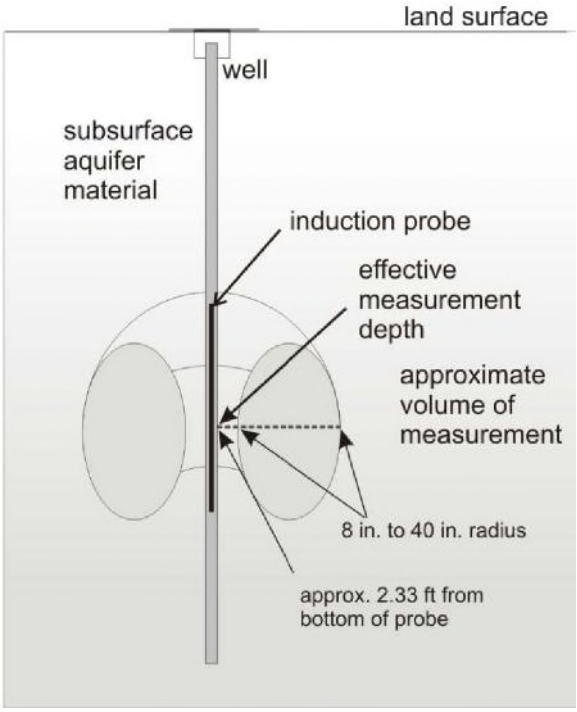
APPENDIX J:

U.S. GEOLOGICAL SURVEY INDUCTION LOGS

RECORDS OF BULK ELECTRICAL CONDUCTIVITY

Bulk electrical conductivity is the combined electrical conductivity of all materials within an approximately 8- to 40-inch toroidal volume around an electromagnetic induction (EM) probe (McNeill and others, 1990; center right). As the name implies, the EM probe generates an electronically pulsed or alternating magnetic field, which induces an electrical current in nearby conductive material. This induced current in turn generates a pulsed or alternating magnetic field that is detected by the probe, compared to the original signal and the difference in phase or frequency recorded. The records from the EM probe are converted to a measure of the bulk electrical conductivity using calibration data collected on the probe's response to a reference magnetic field of known frequency.



For this groundwater monitoring study, a calibrated EM probe is used to log one or more monitoring wells in the study area once per year (sequential logging), recording the bulk conductivity of pore water together with the aquifer sediments surrounding each well. The volume of bulk material that can be measured has a toroidal shape that has both inner and outer boundaries. Because the well casing and the borehole are inside the inner boundary of the toroid, they do not affect the bulk conductivity measurements unless made from ferrous or magnetic materials that can interact with the fields generated by the EM probe. In the absence of such

interference, the bulk conductivity measurements collected with an EM probe are considered representative of the aquifer properties throughout the range of depths logged.

A bulk conductivity measurement by an EM probe, and the overall response pattern that makes up an electromagnetic induction log, can be considered a composite of static and dynamic components. The relative contributions of the components may differ with depth and/or time at a given monitoring well. At a well located where conditions are not changing within the aquifer, the conductivity of static components like lithology may determine the pattern of conductivity values in the logs. A single log or series of logs collected may be sufficient to describe the bulk conductivity of the aquifer at the site. Where the conditions that may affect the bulk conductivity are changing within the aquifer, the conductivity of a dynamic component like water salinity may be the determinant. Sequential logging can be used to identify the location and relative magnitude of changing conductivity, in addition to the static conductivity pattern where water conductivity is not changing.

Static components in bulk conductivity response

Because aquifer sediments change little from year to year, they act as a static component of the logged bulk conductivity. However, the physical and chemical properties of sediment or rock, including dryness or water saturation, may change with depth as the EM probe passes strata having different properties. Those differences combine to produce a distinct pattern of conductivity values changing with depth in the EM logs. This pattern may be used to identify the sediment or rock lithology present at depth, and zones of higher or lower bulk conductivity within the aquifer.

Aquifer materials such as sand or sandstone generally produces lower values in records of bulk conductivity than clay or mudstone saturated with pore water having a similar

composition. The lower conductivity values may result from a combination of the smaller interstitial pore volume within a packed volume of sand than in the finer-grained materials and the greater ability of clays to stay wetted. The pore space in sandstone is partially filled by electrically resistive silica or calcite, reducing the material's bulk material conductivity further. In this investigation's study area, the sediments that host the local aquifer composed mostly of carbonate rock and silica sand. Conductivity values from freshwater-saturated silica and carbonate sediments typically are less than 25 mS/m, whereas conductivity values from materials saturated by brackish or salty water are typically greater than 67 mS/m (Hittle, 1999).

Polyvinyl chloride, or PVC, is commonly used as the casing material for environmental monitoring wells. This electrically resistive plastic has a low magnetic susceptibility and is nearly inert to groundwater and seawater. When used as a well casing material it neither adds corrosion products to the aquifer nor interacts with the magnetic field generated by an EM probe.

Steel and galvanized iron have also been used for well casings, fittings, and well centralizers (used to support a casing within an open hole during drilling and completion). These materials are good electrical conductors and display a greater magnetic susceptibility than PVC. The result is that an EM probe induces a far stronger current in these materials than in the sediment, effectively blinding the probe with high-amplitude electronic noise as the EM probe approaches and passes a steel or iron object during logging. Pure seawater, also highly conductive, produces a similar response, as can be seen in logs collected at the Biscayne Bay offshore wells, between the wellhead and the bay bottom.

Dynamic components of bulk conductivity response

Because the conductivity of water increases with the concentration of dissolved ionic compounds, the composition of pore water in saturated sediment is an important component in the logged bulk conductivity values. Differences in dissolved solids concentration and in

chloride concentration, i.e., water salinity, among water-saturated layers tend to produce the strongest conductivity signals logged by the EM probe. Because water salinity is more likely to change over time, it acts as a dynamic component among the material properties that affect bulk conductivity.

At some of the wells logged for this report, the freshwater aquifer is intruded by saltwater near the base of the aquifer. EM logs from wells drilled deep enough to cross into this salt water may display the interface between the fresh or salt water. A freshwater-saltwater interface may be seen in the logs as the depth at which low values of conductivity increase suddenly and remain at values generally above 67 mS/m with increasing depth. At other wells, saline water might occur only in zones of preferential flow within the aquifer. Depending on the conditions at the well, a relatively saline zone such as this may be difficult to distinguish from sediments that normally display a higher conductivity than those at other depths. If the well is not open to the aquifer at the same depth as the more conductive materials, water samples cannot be collected to quantify the water salinity. However, as water salinity may change over time in a flow zone, sequential logging can be used to determine if bulk conductivity is changing at these depths.

Data Collection and Computation

During periods of relatively lower water levels, saltwater intrusion into a freshwater aquifer is likely to be at a maximum. For that reason, electromagnetic induction logs are generally collected during this period, usually occurring in April and May in southeastern Florida.

Water samples may also be collected from wells selected for electromagnetic induction logging, or from a well collocated with a logged well, and analyzed as a check of the groundwater salinity data provided by the logs. Because the sample represents only the open interval of the well, such comparison may not apply to the rest of the logged interval. Another

drawback limiting comparison of EM logs and water samples is that at wells constructed with a long open interval, a normal groundwater sample may be most representative of one or more depth intervals that are significantly more transmissive than the remainder of the open depth interval.

Because components, including lithology, porosity, and well construction, can contribute to bulk electrical conductivity, the electromagnetic induction log readings may not be directly proportionate to the chloride concentrations in collected groundwater samples. Where dissolved chloride is present, the conductivity of water in the aquifer varies with chloride concentrations but the ratio of conductivity to chloride concentrations may not be constant. However, the other components contributing to the bulk conductivity may add further complexity to the system. For example, if the saturated sediment or rock is not very porous, then changes in bulk electrical conductivity resulting from salinity changes in a correspondingly smaller pore water volume may be smaller than might be expected. In some cases, more porous and permeable materials can also provide a reduced response. A short-term “pulse” of salt water introduced into the aquifer may be diluted with enough fresh water as it moves down the water column in response to gravity, or away from the site of introduction by mass transport, that the bulk conductivity response is muted in the next log or logs collected. Such pulses have been reported based on monitoring data from wells near canals in which seawater has moved inland along the canal bottom, and then into the aquifer.

In the annual data reports published by the USGS, chloride concentrations of groundwater samples collected by the agency’s personnel are usually included with the graph of bulk electrical conductivity, as an aid to understanding the bulk conductivity changes that may be seen in sequential EM logs. However, the April 2011 and March-April 2012 electromagnetic

induction logging sessions were carried out by the USGS after synoptic sampling of the wells had been completed by Florida Power & Light. Because these samples are not directly part of the USGS logging operations, the results obtained from those samples are not included with this series of induction logs.

Electromagnetic logging operations

At the start of logging, the top of the electromagnetic induction probe is lined up with the measuring point of the well. Where practical, this measuring point is the top of the well casing, which may or may not be at ground surface. A set of bulk conductivity readings are logged as the probe is lowered to the bottom of the well, and again as it is raised back to the top of the well. These data comprise the down-hole and up-hole logs collected at the site. The probe is lowered and raised at a constant 15 ft/min (feet per minute), while measurements of the induced current in the bulk material are taken about 3 times per second. The logging equipment records the probe speed and converts it to measurement depth for each set of readings. Unless otherwise noted, data recorded during the final up-hole log are used to produce the graphs for this report. Such exceptions may be made when quality assurance review finds that a different log provides the most representative data of the logs collected at a monitoring well.

Upon completion of the logging session, the data from the logs are reviewed, corrected for vertical (up-hole/down-hole) offsets and amplitude (increased/decreased conductivity offset) variance caused by varying environmental conditions. Vertical offsets are most commonly caused by different starting placements of the probe among the logs collected, or errors in the distance of travel calculation for measurement depth. Offsets and amplitude differentials among logs and sets of logs may be caused by environmental factors such as variable temperature and humidity, or by errors in instrument calibration (see Accuracy of Bulk Electrical Conductivity).

Accuracy of Bulk Electrical Conductivity

There are two principal components of the data that can affect the quality of the published electromagnetic induction logs: (1) depth accuracy, and (2) accuracy and precision of measured bulk electrical conductivity. Accurate depth information is needed to distinguish changes in instrument response caused by changing pore water properties from changes in instrument response caused by lithologic properties, and is therefore considered the most critical factor in this monitoring effort. The accuracy and precision of measured bulk electrical conductivity need to be sufficient to provide a qualitative view of the subsurface materials and conditions.

Depth Accuracy

During processing and review, the logged depth values are adjusted to coincide with the effective measurement depth of the EM probe at the start and end points of the logs. The depth values are then adjusted so that subsequent logs coincide at two conductivity maxima and/or minima. These maxima or minima are chosen as recognizable features in the logs which at consistent depths among the annual logs. While these features are usually static responses to lithology, the interference range of metallic well casings or centralizers may be equally suitable for the vertical correction. In some cases, the maxima caused by thin units of saltwater-saturated sediment can also be used, if the depth of occurrence is a static reoccurring feature in the EM logs.

The resulting precision of depth determinations using this method is be considered to be about ±0.1 foot. The initial one or two logs of a series collected at a well are usually too small a population to eliminate uncertainty in the depth corrections and are therefore considered only accurate to ±0.5 foot until more logs have been collected for comparison. Because the April 2011 electromagnetic induction logs are the first set collected entirely after well completion, they are considered to be the initial logs for the sequential logging at each monitored well. However, both the 2011 and 2012 logs were also compared to the logs collected during well drilling and installation in 2010 (Wacker, 2011.) Although the logs collected during drilling represent different aquifer conditions than the later logs, the additional information provided is useful in refining the relationships among measuring points, ground elevation, total well depth, and the placement of the log in relation to these landmarks. Therefore, the resulting data after corrections, for logs published in 2012, are considered accurate to ±0.2 foot, vs. the 0.5-foot estimate determined for the 2011 publication. Depth corrections applied in the published record may be revised as additional logging data are collected, but such revisions are not expected to be greater than ±0.2 foot.

Accuracy and precision of measurement

The accuracy and precision of measured bulk electrical conductivity are a function of both the inherent accuracy of the electromagnetic induction probe and its calibration. The inherent precision of the probe is considered by the manufacturer to be ±5 percent of the full scale. This amounts to a precision of ±50 mS/m at 1,000 mS/m instrument response, up to ±150 mS/m at 3,000 mS/m instrument response. Data collected at other wells in the vicinity of the study area indicate that although instrument calibration may be affected by site conditions (for

example, ambient temperature, relative humidity, and soil moisture) the offsets among logged responses collected over several years generally are less than ±50 mS/m, and are consistent with the manufacturer's precision estimate. Procedures used to minimize errors resulting from field calibration conditions and data corrections applied to account for error are discussed below.

