Hydrologic Investigation at the C-30 Canal Site (Deseret Ranch) for the Central Florida Water Initiative

Osceola County, Florida

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EXECUTIVE SUMMARY

As part of the Central Florida Water Initiative (www.cfwiwater.com), the Data Monitoring and Investigations Team identified several areas lacking adequate monitoring and information on the hydraulic properties of the subsurface, particularly in the deeper portion of the Floridan aquifer system (FAS) known as the Lower Floridan aquifer (LFA). Consequently, the team developed a work plan for the construction and testing of new monitor sites to meet future data needs within the Central Florida Water Initiative Planning Area and increase understanding of the LFA as an alternative water supply source. This report documents one component of that work plan: the exploratory drilling and construction of monitor wells OSF-110, OSS-111, and OSF-111, located within the boundaries of the Deseret Ranch along the C-30 Canal near Lake Myrtle in Osceola County, Florida.

Work at the Deseret site included wire-line coring, geophysical logging, hydraulic testing, and water quality sampling. Data from these activities were used to identify hydrogeologic unit boundaries and evaluate variations in water quality and rock permeability with depth. Exploratory drilling reached a maximum depth of 1,653 feet below land surface (ft bls).

The shallower hydrogeologic unit boundaries observed at the Deseret site are in close agreement with those anticipated by regional mapping. The intermediate confining unit is not as thick as anticipated; however, based on the large head drop observed from the surficial aquifer system and Upper Floridan aquifer (UFA), its confining properties are not substantially reduced. The UFA has a very high sand content, which accounts for its lower productivity as sand fills in the secondary porosity. The Avon Park permeable zone is a single unit at this site and thicker than anticipated from prior regional mapping. The top of the middle confining unit lies 275 ft below its interpolated map position. Analysis and interpretation of the LFA at this site was limited due to the presence of a large cavern encountered from 1,406 to 1,497 ft bls. The cavern prevented exploratory drilling from penetrating the entire thickness of the LFA at this location.

Various sampling methods were used to assess the chemistry of the formation water at the Deseret site. Drill-stem sampling and fluid resistivity logging provided a continuous vertical profile of the water within the borehole. This sampling indicated fresh water exists to a depth of approximately 1,150 ft bls (top of the LFA). The formation water grows increasingly brackish from there to the total drilled depth. Discrete samples were collected during straddle-packer and step-drawdown testing in OSF-111, and from the completed interval of each well (OSF-110, OSS-111, and OSF-111) to provide more extensive and accurate assessment of those discrete zones. While the UFA contains fresh water throughout, there are significant ionic differences with depth. Samples obtained from the upper portion of the UFA are fresh recharge water, while deeper samples show transitional water where seawater begins to dominate as the source water. Samples also were analyzed for stable isotopes of hydrogen and oxygen. Interpretation of these data suggests water in the LFA was subjected to evaporation prior to groundwater recharge.

The most permeable sections of the FAS are associated with post-depositional fracturing or dissolution of carbonate rock, which makes permeability within the FAS highly variable. Formation permeability, represented by hydraulic conductivity (k), was estimated from each packer test (30-ft intervals). Constant-rate pump tests yielded the following composite estimates for transmissivity for the major hydrostratigraphic units: UFA = 108,900 ft^2/day and LFA = 109,700 ft^2/day. The major confining zones were not individually tested for this project.

Upon completion of exploratory coring and testing, all three wells were completed as monitor wells. OSF-110 was completed with an open hole interval from 260 to 610 ft bls, which is open to both the uppermost permeable zone of the FAS (UFA-upper) and the Avon Park permeable zone. OSS-111 was completed with a screened interval of 44 to 54 ft bls as a water table aquifer monitor well. OSF-111 was completed with an open hole interval between 1,145 and 1,653 ft bls, which monitors the LFA-upper zone, including the cavern that was encountered from 1,406 to 1,497 ft bls.

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ACRONYMS AND ABBREVIATIONS

µS/cm	microsiemens per centimeter
APhpz	Avon Park high-permeability zone
APPZ	Avon Park permeable zone
APT	aquifer performance test
bls	below land surface
CFWI	Central Florida Water Initiative
CTD	conductivity, temperature, and depth
d	day
ECFTX	East Central Florida Transient Expanded (model)
FAS	Floridan aquifer system
ft	foot
gpm	gallons per minute
LFA	Lower Floridan aquifer
MCU	middle confining unit
mg/L	milligrams per liter
NAVD88	North American Vertical Datum of 1988
NGVD29	National Geodetic Vertical Datum of 1929
OBI	optical borehole imaging
OCAPlpz	Ocala-Avon Park low-permeability zone
PVC	polyvinyl chloride
SAS	surficial aquifer system
SFWMD	South Florida Water Management District
SPT	standard penetration test
UFA	Upper Floridan aquifer
UFA-upper	upper permeable zone of the Upper Floridan aquifer
VSMOW	Vienna standard mean ocean water

1 INTRODUCTION

The South Florida Water Management District (SFWMD) has been working cooperatively with the Southwest Florida and St. Johns River water management districts, Florida Department of Environmental Protection, Florida Department of Agriculture and Consumer Services, and local stakeholders over the last several years to evaluate the status of traditional water supplies and plan for the future of water supply in Central Florida. As part of this Central Florida Water Initiative (CFWI; www.cfwiwater.com), several areas were identified as lacking adequate monitoring and information on the hydraulic properties of the subsurface, particularly in the deeper portions of the Floridan aquifer system (FAS). Consequently, a work plan was developed for the construction and testing of new monitor sites to meet future data needs within the CFWI Planning Area. This report documents one component of that work plan: the exploratory drilling and monitor well construction within Deseret Ranch (latitude 28.325403, longitude -81.168429). The Deseret site is located in Osceola County, on the west bank of the C-30 Canal right-of-way just north of Lake Myrtle (**Figure 1**). No wells were present at this location prior to this project. Land elevation at the site is approximately 62.5 feet (ft) North American Vertical Datum of 1988 (NAVD88). Offset to the National Geodetic Vertical Datum of 1929 (NGVD29) is +1.07 ft.

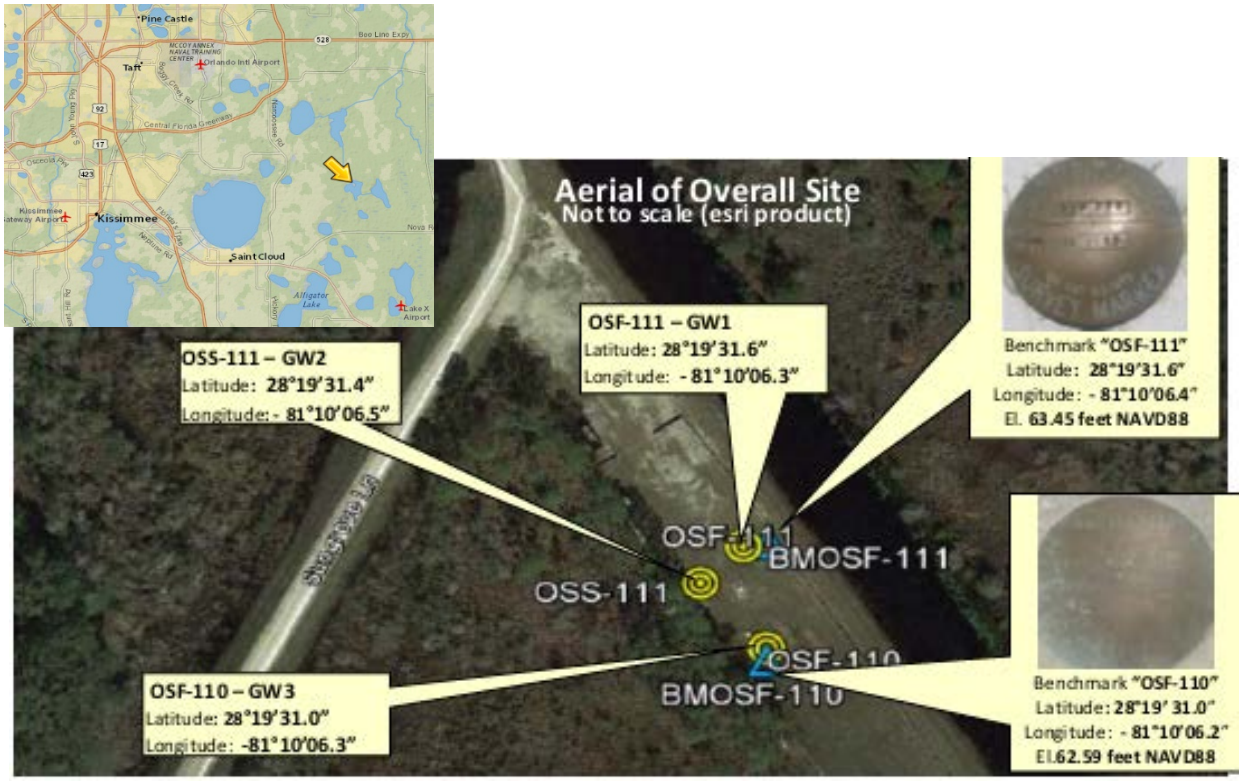


Figure 1. Location of monitor wells and general location (inset) of the Deseret site

1.1 Project Objectives

Hydrogeologic data collection:

1. Evaluate the lithology, productivity, and water quality of the FAS to a depth of 2,500 ft below land surface (bls).
2. Identify key hydrogeologic unit boundaries from the top of the Avon Park permeable zone (APPZ) to the top of the Lower Floridan aquifer (LFA).
3. Determine whether and to what extent the evaporitic facies of the middle confining unit (MCU) is present at this site.

Monitoring objectives:

1. Construct a new well (OSF-110) to monitor the Upper Floridan aquifer (UFA).
2. Construct a new well (OSF-111) as a dual-zone monitor well to discretely monitor two zones within the LFA.
3. Construct a new well (OSS-111) to monitor the unconfined (water table) aquifer.

2 EXPLORATORY DRILLING AND WELL CONSTRUCTION

The SFWMD contracted Huss Drilling, Inc., for OSF-110 on May 9, 2017 (CN#4500100131). The SFWMD contracted with Florida Design Drilling for OSS-111 and OSF-111 on November 1, 2017 (CN#4600003746). Florida Design Drilling subcontracted all activities associated with OSS-111 to Huss Drilling. Drilling operations at the Deseret site began on June 12, 2017, with Huss Drilling mobilizing a Failing 1500 rig to the site to begin construction of OSF-110.

2.1 OSF-110

Construction of OSF-110 began with drilling a 3⅞-inch diameter pilot hole to a depth of 245 ft bls using the mud rotary method. The pilot hole was reamed to a diameter of 14 inches to a depth of 62 ft bls, and a 12-inch diameter polyvinyl chloride (PVC) casing was cemented into place to a depth of 60 ft bls to stabilize the borehole through the unconsolidated shallow aquifer. Then, an 8-inch diameter drill bit was used to ream the pilot hole and advance the 8-inch hole to a depth of 302 ft bls. The drilling tools were removed from the well, and a suite of geophysical logs were obtained (caliper, natural gamma, sonic porosity, short and long normal resistivity, single point resistance, 6-ft lateral, sonic travel time, and spontaneous potential). A 4-inch diameter steel casing was grouted into place using cement baskets from land surface to 260 ft bls, which generally corresponds to the top of the FAS in this area.

Huss Drilling attempted to begin wire-line coring at 302 ft bls using a 10-ft core barrel equipped with a Boart Longyear HQ series bit yielding 2.5-inch diameter rock cores. However, sand caving in from the 260 to 302 ft bls interval of open hole caused considerable problems with coring. It was decided to fill the open hole interval with cement, and once set, core through the cement. The cement remaining around the borehole stabilized that section and prevented sand from caving in. Coring resumed at a depth of 310 ft bls and continued to 603 ft bls. The section between 425 and 603 ft bls was drilled under lost circulation conditions (i.e., no water returning to the surface). The well was then air developed until visibly clear of turbidity, and another suite of geophysical logs was obtained from 300 to 603 ft bls (caliper, natural gamma, temperature gradient [unpumped], fluid resistivity [unpumped], sonic travel time, sonic porosity, temperature differential, 6-ft lateral, single point resistance, short and long normal resistivity, fluid

conductivity [unpumped], and spontaneous potential). During logging, SFWMD staff observed the section of cemented hole between 285 and 302 ft bls was dislodged, may have been lost down hole, and may have partially obstructed the well at an unknown depth. A partial obstruction in the well at 285 ft bls was confirmed with a video log on January 2, 2020.

A specific capacity test was conducted and a water sample obtained on July 26, 2017. Construction of OSF-110 was completed by installing a concrete well pad and protective bollards. Huss Drilling demobilized from the site in July 2017. In May 2018, the well was equipped with telemetry and a pressure transducer to allow remote real-time monitoring of water levels in the upper FAS. An as-built diagram of OSF-110 is provided in **Figure 2**. A photograph of the completed wellhead is provided in **Figure 3**. Water levels, geophysical logs, water quality data, and other information from OSF-110 is available online from the SFWMD DBHYDRO database. Daily drilling logs for OSF-111 are summarized in **Appendix A**.

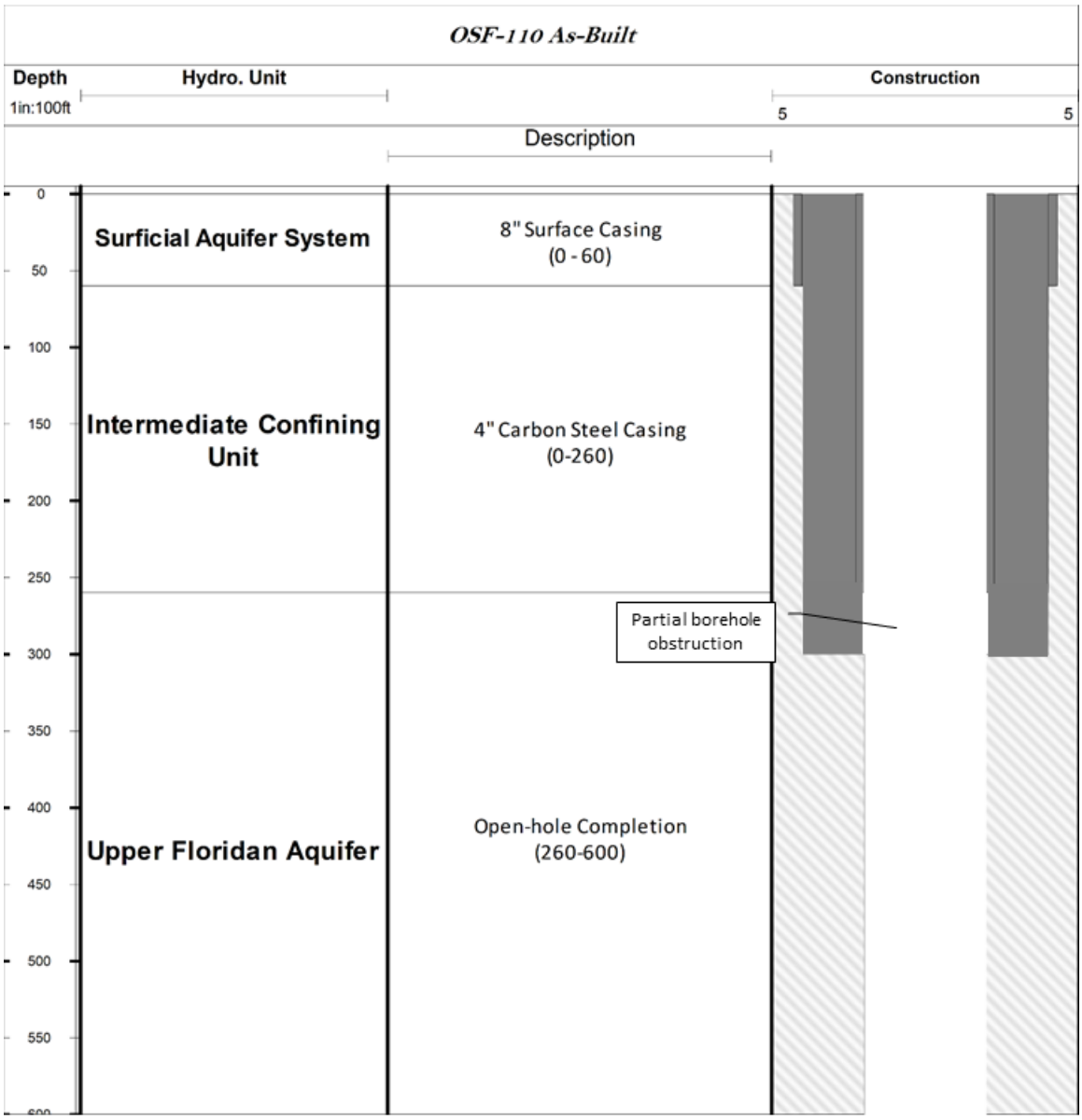


Figure 2. As-built diagram of OSF-110.

Figure 3. OSF-110 completed wellhead with telemetry installed.

2.2 OSS-111

Construction of OSS-111 began on December 11, 2017, with Huss Drilling mobilizing a CME 75 rig to the site. Initial construction of OSS-111 was conducted using the standard penetration test (SPT) method (ASTM Standard No. D-1586-84) to obtain unconsolidated soil samples through the total depth of the well. The SPT drilling reached a depth of 60 ft bls, with unconsolidated sands and silts between land surface and 54 ft bls and predominantly clays from 54 through 60 ft bls. The pilot hole then was reamed by the mud rotary method to a diameter of 9⅞ inches to a depth of 54 ft bls, which corresponds to the bottom of the water table aquifer. The well was finished with 4-inch diameter schedule 40 PVC Tri-Loc risers and 0.010-inch PVC slotted screen installed between 44 and 54 ft bls. A 20/30 silica sand was installed as a filter pack around the well screen to a depth of 41 ft bls, which was confirmed by a hard tag. One bag of bentonite pellets was installed on top of the filter pack to a depth of 38 ft bls, and the casing was cemented into place to land surface. The well was then developed by pumping and air lifting until the water was visibly clear of turbidity and field water quality parameters were stable. The wellhead was completed with an 8-inch diameter steel surface casing and a 3 × 3-ft reinforced concrete well pad. Huss Drilling demobilized from the site on December 12, 2017. In May 2018, the well was equipped with telemetry and a pressure transducer to allow remote real-time monitoring of water levels in the water table aquifer. An as-built diagram of OSS-110 is provided in **Figure 4**. A photograph of the completed wellhead is provided in **Figure 5**. Field data sheets from construction and results of a grain size analysis of the samples obtained from OSS-111 are discussed in **Section 5.1**. Water levels, water quality data, and other information from OSS-111 are available online from the SFWMD DBHYDRO database.

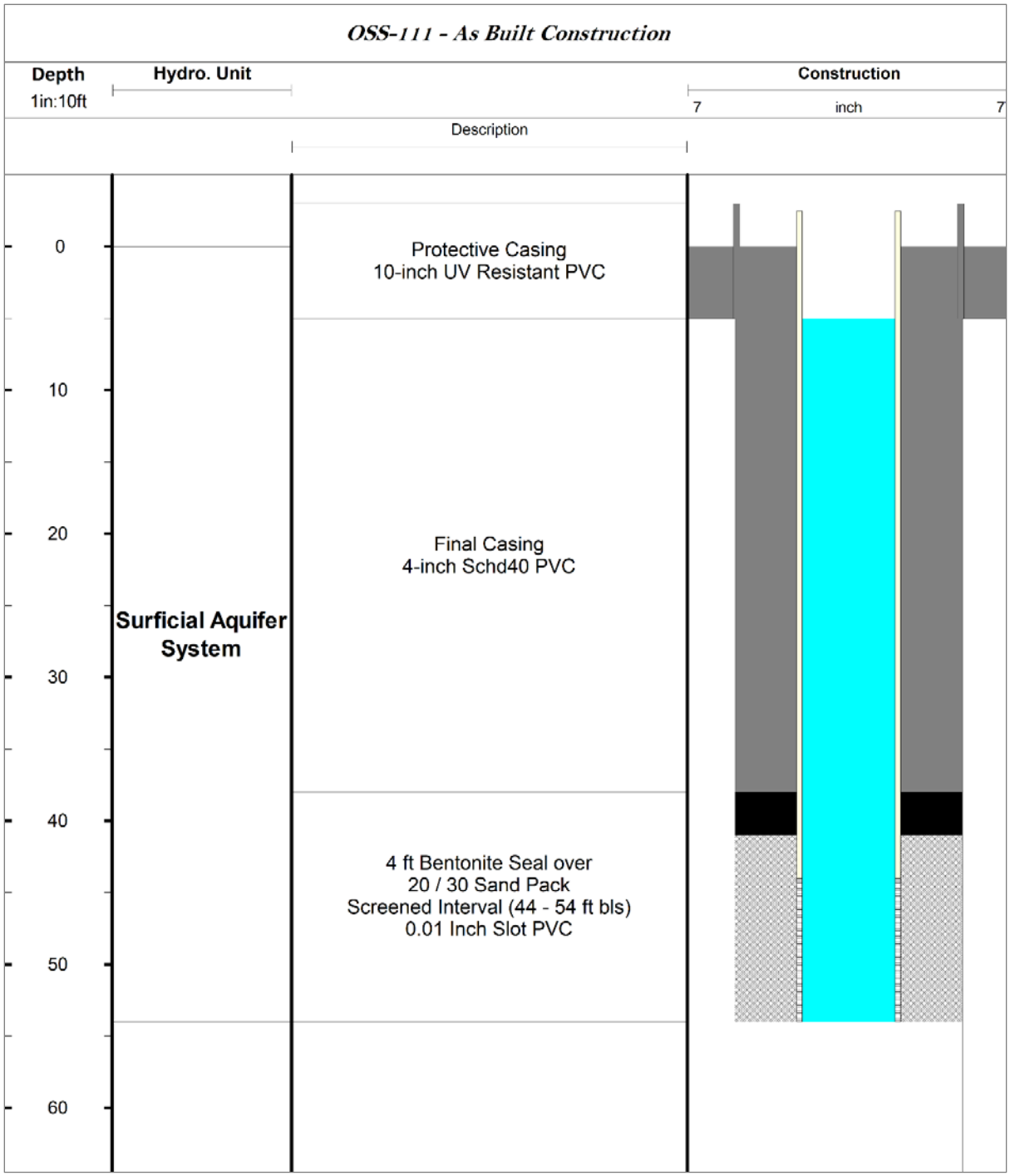


Figure 4. As-built diagram of OSS-111.

Figure 5. OSS-111 completed wellhead with telemetry installed.

2.3 OSF-111

Construction of OSF-111 began in January 2018 with installation of a 36-inch diameter steel pit casing to a depth of 40 ft bls. A temporary concrete pad was installed to provide a stable surface for drilling operations. The rig and supporting equipment were mobilized to the site in February 2018, and drilling operations commenced on March 15. A 36-inch diameter hole was drilled to a depth of 305 ft bls using the mud rotary method, and a suite of geophysical logs (x-caliper, y-caliper, and natural gamma) was run in the mudded borehole. A 24-inch diameter steel casing was installed to a depth of 305 ft bls and grouted into place using neat cement grout on April 10 and 11. The cement plug was drilled to a depth of 310 ft bls on April 13, and the equipment was reconfigured for reverse-air drilling.

Reverse-air drilling operations commenced on April 24, 2018. A 12¼-inch borehole was advanced to a depth of 600 ft bls, which approximates the bottom of the UFA. The drill stem was removed from the borehole, and a series of aquifer performance tests (APTs) were performed between 310 and 600 ft bls. APT results are discussed in **Section 5.4**. Reverse-air drilling resumed on May 8, and the 12¼-inch borehole was advanced to 1,200 ft bls on May 25. A change in water quality between 1,150 and 1,180 ft bls indicated the top of the LFA had been encountered. At this point, the well was conditioned for geophysical logging, and static and dynamic logs (x-caliper, y-caliper, natural gamma, spontaneous potential, induction [shallow, medium, deep], sonic porosity, temperature gradient [pumped and non-pumped], fluid conductivity [pumped and non-pumped], flowmeter [pumped and non-pumped], and sonic travel time) were conducted on May 29 and 30. A downhole video also was collected at this time. All drilling and pumping equipment was removed from the borehole, and it was allowed to sit undisturbed over the weekend in anticipation of conducting optical borehole imaging (OBI), which was completed by the United States Geological Survey on June 4. A series of straddle-packer tests were run at intervals of 422 to 452, 580 to 610, and 730 to 760 ft bls. Results of the straddle-packer tests are discussed in **Section 5.4**.

From June 22 through July 3, 2018, the 12¼-inch borehole was reamed to a diameter of 22 inches from 305 to 1,145 ft bls. On July 5, the reamed borehole was logged to prepare for installation of a 14-inch diameter steel casing to 1,145 ft bls, which occurred on July 8 and 9. The 14-inch casing was pressure grouted into place between July 10 and 18. Cementing was accomplished in 10 stages. Gravel was used to

fill several highly permeable zones. After allowing adequate time for the cement to set after each stage, the 14-inch casing installation was successfully pressure tested on July 19.

Drilling the 12¼-inch pilot hole resumed on July 23, 2018, by drilling out the cement plug between 1,145 and 1,200 ft bls. Between 1,200 and 1,403 ft bls, drilling was paused at 30-ft intervals to allow for drill-stem tests. The tests consisted of air-lifting the well to clear it of sediment, setting a packer to isolate the 30-ft zone to be tested, pumping to purge the well while obtaining drawdown measurements, and sampling for water quality. Between the drill-stem tests at 1,370 and 1,403 ft bls, specific conductance jumped from 2,973 to 5,949 microsiemens per centimeter (µS/cm), indicating the Lower Floridan confining unit had been encountered. It was decided to pause the drilling and run an APT on the interval between 1,150 and 1,403 ft bls.

Preparations for a step-drawdown test commenced on August 1, 2018, by removing the drill stem from the hole and cutting off the 14-inch diameter steel casing at a depth of 250 ft bls to allow a large-diameter pump to be installed in the well. Pump installation was completed on August 8, and the step-drawdown test was conducted on the same day. The well was pumped at rates of approximately 705, 1,363, and 3,000 gallons per minute (gpm) for 1 to 2 hours at each rate until the water level stabilized. Water samples were obtained at the end of the last step. The pump was shut down, and water levels were recorded until they recovered to pre-pumping levels. Results of the step-drawdown test are discussed in **Section 5.4**.

The pump was removed from the borehole and pilot hole drilling resumed on August 9, 2018, at a depth of 1,403 ft bls. At 1,406 ft bls, the drilling bit entered a void, and rock was not encountered again until a depth of 1,497 ft bls. Considerable caving occurred and accumulated at the base of the void in thicknesses of up to 4 ft, resulting in dredging conditions. Three drill-stem tests were conducted in the void, at depths of 1,435, 1,467, and 1,497 ft bls. A 24-hour drilling schedule was implemented to facilitate drilling through the dredging conditions. Between August 9 and September 7, the borehole was advanced from 1,497 to 1,653 ft bls through dredging conditions for the entire interval. On September 7, a substantial cave-in and accumulation of materials at the bottom of the void locked up the drill stem, making it unable to rotate. The drilling assembly was freed by the application of 89,000 pounds of vertical force. Drilling operations ceased at that depth. The hole was conditioned for geophysical logging between 1,145 and 1,653 ft bls. A suite of static and dynamic logs was obtained on September 18 (x-caliper, y-caliper, natural gamma, induction [shallow, medium, and deep], spontaneous potential, sonic travel time [compensated], sonic porosity, temperature gradient [pumped and unpumped], temperature differential, fluid conductivity [pumped and unpumped], and flowmeter [pumped and unpumped]).

The borehole was left undisturbed on September 19, 2018, and an OBI survey was conducted by the United States Geological Survey on September 20, to a depth of 1,630 ft bls. A pump was inserted into the well, and dynamic logs were conducted to 1,504 ft bls on September 24. Final development of the well was accomplished on September 25 by pumping at a rate of 1,800 gpm for 4 hours when the water quality stabilized. The wellhead was finished with a 20-inch diameter stainless steel casing attached to the 24-inch casing using a reducer. A 20-inch diameter stainless steel flange, containing 6-inch and 4-inch risers to accommodate logging, pumping, and sampling, was fitted to the top of the casing. The temporary drilling pad was removed and an 8 × 8-ft by 8-inch thick reinforced concrete pad was installed, along with a 24 × 24-ft by 7-ft high chain link fence. Florida Design Drilling demobilized from the site in November 2018. In June 2019, the well was equipped with telemetry and a pressure transducer to allow remote real-time monitoring of water levels in the lower FAS. An as-built diagram of OSF-111 is provided in **Figure 6**. A photograph of the completed wellhead is provided in **Figure 7**. Water levels, geophysical logs, water quality data, and other information from OSF-111 are available online from the SFWMD DBHYDRO database. A summary of metadata for all three wells is provided in **Table 1**.

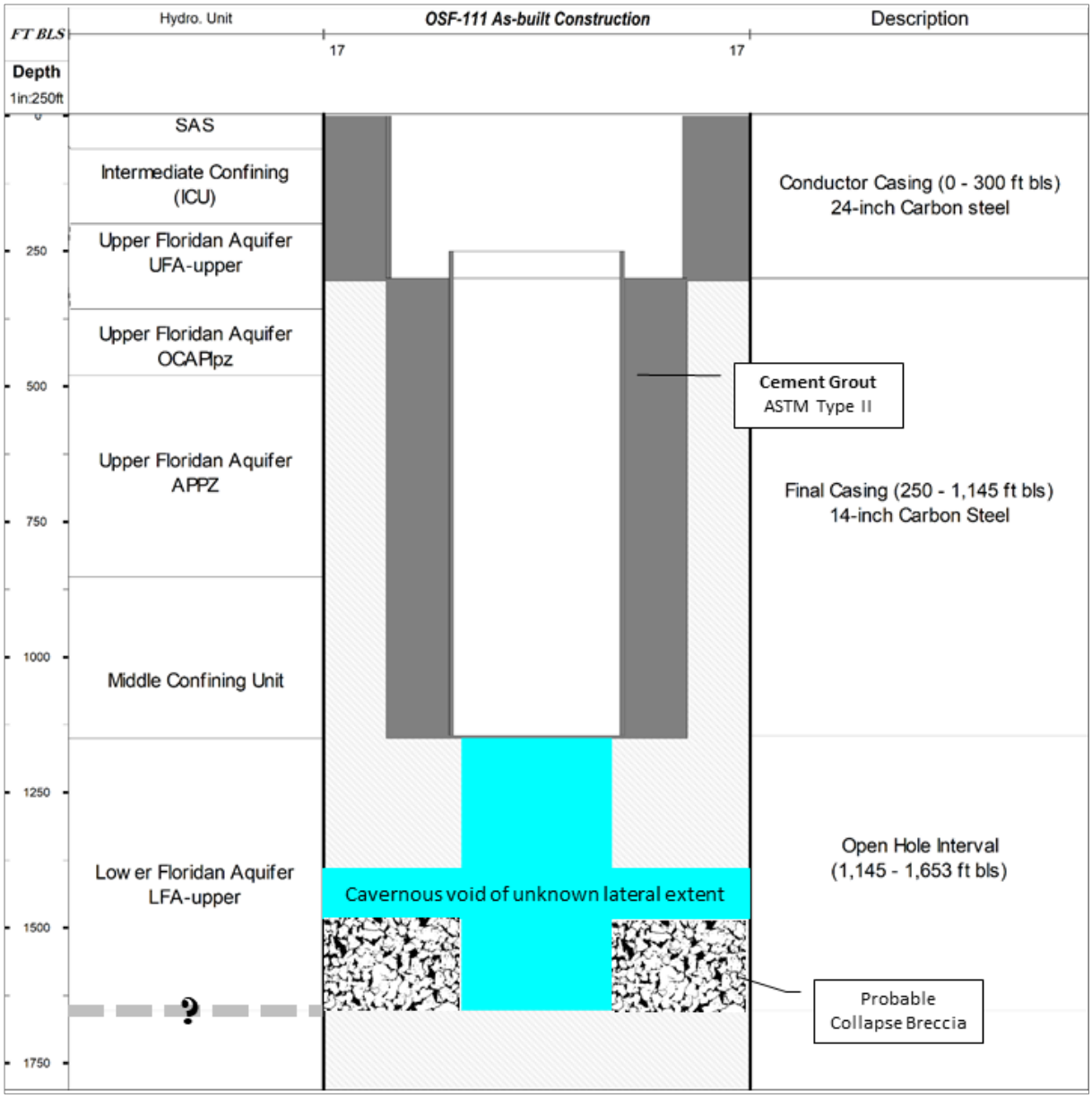


Figure 6. As-built diagram of OSF-111.

Figure 7. OSF-111 completed wellhead with telemetry installed.

Table 1. Summary of metadata for the completed monitor wells.

Well	Latitude	Longitude	Measuring Point Elevation		Completed Depth	
			Feet (NAVD88)	Feet (NGVD29)	Cased Depth (ft bls)	Total Depth (ft bls)
OSS-111	281931.45	-811006.34	65.80	66.87	44	54
OSF-110	281930.95	-811006.32	65.30	66.37	260	603
OSF-111	281931.45	-811006.34	66.45	67.52	1,145	1,653

ft bls = feet below land surface; NAVD88 = North American Vertical Datum of 1988; NGVD29 = National Geodetic Vertical Datum of 1929.
Note offset of +1.07 ft between NAVD88 and NGVD29.

3 STRATIGRAPHIC FRAMEWORK

The SFWMD collected geologic formation samples during pilot hole drilling of OSF-110, OSS-111, and OSF-111 and described the samples based on the dominant lithologic, textural, and porosity characteristics. Sampling methodologies included 2-ft SPT sampling from land surface to 60 ft bls during drilling of OSS-111, drill cuttings collection at 5-ft intervals during rotary drilling of OSF-110 to a depth of 302 ft bls, wire-line core samples from 302 to 600 ft bls during construction of OSF-110, and drill cuttings collection at 5-ft intervals during rotary drilling of OSF-111 to a total depth of 1,635 ft bls. SFWMD geologists described the samples (**Appendix B**) using the expanded Dunham classification for carbonates (Embry and Klovan 1971). Geophysical logs (**Appendix C**), the OBI log (**Appendix D**), and video logs helped characterize the geologic formations encountered during drilling.

3.1 Holocene, Pleistocene, and Pliocene Series

Undifferentiated sediments of Holocene, Pleistocene, and/or Pliocene age occur from land surface to approximately 54 ft bls. These undifferentiated sediments consist of brownish gray, fine to medium quartz sand, with dark minerals and a few interbedded, olive-gray sandy clay. At approximately 54 ft bls, lithology changes from brownish gray quartz sand to greenish black, sandy calcareous clay with low plasticity.

3.2 Miocene Series

The Hawthorn Group is composed of a heterogeneous mixture of silt, clay, calcareous clay, quartz sand, phosphatic sand, shell, silt, limestone, and dolostone. Scott (1988) elevated the Hawthorn Formation to group status in Florida. It consists of two formations: the Peace River Formation, predominantly composed of siliciclastic material; and the underlying Arcadia Formation, principally composed of carbonates.

Peace River and Arcadia Formations

The top of the Hawthorn Group, at approximately 54 ft bls, consists of greenish black, calcareous, sandy clay with low plasticity to a depth of approximately 65 ft bls. Olive-gray, shelly sandstone with calcareous cement, low intergranular porosity, and up to 20% phosphatic sand is present from approximately 65 to 105 ft bls. Calcareous sandy, shelly, and phosphatic clay with some sandstone interbeds is present from 105 to 150 ft bls. Interbedded quartz and phosphatic sand, clayey sand, and sandy clay are present to a depth of approximately 195 ft bls. Olive-gray clayey phosphatic quartz sand, with coarse shell fragments and sandy silt interbeds, is present to a depth of approximately 245 ft bls. Generally, a lithologic change from predominantly siliciclastic to mixed siliciclastic-carbonate sediments differentiates the Arcadia Formation from the overlying Peace River Formation; however, such a change is not observed in these sediments, so the two formations are not differentiated in this description. Based on the lack of carbonate sediments described, the section appears to consist of the Peace River Formation, with the presence of Arcadia Formation not substantiated. The Hawthorn Group is approximately 191 ft thick at this site.

Deposition of Peace River Formation sediments began in the Middle Miocene when siliciclastic sediments overran Florida's carbonate bank environment (Scott 1988). As sea level rose, large amounts of siliciclastic material migrated to southern Florida, restricting carbonate sedimentation. The Arcadia Formation developed during the Lower Miocene in a carbonate bank environment with deposition of siliciclastics from a southward flowing, long shore current (Scott 1988).

3.3 Oligocene Series

Suwannee Limestone

Suwannee Limestone was not present at this location.

3.4 Eocene Series

Ocala Limestone

Upper Eocene Ocala Limestone occurs at a depth of 246 ft bls, based on lithology cuttings and geophysical log analysis. Lithology of the upper 55 ft of the Ocala Limestone consists of a poorly indurated, pale yellow brown, fossiliferous wackestone with low intergranular porosity observed in drill cuttings. From approximately 303 to 345 ft bls, the unit consists of very pale orange to grayish orange, fossiliferous grainstone and packstone, poorly indurated and chalky, with good intergranular porosity observed in the core. Fossils consist of undifferentiated foraminifera, milliolids, bivalves, echinoids, and algal fragments. From 345 to 401 ft bls, the limestone becomes finer grained, predominantly consisting of wackestone and packstone, with a few mudstone interbeds, moderate to low porosity, and frequent lamination. Few fractures were observed on the OBI log. Although fossiliferous, few fossils are identifiable. The base of the Ocala Limestone occurs at a depth of approximately 401 ft bls.

The Ocala Limestone was deposited on a warm, shallow carbonate bank, similar to the modern-day Bahamas (Miller 1986). This low-energy environment probably had low to moderate water circulation (Tucker and Wright 1990).

Avon Park Formation

The top of the Middle Eocene Avon Park Formation is identified from lithologic samples at a depth of 401 ft bls, based on the appearance of the fossil *Neolagnum*. The first occurrence of a *Neolagnum* diagnostic microfossil is used as a biostratigraphic indicator for the Avon Park Formation (Bryan et al. 2011). A transition from the finer-grained Ocala Limestone to interbedded and wackestone, packstone, and floatstone of the Avon Park Formation was observed. The Avon Park Formation continues to the total depth of the borehole (1,635 ft bls).

From approximately 401 to 445 ft bls, lithology consists of interbeds of very pale orange to grayish orange, poorly indurated wackestone, packstone, and floatstone, with moderate to good intergranular and moldic porosity observed in the core. The interval is very fossiliferous with fossil fragments, foraminifera, bivalves, gastropods, and worm borings. The first calcareous dolostone unit occurs from approximately 445 to 454 ft bls, with moderate induration and moderate to good intergranular porosity. The interval from 454 to 473 ft bls consists of poorly to moderately indurated, highly fossiliferous wackestone, with moderate intergranular porosity and few observed fractures.

The interval from 473 to 519 ft bls consists of moderately indurated, very pale orange calcareous dolostone with moderate to good intercrystalline and pinpoint and vuggy porosity. Numerous cavities were observed from 488 to 506 ft bls on the OBI log, and intervals of unconsolidated dolomitic sand less than 1 ft thick were observed in the core from approximately 482 to 515 ft bls, indicative of permeable zones. Several fractured intervals were observed on the OBI log and core, including fracture swarms from 477 to 483, 502 to 505, and 518 to 519 ft bls. A solution-enhanced fracture was observed from 510 to 524 ft bls.

The interval from 519 to 600 ft bls consists of alternating beds of limestone, calcareous dolostone, and dolostone. The limestone interbeds are poorly indurated wackestone and packstone, with moderate to good intergranular porosity, and are fossiliferous, with fossil fragments and gastropods observed in the core. No porosity was observable in a mudstone interval from 520 to 523 ft bls. Calcareous dolostone and dolostone interbeds are moderately to well indurated with good intercrystalline and pinpoint porosity. Numerous laminated zones were observed from 543 to 600 ft bls. Few fractures were observed below 524 ft bls on the OBI log.

From 600 to 844 ft bls, lithology is primarily moderately to well indurated, very pale orange and grayish orange dolostone with moderate to high intercrystalline, pinpoint, vuggy, and moldic porosity observed in drill cuttings. Mostly closed fractures and bedding plane fractures were observed, with the exception of the more intensely fractured intervals seen in the OBI log, described below:

- Several intervals with open fractures and fracture swarms from 618 to 620, 629 to 630, 649 to 650, 674 to 678, and 681 to 682 ft bls. A brecciated zone with borehole washout was observed from 692 to 695 ft bls.
- Up to 15 ft of brecciation with borehole washout was observed on the OBI log from 803 to 837 ft bls, and a fracture swarm was observed from 840 to 844 ft bls.

From 844 to 1,140 ft bls, lithology consists of a mostly well indurated, very pale orange dolostone, with low to high intercrystalline, vuggy, and moldic porosity observed in drill cuttings. Fractures mostly consist of closed fractures and bedding plane fractures, with the exception of a 5-ft thick brecciated zone at 883 ft

bls, a 10-ft thick cavernous zone at 985 ft bls, and a solution-enhanced fracture at 1,095 ft bls. Frequent bedding plane fractures were observed in the OBI log from 1,095 to 1,140 ft bls.

The interval from 1,140 to 1,409 ft bls includes well indurated, grayish orange and pale to moderate yellowish brown dolostone, with low to high intercrystalline, vuggy, and moldic porosity observed in drill cuttings. From 1,350 to 1,390 ft bls, porosity is microsucrosic. Trace amounts of organic material were observed from 1,210 to 1,230 ft bls, and 10% to 20% organic material was observed from 1,400 to 1,409 ft bls. Numerous cavities and fractured intervals were observed from 1,140 to 1,409 ft bls in the OBI and video logs, as described below:

- A solution-enhanced fracture from 1,140 to 1,141 ft bls, an open fracture from 1,150 to 1,151 ft bls, and a brecciated zone from 1,162 to 1,165 ft bls
- Brecciated zones from 1,200 to 1,202; 1,208 to 1,211; and 1,222 to 1,223 ft bls
- A solution-enhanced fracture at 1,283 ft bls and brecciation from 1,288 to 1,289 ft bls
- Open fractures from 1,333 to 1,335 and 1,337 to 1,338 ft bls
- An interval from 1,366 to 1,409 ft bls, including 13 ft of brecciation and 12 ft of open fracture

A cavernous interval approximately 91 ft thick was observed on the OBI log from 1,406 to 1,497 ft bls. Drill cuttings were not returned from this interval. Although cuttings were returned from 1,497 to 1,665 ft bls (total depth), they are not described here because they were interpreted to be cavings and other debris from the overlying cavernous interval and not representative of *in situ* stratigraphy. The video and OBI logs indicate the borehole from 1,497 to 1,629 ft bls is almost entirely brecciated.

4 HYDROGEOLOGIC FRAMEWORK

Two major aquifer systems underlie the Deseret site within the Quaternary/Tertiary sequence, the surficial aquifer system (SAS) and the FAS. The FAS is the primary focus of this investigation. Aquifers within the FAS are composed of multiple discrete zones of moderate to high permeability, many characterized by karst solution and fracturing. These productive zones are separated by lower-permeability units of various degrees of confinement. The sub-units of the FAS are not consistently labeled in the literature. **Figure 8** presents a comparison of commonly used nomenclature.

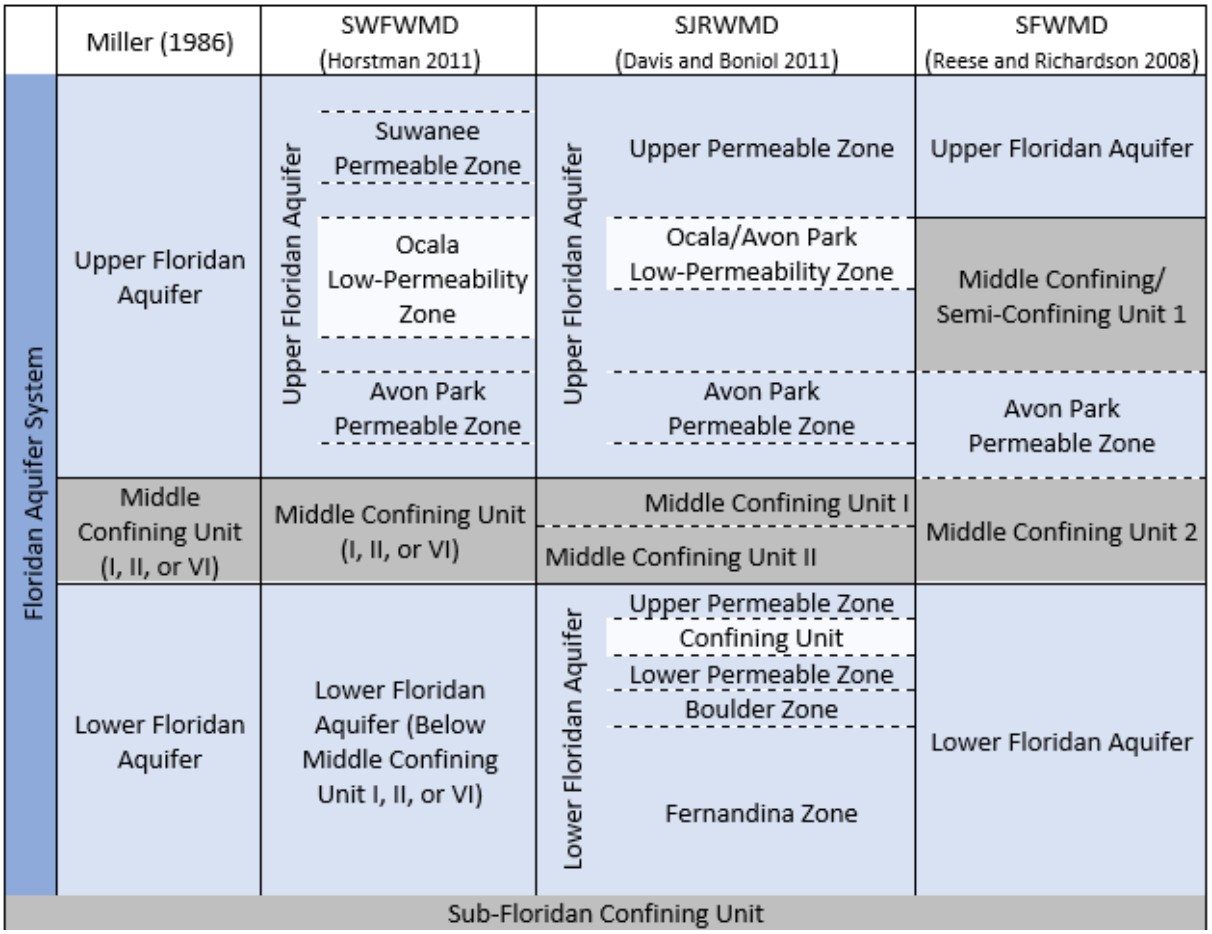


Figure 8. A nomenclature comparison of the hydrogeologic units of within the Floridan aquifer system.

