

Sandstone Aquifer at Lehigh Acres Maximum Developable Limits

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Clayton McMillon and Steve Anderson



South Florida Water Management District
3301 Gun Club Road
West Palm Beach, Florida 33406

I. Summary

In September 2010, the South Florida Water Management District (SFWMD) approved the drilling and testing of two boreholes in the Lehigh Acres area of Lee County to more accurately determine the elevation of the top of the Sandstone aquifer. This effort supports the recommendations made in a June 2011 memo by Herman Taube to conduct gamma geophysical logging at two sites in Lee County for the same purpose. Once a total depth of approximately 100 feet below land surface (ft bls) was reached, geophysical testing was conducted at both sites. Based on analysis of geophysical logs and cores obtained from the boreholes, the top of the Sandstone aquifer in Lehigh Acres is -35 feet National Geodetic Vertical Datum of 1929 (ft NGVD29) (site L-729) and -25 feet NGVD 29 (site L-2186). Since the maximum developable limit (MDL; Section 3.2.4, *Basis of Review for Water Use Permit Applications*, SFWMD 2010) is defined as 20 feet above the top of the aquifer, the MDL at each site would be defined as -15 feet NGVD29 and -5 feet NGVD29, respectively.

II. Historical Context

During recent water shortages in the Lehigh Acres area, emergency water shortage orders and policy decisions at SFWMD affecting the Lehigh Acres area were based on groundwater conditions located at two monitoring sites, L-2186 and L-729. Due to limited lithologic and hydrogeologic information at those sites, as well as the heterogeneous nature and spatial distribution of the Sandstone aquifer, it was determined that more site specific information was needed to ensure that management decisions based on these two sites were as accurate as possible.

The Health Department of Lee County is aware of the water supply issues associated with the rapid growth of users of the Sandstone aquifer in Lehigh Acres. They have documented over 30,000 wells located within the area. Also, in order to protect the water supply of the area, Lee County is requiring any new wells to have at least 100 feet of casing installed.

The staff at SFWMD solicited the input of regional stakeholders with expertise in the hydrogeology of the area. Several meetings were conducted at the Fort Myers Service Center in order to discuss the water supply concerns and hydrogeology of the Sandstone aquifer, specifically to determine which tools were best in selecting the top of the aquifer. Various studies were conducted to evaluate different techniques, such as geophysical signatures, lithologic logs, regulatory mandates, etc.

The agreed upon solution was to drill boreholes and collect cores that could be analyzed for lithologic, paleontologic and geophysical characteristics. Multiple boreholes were required to develop a more regional interpretation of the geology associated within the study area, and funding was provided by SFWMD for construction of two boreholes and associated hydrogeologic testing.

III. Location of Study Area

The study area is defined by the Lee/Hendry county line to the east, the Caloosahatchee River to the north, Interstate 75 to the west, and State Route 82 to the south, as shown in **Figures 1** and **2** below.