Field calibration procedures

The electromagnetic induction probe used to collect data for this report is calibrated prior to each field session. The calibration procedure establishes the mathematical constants used to convert raw instrument readings in counts per second (cps) into values of bulk electrical conductivity in millisiemens per meter (mS/m). As mentioned above, calibration constants for different logging sessions are expected to differ because of temperature and humidity differences during field calibration. For this reason, procedures have been adopted to minimize the influence of variable temperature and humidity. These procedures include selection of a "background" calibration site and well to be used for the calibration, and lowering the induction probe into the well prior to data collection for the calibration, which allows the probe's internal temperature to equilibrate to the temperature of the water column (A similar thermal equilibration is later carried out at each well logged). The probe is then removed from the well and the instrument calibrated using an electromagnetic field coil designed to produce a set response in the electromagnetic induction probe.

A two-point calibration of the electromagnetic induction probe is performed at the calibration well using the following electronic standards:

- **0 mS/m**: provided by measuring a background field reading in open air, in an area considered free of metallic objects or electrical/electronic equipment that would be detected by the probe.
- **460 mS/m**: provided by a manufacturer-calibrated electrical coil at its low induced field setting.

During both calibration and logging, the induction probe is set for a full-range scale of 0 to 1,000 mS/m. Although the measured bulk electrical conductivity exceeds 460 mS/m at most of the monitoring wells being reported, the probe response for similar wells in the region having bulk electrical conductivity values in excess of 460 mS/m has been determined to be approximately linear through most of the range of observations.

Data corrections to bulk electrical conductivity

The background site and calibration well used for the 0 mS/m calibration point may have a slightly different electrical conductivity and magnetic susceptibility from year to year as a function of ambient conditions. The ambient conditions at the background site and the well being logged may be sufficiently different to offset the data. As a result, at some stations this has resulted in initial records of negative bulk conductivity.

The following sequence of computations is used for each station logged in order to account for calibration variations, site-specific environmental effects, and to ensure that the data logged and reported are representative of the aquifer:

1. Any obviously spurious data (e.g., spikes, interference patterns) are removed from the record, along with data collected from depth intervals affected by the presence of metallic objects (well casing, centralizers, etc), or collected while changes were made to the equipment configuration.
2. The available logs are reviewed to identify a depth interval for which bulk electrical conductivity appears to be at a minimum in the log and is not changing because of salinity changes in the pore water. This depth interval is used as a baseline depth interval for comparison among the collected logs. If the conductivity values later begin to change through this baseline depth interval, a new depth interval is selected. If no such interval can be identified, this correction is omitted.
3. Bulk conductivity values from the selected depth interval are averaged to provide a baseline response value from which to compute a correctin. If a sufficient number of years of data are available, the median conductivity value is used instead of the average.
4. The baseline response value is further adjusted to avoid negative bulk conductivity values being reported in the corrected logs for depth intervals of low conductivity
5. For each log, the data correction to bulk electrical conductivity is calculated from the difference between the final baseline response value and the bulk electrical conductivity value from the baseline depth interval.
6. The resulting data correction is then added to the bulk electrical conductivity data for the entire log.

The March-April 2012 logs have been corrected using conductivity data from the WY 2011 logs collected at the same sites. In some cases, the WY2010 logs could also be used for the

mathematical comparison. Because this provides a small population for identifying and quantifying variation in calibration conditions, the corrections applied are considered approximate and may be revised once a longer period of record has been established. The revisions to the WY2011 correction values, incorporated in the WY2012 publication, are small enough to remain within the 5% error threshold set by the manufacturer.

Data Presentation

Records of conductivity are published individually on the page immediately following the well manuscript. Data for conductivity are identified by the station name and well number. Each record consists of a single graph representing conductivity, a table of logs and chloride samples collected. An accompanying lithologic log may be published, if available for the site and not published through an existing USGS publication. The set of provisional (pre-publication) manuscript and induction log graph pages are compiled into a PDF-format file and provided under separate cover.

LAS- and tfd- format data files collected during electromagnetic induction logging are provided as an electronic archive file under separate cover. A reduced set of logs, including only the logs used for the published graphs, is provided in the same format. Because they are intended to serve as original data records with regard to archival requirements, no corrections for vertical offset or conductivity amplitude offset have been made to these files.

Selected References

ASTM Standard D6726-01, 2007, Standard Guide for Conducting Borehole Geophysical Logging-Electromagnetic Induction, ASTM International, West Conshohocken, PA, 2003, DOI: 10.1520/C0033-03, http://www.astm.org/Standards/D6726.htm.

Hittle, C.D., 1999, Delineation of saltwater intrusion in the surficial aquifer system in eastern Palm Beach, Martin, and St. Lucie Counties, Florida, 1997-98: U.S. Geological Survey Water-Resources Investigations Report 99-4214, 1 sheet.

McNeill, J.D., Bosnar, M., Snelgrove, F. B., 1990, Resolution of an electromagnetic borehole conductivity logger for geotechnical and ground water applications, Geonics Limited Technical Note TN-25, 28 p.

Wacker, M.A., 2011, Tools and Data Acquisition of Borehole Geophysical Logging for the Florida Power & Light Company Turkey Point Power Plant in Support of a Groundwater, Surface-Water, and Ecological Monitoring Plan, Miami-Dade County, Florida: U.S. Geological Survey Open-File Report 2010-1260, 34 p.

Turkey Point Groundwater Well Induction Logging Manuscripts and Bulk Conductivity Charts from USGS

2011 - 2019

252601080211601 G-3932, other identifier TPGW-1. USGS Observation Well near Homestead, FL.

Biscayne aquifer
Biscayne Limestone Aquifer

Miami-Dade County, FL

LOCATION.--Lat 25°26'01.1", long 80°21'15.8" referenced to North American Datum of 1983, in sec.12, T.58 S., R.39 E., Miami-Dade County, FL, Hydrologic Unit 03090202, about 8.1 mi east-southeast of Homestead, Florida.

RECORDS OF BULK CONDUCTIVITY

WELL CHARACTERISTICS.--Depth 106.3 ft. Upper casing diameter 2 in; top of first opening 83 ft, bottom of last opening 87 ft.

DATUM.--Land-surface datum is 3.7 ft above the North American Vertical Datum of 1929 and 2.17 ft above National Geodetic Vertical Datum of 1988.

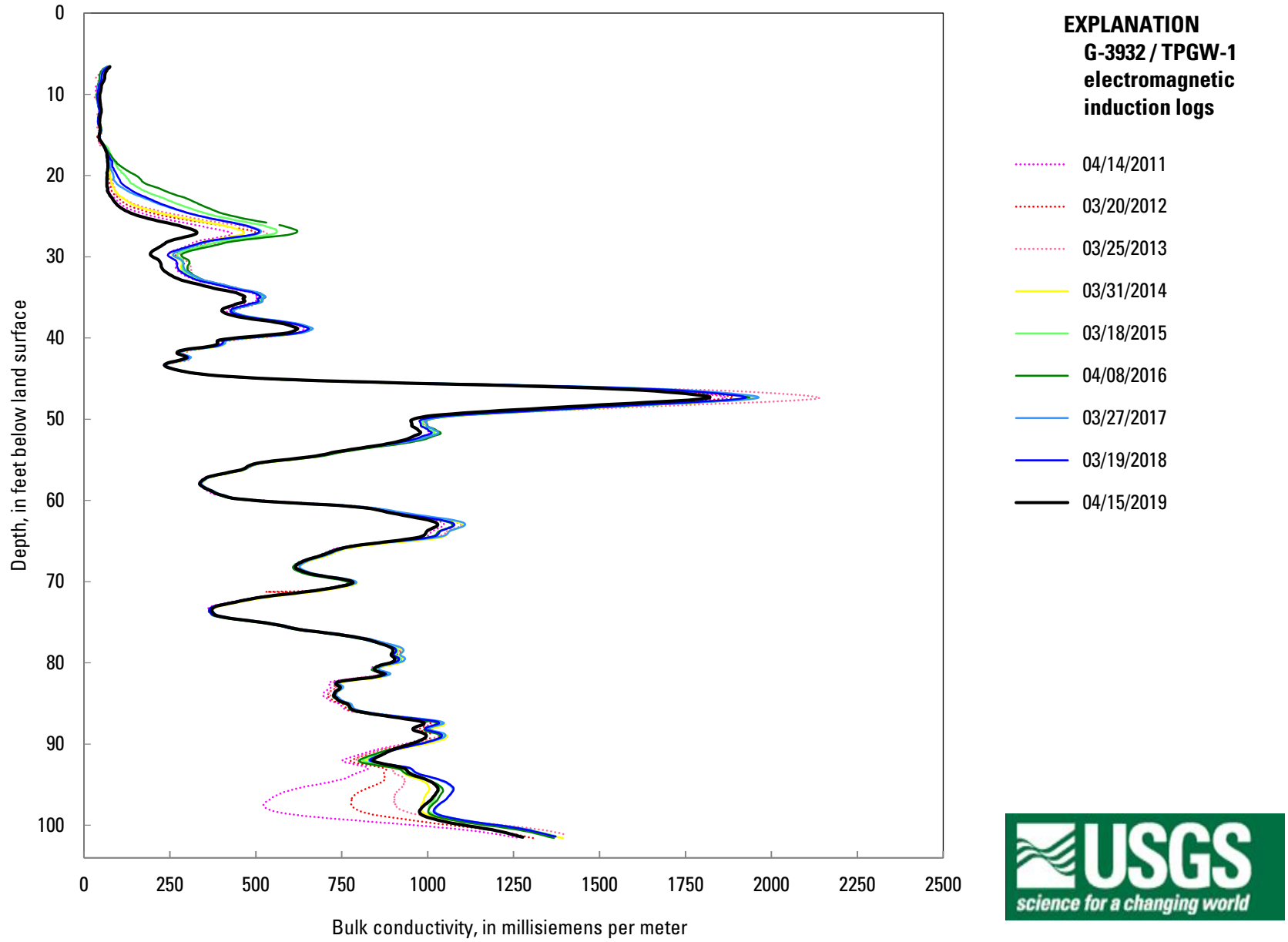
PERIOD OF RECORD.--May 2010 to current year (annually). See REMARKS.

INSTRUMENTATION.--Electromagnetic induction probe.

COOPERATION.--Florida Power & Light Company.

REMARKS.--Pre- and post- construction induction logs collected in WY 2010 are published under local well number TPGW-1 in Open-File Report 2010-1260 (http://pubs.usgs.gov/of/2010/1260/).

REVISED RECORDS.--TSEMIL 2015 Data Report, site 252601080211601, 2010-2014, TSEMIL 2014 Data Report, site 252601080211601, 2010-2013. Revised figures of electromagnetic induction logs, in mS/m, are available at https://www.sciencebase.gov/catalog/item/get/56abd635e4b0403299f46586.


EXPLANATION
G-3932 / TPGW-1
electromagnetic
induction logs
04/14/2011
03/20/2012
03/25/2013
03/31/2014
03/18/2015
04/08/2016
03/27/2017
03/19/2018
04/15/2019
Depth, in feet below land surface
0
10
20
30
40
50
60
70
80
90
100
0
250
500
750
1000
1250
1500
1750
2000
2250
2500
Bulk conductivity, in millisiemens per meter
USGS
science for a changing world

252254080221101 G-3933, other identifier TPGW-2. USGS Observation Well near Homestead, FL.

Biscayne aquifer
Biscayne Limestone Aquifer

Miami-Dade County, FL

LOCATION.--Lat 25°22'54.2", long 80°22'11.4" referenced to North American Datum of 1983, in sec.18, T.58 S., R.40 E., Miami-Dade County, FL, Hydrologic Unit 03090202, about 9 mi southeast of Homestead, Florida.

RECORDS OF BULK CONDUCTIVITY

WELL CHARACTERISTICS.--Depth 103.7 ft. Upper casing diameter 2 in; top of first opening 86 ft, bottom of last opening 88 ft.

DATUM.--Land-surface datum is 1.7 ft above the North American Vertical Datum of 1988 and 3.23 ft above National Geodetic Vertical Datum of 1929.

