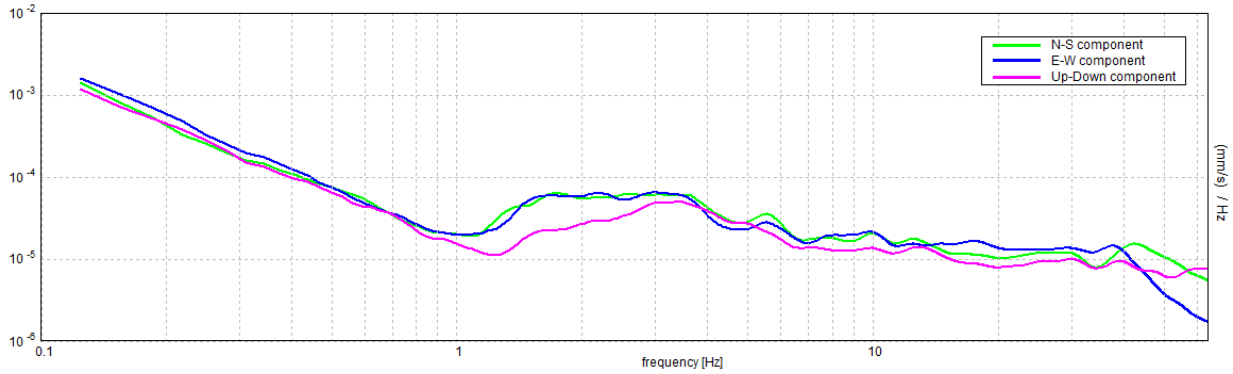
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the SESAME, 2005 guidelines. **Please read carefully the** *Grilla* **manual before interpreting the following tables**.]

Max. H/V at 1.72 ± 0.06 Hz (in the range 0.0 - 64.0 Hz).

Criteria for a reliable H/V curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	1.72 > 0.50	OK	
$n_c(f_0) > 200$	1134.4 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz **$\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz**	Exceeded 0 out of 84 times	OK	
Criteria for a clear H/V peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	1.063 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$	2.781 Hz	OK	
$A_0 > 2$	2.91 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0.01762| < 0.05	OK	
$\sigma_f < \varepsilon(f_0)$	0.03029 < 0.17188	OK	
$\sigma_A(f_0) < \theta(f_0)$	0.4113 < 1.78	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

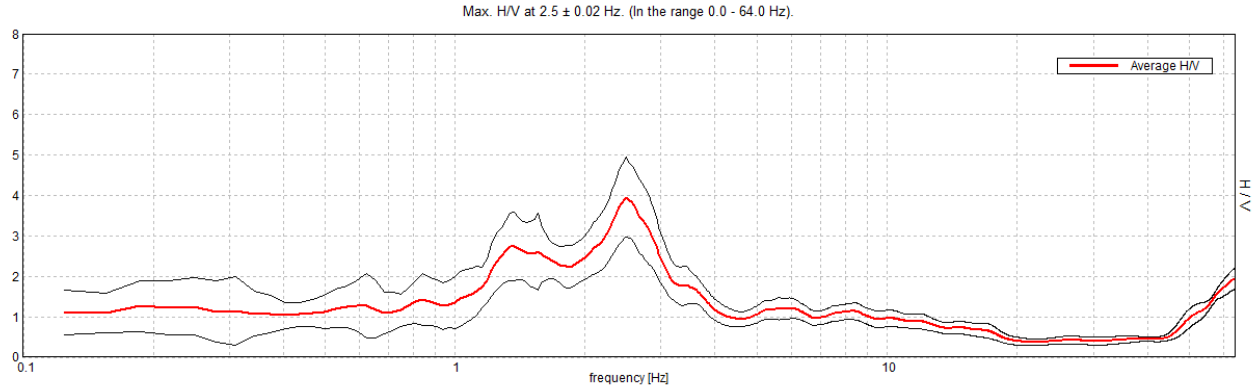
Threshold values for σ_f and $\sigma_A(f_0)$					
Freq. range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