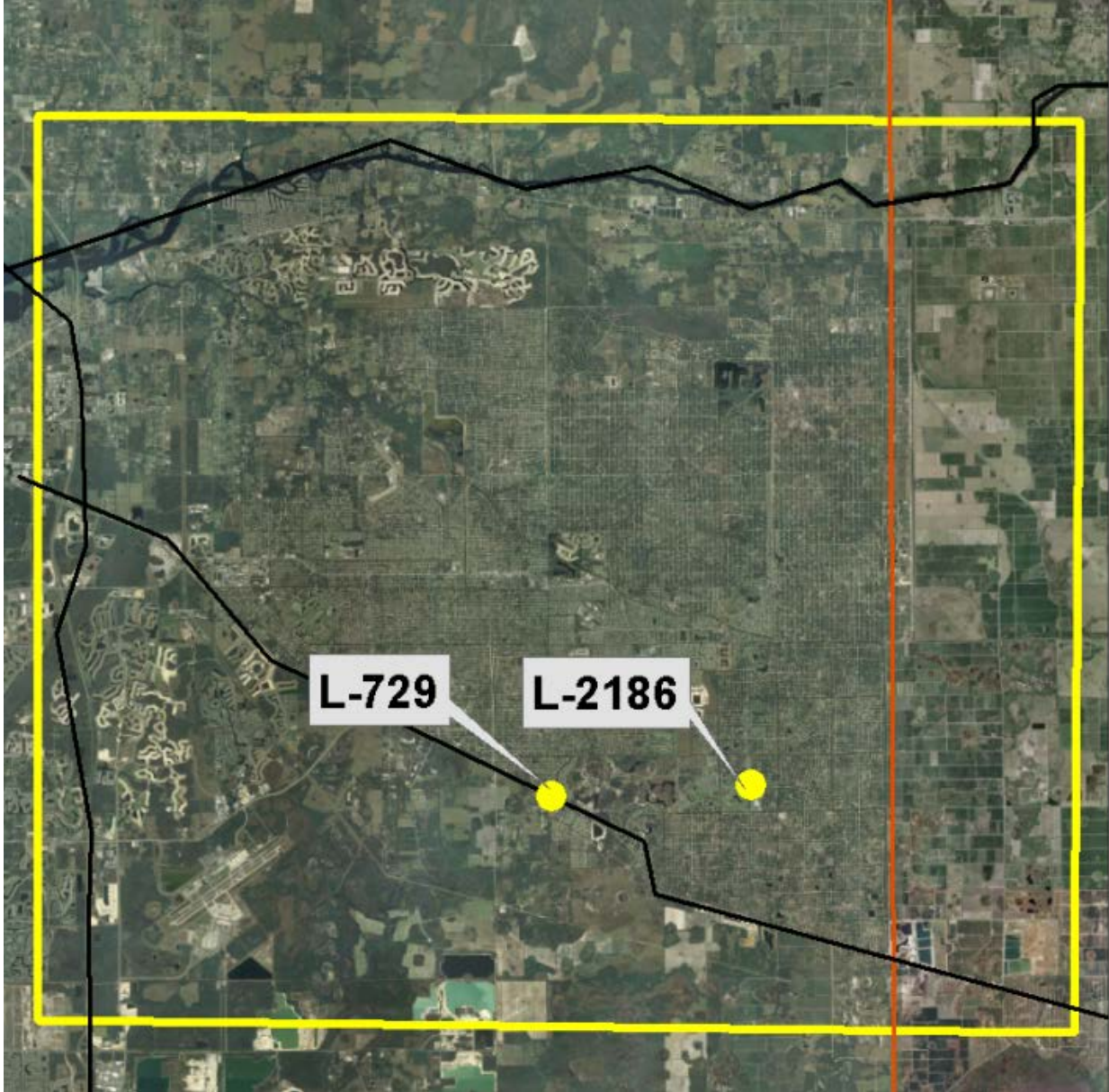


Figure 1. Study area map.

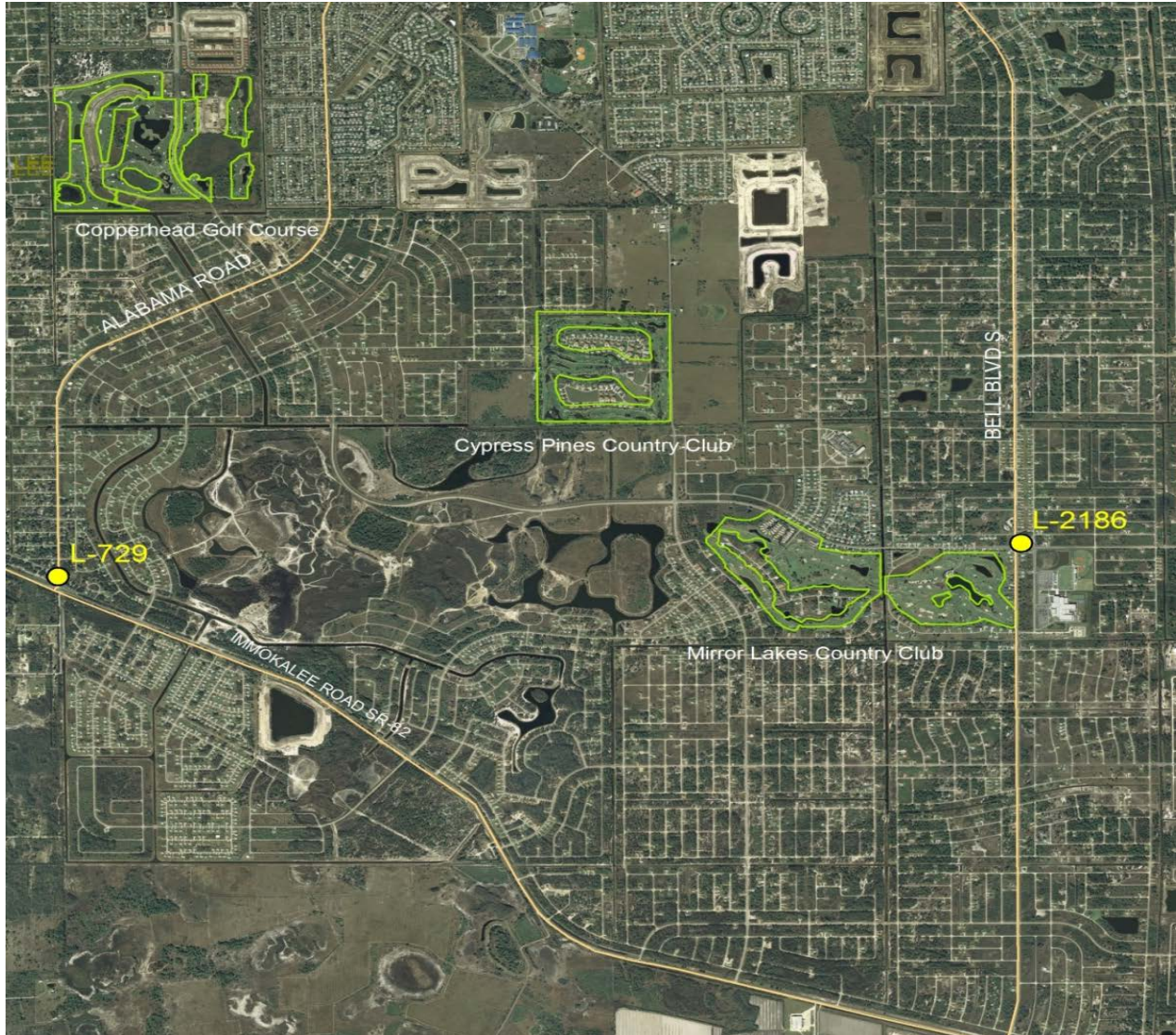


Figure 2. Site location map.