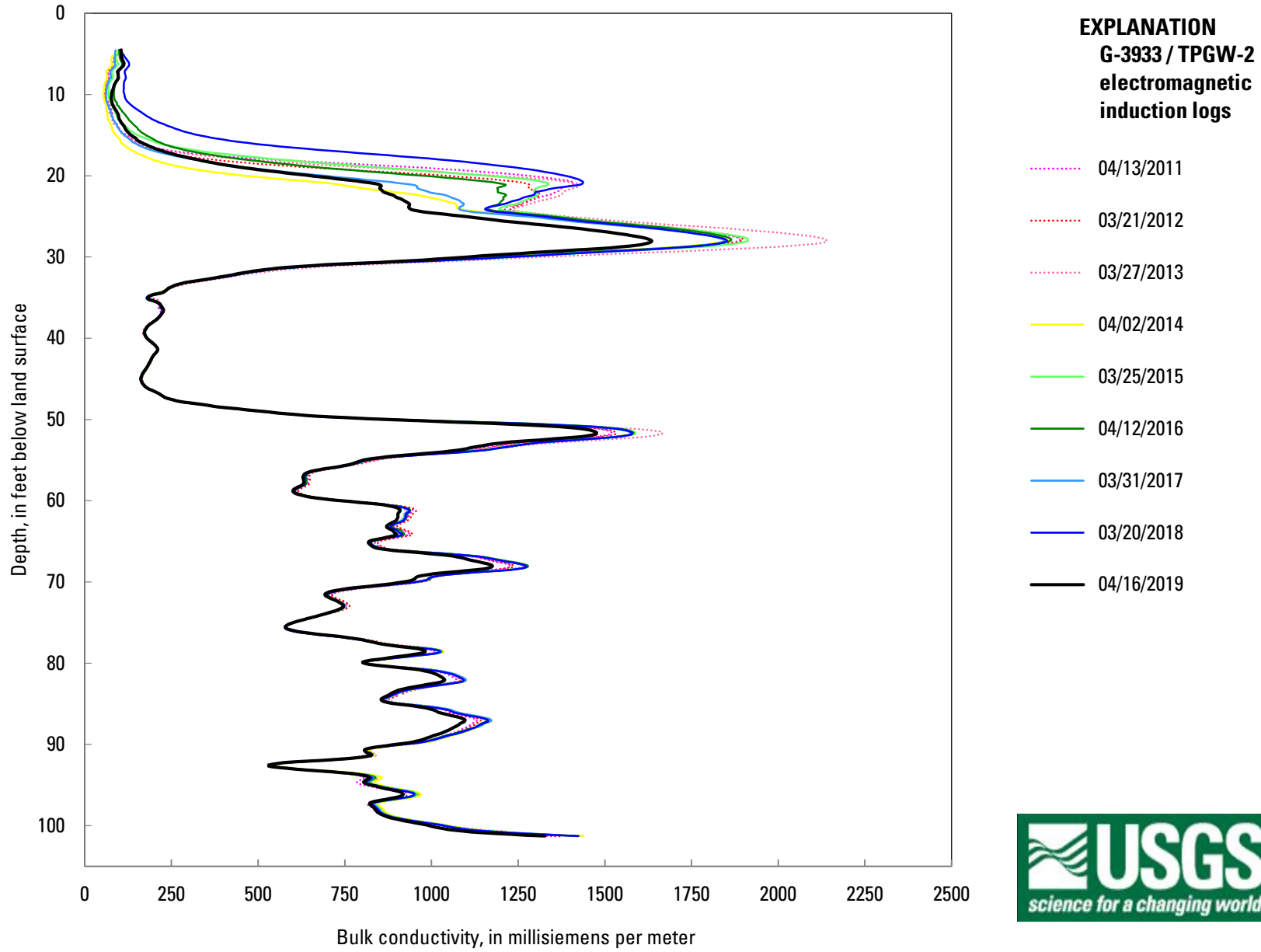
PERIOD OF RECORD.--April 2011 to current year (annually). See REMARKS.

INSTRUMENTATION.--Electromagnetic induction probe.

COOPERATION.--Florida Power & Light Company.

REVISED RECORDS.--TSEMIL 2017 Data Report, site 252254080221101, 2010-2017. Revised figures of electromagnetic induction logs, in mS/m, are available at https://www.sciencebase.gov/catalog/item/5a7c9683e4b00f54eb231af6.

REMARKS.--Pre- and post- construction induction logs collected in WY 2010 are published under local well number TPGW-2 in Open-File Report 2010-1260 (http://pubs.usgs.gov/of/2010/1260/).


Depth, in feet below land surface
0
10
20
30
40
50
60
70
80
90
100
0
250
500
750
1000
1250
1500
1750
2000
2250
2500
Bulk conductivity, in millisiemens per meter
EXPLANATION
G-3933 / TPGW-2
electromagnetic
induction logs
04/13/2011
03/21/2012
03/27/2013
04/02/2014
03/25/2015
04/12/2016
03/31/2017
03/20/2018
04/16/2019

252042080205201 G-3934, other identifier TPGW-3. USGS Observation Well near Homestead, FL.

Biscayne aquifer
Biscayne Limestone Aquifer

Miami-Dade County, FL

LOCATION.--Lat 25°20'42.1", long 80°20'51.9" referenced to North American Datum of 1983, in sec.32, T.58 S., R.40 E., Miami-Dade County, FL, Hydrologic Unit 03090202, about 11.8 mi southeast of Homestead, Florida.

RECORDS OF BULK CONDUCTIVITY

WELL CHARACTERISTICS.--Depth 109.3 ft. Upper casing diameter 2 in; top of first opening 87 ft, bottom of last opening 89 ft.

DATUM.--Land-surface datum is 3.07 ft above National Geodetic Vertical Datum of 1929 and 1.54 ft above the North American Vertical Datum of 1988.

PERIOD OF RECORD.--April 2010 to current year (annually). See REMARKS.

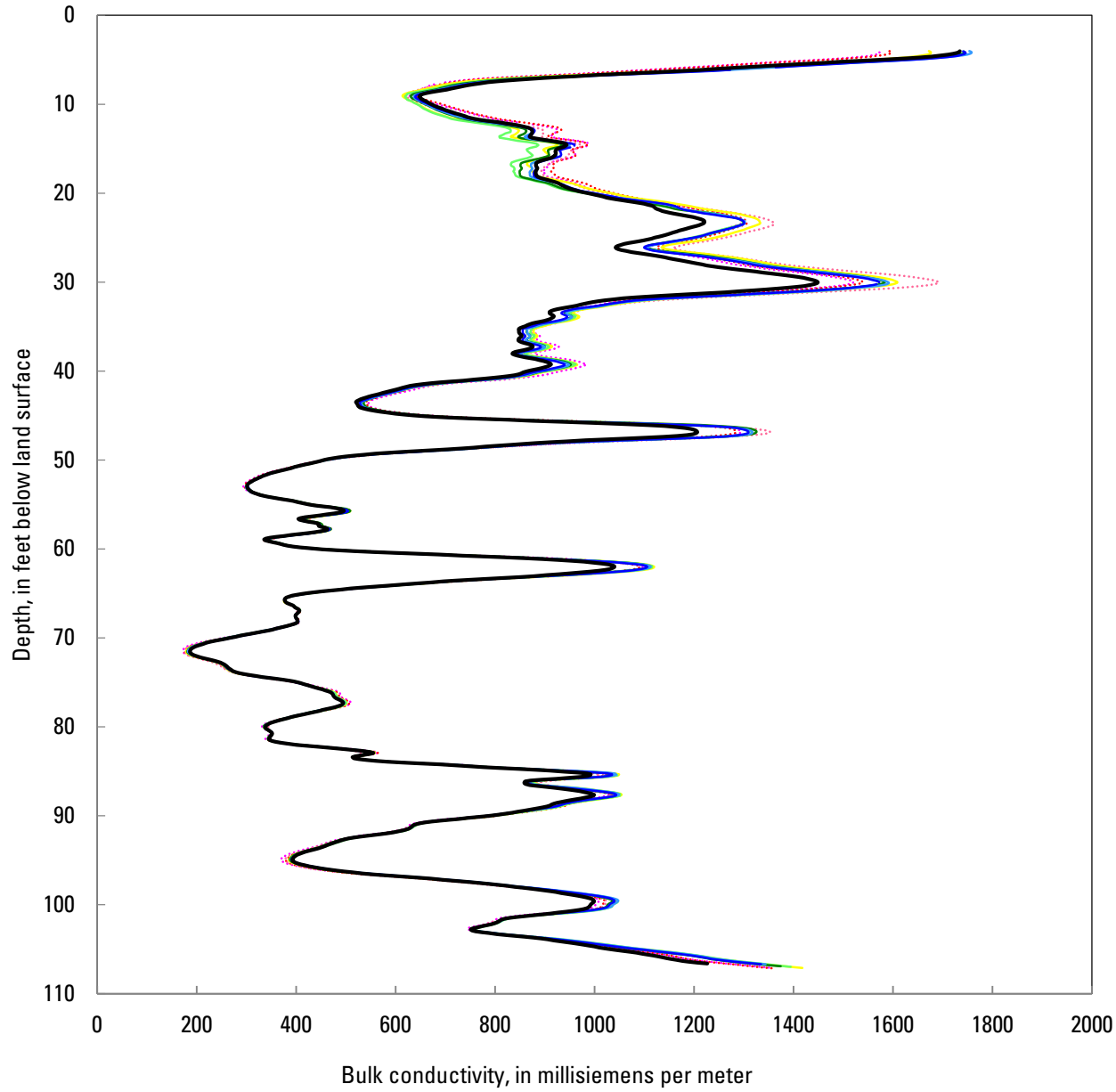
INSTRUMENTATION.--Electromagnetic induction probe.

COOPERATION.--Florida Power & Light Company.

REMARKS.--Pre- and post- construction induction logs collected in WY 2010 are published under local well number TPGW-3 in Open-File Report 2010-1260 (http://pubs.usgs.gov/of/2010/1260/).

REVISIONS.--The bulk conductivities of previously published electromagnetic induction logs collected from April 13, 2011 to March 20, 2018, available in the TSEMIL 2018 Data report at https://www.sciencebase.gov/catalog/item/5d5eccdae4b01d82ce961e1c, have been adjusted by -14.5 to 16.5 mS/m. The change in bulk conductivity is based on the median of the dataset at the current alignment depths.

REVISED RECORDS.--TSEMIL 2014 Data Report, site 252042080205201, 2010-2013. Revised figures of electromagnetic induction logs, in mS/m, are available at https://www.sciencebase.gov/catalog/item/get/56abd635e4b0403299f46586.



EXPLANATION

G-3934 / TPGW-3 electromagnetic induction logs

- 04/13/2011
- 03/21/2012
- 03/27/2013
- 04/02/2014
- 03/25/2015
- 04/12/2016
- 03/31/2017
- 03/20/2018
- 04/16/2019

USGS science for a changing world

252212080244401 G-3935, other identifier TPGW-4. USGS Observation Well near Homestead, FL.

Biscayne aquifer
Biscayne Limestone Aquifer

Miami-Dade County, FL

LOCATION.--Lat 25°22'12.0", long 80°24'44.1" referenced to North American Datum of 1983, in sec.22, T.58 S., R.39 E., Miami-Dade County, FL, Hydrologic Unit 03090202, about 12.3 mi southeast of Homestead, Florida.

RECORDS OF BULK CONDUCTIVITY

WELL CHARACTERISTICS.--Depth 87.8 ft. Upper casing diameter 2 in; top of first opening 62 ft, bottom of last opening 66 ft.

DATUM.--Land-surface datum is 2.34 above the North American Vertical Datum of 1988 and 3.87 ft above the National Geodetic Vertical Datum of 1929.