LE-1-03, folder LAKE_ELMO_2020_1, orig LE-1-03

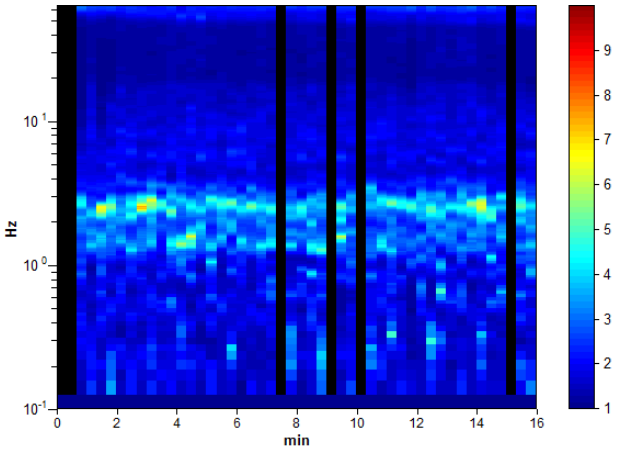
Instrument: TRZ-0082/01-10
Start recording: 11/02/20 03:38:46 End recording: 11/02/20 03:54:45
Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN
GPS data not available

Trace length: 0h16'00". Analyzed 88% trace (manual window selection)
Sampling rate: 128 Hz
Window size: 20 s
Smoothing type: Triangular window
Smoothing: 10%

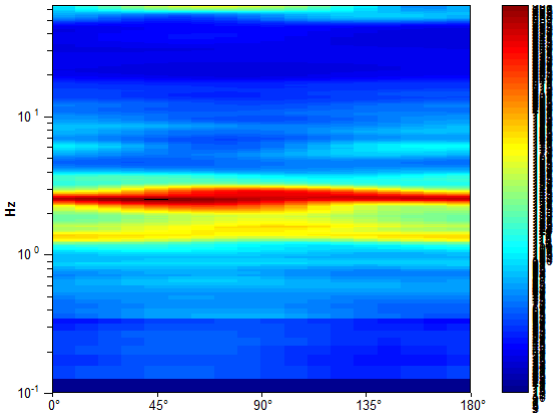
HORIZONTAL TO VERTICAL SPECTRAL RATIO



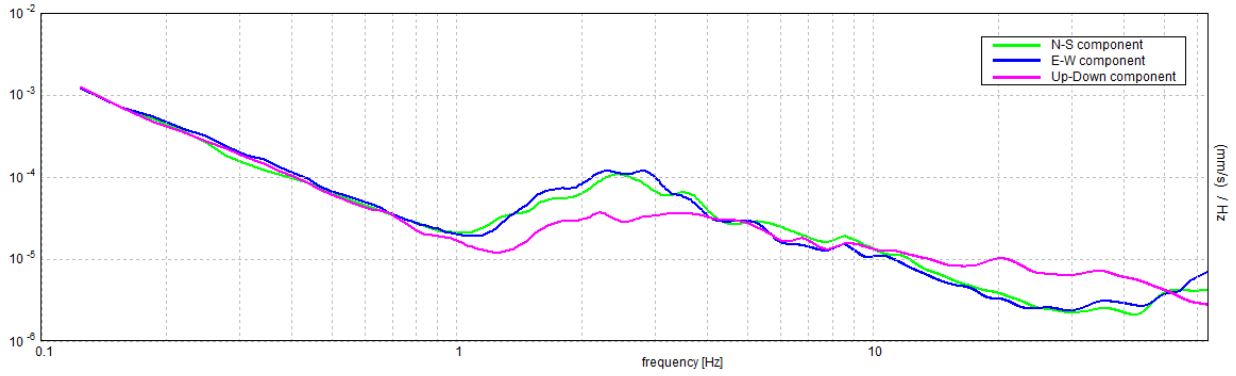
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the SESAME, 2005 guidelines. **Please read carefully the** *Grilla* **manual before interpreting the following tables**.]

Max. H/V at 2.5 ± 0.02 Hz (in the range 0.0 - 64.0 Hz).