To ensure consistency within the CFWI Planning Area, the cooperating water management districts agreed on a slightly modified hydrogeologic conceptualization (**Figure 9**) as the basis for development of the East Central Florida Transient Expanded (ECFTX) groundwater model, which is being used to evaluate groundwater availability in the region. As a component of the CFWI, this report will follow the same convention for the units intersected by the exploratory drilling. A representative hydrogeologic section, with hydrogeologic units conforming most closely to the Deseret site, is presented in **Figure 10**.

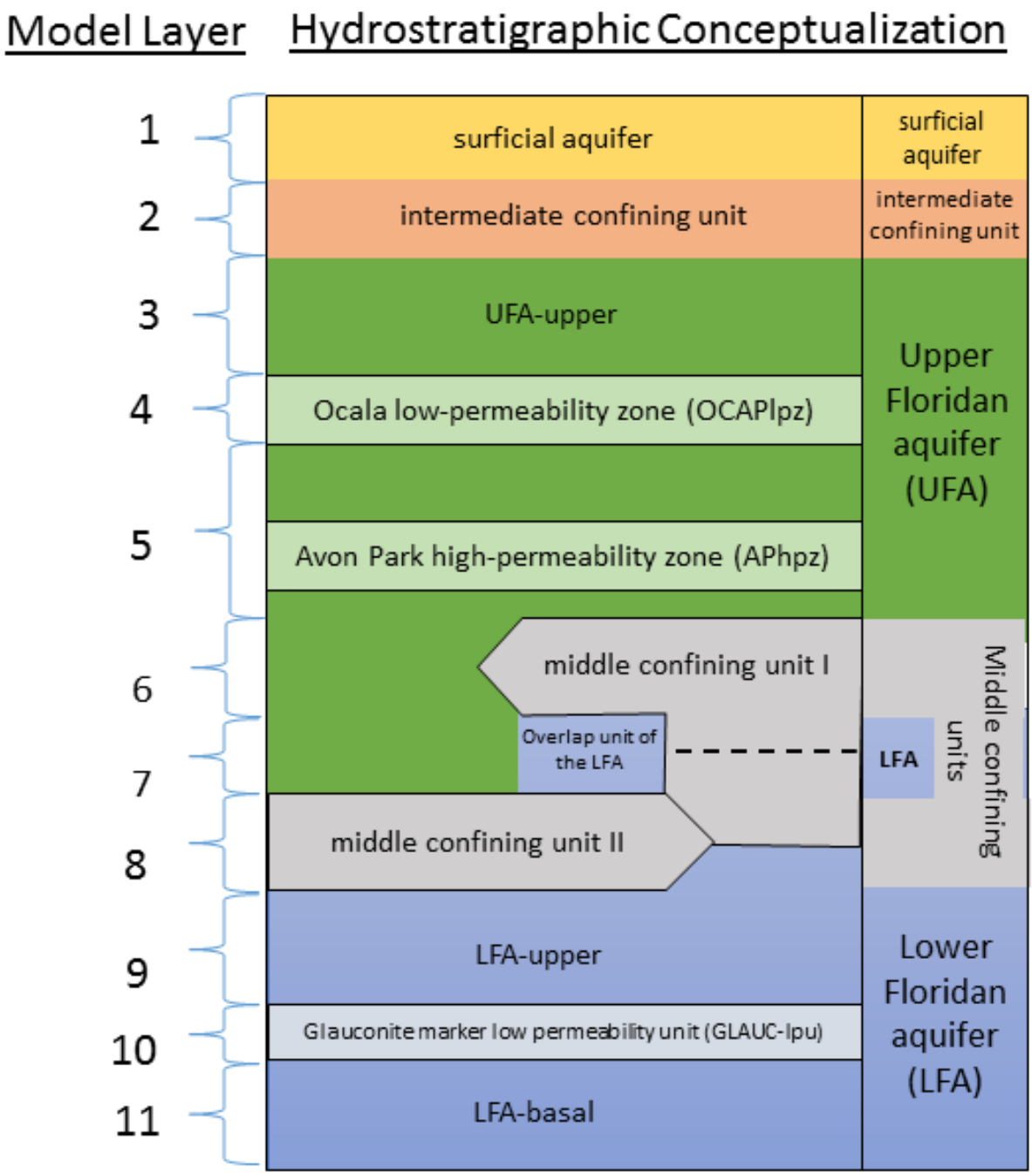


Figure 9. Hydrogeologic conceptualization and vertical discretization of the East Central Florida Transient Expanded model (From: CFWI Hydrologic Assessment Team 2016).

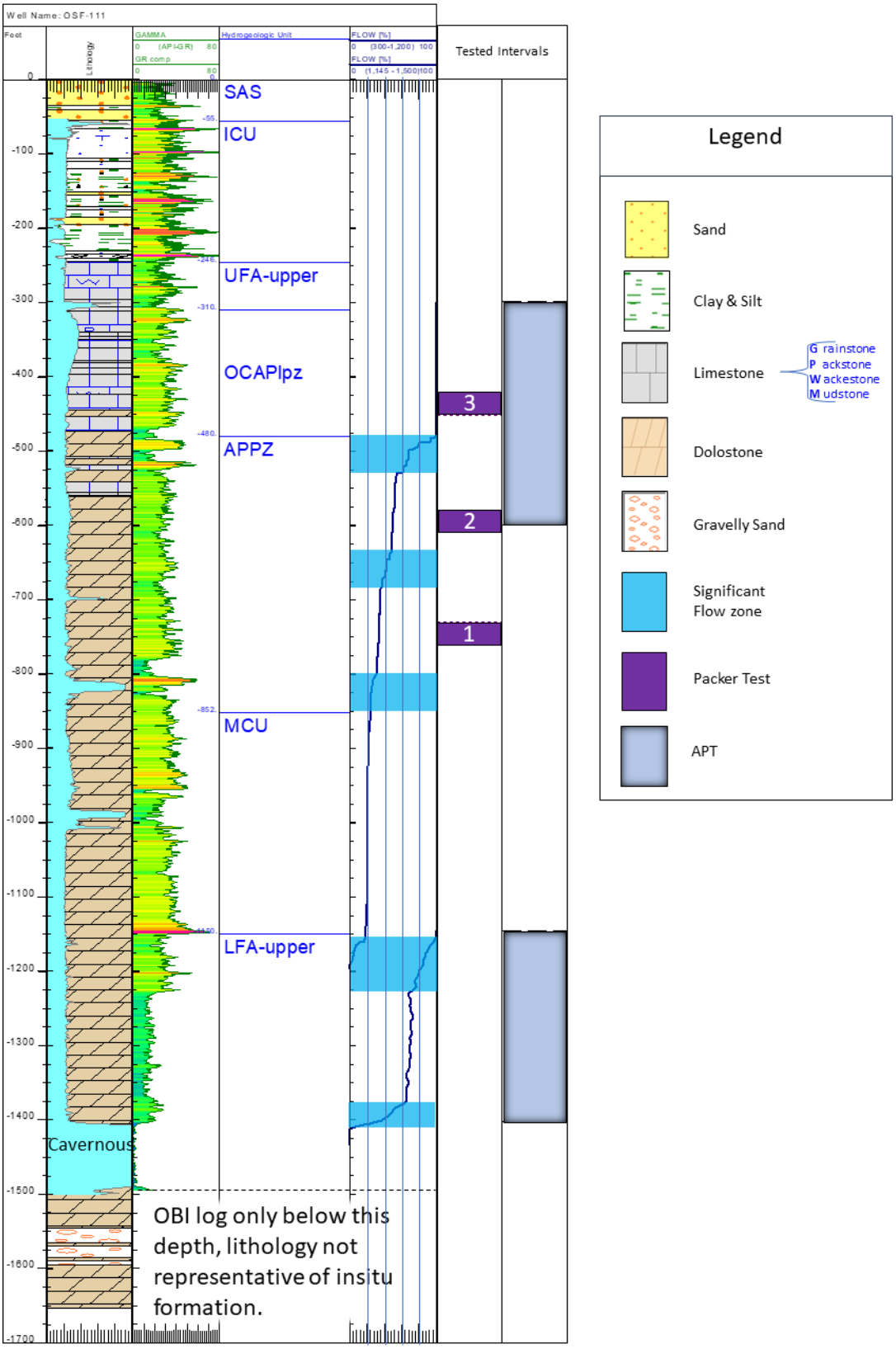


Figure 10. Representative hydrogeologic section for the Deseret site. Caliper log deviation (light blue) from nominal borehole diameter is overlain on the lithologic column.

4.1 Surficial Aquifer System (0 to 55 ft bls)

The SAS at the Deseret site consists of unconsolidated sediments, predominantly fine to medium quartz sand with varying amounts of silt, clay, shell, and heavy minerals. The top of the Hawthorn Group often is selected as the base of the SAS, but lower-permeability sediments frequently are found at much shallower depths, so the base of this unit is gradational. A base of 55 ft bls was selected at the Deseret site based on persistent high clay content in the SPT samples below that point. Based on sieve analysis results from OSS-111, an average hydraulic conductivity of 72 ft/day (ft/d) was calculated for this interval.

4.2 Intermediate Confining Unit (55 to 246 ft bls)

The intermediate confining unit separates the SAS from the FAS. At the Deseret site, the intermediate confining unit consists of a highly variable mix of greenish black to olive-gray clay, limestone, quartz sand and silt with shell fragments, phosphatic wackestone, and up to 10% phosphatic sand. This unit was not expressly tested during drilling at the Deseret site.

4.3 Floridan Aquifer System

The FAS consists of a series of Tertiary-age limestone and dolostone units. At the Deseret site, the FAS includes permeable sedimentary strata of the Hawthorn Group (Miocene age), Ocala Limestone (Oligocene age), and Avon Park Formation (upper to middle Eocene). The Oldsmar Formation (lower Eocene age) was not penetrated at the Deseret site. Hydrogeologic unit boundaries within the FAS were delineated based on exploratory coring, drilling, geophysical logging, hydraulic testing and water chemical analyses at OSF-110 and OSF-111.

Upper Floridan Aquifer

The UFA generally occurs at the base of the Hawthorn Group, though it may include permeable units within the lower Arcadia Formation. It includes the Suwanee Limestone, where present; the Ocala Limestone; and portions of the Avon Park Formation. The UFA generally consists of several thin, highly permeable water-bearing zones interbedded with thicker zones of lower permeability. The CFWI Hydrologic Assessment Team (2016) used three regionally mappable units to represent the vertical heterogeneity of the UFA: upper permeable zone (UFA-upper), Ocala-Avon Park low-permeability zone (OCAPlpz), and Avon Park high-permeability zone (APhpz).

UFA-upper (246 to 310 ft bls)

The UFA-upper is the uppermost permeable zone of the FAS. It is predominantly limestone characterized by intergranular, vuggy or moldic porosity and well-developed secondary porosity (Davis and Boniol 2011). At the Deseret site, the UFA-upper was identified at 246 ft bls as the first occurrence of consolidated limestone below the clayey sands of the Hawthorn Group. It consists predominantly of poorly to moderately consolidated sandy limestone (packstone-wackestone) within the Arcadia Formation of the Hawthorn Group. A solutioned flow zone often is observed at the contact between the Hawthorn Group and Ocala Limestone. This permeable zone is presumed to exist at the Deseret site but could not be confirmed. This portion of the formation is characterized by large quantities of unconsolidated quartz sand, which posed considerable problem during wire-line coring of OSF-110. To prevent similar problems at OSF-111, the conductor casing was set below this formation contact, preventing hydraulic evaluation.

The UFA-upper is highly productive in the northern portion of the CFWI Planning Area, but productivity tends to decline to the south. Reported transmissivity of the UFA-upper ranges from less than 10,000 to more than 100,000 ft^2/d within the Central Florida (CFWI Hydrologic Assessment Team 2016). Given the high sand content filling secondary permeability within the UFA-upper in OSF-110, the transmissivity at the Deseret site is expected to be in the low end of this range.

OCAPlpz (310 to 480 ft bls)

The OCAPlpz generally is distinguished from the UFA-upper by a reduction in secondary permeability, which provides most of the productive capacity of that unit. At the Deseret site, the OCAPlpz comprises limestone, presented as interbedded wackestone, packstone, and grainstone. It tends to be less well consolidated than the overlying UFA-upper, as indicated by the large wash-out on the caliper log from 314 to 400 ft bls (**Figure 10**). Based on well data north and west of the Deseret site, the OCAPlpz was not expected to be hydraulically confining in this region. Consequently, the site was not designed to discretely monitor above and below it. Site data from this unit were ambiguous.

Packer test 3 (422 to 452 ft bls) was completed in the more consolidated portion of the OCAPlpz, below the base of the Ocala Limestone, because a relatively gauge borehole was required to securely seat the packer. This packer test yielded a hydraulic conductivity of 157 ft/d, similar to what might be expected in the UFA-upper. The majority of the packed interval was low-permeability packstone (core permeabilities less than 1 ft/d), but some large vugs were present between 226 and 236 ft bls that could account for the high permeability. During geophysical logging run 2 (305 to 1,200 ft bls), however, the flowmeter showed no influx from the OCAPlpz during production logging. Given the position of the OCAPlpz immediately below the casing, it is clear that the overall permeability of the OCAPlpz is considerably less than indicated by packer test 3.

APhpz (480 to 535, 628 to 702, 768 to 823 ft bls)/APPZ (480 to 850 ft bls)

Reese and Richardson (2008) described the APPZ as a regionally mappable, high-permeability zone within the Avon Park Formation, characterized by dolostone or interbedded dolostone and dolomitic limestone with a high degree of secondary permeability. The permeability primarily is associated with fracturing, but cavernous or karstic, intergranular, and intercrystalline permeability also can be present. As mapped by Reese and Richardson (2008), the APPZ included all materials from the base of the OCAPlpz to the top of the MCU. The CFWI Hydrologic Assessment Team (2016) used the designation APhpz to distinguish the most productive fractured intervals. In **Figure 9**, the APPZ is equivalent to ECFTX model layer 5, while the APhpz is a subset of that unit.

At the Deseret site, the APPZ is composed of dolostone to calcareous dolostone, with interbedded limestone-packstone in the upper 80 ft. The upper boundary is at 480 ft bls (the first occurrence of fracture flow). Dolomitic sand may infill some of the secondary permeability near this contact. The APPZ is highly productive at the Deseret site, yielding 76% of the flow (~3,200 gpm) to the borehole during dynamic logging. Production is not evenly distributed, however, as three discrete intervals (480 to 535, 628 to 702, and 768 to 823 ft bls), 46% of the thickness, yielded 86% of the flow. Production from the 480 to 535 ft bls interval is primarily fracture flow, while flow from the deeper intervals is associated with dissolution features, solutioned bedding planes, and large vugs.

Whether relatively discrete flow zones should be combined into a single APPZ unit is a subject of some interest within the CFWI Planning Area. For many wells, this can be a difficult decision, and much depends on the data set available to apply towards the assessment. In OSF-111, there is little evidence to support subdividing the APPZ. Drill-stem specific conductance data collected during drilling indicated no significant change in water quality from the top of the APPZ to the base of the MCU. Relatively uniform

water quality across the unit also was supported by the fluid conductance logs. The static conductance log reflected the conductance within the upper LFA, due to the upward head gradient, but the dynamic log showed a continuous influx of fresher water across the thickness of the APPZ. Packer tests 1 (730 to 760 ft bls) and 2 (580 to 610 ft bls) were conducted to isolate the intervals between the major flow zones. These tests yielded hydraulic conductivity estimates of 13 and 7.8 ft/d, respectively. These intervals are lower permeability, but unlike the overlying OCAPlpz, were visibly productive in the dynamic flowmeter log. For these reasons, it is most appropriate to treat the APPZ as a single composite unit at this location.

Regional mapping prior to construction of the Deseret site (CFWI Hydrologic Analysis Team 2016) did not anticipate this thickness of the APPZ. Because regional mapping was used to design the testing program at the Deseret site, only the uppermost APPZ flow zone was open during the APT. The test yielded a transmissivity of approximately 100,000 ft^2/d. Given that the tested interval (305 to 600 ft bls) produced 66% of the flow from the APPZ during production logging, and assuming a 1:1 ratio of flow to transmissivity, an approximate transmissivity of 151,000 ft^2/d is estimated for the full thickness of the APPZ in OSF-111.

Middle Confining Unit

The MCU separates the UFA and LFA. Miller (1986) defined the MCU and subdivided it into eight regional units (I to VIII). The CFWI Hydrologic Assessment Team (2016) recognized two units (MCU_I and MCU_II) as composing the MCU within the ECFTX model domain. MCU_I, which ranges in lithology from dolostone to micritic limestone, is the leakier of the two units. The lithologic composition of MCU_II is more distinct. MCU_II is composed of hard crystalline dolostone to dolomitic limestone, characterized by the occurrence of evaporites as beds or pore infillings, which greatly reduces its permeability. MCU_I, the shallower unit, is absent from the western portion of the ECFTX model area, while MCU_II is absent from the eastern portion. Only MCU_I is present at the Deseret site.

MCU_I (850 to 1,150 ft bls)

At the Deseret site, MCU_I is composed almost entirely of dolostone. The upper half of the unit is moderately indurated, with pinpoint vuggy and moderate intergranular porosity. The lower half of the unit is lithologically similar but better indurated (as seen in the nearly gauge caliper log) and lacking the intergranular porosity. There is a large cavity observable in the caliper log from 986 to 992 ft bls, but flowmeter station measurements collected immediately above and below show it does not produce water. Sonic porosity decreases steadily from 1,000 to 1,089 ft bls and remains at the lowest levels in the well from there to 1,150 ft bls. This interval, from 1,000 to 1,150 ft bls, is the primary confinement between the UFA and LFA at the Deseret site. Hydraulic properties of MCU_I were not explicitly tested. Confinement is inferred from the geophysical logs (minimal secondary permeability features, low porosity, lack of flow to production logs), drill-stem water quality, and the presence of an average 0.35-ft head gradient upward across the unit.

Lower Floridan Aquifer

LFA-upper (1,150 ft bls to Total Depth)

There is no distinctive difference in lithology between MCU_I and LFA-upper in OSF-111. The top of the LFA was identified at 1,150 ft bls, in conjunction with notable changes in permeability, water chemistry, and water level. Drill-stem data from OSF-111 yielded very fresh water (less than 650 µS/cm) to a depth of approximately 1,150 ft bls, but water grew increasingly brackish from there to total drilled depth (greater than 7,000 µS/cm). Water samples collected from LFA-upper (average total dissolved solids were 2,418 milligrams per liter [mg/L]) were much more brackish than the composite UFA, represented by

OSF-110 (total dissolved solids were 412 mg/L), and are ionically and isotopically distinct from UFA waters as well. Geophysical log analysis indicated cross-borehole flow upward from LFA-upper into the APPZ and UFA-upper in logging run 2. This upward head gradient was confirmed by the presence of LFA salinity water within the UFA during packer testing, and post-construction, when a slight upward head gradient was recorded between OSF-111 and OSF-110.

Step-drawdown testing from 1,150 to 1,403 ft bls yielded an estimated transmissivity of 109,700 ft^2/d. Production flowmeter analysis indicated transmissivity is not uniformly distributed over this interval. Two higher-permeability flow zones were identified. The uppermost flow zone (1,150 to 1,230 ft bls) is slightly fresher and contributed 30% of the flow during logging run 4. The flowmeter showed the deeper production interval began at 1,372 ft bls and terminated at the top of the cavern. The presence of the open water-filled cavern from 1,406 to 1,497 ft bls prevented deeper testing within the borehole, as it provides an inexhaustible local supply of water. The base of LFA-upper was below the depth of investigation and could not be determined from the borehole information.

4.4 Discussion

Exploratory drilling and coring at the Deseret site reached a maximum depth of 1,653 ft bls. Work was completed in November 2018 and included:

- Exploratory drilling and wire-line coring, geophysical logging, hydraulic testing, and water quality sampling to identify hydrogeologic unit boundaries and evaluate variations in water quality and rock permeability with depth;
- Drilling and construction of a permanent SAS monitor well (OSS-111);
- Completion of the exploratory borehole as a permanent composite UFA (UFA-upper/APPZ) monitor well (OSF-110); and
- Completion of the exploratory borehole as a permanent LFA (LFA-upper) monitor well (OSF-111).

As a component of the CFWI Data Monitoring and Investigations Team project, it is important to review the results from the Deseret site for their potential impact to the understanding of the hydrogeologic framework as applied in the ECFTX groundwater model. Some findings were as expected, while others were surprising. Differences between interpreted hydrogeologic unit boundaries pre- and post-project are summarized in **Table 2**.

Table 2. Difference between interpreted hydrogeologic unit boundaries at the Deseret site and those anticipated based on regional mapping for ECFTX model development (From: CFWI Hydrologic Assessment Team 2016).

Hydrogeologic Unit	Current Report		Regional Mapping	
	Top (ft bls)	Thickness (ft)	Top (ft bls)	Thickness (ft)
Surficial aquifer system	0	55	0	101
Intermediate confining unit	55	191	101	146
Upper Floridan aquifer-upper	246	64	247	97
Ocala-Avon Park low-permeability zone	310	170	344	129
Avon Park permeable zone	480	370	473	102
Middle confining unit I	850	300	575	576
Lower Floridan aquifer-upper	1,150	>503	1,151	374
Glauconite marker low-permeability unit	No Data	No Data	1,525	308
Lower Floridan aquifer-basal	No Data	No Data	1,833	351

bls = below land surface; CFWI = Central Florida Water Initiative; ECFTX = East Central Florida Transient Expanded; ft = foot.

The shallower hydrogeologic unit boundaries observed at the Deseret site are in close agreement with those anticipated by regional mapping (CFWI Hydrologic Assessment Team 2016). There is less thickness to the intermediate confining unit than anticipated; however, based on the large head drop between the SAS and UFA, its confining properties are not substantially reduced. The first significant deviation from pre-project expectations is the top of MCU_I, 275 ft below its interpolated map position.

The deeper than expected MCU_I resulted from a thicker than expected APPZ. As noted in the previous section, the APPZ at the Deseret site is composed of three relatively discrete high-permeability zones from 480 to 535, 628 to 702, and 768 to 823 ft bls, separated by less-permeable rock. The base of the uppermost high-permeability zone (535 ft bls) coincides well with the expected base of the unit from the regional mapping. To the south and east, multiple fracture or solution zones of this type are commonly found within the upper Avon Park Formation, but the APPZ at the Deseret site is anomalously thick. This anomaly may be related to the presence of the underlying cavern.

Ford and Williams (1989) noted that upward stoping over a deeply buried cavern collapse has been observed to propagate through more than 1,000 meters of cover rocks. In South Florida, Cunningham and Walker (2009) noted multiple cave collapse-related seismic sag structures in Biscayne Bay, which extended through most of the thickness of the FAS. **Figure 11** illustrates the mechanism for the stoping process. Even minor parting along overlying bedding planes could lead to enhanced dissolution and productivity in what otherwise would have been low-permeability rock. Consequently, the base of the APPZ/top of MCU_I boundary identified from OSF-111 may not be a good representation of regional conditions.

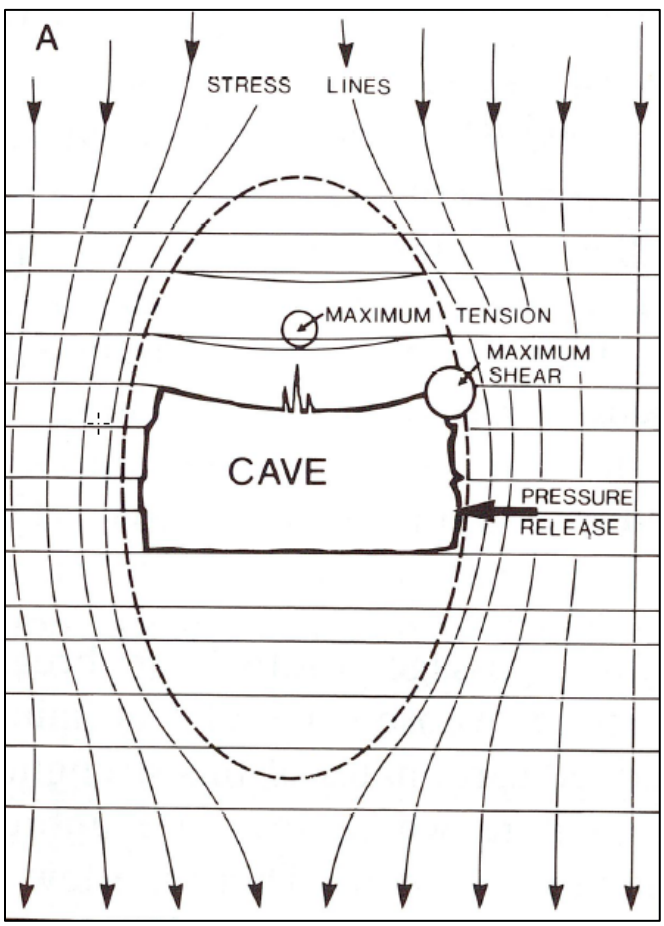


Figure 11. Distribution of stress lines around a cave and tension dome (From: Ford and Williams 1989).

The top of the LFA at the Deseret site is almost exactly where predicted by regional mapping, but the position of the Glauconite marker low-permeability unit, which forms the base of the LFA-upper, is much deeper. The actual base could not be identified, but the expected depth is within the cave breccia, angular gravel to boulder-sized rocks that appear to fill the cavern from approximately 1,497 to more than 1,629 ft bls (base of the OBI log). As with the base of the APPZ, the enhanced thickness of the LFA-upper at this site should not be considered representative of regional conditions.

Some of the planned objectives for this site could not be met. It was the original intent of this project to explore to the base of the FAS; identifying the underground source of drinking water and all major hydrogeologic unit boundaries; conducting a long-term, constant-rate discharge test of the LFA-upper; and completing OSF-111 as a dual-zone well monitoring the upper and basal LFA. The dangerous drilling conditions within the breccia below the open part of the cavern prevented advancement of the borehole below 1,653 ft bls, constraining exploration at this site.

Though not the intended purpose of the site, the presence of the cavern is of considerable scientific interest. Most Florida karst is epigenetic, formed at or near the water table, where recharging waters pick up carbon dioxide in the unsaturated zone, creating carbonic acid that dissolves the underlying carbonate rock. The void at the Deseret site is unusually deep for this type of karst formation. Because of its depth, it is more likely to be hypogenetic karst, formed by chemically aggressive water derived from the subsurface. Upchurch et al. (2019) described two major causes of hypogene cave formation: 1) dissolution along the freshwater/saltwater mixing zone, and 2) upward migration of sulfuric acid from hydrogen sulfide gas. It is not clear which is the most likely cause for the void formation at the Deseret site.

Cunningham and Walker (2009) posited that deep-seated karst collapse zones in southeastern Florida could be the result of dissolution due to upward migration of sulfuric acid-laden water powered by Kohout circulation. The temperature anomaly that drives Kohout circulation in the southeastern portion of the state has not been reported in Central Florida, however, so the driver for upward sulfuric acid migration at the Deseret site is unknown. Alternatively, the depth of the void and position relative to the modern freshwater/saltwater mixing zone makes it a reasonable candidate for mixing zone dissolution at a sea level comparable to today. If it is associated with the freshwater/saltwater interface, then the void should have significant lateral extent (S. Upchurch., personal communication, December 11, 2019). An effort was made in cooperation with the United States Geological Survey to evaluate the lateral extent of the void using three-dimensional seismic survey techniques successfully applied in Broward and Miami-Dade counties (Cunningham and Walker 2009). Unfortunately, the organic soils surrounding the well site interfered with transmission of the seismic signal, producing uninterpretable results. The questions of lateral extent and origin of the void remain unanswered.

The void at the Deseret site is not the first encountered in Osceola County. The St. Johns River Water Management District penetrated a similar void near the top of the LFA (1,347 to 1,434 ft bls) during wire-line coring of well OS0261 (**Figure 12**). Ninety feet of core rod were dislodged from the drilling rig within this cavernous area. The driller reported that downhole video showed the core rod lying flat on the floor of the cavern, providing some indication of its minimum lateral extent.

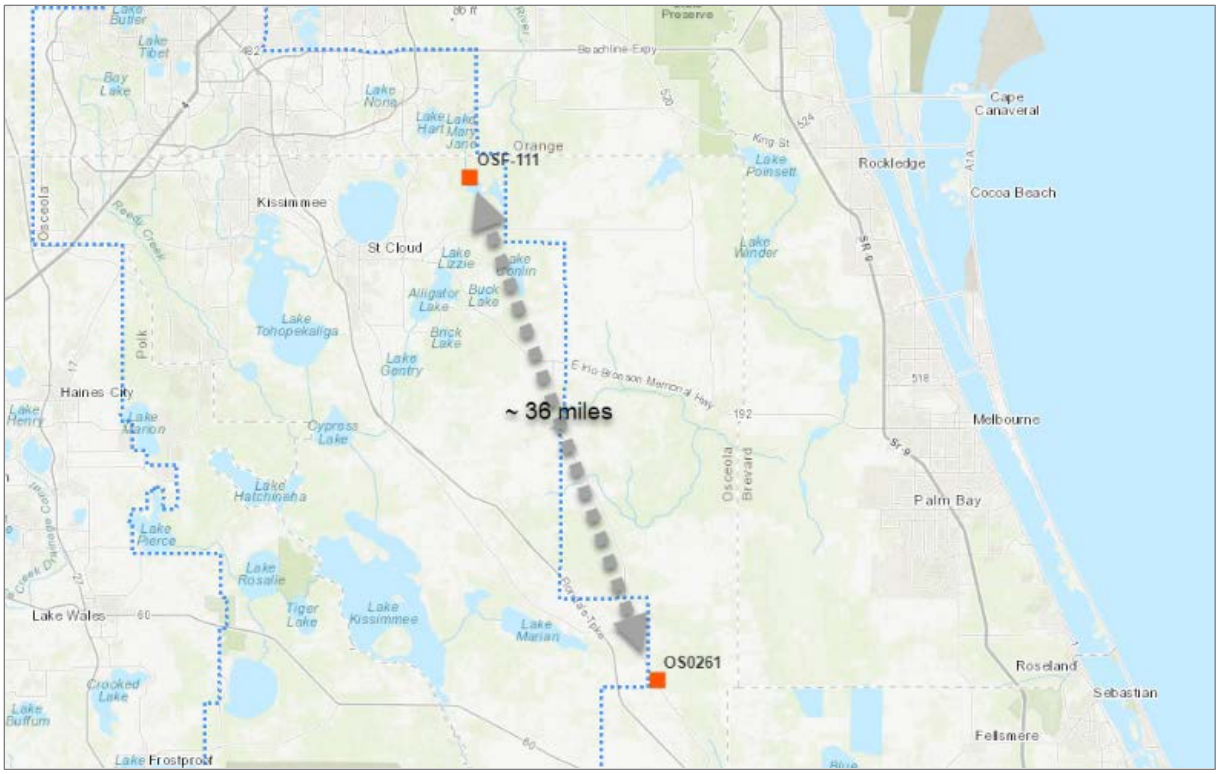


Figure 12. Location of the St. Johns River Water Management District well in which a similar void was encountered within the Lower Floridan aquifer, relative to OSF-111.

5 SITE DATA

5.1 Standard Penetration Testing

An SPT was conducted at 2-ft intervals from land surface to 60 ft bls at OSS-111 to obtain representative sediment samples, determine the penetration resistance, and calculate hydraulic conductivity through mechanical (sieve) analysis.

Methodology

In an SPT, collection of sediment samples (1⅜ inches inner diameter × 2 inches outer diameter) involves dropping a 140-pound enclosed safety hammer 30 inches onto a thick-walled sample tube in order to drive the tube into the ground. Every strike from the hammer is a "blow" and the number of blows it takes to fill the sampler 25% and move the sampler 6 inches deeper is a blow count (N_1, N_2, N_3, and N_4). Once the sample tube is filled with sediment, it is retrieved and labeled. ATSM Standard D1586-99, Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils, was followed to correlate SPT blow counts (N-value = $N_2 + N_3$) to penetration resistance over depth. The N counts in this investigation have not been corrected or compensated for overburden pressures. The greater the N-value, the greater the resistance.

Samples were transported to the SFWMD office in West Palm Beach, where the lithology was described. Mechanical sieve analysis was conducted in the laboratory on the interior 12 inches of sediment from every sample. This representative sample was prepared in a drying oven overnight at 100°C and shaken for 15 minutes to optimally separate particles of different sizes through a series of eight graduated sieves. Each sieve was weighed, and the tare (i.e., weight of the sieve) was subtracted to give the sample weight for that specific grain size. Using the method described in Kasenow (1997), the weight by percent of sediment from each sieve was plotted on a cumulative frequency graph, and a curve was fitted to determine the effective grain size.

Sieve data were processed through MVASKF software (Vukovic and Soro 1992). The software uses 10 empirical formulas, including Hanzen, Slichter, Beyer, Sauerbrei, and Zunker, to calculate hydraulic conductivity. Some samples did not have the right distribution of weight by percent sediment for a curve on the cumulative frequency graph to meet the defining assumptions for all formulas. The MVASKF software flags each formula as pass or fail, depending on this requirement, and averages the resultant hydraulic conductivity values from the passing formulas to produce a mean hydraulic conductivity for the sample.

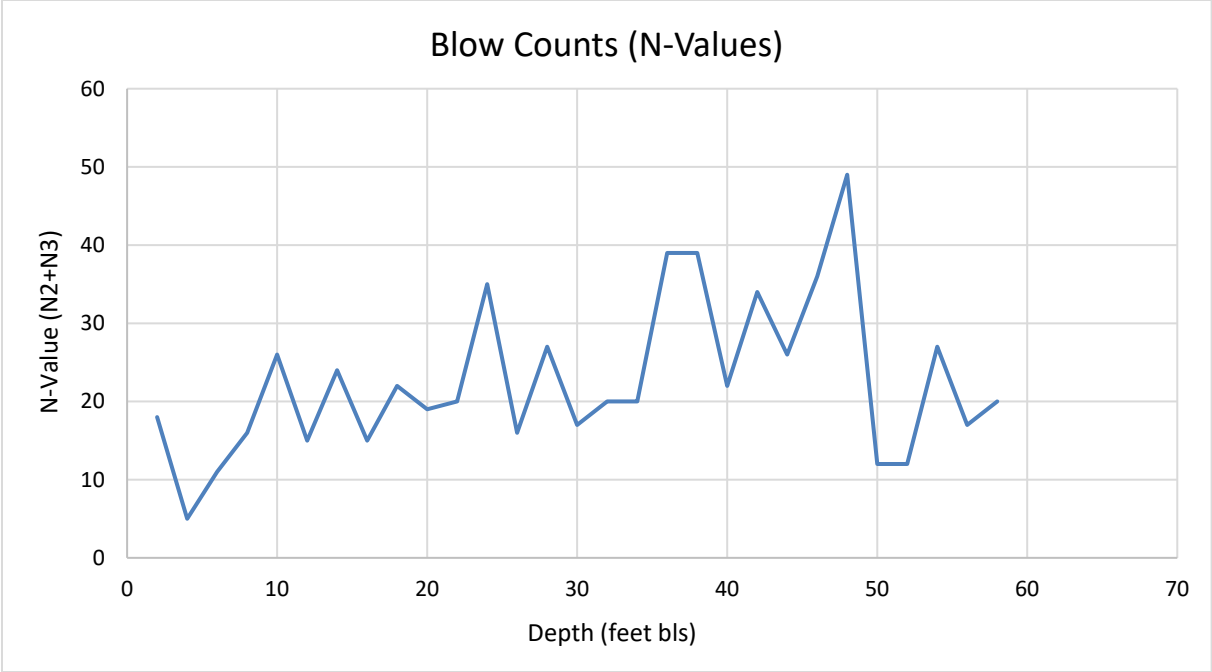
Penetration Resistance and Hydraulic Conductivity Results

Results of the SPT and sieve analysis are summarized in **Table 3** and presented graphically in **Figure 13**. Field data sheets and data from the sieve analysis are presented in **Appendix E**. The N-values appear randomly distributed with depth and do not show a clear relationship to the hydraulic conductivity or Folk classification. Sediment samples from OSS-111 indicate resistance to penetration is fairly uniform from 10 to 50 ft bls, with approximately 20 N-values on average. However, there is a slight increase in resistance below 36 ft bls, peaking at 48 ft bls with an N-value of 49. This could indicate lower clay content with depth. Hydraulic conductivity exhibits a similar distribution with depth, although the increase in conductivity below 36 ft bls is more apparent. Calculated hydraulic conductivity peaks at a depth of 48 ft bls (128.8 ft/d). Between land surface and 42 ft bls, hydraulic conductivity ranges between 44.5 and 75.0 ft/d.

Table 3. Summary results from the standard penetration test and sieve analysis of unconsolidated sediments in the surficial aquifer system.

Depth (ft bls)	N-Value ($N_2 + N_3$)	Mean Hydraulic Conductivity (ft/d)	Folk Classification
2-4	18	60.6	Moderately well sorted
4-6	5	--	
6-8	11	53.0	Extremely poorly sorted
8-10	16	59.2	Moderately well sorted
10-12	26	56.1	Moderately well sorted
12-14	15	44.5	Extremely poorly sorted
14-16	24	52.3	Extremely poorly sorted
16-18	15	59.7	Moderately well sorted
18-20	22	57.0	Moderately well sorted
20-22	19	72.9	Moderately sorted
22-24	20	61.5	Moderately well sorted
24-26	35	62.9	Moderately well sorted
26-28	16	59.5	Moderately well sorted
28-30	27	61.2	Moderately well sorted
30-32	17	64.5	Moderately well sorted
32-34	20	57.7	Extremely poorly sorted
34-36	20	74.0	Moderately well sorted
36-38	39	74.1	
38-40	39	68.9	
40-42	22	75.0	Extremely poorly sorted
42-44	34	103.5	Moderately well sorted
44-46	26	109.0	Moderately well sorted
46-48	36	99.7	Moderately well sorted
48-50	49	128.8	Moderately well sorted
50-52	12	79.5	Moderately sorted
52-54	12	110.0	Moderately well sorted
54-56	27	--	
56-58	17	--	
58-60	20	--	

bls = below land surface; d = day; ft = foot.



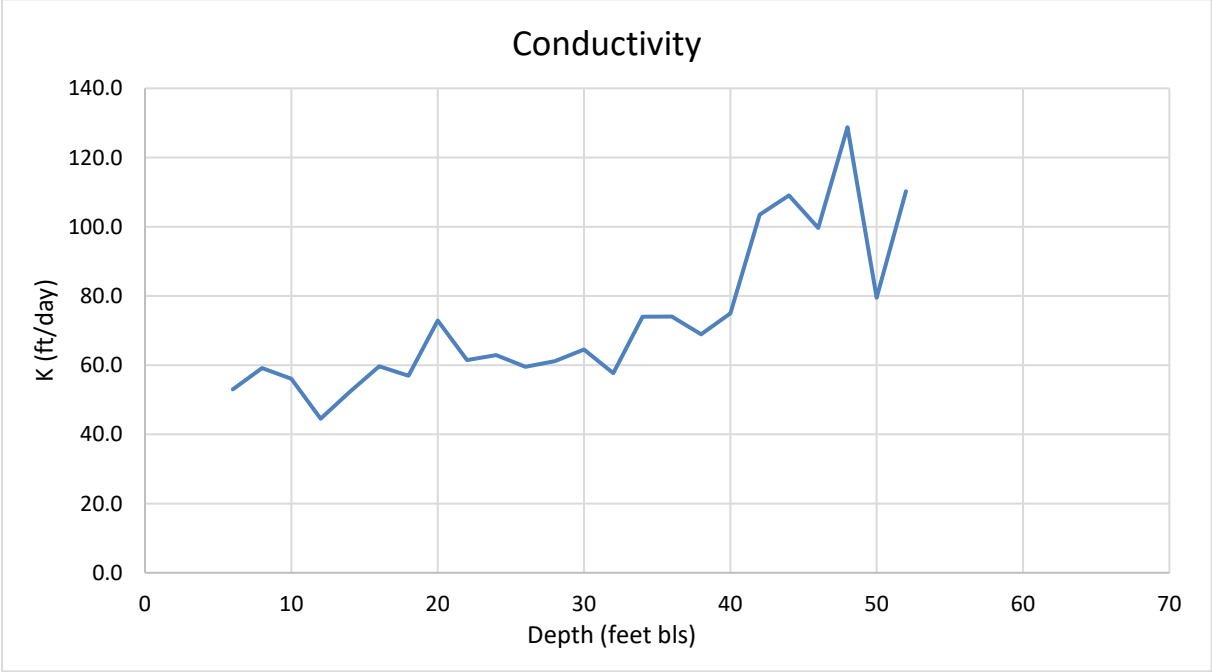


Figure 13. N-value and mean calculated hydraulic conductivity for each 2-foot split-spoon sample.

5.2 Laboratory Core Analysis

Ten core samples from lower-permeability sections of the OSF-110 borehole were shipped to Core Lab in Houston, Texas for conventional plug analysis. Samples were analyzed for horizontal and vertical permeability, porosity, and bulk density. Following these measurements, thin-sections were cut from five of the plugs, all limestone, for additional petrographic analysis. The data are summarized in **Table 4**. **Appendix F** contains the complete laboratory and petrographic reports.

Porosity in all samples was high, ranging from 31% to 47%, while permeabilities universally were less than 1 ft/d. Two samples were too fragile for permeability analysis and are reported as N/A in **Table 4**. Given both samples are grainstones, their permeabilities can be assumed to be similar to the third grainstone sample (0.6 to 0.8 ft/d). The ratio of vertical to horizontal hydraulic conductivity ranged from 0.07 to 2.43, with a median value of 1.00; however, the sample data set is too small to draw significant conclusions on the anisotropy of permeability in this area of the UFA.

Table 4. Summary of laboratory core measurements from OSF-110.

Depth (ft bls)	Grain Density (g/cm^3)	Dunham Classification	Horizontal Plug Orientation			Vertical Plug Orientation		
			Permeability (md)	Hydraulic Conductivity (ft/d)	Porosity (%)	Permeability (md)	Hydraulic Conductivity (ft/d)	Porosity (%)
329.1	2.69	Grainstone	290.00	0.78	33.44	224.00	0.60	35.27
331.8	2.69	Grainstone	N/A	N/A	44.19	N/A	N/A	38.37
343.0	2.70	Grainstone	N/A	N/A	38.68	N/A	N/A	33.35
368.8	2.70	Mudstone	6.14	0.02	41.17	9.40	0.03	41.22
372.6	2.70	Packstone	92.90	0.25	40.57	160.00	0.43	39.61
389.0	2.70	--	79.80	0.22	42.07	17.00	0.05	39.46
433.7	2.70	--	93.20	0.25	36.73	13.80	0.04	37.88
448.7	2.82	--	16.30	0.04	32.82	39.50	0.11	36.45
582.2	2.82	--	36.60	0.10	31.43	43.40	0.12	33.85
589.3	2.80	--	247.00	0.67	47.20	17.90	0.05	43.62

bls = below land surface; d= day; ft = foot; g/cm^3 = grams per cubic centimeter; md = milliDarcy.
N/A = Sample unsuitable for measurement at stress. Porosity determined using Archimedes bulk volume at ambient conditions.

5.3 Geophysical Logging

Geophysical logging was conducted in the pilot hole of each well after each stage of drilling and following reaming of the borehole prior to casing installation. The logs provide a continuous record of physical properties of the subsurface formations and the fluids they contain. The log data were used to assist with casing seat selection and lithologic determination, to identify potential production and confining zones, and to aid correlation among the wells.

Table 5 summarizes the geophysical logging program conducted during construction of the Deseret site. A complete data set of the logs collected at this site is provided in **Appendices C** and **D**. Brief descriptions of key information from the logging program are in the following subsections.

Table 5. Information from the geophysical logging program at the Deseret site. Checkmarks indicate the specific logs collected on each date and whether collected under static (black) or pumped (red) conditions.

Well	OSF-110		OSF-111							
Date	6/19/17	7/19/17	4/9/18	5/30/18	5/31/18	6/4/18	7/5/18	9/18/18	9/20/18	9/24/18
Logging Company	ABS	ABS	MVG	MVG	MVG	USGS	MVG	MVG	USGS	MVG
Borehole Diameter (in.)	6	4	34	12.25	12.25	12.25	22	12.25	12.25	12.25
Logged Interval (ft bls)	0-302	280-603	40-305	300-1,200	300-1,200	300-1,200	300-1,152	1,145-1,500	1,145-1,653	1,145-1,500
Caliper	✓	✓	✓	✓			✓	✓		
Natural Gamma	✓	✓	✓	✓			✓	✓		
Single-point Resistivity	✓	✓								
Normal Resistivity	✓	✓								
Dual Induction/SP				✓				✓		
Sonic Porosity	✓	✓		✓				✓		
Flow Meter		✓		✓	✓			✓		✓
Temperature		✓		✓	✓			✓		✓
Fluid Resistivity		✓		✓	✓			✓		✓
Downhole Video		✓			✓					✓
OBI						✓			✓	

ABS = Advanced Borehole Services; ft bls = feet below land surface; in. = inch; MVG = MV Geophysical; OBI = optical borehole imaging; SP = spontaneous potential; USGS = United States Geological Survey.

0 to 1,200 ft bls

The caliper diameter was less than the nominal bit diameter at multiple locations from 77 to 239 ft bls, indicating the presence of squeezing clay layers within the intermediate confining unit. Two sharp deflections indicate apparent open fractures at 295 and 303 ft bls, but these were solutioned bed boundaries, possibly in-filled with sand prior to drilling. Persistently high gamma ray spikes occur in these clay beds and interbedded phosphate rich silts and sands from 50 ft bls to the top of consolidated limestone at 239 ft bls. This gamma signature is depressed in OSF-111 due to the large borehole diameter but clearly seen in the logs from OSF-110.

From 310 to 400 ft bls (OSF-111) and 315 to 400 ft bls (OSF-110), the caliper curve shows a smoothly enlarged (pot-bellied) borehole, indicative of poorly consolidated formation rock. The gamma ray returns are reduced through this interval, and formation resistivity is low. The porosity log averaged 44% across this interval, but it yielded no flow to the pumped dynamic log.

From 400 to 1,013 ft bls, the caliper indicates more consolidated rock, broken by sporadic fractures and two larger voids: 814 to 821 ft bls and 985 to 992 ft bls. This pattern of more indurated rock punctuated by fractures is echoed in the porosity and formation resistivity logs. From 1,013 to 1,150 ft bls, the borehole is gauge, and there is a steady decrease in porosity and increase in formation resistivity with depth. The gamma ray log indicates a sharp bed boundary around 1,149 ft bls. The caliper log shows more ragged

borehole conditions below this depth, and the OBI log indicates these are due to secondary permeability, large vugs, and bedding plane solution features.