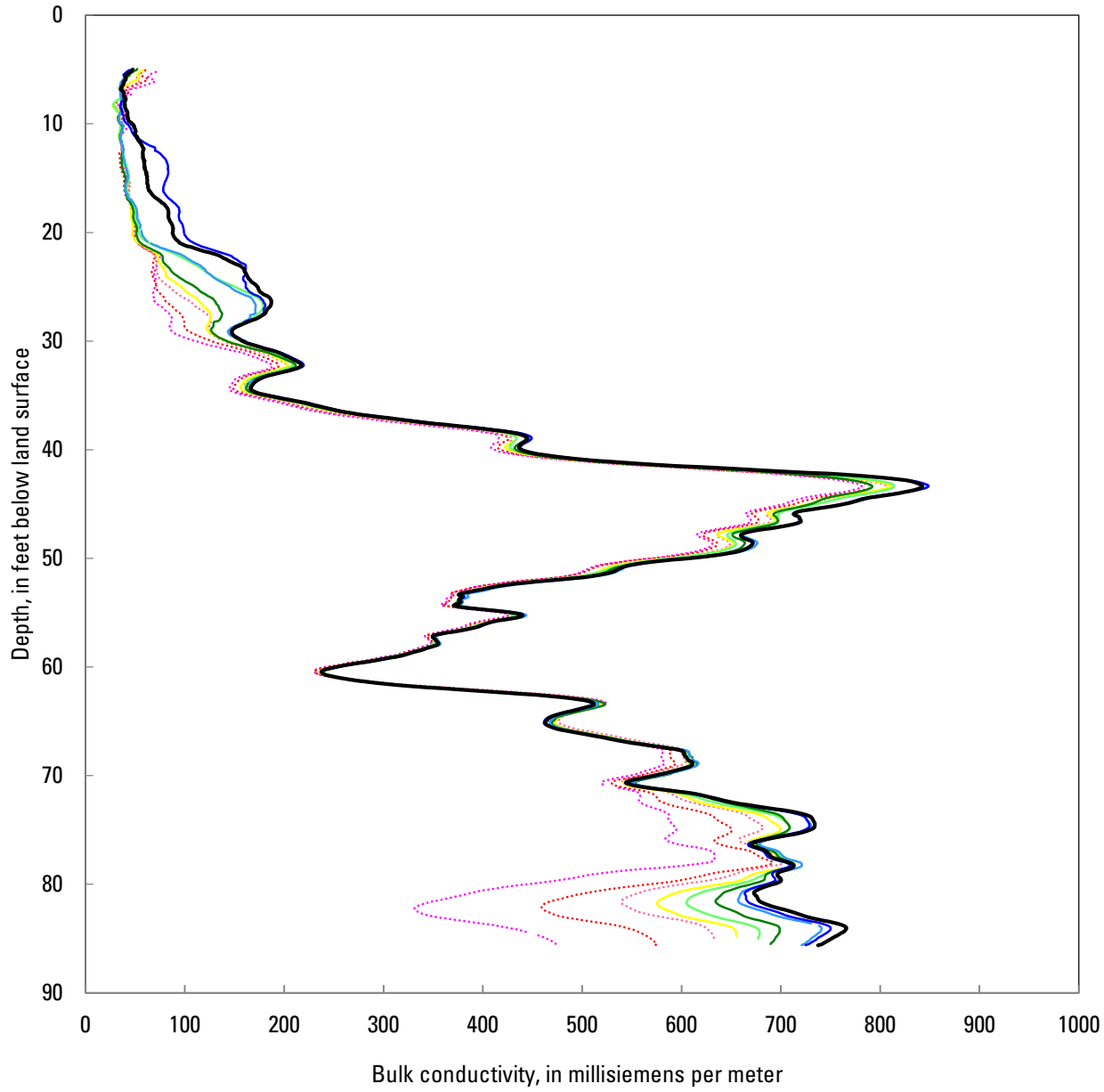
PERIOD OF RECORD.--May 2010 to current year (annually). See REMARKS.

INSTRUMENTATION.--Electromagnetic induction probe.

COOPERATION.--Florida Power & Light Company.

REMARKS.--Pre- and post- construction induction logs collected in WY 2010 are published under local well number TPGW-4 in Open-File Report 2010-1260 (http://pubs.usgs.gov/of/2010/1260/).

REVISED RECORDS.--TSEMIL 2014 Data Report, site 252212080244401, 2010-2013. Revised figures of electromagnetic induction logs, in mS/m, are available at https://www.sciencebase.gov/catalog/item/get/56abd635e4b0403299f46586.



EXPLANATION

G-3935 / TPGW-4 electromagnetic induction logs

- 04/13/2011
- 03/19/2012
- 03/27/2013
- 04/02/2014
- 03/27/2015
- 04/05/2016
- 04/06/2017
- 03/21/2018
- 04/17/2019

USGS
science for a changing world

252524080241301 G-3936, other identifier TPGW-5. USGS Observation Well near Homestead, FL.

Biscayne aquifer
Biscayne Limestone Aquifer

Miami-Dade County, FL

LOCATION.--Lat 25°25'23.9", long 80°24'13.3" referenced to North American Datum of 1983, in sec.35, T.57 S., R.39 E., Miami-Dade County, FL, Hydrologic Unit 03090202, about 5 mi south-southeast of Homestead, Florida.

RECORDS OF BULK CONDUCTIVITY

WELL CHARACTERISTICS.--Depth 91.2 ft. Upper casing diameter 2 in; top of first opening 61 ft, bottom of last opening 66 ft.

DATUM.--Land-surface datum is 0.56 ft below the North American Vertical Datum of 1988 and 0.97 ft above the National Geodetic Vertical Datum of 1929.

PERIOD OF RECORD.--April 2010 to current year (annually). See REMARKS.

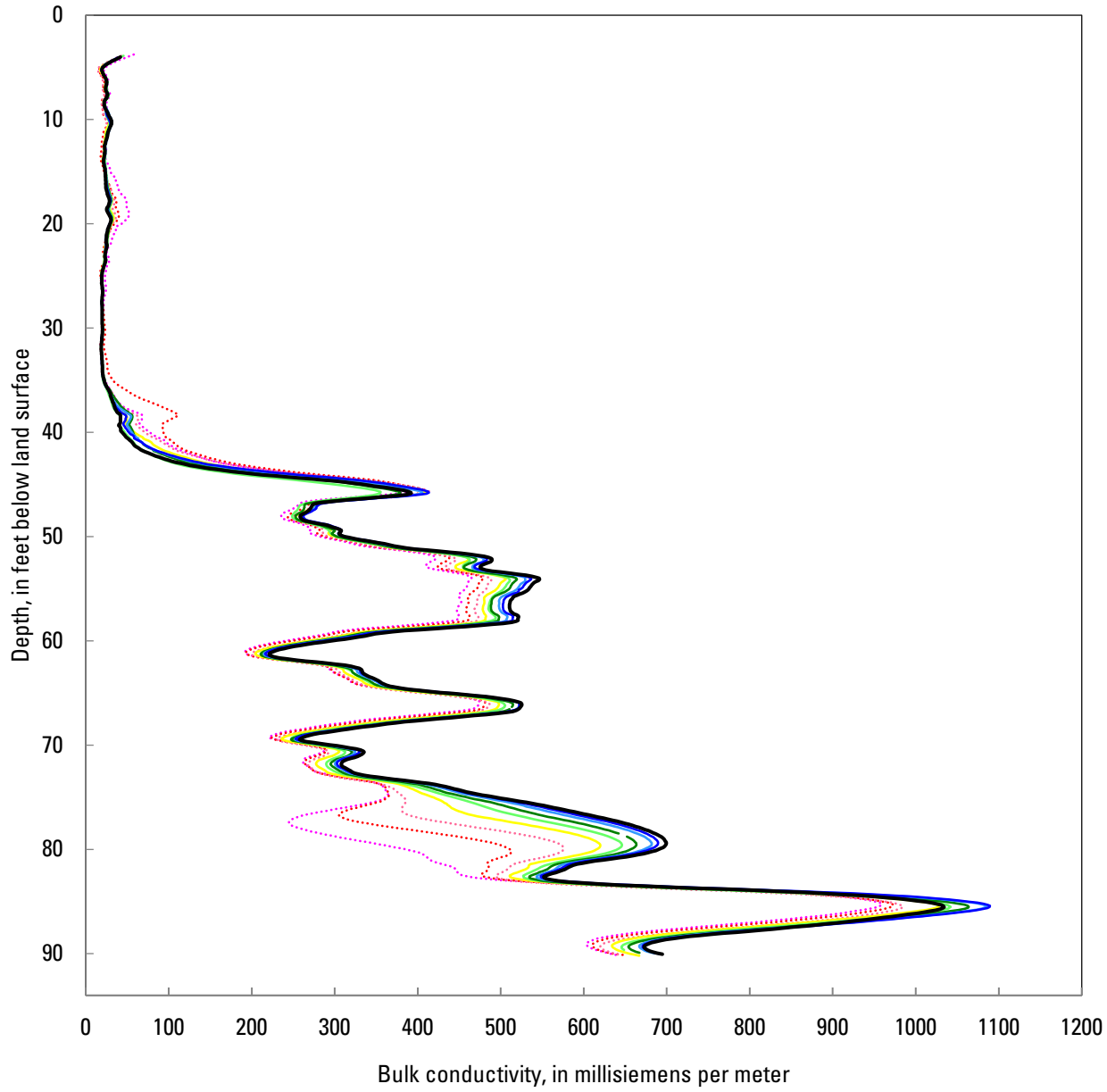
INSTRUMENTATION.--Electromagnetic induction probe.

COOPERATION.--Florida Power & Light Company.

REMARKS.--Pre- and post- construction induction logs collected in WY 2010 are published under local well number TPGW-5 in Open-File Report 2010-1260 (http://pubs.usgs.gov/of/2010/1260/).

REVISIONS.--The bulk conductivities of previously published electromagnetic induction logs collected from May 17, 2010 to March 22, 2018, available in the TSEMIL 2018 Data Report at https://www.sciencebase.gov/catalog/item/5d5eccdae4b01d82ce961e1c, have been adjusted by -8.1 to -2.6 mS/m. The change in bulk conductivity is based on the median of the dataset at the current alignment depth.

REVISED RECORDS.--TSEMIL 2015 Data Report, site 252524080241301, 2010-2014, TSEMIL 2014 Data Report, site 252524080241301, 2010-2013. Revised figures of electromagnetic induction logs, in mS/m, are available at https://www.sciencebase.gov/catalog/item/get/56abd635e4b0403299f46586.



EXPLANATION

G-3936 / TPGW-5 electromagnetic induction logs

- 04/12/2011
- 03/20/2012
- 03/26/2013
- 04/01/2014
- 03/24/2015
- 04/11/2016
- 04/04/2017
- 03/22/2018
- 04/19/2019

USGS
science for a changing world

252720080231301 G-3937, other identifier TPGW-6. USGS Observation Well near Homestead, FL.

Biscayne aquifer
Biscayne Limestone Aquifer

Miami-Dade County, FL

LOCATION.--Lat 25°27'20.23", long 80°23'13.0" referenced to North American Datum of 1983, in sec.24, T.57 S., R.39 E., Miami-Dade County, FL, Hydrologic Unit 03090202, about 5.7 mi east of Homestead, Florida.

RECORDS OF BULK CONDUCTIVITY

WELL CHARACTERISTICS.--Depth 111.6 ft. Upper casing diameter 2 in; top of first opening 82 ft, bottom of last opening 86 ft.

DATUM.--Land-surface datum is 1.80 ft above the North American Vertical Datum of 1988 and 3.33 ft above the National Geodetic Vertical Datum of 1929.

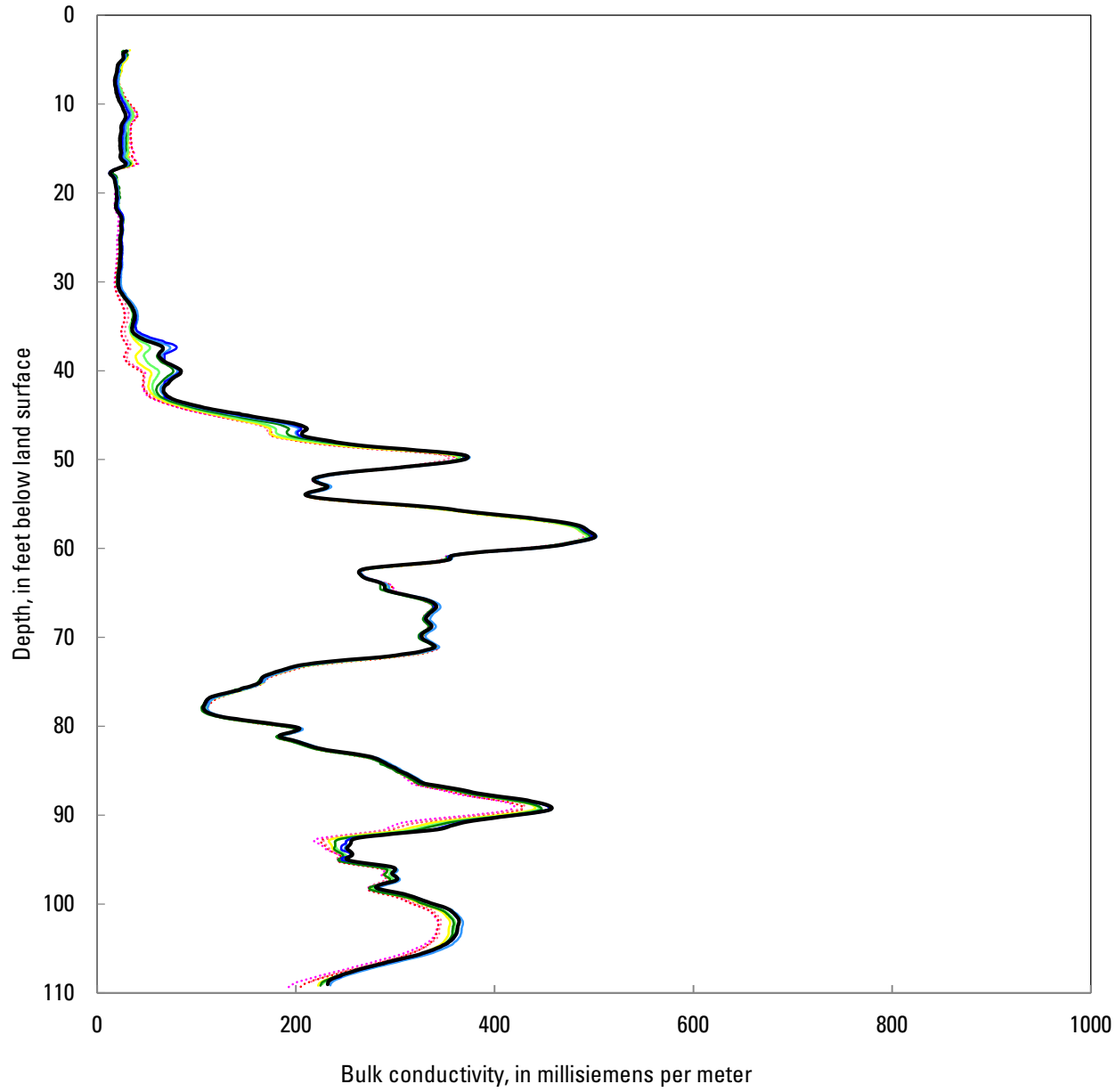
PERIOD OF RECORD.--May 2010 to current year (annually). See REMARKS.