IV. Maximum Developable Limit

In 2003, SFWMD adopted MDL rules requiring that consumptive use permittees not cause harmful drawdown that will mine (or overdraw) semi-confined freshwater aquifers within the Lower West Coast Planning Area (Section 3.2.4, SFWMD 2010a). The rule language states the following:

Reasonable assurances shall be provided that the proposed use shall not cause harmful drawdowns so as to mine semi-confined freshwater aquifers on the Lower West Coast. The potentiometric head within the Lower Tamiami aquifer, Sandstone aquifer and mid-Hawthorn aquifer shall not be allowed to drop to less than 20 feet above the top of the uppermost geologic strata that comprises the aquifer at any point during a 1-in-10 drought condition. This criteria must be met except in areas closer than 50 feet from any existing pumping well. Reasonable assurances shall consider actual measured water

level data for the affected area for the most recent 1-in-10 drought condition combined with the calculated drawdowns for all permits issued since that drought located within the area of influence of the requested allocation combined with the requested allocation.

The MDLs represent a key prevention strategy for keeping aquifer water levels compliant with the minimum flow and levels (MFLs) established for these three aquifers (Chapter 40E-8.231 and 8.331, Florida Administrative Code). A conceptualization of the MDL concept is illustrated in **Figure 3**.

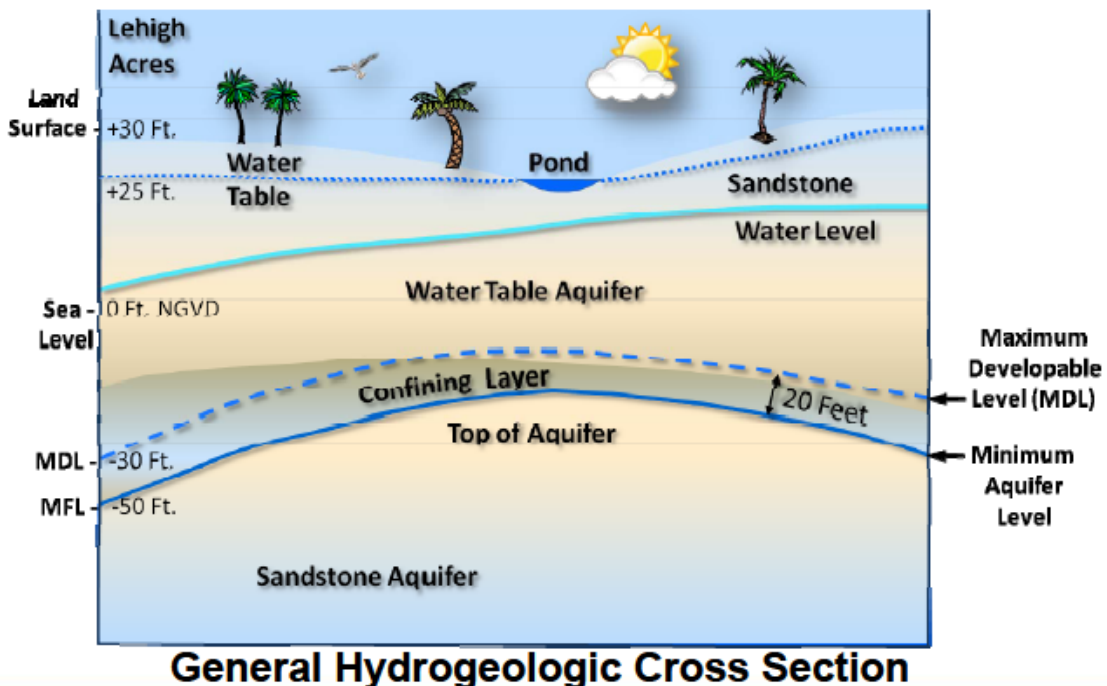


Figure 3. Illustration of the MFL and MDL.

V. Methodology

In September 2010, SFWMD approved the drilling and testing of two boreholes in Lee County in order to more accurately determine the depth to the top of the Sandstone aquifer in the Lehigh Acres area. The boreholes were located adjacent to the two monitoring wells of interest, L-729 and L-2186. Both boreholes were drilled using the mud-rotary method and a 5-inch drill bit to an approximate depth of 50 ft bls, where continuous wire line cores were collected between 50 and 100 feet bls. Once the total depth of approximately 100 feet bls was reached, geophysical testing was conducted on both sites. An example of the cores is illustrated in **Figure 4**. The geophysical logs for each borehole are attached in Appendix A, and lithologic descriptions are presented in Appendix B.



Figure 4. Example of lithologic changes typical in Sandstone aquifer in Lehigh Acres. Site L-2186 at an approximate depth of 64 ft bls (top is on left).

VI. Results

Based on analysis of geophysical logs and rock cores, the top of the Sandstone aquifer in Lehigh Acres is located at -35 feet NGVD29 (site L-729) and -25 feet NGVD29 (site L-2186). Based on regional cross-sections developed by Taube, the elevations of the top of the aquifer at these sites correlate to other regional studies conducted in the area.

These results were also compared to more recent work being done by SFWMD to further refine the mapping of hydrogeologic units of the Lower West Coast Planning Area (SFWMD, 2015). Comparison of the data obtained from the two boreholes and the regional interpretations of the mapping study show reasonable correlation. A map of the top of the Sandstone aquifer, and a cross-section in close proximity to the borehole locations are shown in **Figures 5** and **6**, respectively.