Fluid and spinner flowmeter logs were conducted under static and dynamic conditions when the pilot hole was open from 300 to 1,200 ft bls. To maximize the probability of stressing the entire borehole during logging, the well was pumped at 4,000 gpm. The formation from the base of the casing to 480 ft bls yielded no flow to the production logs. The static fluid logs indicated a notable differential in temperature (4.5°F) and specific conductance (610 μS/cm) from the top to the base of this interval, but a notable influx of cool, fresher water was not seen in the dynamic logs, confirming the spinner flowmeter results.

The interval from 480 to 852 ft bls produced approximately 78% of the flow to the dynamic logs. Three high-permeability zones (480 to 535, 628 to 702, and 788 to 850 ft bls) yielded more than 70% of the production capacity. Freshening and cooling of the produced water was observed in the 628 to 702 and 788 to 850 ft bls intervals. Minor yield (approximately 2%) was produced from 852 to 976 ft bls, and the interval from 976 to 1,150 ft bls yielded no water to the dynamic logs.

The source of the most brackish water (approximately 1,200 μS/cm) was the interval from 1,150 to 1,200 ft bls, the base of the borehole at that time. Static flow logs indicated an upward head gradient from this deepest zone to the shallower reaches of the borehole. When the well was not pumped, this gradient could induce migration of brackish water into shallower producing zones. Therefore, the specific conductance readings from the borehole fluid logs could be biased upward.

1,145 to 1,653 ft bls

This section of the borehole is dominated by the presence of a massive karst collapse cavern from 1,406 to 1,497 ft bls. This cavernous interval is visible in the caliper, which is pegged at its maximum diameter; zero readings from the dual-induction log and natural gamma; and a flat line on the sonic travel time. The downhole video revealed that the base of the cavern was littered with loose rocks (**Figure 14**), and the borehole below was broken and unstable (**Figure 15**). Because of the potential risk to the logging tools, most logs stopped at 1,500 ft bls, where the caliper began to register again. The USGS continued with the OBI tool to a depth of 1,629 ft bls but also stopped due to hazardous borehole conditions. It was clear from the OBI images that a large portion of the borehole below 1,500 ft bls was drilled through a loose boulder field rather than *in situ* formation rock (**Figure 16**). Consequently, further discussion of the logging results is limited to the interval from the base of casing to the top of the cavern.

Fluid and spinner flowmeter logs were conducted under static and dynamic conditions, using a pumping rate of 1,900 gpm. Two major producing zones were identified. The upper zone (1,157 to 1,229 ft bls) yielded approximately 25% of the produced flow, with the majority of the remaining flow coming from the lower zone (1,372 to 1,406 ft bls), where the water-filled cavern offered unlimited supply. Specific conductance within the cavern registered a maximum value of 7,450 μS/cm, while the upper permeable zone is distinctly fresher, registering 1,153 μS/cm on the specific conductance log.

Figure 14. Image from the downhole video log of rock debris littering the base of the cavern floor.

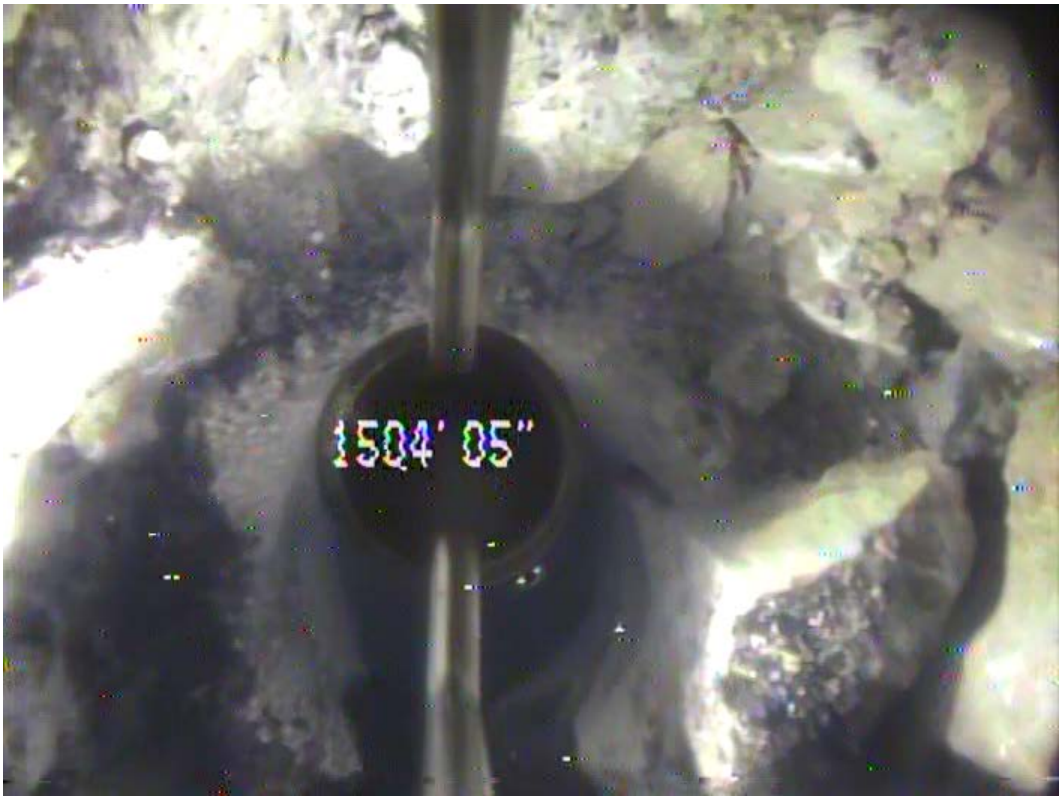


Figure 15. Image from the downhole video log, showing hazardous logging conditions where the borehole resumes at the base of the cavernous interval.

Figure 16. Optical borehole image showing a 360° view of OSF-111 from 1,566 to 1,570 feet below land surface, where loose boulders compose the wall of the borehole.

5.4 Hydraulic Data

Upper Floridan Aquifer Performance Test (300 to 600 ft bls)

On May 3, 2018, a step-drawdown test was performed on OSF-111, which was open to a portion of the UFA from 300 to 600 ft bls (**Figure 17**). Using a 10-inch diameter drop pipe, a submersible turbine pump was set in OSF-111 to a depth of 200 ft bls. A 12-inch discharge line was installed and configured to convey the pumped water through an inline flowmeter and orifice weir to measure the flow rate. Upon exiting the orifice weir, the water was discharged onto stone rip-rap on the bank of the adjacent C-30 Canal.

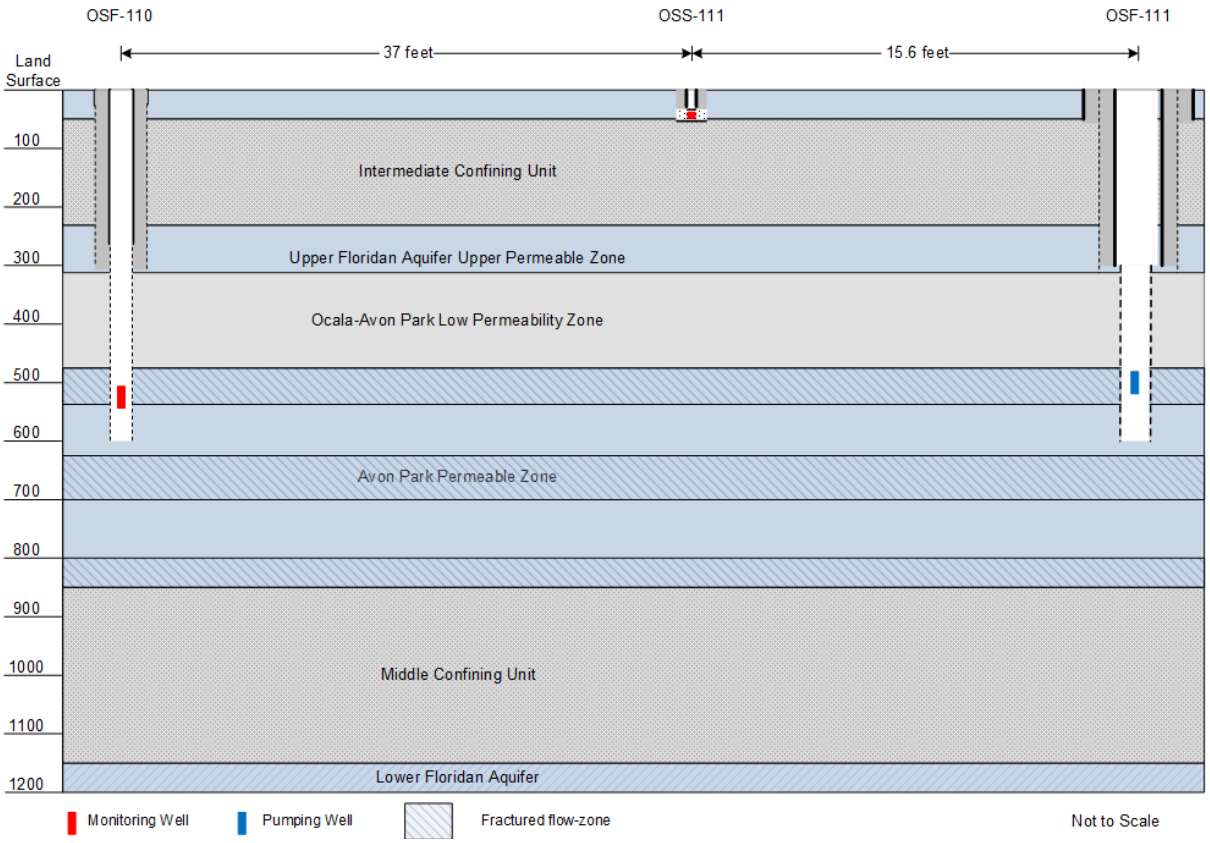


Figure 17. Configuration of wells at the Deseret site for the Upper Floridan aquifer performance test. (Note: Depth measurements are presented in feet below land surface.)

At 8:15, pumping commenced at a rate of 1,939 gpm. The well was pumped for 1 hour, then stepped up to a rate of 2,714 gpm. At the higher pumping rate, the stream of discharging water overshot the protective rip-rap and began to erode the canal bank, forcing a stop to the test. Water levels in the aquifer were allowed to recover to background while remedial measures were undertaken to protect the canal bank. At 11:15, the test was re-started. The well was pumped at four rates, ranging from 2,440 to 3,448 gpm. It was intended to run each step for 1 hour, but pump instability at the highest rate necessitated reducing the flow after 23 minutes. To ensure stability going into recovery, pumping continued at that lower rate for an additional 100 minutes. This preliminary step-drawdown test was run to assess expected well losses and select an appropriate pumping rate for the constant-rate discharge test.

Transmissivity for each step was estimated using the following equation for confined aquifers (Driscoll 1986):

$$T = \frac{Q}{s} * 2{,}000 \qquad \text{Equation 1}$$

Where:

T = transmissivity (gallons/day/ft)

Q = pumping rate (gpm)

s = drawdown (ft)

Results of the calculations are shown in **Table 6**.

Table 6. Transmissivity estimations from calculated specific capacity (Q/s).

Pumping Rate (gpm)	Drawdown (ft)	Specific Capacity (gpm/ft)	Transmissivity (ft^2/d)
1,939	8.35	232	62,032
2,440	11.16	219	58,556
2,857	14.71	194	51,872
3,165	17.00	186	49,733
3,448	19.60	176	47,059

d = day; ft = foot; gpm = gallons per minute.

Linear (laminar) and nonlinear (turbulent) components of flow contribute to the total head loss in a production well. Driscoll's empirical solution for estimating transmissivity from specific capacity and most analytical solutions for APT analysis are based on the assumption that flow during the test is laminar (i.e., drawdown is directly proportional to pumping rate). This assumption breaks down if turbulent conditions occur. In the absence of turbulent conditions, Driscoll (1986) noted that specific capacity should not decrease with increasing pumping rate; therefore, it is clear that some component of the drawdown in OSF-111 must be due to turbulent well losses. The step-drawdown test results were used to evaluate the laminar (BQ) "aquifer loss" and turbulent (CQ^p) "well loss" components of drawdown in OSF-111.

A graphical method developed by Bierschenk (1964) was used to estimate the laminar aquifer loss coefficient (B) and turbulent well loss coefficient (C) (**Figure 18**). This method, which assumes a value of P = 2 (i.e., turbulent flow is a function of the discharge rate squared), yielded B = 0.0024 ft/gpm and $C = 9 \times 10^{-7}$ ft/gpm^2. At the tested pumping rates, this corresponds to turbulent well losses of 42% to 56% of the total drawdown.

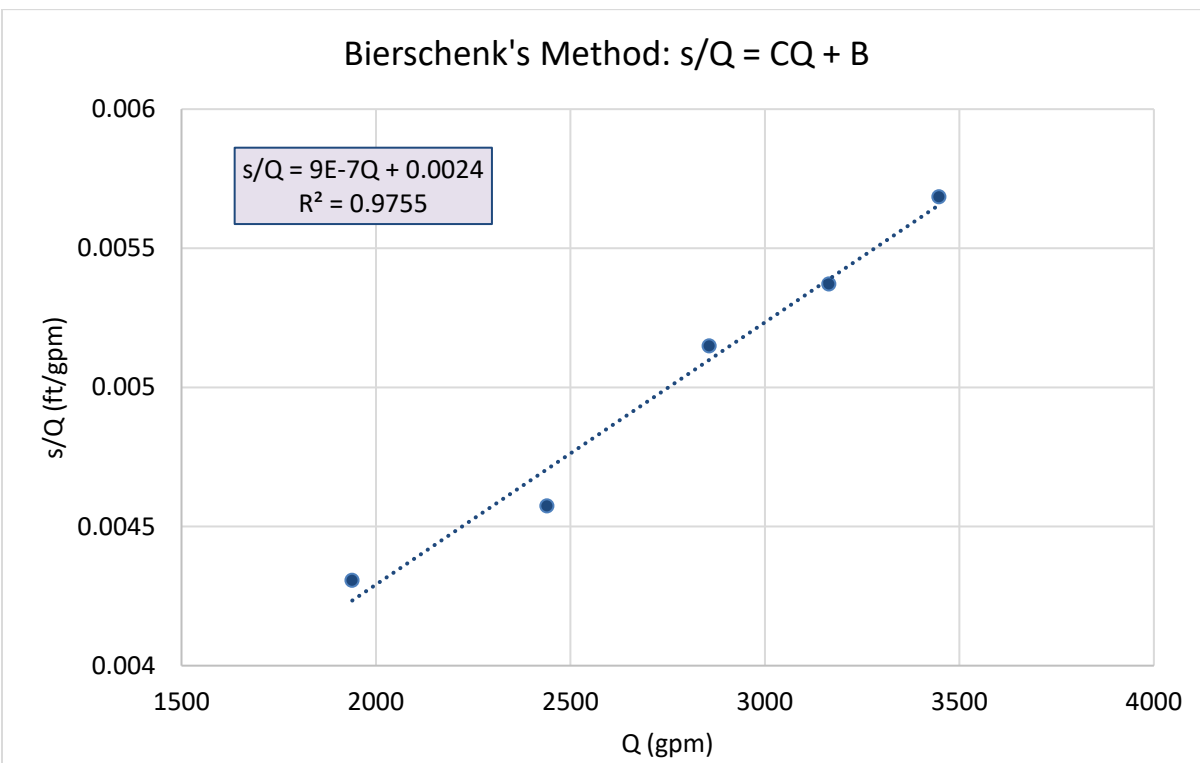


Figure 18. Bierschenk's graphical solution for laminar and turbulent well loss terms.

The time-series data from the step-drawdown test were evaluated analytically using AQTESOLV software (Duffield 2007). Beginning with the initial estimates of C and P = 2 from the Bierschenk analysis, the Dougherty and Babu (1984) analytical solution for a step-drawdown test provided a best-fit estimate of transmissivity (108,900 ft^2/d) and the storage coefficient (2.6×10^{-5}). Values of C, P, and wellbore skin (Sw) were adjusted to optimize the fit of the data to the solution type curves (**Figure 19**). These yielded slightly reduced estimates of drawdown due to nonlinear well losses of 37% to 42% over the tested range of discharge rates.

Following the step-drawdown test, water levels were allowed to recover to background levels. At 17:30 on May 3, 2018, a constant-rate discharge test was initiated at a pumping rate of 3,077 gpm, the maximum rate the pump would sustain at the time. After almost 21 hours of continuous pumping, the discharge rate spontaneously and inexplicably increased to 3,300 gpm. Discharge continued at this elevated rate for an additional 21.25 hours, when severe weather necessitated an end to pumping. The recovery portion of the test began at 11:30 on May 5, 2018 and continued without disruption until 8:00 on May 7, 2019. UFA test data are presented in **Appendix G**.

Recovery data from the constant-rate discharge test were analyzed using the Theis (1935) recovery solution to mitigate the effects of nonlinear well losses observed during the pumping portion of the test. This analysis (**Figure 20**) yielded a transmissivity of 99,000 ft^2/d and a ratio of storativity during pumping to storativity during recovery (S/S') of 5.2. A value of S/S' greater than 1.0 indicates the presence of recharge during the test (Duffield 2007).

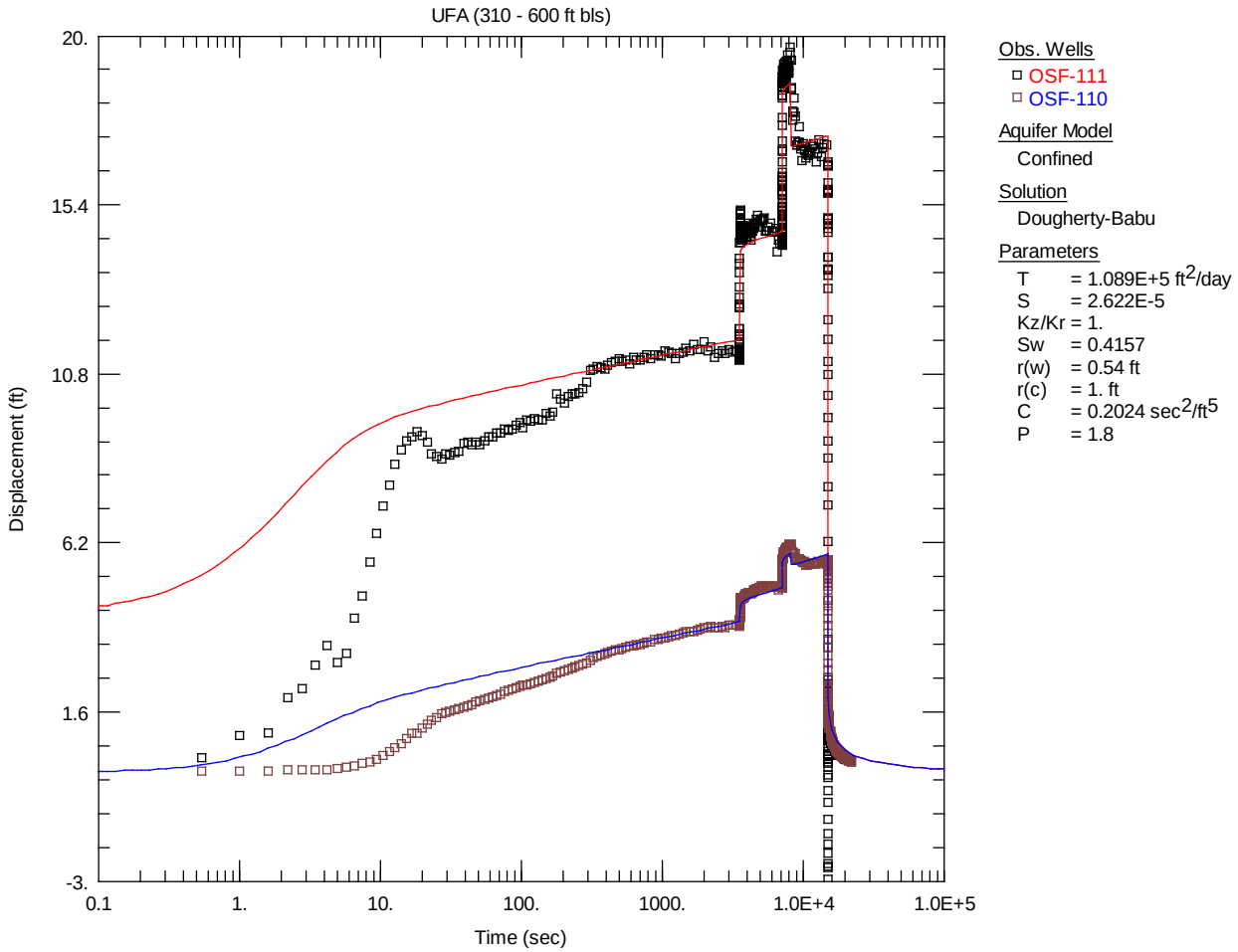


Figure 191. Dougherty and Babu (1984) analysis of the data from the step-drawdown test.

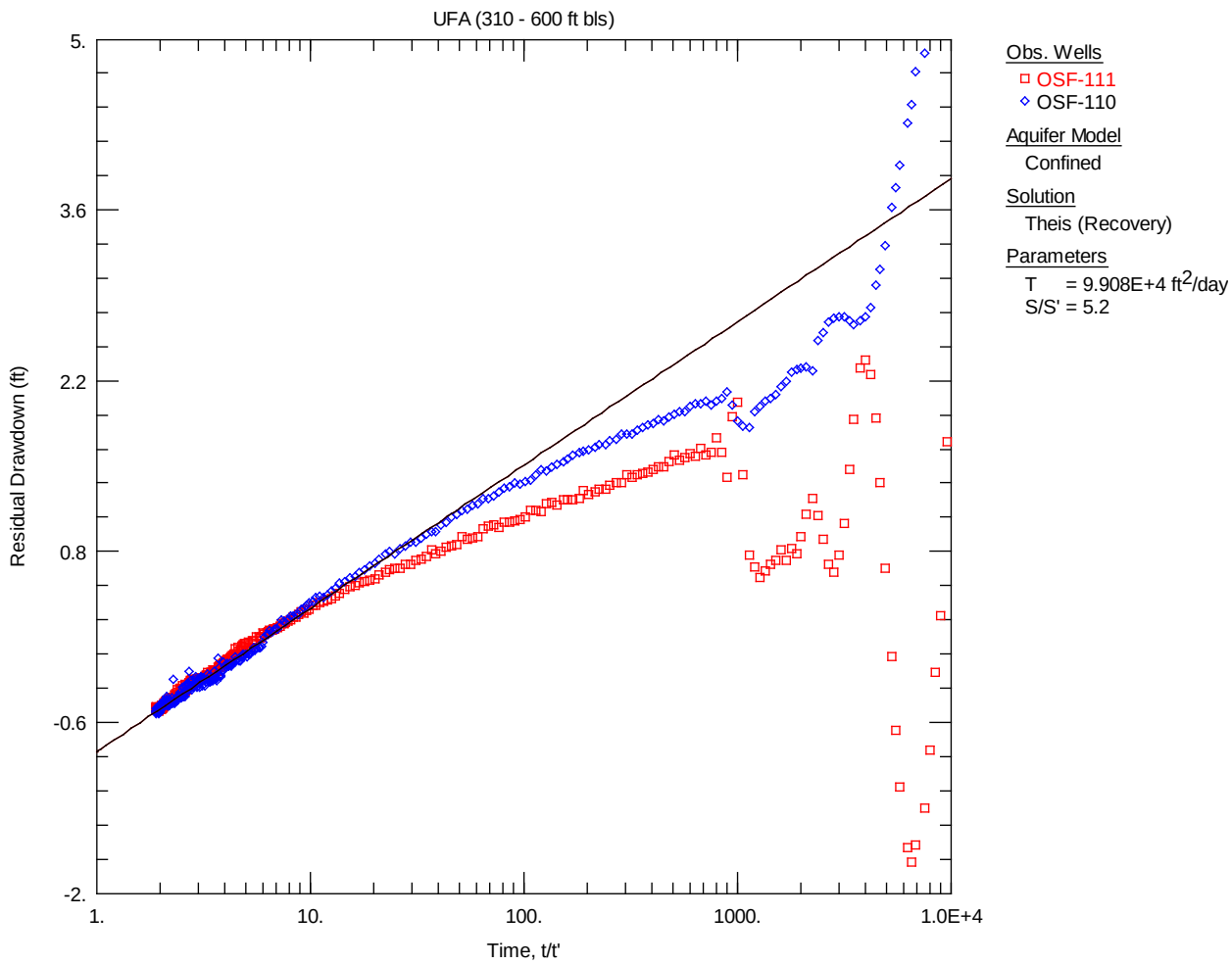


Figure 20. Recovery data analysis from the constant-rate discharge test of the Upper Floridan aquifer.

Lower Floridan Aquifer (LFA-upper) Step-drawdown Test (1,145 to 1,403 ft bls)

Specific conductance from drill-stem sampling jumped from 2,973 to 5,949 µS/cm between 1,377 and 1,403 ft bls. Consequently, pilot-hole drilling was paused, and a short-term test was conducted on this portion of the LFA. A long-term, constant-rate discharge test was planned for this interval once the lower monitor zone was completed. The objective of the short-term test was to provide an estimate of the permeability and water quality of the fresher portion of the LFA prior to exposing it to more saline waters below. On August 8, 2018, a step-drawdown test was performed on OSF-111, which was cased to the top of the LFA and open from 1,145 to 1,403 ft bls. Discharge piping was configured similarly to the UFA APT. A 12-inch discharge line conveyed the pumped water through an inline flowmeter, discharging to the adjacent C-30 Canal.

Figure 21 shows the complete time-series of drawdown and pumping during this test. Difficulties with the power adjustments on the pump and problems with the generator led to less than ideal test conditions. The discharge rates were recorded from the inline flowmeter for the initial two pumping steps, but they are suspected to be unreliable due to probable partial filling of the discharge piping. Due to the uncertainty in these discharge rates, analysis of the test data was constrained to the 1,370 gpm and greater pumping rates. LFA test data are presented in **Appendix H**.

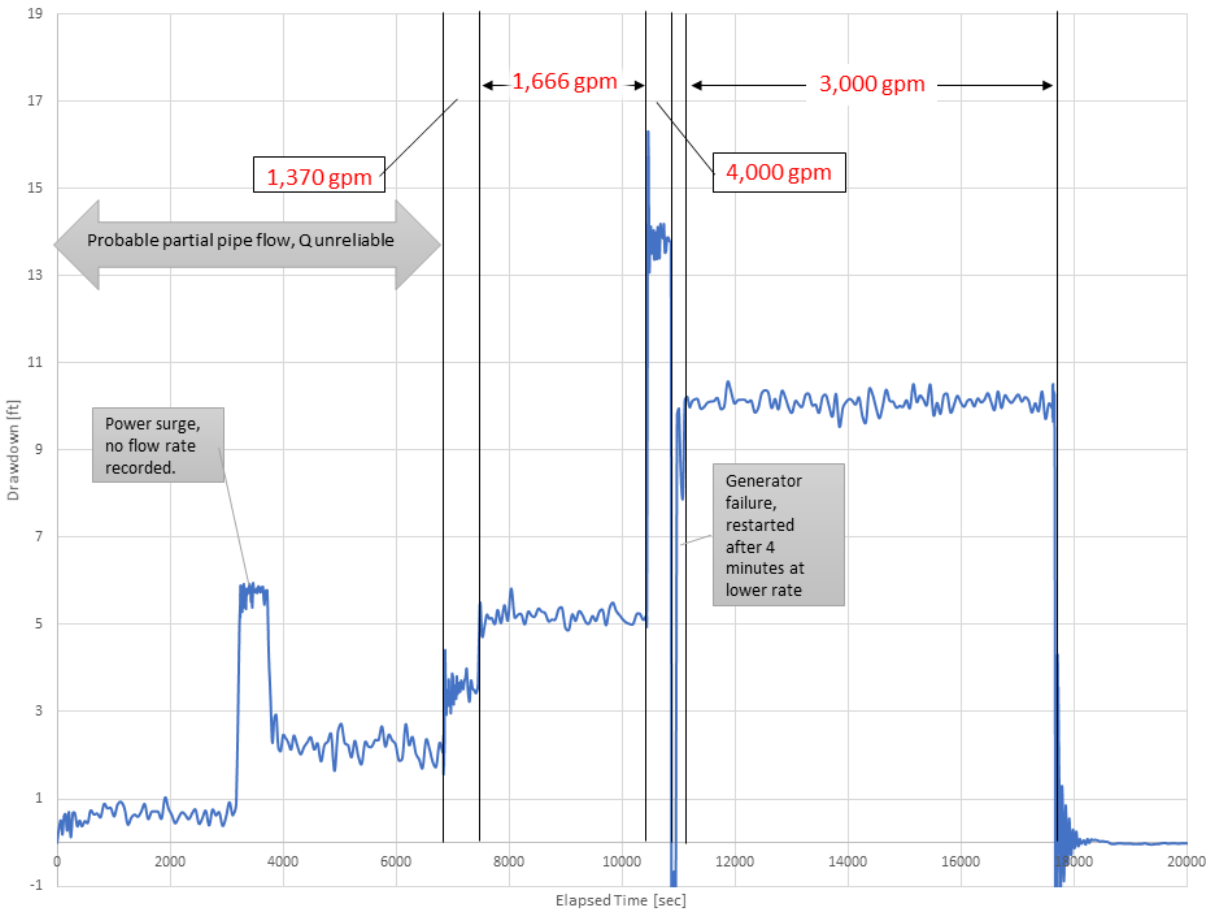


Figure 21. Measured drawdown during the step-drawdown test of the upper permeable zone of the Lower Floridan aquifer.

The UFA APT was conducted with only a 24-inch casing in the well. During this test, the final 14-inch casing was in place from 250 to 1,145 ft bls. This reconfiguration necessitated re-evaluation of the laminar aquifer loss and turbulent well loss components of drawdown in OSF-111. The test was run with stepped rates to facilitate evaluation. The previously described Bierschenk (1964) method was used to parse out the turbulent well loss and yielded a turbulent well loss coefficient (C) = 3×10^{-7} ft/gpm^2 (0.0558 s^2/ft^5).

The time-series data from the step-drawdown test were evaluated analytically using AQTESOLV software (Duffield 2007). Because this was a single-well test, it was not possible to expressly solve for the storage coefficient. In order to constrain the analysis, the turbulent well loss coefficient was held constant at the Bierschenk-derived estimate, and a reasonable storage coefficient for the aquifer was assumed. The closest available LFA-upper APT data to OSF-111 yielded a storage coefficient of 3.0×10^{-4}. The Dougherty and Babu (1984) analytical solution for a step-drawdown test (**Figure 22**) provided a best-fit estimate for transmissivity (109,700 ft^2/d) at the assumed storage coefficient of 3.0×10^{-4}. **Table 7** illustrates the estimated variation in transmissivity when the storage coefficient is varied within an order of magnitude of that value. The physical limitations of the test do not allow for a definitive calculation of transmissivity. The values in **Table 7** are reasonable for the FAS, but the under-damped response to cessation of pumping suggests the higher transmissivity values are more likely.

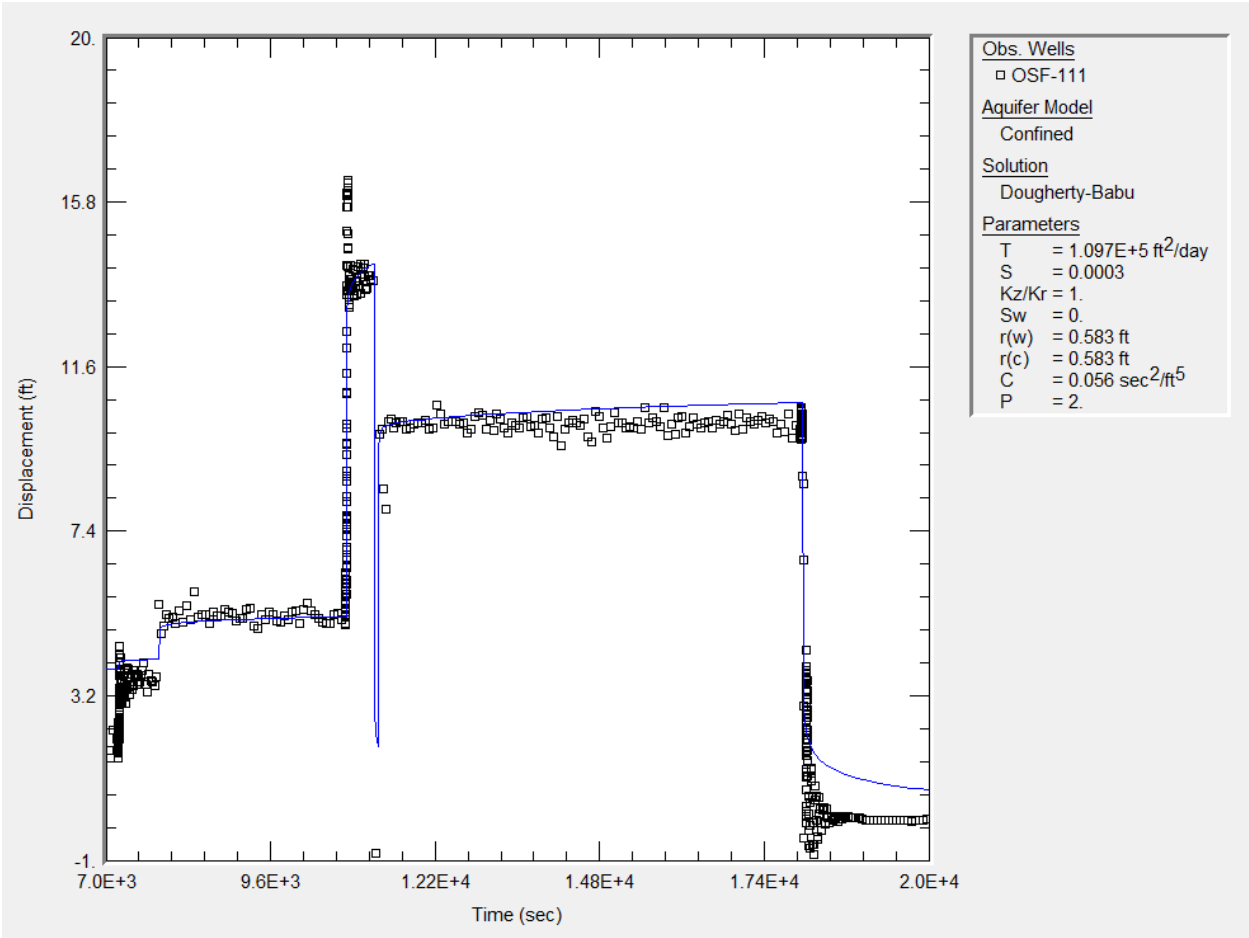


Figure 22. Optimal estimation for transmissivity in the upper permeable zone of the Lower Floridan aquifer when the storage coefficient (S) is 3.0×10^{-4}.

Table 7. Variation in estimated transmissivity with different assumed values for the storage coefficient.

Assumed Storage Coefficient	Estimated Transmissivity (ft^2/d)
3.00×10^{-3}	95,500
3.00×10^{-4}	109,700
3.00×10^{-5}	124,000

ft^2/d = square feet per day.

Packer Testing

Three straddle-packer tests were conducted during exploratory drilling of OSF-111 to determine productive capacities and collect representative formation water samples. Specific goals were to test for confinement between fracture sets within the APPZ and permeability in the UFA above it. Testing depths were selected from intervals producing little water during production flow logging. The caliper log from the pilot hole was reviewed to determine optimal spacing for the packers. Based on this review, a target test interval of 30 ft was selected. The depth configuration for each test is shown in **Table 8**.

Table 8. Straddle-packer testing depths and duration.

Test #	Packer Interval (ft bls)	Test Start	Pumping Duration (hh:mm)	Recovery Duration (hh:mm)
1	730 – 760	6/6/18 07:20	02:35	02:02
2	580 – 610	6/7/18 13:28	02:17	01:58
3	422 – 452	6/8/18 12:29	03:02	04:28

As part of the setup for packer testing, the upper 225 ft of 3⅞-inch diameter drill pipe was replaced with 6-inch diameter pipe to accommodate submersible pump and pressure transducer installation. The drill crew connected two inflatable packers to the drill pipe to effectively isolate the test zone. An Idronaut 310 conductance, temperature, and depth (CTD) probe was installed in the screened interval between the packers to provide *in situ* water level and water quality information. Water quality field parameters (specific conductance, temperature, and pH) also were tracked real-time on the surface to assess when chemical stability was reached. A pressure transducer was placed outside the drill pipe to monitor changes in pressure that might indicate leakage around the packer. Manual measurements in the test interval and annular space were taken before, during, and after the test to confirm transducer readings. Each test consisted of pre-development, drawdown, and recovery phases, during which heads in the packed-off interval were continuously recorded. Check valves were installed in the pumps to prevent recharge of water above the pump when turned off.

During pre-development, a minimum of three volumes of the complete packer assembly were pumped from the borehole to clear the test interval of non-native water and determine an appropriate pumping rate for the test. After this, water levels were allowed to recover to a static level prior to initiation of the drawdown phase of the test.

Hydraulic conductivity calculated from packer test data often is considered qualitative in nature. The necessities of this type of testing (e.g., narrow diameter drill rod, variable casing diameters, often unique discharge piping configurations) lead to multiple sources of head loss resulting from friction or turbulent flow. Surface measurements of drawdown (manual depth to water and transducer readings) must be corrected for these losses to isolate the portion of drawdown due solely to the formation. Such corrections can be difficult, leading to uncertainty in the estimated hydraulic conductivity. To avoid this problem, hydraulic analyses at the Deseret site were conducted only with data from the CTD probe. The CTD probe was situated directly within the open formation, so its readings were not subject to the effects of well losses across the testing assembly. Surface measurements were used solely to evaluate for stability during testing and provide a backup measurement in case of CTD failure.

Values of hydraulic conductivity (coefficient of permeability) were estimated for each test using the method presented by Cedergren (1977) for packer analysis:

$$K = \frac{q}{2\pi Ls} ln \frac{L}{r} \qquad \text{Equation 2}$$

Where consistent units are used and:

K = hydraulic conductivity (length/time [l/t])

q = constant rate of flow into the borehole (l^3/t)

s = drawdown (l)

L = length of the section of hole being tested (l)

r = radius of the section of hole being tested (l)

Hydraulic data from the packer tests are summarized in **Table 9**. The hydraulic properties calculated for tests 1 and 2 are consistent with observations of the lithology and geophysical log data from the well. The results from test 3, however, are unexpectedly high. The formation within this interval yielded no flow during dynamic flow logging, and laboratory determinations of permeability from cores in this depth interval yielded hydraulic conductivity values of less than 1 ft/d. Given the conflicting information, it is assumed that packer test 3 either intersected a very isolated high-permeability zone or there was a leak in the bottom packer that failed to completely isolate it from the underlying APPZ.

Table 9. Results of hydraulic properties analysis from straddle-packer testing.

Test #	Packer Interval (ft bls)	Pumping Rate (gpm)	Maximum Drawdown (ft)	Specific Capacity (gpm/ft)	Hydraulic Conductivity (ft/d)	Specific Conductance* (µS/cm)	Static Water Level (ft NAVD88)
1	730 – 760	202	62.76	3.2	13.0	800	42.14
2	580 – 610	145	75.02	1.9	7.8	640	42.94
3	422 – 452	376	9.62	39.1	157.3	1,160	42.51

µS/cm = microsiemens per centimeter; d = day; ft = foot; gpm = gallons per minute; NAVD88 = North American Vertical Datum of 1988.
* Specific conductance within the formation as measured by the conductivity, temperature, and depth (CTD) probe.

5.5 Water Quality and Inorganic Chemistry

Various sampling methods were used to assess the chemistry of the formation water at the Deseret site. Drill-stem sampling and fluid resistivity logging provided a continuous vertical profile of the water within the borehole. Samples also were collected during straddle-packer and step-drawdown testing in OSF-111 and from the completed interval of each well (OSS-111, OSF-111, and OSF-110) to provide more extensive and accurate assessment of those discrete zones.

Drill-stem Water Quality

Groundwater samples were collected at 30-ft intervals during open-circulation, reverse-air drilling of OSF-111. The site geologist analyzed the samples in the field for pH, temperature, and specific conductance, using a calibrated YSI 600XL multiprobe. Laboratory analyses of samples from 1,185 ft bls to the base of OSF-111 also were performed for total dissolved solids, alkalinity, chloride, and sulfate concentrations (**Table 10**). **Figure 23** shows the specific conductance profile from the drill-stem data in OSF-111. The values are plotted based on the drilled depth at time of sampling, but actually represent a composite sample of the producing zones within the open interval from the base of the last casing to the currently drilled depth. To a depth of 1,150 ft bls, the last casing was at 300 ft bls, and below that 1,145 ft bls.

In OSF-111, the key finding from the drill-stem data was that the productive zones of the FAS yield very fresh water (less than 650 µS/cm) to a depth of approximately 1,150 ft bls, but water quality becomes increasingly brackish from there to total drilled depth.

Table 10. Analytical results from OSF-111 drill-stem samples collected during drilling within the Lower Floridan aquifer.

Lab Sample ID	Drilled Depth (ft bls)	pH	Temperature (°C)	Specific Conductance (µS/cm)	Alkalinity (mg/L $CaCO_3$)	Cl (mg/L)	SO_4 (mg/L)	TDS (mg/L)
P94697-2	1,185	7.4	27.6	1,218	190	146	178	749
P94697-3	1,216	7.5	27.7	1,228	188	150	190	760
P94697-4	1,247	8	28.0	1,381	184	183	219	861
P94697-5	1,280	6.8	27.5	1,718	184	261	276	1,074
P94698-2	1,310	6.8	28.4	1,921	166	313	308	1,214
P94699-2	1,342	7.4	28.3	2,860	147	550	447	1,815
P94700-2	1,370	6.8	28.3	2,973	168	531	423	1,850
P94701-2	1,403	6.3	26.4	5,949	101	1,325	890	3,813
P94702-2	1,435	6.9	28.8	6,310	106	1,457	1,003	3,995
P94702-3	1,467	6.7	29.0	6,983	102	1,723	1,012	4,340
P94702-4	1,497	6.8	28.3	7,023	104	1,725	1,013	4,316
P94704-2	1,528	7.3	28.7	6,976	101	1,725	1,004	4,392
P94705-2	1,561	7.4	29.1	7,067	108	1,665	962	4,499
P94706-2	1,590	7.3	28.5	7,091	105	1,637	946	4,438
P94707-2	1,623	7.8	28.1	7,089	106	1,560	903	4,394

°C = degrees Celsius; µS/cm = microsiemens per centimeter; $CaCO_3$ = calcium carbonate; Cl = chloride; ft bls = feet below land surface; mg/L = milligrams per liter; SO_4 = sulfate; TDS = total dissolved solids.
Note: Cased depth was 1,145 ft bls.

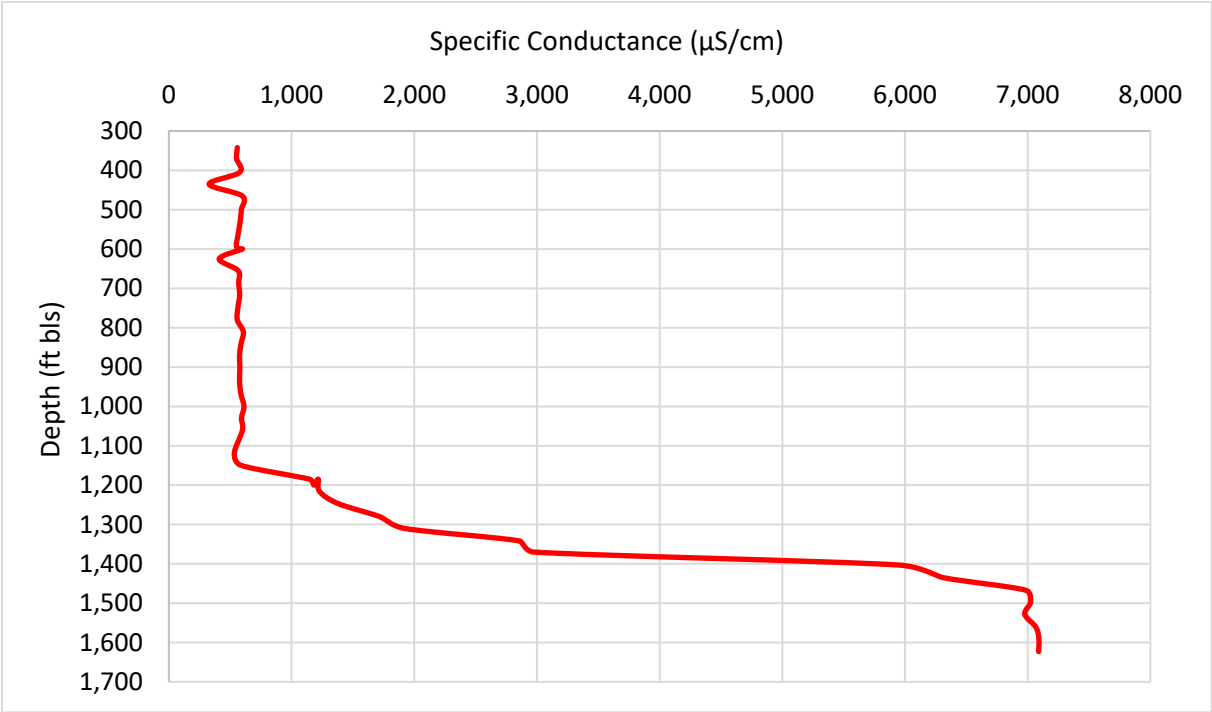


Figure 23. Specific conductance measured from OSF-111 drill-stem samples.

Discrete Sample Collection

Water quality samples were collected at the end of the pumped portion of each packer test. Unfortunately, the specific conductance values from those tests (**Table 10**) identified a problem with the data. During drilling of this section (0 to 1,200 ft bls) of the borehole, specific conductance from drill-stem samples did not exceed 650 µS/cm until the borehole was below 1,150 ft bls. Between 1,150 and 1,200 ft bls, the drill-stem samples exceeded 1,100 µS/cm. All three packer tests were conducted at depths less than 1,150 ft bls, but two tests yielded specific conductance values greater than 650 µS/cm, implying they were not representative of native water from those depths.

The packer tests were conducted when the pilot hole was open from 300 to 1,200 ft bls. An open borehole provides a pathway for migration of formation waters where vertical gradients exist between strata. The static flowmeter log of the borehole indicated upward flow from below 1,150 ft bls. During dynamic (pumped) flow logging, more than 18% of production came from below that depth. Both logs indicate high potential for vertical migration. Although each packer test was preceded by a period of pre-development to eliminate any water from the packed-off interval that might not be native to that part of the formation, it is clear that for tests 1 and 3, the pre-development period was inadequate. For this reason, only analytical results from packer test 2 are included in this report and considered in the interpretation of hydrogeologic units.