Criteria for a reliable H/V curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	2.50 > 0.50	OK	
$n_c(f_0) > 200$	2100.0 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz **$\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz**	Exceeded 0 out of 121 times	OK	
Criteria for a clear H/V peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	1.188 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$	3.188 Hz	OK	
$A_0 > 2$	3.95 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0.00333| < 0.05	OK	
$\sigma_f < \varepsilon(f_0)$	0.00832 < 0.125	OK	
$\sigma_A(f_0) < \theta(f_0)$	0.484 < 1.58	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

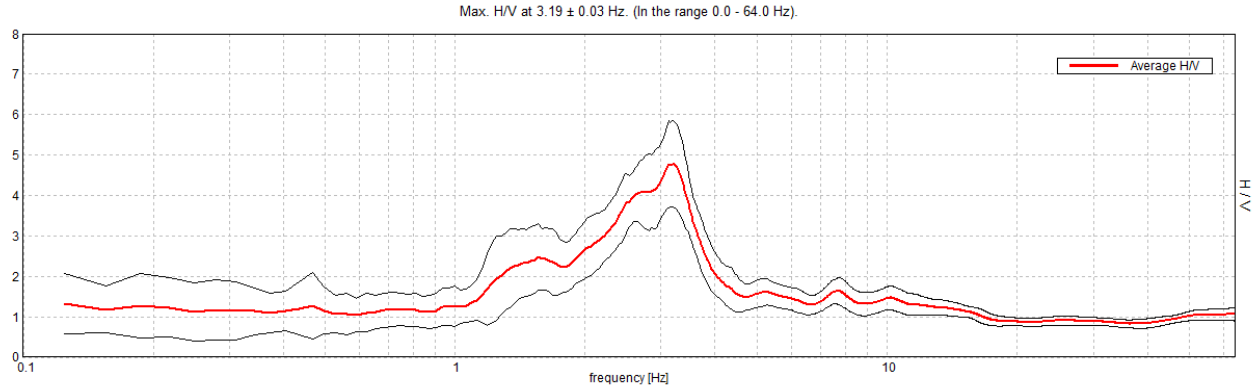
Threshold values for σ_f and $\sigma_A(f_0)$					
Freq. range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

LE-1-02. Folder LAKE_ELMO_2020_orig 1, LE-1-02

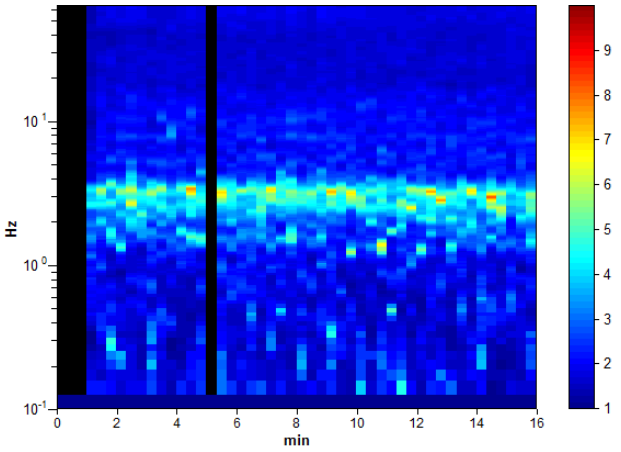
Instrument: TRZ-0082/01-10
Start recording: 11/02/20 03:12:32 End recording: 11/02/20 03:28:32
Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN
GPS data not available

Trace length: 0h16'00". Analyzed 92% trace (manual window selection)
Sampling rate: 128 Hz
Window size: 20 s
Smoothing type: Triangular window
Smoothing: 10%