INSTRUMENTATION.--Electromagnetic induction probe.

COOPERATION.--Florida Power & Light Company.

REMARKS.--Pre- and post- construction induction logs collected in WY 2010 are published under local well number TPGW-6 in Open-File Report 2010-1260 (http://pubs.usgs.gov/of/2010/1260/).

REVISED RECORDS.--TSEMIL 2014 Data Report, site 252720080231301, 2010-2013. Revised figures of electromagnetic induction logs, in mS/m, are available at https://www.sciencebase.gov/catalog/item/get/56abd635e4b0403299f46586.



EXPLANATION

G-3937 / TPGW-6 electromagnetic induction logs

- 04/13/2011
- 03/21/2012
- 03/28/2013
- 04/03/2014
- 03/26/2015
- 04/04/2016
- 04/04/2017
- 03/20/2018
- 04/16/2019

USGS
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252603080254101 G-3938, other identifier TPGW-7. USGS Observation Well near Homestead, FL.

Biscayne aquifer
Biscayne Limestone Aquifer

Miami-Dade County, FL

LOCATION.--Lat 25°26'02.5", long 80°25'40.7" referenced to North American Datum of 1983, in sec.27, T.57 S., R.39 E., Miami-Dade County, FL, Hydrologic Unit 03090202, about 3.9 mi southeast of Homestead, Florida.

RECORDS OF BULK CONDUCTIVITY

WELL CHARACTERISTICS.--Depth 114 ft. Upper casing diameter 2 in; top of first opening 80 ft, bottom of last opening 84 ft.

DATUM.--Land-surface datum is 1.52 ft above the North American Vertical Datum of 1988 and 3.05 ft above the National Geodetic Vertical Datum of 1929.

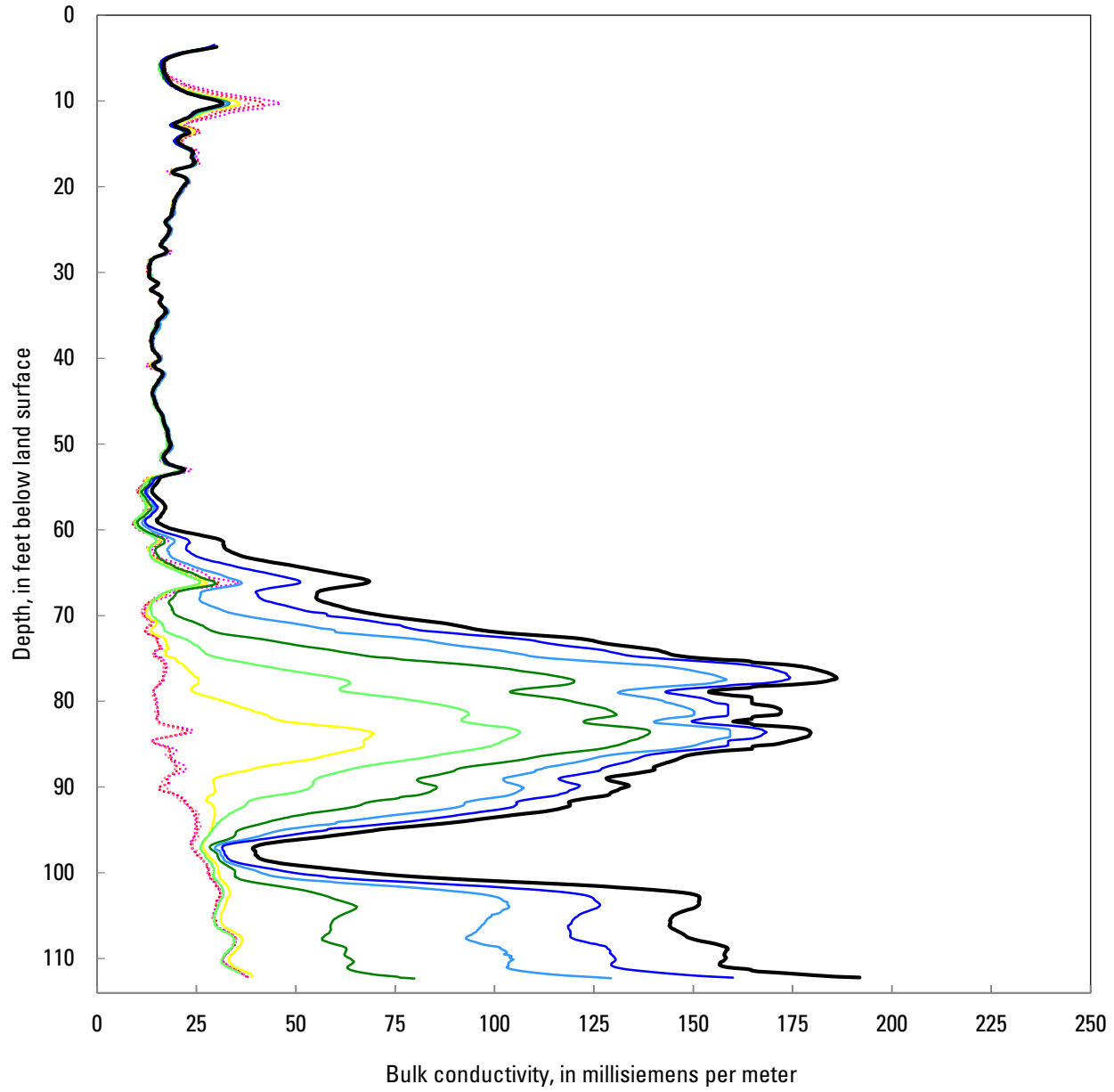
PERIOD OF RECORD.--April 2010 to current year (annually). See REMARKS.

INSTRUMENTATION.--Electromagnetic induction probe.

COOPERATION.--Florida Power & Light Company.

REMARKS.--Pre- and post- construction induction logs collected in WY 2010 are published under local well number TPGW-7 in Open-File Report 2010-1260 (http://pubs.usgs.gov/of/2010/1260/).

REVISED RECORDS.--TSEMIL 2015 Data Report, site 252603080254101, 2010-2014; TSEMIL 2014 Data Report, site 252603080254101, 2010-2013. Revised figures of electromagnetic induction logs, in mS/m, are available at https://www.sciencebase.gov/catalog/item/get/56abd635e4b0403299f46586.



EXPLANATION

G-3938 / TPGW-7 electromagnetic induction logs

- 04/14/2011
- 03/20/2012
- 03/26/2013
- 04/01/2014
- 03/24/2015
- 04/08/2016
- 04/03/2017
- 03/22/2018
- 04/16/2019

USGS
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252436080270901 G-3939, other identifier TPGW-8. USGS Observation Well near Homestead, FL.

Biscayne aquifer
Biscayne Limestone Aquifer

Miami-Dade County, FL

LOCATION.--Lat 25°24'36.4", long 80°27'08.7" referenced to North American Datum of 1983, in sec.5, T.58 S., R.39 E., Miami-Dade County, FL, Hydrologic Unit 03090202, about 4.3 mi south-southeast of Homestead, Florida.

RECORDS OF BULK CONDUCTIVITY

WELL CHARACTERISTICS.--Depth 92.5 ft. Upper casing diameter 2 in; top of first opening 49 ft, bottom of last opening 53 ft.

DATUM.--Land-surface datum is 2.30 ft above the North American Vertical Datum of 1988 and 3.83 ft above the National Geodetic Vertical Datum of 1929.

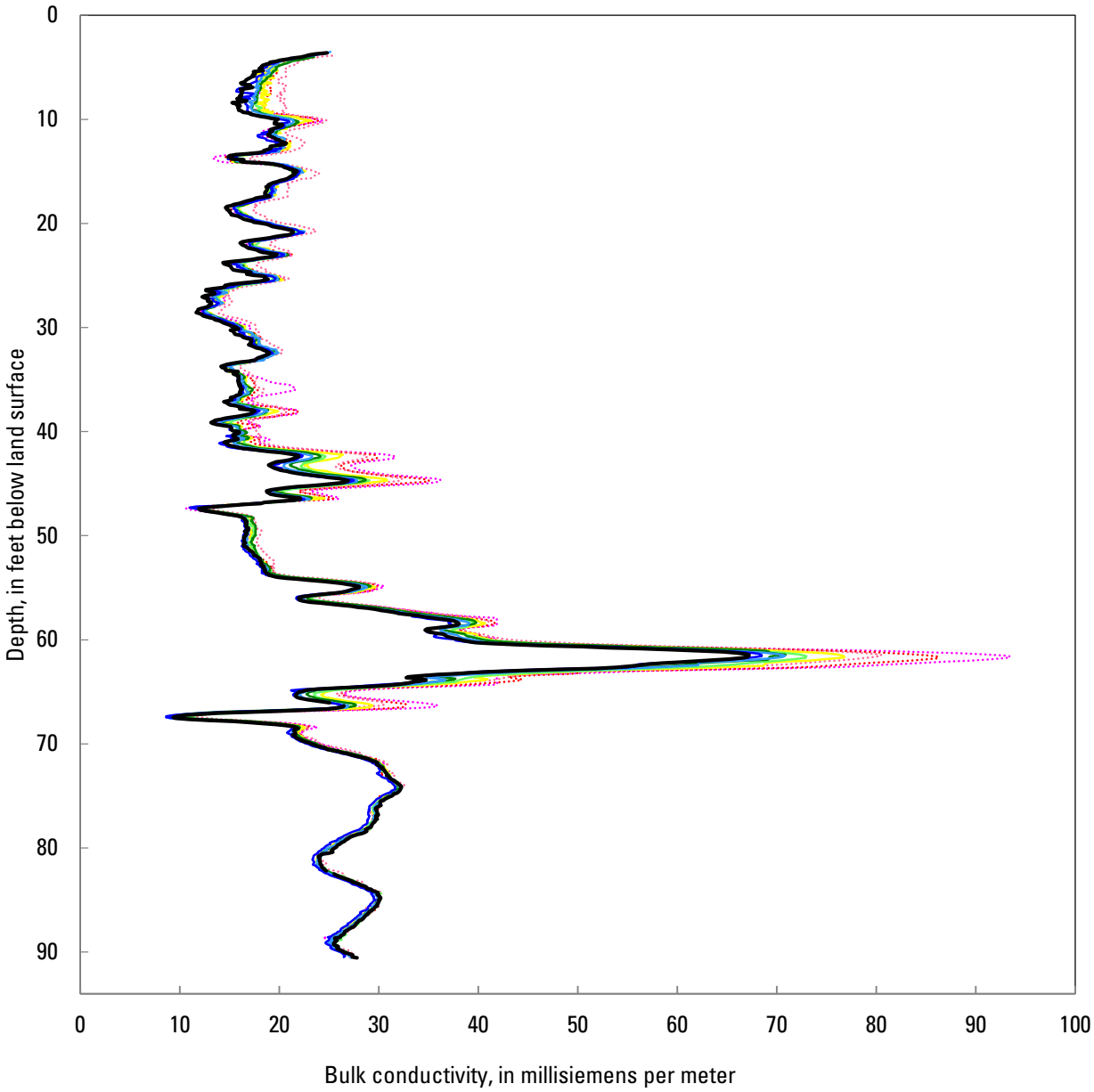
PERIOD OF RECORD.--March 2010 to current year (annually). See REMARKS.