One water sample was collected at the end of the LFA-upper step-drawdown test, when the borehole was open from 1,145 to 1,403 ft bls. This sample was collected at the end of the 5-hour test. Because of the high pumping capacity (3,000 gpm), it can be assumed to be a representative composite of all the productive horizons within that depth interval.

When construction was complete at OSF-111 and the driller demobilized from the site, a final sample was collected from the completed interval of each well. At OSF-111, the completed interval was within the LFA-upper, but it stretched from 1,145 to 1,643 ft bls and included a massive water-filled cavern of unknown dimension. It would be impossible to purge even a single borehole volume from the well. To ensure a clean formation sample, 1.5 casing volumes (more than 23,000 gallons) were purged from the well prior to sample collection. The completed well was purged at a much lower rate, however, than during the earlier step-drawdown testing. This is an important consideration when interpreting the results of the sample. Although the open interval intersected multiple producing zones across its length, the rate of pumping (78 gpm) was not sufficient to stress the aquifer below the uppermost producing zone at the base of the casing. For this reason, the effective sample interval is closer to 1,145 to 1,227 ft bls.

Field parameters and quality assurance data from all discrete samples are summarized in **Table 11**, and major ion chemistry is provided in **Table 12**. The discrete samples are organized from shallowest to deepest to more easily distinguish differences between hydrogeologic units.

Table 11. Summary of field parameters and sample quality assessment for the discrete samples.

Well	Sampled Interval (ft bls)	Lab Sample ID	Field Parameters			Sample Ion Balance			Field Notes
			pH	Temp. (°C)	Specific Cond. (µS/cm)	Sum of Anions (meq/L)	Sum of Cations (meq/L)	Balance Error %	
OSS-111	44-60	P95658-2	**5.6**	24.2	202	1.619	1.776	4.60%	Final Completion, Q = 1.7 gpm
OSF-110	285-600	P95658-4	7	23.7	686	6.73	7.15	3.00%	Final Completion, Q = 10 gpm
OSF-111	580-610	P94363-2	7.4	27.1	685	6.48	6.36	-0.90%	Packer Test 2, Q = 145 gpm
OSF-111	1145-1653	P95658-3	7.3	26.7	3530	32.5	33.5	1.48%	Final Completion, Q = 78 gpm
OSF-111	1145-1403	P90745-2	6.9	31	4389	42.68	41.69	-1.17%	Step-test, Q = 3,000 gpm

°C = degrees Celsius; µS/cm = microsiemens per centimeter; ft bls = feet below land surface; gpm = gallons per minute; meq/L = milliequivalents per liter; Q = pumping rate.
Note: Bolded values exceed the secondary drinking water standard.

Table 12. Major ion composition with depth.

Sampled Interval (ft bls)	Anions (mg/L)			Cations (mg/L)						Total Dissolved Solids (mg/L)
	HCO_3	SO_4	Cl	Ca	K	Mg	Na	Fe	Sr	
44-60	73	0	15	19.4	1.2	2.6	12.9	**1.6**	0.1	160
285-600	368	7	19	114	1.6	5.9	20.8	**7.9**	0.5	412
580-610	250	28	64	83	1.8	8.5	33.5	0.04	0.9	438
1,145-1,653 (1,145-1,227)[a]	185	**495**	**679**	203	13.8	75	383	**1.3**	7.6[b]	**2,148**
1,145-1,403	169	**667**	**922**	239	17.6	94	492	0.1	7.8[b]	**2,689**

Ca = calcium; Cl = chloride; Fe = iron; ft bls = feet below land surface; HCO_3 = bicarbonate; K = potassium; Mg = magnesium; mg/L = milligrams per liter; Na = sodium; SO_4 = sulfate; Sr = strontium.
Note: Bolded values exceed the secondary drinking water standard.
[a] Effective sample depth (see explanation in earlier text).
[b] Strontium currently is not regulated, but the value exceeds the United States Environmental Protection Agency's proposed health reference level for strontium of 1.5 mg/L.

The focus of this sampling was to aid hydrogeologic interpretation rather than evaluation for economic use; however, secondary drinking water standards exist for several of the naturally occurring ions tested. Concentrations exceeding those standards are noted in **Tables 11** and **12**.

A wide range of ions and elements can become dissolved in groundwater as a result of interaction with the atmosphere, soil, and rock over time and distance. Waters with very similar chemical composition are assumed to have similar histories, so diagnostic ion chemistry (i.e., hydrochemical facies) of a sample can identify its age, flow path, and water-rock interactions. At a single location, differences in hydrochemical facies between samples at different depths are an indication of vertical hydraulic separation. Numerous hydrochemical facies classification schemes have been developed. The Deseret samples were evaluated using the geochemical pattern analysis method developed for the FAS by Frazee (1982) to relate the chemical signature to recharge source, residence time, and saltwater intrusion. The Frazee water types are defined in **Table 13**. **Figure 24** shows how the discrete samples conform to the water types on Frazee's pattern overlay. Summary results are provided in **Table 14**.

Table 13. Description of Frazee (1982) water types.

Abbreviation	Description	Characteristics
FW-I	Fresh Recharge Water Type I	Rapid infiltration through sands, high calcium bicarbonate ($CaHCO_3$).
FW-II	Fresh Recharge Water Type II	Infiltration through sands and clay lenses, $CaHCO_3$ with sodium (Na), sulfate (SO_4), and chloride (Cl). Marginal type II waters are beginning to transition toward FW-IV.
FW-III	Fresh Recharge Water Type III	Infiltration through clay-silt estuarine depositional environment, high sodium bicarbonate ($NaHCO_3$).
FW-IV	Fresh Formation Water Type IV	Fresh water, low calcium (Ca), magnesium (Mg), SO_4, and Cl. Vertical infiltration insignificant. Older form of FW-II or FW-III.
TW-I	Transitional Water Type I	Seawater begins to dominate source water; Cl begins to dominate bicarbonate (HCO_3) with increasing sodium chloride (NaCl) percentage.
TW-II	Transitional Water Type II	Transitional water with source water still dominant, $HCO_3 - SO_4$ mixing zone with increasing Cl.
TCW	Transitional Connate Water	Connate water dominates source water, SO_4 begins to dominate HCO_3 with increasing Cl.
TRSW	Transitional Seawater	Transitional water with seawater dominating source water.
CW	Connate Water	Highly mineralized fresh water with high total dissolved solids and calcium sulfate ($CaSO_4$) dominance. Presence of highly soluble minerals; hydrogen sulfide (H_2S) gas prevalent.
RSW	Relict Seawater	Unflushed seawater with NaCl.

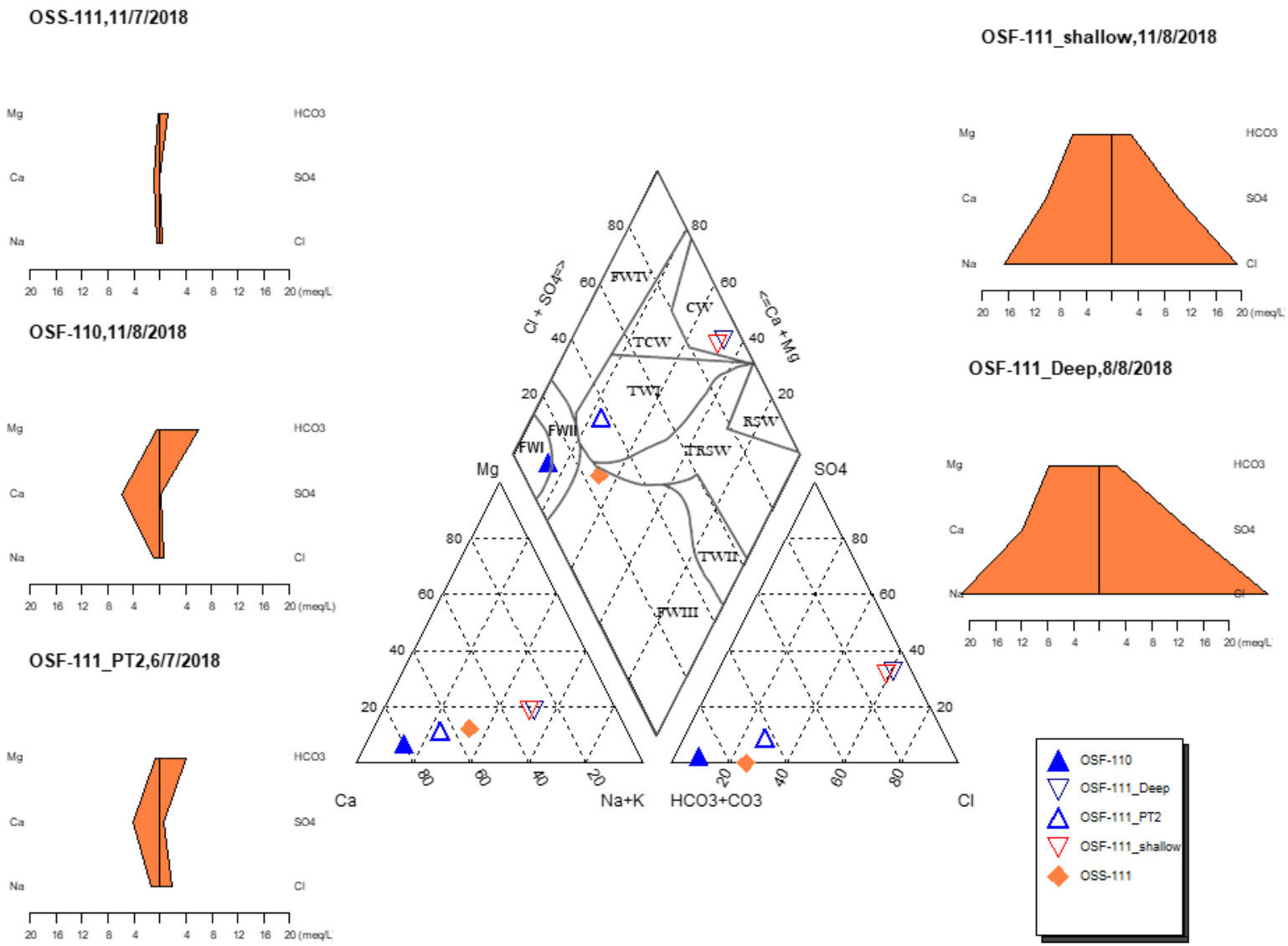


Figure 24. Distribution of major cations and anions at OSF-111, shown as stiff diagrams (left and right sides) and a Piper tri-linear plot (center) with Frazee (1982) water types.

Table 14. Summary of hydrochemical facies results.

Well	Sampled Interval (ft bls)	Hydrogeologic Unit	Hydrochemical Facies	Salinity Classification	Frazee (1982) Water Type
OSS-111	44 – 60	SAS	Ca-Na-HCO_3-Cl	Fresh	FW-III
OSF-110	285 – 600	UFA (composite)	Ca-HCO_3	Fresh	FW-I
OSF-111 (PT2)	580 – 610	UFA (lower permeability)	Ca-Na-HCO_3-Cl	Fresh	TW-I
OSF-111	1,145 – 1,653	LFA-upper (shallow)	Na-Ca-Cl-SO_4	Brackish	CW
OSF-111	1,145 – 1,403	LFA-upper (composite)	Na-Ca-Cl-SO_4	Brackish	CW

Ca = calcium; Cl = chloride; CW = connate water; ft bls = feet below land surface; FW = fresh recharge water; HCO_3 = bicarbonate; LFA = Lower Floridan aquifer; Na = sodium; PT2 = packer test #2; SAS = surficial aquifer system; SO_4 = sulfate; TW = transitional water; UFA = Upper Floridan aquifer.

As predicted by the drill-stem data, the three samples collected above 1,150 ft bls are fresh water based on the total concentration of dissolved solids. However, there are differences in the major ion species that distinguish them.

The final sample from OSF-110 was pure calcium bicarbonate water. The sample plots on a Piper diagram as Frazee (1982) water type FW-I, fresh recharge water subjected to rapid infiltration through sand. Upchurch et al. (2019) indicated this water type is the most widespread in the UFA, derived from dissolution of calcite or aragonite in limestone, shell beds, and shelly siliciclastic sediments. The most productive unit within the sampled interval is a highly fractured dolostone from 480 to 535 ft bls, so magnesium was expected to constitute a larger portion of the sample. Given the results, the collected sample likely was drawn entirely from the upper, pure limestone, portion of the open hole (285 to 445 ft bls).

The SAS and UFA samples from packer test 2 (conducted in a lower-permeability portion of the aquifer) have the same hydrochemical facies (relative proportion of different ions) but different Frazee (1982) water types because Frazee incorporated the overall magnitude of salinity into the classification. The SAS sample (OSS-111) plots as Frazee water type FW-III, fresh water subjected to infiltration through a clay-silt estuarine depositional environment, with a high sodium bicarbonate component. Upchurch et al. (2019) noted that dilute sodium chloride composition is common in the SAS due to marine aerosols.

The deeper UFA sample from packer test 2 was designated as transitional water in the Frazee (1982) classification, indicating an increasing percentage of sodium chloride. As this sample was from a relatively low-permeability portion of the UFA, the sodium chloride could be from relict seawater inadequately flushed from a previous transgression. Alternatively, it could be the result of mixing between shallow UFA composition and LFA waters. The position of the packer sample on a straight line between the OSF-110 and OSF-111 LFA samples on the Piper plot (**Figure 24**) supports the theory that the sample is a mix of the two waters. It is not possible, however, to determine whether the mixing was due to natural upconing from the LFA or as a result of cross-borehole flow during well construction.

The two LFA samples are very similar in composition. Both samples are brackish water (total dissolved solids between 1,000 and 10,000 mg/L). Frazee (1982) classification of these samples is connate water, highly mineralized fresh water with high total dissolved solids and calcium sulfate dominance. Upchurch et al. (2019) indicated calcium sulfate characteristically is derived from interaction with evaporite minerals at the base of the UFA and/or LFA, while the sodium chloride component most likely is derived from seawater mixing.

In addition to major ions, the discrete samples were analyzed for stable isotopes of hydrogen (^{2}H) and oxygen (^{18}O) by the Environmental Isotope Laboratory at the University of Arizona. Like the hydrochemical facies analysis, these analytes provide a glimpse into the water's history and help distinguish the degree of isolation between waters of different hydrogeologic units. Measured values for ^{2}H and ^{18}O isotopes at the Deseret site are plotted in **Figure 25**. The values represent the deviation in the isotope ratio of the sample from the reference standard, in this case, Vienna standard mean ocean water (VSMOW). Negative values indicate the sample is depleted in ^{2}H or ^{18}O relative to VSMOW, and positive values the sample is enriched relative to VSMOW. All the Deseret samples are slightly depleted relative to VSMOW. A line fitted to the Deseret data yields a slope of 4.679, while the global meteoric water line, the relationship between worldwide ^{2}H and ^{18}O values for precipitation, is characterized by a slope of 8. IAEA-UNESCO (2001) noted that slopes of 4 to 5 are characteristic of evaporating surface waters, so this deviation from the global meteoric water line most likely represents the effects of evaporation prior to groundwater recharge.

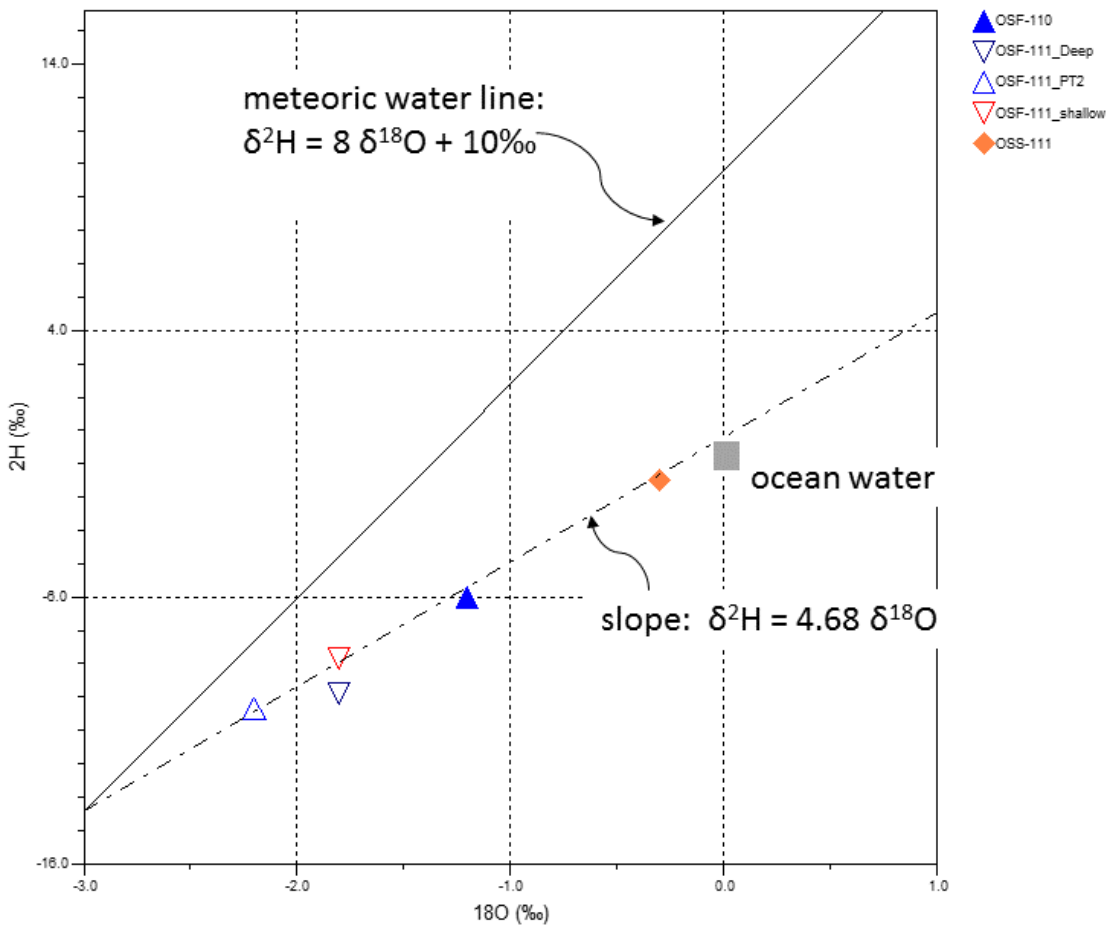


Figure 252. Relationship between measured ^{2}H and ^{18}O isotopes at the Deseret site in reference to the global meteoric water line.

5.6 Water Level Monitoring

Shortly after construction of the three monitor wells, the wells were surveyed and equipped with downhole pressure transducers, and a radio telemetry unit was installed for incorporation into the SFWMD real-time regional water level monitoring network. Site telemetry went live on July 25, 2019, collecting readings at 15-minute intervals.

Figure 26 illustrates the break-point (15-minute interval) data for the first 4 months of the period of record. The highest heads are in the SAS, represented by OSS-111, with a mean water level elevation of 62.1 ft NGVD29. There is a head drop of more than 19 ft across the intermediate confining unit into the UFA, represented by OSF-110, with a mean water level elevation of 42.8 ft NGVD29. The LFA monitor well (OSF-111) has a mean water level elevation of 43.2 ft NGVD29, indicating a small upward gradient across the MCU (0.34 ft on average for the observed period).

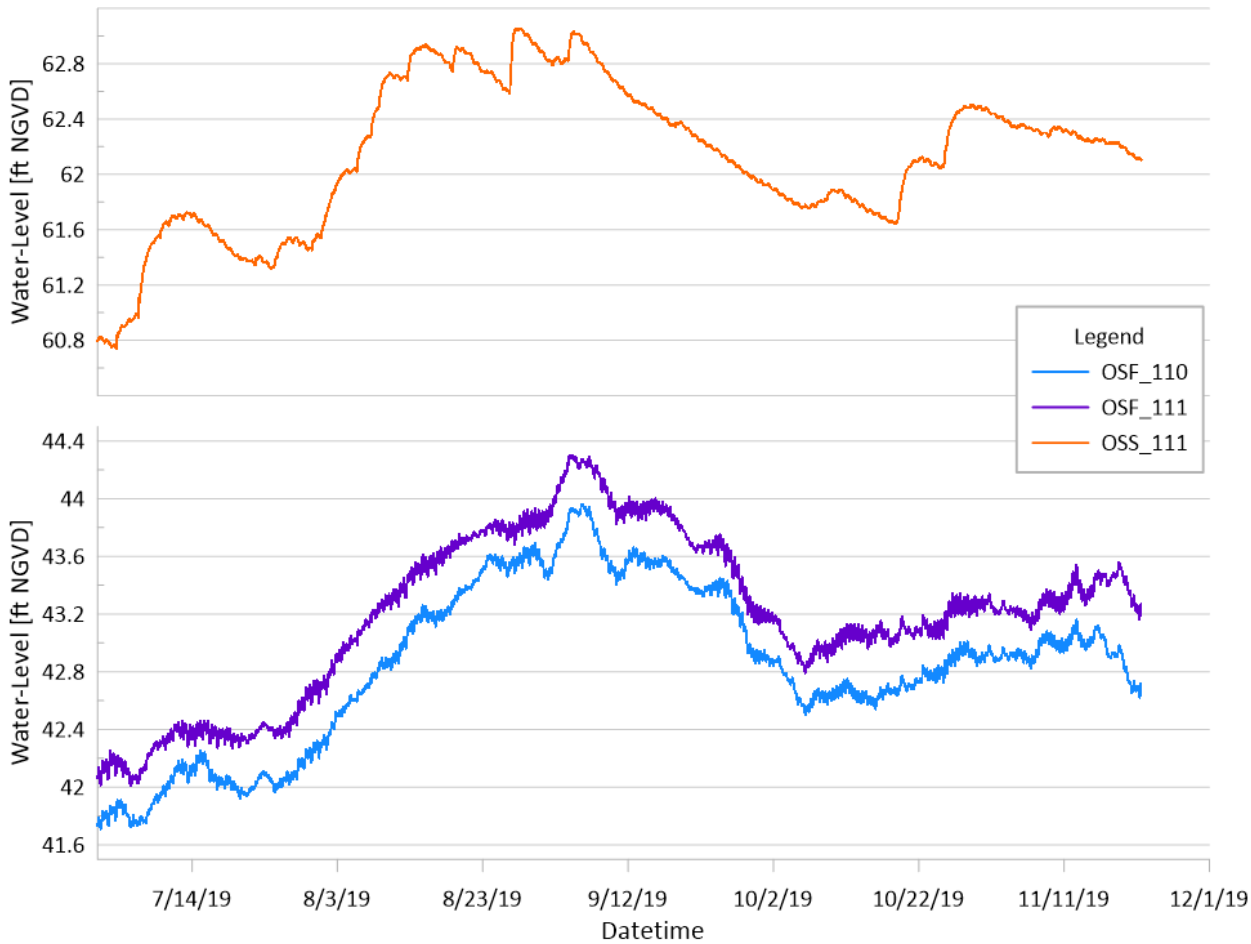


Figure 26. Break-point groundwater level readings from the Deseret site (July 1 to November 21, 2019). Note: The high-frequency oscillations in the data are responses to fluctuations in barometric pressure.

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APPENDICES

APPENDIX A:
SUMMARY OF DAILY DRILLING LOGS

Table A-1. Summary of daily drilling logs at the Deseret site.

Date From	Date To	Activity	Site Geologist
3/15/2018		Mobilization	--
3/26/2018	4/6/2018	Drill 36-inch mud hole to 305 ft.	--
4/9/2018	4/11/2018	Log mudded borehole, set 24-inch steel casing to 300 ft bls, and grout to land surface with neat cement grout.	--
4/12/2018	4/23/2018	Drill out cement plug with 22-inch center-punch bit to 310 ft bls. Reconfigure for reverse-air drilling.	--
4/24/2018	4/27/2018	Begin reverse-air drilling. Advance pilot hole from 310 to 515 ft bls	J. Janzen
4/30/2018	5/1/2018	Advance pilot hole to 600 ft bls, then trip out of the borehole in preparation for Upper Floridan APT.	E. Richardson
5/2/2018	5/5/2018	Conduct preliminary step-drawdown test, followed by constant-rate APT of the Upper Floridan aquifer.	E. Richardson/ S. Krupa
5/8/2018	5/11/2018	Advance pilot hole from 600 to 805 ft bls. Work stopped early on 5/11/18 due to generator failure.	K. Smith
5/14/2018	5/18/2018	Advance pilot hole from 805 to 995 ft bls. One day lost to dredging due to unstable borehole between 805 and 830 ft bls, but able to proceed from there without further issue.	L. Lindstrom
5/21/2018	5/25/2018	Advance pilot hole from 995 to 1,200 ft bls. Between 1,150 and 1,180 ft bls, noted a jump in specific conductance, indicating probable top of Lower Floridan aquifer. Stop drilling at 1,200 ft bls and begin to condition the borehole for geophysical logging.	B. Collins
5/28/2018		Memorial Day Holiday – No Work	
5/29/2018	5/31/2018	Condition borehole for geophysical logging. MV Geophysical mobilized to site and conducted static and dynamic geophysical logs and downhole video.	E. Richardson
6/1/2018		Florida Design Drilling trip out of the borehole with pumping equipment and allow the borehole to sit undisturbed over the weekend in anticipation of OBI logging.	--
6/4/2018		USGS – Mike Wacker mobilized to site to conduct optical borehole image survey of the pilot hole from 300 to 1,200 ft bls.	K. Smith
6/5/2018	6/8/2018	Straddle-packer testing: 1 – (730 to 760 ft bls), 2 – (580 to 610 ft bls), 3 – (422 to 452 ft bls).	K. Smith
6/11/2018		Florida Design Drilling trip out of the borehole with pumping equipment and straddle-packers. CTD probe safely retrieved.	S. Krupa
6/12/2018	7/3/2018	Ream pilot hole to 22-inch diameter from 300 to 1,145 ft bls in preparation for casing installation. Florida Design Drilling operating two 12-hour shifts.	--
7/4/2018		Independence Day Holiday – No Work	
7/5/2018		MV Geophysical logs reamed borehole.	--
7/8/2018	7/9/2018	Install 14-inch steel casing to 1,145 ft bls.	E. Richardson
7/10/2018	7/13/2018	Grout 14-inch steel casing in place from 1,145 to 674 ft bls.	J. Janzen
7/16/2018	7/19/2018	Grout 14-inch steel casing in place from 674 to 269 ft bls. Successful pressure test of 14-inch casing.	B. Collins/K. Esterson
7/23/2018	7/28/2018	Drill through cement plug with 12-inch nominal bit. Pilot hole drilling and drill-stem testing from 1,200 to 1,342 ft bls.	K. Smith
7/30/2018	7/31/2018	Pilot hole drilling and drill-stem testing from 1,342 to 1,403 ft bls. Specific conductance doubled at 1,403 ft bls drill-stem test, so elected to stop and run first interval test at this depth.	E. Richardson

Date From	Date To	Activity	Site Geologist
8/1/2018	8/3/2018	Cut off 14-inch steel casing at 250 ft bls to make room for large diameter pump. Begin pump installation for step-drawdown/recovery test from 1,150 to 1,403 ft bls. Awaiting pump component delivery.	E. Richardson
8/6/2018	8/8/2018	Complete pump installation and conduct step-drawdown/ recovery test from 1,150 to 1,403 ft bls. Lost 2 days due to issues with pump components and generator failure.	L. Lindstrom
8/9/2018	8/10/2018	Pilot hole drilling and drill-stem testing from 1,403 to 1,497 ft bls. At 1,406 ft bls, drilled into a void. The drill bit did not encounter rock again until 1,497 ft bls. Considerable caving encountered at the base of the void, lost 4 ft of footage overnight.	L. Lindstrom
8/13/2018	8/14/2018	Dredging at or near base of void.	B. Collins
8/15/2018	8/17/2018	Re-commenced 24-hour drilling operations to facilitate dredging. Advance pilot hole to 1,552 ft bls.	B. Collins
8/20/2018	8/25/2018	Advance pilot hole from 1,552 to 1,614 ft bls. Very slow drilling due to frequent dredging of sluffed materials.	K. Smith/S. Krupa
8/27/2018	8/31/2018	Advance pilot hole to 1,623 ft bls. This depth selected for coring, so attempt to clear the borehole for coring operations. Fill encountered on each wiper trip. Borehole bridged repeatedly requiring additional dredging to clear. Florida Design Drilling submits formal notice of impact due to dredging problems in the borehole. Meeting scheduled to discuss time and cost impacts and alternate options for completing the well.	K. Smith
9/4/2018	9/5/2018	Dredging at 1,620 ft bls. Florida Design Drilling and SFWMD meet to discuss options for the borehole. SFWMD instructs Florida Design Drilling to cease attempting to wipe for coring and attempt to advance the borehole between now and next meeting on 9/11/2018, when SFWMD will have decided on the available options for going forward.	--
9/6/2018	9/11/2018	Florida Design Drilling advances pilot hole from 1,620 to 1,653 ft bls. Dredging issue continues. On 9/7/2018, a fall of materials from above locked up the drill bit so it was unable to rotate; 89,000 pounds of force were required to free the bit. It was decided that conditions in the well were too unstable for safe completion. Drilling operations were ceased at a total depth of 1,653 ft bls, and preparations were made for final logging of the borehole.	--
9/18/2018	9/19/2018	Steve Miller (MV Geophysical) mobilized to site for logging of final borehole (1,145 to 1,653 ft bls). Florida Design Drilling has placed pump in the borehole to facilitate dynamic logging. An encounter with the 14-inch casing at the borehole back-off damaged the bulb of the downhole camera. Replacement parts must be acquired before the camera survey can be completed. Static logs completed only to 1,502 ft bls out of concern for the possibility of being trapped in the hole below the cavernous interval.	B. Collins
9/20/2018		USGS – Mike Wacker mobilized to site to conduct OBI survey of the pilot hole from 1,145 to 1,630 ft bls.	B. Collins
9/24/2018	9/28/2018	MV Geophysical mobilized to site to run final video and dynamic logs (spinner flow and fluids). Logged only to	L. Lindstrom

Date From	Date To	Activity	Site Geologist
		1,504 ft bls due to concerns about stability of the borehole below that.	
9/25/2018		Began final well development on 9/25/2018 but stopped at 10:10 due to repeated pump failure. Awaiting pump parts from West Palm Beach.	L. Lindstrom
9/26/2018		Pump repaired, re-commence well development. Pumped for 4 hours at1,800 gpm. Final field parameters for open-hole at this rate: pH 7.33, temperature 28.98°C, turbidity 3.14 NTU, specific conductance 4,746 µS/cm.	L. Lindstrom

-- = no geologist on site; °C = degrees Celsius; µS/cm = microsiemens per centimeter; APT = aquifer performance test; CTD = conductivity, temperature, and depth; ft bls = feet below land surface; NTU = nephelometric turbidity units; OBI = optical borehole imaging; SFWMD = South Florida Water Management District; USGS = United States Geological Survey.

APPENDIX B:
LITHOLOGIC DESCRIPTIONS OF OSF-110 AND OSF-111

Table B-1. Lithologic descriptions of OSF-110.

From Depth (ft bls)	To Depth (ft bls)	Description
0	5	Fine quartz sand, brownish gray (5yr 4/1); angular, non-cohesive
5	10	Fine quartz sand, brownish gray (5yr 4/1); angular, non-cohesive
10	15	Fine quartz sand, medium gray (n5); angular, non-cohesive
15	20	Fine quartz sand, brownish gray (5yr 4/1); angular, non-cohesive
20	25	Fine quartz sand, brownish gray (5yr 4/1); sub-rounded, non-cohesive, dark minerals
25	30	Fine quartz sand, brownish gray (5yr 4/1); sub-rounded, non-cohesive, dark minerals
30	35	Fine quartz sand, brownish gray (5yr 4/1); sub-rounded, non-cohesive, dark minerals
35	40	Sandy clay, olive gray (5y 4/1); low plasticity
40	45	Medium quartz sand; brownish gray (5y/r4/1); sub-rounded; non-cohesive
45	50	Medium quartz sand; brownish gray (5y/r4/1); sub-rounded; non-cohesive
50	54	Fine to medium quartz sand, dark gray (n3); sub-rounded; non-cohesive
54	65	Sandy clay, greenish black (n3); 30% fine to medium quartz sand; low plasticity; calcareous
65	95	Sandstone; medium gray (n5); low interparticle porosity; very fine to fine quartz sand with 30% shell and 20% sand; poor induration; calcareous cement
95	105	Sandstone; olive gray (5y4/1); low interparticle porosity; fine to medium well rounded quartz sand with 30% shell and 20% sand; poor induration; calcareous cement
105	110	Sandy clay, greenish black (5g 2/1); 30% fine to medium quartz sand; low plasticity; calcareous
110	120	Sandstone; olive gray (5y 4/1); low interparticle porosity; fine to medium well rounded quartz sand with 30% shell and 20% sand; poor induration; calcareous cement
120	150	Sandy clay, light olive gray (5y 6/10); 30% quartz sand, 20% shell, 5% phosphate; low plasticity; calcareous
150	155	Fine to medium quartz sand; light brownish gray (5yr6/1); angular; 30% shell fragments, 5% phosphate
155	170	Sandy clay; light olive gray (5y 6/10); 30% quartz sand, 20% shell, 5% phosphate; low plasticity; calcareous
170	175	Quartz sandstone; medium light gray (n6); low intergranular porosity; very fine quartz sand and shell; calcareous cement; 5% phosphate; moderate induration
175	185	Sandy clay, light olive gray (5y 6/10); 30% quartz sand, 20% shell; 5% phosphate; low plasticity; calcareous
185	195	Fine quartz sand; olive gray (5yr 4/1); angular, non-cohesive; shell fragments; phosphate
195	230	Clayey sand; olive gray (5y 4/1); very fine quartz sand with 30% shell and 10% phosphate; very coarse shell fragments
230	235	Sandstone; olive gray (5y 4/1); low intergranular porosity; fine to medium well rounded quartz sand with 30% shell and 20% sand; poor induration; calcareous cement
230	235	Limestone (packstone); olive gray (5y 4/1); low intergranular porosity; poor induration; very shelly; quartz sand; phosphatic
235	240	Silt; olive gray (5y 4/1); unconsolidated; 30% quartz sand; with sandstone and limestone fragments
235	240	Silt; olive gray (5y 4/1); unconsolidated; 30% quartz sand; with ss and ls fragments
240	245	Clayey sand; olive gray (5y 4/1); very fine quartz sand with 30% shell and 10% phosphate, very coarse shell fragments
245	270	Limestone (wackestone); pale yellow brown (10yr 6/2); low intergranular porosity; poor induration; quartz sand; highly fossiliferous (fragments), bivalve shells

From Depth (ft bls)	To Depth (ft bls)	Description
270	275	No sample collected
275	290	Limestone (wackestone); pale yellow brown (10yr 6/2); low intergranular porosity; poor induration; quartz sand; highly fossiliferous (fragments), bivalve shells
290	295	Limestone (wackestone); very pale orange (10yr 8/2); low intergranular porosity; good induration; quartz sand; fossiliferous (fragments), shell fragments, mollusks, and intraclasts
295	300	Limestone (packstone); pale yellow brown (10yr 6/2); low intergranular porosity; poor induration; quartz sand; highly fossiliferous; intraclasts (fragments)
303	304.2	Limestone (grainstone); very pale orange (10yr 8/2); high intergranular porosity; poor induration; chalky; very fossiliferous (fragments), some organic material
304.2	306	Limestone (packstone); very pale orange (10yr 8/2); high intergranular porosity; poor induration; chalky; very fossiliferous (fragments), some organic material
306	312	Limestone (wackestone); very pale orange (10yr 8/2); high intergranular porosity; poor induration; chalky; fine quartz sand; trace organics
312	316	Limestone (packstone); grayish orange (10yr 7/4); high intergranular porosity; poor induration; chalky; highly fossiliferous (fragments), with milliolids, *Neolagnum* (?), and some organics; some lamination
316	317	Limestone (grainstone); very pale orange (10yr 6/2); high intergranular porosity; poor induration; chalky; quartz sand; highly fossiliferous (fragments), with milliolids, *Fallotella* (?), and algal fragments
317	321	Limestone (packstone); very pale orange (10yr 8/2); high intergranular porosity; poor induration; chalky; very fossiliferous (fragments), some organic material
321	330	Limestone (packstone with interbedded grainstone); very pale orange (10yr 8/2); intergranular porosity (high); poor induration; chalky; very fossiliferous (fragments) with bivalves, *Fallotella* (?), milliolids, algal fragments, echinoids, and organic material
330	340	Limestone (packstone); very pale orange (10yr 8/2); intergranular porosity (high); poor induration; chalky; very fossiliferous (fragments), bivalves, *Fallotella*, *Neolagnum* (?)
340	344.8	Limestone (floatstone with interbedded rudstone); grayish orange (10yr 7/4); intergranular porosity (high); moderate induration; chalky; very fossiliferous (fragments), bivalves, gastropods
344.8	350	Limestone (wackestone); very pale orange (10yr 8/2); low intergranular porosity; poor induration; chalky; highly fossiliferous (fragments)
350	351.4	Limestone (packstone with interbedded grainstone); very pale orange (10yr8/2); intergranular porosity (high); low induration; chalky; very fossiliferous (fragments), trace *Fallotella* (?)
351.4	353	Limestone (wackestone); very pale orange (10yr 8/2); low intergranular porosity; poor induration; chalky; highly fossiliferous (fragments)
353	356	Limestone (packstone); very pale orange (10yr 8/2); low intergranular porosity; moderate induration; chalky; highly fossiliferous (fragments)
356	359.5	Limestone (wackestone); very pale orange (10yr 8/2); moderate intergranular porosity; poor induration; chalky; highly fossiliferous (fragments)
359.5	361	Limestone (packstone); very pale orange (10yr 8/2); low intergranular porosity; moderate induration; chalky; highly fossiliferous (fragments)
361	371.5	Limestone (wackestone grading to mudstone); very pale orange (10yr 8/2); low intergranular porosity; poor induration
371	372.4	Limestone (packstone); very pale orange (10yr 8/2); moderate intergranular porosity; moderate induration; chalky; highly fossiliferous (fragments); some lamination
372.4	378	Limestone (wackestone); very pale orange (10yr 8/2); low intergranular porosity; moderate induration; chalky; highly fossiliferous (fragments)
378	380.8	Limestone (packstone); very pale orange (10yr 8/2); low intergranular porosity; poor induration; chalky; highly fossiliferous (fragments)

From Depth (ft bls)	To Depth (ft bls)	Description
380.8	388	Limestone (wackestone); very pale orange (10yr 8/2); low intergranular porosity; moderate induration; chalky; highly fossiliferous (fragments)
388	394.1	Limestone (packstone), grading to wackestone; very pale orange (10yr 8/2); moderate intergranular and vuggy porosity; poor induration; chalky; highly fossiliferous (fragments)
394.1	394.3	Limestone (mudstone); very pale orange (10yr 8/2); low intergranular porosity; poor induration; chalky
394.3	396.5	Limestone (packstone); grayish orange (10yr 7/4); moderate intergranular and vuggy porosity; moderate induration; highly fossiliferous (fragments)
396.5	400	Limestone (wackestone), grading to packstone; very pale orange (10yr 8/2); moderate intergranular porosity; poor induration; chalky; fossiliferous (fragments)
400	400.8	Limestone (mudstone); very pale orange (10yr 8/2); low intergranular porosity; poor induration; chalky
400.8	415.2	Limestone (wackestone); very pale orange (10yr 8/2); low intergranular porosity; poor induration; chalky; highly fossiliferous (fragments), *Neolagnum* sp.; some lamination
415.2	417	Limestone (floatstone); very pale orange (10yr 8/2); moderate intergranular, vuggy, moldic porosity; moderate induration; highly fossiliferous (fragments), gastropods, worm borings, tubes (?), *Neolagnum* sp.
417	419.6	Dolomitic limestone (wackestone); grayish orange (10yr 7/4); moderate intergranular porosity; poor induration; fossiliferous (fragments)
419.6	424	Limestone (wackestone); grayish orange (10yr 8/2); moderate intergranular and moldic porosity; poor induration; chalky; fossiliferous (fragments), some worm boring, some lamination
424	425.6	Limestone (packstone); grayish orange (10yr 8/2); moderate intergranular porosity; moderate induration; fossiliferous (fragments)
425.6	428	Limestone (floatstone); medium light gray (n6); good intergranular, vuggy, moldic porosity; good induration; highly fossiliferous (fragments), gastropods, worm borings
428	428.8	Limestone (mudstone); very pale orange (10yr 8/2); low intergranular porosity; poor induration; chalky
428.8	430	Limestone (packstone); very pale orange (10yr 8/2); moderate intergranular and vuggy porosity; poor induration; chalky; highly fossiliferous (fragments)
430	432.6	Limestone (packstone); very pale orange (10yr 8/2); moderate intergranular porosity; poor induration; chalky; highly fossiliferous (fragments); few burrows
432.6	440	Limestone (packstone grading to wackestone); very pale orange (10yr 8/2); moderate intergranular porosity; poor induration; chalky; highly fossiliferous (fragments); few burrows
440	445	Limestone (packstone grading to wackestone); very pale orange (10yr 8/2); high intergranular porosity; poor induration; chalky; highly fossiliferous (fragments); few burrows, bivalves, and organic material
445	449	Calcareous dolostone; very pale orange (10yr 8/2); moderate vuggy, intercrystalline, and moldic porosity; moderate induration
449	453.5	Calcareous dolostone; very pale orange (10yr 8/2); low intercrystalline porosity, moderate induration
453.5	456.8	Limestone (wackestone); very pale orange (10yr 8/2); moderate vuggy and intergranular porosity; moderate induration; highly fossiliferous (fragments); some lamination
456.8	465	Limestone (wackestone); very pale orange (10yr 8/2); moderate intergranular porosity; poor induration; highly fossiliferous (fragments); some lamination
465	466.5	Limestone (wackestone); very pale orange (10yr 8/2); moderate intergranular porosity; moderate induration; highly fossiliferous (fragments); some lamination
466.5	468.7	Limestone (packstone) very pale orange (10yr 8/2); high intergranular porosity; poor induration; chalky; highly fossiliferous (fragments)

From Depth (ft bls)	To Depth (ft bls)	Description
468.7	469.8	Limestone (wackestone); very pale orange (10yr 8/2); moderate intergranular porosity; moderate induration; highly fossiliferous (fragments), lithoclasts
469.8	472.8	Limestone (wackestone); very pale orange (10yr 8/2); moderate intergranular porosity; poor induration; highly fossiliferous (fragments)
472.8	476.8	Calcareous dolostone; pale yellow brown (10yr 6/2); low intercrystalline and pinpoint vuggy porosity; moderate induration; some lamination
476.8	478	Calcareous dolostone; pale yellow brown (10yr 6/2); moderate intercrystalline porosity, moderate induration
478	479	Calcareous dolostone; pale yellow brown (10yr 6/2); high intercrystalline porosity, moderate induration
479	482	Calcareous dolostone; pale yellow brown (10yr 6/2); low intercrystalline and pinpoint vuggy porosity; moderate induration
482	482.8	Dolomitic sand; moderate yellow brown (10yr 5/4); moderate intergranular porosity
482.8	485	Calcareous dolostone; pale yellow brown (10yr 6/2); low intercrystalline and pinpoint vuggy porosity; good induration
485	486	Calcareous dolostone; pale yellow brown (10yr 6/2); moderate intercrystalline and pinpoint vuggy porosity; good induration
486	487.4	Calcareous dolostone; pale yellow brown (10yr 6/2); low intercrystalline and pinpoint vuggy porosity; good induration
487.4	487.7	Dolomitic sand; moderate yellow brown (10yr 5/4); moderate intergranular porosity
487.7	488.3	Calcareous dolostone; pale yellow brown (10yr 6/2); high intercrystalline and pinpoint vuggy porosity; good induration
488.3	489.9	Calcareous dolostone; pale yellow brown (10yr 6/2); low intercrystalline and pinpoint vuggy porosity; good induration
489.9	491	Calcareous dolostone; pale yellow brown (10yr 6/2); high intercrystalline and pinpoint vuggy porosity; good induration
491	493	Calcareous dolostone; pale yellow brown (10yr 6/2); moderate intercrystalline and pinpoint vuggy porosity; good induration
493	495	Calcareous dolostone; pale yellow brown (10yr 6/2); high intercrystalline and pinpoint vuggy porosity; good induration
495	496.5	Calcareous dolostone; pale yellow brown (10yr 6/2); moderate intercrystalline and pinpoint vuggy porosity; good induration
496.5	498	Calcareous dolostone; pale yellow brown (10yr 6/2); high intercrystalline and pinpoint vuggy porosity; good induration
498	500	Calcareous dolostone; moderate yellow brown (10yr 5/4); moderate intercrystalline and pinpoint vuggy porosity; good induration
500	503.9	Calcareous dolostone; very pale orange (10yr 8/2); low intercrystalline porosity; moderate induration
503.9	504.3	Dolomitic sand; moderate yellow brown (10yr 5/4); moderate intergranular porosity
504.3	506.8	Calcareous dolostone; pale yellow brown (10yr 6/2); moderate intercrystalline and pinpoint vuggy porosity; good induration
506.8	507	Dolomitic sand; moderate yellow brown (10yr 5/4); moderate intergranular porosity
507	509.3	Limestone (wackestone); very pale orange (10yr 8/2); moderate intergranular porosity; moderate induration; highly fossiliferous (fragments); some lamination
509.3	510.8	Calcareous dolostone; pale yellow brown (10yr 6/2); moderate intercrystalline and vuggy porosity; good induration
510.8	512.3	Calcareous dolostone; moderate yellow brown (10yr 5/4); low intercrystalline and pinpoint vuggy porosity; good induration
512.3	513.4	Calcareous dolostone; moderate yellow brown (10yr 5/4); good intercrystalline and pinpoint vuggy porosity; good induration
513.4	514	Calcareous dolostone; moderate yellow brown (10yr 5/4); good intercrystalline and pinpoint vuggy porosity; poor induration (rubble)

From Depth (ft bls)	To Depth (ft bls)	Description
514	515.5	Calcareous dolostone; moderate yellow brown (10yr 5/4); good intercrystalline and pinpoint vuggy porosity; poor induration (rubble)
515.5	515.7	Dolomitic sand; moderate yellow brown (10yr 5/4); moderate intergranular porosity
515.7	519	Calcareous dolostone; pale yellow brown (10yr 6/2); good intercrystalline and pinpoint vuggy porosity; good induration
519	520	Limestone (wackestone); pale yellowish brown (10yr 6/2); moderate intergranular and vuggy porosity; poor induration; with clay
520	522.7	Limestone (mudstone); very pale orange (10yr 8/2); low intergranular porosity; poor induration; chalky
522.7	524.8	Limestone (wackestone); very pale orange (10yr 8/2); low intergranular porosity; poor induration; chalky
524.8	525	Calcareous dolostone with organic laminae
525	529	Dolomitic limestone (wackestone); moderate yellow brown (10yr 5/4); moderate vuggy and intergranular porosity; moderate induration
529	534	Calcareous dolostone; dark yellow orange (10yr 6/6); good intercrystalline and pinpoint vuggy porosity; good induration
534	536.8	Dolostone; dark yellow orange (10yr 6/6); good intercrystalline and vuggy porosity; good induration
536.8	540	Dolostone; dark yellow orange (10yr 6/6); moderate intercrystalline and pinpoint vuggy porosity; good induration
540	541	Dolomitic limestone (packstone); very pale orange (10yr 8/2); good vuggy and intergranular porosity; moderate induration
541	543.7	Limestone (wackestone, grading to mudstone); very pale orange (10yr 8/2); low intergranular porosity; poor induration; chalky; highly laminated
543.7	551.5	Limestone (packstone); grayish orange (10yr 7/4); good vuggy and intergranular porosity; moderate induration; large gastropods; laminated
551.5	552	Limestone (packstone); very pale orange (10yr 8/2); low intergranular porosity; poor induration; intraclasts
552	554.7	Limestone (packstone); very pale orange (10yr 8/2); low intergranular porosity; poor induration; much clay
554.7	554.9	Calcareous clay; pale yellow brown (10yr 6/2)
554.9	555.5	Limestone (packstone); very pale orange (10yr 8/2); good intergranular porosity; poor induration
555.5	556	Dolostone; moderate yellow brown (10yr 5/4); moderate intercrystalline porosity; moderate induration
556	560	Dolomitic limestone (wackestone); grayish orange (10yr 7/4); moderate intergranular porosity; poor induration
560	566.8	Dolostone; interbedded with calcareous dolostone; grayish orange (10yr 7/4); good intercrystalline porosity; moderate induration
566.8	568.6	Calcareous dolostone; grayish orange (10yr 7/4); moderate intercrystalline porosity; moderate induration; highly laminated
568.6	570	Calcareous dolostone; grayish orange (10yr 7/4); high vuggy and intercrystalline porosity; moderate induration
570	572.1	Limestone (wackestone); very pale orange (10yr 8/2); moderate intergranular and moldic porosity; moderate induration
572.1	573.6	Dolostone; moderate yellow brown (10yr 5/4); high intercrystalline and pp vuggy porosity; moderate induration
573.6	576	Dolostone; moderate yellow brown (10yr 5/4); moderate intercrystalline and pinpoint vuggy porosity; good induration
576	579.2	Dolostone; moderate yellow brown (10yr 5/4); high intercrystalline and pinpoint vuggy porosity; moderate induration

From Depth (ft bls)	To Depth (ft bls)	Description
579.2	579.8	Calcareous dolostone; very pale orange (10yr 8/2); low intercrystalline porosity; poor induration; laminated
579.8	584	Calcareous dolostone; very pale (10yr 8/2); moderate intergranular and pinpoint vuggy porosity; moderate induration organic laminae at 582.6 ft bls
584	585.7	Dolostone; moderate yellow brown (10yr 5/4); moderate intergranular and pinpoint vuggy porosity; poor induration
585.7	590	Calcareous dolostone; moderate yellow brown (10yr 5/4); low intergranular porosity; poor induration
590	600	Calcareous dolostone; grayish orange (10yr 7/4); low intergranular and pinpoint vuggy porosity; poor induration; laminated from 596 to 598 ft bls

ft bls = feet below land surface.