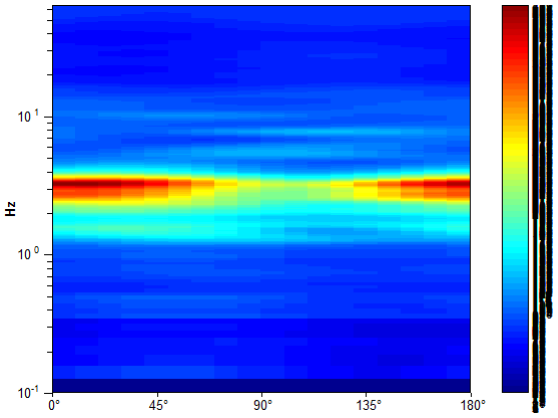
HORIZONTAL TO VERTICAL SPECTRAL RATIO



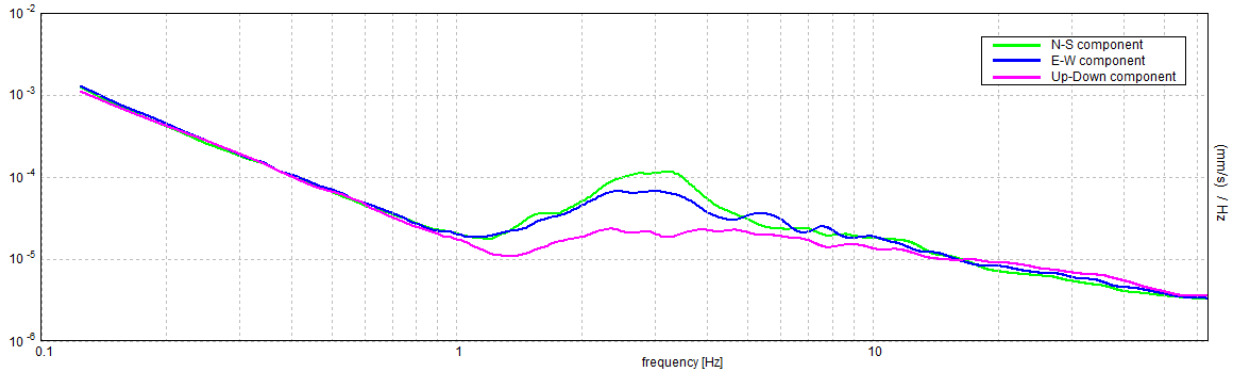
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the SESAME, 2005 guidelines. **Please read carefully the** *Grilla* **manual before interpreting the following tables**.]

Max. H/V at 3.19 ± 0.03 Hz (in the range 0.0 - 64.0 Hz).

Criteria for a reliable H/V curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	3.19 > 0.50	OK	
$n_c(f_0) > 200$	2805.0 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz **$\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz**	Exceeded 0 out of 154 times	OK	
Criteria for a clear H/V peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	1.875 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$	3.875 Hz	OK	
$A_0 > 2$	4.78 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0.00469| < 0.05	OK	
$\sigma_f < \varepsilon(f_0)$	0.01495 < 0.15938	OK	
$\sigma_A(f_0) < \theta(f_0)$	0.5257 < 1.58	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

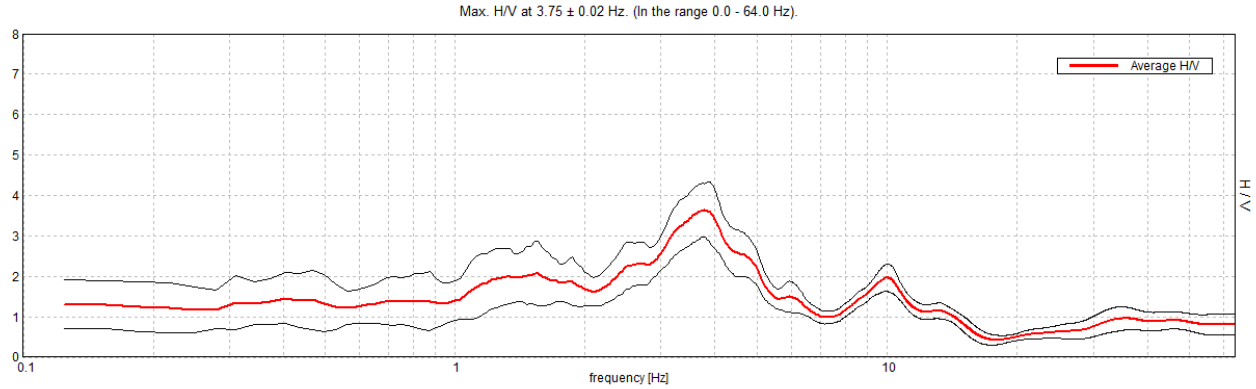
Threshold values for σ_f and $\sigma_A(f_0)$					
Freq. range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