INSTRUMENTATION.--Electromagnetic induction probe.

COOPERATION.--Florida Power & Light Company.

REMARKS.--Pre- and post- construction induction logs collected in WY 2010 are published under local well number TPGW-8 in Open-File Report 2010-1260 (http://pubs.usgs.gov/of/2010/1260/).

REVISED RECORDS.--TSEMIL 2014 Data Report, site 252436080270901, 2010-2013. Revised figures of electromagnetic induction logs, in mS/m, are available at https://www.sciencebase.gov/catalog/item/get/56abd635e4b0403299f46586.



EXPLANATION

G-3939 / TPGW-8 electromagnetic induction logs

- 04/12/2011
- 03/19/2012
- 03/26/2013
- 04/03/2014
- 03/27/2015
- 04/11/2016
- 04/06/2017
- 03/21/2018
- 05/17/2019

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252229080284201 G-3940, other identifier TPGW-9. USGS Observation Well near Homestead, FL.

Biscayne aquifer
Biscayne Limestone Aquifer

Miami-Dade County, FL

LOCATION.--Lat 25°22'28.6", long 80°28'41.9" referenced to North American Datum of 1983, in sec.24, T.58 S., R.38 E., Miami-Dade County, FL, Hydrologic Unit 03090202, on south side of SW 424th Street, 0.95 mi west of U.S. Highway 1, 6.4 mi south of Homestead, Florida.

RECORDS OF BULK CONDUCTIVITY

WELL CHARACTERISTICS.--Depth 90.3 ft. Upper casing diameter 2 in; top of first opening 48 ft, bottom of last opening 50 ft.

DATUM.--Land-surface datum is 3.66 ft above the North American Vertical Datum of 1988 and 5.19 ft above National Geodetic Vertical Datum of 1929.

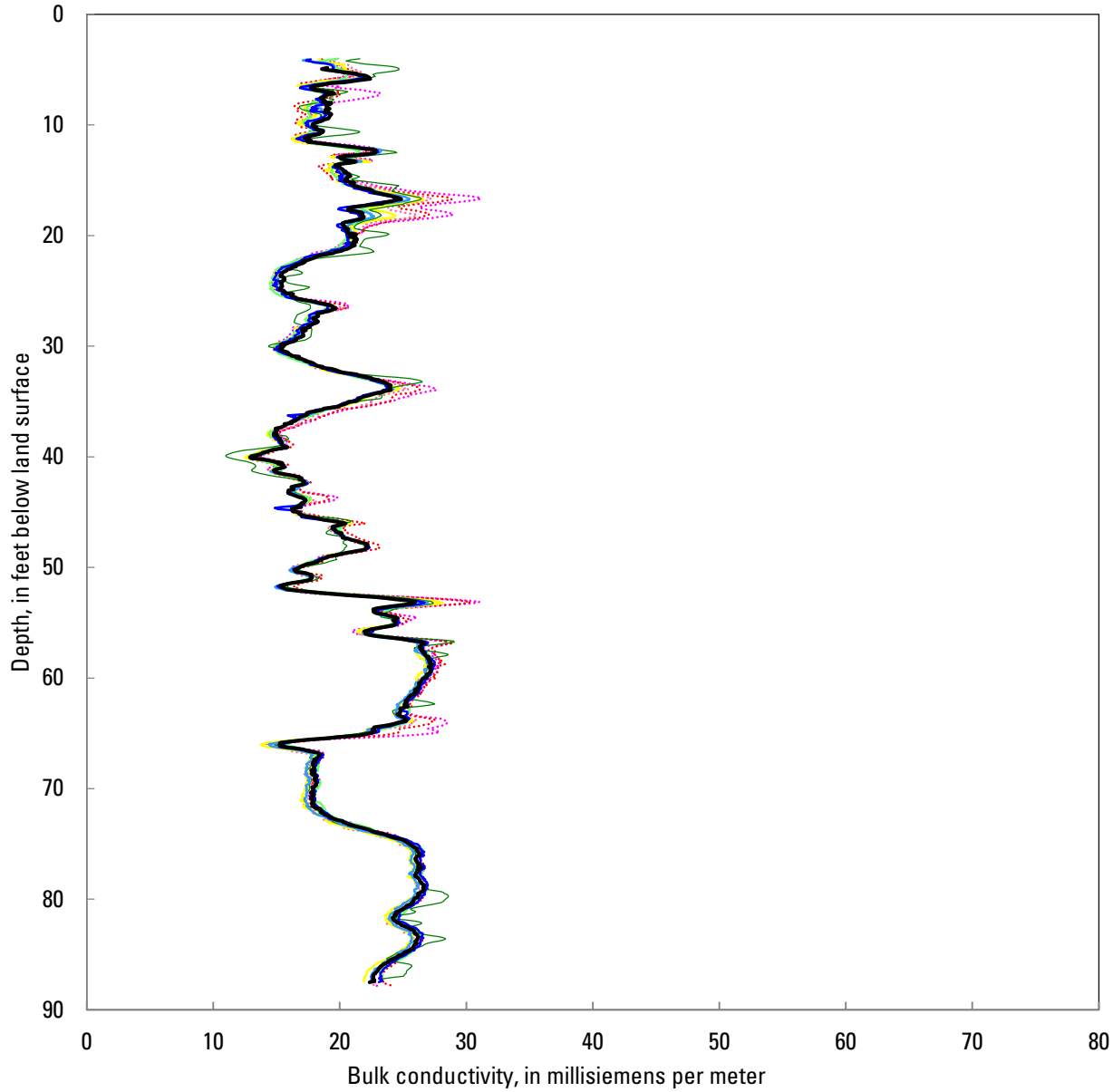
PERIOD OF RECORD.--May 2010 to current year (annually). See REMARKS.

INSTRUMENTATION.--Electromagnetic induction probe.

COOPERATION.--Florida Power & Light Company.

REMARKS.--Pre- and post- construction induction logs collected in WY 2010 are published under local well number TPGW-9 in Open-File Report 2010-1260 (http://pubs.usgs.gov/of/2010/1260/).

REVISED RECORDS.--TSEMIL 2014 Data Report, site 252229080284201, 2010-2013. Revised figures of electromagnetic induction logs, in mS/m, are available at https://www.sciencebase.gov/catalog/item/get/56abd635e4b0403299f46586.



EXPLANATION

G-3940 / TPGW-9 electromagnetic induction logs

- 04/12/2011
- 03/19/2012
- 03/28/2013
- 04/03/2014
- 03/26/2015
- 04/05/2016
- 03/28/2017
- 03/21/2018
- 04/17/2019

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252627080192901 G-3941, other identifier TPGW-10. USGS Observation Well near Homestead, FL.

Biscayne aquifer
Biscayne Limestone Aquifer

Miami-Dade County, FL

LOCATION.--Lat 25°26'27.4", long 80°19'29.0" referenced to North American Datum of 1983, Miami-Dade County, FL, Hydrologic Unit 03090202, in Biscayne Bay, about 9.8 mi east of Homestead, FL.

RECORDS OF BULK CONDUCTIVITY

WELL CHARACTERISTICS.--Depth 130.9 ft. Upper casing diameter 2 in; top of first opening 113 ft, bottom of last opening 117 ft. Depths listed are below the bottom of Biscayne Bay.

DATUM.--Land-surface datum is not defined. The approximate bottom of Biscayne Bay at this location is 5.3 ft below the North American Vertical Datum of 1988 and 3.8 ft below the National Geodetic Vertical Datum of 1929. See REMARKS.

PERIOD OF RECORD.--April 2010 to current year (annually). See REMARKS.

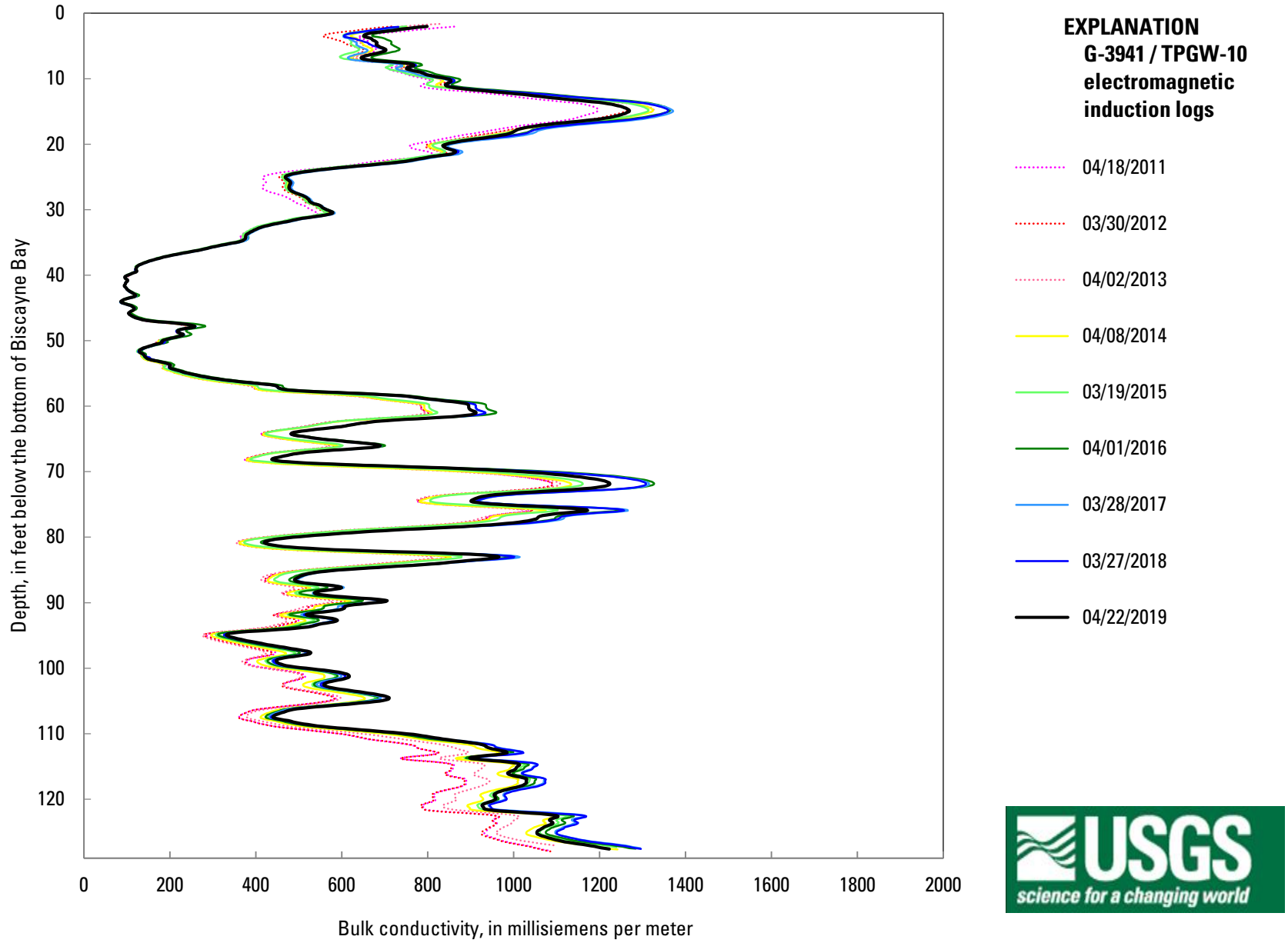
INSTRUMENTATION.--Electromagnetic induction probe.

COOPERATION.--Florida Power & Light Company.

REMARKS.--This site is located offshore; land-surface datum is not defined. Pre- and post- construction induction logs collected in WY 2010 are published under local well number TPGW-10 in Open-File Report 2010-1260 (http://pubs.usgs.gov/of/2010/1260/).

REVISIONS.--The bulk conductivities of previously published electromagnetic induction logs collected from April 18, 2011 to March 27, 2018, available in the TSEMIL 2018 Data Report at https://www.sciencebase.gov/catalog/item/5d5eccdae4b01d82ce961e1c, have been adjusted by -17.8 to 0.9 mS/m. The change in bulk conductivity is based on the median of the dataset at the current alignment depth.