Table B-2. Lithologic descriptions of OSF-111.

From Depth (ft bls)	To Depth (ft bls)	Description
600	620	Dolostone; very pale orange (10yr 8/2); moderate vuggy and intercrystalline porosity; moderate induration
620	625	Dolostone; grayish orange (10yr 7/4); moderate vuggy and intercrystalline porosity; moderate induration
625	645	Dolostone; grayish orange (10yr 7/4); moderate vuggy and intergranular porosity; good induration
645	650	Dolostone; grayish orange (10yr 7/4); moderate vuggy and intercrystalline porosity; moderate induration; trace organics
650	665	Dolostone; grayish orange (10yr 7/4); low intercrystalline porosity; good induration
665	675	Dolostone; grayish orange (10yr 7/4); moderate vuggy and intercrystalline porosity; moderate induration
675	680	Dolostone; very pale orange (10yr 8/2); moderate vuggy and intercrystalline porosity; moderate induration
680	700	Dolostone; grayish orange (10yr 7/4); moderate vuggy and intergranular porosity; good induration; trace organics
700	720	Dolostone; grayish orange (10yr 7/4); low intercrystalline porosity; good induration
720	725	Dolostone; grayish orange (10yr 7/4); moderate intercrystalline porosity; good induration
725	730	Dolostone; grayish orange (10yr 7/4); good intercrystalline and moldic porosity; good induration
730	785	Dolostone; grayish orange (10yr 7/4); moderate vuggy and intergranular porosity; good induration
785	790	Dolostone; grayish orange (10yr 7/4); moderate vuggy and intercrystalline porosity; moderate induration
790	795	Dolostone; grayish orange (10yr 7/4); moderate vuggy and intergranular porosity; good induration
795	800	Dolostone; grayish orange (10yr 7/4); good intercrystalline and moldic porosity; good induration
800	835	Dolostone; very pale orange (10yr 8/2); good intercrystalline, vuggy, and moldic porosity; good induration
835	840	Dolostone; grayish orange (10yr 7/4); low intercrystalline porosity; moderate induration
840	860	Dolostone; grayish orange (10yr 7/4); good intercrystalline and moldic porosity; moderate induration
860	880	Dolostone; grayish orange (10yr 7/4); moderate pinpoint vuggy and intergranular porosity; moderate induration

From Depth (ft bls)	To Depth (ft bls)	Description
880	885	Dolostone; very pale orange (10yr 8/2); moderate pinpoint and intercrystalline porosity; moderate induration
885	890	Dolostone; very pale orange (10yr 8/2); low intercrystalline porosity; good induration
890	895	Dolostone; very pale orange (10yr 8/2); good intercrystalline, vuggy and moldic porosity; good induration
895	900	Dolostone; very pale orange (10yr 8/2); low intercrystalline porosity; good induration
900	950	Dolostone; very pale orange (10yr 8/2); moderate pinpoint and intercrystalline porosity; moderate induration
950	965	Dolostone; very pale orange (10yr 8/2); good intercrystalline, pinpoint, and moldic porosity; moderate induration
965	990	Dolostone; very pale orange (10yr 8/2); moderate pinpoint and intercrystalline porosity; moderate induration
990	1,025	Dolostone; very pale orange (10yr 8/2); good intercrystalline, pinpoint, and moldic porosity; good induration
1,025	1,050	Dolostone; very pale orange (10yr 8/2); moderate pinpoint and intercrystalline porosity; good induration
1,050	1,060	Dolostone; grayish orange (10yr 7/4); moderate pinpoint vuggy and intergranular porosity; good induration; trace organics
1,060	1,085	Dolostone; very pale orange (10yr 8/2); moderate pinpoint and intercrystalline porosity; good induration; trace organics
1,085	1,090	Dolostone; very pale orange (10yr 8/2); good intercrystalline, pinpoint, and moldic porosity; good induration
1,090	1,115	Dolostone; very pale orange (10yr 8/2); moderate pinpoint and intercrystalline porosity; good induration
1,115	1,120	Dolostone; very pale orange (10yr 8/2); good intercrystalline, pinpoint, and moldic porosity; good induration
1,120	1,125	Dolostone; very pale orange (10yr 8/2); low intercrystalline porosity; good induration
1,125	1,130	Dolostone; very pale orange (10yr 8/2); moderate pinpoint and intercrystalline porosity; good induration
1,130	1,135	Dolostone; very pale orange (10yr 8/2); good intercrystalline, pinpoint, and moldic porosity; good induration
1,135	1,145	Dolostone; very pale orange (10yr 8/2); moderate pinpoint and intercrystalline porosity; good induration
1,145	1,150	Dolostone; very pale orange (10yr 8/2); good intercrystalline, pinpoint and moldic porosity; good induration
1,150	1,155	Dolostone; very pale orange (10yr 8/2); low intercrystalline porosity; good induration
1,155	1,160	Dolostone; medium dark gray (n4); low intercrystalline porosity; good induration
1,160	1,170	Dolostone; pale yellowish brown (10yr 6/2); moderate pinpoint and intercrystalline porosity; good induration
1,170	1,175	Dolostone; pale yellowish brown (10yr 6/2); good pinpoint and intercrystalline porosity; microsucrosic; good induration
1,175	1,180	Dolostone; moderate yellowish brown (10yr 5/4); moderate intercrystalline porosity; microsucrosic; good induration
1,180	1,185	Dolostone; moderate yellowish brown (10yr 5/4); moderate intercrystalline and pinpoint porosity; good induration
1,185	1,190	Dolostone; pale yellowish brown (10yr 6/2); moderate intercrystalline porosity; good induration
1,190	1,195	Dolostone; moderate yellowish brown (10yr 5/4); low intercrystalline porosity; good induration
1,195	1,200	Dolostone; pale yellowish brown (10yr 6/2); moderate intercrystalline and pinpoint porosity; grading to microsucrosic; good induration
1,200	1,205	Dolostone; very pale orange (10yr 8/2); low intercrystalline porosity; good induration

From Depth (ft bls)	To Depth (ft bls)	Description
1,205	1,210	Dolostone; grayish orange (10yr 7/4); low intergranular porosity; good induration
1,210	1,215	Dolostone; grayish orange (10yr 7/4); moderate intercrystalline porosity; microsucrosic; good induration; trace organics
1,215	1,220	Dolostone; grayish orange (10yr 7/4); moderate intercrystalline porosity; good induration; trace organics
1,220	1,225	Dolostone; pale yellowish brown (10yr 6/2); low intercrystalline porosity; good induration; trace organics
1,225	1,230	Dolostone; pale yellowish brown (10yr 6/2); good intercrystalline, vuggy, and moldic porosity; microsucrosic; good induration; trace organics
1,230	1,245	Dolostone; moderate yellowish brown (10yr 5/4); moderate intercrystalline and pinpoint porosity; good induration
1,245	1,260	Dolostone; grayish orange (10yr 7/4); moderate intercrystalline porosity; good induration
1,260	1,265	Dolostone; grayish orange (10yr 7/4); good intercrystalline and pinpoint porosity; good induration
1,265	1,270	Dolostone; grayish orange (10yr 7/4); moderate intercrystalline porosity; good induration
1,270	1,275	Dolostone; grayish orange (10yr 7/4); good intercrystalline and pinpoint porosity; good induration
1,275	1,290	Dolostone; grayish orange (10yr 7/4); moderate intercrystalline porosity; good induration
1,290	1,300	Dolostone; moderate yellowish brown (10yr 5/4); moderate intercrystalline and pinpoint porosity; good induration
1,300	1,315	Dolostone; moderate yellowish brown (10yr 5/4); good intercrystalline and pinpoint porosity; microsucrosic; good induration
1,315	1,350	Dolostone; moderate yellowish brown (10yr 5/4); moderate intercrystalline and pinpoint porosity; microsucrosic; good induration
1,350	1,355	Dolostone; moderate yellowish brown (10yr 5/4); good intercrystalline and pinpoint porosity; microsucrosic; good induration
1,355	1,370	Dolostone; moderate yellowish brown (10yr 5/4); moderate intercrystalline and pinpoint porosity; microsucrosic; good induration
1,370	1,375	Dolostone; moderate yellowish brown (10yr 5/4); low intercrystalline porosity; microsucrosic; good induration; 5% organic material
1,375	1,390	Dolostone; moderate yellowish brown (10yr 5/4); moderate intercrystalline and pinpoint porosity; microsucrosic; good induration
1,390	1,400	Dolostone; very pale orange (10yr 8/2); low intercrystalline porosity; good induration
1,400	1,405	Dolostone; moderate yellowish brown (10yr 5/4); moderate intercrystalline and pinpoint porosity; microsucrosic; good induration; 10% organic material
1,405	1,410	Dolostone; dark yellowish brown (10yr 4/2); moderate intercrystalline and pinpoint porosity; microsucrosic; good induration; 20% organic material
1,410	1,490	Void
1,490	1,500	Dolostone; dark yellowish brown (10yr 4/2); moderate intercrystalline and pinpoint porosity; microsucrosic; good induration; 10% organic material
1,500	1,510	Dolostone; dark yellowish brown (10yr 4/2); low intercrystalline porosity; good induration; 5% organic material
1,510	1,515	Dolostone; dark yellowish brown (10yr 4/2); low intercrystalline porosity; good induration; 5% organic material; 50% medium sand to fine gravel dolostone, unconsolidated
1,515	1,530	Dolostone; dark yellowish brown (10yr 4/2); low intercrystalline porosity; good induration; 5% organic material
1,530	1,545	Dolostone; pale yellow brown (10yr 6/2); low intercrystalline porosity; good induration

From Depth (ft bls)	To Depth (ft bls)	Description
1,545	1,565	Dolomitic sand; pale yellow brown (10yr 6/2); medium sand to fine gravel, sub-angular; unconsolidated
1,565	1,570	Dolostone; dark yellowish brown (10yr 4/2); low intercrystalline porosity; good induration; 10% organic material
1,570	1,575	Dolomitic sand; pale yellow brown (10yr 6/2); medium sand to fine gravel, sub-angular; unconsolidated
1,575	1,585	Dolomitic sand; medium light gray (n6); medium sand to fine gravel, sub-angular; unconsolidated
1,585	1,590	Dolostone; medium light gray (n6); moderate intercrystalline porosity; microsucrosic; good induration; 10% organic material
1,590	1,595	Dolomitic sand; pale yellow brown (10yr 6/2); medium sand to fine gravel, sub-angular; unconsolidated
1,595	1,615	Dolostone; pale yellow brown (10yr 6/2); low intercrystalline porosity; good induration; trace organics
1,615	1,620	Dolostone; medium light gray (n6); low intercrystalline porosity; good induration
1,620	1,625	Dolostone; pale yellowish brown (10yr 6/2); moderate intercrystalline and pinpoint porosity; microsucrosic; good induration
1,625	1,640	Dolostone; pale yellowish brown (10yr 6/2); moderate intercrystalline and pinpoint porosity; good induration
1,640	1,645	Dolostone; pale yellow brown (10yr 6/2); low intercrystalline porosity; good induration
1,645	1,650	Dolostone; medium light gray (n6); low intercrystalline porosity; good induration; trace organics
1,650	1,653	Dolostone; pale yellow brown (10yr 6/2); low intercrystalline porosity; good induration; trace organics

ft bls = feet below land surface.

APPENDIX C:
GEOPHYSICAL LOGS OF OSF-110 AND OSF-111

ABS

Advanced Borehole Services

FULL WAVE BHC ACOUSTIC-VDL

WELL OSF-110

COMPANY	:	HUSS DRILLING
WELL	:	WELL OSF-110
FIELD	:	DESERET
COUNTY	:	OSCEOLA
STATE	:	FLORIDA

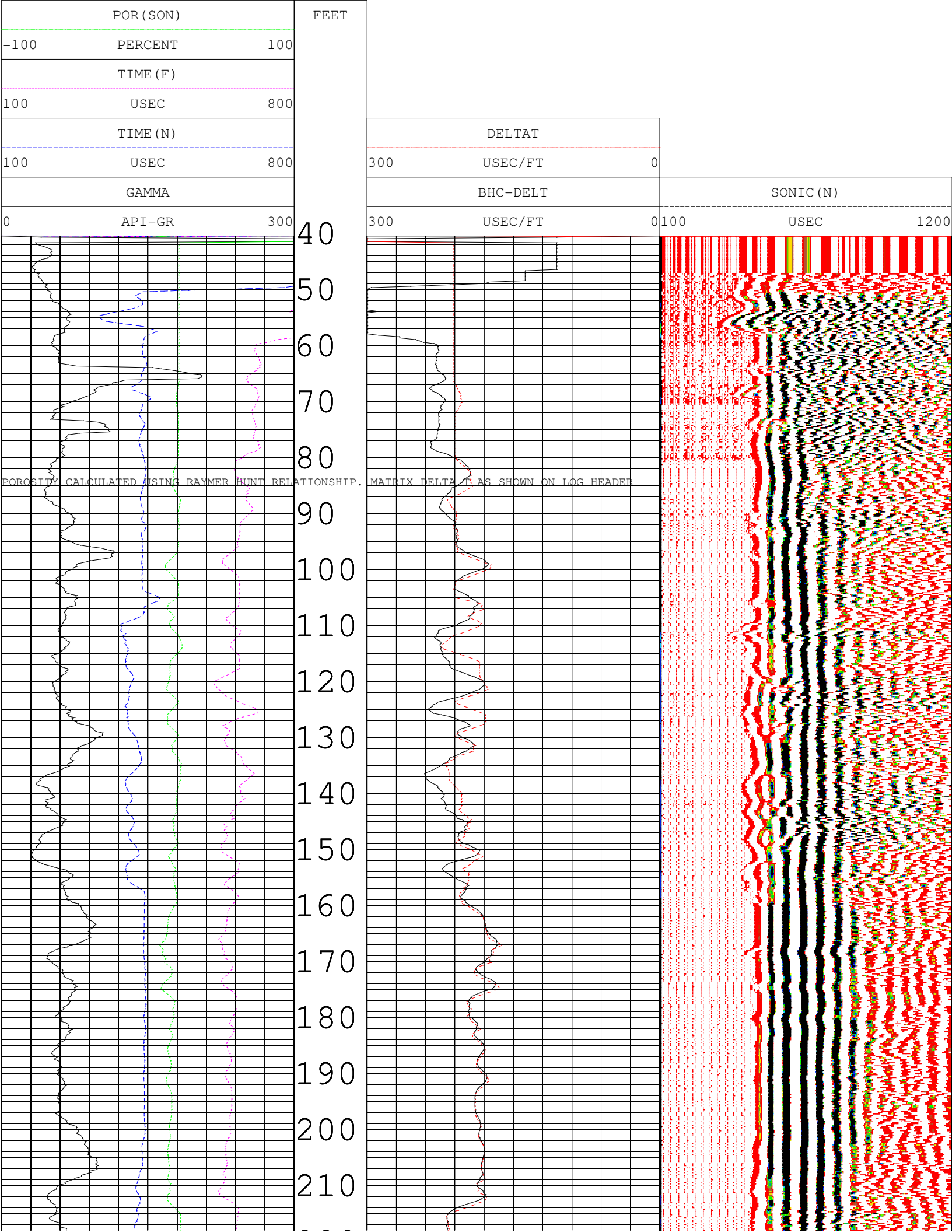
OTHER SERVICES:
9074
8044
9320

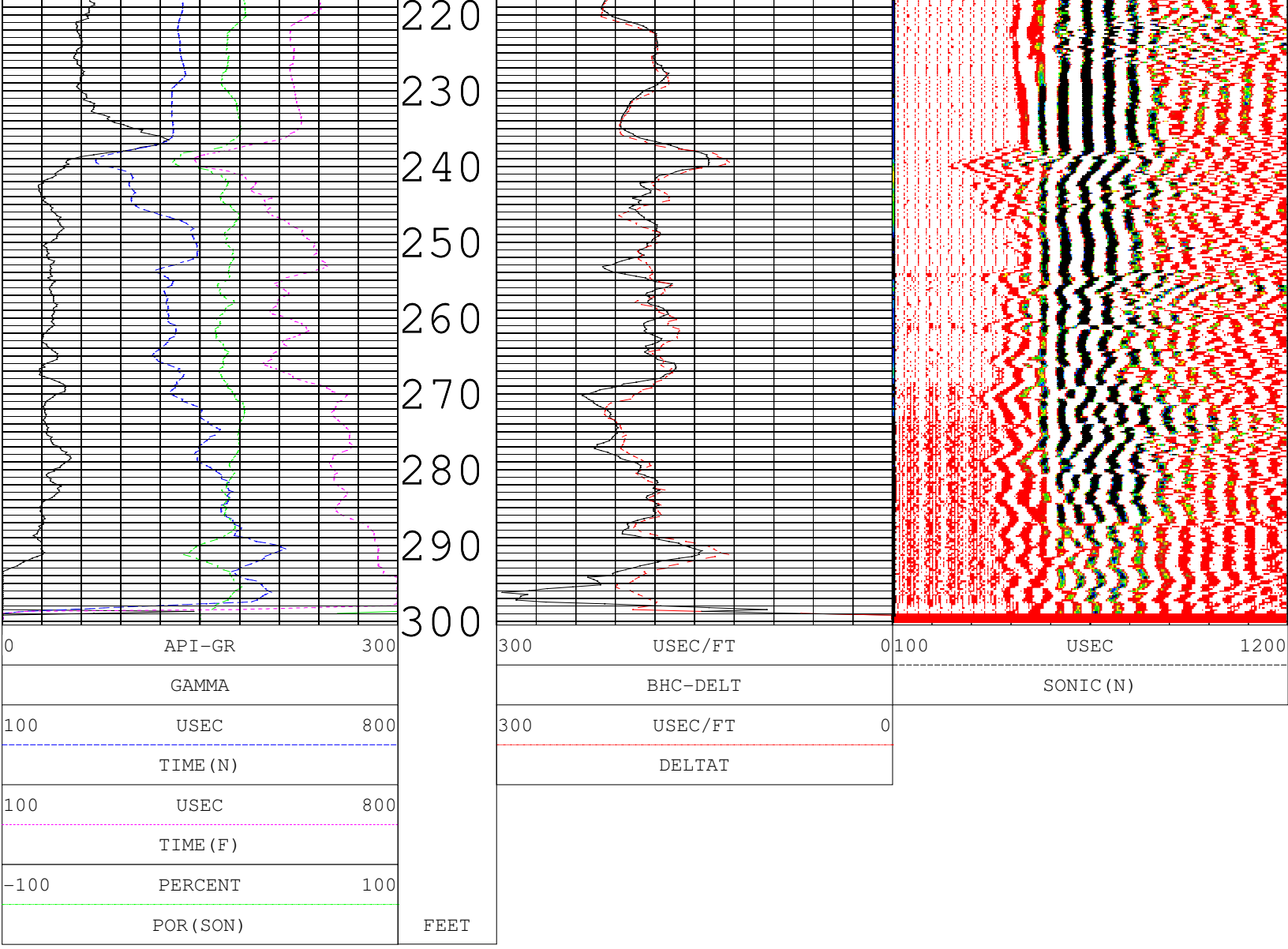
LOCATION	:	
SECTION	:	None
TOWNSHIP	:	None
RANGE	:	None
API NO.	:	
UNIQUE WELL ID.	:	

PERMANENT DATUM	:	MSL	ELEVATION KB:	None
LOG MEASURED FROM	:	GS	ELEVATION DF:	NA
DRL MEASURED FROM	:	NA	ELEVATION GL:	NA

DATE	:	06/19/17
DEPTH DRILLER	:	302
BIT SIZE	:	6
LOG TOP	:	40.50
LOG BOTTOM	:	300.25
CASING OD	:	
CASING BOTTOM	:	60
CASING TYPE	:	CLOCK
BOREHOLE FLUID	:	MUD
RM TEMPERATURE	:	0
MUD RES	:	0
MUD WEIGHT	:	
WITNESSED BY	:	
RECORDED BY	:	AFB
REMARKS 1	:	
REMARKS 2	:	

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS


POR(SON)
FEET
-100 PERCENT 100
TIME(F)
100 USEC 800
TIME(N)
100 USEC 800
GAMMA
0 API-GR 300
DELTAT
300 USEC/FT 0
BHC-DELT
300 USEC/FT 0
SONIC(N)
100 USEC 1200
40
50
60
70
80
POROSITY CALCULATED USING RAYMER HUNT RELATIONSHIP. MATRIX DELTAT AS SHOWN ON LOG HEADER
90
100
110
120
130
140
150
160
170
180
190
200
210


220
230
240
250
260
270
280
290
300
0 API-GR 300
GAMMA
100 USEC 800
TIME(N)
100 USEC 800
TIME(F)
-100 PERCENT 100
POR(SON)
FEET
300 USEC/FT 0
BHC-DELT
300 USEC/FT 0
DELTAT
100 USEC 1200
SONIC(N)

TOOL CALIBRATION WELL OSF-110 06/19/17 13:49
TOOL 9320A2 TM VERSION 0
SERIAL NUMBER 667

	DATE	TIME	SENSOR	STANDARD			RESPONSE	
1	Apr12,99	23:12:30	GAMMA	Default	[CPS]		Default	[CPS]
	Apr12,99	20:12:30	GAMMA	Default	[CPS]		Default	[CPS]

ABS

Advanced Borehole Services

GAMMA RAY (API)-CALIPER

WELL OSF-110

COMPANY	:	HUSS DRILLING
WELL	:	WELL OSF-110
FIELD	:	DESERET
COUNTY	:	OSCEOLA
STATE	:	FLORIDA

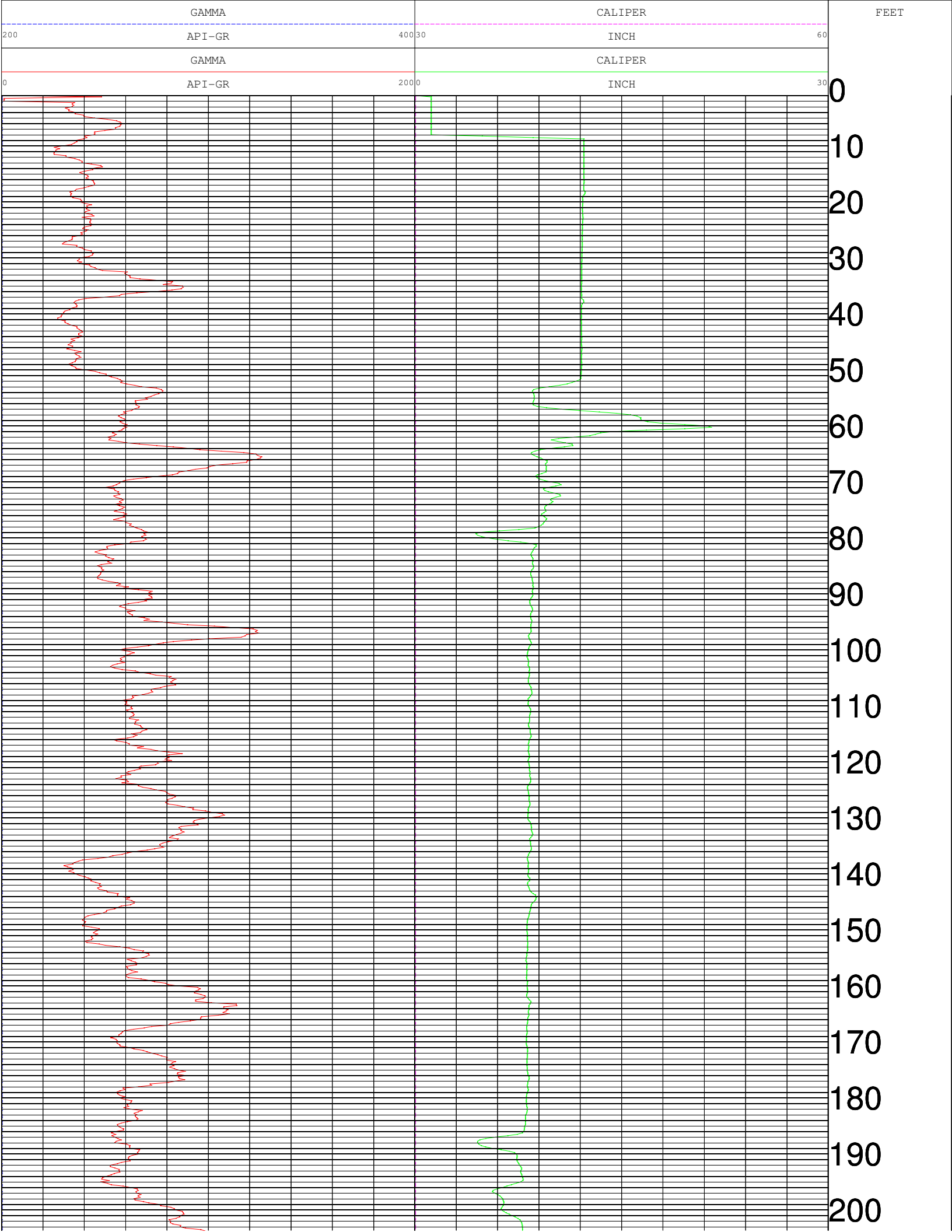
OTHER SERVICES:
9074
8044
9320

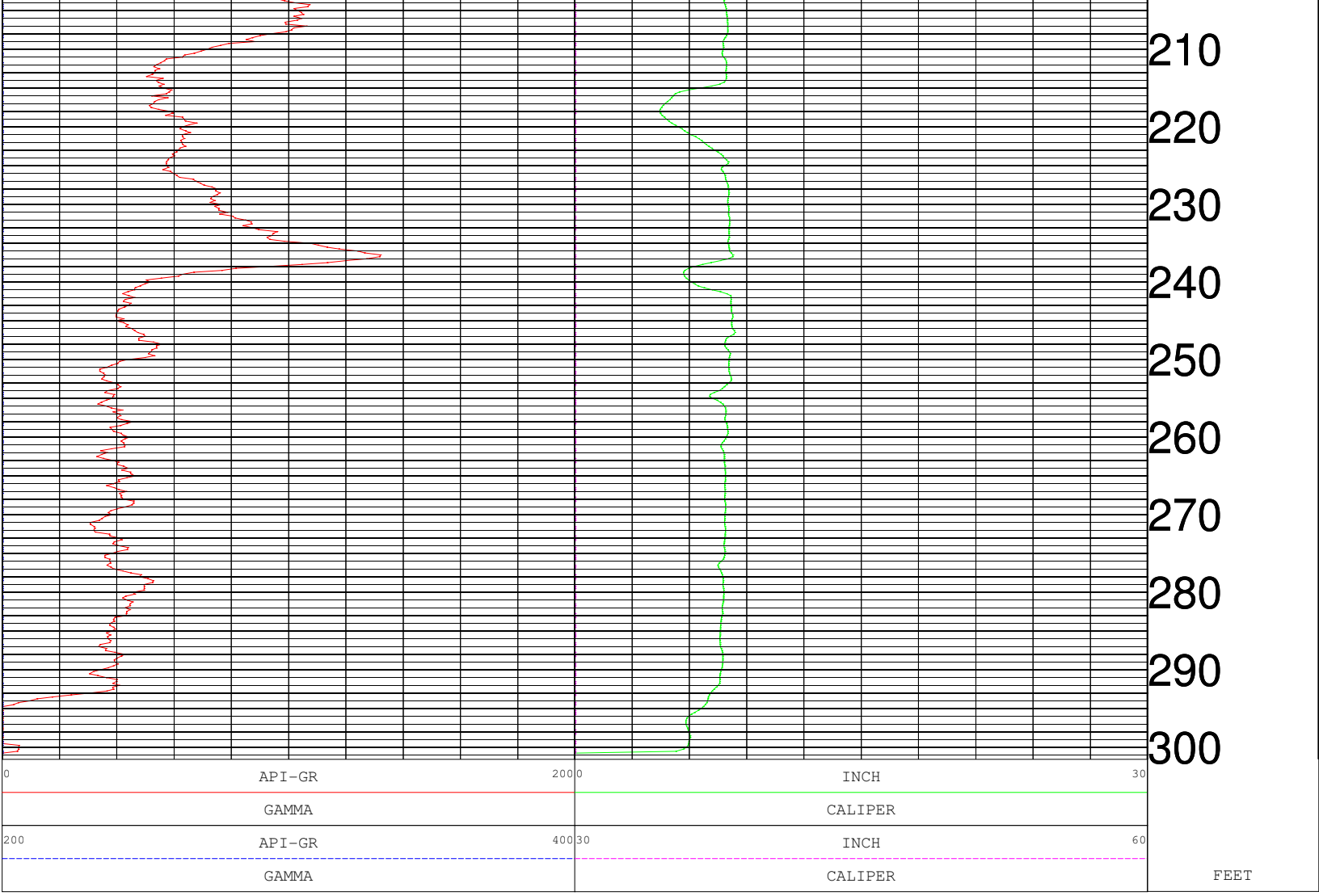
LOCATION	:	
SECTION	:	None
TOWNSHIP	:	None
RANGE	:	None
API NO.	:	
UNIQUE WELL ID.	:	

PERMANENT DATUM	:	MSL	ELEVATION KB:	None
LOG MEASURED FROM	:	GS	ELEVATION DF:	NA
DRL MEASURED FROM	:	NA	ELEVATION GL:	NA

DATE	:	06/19/17
DEPTH DRILLER	:	302
BIT SIZE	:	6
LOG TOP	:	1.00
LOG BOTTOM	:	301.25
CASING OD	:	
CASING BOTTOM	:	60
CASING TYPE	:	CLOCK
BOREHOLE FLUID	:	MUD
RM TEMPERATURE	:	0
MUD RES	:	0
MUD WEIGHT	:	
WITNESSED BY	:	
RECORDED BY	:	AFB
REMARKS 1	:	
REMARKS 2	:	

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS


GAMMA
200
API-GR
400
CALIPER
30
INCH
60
FEET
GAMMA
0
API-GR
200
CALIPER
0
INCH
30
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200


210
220
230
240
250
260
270
280
290
300
0
API-GR
200
GAMMA
200
API-GR
400
GAMMA
0
INCH
30
CALIPER
30
INCH
60
CALIPER
FEET

TOOL CALIBRATION WELL OSF-110 06/19/17 13:07
TOOL 9074A1 TM VERSION 0
SERIAL NUMBER 857

	DATE	TIME	SENSOR	STANDARD		RESPONSE	
1	Jan12,03	07:10:06	GAMMA	Default	[CPS]	Default	[CPS]
	Jan12,03	04:10:06	GAMMA	180.000	[API-GR]	205.00	[CPS]
2	May11,17	21:01:04	CALIPER	3.000	[INCH]	156245.00	[CPS]
	May11,17	21:01:04	CALIPER	5.000	[INCH]	150790.00	[CPS]
3	May11,17	12:56:07	CALIPERL	6.000	[INCH]	151386.00	[CPS]
	May11,17	12:56:07	CALIPERL	35.500	[INCH]	86954.00	[CPS]
4	Dec13,00	22:19:45	CALIPERX	Default	[CPS]	Default	[CPS]
	Dec13,00	22:19:45	CALIPERX	Default	[CPS]	Default	[CPS]

ABS

Advanced Borehole Services

GAMMA RAY-RESISTIVITY (16-64)

WELL OSF-110

COMPANY	:	HUSS DRILLING
WELL	:	WELL OSF-110
FIELD	:	DESERET
COUNTY	:	OSCEOLA
STATE	:	FLORIDA

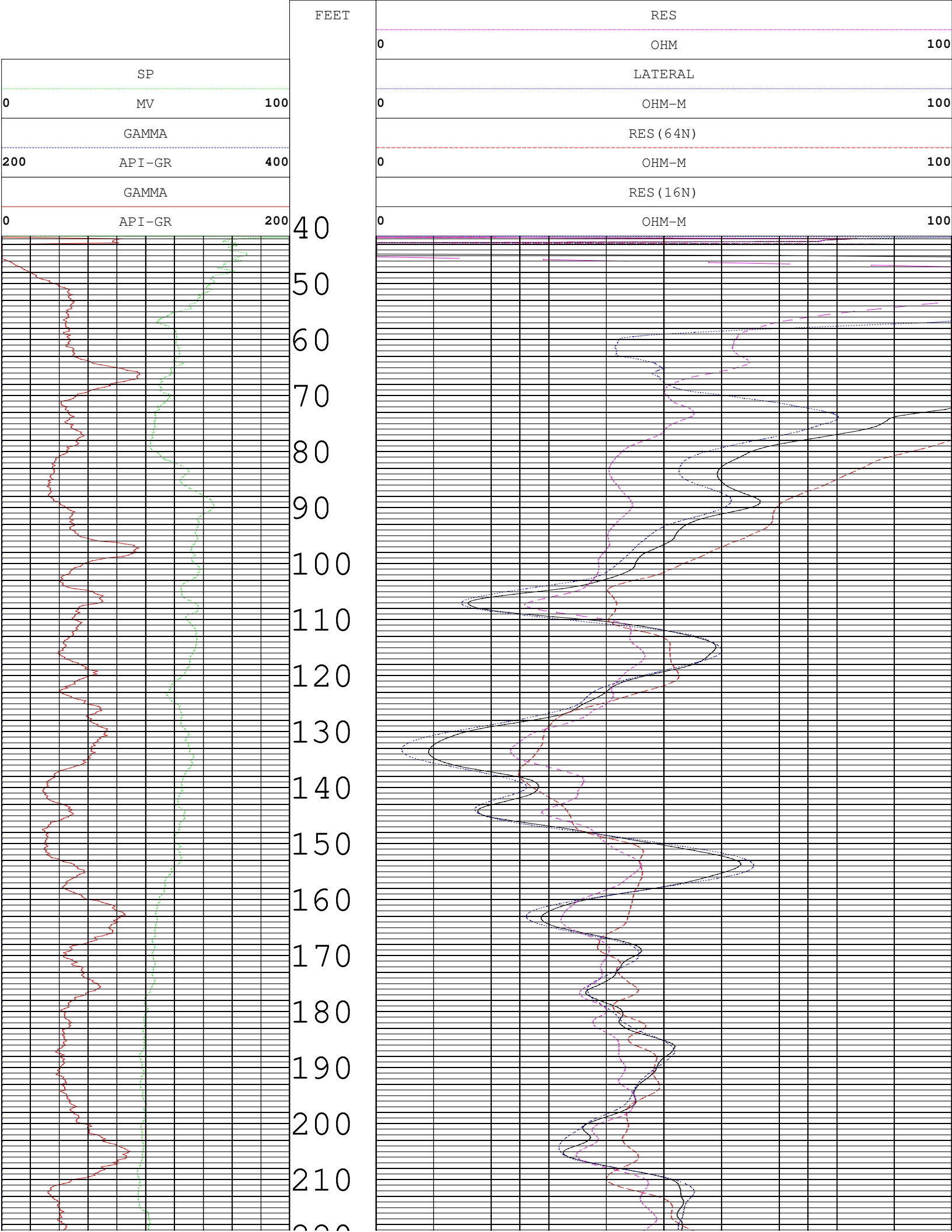
OTHER SERVICES:
9074
8044
9320

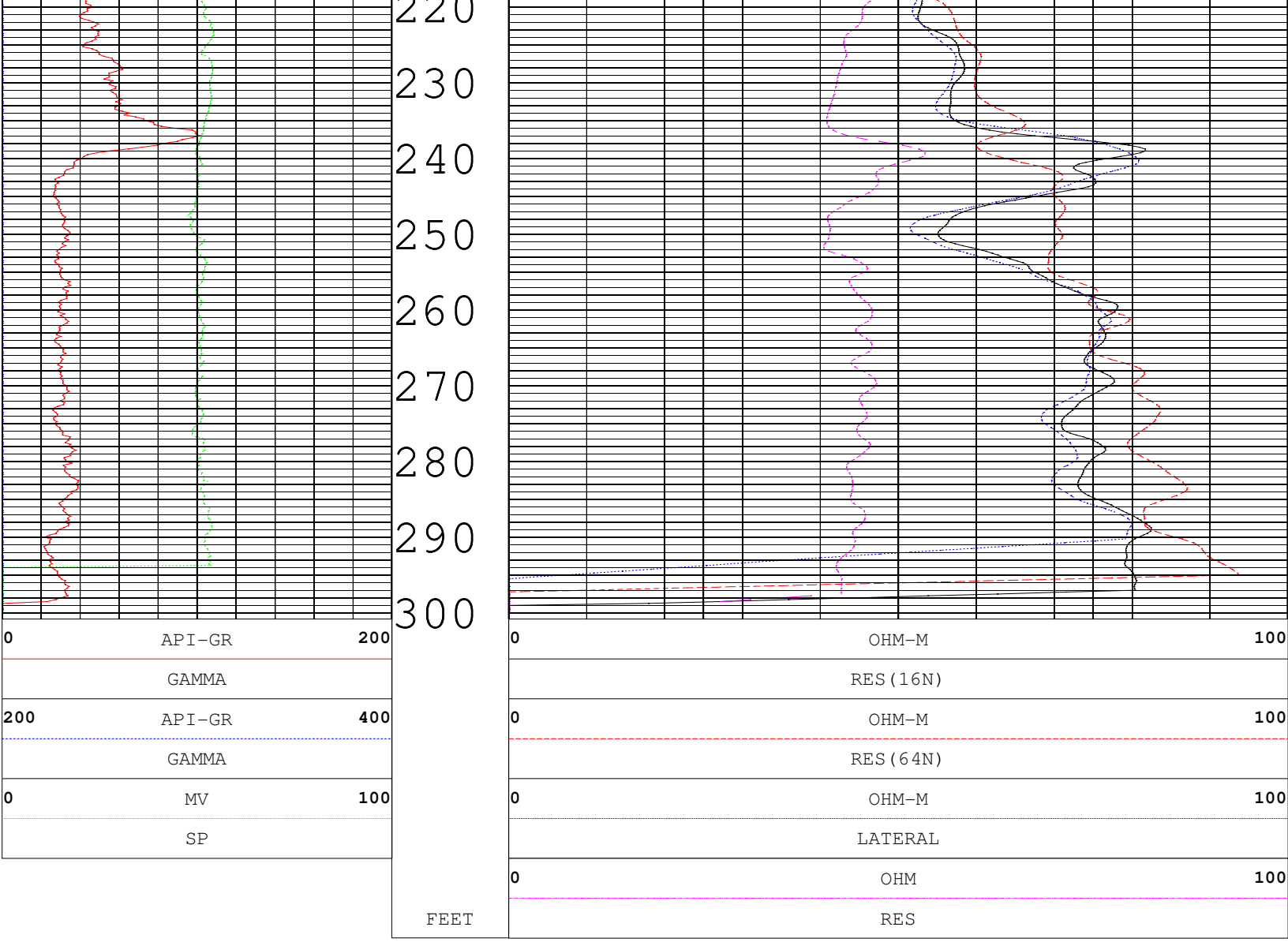
LOCATION	:	
SECTION	:	None
TOWNSHIP	:	None
RANGE	:	None
API NO.	:	
UNIQUE WELL ID.	:	

PERMANENT DATUM	:	MSL	ELEVATION KB:	None
LOG MEASURED FROM	:	GS	ELEVATION DF:	NA
DRL MEASURED FROM	:	NA	ELEVATION GL:	NA

DATE	:	06/19/17
DEPTH DRILLER	:	302
BIT SIZE	:	6
LOG TOP	:	41.50
LOG BOTTOM	:	300.50
CASING OD	:	
CASING BOTTOM	:	60
CASING TYPE	:	CLOCK
BOREHOLE FLUID	:	MUD
RM TEMPERATURE	:	0
MUD RES	:	0
MUD WEIGHT	:	
WITNESSED BY	:	
RECORDED BY	:	AFB
REMARKS 1	:	
REMARKS 2	:	

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS


FEET
SP
0 MV 100
GAMMA
200 API-GR 400
GAMMA
0 API-GR 200
RES
0 OHM 100
LATERAL
0 OHM-M 100
RES(64N)
0 OHM-M 100
RES(16N)
0 OHM-M 100
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210


220
230
240
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260
270
280
290
300
0 API-GR 200
GAMMA
200 API-GR 400
GAMMA
0 MV 100
SP
FEET
0 OHM-M 100
RES(16N)
0 OHM-M 100
RES(64N)
0 OHM-M 100
LATERAL
0 OHM 100
RES

TOOL CALIBRATION WELL OSF-110 06/19/17 13:31
TOOL 8044A TM VERSION 0
SERIAL NUMBER 938

	DATE	TIME	SENSOR	STANDARD			RESPONSE	
1	Jan03,03	10:49:05	GAMMA	0.001	[API-GR	]	0.00	[CPS]
	Jan03,03	07:49:05	GAMMA	180.000	[API-GR	]	169.00	[CPS]
2	May16,17	19:08:20	RES(FL	41.600	[OHM-M	]	54104.00	[CPS]
	May16,17	19:08:20	RES(FL	0.100	[OHM-M	]	11978.00	[CPS]
3	Aug17,14	17:00:23	SP	0.000	[MV	]	59670.00	[CPS]
	Aug17,14	17:00:23	SP	395.000	[MV	]	23612.00	[CPS]
4	Aug17,14	15:38:06	RES(16]	0.000	[OHM-M	]	4284.00	[CPS]
	Aug17,14	15:38:06	RES(16]	1996.000	[OHM-M	]	103525.00	[CPS]
5	Aug17,14	15:38:38	RES(64]	0.000	[OHM-M	]	4160.00	[CPS]
	Aug17,14	15:38:38	RES(64]	1990.000	[OHM-M	]	102789.00	[CPS]
6	Aug17,14	17:19:05	TEMP	71.700	[DEG F	]	63355.00	[CPS]
	Aug17,14	17:19:05	TEMP	81.500	[DEG F	]	58740.00	[CPS]
7	Aug17,14	15:39:11	RES	0.000	[OHM	]	9855.00	[CPS]
	Aug17,14	15:39:11	RES	988.000	[OHM	]	58788.00	[CPS]