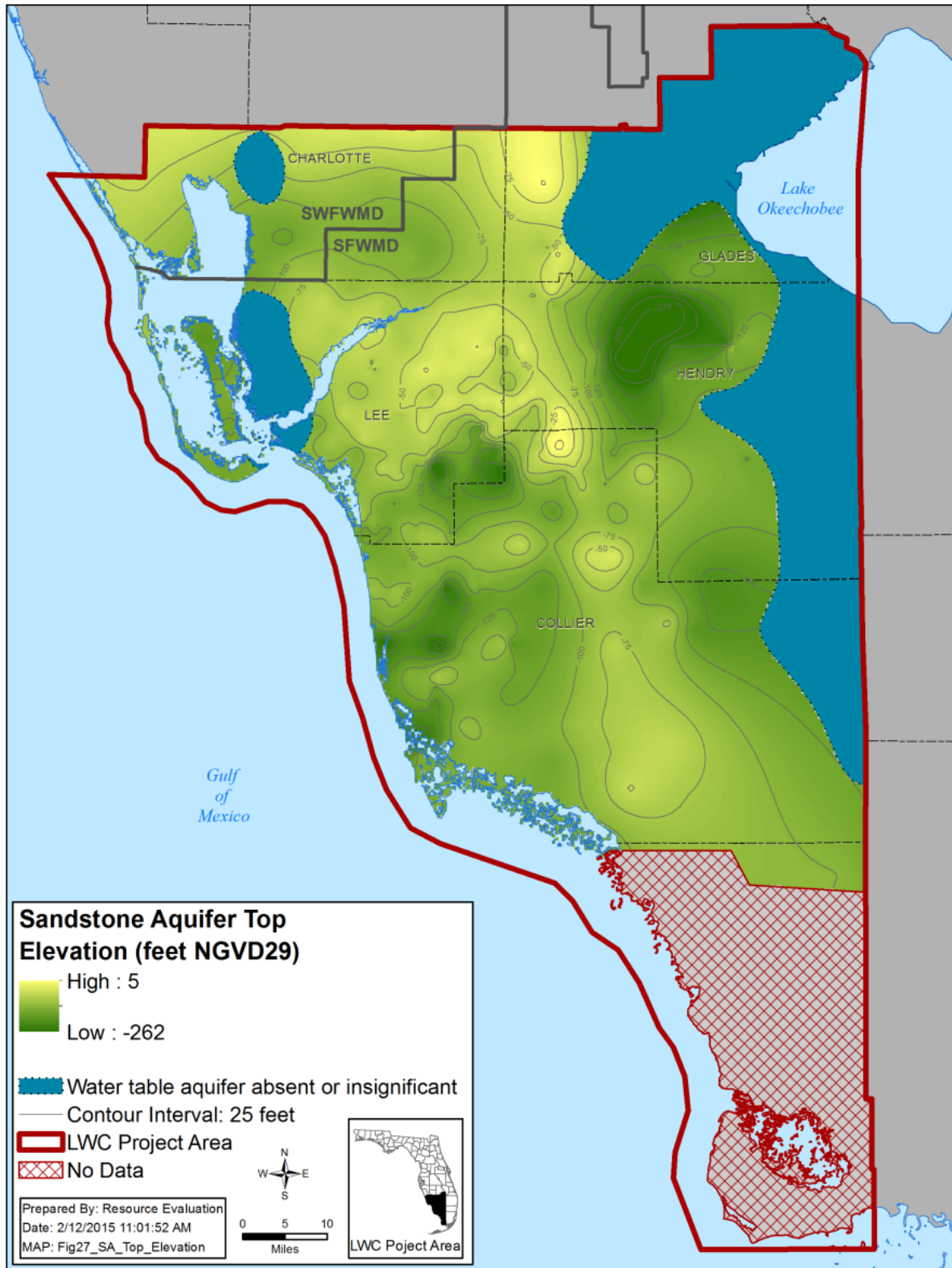
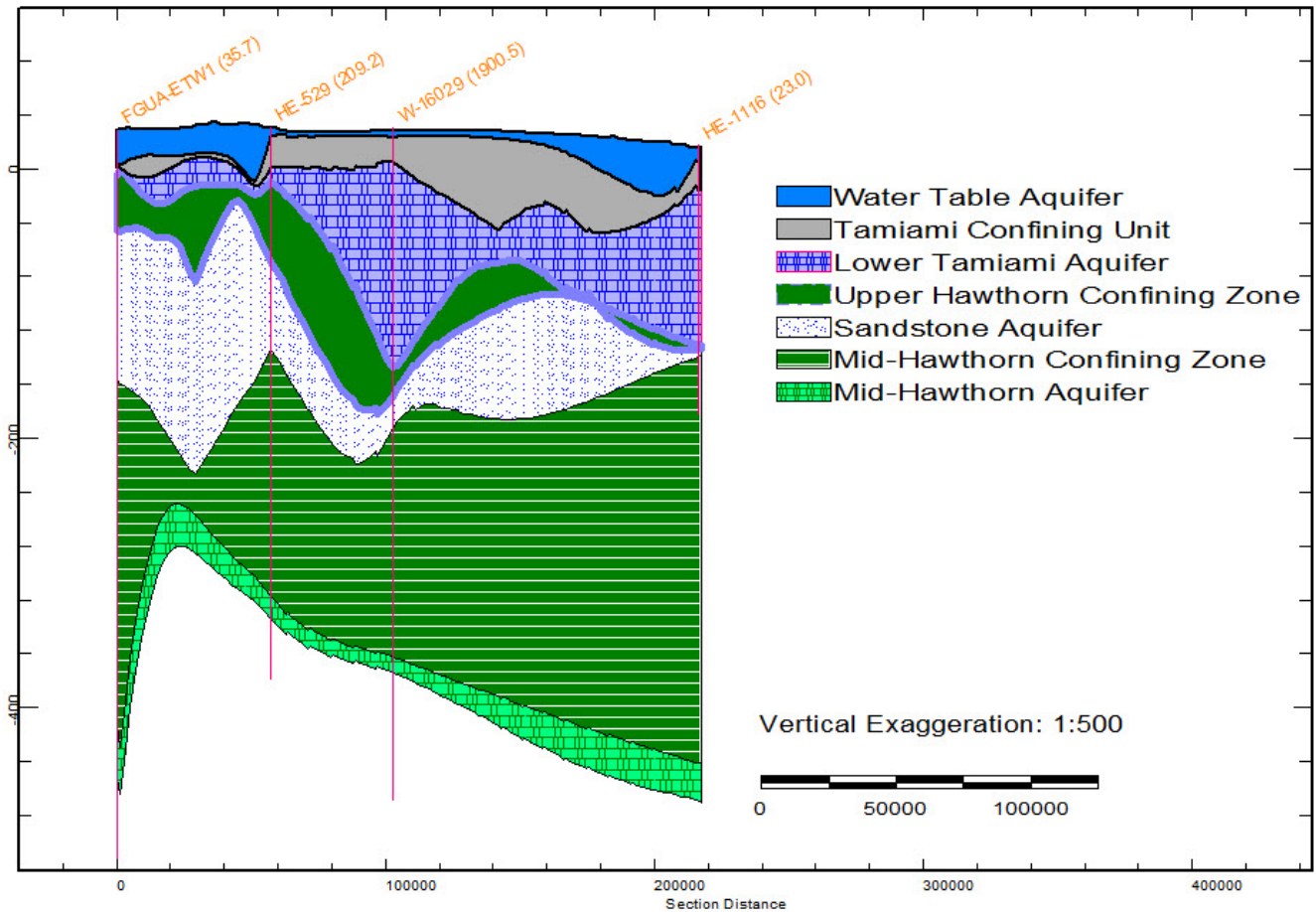