REVISED RECORDS.--TSEMIL 2014 Data Report, site 252627080192901, 2010-2013. Revised figures of electromagnetic induction logs, in mS/m, are available at https://www.sciencebase.gov/catalog/item/get/56abd635e4b0403299f46586.


Depth, in feet below the bottom of Biscayne Bay
0
10
20
30
40
50
60
70
80
90
100
110
120
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Bulk conductivity, in millisiemens per meter
EXPLANATION
G-3941 / TPGW-10
electromagnetic
induction logs
04/18/2011
03/30/2012
04/02/2013
04/08/2014
03/19/2015
04/01/2016
03/28/2017
03/27/2018
04/22/2019
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252349080181501 G-3942, other identifier TPGW-11. USGS Observation Well near Homestead, FL.

Biscayne aquifer
Biscayne Limestone Aquifer

Miami-Dade County, FL

LOCATION.--Lat 25°23'49.4", long 80°18'15.0" referenced to North American Datum of 1983, Miami-Dade County, FL, Hydrologic Unit 03090202, about 0.5 mi south of West Arsenicker Key in Biscayne Bay, about 11.9 mi east-southeast of Homestead, FL.

RECORDS OF BULK CONDUCTIVITY

WELL CHARACTERISTICS.--Depth 135 ft. Upper casing diameter 2 in; top of first opening 107 ft, bottom of last opening 111ft. Depths listed are below the bottom of Biscayne Bay.

DATUM.--Land-surface datum is not defined. The approximate bottom of Biscayne Bay at this location is 6.7 ft below the North American Vertical Datum of 1988 and 5.2 ft below the National Geodetic Vertical Datum of 1929. See REMARKS.

PERIOD OF RECORD.--September 2010 to current year (annually). See REMARKS.

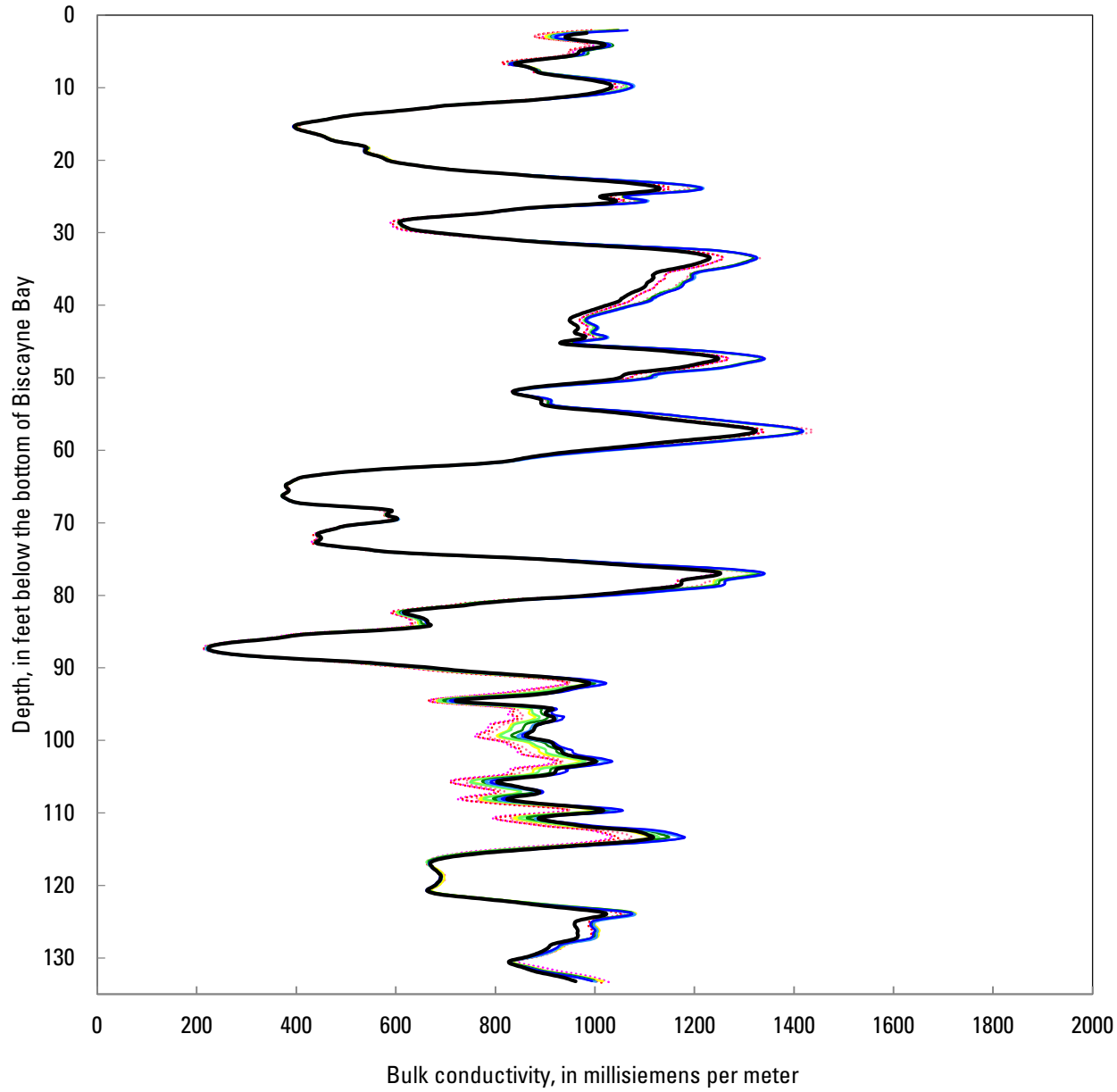
INSTRUMENTATION.--Electromagnetic induction probe.

COOPERATION.--Florida Power & Light Company.

REMARKS.--This site is located offshore; land-surface datum is not defined. Pre- and post- construction induction logs collected in WY 2010 are published under local well number TPGW-11 in Open-File Report 2010-1260 (http://pubs.usgs.gov/of/2010/1260/.

REVISIONS.--The bulk conductivities of previously published electromagnetic induction logs collected from September 2, 2010 to March 28, 2018, available in the TSEMIL 2018 Data Report at https://www.sciencebase.gov/catalog/item/5d5eccdae4b01d82ce961e1c, have been adjusted by -21.7 to 11.0 mS/m. The change in bulk conductivity is based on the median of the dataset at the current alignment depth.

REVISED RECORDS.--TSEMIL 2014 Data Report, site 252349080181501, 2010-2013. Revised figures of electromagnetic induction logs, in mS/m, are available at https://www.sciencebase.gov/catalog/item/get/56abd635e4b0403299f46586.



EXPLANATION

G-3942 / TPGW-11 electromagnetic induction logs

- 04/20/2011
- 03/30/2012
- 04/02/2013
- 04/09/2014
- 03/20/2015
- 04/15/2016
- 03/29/2017
- 03/28/2018
- 04/22/2019

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252655080202301 G-3943, other identifier TPGW-12. USGS Observation Well near Homestead, FL.

Biscayne aquifer
Biscayne Limestone Aquifer

Miami-Dade County, FL

LOCATION.--Lat 25°26'55.4", long 80°20'22.9" referenced to North American Datum of 1983, in sec.21, T.57 S., R.40 E., Miami-Dade County, FL, Hydrologic Unit 03090202, in Biscayne National Park, about 8.7 mi east of Homestead, Florida.

RECORDS OF BULK CONDUCTIVITY

WELL CHARACTERISTICS.--Depth 124 ft. Upper casing diameter 2 in; top of first opening 90 ft, bottom of last opening 94 ft.

DATUM.--Land-surface datum is 0.90 ft above the North American Vertical Datum of 1988 and 2.43 ft above the National Geodetic Vertical Datum of 1929.

PERIOD OF RECORD.--March 2010 to current year (annually). See REMARKS.

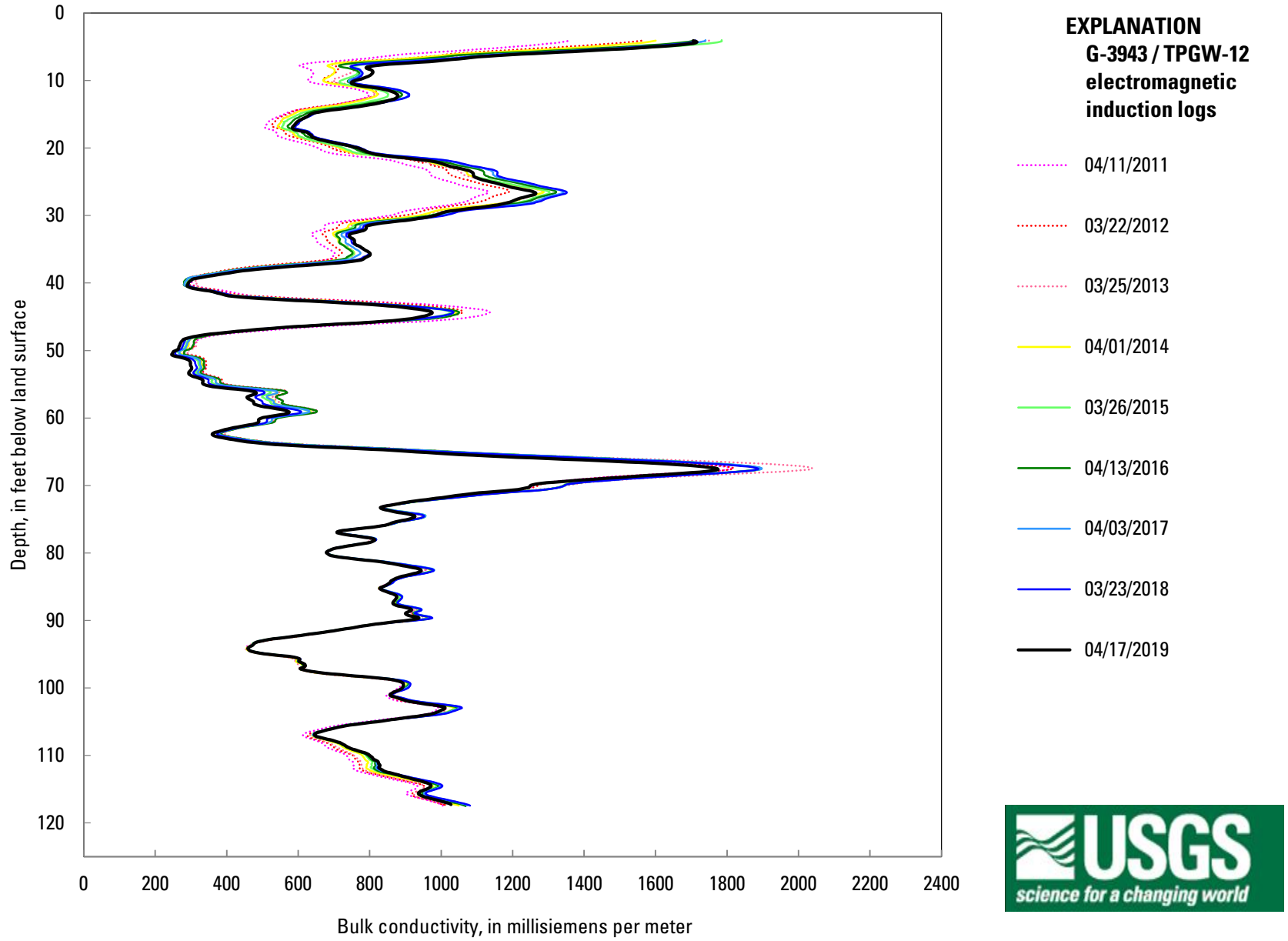
INSTRUMENTATION.--Electromagnetic induction probe.

COOPERATION.--Florida Power & Light Company.

REMARKS.--Pre- and post- construction induction logs collected in WY 2010 are published under local well number TPGW-12 in Open-File Report 2010-1260 (http://pubs.usgs.gov/of/2010/1260/).

REVISIONS.--The bulk conductivities of previously published electromagnetic induction logs collected from April 11, 2011 to March 23, 2018, available in the TSEMIL 2018 Data Report at https://www.sciencebase.gov/catalog/item/5d5eccdae4b01d82ce961e1c, have been adjusted by -21.5 to 9.8 mS/m. The change in bulk conductivity is based on the median of the dataset at the current alignment depth.

REVISED RECORDS.--TSEMIL 2014 Data Report, site 252655080202301, 2010-2013. Revised figures of electromagnetic induction logs, in mS/m, are available at https://www.sciencebase.gov/catalog/item/get/56abd635e4b0403299f46586.