ABS

Advanced Borehole Services

COMBINATION LOG
STATIC WATER QUALITY
OSF-110

COMPANY	:	HUSS DRILLING
WELL	:	OSF-110
FIELD	:	DESERET RANCH
COUNTY	:	OSCEOLA
STATE	:	FLORIDA

OTHER SERVICES:
8044
9320

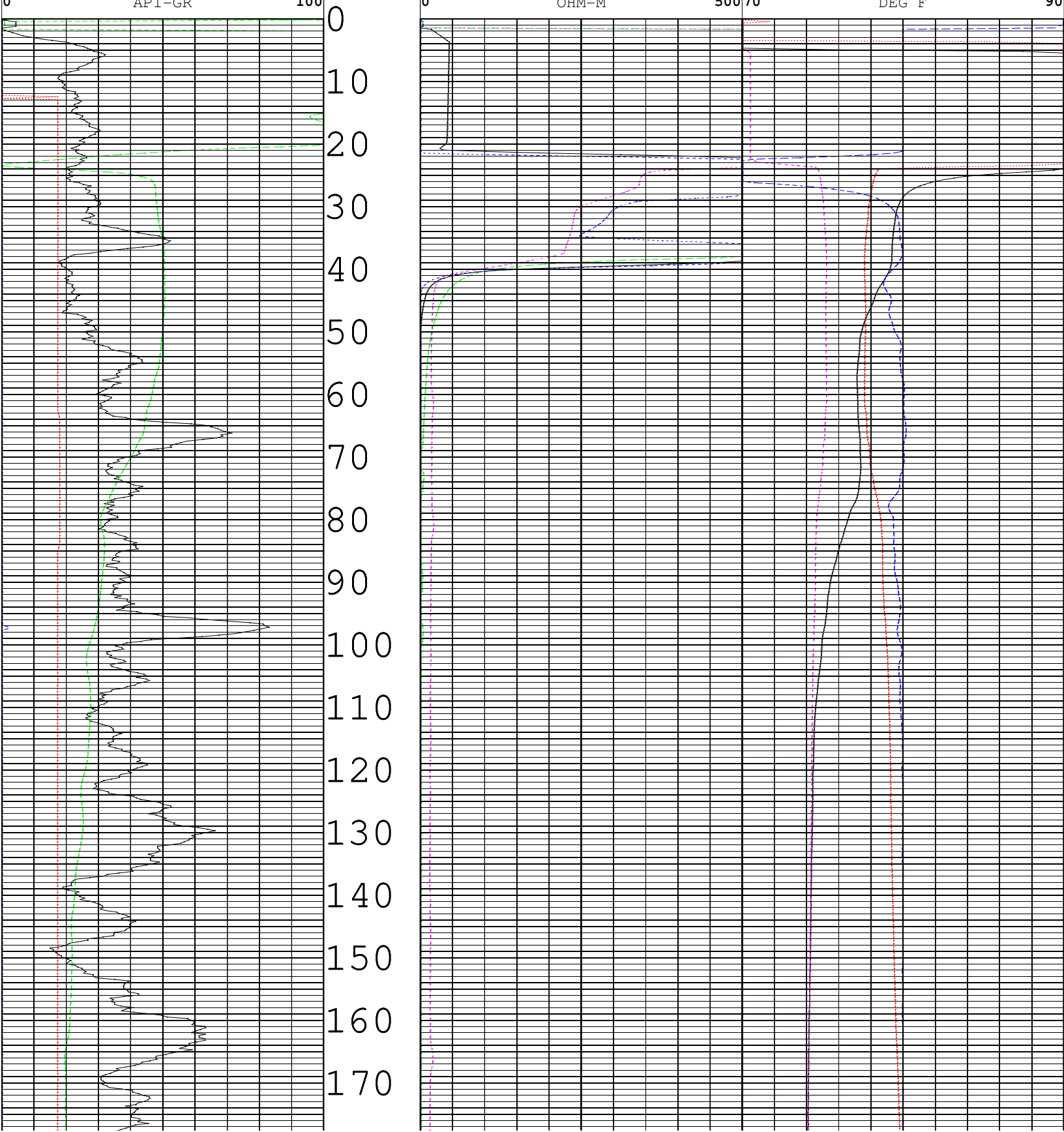
LOCATION	:	
SECTION	:	None
TOWNSHIP	:	None
RANGE	:	None
API NO.	:	
UNIQUE WELL ID.	:	

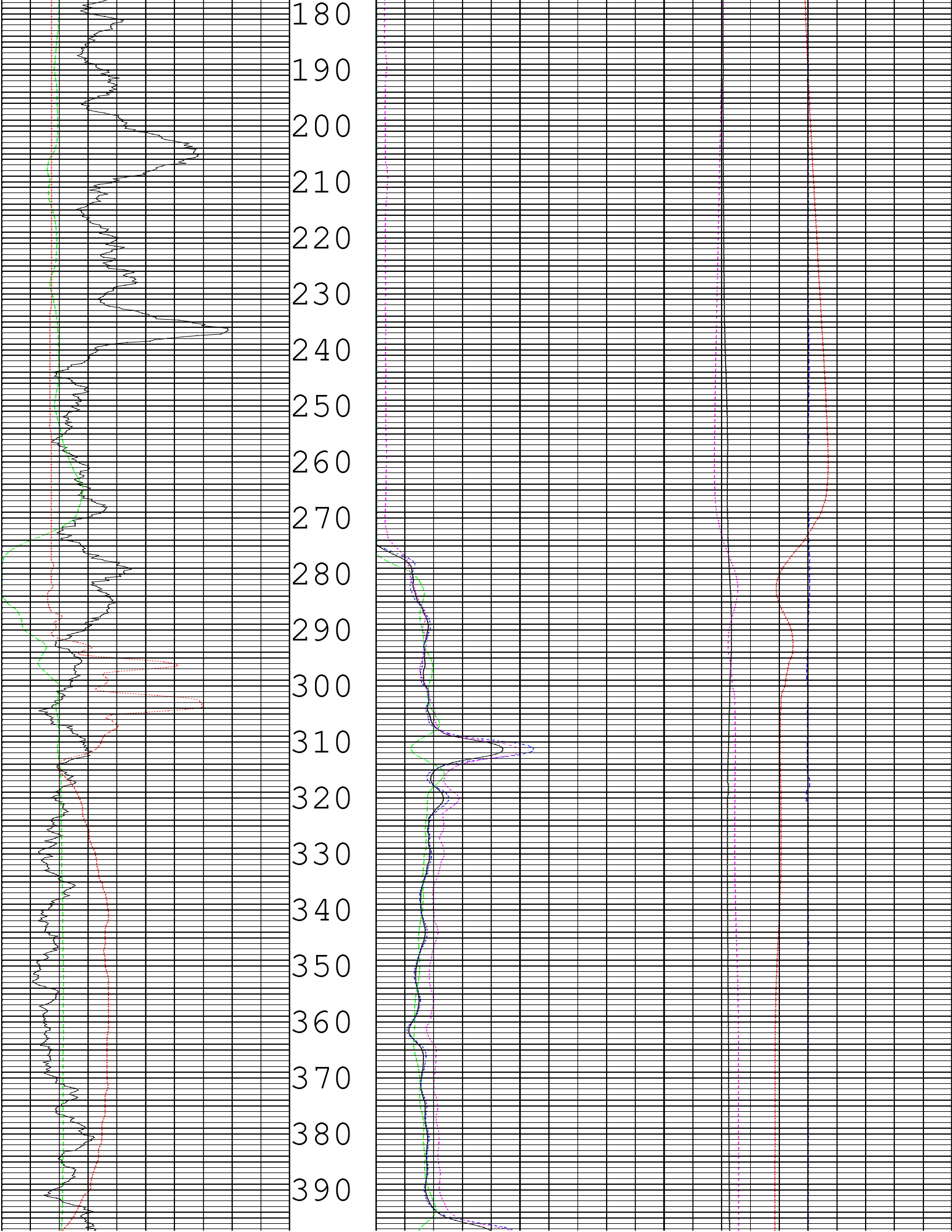
PERMANENT DATUM	:	MSL	ELEVATION KB:	None
LOG MEASURED FROM	:	TOP CAS	ELEVATION DF:	NA
DRL MEASURED FROM	:	NA	ELEVATION GL:	NA

DATE	:	07/19/17
DEPTH DRILLER	:	600
BIT SIZE	:	6
LOG TOP	:	-2.00
LOG BOTTOM	:	603.25
CASING OD	:	
CASING BOTTOM	:	280
CASING TYPE	:	STEEL
BOREHOLE FLUID	:	FOR
RM TEMPERATURE	:	0
MUD RES	:	0
MUD WEIGHT	:	
WITNESSED BY	:	
RECORDED BY	:	AFB
REMARKS 1	:	HQ CORE
REMARKS 2	:	

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

CALIPER			FEET	RES			SP COND		
0	INCH	25		0	OHM	500	0	US/CM	2000
SP				LATERAL			RES(FL)		
0	MV	500		0	OHM-M	500	0	OHM-M	50
GAMMA				RES(64N)			DEL TEMP		
100	API-GR	400		0	OHM-M	500	-0.5	DEG F	0.5
GAMMA				RES(16N)			TEMP		
0	API-GR	100		0	OHM-M	500	70	DEG F	90




180
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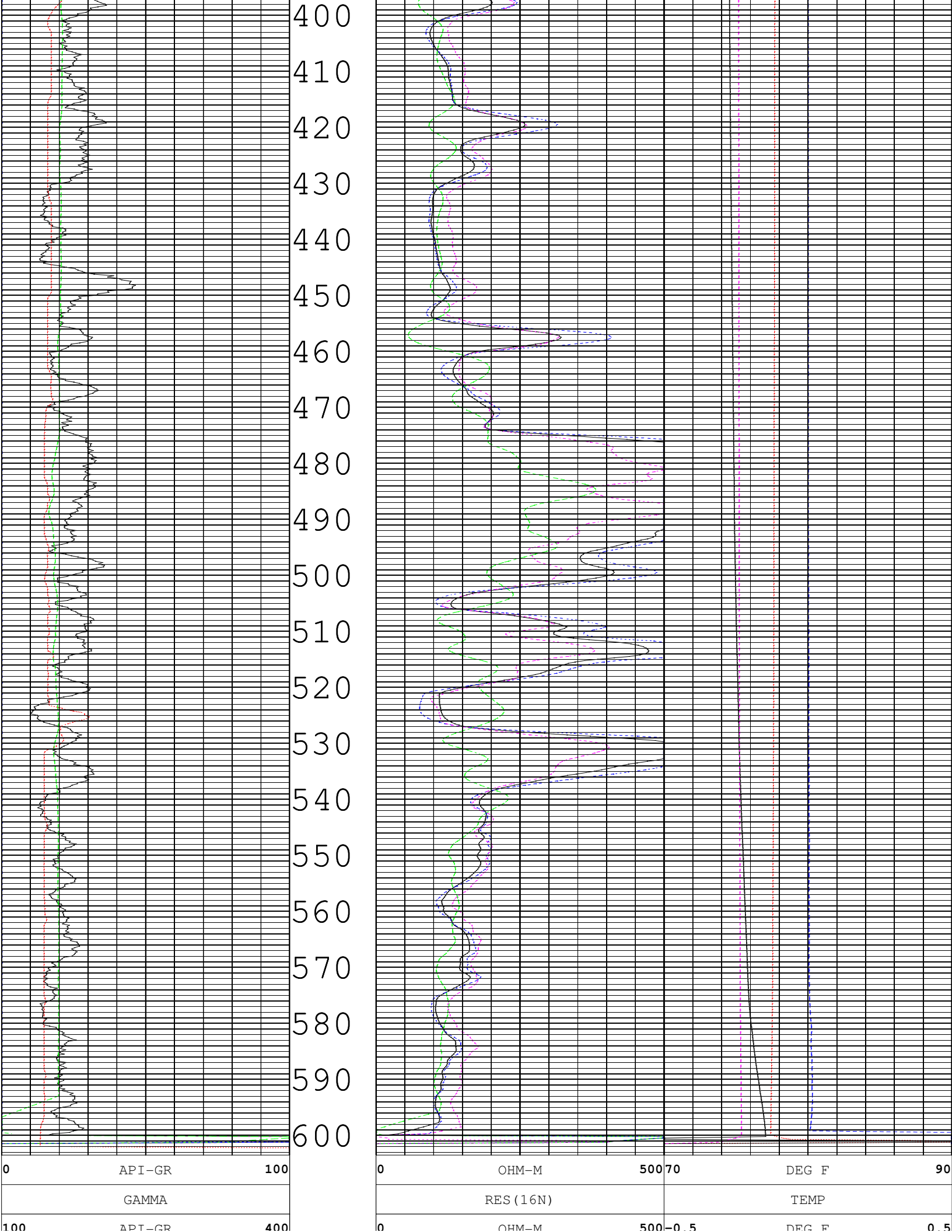
380
390


400
410
420
430
440
450
460
470
480
490
500
510
520
530
540
550
560
570
580
590
600
0
API-GR
100
GAMMA
100
API-GR
400
0
OHM-M
500
RES(16N)
0
OHM-M
500
70
DEG F
90
TEMP
-0.5
DEG F
0.5

200	API GR	100		0	OHM-M	500	0.5	DEG F	0.5
	GAMMA				RES(64N)			DEL TEMP	
0	MV	500		0	OHM-M	500	0	OHM-M	50
	SP				LATERAL			RES(FL)	
0	INCH	25		0	OHM	500	0	US/CM	2000
	CALIPER		FEET		RES			SP COND	

TOOL CALIBRATION OSF-110 07/19/17 11:15
TOOL 8044A TM VERSION 0
SERIAL NUMBER 938

	DATE	TIME	SENSOR	STANDARD			RESPONSE	
1	Jan03,03	10:49:05	GAMMA	0.001	[API-GR	]	0.00	[CPS]
	Jan03,03	07:49:05	GAMMA	180.000	[API-GR	]	169.00	[CPS]
2	May16,17	19:08:20	RES(FL	41.600	[OHM-M	]	54104.00	[CPS]
	May16,17	19:08:20	RES(FL	0.100	[OHM-M	]	11978.00	[CPS]
3	Aug17,14	17:00:23	SP	0.000	[MV	]	59670.00	[CPS]
	Aug17,14	17:00:23	SP	395.000	[MV	]	23612.00	[CPS]
4	Aug17,14	15:38:06	RES(16]	0.000	[OHM-M	]	4284.00	[CPS]
	Aug17,14	15:38:06	RES(16]	1996.000	[OHM-M	]	103525.00	[CPS]
5	Aug17,14	15:38:38	RES(64]	0.000	[OHM-M	]	4160.00	[CPS]
	Aug17,14	15:38:38	RES(64]	1990.000	[OHM-M	]	102789.00	[CPS]
6	Aug17,14	17:19:05	TEMP	71.700	[DEG F	]	63355.00	[CPS]
	Aug17,14	17:19:05	TEMP	81.500	[DEG F	]	58740.00	[CPS]
7	Aug17,14	15:39:11	RES	0.000	[OHM	]	9855.00	[CPS]
	Aug17,14	15:39:11	RES	988.000	[OHM	]	58788.00	[CPS]

ABS

Advanced Borehole Services

FULL WAVE BHC ACOUSTIC-VDL

OSF-110

COMPANY	:	HUSS DRILLING
WELL	:	OSF-110
FIELD	:	DESERET RANCH
COUNTY	:	OSCEOLA
STATE	:	FLORIDA

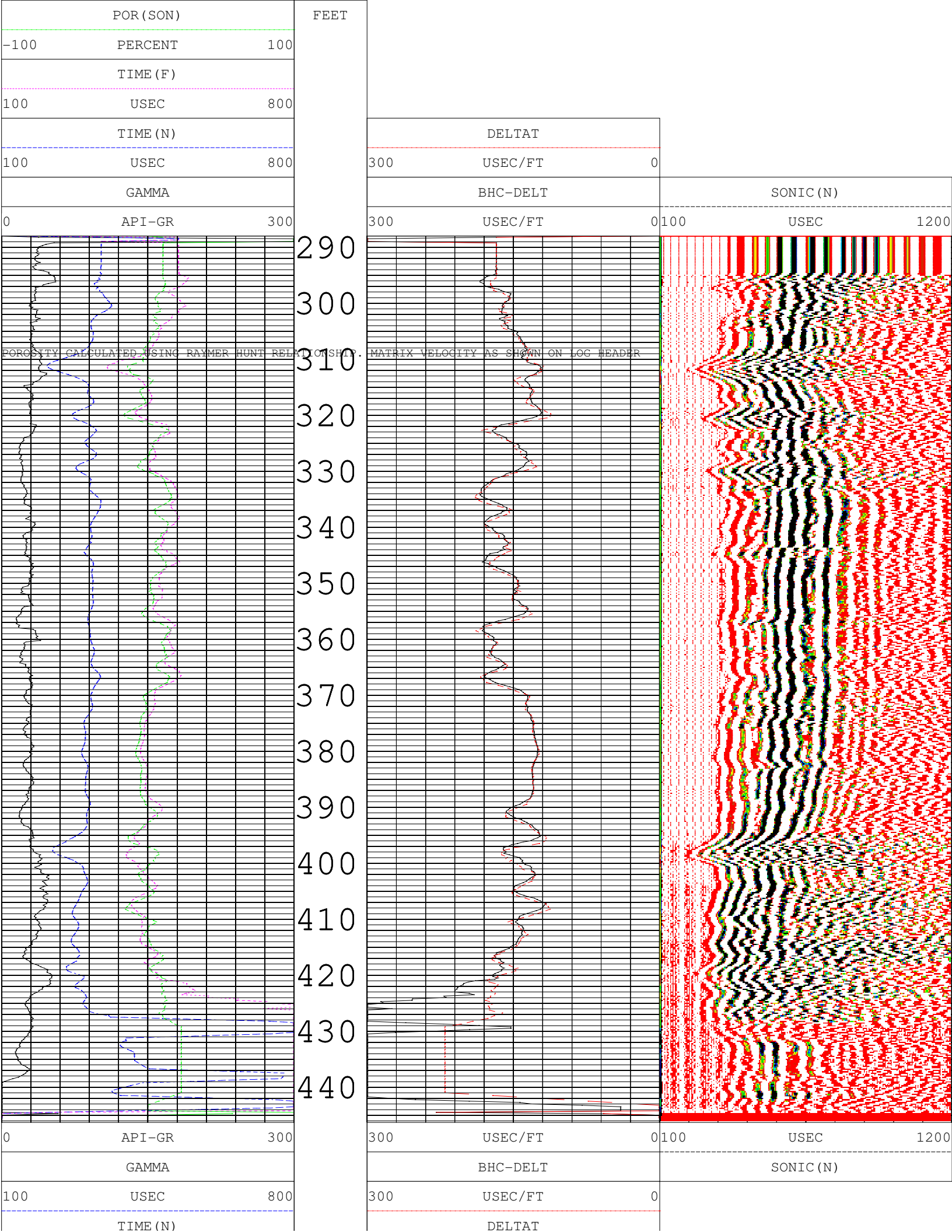
OTHER SERVICES:
8044
9320

LOCATION	:	
SECTION	:	None
TOWNSHIP	:	None
RANGE	:	None
API NO.	:	
UNIQUE WELL ID.	:	

PERMANENT DATUM	:	MSL	ELEVATION KB:	None
LOG MEASURED FROM	:	TOP CAS	ELEVATION DF:	NA
DRL MEASURED FROM	:	NA	ELEVATION GL:	NA

DATE	:	07/19/17
DEPTH DRILLER	:	600
BIT SIZE	:	6
LOG TOP	:	288.00
LOG BOTTOM	:	446.00
CASING OD	:	
CASING BOTTOM	:	280
CASING TYPE	:	STEEL
BOREHOLE FLUID	:	FOR
RM TEMPERATURE	:	0
MUD RES	:	0
MUD WEIGHT	:	
WITNESSED BY	:	
RECORDED BY	:	AFB
REMARKS 1	:	HQ CORE
REMARKS 2	:	

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS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TIME(N)
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GAMMA
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300 USEC/FT 0
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SONIC(N)
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POROSITY CALCULATED USING RAYMER HUNT RELATIONSHIP. MATRIX VELOCITY AS SHOWN ON LOG HEADER
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300 USEC/FT 0
100 USEC 1200
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BHC-DELT
SONIC(N)
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300 USEC/FT 0
TIME(N)
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FEET

TOOL CALIBRATION OSF-110 07/19/17 12:41
TOOL 9320A2 TM VERSION 0
SERIAL NUMBER 667

	DATE	TIME	SENSOR	STANDARD			RESPONSE	
1	Apr12,99	23:12:30	GAMMA	Default	[CPS]		Default	[CPS]
	Apr12,99	20:12:30	GAMMA	Default	[CPS]		Default	[CPS]

Company	Florida Design Drilling Corp.
Well	C-30
Field	St. Cloud
County	Osceola
State	Florida

Country USA

MV Geophysical

Company Florida Design Drilling Corp.
Well C-30
Field St. Cloud
County Osceola
State Florida
Country USA
Location Section 1 T-25-S R-31-E
South Springlake Lake St. Cloud
Lat. 28° 12' 12.0" N Long. 81° 12' 44.4" W
Elevation 7' G.L. 0 K.B. 0 D.F. 0 G.L.
API # 12-25-1-1333-00000-00
Elevation NONE
Date Run 1 Date Time 2018-03-09 12:00:00
Date Time Rec. 2018-03-09 12:00:00
Logging Unit 3
Operator Rick
Max Temp. 0 °F
Max Recorded Temp. 0 °F
Time Logger on Bottom 0
Equipment Code 1 GR-XY-CALIPER
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Company Florida Design Drilling Corp.
Well C-30
Field St. Cloud
County Osceola
State Florida
Country USA

X-Y CALIPER GAMMA RAY LOG

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Comments

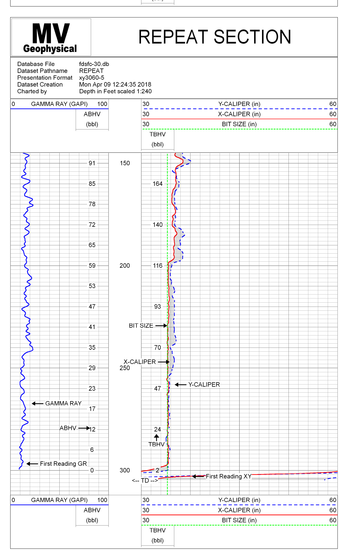
MAXIMUM ARM EXTENSION: 53"

BOREHOLE VOLUMES IN BARRELS

FUTURE CASING SIZE: 24"

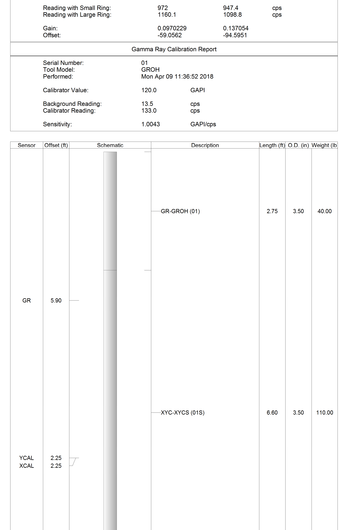
MAIN PASS

Database File fdsfc-30.db
Dataset Pathname MAIN
Presentation Format xy3060-5
Dataset Creation Mon Apr 09 12:20:34 2018
Charted by Depth in Feet scaled 1:240



REPEAT SECTION

Database File fdsfc-30.db
Dataset Pathname REPEAT
Presentation Format xy3060-5
Dataset Creation Mon Apr 09 12:24:35 2018
Charted by Depth in Feet scaled 1:240



Calibration Report

Database File fdsfc-30.db
Dataset Pathname pass2
Dataset Creation Mon Apr 09 11:53:03 2018

XY Caliper Calibration Report

Serial Number:	015		
Tool Model:	XYCS		
Performed:	Mon Apr 09 12:06:05 2018		
Small Ring:	35.25	in	
Large Ring:	53.5	in	
	X Caliper	Y Caliper	
Reading with Small Ring:	972	947.4	cps
Reading with Large Ring:	1160.1	1098.8	cps
Gain:	0.0970229	0.137054	
Offset:	-59.0562	-94.5951	

Gamma Ray Calibration Report

Serial Number:	01	
Tool Model:	GROH	
Performed:	Mon Apr 09 11:36:52 2018	
Calibrator Value:	120.0	GAPI
Background Reading:	13.5	cps
Calibrator Reading:	133.0	cps
Sensitivity:	1.0043	GAPI/cps

Sensor	Offset (ft)	Schematic	Description	Length (ft)	O.D. (in)	Weight (lb)
			GR-GROH (01)	2.75	3.50	40.00
GR	5.90					
			XYC-XYCS (01S)	6.60	3.50	110.00
YCAL	2.25					
XCAL	2.25					

Dataset: fdsfc-30.db: field/well/run1/pass2
Total length: 9.35 ft
Total weight: 150.00 lb
O.D.: 3.50 in

MV Geophysical

Company Florida Design Drilling Corp.
Well C-30
Field St. Cloud
County Osceola
State Florida
Country USA

Company	Florida Deepo Drilling Corp.
Well	DDF 111
Field	Dunnellon
County	Marion
State	Florida
Country	USA
Date	2018-03-13
Time	10:00:00
Operator	Dunnellon Phosphate Co.
Logging Co.	MV Geophysical
Log	DUAL INDUCTION LOG
Log Date	2018-03-13
Log Time	10:00:00
Log Number	1
Depth Reference	Ground Level
Elevation	0.00
Log Measured From	Ground Level
Drilling Measured From	Ground Level
Permanent Datum	Ground Level
Log Interval	1200.00
Casing Shoe	1200.00
Casing Driller	1200.00
Casing Logged	1200.00
Bottom Log Interval	1200.00
Top Log Interval	0.00
Drilling Fluid	Water
Fluid Level	Full
Max Rec Temp	0.00
Equipment	1200
Recorded By	Randolph Jr.
Witnessed By	Mr. Bryant

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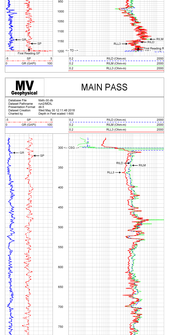
Contents

Randolph Jr @ .pvjf

MAIN PASS

Datafiles: 1600.00.dfl
Dataset Filename: 1600.pvjf
Presentation Format: dual
Dataset Created: Wed May 30 12:11:48 2018
Created by: Depth of Pick scaled: 1.000



Company	Trans Energy Drilling Inc.
Well	Ivy Unit 1
Field	Ivy Field
County	Wetzel
State	West Virginia
Date	10-Jan-2011
Time	10:00
Run No.	1
Depth Reference	KB
Elevation	1,240.00 ft
Log Measured From	KB
Permanent Datum	Ground Level
Drilling Measured From	KB
Casing Driller	13.375 @ 0.00 ft
Casing Logged	13.375 @ 0.00 ft
Bottom Driller	1,900.00 ft
Bottom Logged	1,900.00 ft
Top Log Interval	0.00 ft
Bottom Log Interval	1,900.00 ft
Type Fluid in Hole	Air
Density / Viscosity	- / -
Max Rec. Temp.	-
Estimated Cement Top	0.00 ft
Equipment	2 Arm Caliper
Witnessed By	Mr. Bob Wilson

Comments

Some Porosity was calculated from a sandstone matrix (ρ=2.65 g/cc).

MFC Gamma tool was operational.

MAIN PASS

Depth Scale: Hole Size: 8.75 in
Logging Speed: 30 ft/min
Depth Correction: Casing Shoe: 1,900.00 ft
Density Tool: Model: Mk II Gamma Density Sonde
Serial No.: 2108
Calibration: Date: Mar. 30, 2010 BY: STEVE
Gamma Ray Tool: Model: MGS
Serial No.: 2108
Calibration: Date: Mar. 30, 2010 BY: STEVE

GAMMA RAY (GAPI) 0 — 150
CALIPER (IN) 6 — 16
DENSITY (G/CC) 1.95 — 2.95
POROSITY (%) 45 — -15

Scale 1:240 (5"/100')

MAIN PASS

Depth Scale: Hole Size: 8.75 in
Logging Speed: 30 ft/min
Depth Correction: Casing Shoe: 1,900.00 ft
Density Tool: Model: Mk II Gamma Density Sonde
Serial No.: 2108
Calibration: Date: Mar. 30, 2010 BY: STEVE
Gamma Ray Tool: Model: MGS
Serial No.: 2108
Calibration: Date: Mar. 30, 2010 BY: STEVE

GAMMA RAY (GAPI) 0 — 150
CALIPER (IN) 6 — 16
DENSITY (G/CC) 1.95 — 2.95
POROSITY (%) 45 — -15

Scale 1:240 (5"/100')

MAIN PASS

Depth Scale: Hole Size: 8.75 in
Logging Speed: 30 ft/min
Depth Correction: Casing Shoe: 1,900.00 ft
Density Tool: Model: Mk II Gamma Density Sonde
Serial No.: 2108
Calibration: Date: Mar. 30, 2010 BY: STEVE
Gamma Ray Tool: Model: MGS
Serial No.: 2108
Calibration: Date: Mar. 30, 2010 BY: STEVE

GAMMA RAY (GAPI) 0 — 150
CALIPER (IN) 6 — 16
DENSITY (G/CC) 1.95 — 2.95
POROSITY (%) 45 — -15

Scale 1:240 (5"/100')

MAIN PASS

Depth Scale: Hole Size: 8.75 in
Logging Speed: 30 ft/min
Depth Correction: Casing Shoe: 1,900.00 ft
Density Tool: Model: Mk II Gamma Density Sonde
Serial No.: 2108
Calibration: Date: Mar. 30, 2010 BY: STEVE
Gamma Ray Tool: Model: MGS
Serial No.: 2108
Calibration: Date: Mar. 30, 2010 BY: STEVE

GAMMA RAY (GAPI) 0 — 150
CALIPER (IN) 6 — 16
DENSITY (G/CC) 1.95 — 2.95
POROSITY (%) 45 — -15

Scale 1:240 (5"/100')

REPEAT SECTION

Depth Scale: Hole Size: 8.75 in
Logging Speed: 30 ft/min
Depth Correction: Casing Shoe: 1,900.00 ft
Density Tool: Model: Mk II Gamma Density Sonde
Serial No.: 2108
Calibration: Date: Mar. 30, 2010 BY: STEVE
Gamma Ray Tool: Model: MGS
Serial No.: 2108
Calibration: Date: Mar. 30, 2010 BY: STEVE

GAMMA RAY (GAPI) 0 — 150
CALIPER (IN) 6 — 16
DENSITY (G/CC) 1.95 — 2.95
POROSITY (%) 45 — -15

Scale 1:240 (5"/100')

Scale: 1:240(5") Scale(cm): Resolution: Length (ft) 0.00 cm Width (in)

Depth Scale: Hole Size: 8.75 in (Schlumberger)
Logging Speed: 30 ft/min
Depth Correction: Casing Shoe: 1,900.00 ft

Company	Trans Energy Drilling Inc.
Well	Ivy Unit 1
Field	Ivy Field
County	Wetzel
State	West Virginia

MV Geophysical

Company	Florida Design Drilling Corp.
Well	GSF-111
Field	St. Cloud
County	Osceola
State	Florida
Country	USA

FLUID CONDUCTIVITY TEMPERATURE LOG

Company	Florida Design Drilling Corp.	Field	St. Cloud
Well	GSF-111	County	Osceola
Location	Florida	State	Florida
API #	1-0-0-0-0-0-0-0-0-0	Country	USA
Permanent Datum	Ground Level	Elevation	0 ft AGL
Log Measured From	Ground Level	Elevation	0 ft AGL
Drilling Measured From	Ground Level	Elevation	0 ft AGL
Date	21-MAY-2018		
Run Number	ONE		
Depth Driller	1200 ft		
Depth Logger	1200 ft		
Bottom Logged Interval	1200 ft		
Top Logged Interval	0 ft		
Casing Driller Size	0 in @ 0 ft		
Casing Logger Size	0 in @ 0 ft		
Bit Size	0 in		
Type Fluid in Hole	Water		
Density	0 lb/gal		
Viscosity	0 cp		
Max Rec Temp	0 deg F		
Estimated Surface Temp	0 deg F		
Equipment	MV-RTS-ONE		
Operator	Brandon		
Witnessed By	Brandon		

Run	Tool Serial No.	Tool Type	Top Log Int.	Bottom Log Int.	Hole Size	Tool Length	Max Temp	Time Rec.	Time Circ.
1	1	CCL	0 ft	1200 ft	0 in	4.46 ft	0 deg F	0 hr	0 hr
1	1	GR	0 ft	1200 ft	0 in	1.15 ft	0 deg F	0 hr	0 hr
1	1	TEMP	0 ft	1200 ft	0 in	0.10 ft	0 deg F	0 hr	0 hr

Run	Time	Depth	Speed	Comments
1	21-MAY-2018	0 ft	0 ft/min	Logging Begin
		1200 ft	0 ft/min	Logging End

*** Field Note ***

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Comments

STATIC and DYNAMIC down passes were performed. Cw=938 uS/cm @ 25 degC. Cr=4227 gpm.
FLUID CONDUCTIVITY CALIBRATION REPORT (Performed: 21-MAY-2018, 14:45)

uS/cm	CPS
1,224.1	2551.4
22,070	1926.6
125,000	1002.2

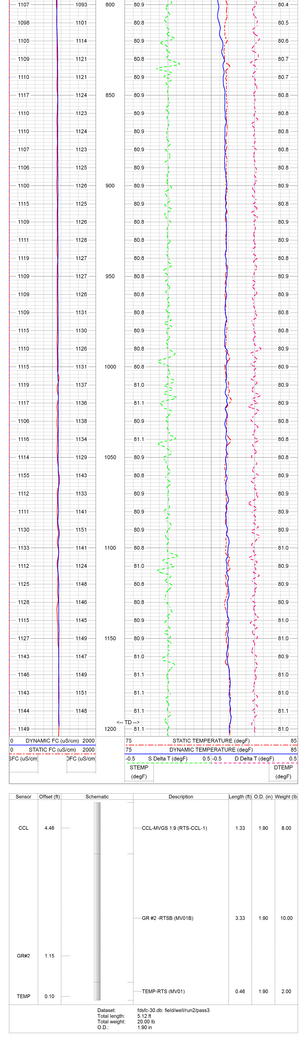
TEMPERATURE CALIBRATION REPORT (Performed: 21-MAY-2018, 14:15)

degF	CPS
36.9	149.1
147.3	2681.2

MV Geophysical

S/D Merged FCT

Database File	fdsfc-30.db
Dataset Pathname	run2/SDFC2
Presentation Format	fdsdc30
Dataset Creation	Thu May 31 18:30:03 2018
Charted by	Depth in Feet scaled 1:240



Sensor	Offset (ft)	Schematic	Description	Length (ft)	O.D. (in)	Weight (lb)
CCL	4.46		CCL-MVGS 1.9 (RTS-CCL-1)	1.33	1.90	8.00
			GR #2 -RTSB (MVG1B)	3.33	1.90	10.00
GR#2	1.15					
TEMP	0.10		TEMP-RTS (MVG1)	0.46	1.90	2.00

Dataset: fdsfc-30.db: field/well/run2/pass3
Total length: 5.12 ft
Total weight: 20.00 lb
O.D.: 1.90 in

MV Geophysical

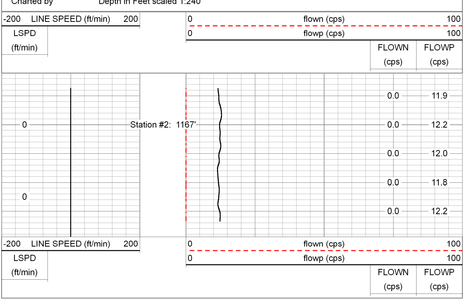
Company	Florida Design Drilling Corp.
Well	GSF-111
Field	St. Cloud
County	Osceola
State	Florida
Country	USA

Company	Mountain Valley Pipeline, LLC
Well	Station 14
Field	Station 14
County	Wetzel
State	West Virginia
Date	2/11/2020
Time	10:00:00
Operator	Mountain Valley Pipeline, LLC
Logging Company	Mountain Valley Pipeline, LLC
Logging Engineer	Mountain Valley Pipeline, LLC
Tool Type	Spectral Gamma Ray
Tool Serial Number	54227
Tool Length	10 ft
Tool Diameter	1.75 in
Logging Speed	50 fpm
Time Constant	1 sec
Sample Rate	0.5 sec
Log Type	Down
Log Direction	Down
Log Interval	0.5 in
Log Start Depth	0 ft
Log Stop Depth	1145 ft
Log Length	1145 ft
Log Start Time	10:00:00
Log Stop Time	10:38:00
Log Duration	38:00
Log Quality	Good
Log Comments	Logging Speed 50 fpm, Time Constant 1 sec, Sample Rate 0.5 sec, Log Interval 0.5 in, Log Start Depth 0 ft, Log Stop Depth 1145 ft, Log Length 1145 ft, Log Start Time 10:00:00, Log Stop Time 10:38:00, Log Duration 38:00, Log Quality Good

Mountain Valley Pipeline, LLC
Mountain Valley Pipeline, LLC
Mountain Valley Pipeline, LLC

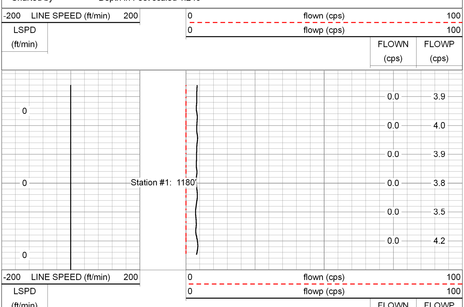
Station #2: 1167'

Database File	fdsfc-30.db
Dataset Pathname	run2/pass17
Presentation Format	flow
Dataset Creation	Thu May 31 16:16:08 2018
Charted by	Depth in Feet scaled 1:240



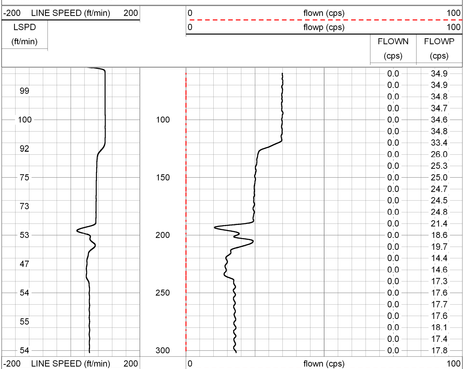
Station #1: 1180'

Database File	fdsfc-30.db
Dataset Pathname	run2/pass16
Presentation Format	flow
Dataset Creation	Thu May 31 16:13:18 2018
Charted by	Depth in Feet scaled 1:240



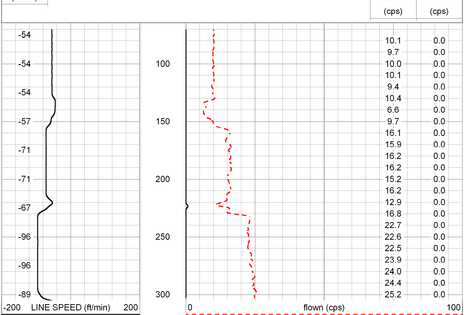
Q Calibration Down

Database File	fdsfc-30.db
Dataset Pathname	run2/pass10
Presentation Format	flow
Dataset Creation	Wed May 30 13:33:34 2018
Charted by	Depth in Feet scaled 1:600



Q Calibration Up

Database File	fdsfc-30.db
Dataset Pathname	run2/pass11
Presentation Format	flow
Dataset Creation	Wed May 30 13:37:59 2018
Charted by	Depth in Feet scaled 1:600



Sensor	Offset (ft)	Schematic	Description	Length (ft)	O.D. (in)	Weight (lb)
FLOWN	0.00		FLOW-LARGE (65)	4.80	3.75	35.00
FLOWP	0.00					

Dataset:	fdsfc-30.db: field/well//run2/pass13
Total length:	4.80 ft
Total weight:	35.00 lb
O.D.:	3.75 in

Company	Florida Design Drilling Corp.		
Well	OSF-111		
Field	St. Cloud		
County	Osceola		
State	Florida	Country	USA

Company	Florida Design Drilling Corp.	Country (CC)	
Well	CGP-111	Job	
Field	St. Cloud	Operator	Florida Design Drilling Corp.
County	Osceola	Rig	DC-111
State	Florida	Date	2018-10-15

MV Geophysical

FLOWMETER INTERPRETATION

Dataset File	9dh30.db	Dataset Name	run2pass9
Presentation Format	flow3D	Dataset Creation	Tue Jun 05 10:57:23 2018
Charted by	Depth in Feet scaled 1:240		

Logging Company	Florida Design Drilling Corp.	Well	CGP-111
Field	St. Cloud	County	Osceola
State	Florida	Country	USA
Latitude		Longitude	
Elevation		Datum	
Log Measured From		Drilling Measured From	
Permanent Datum		Elevation	
Date	2018-10-15	Run Number	7
Depth Driller		Depth Logger	
Depth Logged		Bottom Log Interval	
Top Log Interval		Casing Driller	
Casing Logger		Bit Size	
Type Fluid in Hole		Density / Viscosity	
PH / Fluid Loss		Source of Sample	
Rm @ Meas. Temp.		Rmf @ Meas. Temp.	
Rmc @ Meas. Temp.		Source Rmf / Rmc	
Rm @ BHT		Time Since Circulation	
Time Since Circ.		Max. Rec. Temp.	
Equip. Location		Recorded By	
Witnessed By			

Bit Size (in)	Type Fluid	Density (lb/gal)	Viscosity (cp)	PH	Fluid Loss (ml)	Source	Rm @ Meas. Temp.	Rmf @ Meas. Temp.	Rmc @ Meas. Temp.

Equipment	Location	Hours	Equipment	Location	Hours	Equipment	Location	Hours

Comments			

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Comments

Both "RAW" and "LOGICAL" Q, %Q and Fluid Velocity are merged into one presentation; the "RAW" curves are Line Speed and Caliper corrected; the interpretative "LOGICAL" curves are further enhanced by the assumption of no thief zones (i.e., Q & %Q can only increase).

STATIC and DYNAMIC down passes were performed @ 50 fpm. 14x stations performed.

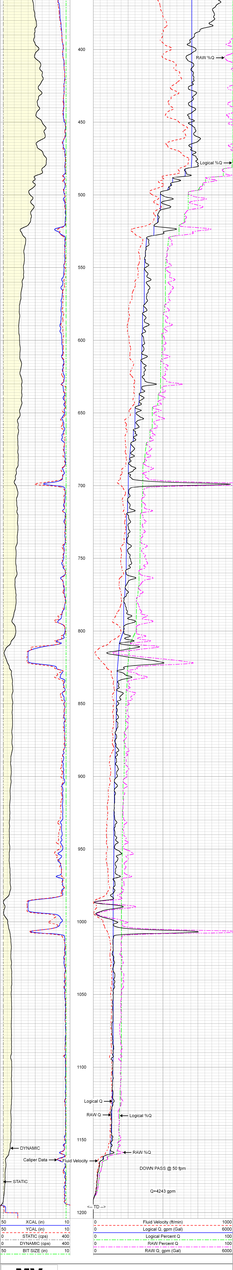
Q=4243 gpm (as calculated from Q Calibration Down and Station #14)

MV Geophysical — Logical/Raw F.Vel., Q & %Q

Dataset File	9dh30.db	Dataset Name	run2pass9
Presentation Format	flow3D	Dataset Creation	Tue Jun 05 10:57:23 2018
Charted by	Depth in Feet scaled 1:240		

50	XCAL (in)	10	
50	YCAL (in)	10	
0	STATIC (cps)	400	
0	DYNAMIC (cps)	400	
50	BIT SIZE (in)	10	

0	Fluid Velocity (ft/min) 1000
0	Logical Q. gpm (Gal) 6000
0	Logical Percent Q 100
0	RAW Percent Q 100
0	RAW Q. gpm (Gal) 6000



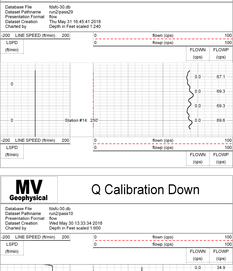
50	XCAL (in)	10	
50	YCAL (in)	10	
0	STATIC (cps)	400	
0	DYNAMIC (cps)	400	
50	BIT SIZE (in)	10	

0	Fluid Velocity (ft/min) 1000
0	Logical Q. gpm (Gal) 6000
0	Logical Percent Q 100
0	RAW Percent Q 100
0	RAW Q. gpm (Gal) 6000

MV Geophysical — Logical/Raw F.Vel., Q & %Q

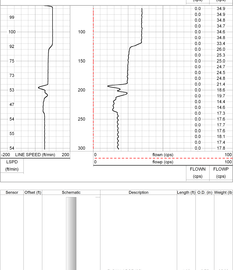
MV Geophysical — Station #14: 250'

Dataset File	9dh30.db	Dataset Name	run2pass9
Presentation Format	flow3D	Dataset Creation	Thu May 31 18:45:41 2018
Charted by	Depth in Feet scaled 1:240		



MV Geophysical — Q Calibration Down

Dataset File	9dh30.db	Dataset Name	run2pass13
Presentation Format	flow3D	Dataset Creation	Wed May 30 10:33:54 2018
Charted by	Depth in Feet scaled 1:600		



Sensor	Offset (ft)	Schematic	Description	Length (ft)	O.D. (in)	Weight (lb)
			FLOW LARGE (65)	4.80	3.75	35.00

FLOWN 0.00
FLOWP 0.00

Dataset: 9dh30.db: flex9dwlrun2pass13
Total length: 4.80 ft
Total weight: 35.00 lb
O.D: 3.75 in

Company	Florida Design Drilling Corp.		
Well	CGP-111		
Field	St. Cloud		
County	Osceola		
State	Florida	Country	USA

Company	Florida Design Drilling Corp.
Well	OSF-111
Field	St. Cloud
County	Osceola
State	Florida
Country	USA

MV Geophysical

KY-CALIPER
GAMMA RAY
OR RAY

Florida Design Drilling Corp.
OSF-111
St. Cloud
Osceola
Florida
USA

Date	10/10/2018	Time	10:00:00
Depth	0	Speed	0
Tension	0	Cable	0
Gamma	0	Cable	0
Caliper	0	Cable	0
Temp	0	Cable	0
Cable	0		

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Comments

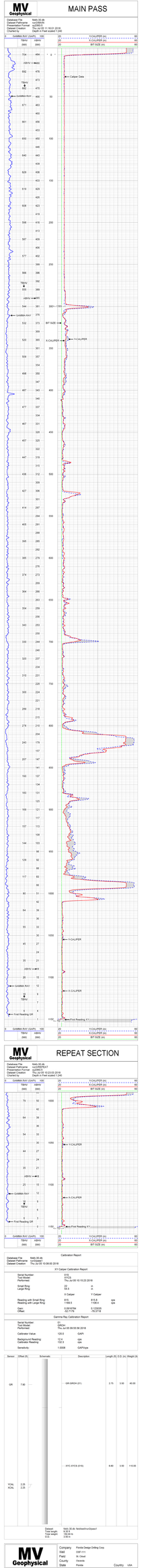
MAXIMUM ARM EXTENSION: 54"

BOREHOLE VOLUMES IN BARRELS

FUTURE CASING SIZE: 14" OD

MAIN PASS

Database File: Math.00.db
Dataset Pathname: sc0390/4b
Presentation Format: sc0390-01
Dataset Creation: Thu Jul 05 11:16:01 2018
Charted by: Depth in Feet scaled 1:240



REPEAT SECTION

Database File: Math.00.db
Dataset Pathname: sc0390/5-47
Presentation Format: sc0390-01
Dataset Creation: Thu Jul 05 12:23:03 2018
Charted by: Depth in Feet scaled 1:240

Calibration Report

Database File: Math.00.db
Dataset Pathname: sc0390/cal
Dataset Creation: Thu Jul 05 10:58:00 2018

XY Caliper Calibration Report

Serial Number:	6115		
Tool Model:	XYCI3		
Performed:	Thu Jul 05 10:10:23 2018		
Small Ring:	12	in	
Large Ring:	24.5	in	
	X Caliper	Y Caliper	
Reading with Small Ring:	8.03	8.15.8	cps
Reading with Large Ring:	118.5	1108.4	cps
Gain:	0.0918784	0.123035	
Offset:	-52.7176	-76.3718	

Gamma Ray Calibration Report

Serial Number:	111	
Tool Model:	GRDH	
Performed:	Thu Jul 05 09:55:56 2018	
Calibrator Value:	120.0	GAPI
Background Reading:	12.4	cps
Calibrator Reading:	132.3	cps
Sensitivity:	1.0008	GAPI/cps

Sensor	Offset (ft)	Schematic	Description	Length (ft)	O.D. (in)	Weight (lb)
GR	7.90		GR-GRDH (01)	2.75	3.50	40.00
			KYC-KYCS (0135)	6.80	3.50	110.00
YCAL	2.25					
XCAL	2.25					

Dataset: Math.00.db: NoStatusFromDataset1
Total length: 9.35 ft
Total weight: 150.00 lb
O.D.: 3.50 in

MV Geophysical

Company	Florida Design Drilling Corp.
Well	OSF-111
Field	St. Cloud
County	Osceola
State	Florida
Country	USA

Company	Florida Design Drilling Corp.
Well	CGP-111
Field	St. Cloud
County	Osceola
State	Florida
Country	USA
Date	10/4/2018
Time	10:00
Depth	1500
Speed	30
Tool	DT,GR,VDL
Tool Serial	2,1,1,1
Tool Length	15.00
Tool Weight	1000.00
Tool Diameter	3.625
Tool Type	Sonic Porosity
Tool Mode	Pulse Echo
Tool Status	Normal
Calibration Date	10/4/2018
Calibration Time	10:00
Calibration Type	Air
Calibration Value	0.00
Calibration Tolerance	0.00
Calibration Offset	0.00
Calibration Speed	0.00
Calibration Pulse	0.00
Calibration Gain	0.00
Calibration Amplitude	0.00
Calibration Error	0.00
Calibration Status	Normal
Calibration Comment	
Comments	
Comments	
Comments

Company	Florida Design Drilling Corp.
Well	CSP-111
Field	St. Cloud
County	Osceola
State	Florida
Country (CC)	USA
Date	06-Jul-2018
Latitude (DD.DDDDD)	28.24000
Longitude (DDD.DDDDD)	-81.11000
Elevation (Feet)	0.00
Datum	WGS-84
Log Interval	0.0 - 1500.0
Log Type	Dual Induction Calibration Report
Log Date	06-Jul-2018
Log Time	13:05:18
Log Number	1
Log Speed (Feet/Hour)	1200
Log Direction	Down
Tool Type	1.75" Dual Induction
Tool Serial Number	5390-R
Tool Length (Feet)	34.00
Tool Diameter (Inches)	4.00
Tool Weight (Pounds)	345.00
Max Temperature (Deg. C)	60.00
Max Pressure (PSI)	5000.00
Mud Type	Water
Mud Density (Lb/Gal)	8.33
Mud Viscosity (Sec)	28.00
Mud Resistivity (Ohm-m)	0.200
Mud Temperature (Deg. C)	23.00
Mud Resistivity Measured Temperature (Deg. C)	23.00
Mud Resistivity Calculated

Company	Florida Design Drilling Corp.		
Well	31-1		
Field	St. Cloud		
County	Osceola		
State	Florida	Country	USA
Latitude		Longitude	
Elevation		Datum	
Log Date	15-Dec-2018	Run No.	1
Depth Reference	KB	Elevation	
Depth Datum	Ground Level	Elevation	
Depth Drilled	1,500.0 ft	Depth Logged	1,500.0 ft
Depth Logged	1,500.0 ft	Depth Interval	0.0 ft - 1,500.0 ft
Log Interval	0.0 ft - 1,500.0 ft	Log Speed	30.0 ft/min
Mud Type	Water	Mud Density	
Mud Viscosity		Mud Resistivity	
Max Temp		Max Rec Time	
Bit Size	8 3/4 in	Casing Size	8 5/8 in
Casing Depth	1,500.0 ft	Casing Weight	24.0 lb/ft
Casing Type	Steel	Casing Grade	J-55
Casing Shoe	1,500.0 ft	Casing Shoe Depth	1,500.0 ft
Cement Top	Surface	Cement Type	Class A
Cement Volume	1,000.0 sx	Cement Density	15.8 lb/gal
Cement Yield	1.15 ft³/sk	Cement Water	5.0 gal/sk
Cement Retarder	Yes	Cement Additive	Yes
Cement Fill	100 %	Cement Top	Surface
Cement Bottom	1,500.0 ft	Cement Method	Circulated
Cement Excess	100 %	Cement Slurry	1,000.0 sx
Cement Slurry

MV Geophysical

FLUID CONDUCTIVITY TEMPERATURE LOG

Company	Florida Design Drilling Corp.
Well	OSF-111
Field	St. Cloud
County	Osceola
State	Florida
Country	USA

Location: API # : 12-25-31-3333-0020-0000

South Florida Water Management District
Sunnygrove Lane, St. Cloud - C-30 Canal
Lat.: 28 19' 31.48" N Long.: 081 10' 06.44" W
SEC 12 TWP 25S RGE 31E

Power Services: XY/GR.DIL, BHC.FLO, FCT.DHTV

Elevation: K.B. D.F. G.L.