Figure 5. Elevation of the top of the Sandstone aquifer (SFWMD, 2015).

G to G' Hendry County West to East



- Legend:**
- Water Table Aquifer
 - Tamiami Confining Unit
 - Lower Tamiami Aquifer
 - Upper Hawthorn Confining Zone
 - Sandstone Aquifer
 - Mid-Hawthorn Confining Zone
 - Mid-Hawthorn Aquifer

Figure 6. Cross-section of the Sandstone aquifer (SFWMD, 2015).

Since the MDL is defined at 20 feet above the top of the aquifer, and the top of the Sandstone aquifer in Lehigh Acres is located at -35 feet NGVD29 (site L-729) and -25 feet NGVD29 (site L-2186), the MDL at each site would be defined as -15 feet NGVD29 and -5 feet NGVD29, respectively.

Examination of water levels over the last 30 years found that these MDL elevations were not reached. This time period also includes some of the worst drought conditions on record, which caused water levels to approach, but not reach, the MDL elevations. Hydrographs of the two sites are shown in the **Figures 7 and 8**.

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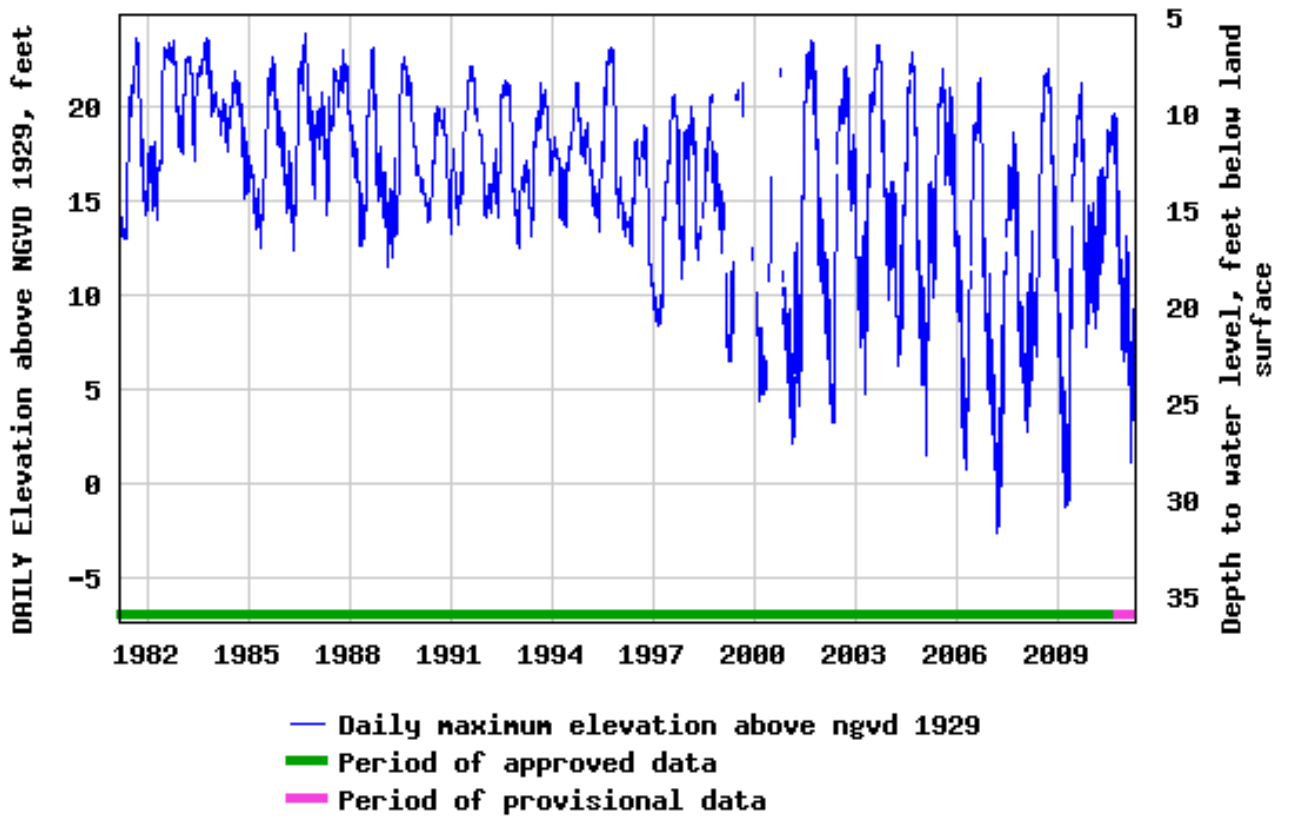