LE-1-01, Folder LAKE_ELMO_2020_orig. 1, LE-1-01

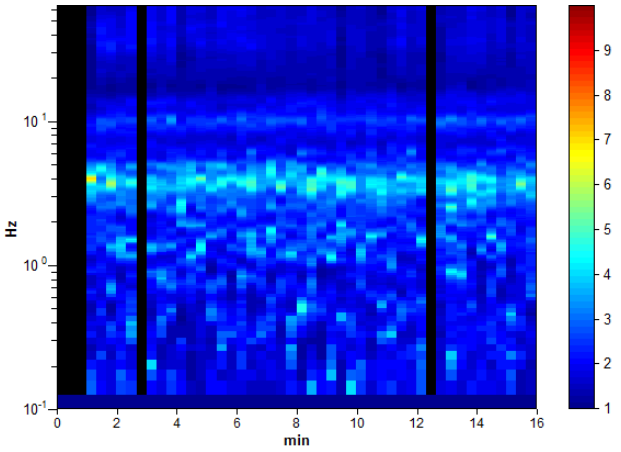
Instrument: TRZ-0082/01-10
Start recording: 11/02/20 02:47:54 End recording: 11/02/20 03:03:54
Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN
GPS data not available

Trace length: 0h16'00". Analyzed 90% trace (manual window selection)
Sampling rate: 128 Hz
Window size: 20 s
Smoothing type: Triangular window
Smoothing: 10%

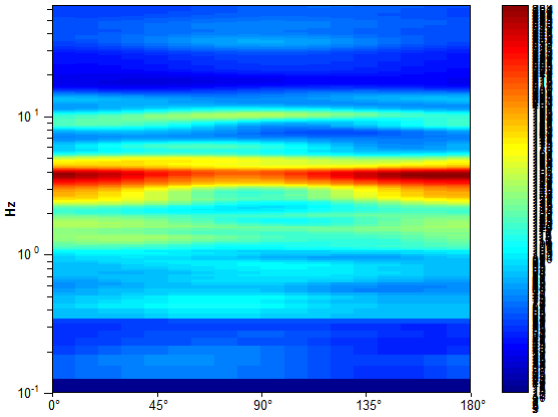
HORIZONTAL TO VERTICAL SPECTRAL RATIO



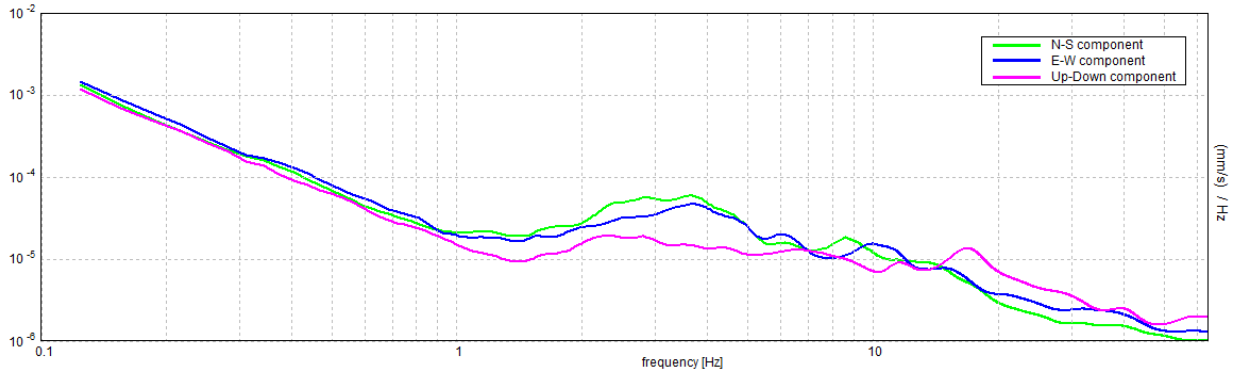
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the SESAME, 2005 guidelines. **Please read carefully the *Grilla* manual before interpreting the following tables**.]

Max. H/V at 3.75 ± 0.02 Hz (in the range 0.0 - 64.0 Hz).

Criteria for a reliable H/V curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	3.75 > 0.50	OK	
$n_c(f_0) > 200$	3225.0 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz **$\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz**	Exceeded 0 out of 181 times	OK	
Criteria for a clear H/V peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	2.25 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$	5.219 Hz	OK	
$A_0 > 2$	3.64 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0.00228| < 0.05	OK	
$\sigma_f < \varepsilon(f_0)$	0.00857 < 0.1875	OK	
$\sigma_A(f_0) < \theta(f_0)$	0.3258 < 1.58	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

Threshold values for σ_f and $\sigma_A(f_0)$					
Freq. range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20