Permanent Datum	G.L.	Elevation	
Log Measured From	G.L.		
Drilling Measured From	G.L.		

Company	Florida Design Drilling Corp.
Well	OSF-111
Field	St. Cloud
County	Osceola
State	Florida
Country	USA

Date	18-SEP-2018
Run Number	FOUR
Depth Driller	1653'
Depth Logger	NA
Bottom Logged Interval	1500'
Top Log Interval	1145'
Open Hole Size	12.25"
Type Fluid	H20
Density / Viscosity	NANA
Max. Recorded Temp.	see FCT log
Estimated Cement Top	SURFACE
Time Well Ready	07:30 9/18/2018
Time Logger on Bottom	14:30 9/18/2018
Equipment Number	MVSS-1
Location	Fort Myers
Recorded By	S.Miller/C.Miller — N.Glenn (FDD)
Witnessed By	B.Collins (SFWMD) L.Lindstrom (SFWMD) — B.Balmer (FDD)

Borehole Record

Run Number	Bit	From	To
ONE	34"	40'	305'
TWO	12.25"	300'	1200'
THREE	22"	300'	1152'
FOUR	12.25"	1653'	

Tubing Record

Size	Weight	From	To

Casing Record	Size	Wgt/Ft	Top	Bottom
Surface String	36"	0.375" WT	SURFACE	40'
Prod. String	24"	0.375" WT	SURFACE	300'
Production String	14"	0.375" WT	250'	1145'
Liner				

Invoice No. 2018136 3x/pdf/as fdsfc-30.db * FINAL PRINT *

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Comments

A STATIC down pass was performed. Cw=7575 uS/cm @ 28.6 degC (from FCT near bottom). NO Sample
FLUID CONDUCTIVITY CALIBRATION REPORT (Performed: 27-AUG-2018, 13:45)

uS/cm	CPS
1413.5	2562.5
22.035	1928.3
125.100	1503.4

TEMPERATURE CALIBRATION REPORT (Performed: 27-AUG-2018, 13:15)

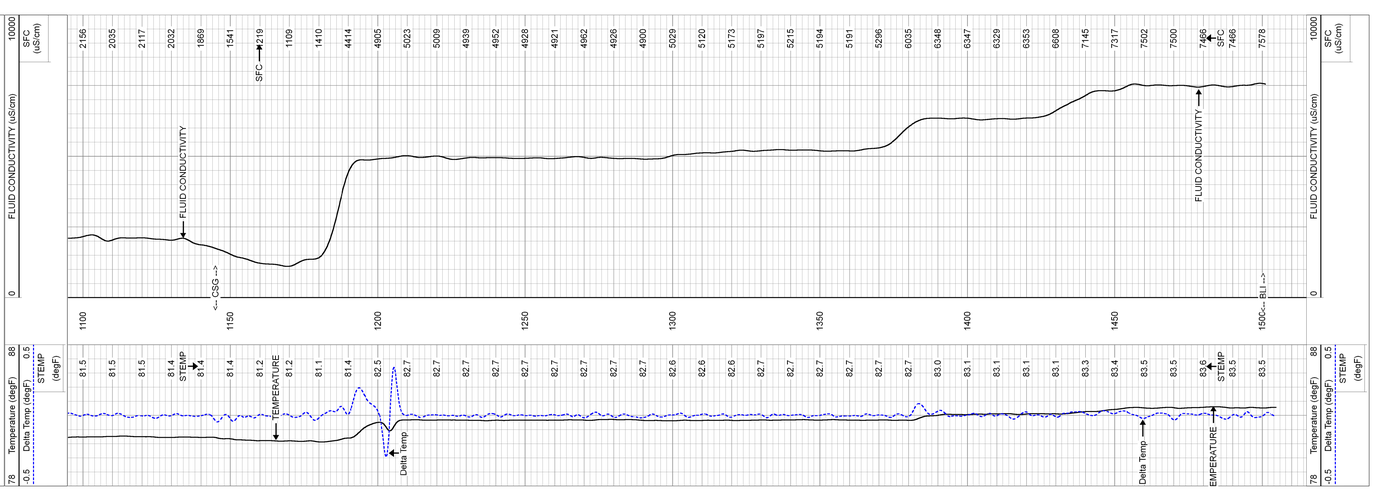
degF	CPS
39.6	149.6
147.3	2576.5

Log is not presented as SPECIFIC CONDUCTIVITY.

STATIC FCT DOWN

MV Geophysical

Database File fdsfc-30.db
Dataset Pathname run4/SFCT
Presentation Format fct-static1
Dataset Creation Thu Sep 27 18:16:09:37 2018
Charted by Depth in Feet scaled 1:240



Sensor	Offset (ft)	Schematic	Description	Length (ft)	O.D. (in)	Weight (lb)
CCL	4.46		CCL-MVGS 1.9 (RTS CCL 1)	1.33	1.90	8.00
GR#2	1.15		GR #2 - RTSB (MV01B)	3.33	1.90	10.00
TEMP	0.10		TEMP-RTS (MV01)	0.46	1.90	2.00

Dataset: fdsfc-30.db: field/well/run4/pass7
Data length: 1,52 ft
Total weight: 20.00 lb
O.D.: 1.90 in

Company	Florida Design Drilling Corp.
Well	OSF-111
Field	St. Cloud
County	Osceola
State	Florida
Country	USA

MV Geophysical

FLOWMETER LOG

MV Geophysical

Company: Florida Design Drilling Corp.
Well: OSF-111
Field: St. Cloud
County: Osceola
State: Florida
Country: USA

Company: Florida Design Drilling Corp.
Well: OSF-111
Field: St. Cloud
County: Osceola
State: Florida
Country: USA
API #: 12-25-1-33333-00000
Location: Sonnenport Lake S. Canal - 2.00 miles
Lat: 28° 12' 12" N Long: 81° 16' 44" W
Elevation: G.L. 0 ft; K.B. 0 ft; D.F. 0 ft
Date: 2018-09-30
Run Number: 1
Depth Driller: 1600
Depth Logged: 1600
Top Log Interval: 0
Bottom Log Interval: 1600
Casing Driller: 1600 @ 0
Casing Logger: 1600
Bit Size: 12.25 in
Type Fluid in Hole: Water
Density: 1.0 g/cm3
Viscosity: 0 cp
Fluid Level: 0 ft
Max Recorded Temp: 0 deg F
Estimated Cement Top: 0
Time Logger on Bottom: 0:00:00
Unit Number: 0
Equipment: 0
Location: 0
Recorded By: J. Lindsey
Witnessed By: J. Allen

Service Order	Resistivity	Temperature	Density	Porosity	Viscosity	Calipers	Other Services

Equipment	Serial No.	Type	Size	Weight	Fluid	To
Sonde Type						
Sonde Centralizer						
Logging Speed (fpm)	30					
Depth Control						
Depth Check						
Weight Indicator						
Tension						
Blocked To Drum						
Line Speed Anomaly						
Length Measured From	KB					
Casing Collar Locator						
Cable Type						
Cable Length	1600					
Prime Mover						
Height Above Perm. Datum	0					
Depth Datum	GL					
Elevation	0					
Logging Method						
Logging Company						
Operating Rig Time						
Logging Time						
Logging Date						
Logging Truck No.						
Logging Engineer						
Operator						
Truck Number						

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Comments

STATIC and DYNAMIC DOWN passes were performed @ 50 fpm.

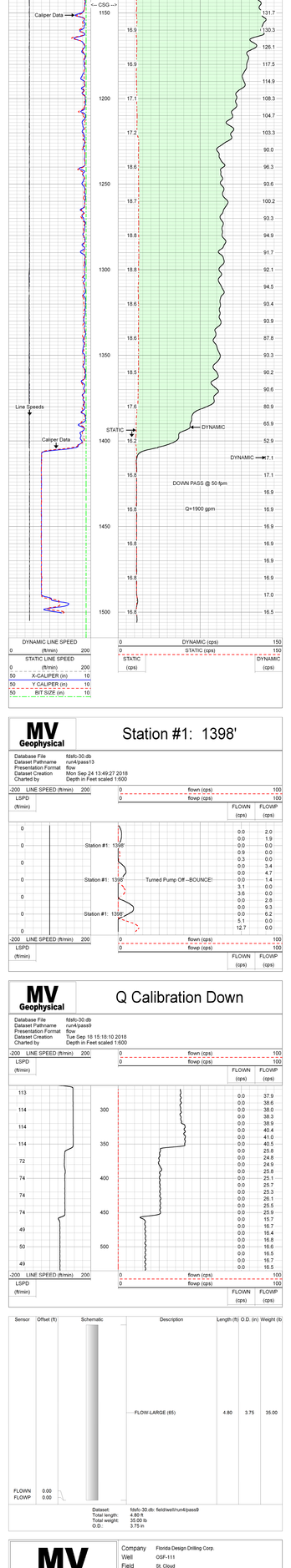
NO stations performed.

Q=~1900 gpm

S/D Down@50fpm&1900gpm

MV Geophysical

Database File: fdsfc-30.db
Dataset Pathname: run4:60250
Presentation Format: q150
Dataset Creation: Mon Sep 24 15:02:52 2018
Charted by: Depth in Feet scaled 1:240



Station #1: 1398'

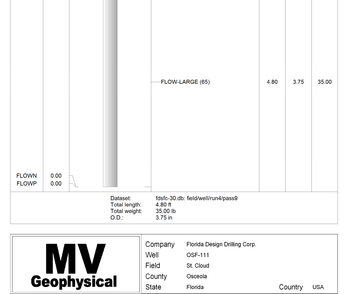
MV Geophysical

Database File: fdsfc-30.db
Dataset Pathname: run4:pass13
Presentation Format: flow
Dataset Creation: Mon Sep 24 13:49:27 2018
Charted by: Depth in Feet scaled 1:600

Q Calibration Down

MV Geophysical

Database File: fdsfc-30.db
Dataset Pathname: run4:pass9
Presentation Format: flow
Dataset Creation: Tue Sep 18 15:18:10 2018
Charted by: Depth in Feet scaled 1:600



Sensor	Offset (ft)	Schematic	Description	Length (ft)	O.D. (in)	Weight (lb)
FLOWN	0.00		FLOW-LARGE (65)	4.80	3.75	35.00
FLOWP	0.00					

Dataset: fdsfc-30.db: field/well/run4/pass9
Total length: 4.80 ft
Total weight: 35.00 lb
O.D.: 3.75 in

MV Geophysical

Company: Florida Design Drilling Corp.
Well: OSF-111
Field: St. Cloud
County: Osceola
State: Florida
Country: USA

MV Geophysical

FLOWMETER LOG

Company	Florida Design Drilling Corp.
Well	OSF-111
Field	St. Cloud
County	Osceola
State	Florida
Country	USA

Company Florida Design Drilling Corp.
Well OSF-111
Field St. Cloud
County Osceola
State Florida
Country USA

Location: API # 12-25-31-333-0020-0000 Section Township Range
Southbound Lane St. Cloud - 30 Center
Lat: 28 15' 47" N Long: 081 18' 36.44" W
28.131 N 12 25 31 S 33E E
Permanent Datum: GL Elevation 0 ft
Log Measured From: KB 15 ft above Permanent Datum
Drilling Measured From: GL

Date	8-28-2018		
Run Number	ONE		
Depth Driller	1100		
Depth Logged Interval	1100		
Top Log Interval	0		
Open Hole Size	12.25		
Type Fluid in Hole	WATER		
Max Rec Temp	104F		
Estimated Surface Temp	75F		
Equipment Number	14-MV-01		
Location	Orlando		
Recorded By	S.Martel, Miller		
Witnessed By	E.Collins (DFMMC)	L.Lundstrom (Utility Wrkrs)	D.Glenn (FGO)

Casing Record	Size	Weight	Top	Bottom
Surface	8 5/8"	24#	0	300
Production	5 1/2"	17#	0	1100

Tubing Record	Size	Weight	Top	Bottom
Tubing	2 3/8"	4.7#	0	1100

Perforation Record	Size	Shots/Ft	Top	Bottom
Perforations	NONE			

Cable Head	Type
Cable Head Type	Rope Socket

Tool String	Type	Length	Diameter
Top Tool	FLOWMETER	4.80	3.75
Bottom Tool			

Flowmeter	Serial #	Calibration Date	Calibration Method
Flowmeter	15-FMS-2018	07-31-2018	Spinner

Spinner Calibration			
Slope	1.0000		
Offset	0.0000		

Fluid Properties		
Fluid Type	Water	Salinity 0 PPM
Fluid Density	1 SG	Viscosity 1 CP
Fluid Resistivity	5000 OHM-M	@ 75 F

Log Header Comments
Log Header Comments
Log Footer Comments
Log Footer Comments

Log Header Comments
Log Header Comments
Log Footer Comments
Log Footer Comments

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Comments

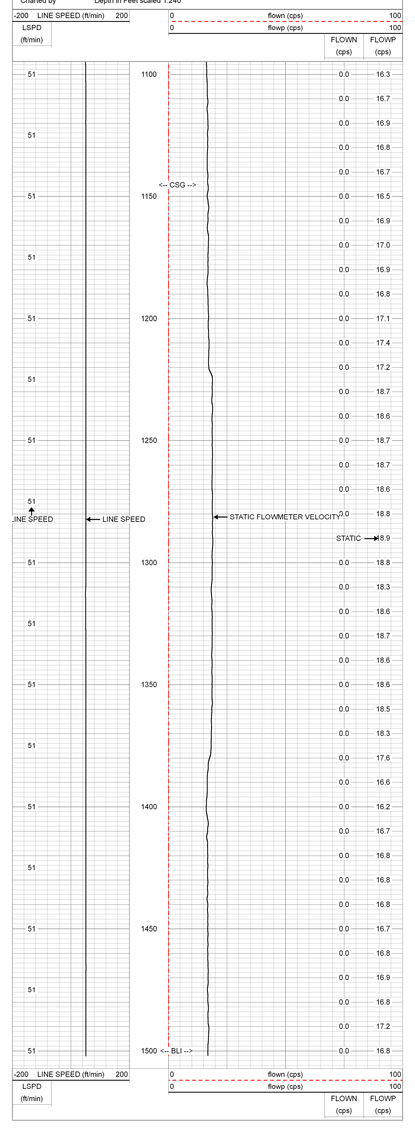
A STATIC down pass was performed at 50 fpm.

NO Stations performed (NO FLOW)

MV Geophysical

STATIC FLOW DOWN

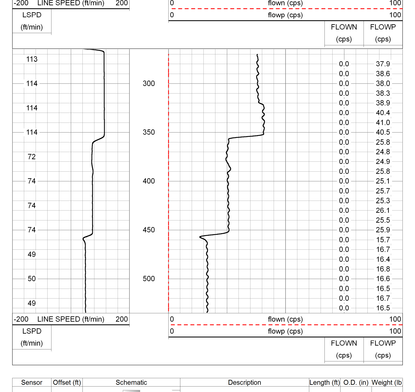
Database File fdsfc-30.db
Dataset Pathname run4/pass10
Presentation Format flow
Dataset Creation Tue Sep 18 15:28:36 2018
Charted by Depth in Feet scaled 1:240



MV Geophysical

Q Calibration Down

Database File fdsfc-30.db
Dataset Pathname run4/pass9
Presentation Format flow
Dataset Creation Tue Sep 18 15:18:10 2018
Charted by Depth in Feet scaled 1:600



Sensor	Offset (ft)	Schematic	Description	Length (ft)	O.D. (in)	Weight (lb)
FLOWN	0.00		FLOW-LARGE (65)	4.80	3.75	35.00
FLOWP	0.00					

Dataset: fdsfc-30.db: field/well/run4/pass9
Total length: 4.80 ft
Total weight: 35.00 lb
O.D.: 3.75 in

MV Geophysical

Company	Florida Design Drilling Corp.
Well	OSF-111
Field	St. Cloud
County	Osceola
State	Florida
Country	USA

FLOWMETER LOG

MV Geophysical

Company: Florida Design Drilling Corp.
Well: OSF-111
Field: St. Cloud
County: Osceola
State: Florida
Country: USA

Company: Florida Design Drilling Corp.
Well: OSF-111
Field: St. Cloud
County: Osceola
State: Florida
Country: USA
API #: 12-25-1-33333-00000
Location: Sonnenport Lake S. Canal - 2.00 miles
Lat: 28° 12' 12" N Long: 81° 16' 44" W
Elevation: G.L. 0 ft; K.B. 0 ft; D.F. 0 ft
Date: 2018-09-30
Run Number: 1
Depth Driller: 1600
Depth Logged: 1600
Top Log Interval: 0
Bottom Log Interval: 1600
Casing Driller: 1600 @ 0
Casing Logger: 1600
Bit Size: 12.25 in
Type Fluid in Hole: Water
Density: 1.0 g/cm3
Viscosity: 0 cp
Fluid Level: 0 ft
Max Recorded Temp: 0 deg F
Estimated Cement Top: 0
Time Logger on Bottom: 0:00:00
Unit Number: 0
Equipment: 0
Location: 0
Recorded By: J. Lindsey
Witnessed By: J. Allen

Service Order	Resistivity	Temperature	Density	Porosity	Viscosity	Calipers	Other Services

Equipment	Serial No.	Type	Size	Weight	Fluid	To
Sonde Type						
Sonde Centralizer						
Logging Speed (fpm)	30					
Depth Control						
Depth Check						
Weight Indicator						
Tension						
Blocked To Drum						
Line Speed Anomaly						
Length Measured From	KB					
Casing Collar Locator						
Cable Type						
Cable Length	1600					
Prime Mover						
Height Above Perm. Datum	0					
Depth Datum	GL					
Elevation	0					
Logging Method						
Logging Company						
Operating Rig Time						
Logging Time						
Logging Date						
Logging Truck No.						
Logging Engineer						
Operator						
Truck Number						

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Comments

STATIC and DYNAMIC DOWN passes were performed @ 50 fpm.

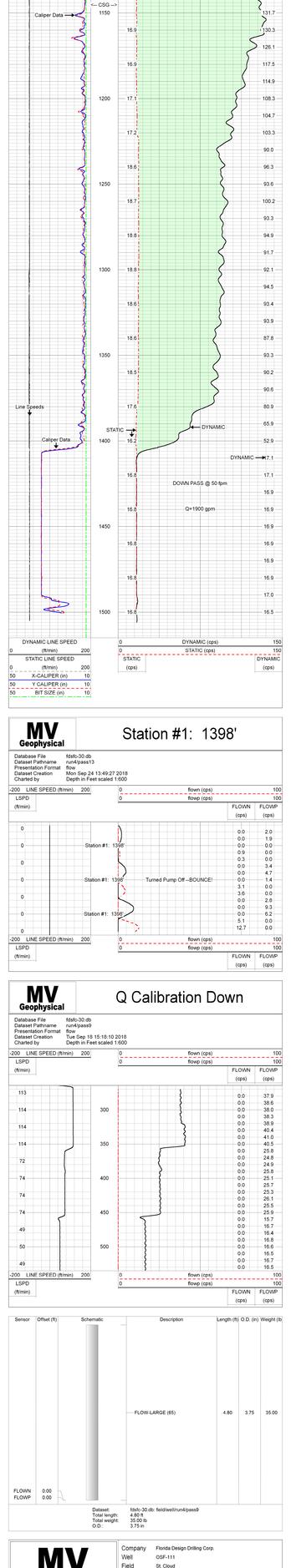
NO stations performed.

Q=~1900 gpm

S/D Down@50fpm&1900gpm

MV Geophysical

Database File: fdsfc-30.db
Dataset Pathname: run4:60250
Presentation Format: q150
Dataset Creation: Mon Sep 24 15:02:52 2018
Charted by: Depth in Feet scaled 1:240



Station #1: 1398'

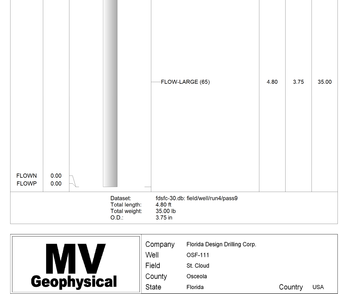
MV Geophysical

Database File: fdsfc-30.db
Dataset Pathname: run4:pass13
Presentation Format: flow
Dataset Creation: Mon Sep 24 13:49:27 2018
Charted by: Depth in Feet scaled 1:600

Q Calibration Down

MV Geophysical

Database File: fdsfc-30.db
Dataset Pathname: run4:pass9
Presentation Format: flow
Dataset Creation: Tue Sep 18 15:18:10 2018
Charted by: Depth in Feet scaled 1:600



Sensor	Offset (ft)	Schematic	Description	Length (ft)	O.D. (in)	Weight (lb)
FLOWN	0.00		FLOW-LARGE (65)	4.80	3.75	35.00
FLOWP	0.00					

Dataset: fdsfc-30.db: field/well/run4/pass9
Total length: 4.80 ft
Total weight: 35.00 lb
O.D.: 3.75 in

MV Geophysical

Company: Florida Design Drilling Corp.
Well: OSF-111
Field: St. Cloud
County: Osceola
State: Florida
Country: USA

APPENDIX D:
OPTICAL BOREHOLE IMAGING LOG OF OSF-111

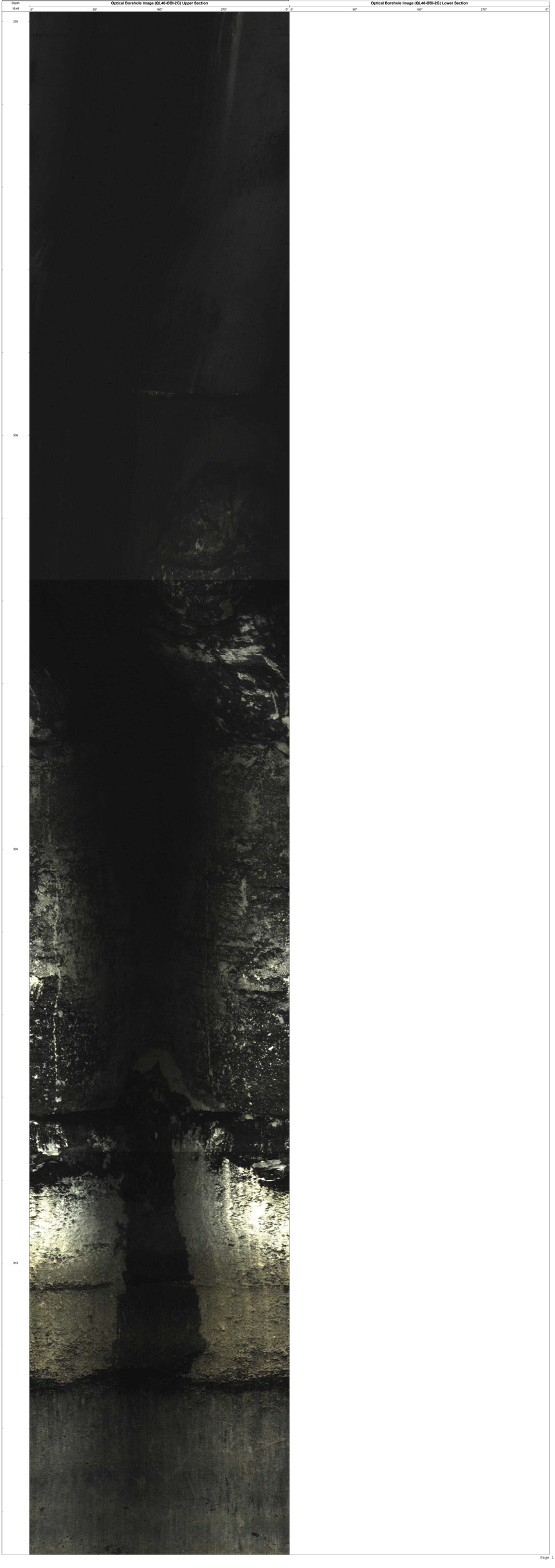
USGS Caribbean-Florida Water Science Center

WELL	OSF-111	PROJECT	OSF-111 OBI Logging	DATE OF COMPLETION	
LOCATION	28-19-30.936 N (GPS, NAD 83) 081-10-06.312 W	ELEVATION	GL 63.45 Feet (NAVD88)	WELL DEPTH	1,195 Feet
		DATE OF INITIAL LOGGING	04 June 2018		

Depth

Optical Borehole Image (QL40-OBI-2G) Upper Section

Optical Borehole Image (QL40-OBI-2G) Lower Section



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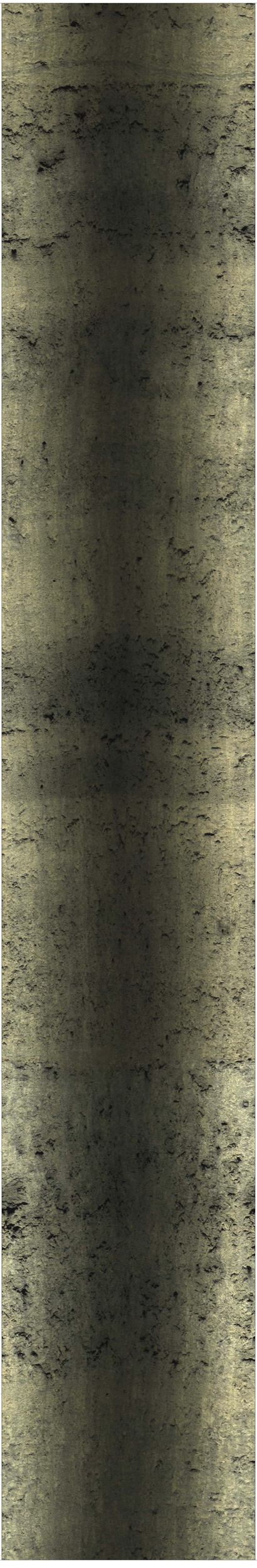
320
325
330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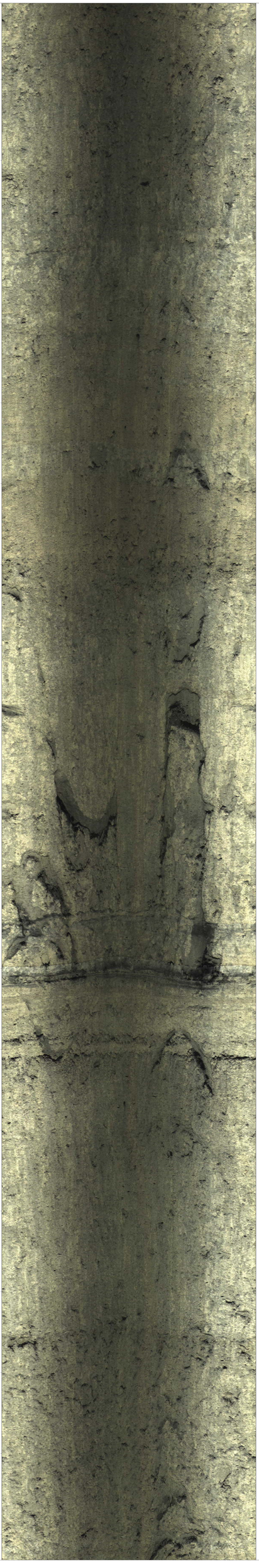
350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360
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370

375
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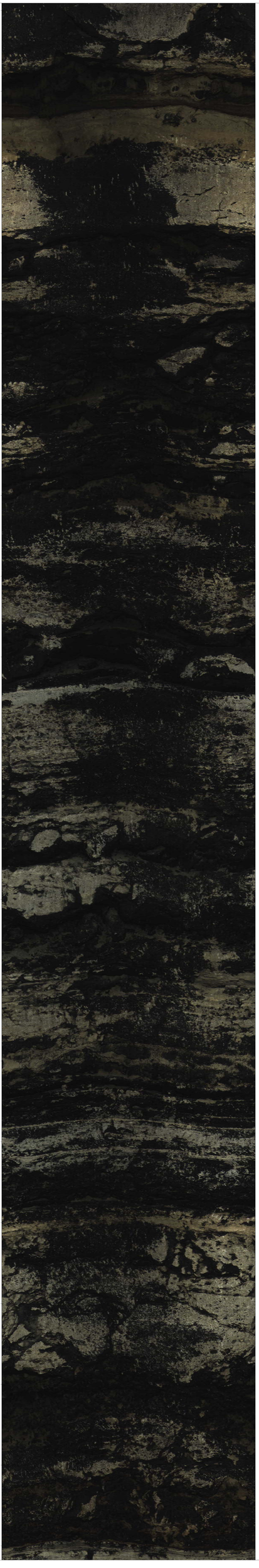
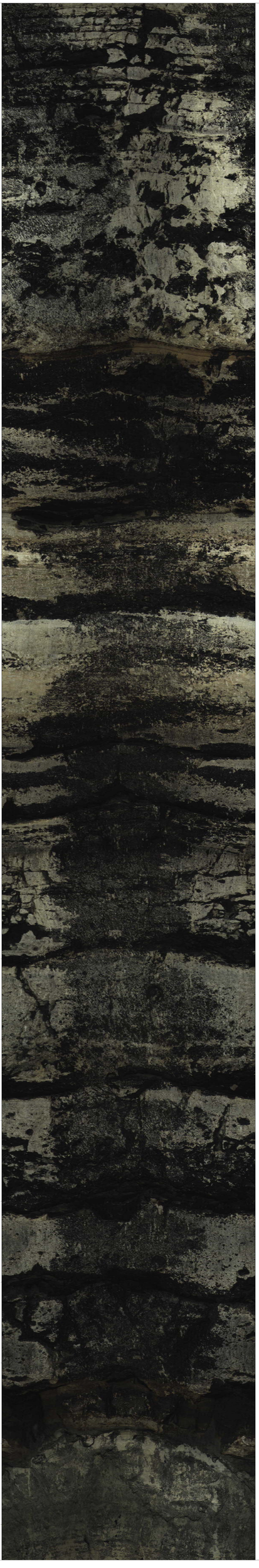
390

395
400
405





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775

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810

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860
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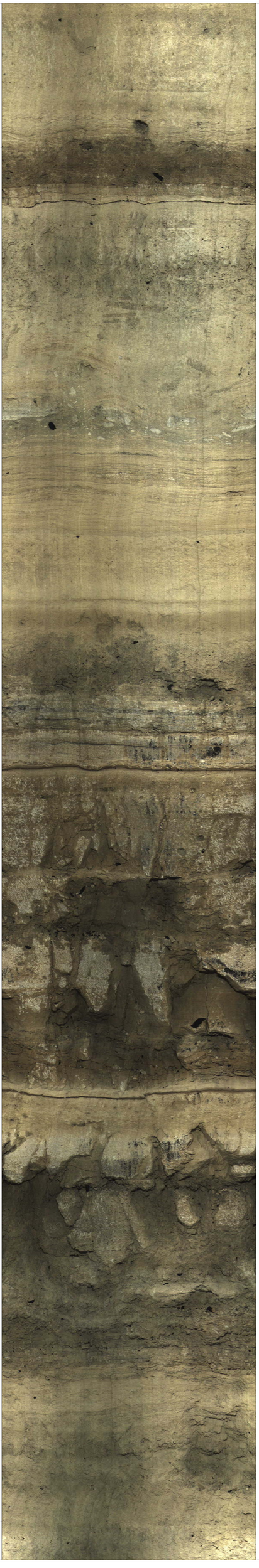
870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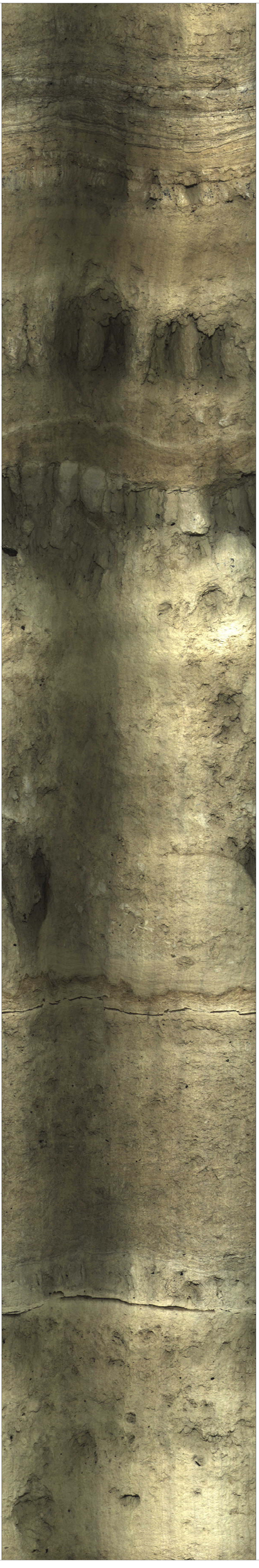
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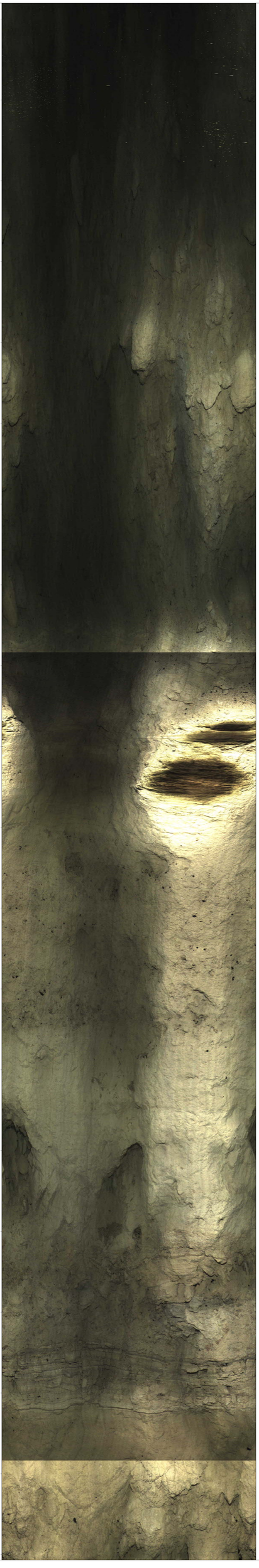

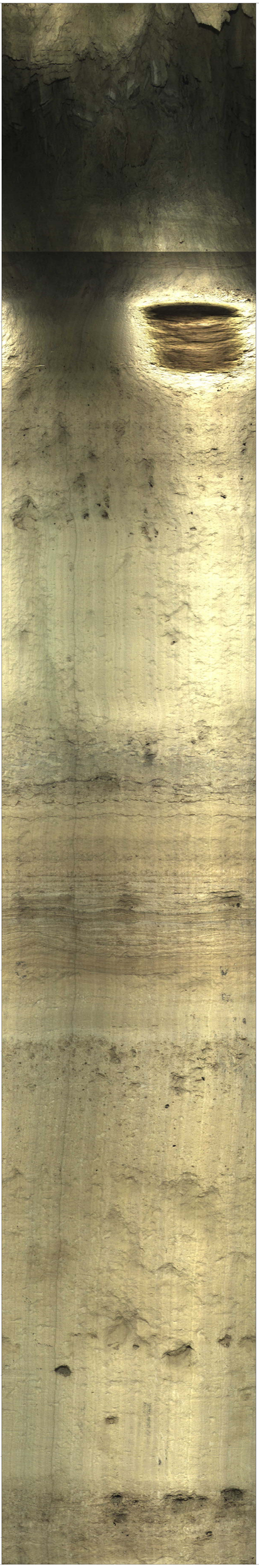
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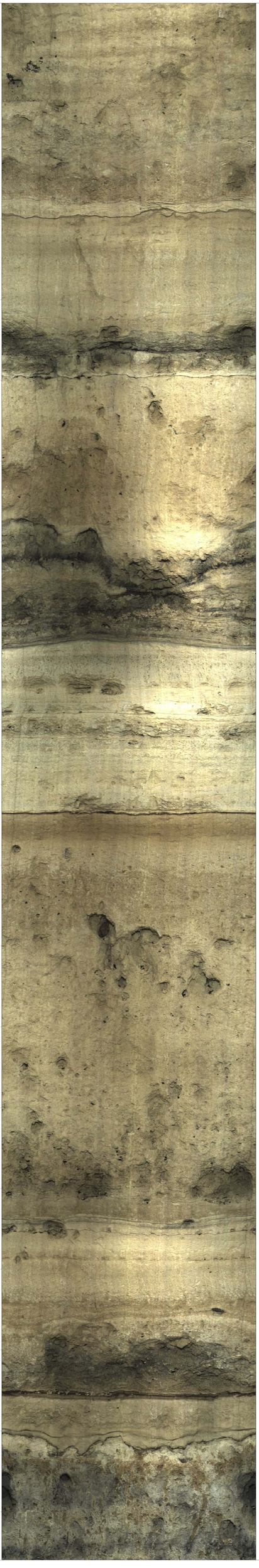
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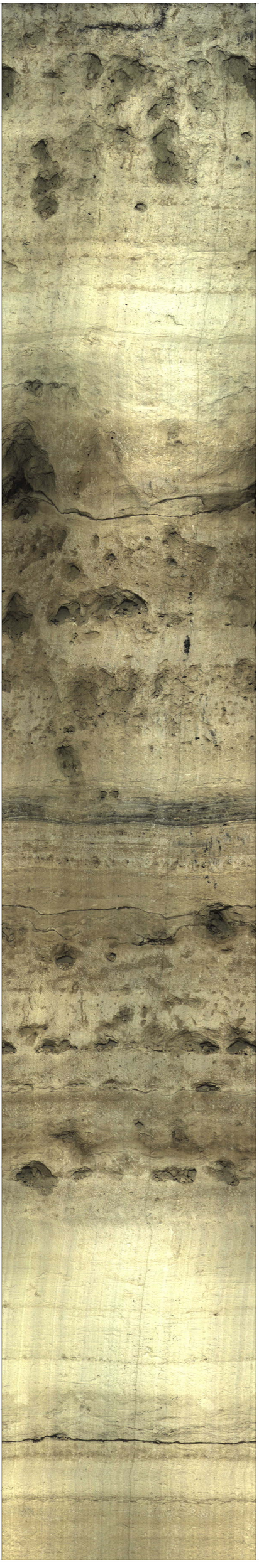
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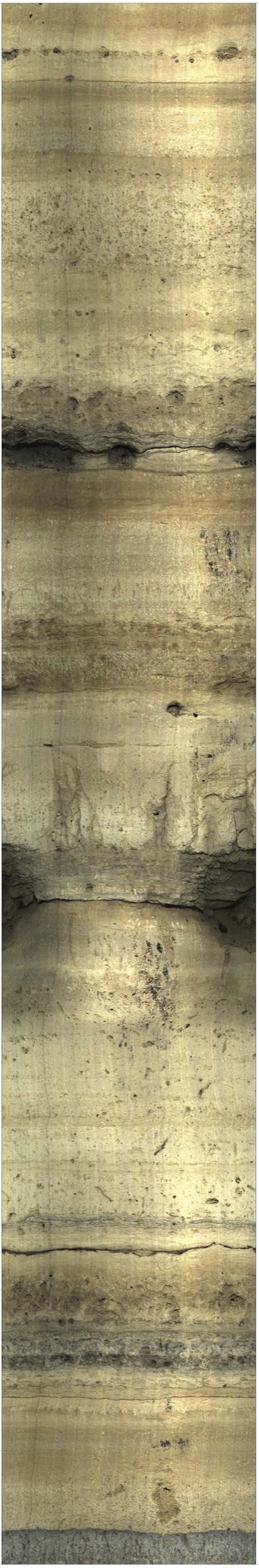
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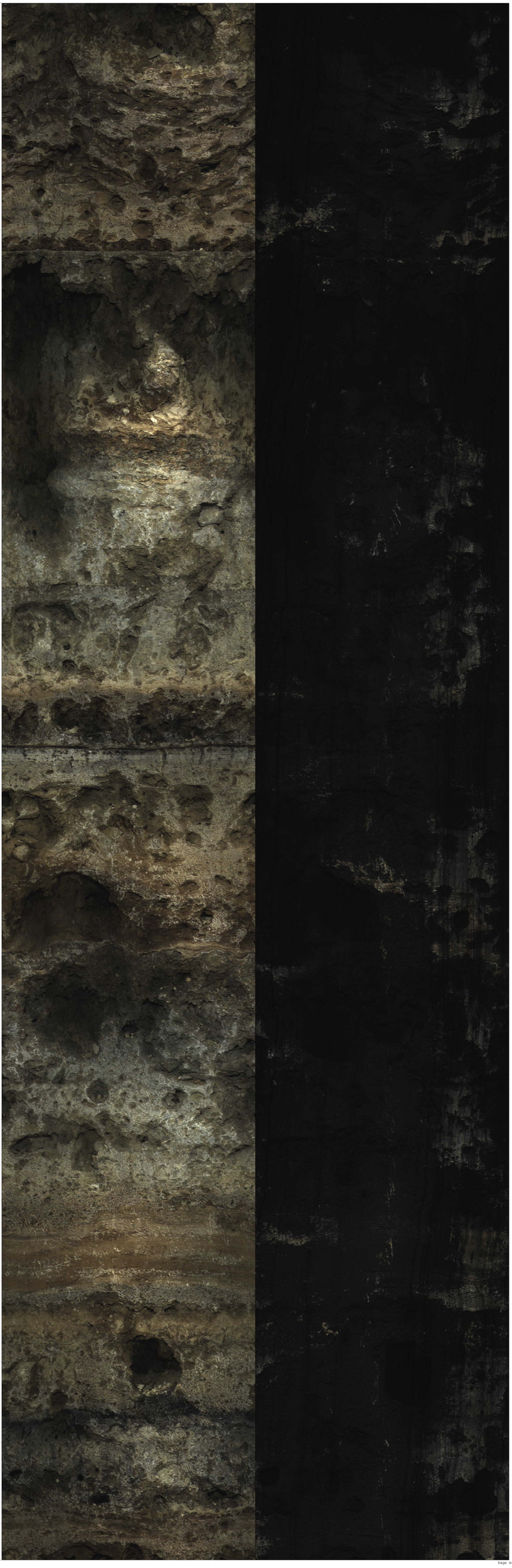

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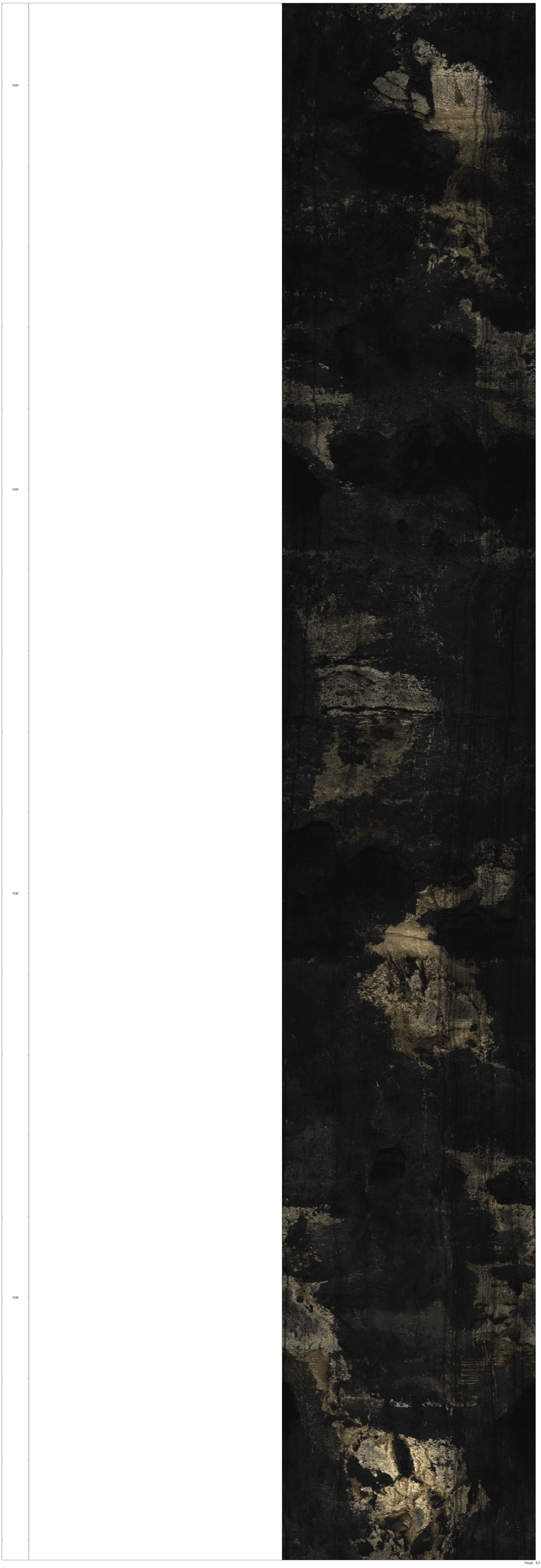

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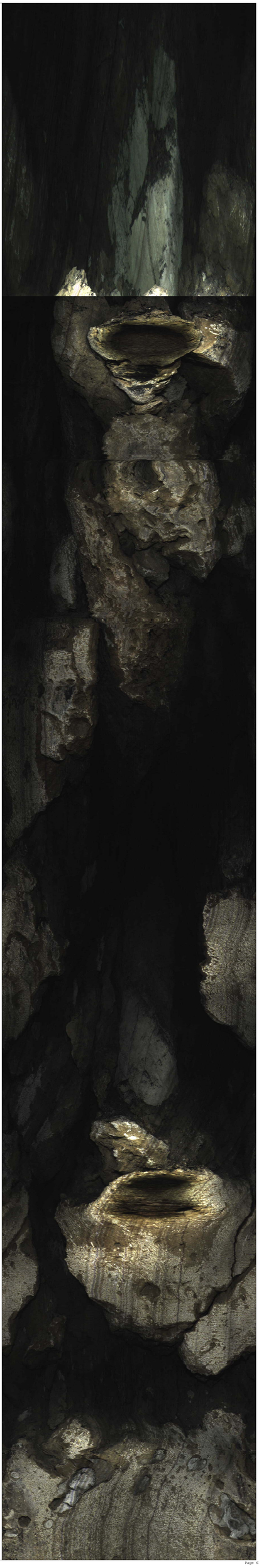

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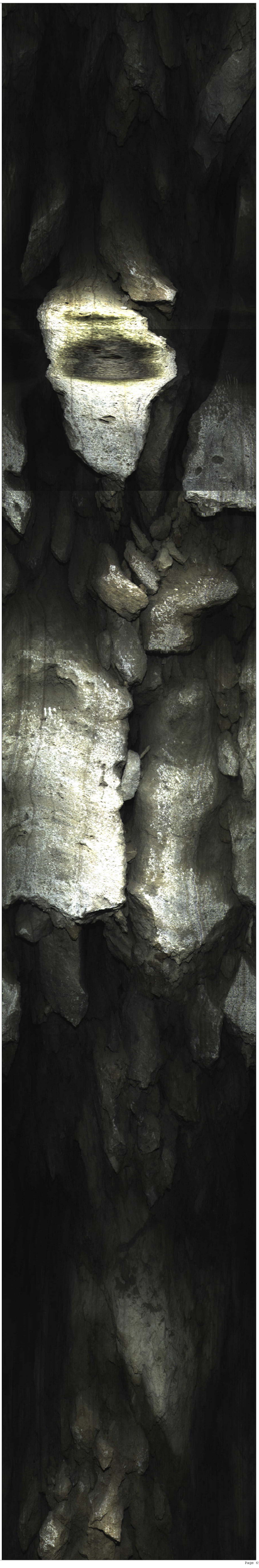

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APPENDIX E:
STANDARD PENETRATION TEST AND SIEVE ANALYSIS DATA

Table E-1. Sieve analysis data from OSS-111.