Figure 7. Historical water levels for Well L-729 (30-year duration).

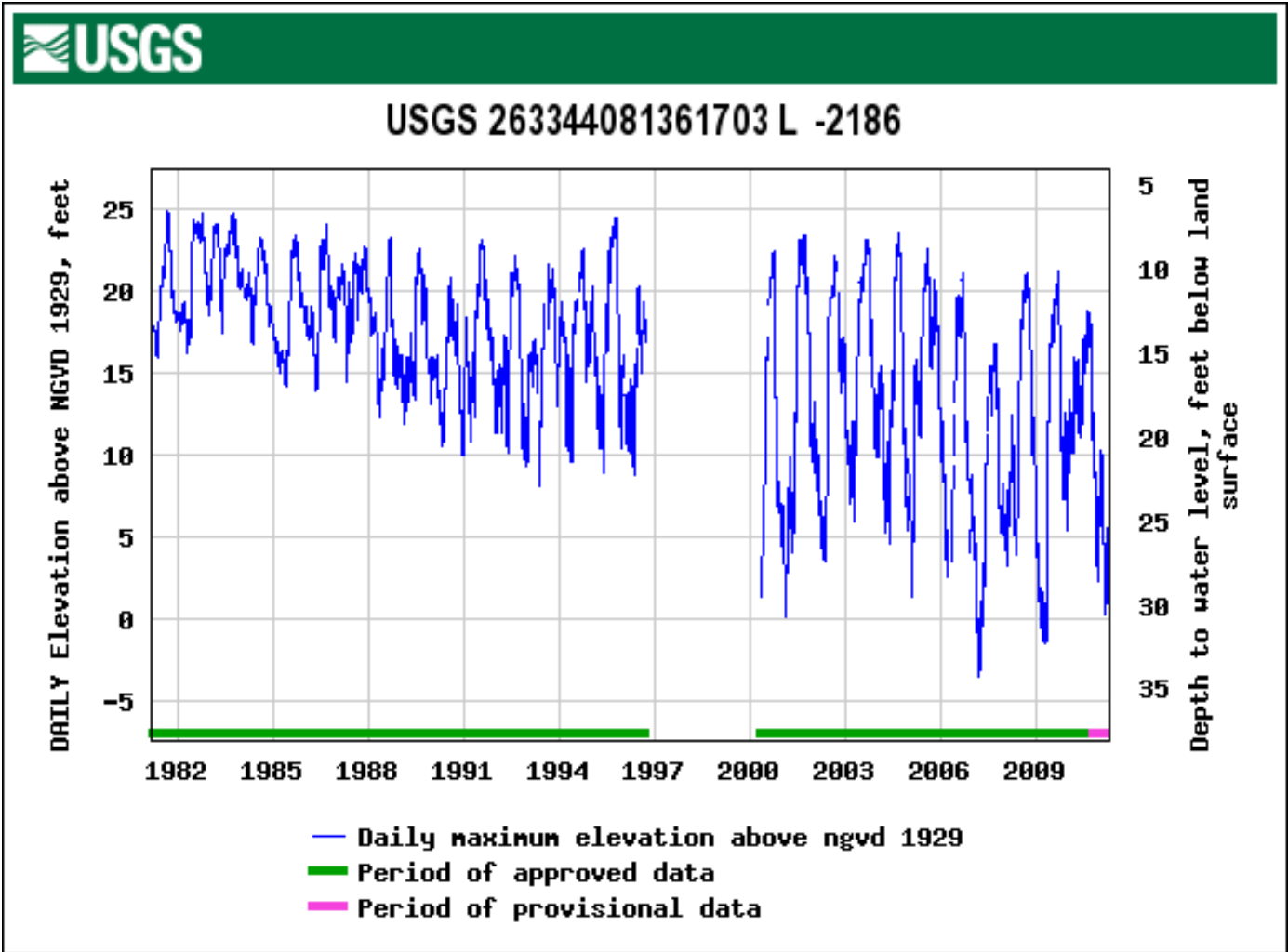


Figure 8. Historical water levels for Well L-2186 (30-year duration).

VII. Conclusion and Recommendations

The top of the Sandstone aquifer is typically defined as a well-cemented sandstone that generally underlies a confining olive-green dolosilt. The Sandstone aquifer in Lehigh Acres may include limestone, shells, sand and phosphatic materials. A natural gamma signature for the dolosilt or clay confining unit is useful in determining the top of the aquifer, but additional information may be necessary to eliminate uncertainty.