Depth, in feet below land surface
0
10
20
30
40
50
60
70
80
90
100
110
120
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
Bulk conductivity, in millisiemens per meter
EXPLANATION
G-3943 / TPGW-12
electromagnetic
induction logs
04/11/2011
03/22/2012
03/25/2013
04/01/2014
03/26/2015
04/13/2016
04/03/2017
03/23/2018
04/17/2019

252339080210701 G-3944, other identifier TPGW-13. USGS Observation Well near Homestead, FL.

Biscayne aquifer
Biscayne Limestone Aquifer

Miami-Dade County, FL

LOCATION.--Lat 25°23'39.0", long 80°21'07.1" referenced to North American Datum of 1983, in sec.8, T.58 S., R.40 E., Miami-Dade County, FL, Hydrologic Unit 03090202, about 9.4 mi southeast of Homestead, Florida.

RECORDS OF BULK CONDUCTIVITY

WELL CHARACTERISTICS.--Depth 110.4 ft. Upper casing diameter 2 in; top of first opening 85 ft, bottom of last opening 89 ft.

DATUM.--Land-surface datum is 2.41 ft above the North American Vertical Datum of 1988 and 3.94 ft above National Geodetic Vertical Datum of 1929.

PERIOD OF RECORD.--April 2010 to current year (annually). See REMARKS.

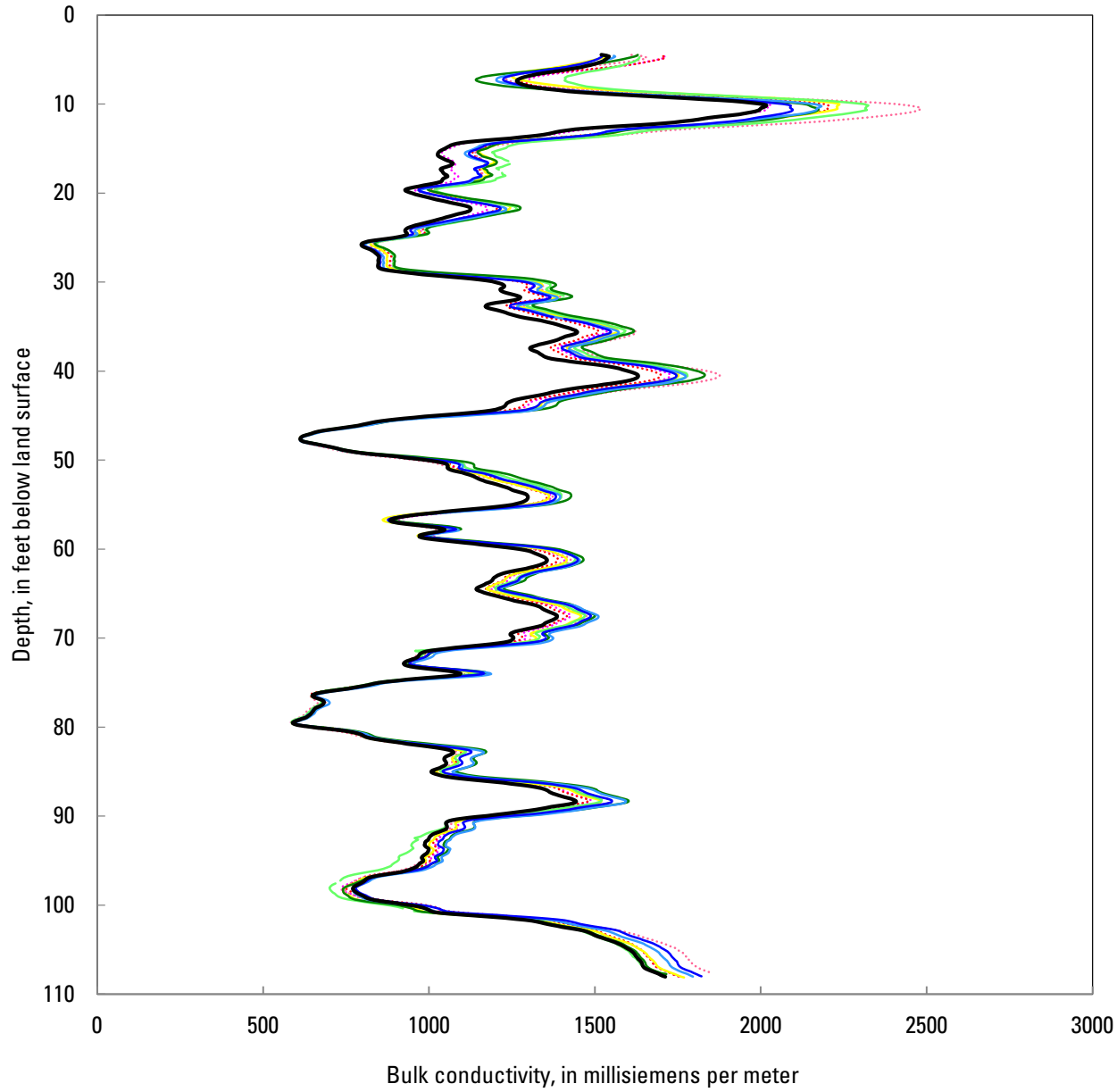
INSTRUMENTATION.--Electromagnetic induction probe.

COOPERATION.--Florida Power & Light Company.

REMARKS.--Pre- and post- construction induction logs collected in WY 2010 are published under local well number TPGW-13 in Open-File Report 2010-1260 (http://pubs.usgs.gov/of/2010/1260/).

REVISIONS.--The bulk conductivities of previously published electromagnetic induction logs collected from April 11, 2011 to March 30, 2018, available in the TSEMIL 2018 Data Report at https://www.sciencebase.gov/catalog/item/5d5eccdae4b01d82ce961e1c, have been adjusted by -30.8 to 18.8 mS/m. The change in bulk conductivity is based on the median of the dataset at the current alignment depth.

REVISED RECORDS.--TSEMIL 2014 Data Report, site 252339080210701, 2010-2013. Revised figures of electromagnetic induction logs, in mS/m, are available at https://www.sciencebase.gov/catalog/item/get/56abd635e4b0403299f46586.



EXPLANATION

G-3944 / TPGW-13 electromagnetic induction logs

- 04/11/2011
- 03/21/2012
- 03/28/2013
- 04/07/2014
- 03/23/2015
- 04/19/2016
- 03/30/2017
- 03/30/2018
- 05/24/2019

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252116080193501 G-3945, other identifier TPGW-14. USGS Observation Well near Homestead, FL.

Biscayne aquifer
Biscayne Limestone Aquifer

Miami-Dade County, FL

LOCATION.--Lat 25°21'15.5", long 80°19'34.5" referenced to North American Datum of 1983, Miami-Dade County, FL, Hydrologic Unit 03090202, in Card Sound, about 12.3 mi southeast of Homestead, FL.

RECORDS OF BULK CONDUCTIVITY

WELL CHARACTERISTICS.--Depth 120.5 ft. Upper casing diameter 2 in; top of first opening 86 ft, bottom of last opening 90 ft. Depths are below bottom of the bay.

DATUM.--Land-surface datum is not defined. The approximate bottom of Biscayne Bay at this location is 7.4 ft below the North American Vertical Datum of 1988 and 5.9 ft below the National Geodetic Vertical Datum of 1929. See REMARKS.

PERIOD OF RECORD.--September 2010 to current year (annually). See REMARKS.

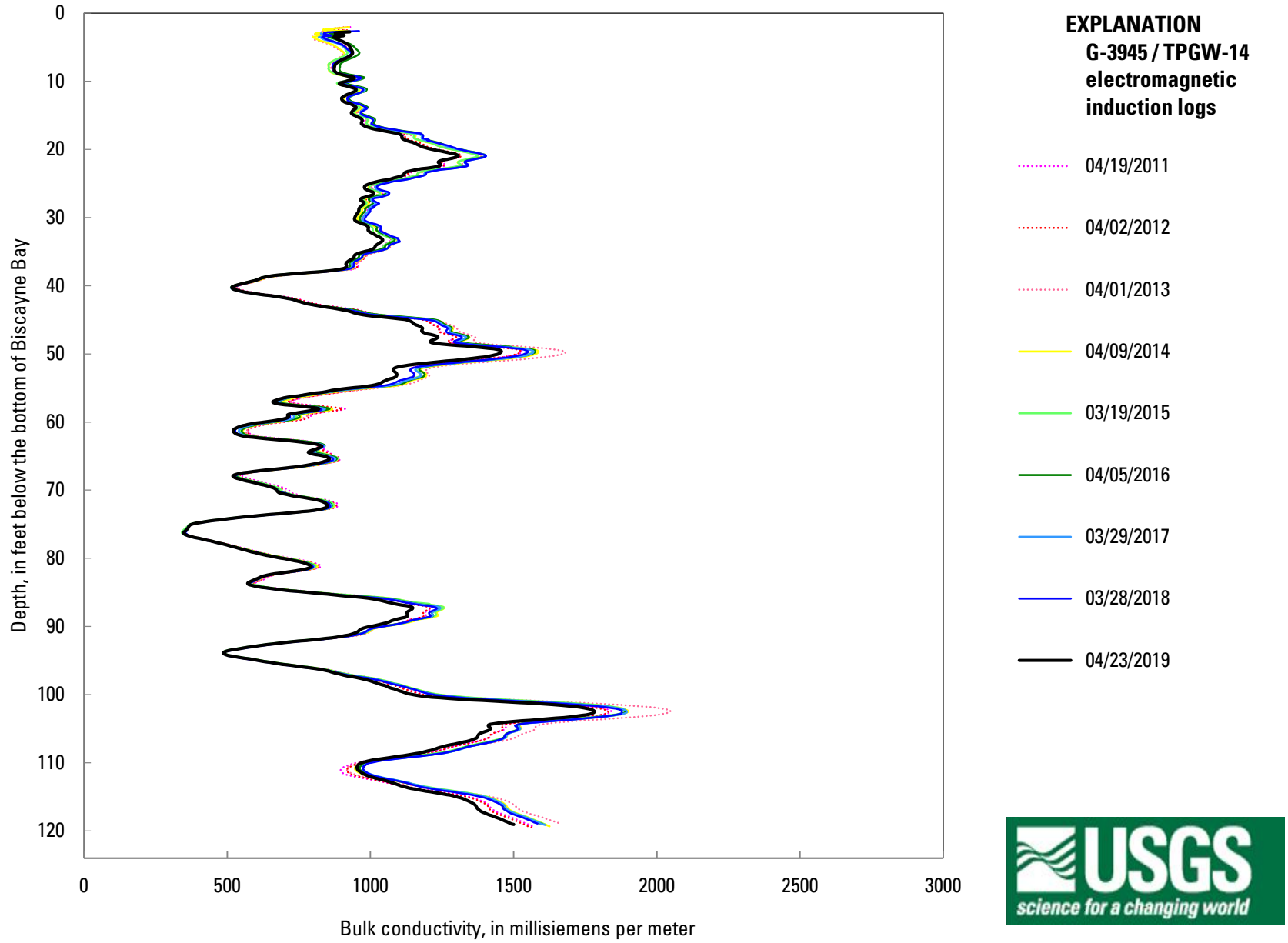
INSTRUMENTATION.--Electromagnetic induction probe.

COOPERATION.--Florida Power & Light Company.

REMARKS.--This site is located offshore; land-surface datum is not defined. Pre- and post- construction induction logs collected in WY 2010 are published under local well number TPGW-14 in Open-File Report 2010-1260 (http://pubs.usgs.gov/of/2010/1260/).

REVISIONS.--The bulk conductivities of previously published electromagnetic induction logs collected from April 19, 2011 to March 28, 2018, available in the TSEMIL 2018 Data Report at https://www.sciencebase.gov/catalog/item/5d5eccdae4b01d82ce961e1c, have been adjusted by -16.3 to 6.9 mS/m. The change in bulk conductivity is based on the median of the dataset at the current alignment depth.

REVISED RECORDS.--TSEMIL 2014 Data Report, site 252116080193501, 2010-2013. Revised figures of electromagnetic induction logs, in mS/m, are available at https://www.sciencebase.gov/catalog/item/get/56abd635e4b0403299f46586.


Depth, in feet below the bottom of Biscayne Bay
0
10
20
30
40
50
60
70
80
90
100
110
120
0
500
1000
1500
2000
2500
3000
Bulk conductivity, in millisiemens per meter
EXPLANATION
G-3945 / TPGW-14
electromagnetic
induction logs
04/19/2011
04/02/2012
04/01/2013
04/09/2014
03/19/2015
04/05/2016
03/29/2017
03/28/2018
04/23/2019
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