Close coordination between Lee County well construction regulation and SFWMD water use permitting prior to issuance of a permit for a Sandstone aquifer well in the Lehigh Acres area could assist with management of the water supply. Also, a comprehensive Sandstone aquifer database for the Lehigh Acres area should be developed and maintained by both agencies. Much of this is being accomplished by SFWMD's project to refine the overall hydrogeology of the Lower West Coast Planning Area.

VIII. References

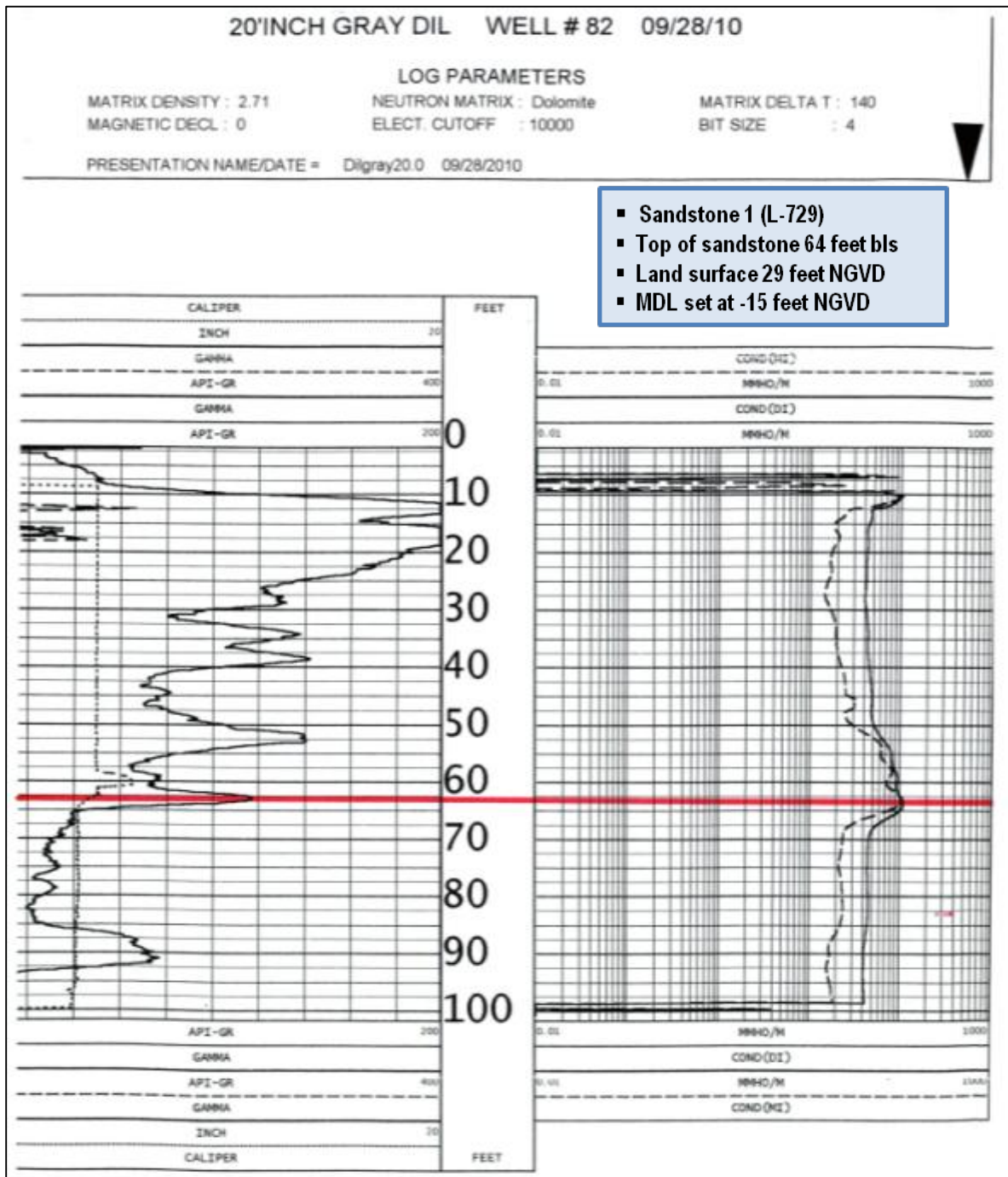
Geddes, E., E. Richardson and A. Dodd. *Hydrogeologic Unit Mapping Update for the Lower West Coast Water Supply Planning Area*. Technical Publication WS-35, South Florida Water Management District, West Palm Beach, FL. February 2015.

SFWMD. 2010. *Basis of Review for Water Use Permit Applications*. South Florida Water Management District, West Palm Beach, FL.

Taube, H., III. Memo to Terry Bengtsson, South Florida Water Management District, West Palm Beach, FL. Dated June 28, 2011.

IX. Appendices

Appendix A - Geologic and Geophysical Logs



20' INCH GRAY DIL WELL # 89 09/28/10

LOG PARAMETERS

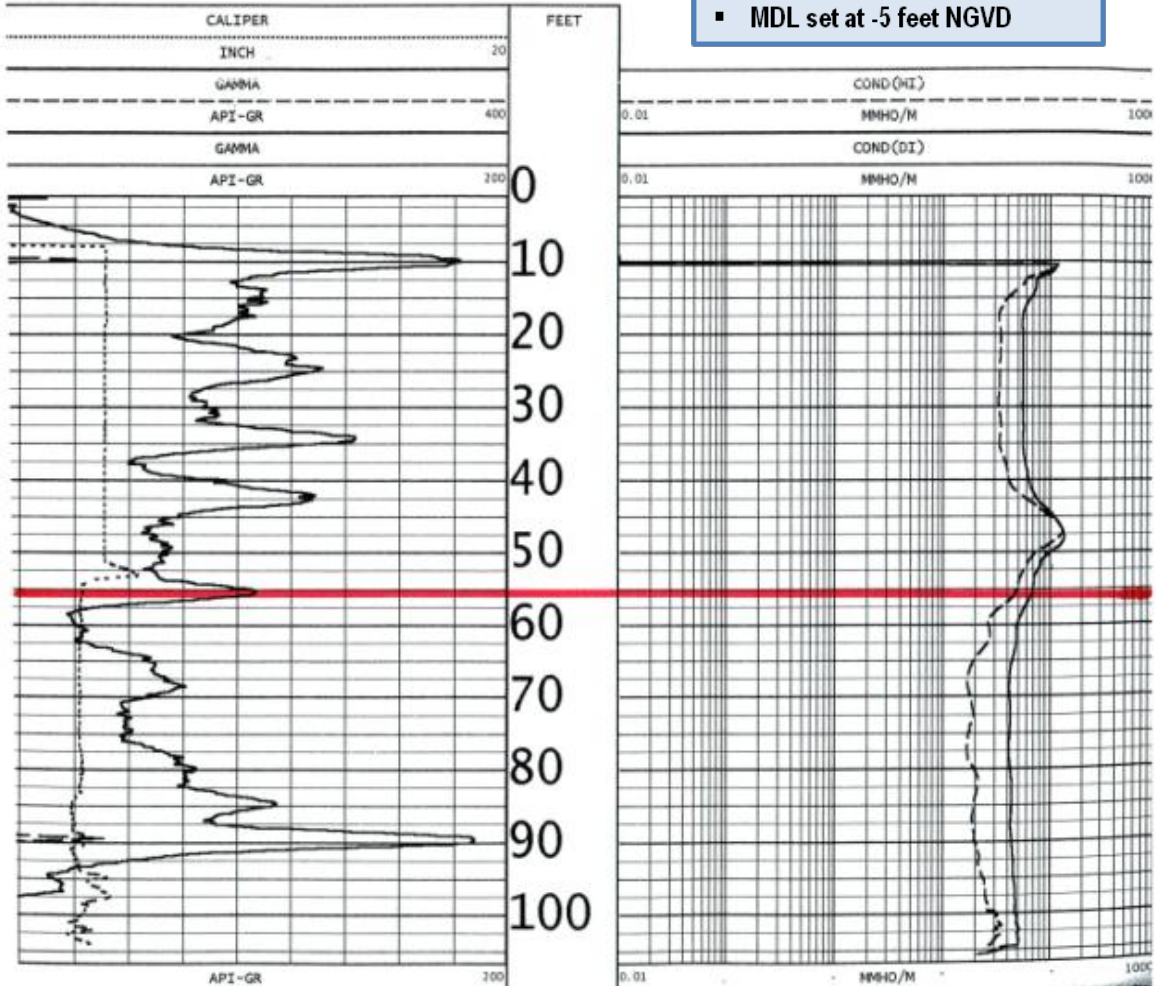
MATRIX DENSITY : 2.71
MAGNETIC DECL : 0

NEUTRON MATRIX : Dolomite
ELECT. CUTOFF : 10000

MATRIX DELTA T : 140
BIT SIZE : 4

PRESENTATION NAME/DATE = Dilgray20.0 09/28/2010

- Sandstone 2 (L-2186)
- Top of sandstone 56 feet bls
- Land surface 31 feet NGVD
- MDL set at -5 feet NGVD



Appendix B - Lithologic Descriptions

Site L-729	
Depth feet bls	Description
15	gray limestone, soft, some clay
20	white limestone, soft
25	white limestone, soft
30	white - beige limestone, soft
35	white - beige limestone, soft
40	beige - white limestone, soft
45	beige silty clay with some limestone, soft, shells
50	green clay, silt, shells
55	green silty clay, shells
58	phosphatic green clay
59	large phosphates, green clay
60	beige, shells, increased phosphates
61	olive-green dolosilt
62	light to medium gray, fine grained, silty
67	medium gray, moderately cemented sandstone
72	medium gray, well-cemented sandstone with shells
77	loose sand
81	well-cemented sandstone with shells
82	medium gray cemented shells and sand, large abundant shells
87	beige, medium gray sandstone, large, abundant shells
92	beige sandstone with shells
97	beige sandstone with well-cemented shells

Site L-2186	
Depth feet bls	Description
0	dark brown sand
5	light brown, fine sand with shells
10	beige limestone with shells
15	soft, beige limestone with shells
20	soft, beige limestone with shells
25	beige limestone, transition to gray weathered silt around 28 feet
30	soft, weathered limestone with light gray silt
35	soft, weathered limestone with light gray silt
40	light green / olive dolosilt, shells
45	soft, dark olive-green dolosilt, not plastic, traces of gray silt
50	dark olive-green dolosilt
55	no recovery
57	medium gray well-cemented sandstone with abundant shells
62	gray sandstone with limestone mixed, abundant well-cemented fossils
67	medium gray sandstone with abundant shells, white markings in matrix
72	medium gray sandstone with abundant shells
79	unconsolidated fine gray sand
82	gray sandstone with abundant shells, layers of sands
87	fine-grained sand with moderate phosphate
92	dark gray, unconsolidated sands, moderate shell presence