Sample ID	Depth from Land Surface to Top of Sample (ft)	Depth from Land Surface to Bottom of Sample (ft)	Elevation of Top of Sample (ft)	Elevation of Bottom of Sample (ft)	Sample Weight (grams)	Passed Equations	Number of Equations Used in Solution	Mean K (ft/d)	D_5 (mm)	D_{10} (mm)	D_{16} (mm)	D_{20} (mm)	D_{30} (mm)	D_{50} (mm)	D_{60} (mm)	D_{84} (mm)	D_{95} (mm)	Ø of d_5	Ø of d_{10}	Ø of d_{16}	Ø of d_{20}	Ø of d_{30}	Ø of d_{50}	Ø of d_{60}	Ø of d_{84}	Ø of d_{95}	Cu	Cc	Standard Deviation or Sorting (Øi)	Folk Classification	Geometric Mean	Wentworth Classification
1	4	6	57.95	55.95	378.36	Hanzen Slichter Beyer Sauerbrei Zunker	5	60.62794	0.0931	0.1146	0.1305	0.1423	0.1604	0.1898	0.2047	0.2456	0.3714	3.4251	3.1253	2.9379	2.813	2.6403	2.3974	2.2884	2.0256	1.429	1.7862	1.0967	0.5305	Moderately well sorted	2.4536	Fine Sand
2	6	8	55.95	53.95	61.6	Zunker	1	213.289			0.1572	0.1995	0.3192	0.8031	1.1793					2.6693	2.3255	1.6475	0.3163	-0.2379									Clay
3	8	10	53.95	51.95	332.97	Slichter Beyer Zunker	3	53.03177		0.0755	0.1142	0.1305	0.1647	0.2143	0.2418	0.6372	1.5392		3.7274	3.1304	2.9379	2.6021	2.2223	2.0481	0.6502	-0.6222	3.2026	1.4859		Extremely poorly sorted	2.001	Fine Sand
4	10	12	51.95	49.95	449.99	Hanzen Slichter Beyer Sauerbrei Zunker	5	59.15606	0.083	0.112	0.1285	0.1407	0.1619	0.1938	0.2088	0.2495	0.3772	3.5907	3.1584	2.9602	2.8293	2.6268	2.3674	2.2598	2.0029	1.4066	1.8643	1.1208	0.5702	Moderately well sorted	2.4435	Fine Sand
5	12	14	49.95	47.95	420.32	Hanzen Slichter Beyer Sauerbrei Zunker	5	56.083	0.0841	0.11	0.1242	0.1348	0.1572	0.1891	0.2045	0.2468	0.3735	3.5718	3.1844	3.0093	2.8911	2.6693	2.4028	2.2898	2.0186	1.4208	1.8591	1.0985	0.5736	Moderately well sorted	2.4769	Fine Sand
6	14	16	47.95	45.95	501.42	Slichter Beyer Sauerbrei Zunker	4	44.53365		0.0889	0.1144	0.1251	0.1532	0.1888	0.2053	0.2544	0.4095		3.4917	3.1278	2.9988	2.7065	2.4051	2.2842	1.9748	1.2881	2.3093	1.286		Extremely poorly sorted	2.5026	Fine Sand
7	16	18	45.95	43.95	524.92	Hanzen Slichter Beyer Sauerbrei Zunker	5	52.34532		0.1043	0.1199	0.1306	0.1555	0.188	0.2031	0.2446	0.3559		3.2612	3.0601	2.9368	2.685	2.4112	2.2997	2.0315	1.4905	1.9473	1.1415		Extremely poorly sorted	2.5009	Fine Sand
8	18	20	43.95	41.95	367.92	Hanzen Slichter Beyer Sauerbrei Zunker	5	59.69546	0.0878	0.1132	0.1287	0.1403	0.1606	0.1926	0.2086	0.2613	0.3835	3.5096	3.1431	2.9579	2.8334	2.6385	2.3763	2.2612	1.9362	1.3827	1.8428	1.0923	0.5777	Moderately well sorted	2.4235	Fine Sand
9	20	22	41.95	39.95	412.11	Hanzen Slichter Beyer Sauerbrei Zunker	5	56.9672	0.0834	0.1108	0.1247	0.135	0.1569	0.1872	0.2004	0.2359	0.4428	3.5838	3.174	3.0035	2.889	2.6721	2.4173	2.319	2.0838	1.1753	1.8087	1.1087	0.5948	Moderately well sorted	2.5015	Fine Sand
10	22	24	39.95	37.95	428.01	Hanzen Slichter Beyer Zunker	4	72.87907	0.0809	0.1188	0.1443	0.1551	0.1749	0.2086	0.2268	0.3535	0.7377	3.6277	3.0734	2.7929	2.6887	2.5154	2.2612	2.1405	1.5002	0.4389	1.9091	1.1353	0.8063	Moderately sorted	2.1848	Fine Sand
11	24	26	37.95	35.95	496.4	Hanzen Slichter Beyer Sauerbrei Zunker	5	61.48864	0.0772	0.1126	0.1301	0.1432	0.1623	0.194	0.2101	0.2741	0.4627	3.6953	3.1507	2.9423	2.8039	2.6233	2.3659	2.2509	1.8672	1.1119	1.8659	1.1135	0.6602	Moderately well sorted	2.3918	Fine Sand
12	26	28	35.95	33.95	504.29	Hanzen Slichter Beyer Sauerbrei Zunker	5	62.91906	0.078	0.1135	0.1329	0.1476	0.1651	0.1976	0.2142	0.2949	0.4535	3.6804	3.1392	2.9116	2.7602	2.5986	2.3393	2.223	1.7617	1.1408	1.8872	1.1212	0.6723	Moderately well sorted	2.3375	Fine Sand
13	28	30	33.95	31.95	486.15	Hanzen Slichter Beyer Sauerbrei Zunker	5	59.53723	0.0804	0.1119	0.1279	0.1397	0.1594	0.1894	0.2051	0.2485	0.4103	3.6367	3.1597	2.9669	2.8396	2.6493	2.4005	2.2856	2.0087	1.2852	1.8329	1.1071	0.5958	Moderately well sorted	2.4587	Fine Sand
14	30	32	31.95	29.95	460.9	Hanzen Slichter Beyer Sauerbrei Zunker	5	61.15725	0.0823	0.1128	0.1317	0.146	0.1639	0.1956	0.2117	0.2783	0.4165	3.603	3.1482	2.9247	2.776	2.6091	2.354	2.2399	1.8453	1.2636	1.8768	1.1249	0.6243	Moderately well sorted	2.3747	Fine Sand
15	32	34	29.95	27.95	478.34	Hanzen Slichter Beyer Sauerbrei Zunker	5	64.5081	0.0769	0.1138	0.1377	0.1522	0.1698	0.2014	0.2173	0.2991	0.4279	3.7009	3.1354	2.8604	2.716	2.5581	2.3119	2.2022	1.7413	1.2247	1.9095	1.1659	0.655	Moderately well sorted	2.3045	Fine Sand
16	34	36	27.95	25.95	380.86	Hanzen Slichter Beyer Sauerbrei Zunker	5	57.68573		0.1078	0.1269	0.1415	0.1635	0.1973	0.2143	0.2967	0.4247		3.2136	2.9782	2.8211	2.6126	2.3415	2.2223	1.7529	1.2355	1.9879	1.1572		Extremely poorly sorted	2.3575	Fine Sand
17	36	38	25.95	23.95	344.88	Hanzen Slichter Beyer Zunker	4	74.03004	0.0777	0.12	0.1521	0.161	0.1829	0.2128	0.2295	0.3389	0.5117	3.6859	3.0589	2.7169	2.6349	2.4509	2.2324	2.1234	1.5611	0.9666	1.9125	1.2147	0.701	Moderately well sorted	2.1701	Fine Sand
18	38	40	23.95	21.95	430.5	Hanzen Slichter Beyer Zunker USBR	5	74.05827		0.1188	0.156	0.1677	0.1906	0.23	0.2585	1.0843			3.0734	2.6804	2.576	2.3914	2.1203	1.9518	-0.1168		2.1759	1.183			1.5613	Medium Sand
19	40	42	21.95	19.95	359.38	Hanzen Slichter Beyer Zunker USBR	5	68.91739		0.1184	0.1504	0.1582	0.1794	0.2192	0.2422	0.7736			3.0783	2.7331	2.6602	2.4787	2.1897	2.0457	0.3703		2.0456	1.1223			1.7644	Medium Sand
20	42	44	19.95	17.95	445.53	Hanzen Slichter Beyer Zunker	4	74.96793		0.1184	0.1539	0.1639	0.1854	0.2144	0.2306	0.3395	0.5125		3.0783	2.6999	2.6091	2.4313	2.2216	2.1165	1.5585	0.9644	1.9476	1.2589		Extremely poorly sorted	2.16	Fine Sand
21	44	46	17.95	15.95	380.05	Hanzen Slichter Beyer Zunker USBR	5	103.5303	0.1243	0.1613	0.1821	0.1888	0.2069	0.2483	0.2853	0.4014	0.7036	3.0081	2.6322	2.4572	2.4051	2.273	2.0098	1.8094	1.3169	0.5072	1.7688	0.9302	0.664	Moderately well sorted	1.928	Medium Sand
22	46	48	15.95	13.95	475.83	Hanzen Slichter Beyer Zunker USBR	5	109.0494	0.128	0.1677	0.1859	0.1927	0.2107	0.2526	0.2856	0.3835	0.552	2.9658	2.576	2.4274	2.3756	2.2467	1.9851	1.8079	1.3827	0.8573	1.703	0.9269	0.5806	Moderately well sorted	1.9317	Medium Sand
23	48	50	13.95	11.95	474.49	Hanzen Slichter Beyer Zunker USBR	5	99.67191	0.1193	0.1589	0.1813	0.1879	0.2052	0.2448	0.2765	0.3795	0.5364	3.0673	2.6538	2.4635	2.412	2.2849	2.0303	1.8546	1.3978	0.8986	1.7401	0.9584	0.595	Moderately well sorted	1.9639	Medium Sand
24	50	52	11.95	9.95	501.66	Hanzen Slichter Beyer Zunker USBR	5	128.7739	0.1209	0.181	0.1985	0.2111	0.2462	0.2976	0.3261	0.4064	0.6265	3.0481	2.4659	2.3328	2.244	2.0221	1.7486	1.6166	1.299	0.6746	1.8017	1.0269	0.6181	Moderately well sorted	1.7935	Medium Sand
25	52	54	9.95	7.95	474.7	Hanzen Slichter Beyer Zunker USBR	5	79.51049	0.0973	0.1356	0.1705	0.1845	0.2059	0.2577	0.2948	0.4072	0.6778	3.3614	2.8826	2.5522	2.4383	2.28	1.9562	1.7622	1.2962	0.5611	2.174	1.0605	0.7383	Moderately sorted	1.9349	Medium Sand
26	54	56	7.95	5.95	486.04	Hanzen Slichter Beyer Zunker USBR	5	110.2433	0.135	0.1691	0.1863	0.1931	0.2111	0.2535	0.2871	0.3869	0.5758	2.889	2.5641	2.4243	2.3726	2.244	1.9799	1.8004	1.37	0.7964	1.6978	0.9179	0.5806	Moderately well sorted	1.9247	Medium Sand
27	56	58	5.95	3.95	228.81	Zunker	1	35.93761				0.0799	0.1004	0.1525	0.3109	1.6335					3.6457	3.3162	2.7131	1.6855	-0.708							Clay
28	58	60	3.95	1.95	317.62		0	0					0.0774	0.1027	0.1226	0.3624	0.7828					3.6915	3.2835	3.028	1.4643	0.3533				Extremely poorly sorted		Clay
29	60	62	1.95	-0.05	309.99	Zunker	1	80.11781				0.0765	0.142	0.3058	0.4196	1.3217					3.7084	2.816	1.7093	1.2529	-0.4024							Clay

Ø = phi scale units; Cc = curvature coefficient; Cu = uniformity coefficient; d = day; D# = effective grain size diameter at #% finer by weight; ft = foot; K = hydraulic conductivity; mm = millimeter; USBR = United States Bureau of Reclamation.

SFWMD Split-spoon Drilling Form

Date: 12-11-17 Page 1 of 3	Drilling Equipment / Methods				
Well Name: OSS1-11	Spoon I.D.: 1 1/2"	Spoon O.D.: 2"	Liner: (Yes) No	Drill Fluid: (Mud) / Water	Drill Rod Length: 10'
Contractor/Driller: HUSS	Rig Type: CME 75			Water Table	
Site Geologist: K. Smith	Hammer Type: MANUAL steel hammer			Time	Ft BLS
Starting Depth: 2'	Hammer Weight [lb]: 140				
Ending Depth: 60'	Hammer Drop [in]: 18"				

Drilling Notes: Recorded Also Recorded by Tony (Huss)

Start Depth	End Depth	N_1	N_2	N_3	N_4	N Value (N_2+N_3)	Percent Recovery	Notes: Lithology, # wraps on cat-head etc.
2'	4'	8	8	10	10		60%	0 3 wraps
4'	6'	2	2	3	4		100%	1 3 wraps
6'	8'	3	4	7	11		95%	2 3 wraps
8'	10'	7	7	9	10		100%	3 3 wraps
10'	12'	7	9	17	20		95%	4 3 wraps
12'	14'	5	6	9	15		100%	5 3 wraps
14'	16'	6	9	15	19		100%	6 3 wraps
16'	18'	5	7	8	8		60%	7 3 wraps
18'	20'	7	9	13	19		100%	8 3 wraps
20'	22'	7	9	10	10		100%	9

N = Blow counts for ea 6" interval. N Value = sum N_2 + N_3

SFWMD Split-spoon Drilling Form

Date: 12-11-17 Page 2 of 3	Drilling Equipment / Methods				
Well Name: OSS1-11	Spoon I.D.: 1 1/2"	Spoon O.D.: 2"	Liner: (Yes) No	Drill Fluid: (Mud) / Water	Drill Rod Length: 10'
Contractor/Driller: Huss / Nick	Rig Type: CME 75			Water Table	
Site Geologist: H. Smith	Hammer Type: MANUAL Steel hammer			Time	Ft BLS
Starting Depth: 2'	Hammer Weight [lb]: 140				
Ending Depth: 60'	Hammer Drop [in]: 18"				

Drilling Notes: Recorded by Tony (Hess)

Start Depth	End Depth	N_1	N_2	N_3	N_4	N Value (N_2+N_3)	Percent Recovery	Notes: Lithology, # wraps on cat-head etc.
22'	24'	7	9	11	15		95%	10 3 WRAPS
24'	26'	11	16	19	20		100%	11 3 WRAPS
26'	28'	8	8	8	9*		100%	12 3 WRAPS
28'	30'	10	12	15	17		95%	13 3 WRAPS
30'	32'	8	8	9	10		95%	14 3 WRAPS
32'	34'	8	9	11	14		100%	15 3 WRAPS
34'	36'	6	9	11	13		100%	16 3 WRAPS
36'	38'	10	20	19	32		100%	17 3 WRAPS
38'	40'	9	10	11	15		95%	18 3 WRAPS
40'	42'	7	9	13	13		60%	19 3 WRAPS

N = Blow counts for ea 6" interval. **N Value = sum N_2 + N_3**

SFWMD Split-spoon Drilling Form

Date: 12-11-17 Page 3 of 3	Drilling Equipment / Methods				
Well Name: OSS1-11	Spoon I.D.: 1 1/2"	Spoon O.D.: 2"	Liner: (Yes) / No	Drill Fluid: (Mud) / Water	Drill Rod Length: 10'
Contractor/Driller: HUSS / Nick	Rig Type: CME 75			Water Table	
Site Geologist: K. Smith	Hammer Type: manual / steel hammer			Time	Ft BLS
Starting Depth: 2'	Hammer Weight [lb]: 140				
Ending Depth: 60'	Hammer Drop [in]: 18"				

Drilling Notes: Recorded by Tony (Huss)

Start Depth	End Depth	N_1	N_2	N_3	N_4	N Value (N_2+N_3)	Percent Recovery	Notes: Lithology, # wraps on cat-head etc.
42'	44'	12	15	19	23		100%	20 3 wraps
44'	46'	11	12	14	18		95%	21 3 wraps
46'	48'	11	17	19	28		100%	22 3 wraps
48'	50'	17	18	31	40		100%	23 3 wraps
50'	52'	4	9	3	5		95%	24 3 wraps
52'	54'	12	13	14	17		100%	25 3 wraps
54'	56'	6	6	6	6		100%	26 3 wraps
56'	58'	5	7	10	13		100%	27 3 wraps
58'	60'	10	10	10	10		60%	28 3 wraps
60	62							29

N = Blow counts for ea 6" interval. **N Value = sum N_2 + N_3**

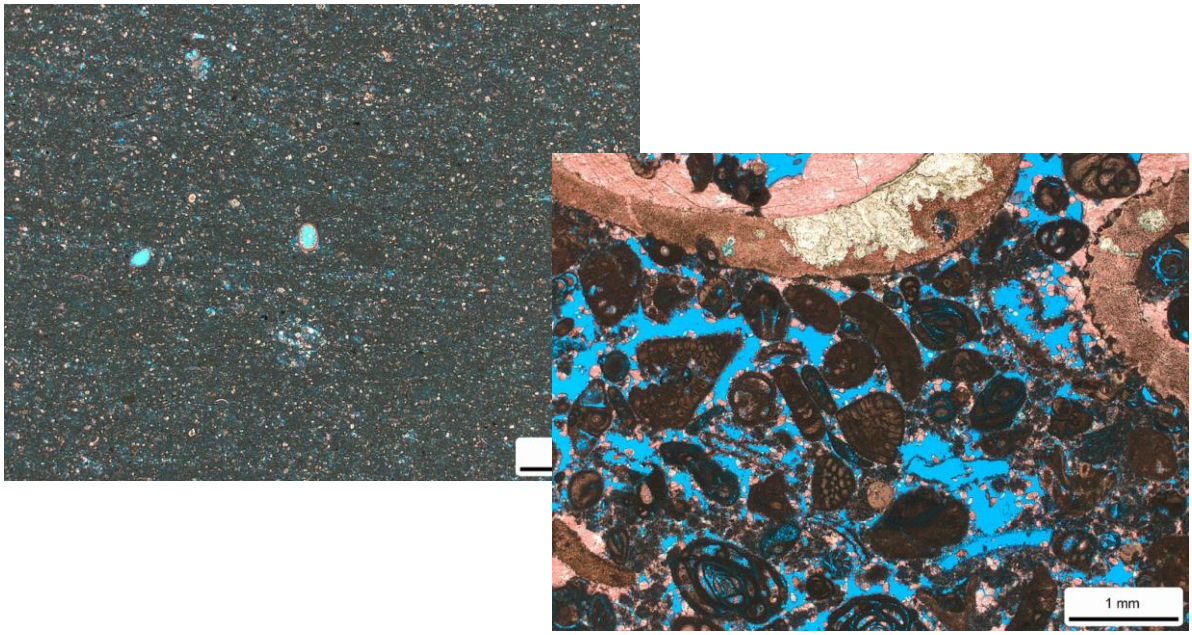
APPENDIX F:
LABORATORY CORE ANALYSIS REPORTS

PETROLEUM SERVICES

Thin Section Analysis of Core Samples

South Florida Water Management

OSF-110 Well



October 2018

Core Laboratories, Inc.
Houston Advanced Technology Center
6316 Windfern Road
Houston, Texas 77040

Houston ATC Job File No.: 1802884G

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PETROGRAPHIC SUMMARY

Five (5) core samples from OSF-110 Well were selected for thin section analysis (Table 1).

- Thin section samples were impregnated with blue-dyed epoxy, and subsequently ground and polished to a thickness of 30 microns. The samples were stained for calcite, ferroan calcite (Fe-calcite) and ferroan dolomite (Fe-dolomite). Thin section photomicrographs and descriptions are provided in Plates 1-5.

- Based on thin section analysis, the analyzed samples are all limestones and have the fabric of grainstone (Plate 1, 2, 3), packstone (Plate 5) or lime mudstone (Plate 4).

- Visible pores are abundant and well interconnected in grainstone samples. They are mostly interparticle and intercrystal pores.

- Visible pores are abundant and moderately interconnected in the packstone sample; they are mostly moldic pores.

- Visible pores are rare and poorly interconnected in the lime mudstone.

Thank you for choosing Core Laboratories to perform this study. Please feel free to contact us if you have any questions or comments concerning this report.

Sincerely,

Yong Q. Wu PhD
Senior Project Geologist
Reservoir Geology
Core Laboratories - Houston
Phone: 713-328-2554
E-mail: Yong.Wu@corelab.com

ANALYTICAL PROCEDURES

THIN SECTION PETROGRAPHY

Thin sections were prepared by first impregnating the samples with epoxy to augment cohesion and to prevent loss of material during grinding. Blue dye was added to the epoxy. Each thinly sliced sample was mounted on a frosted glass slide and then cut and ground to an approximate thickness of 30 microns. The thin sections were stained with the following: Alizarin Red-S to differentiate calcite (stains red) from clear dolomite (does not stain); potassium ferricyanide to identify ferroan dolomite (stains dark blue) and ferroan calcite (stains purple to dark blue depending on acid concentration and iron content of the sample). The thin sections were analyzed using standard petrographic techniques.

TABLE 1

South Florida Water Management , OSF-110 Well

ANALYTICAL PROGRAM AND SAMPLE SUMMARY

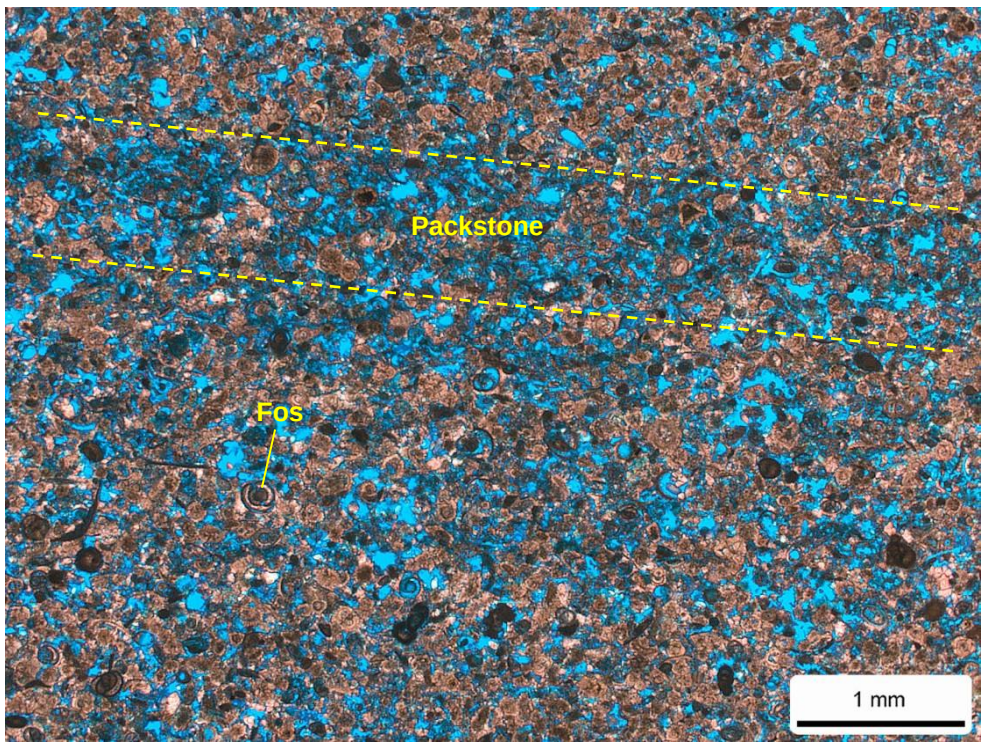
Sample ID	Depth (ft)	TS	Lithology	Classification (mod. Dunham 1962)	Plate No.
1H	329.10-329.25	X	Limestone	Grainstone	1
2H	331.65-331.80	X	Limestone	Grainstone	2
3H	343.10-343.25	X	Limestone	Grainstone	3
4H	368.65-368.80	X	Limestone	Lime mudstone	4
5H	372.60-372.75	X	Limestone	Packstone	5

PLATE 1

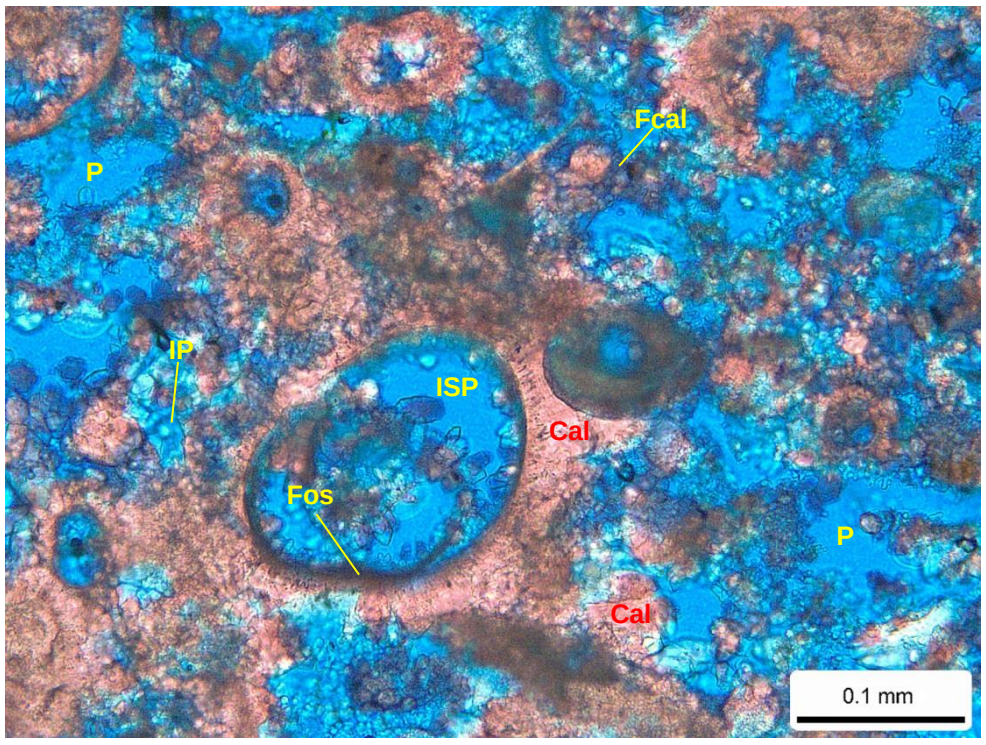
Thin Section Petrography

Company: South Florida Water Management
Well: OSF-110
Location: na
Core Type: Conventional Core
Depth (ft): 329.10-329.25
Sample ID: 1H

A



B



Relative Abundances:

Trace	<1%
Minor	1-5%
Moderate	5-10%
Common	10-20%
Abundant	>20%

Core Lab
RESERVOIR OPTIMIZATION

Sample Description

Lithology: Limestone

Classification (mod. Dunham 1962)
Grainstone

Texture and Structures:
Laminae

Allochemical Grains:
Abundant fossil fragments (dominantly foraminifers); minor peloids and other allochems

Other Grains:
na

Matrix:
Minor micritic matrix

Cement and Replacement:
Common calcite/Fe-calcite cement

Pore Types:
Common to abundant interparticle pores; minor to moderate intercrystal, intraskeletal and moldic pores

Photo Caption:

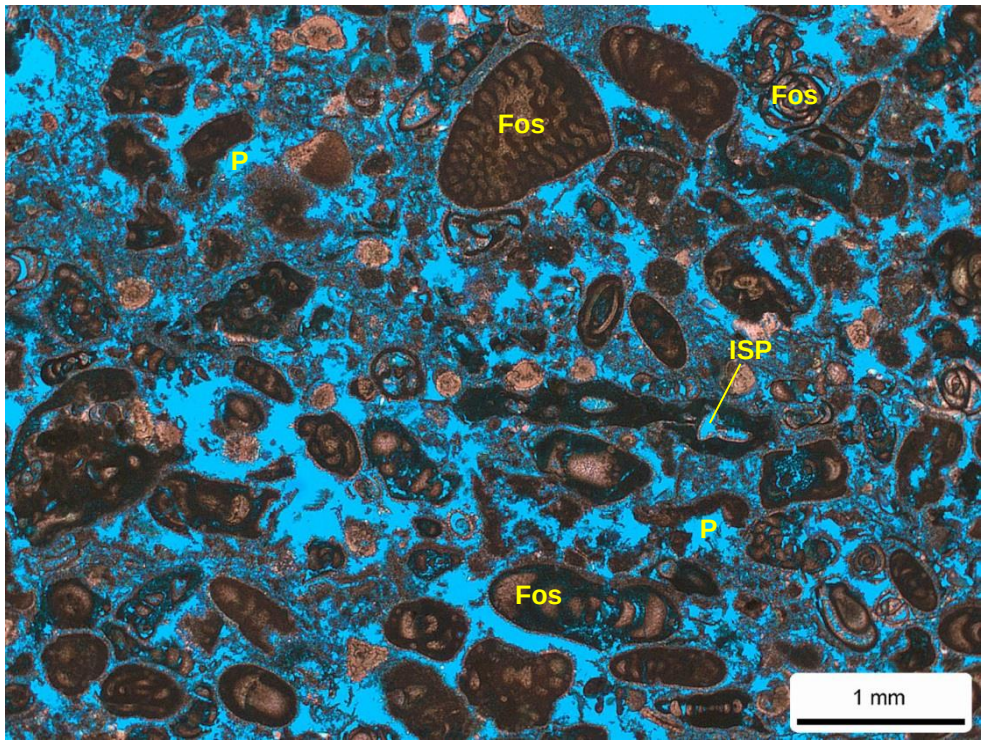
Visible pores (blue) are abundant and well interconnected in this limestone, consisting of interparticle (P), intercrystal (IP), intraskeletal (ISP) and moldic pores. Fossil fragments (Fos; mainly foraminifers) are the principal allochem grains; interparticle areas are partly filled with calcite (Cal; stained reddish) and Fe-calcite (Fcal; stained purplish) cements. Note that packstone laminae are locally present; intergranular areas in the packstone are mainly filled with micritic matrix.

PLATE 2

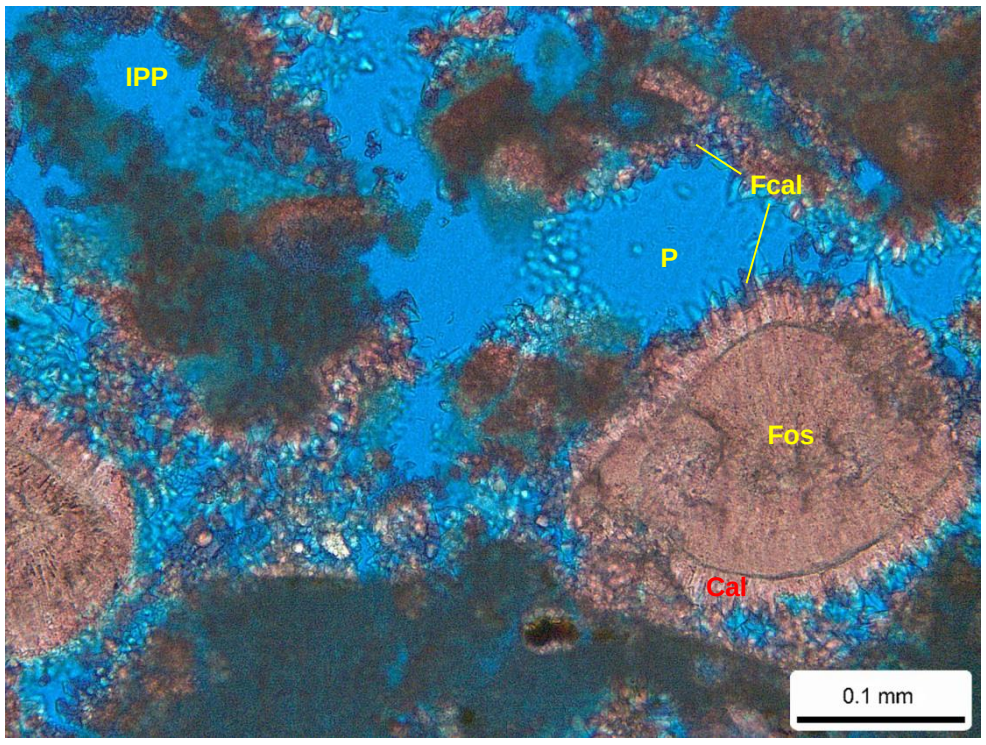
Thin Section Petrography

Company: South Florida Water Management
Well: OSF-110
Location: na
Core Type: Conventional Core
Depth (ft): 331.65-331.80
Sample ID: 2H

A



B



Sample Description

Lithology: Limestone

Classification (mod. Dunham 1962)
Grainstone

Texture and Structures:
Massive

Allochemical Grains:
Abundant fossil fragments (dominantly foraminifers); minor peloids and other allochems

Other Grains:
na

Matrix:
Trace micritic matrix

Cement and Replacement:
Common calcite/Fe-calcite cement

Pore Types:
Abundant interparticle pores; minor to moderate intercrystal, intraskeletal and moldic pores

Photo Caption:

Fossil fragments (Fos; mainly foraminifers) are the principal allochem grains in this limestone; interparticle areas are partly filled with calcite (Cal; stained reddish) and Fe-calcite (Fcal; stained purplish) cements. Visible pores (blue) are abundant and well interconnected; they are mostly interparticle pores (P), followed by intercrystal, intraskeletal (ISP) and intraparticle (IPP) pores.

Relative Abundances:

Trace	<1%
Minor	1-5%
Moderate	5-10%
Common	10-20%
Abundant	>20%

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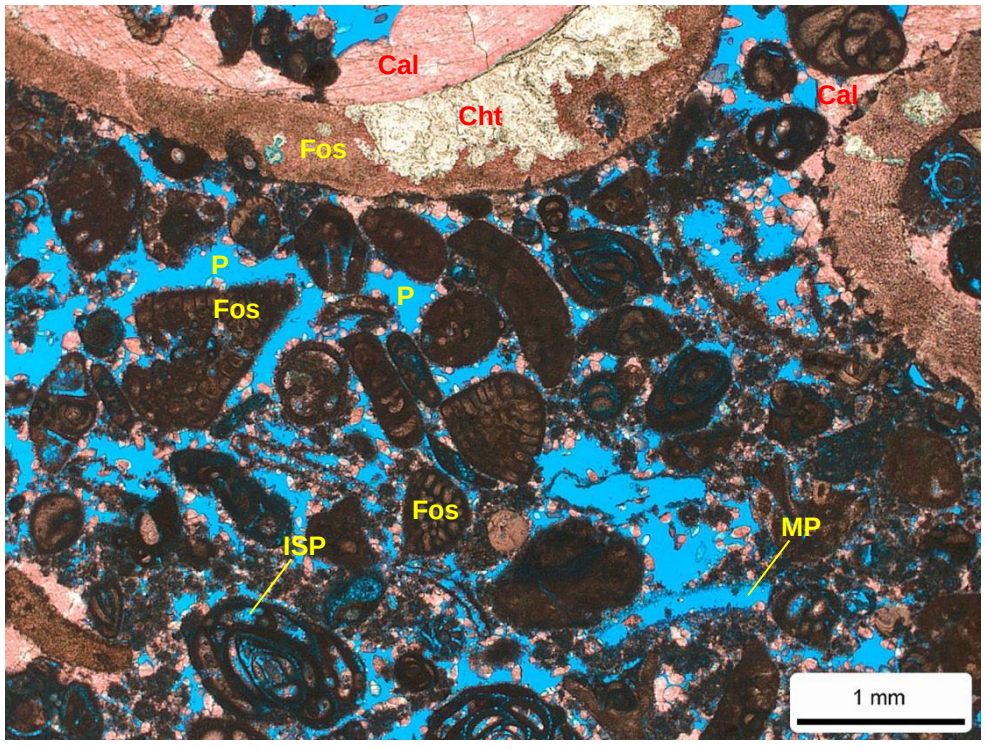
PLATE 3

Thin Section Petrography

Company: South Florida Water Management
Well: OSF-110
Location: na
Core Type: Conventional Core
Depth (ft): 343.10-343.25
Sample ID: 3H

A



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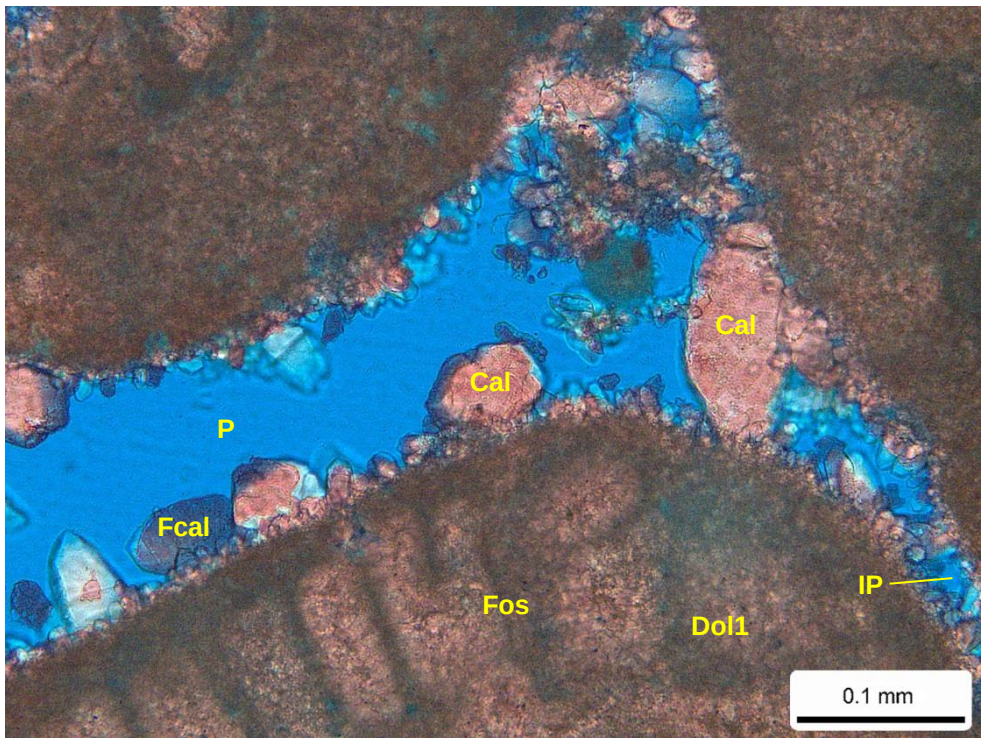

Sample Description

Lithology: Limestone

Classification (mod. Dunham 1962)
Grainstone

Texture and Structures:
Massive

Allochemical Grains:
Abundant fossil fragments (dominantly foraminifers); minor peloids and other allochems

Other Grains:
na

Matrix:
Trace micritic matrix

Cement and Replacement:
Common calcite/Fe-calcite cement; trace chert (replacing fossils)

Pore Types:
Abundant interparticle pores; minor to moderate intercrystal, intraskeletal and moldic pores

Photo Caption:

Visible pores (blue) are abundant and well interconnected in this limestone, consisting of interparticle (P), intercrystal (IP), intraskeletal (ISP) and moldic pores. Fossil fragments (Fos; mainly foraminifers) are the principal allochem grains and locally replaced by chert (Cht); interparticle areas are partially filled with calcite (Cal; stained reddish) and Fe-calcite (Fcal; stained purplish) cements.

Relative Abundances:

Trace	<1%
Minor	1-5%
Moderate	5-10%
Common	10-20%
Abundant	>20%

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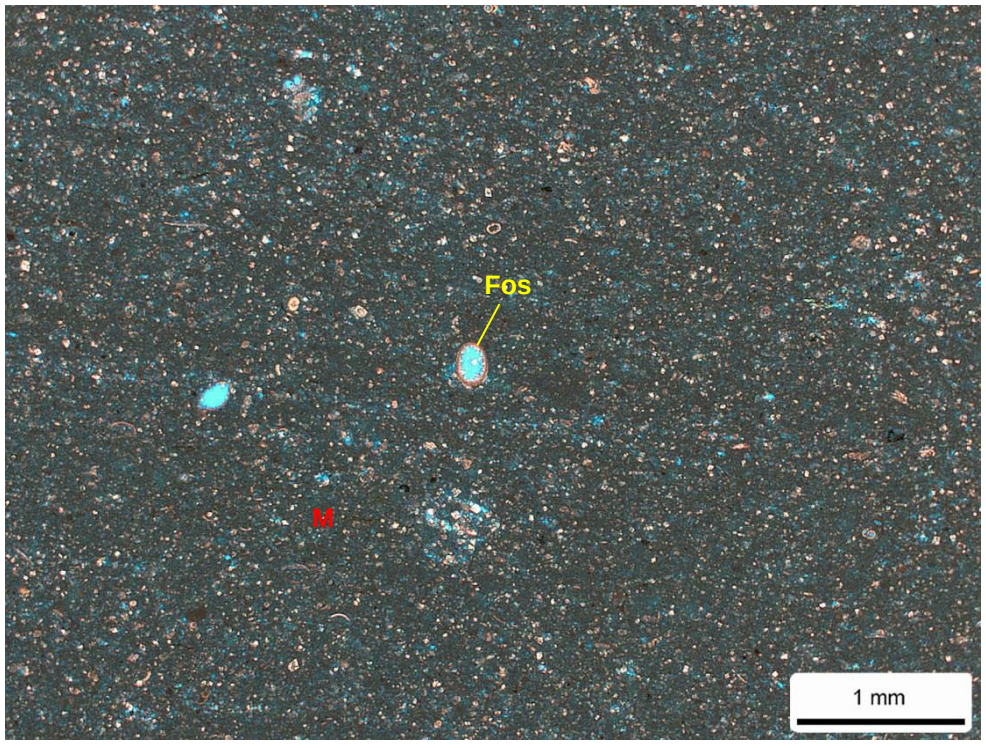
PLATE 4

Thin Section Petrography

Company: South Florida Water Management
Well: OSF-110
Location: na
Core Type: Conventional Core
Depth (ft): 368.65-368.80
Sample ID: 4H

A



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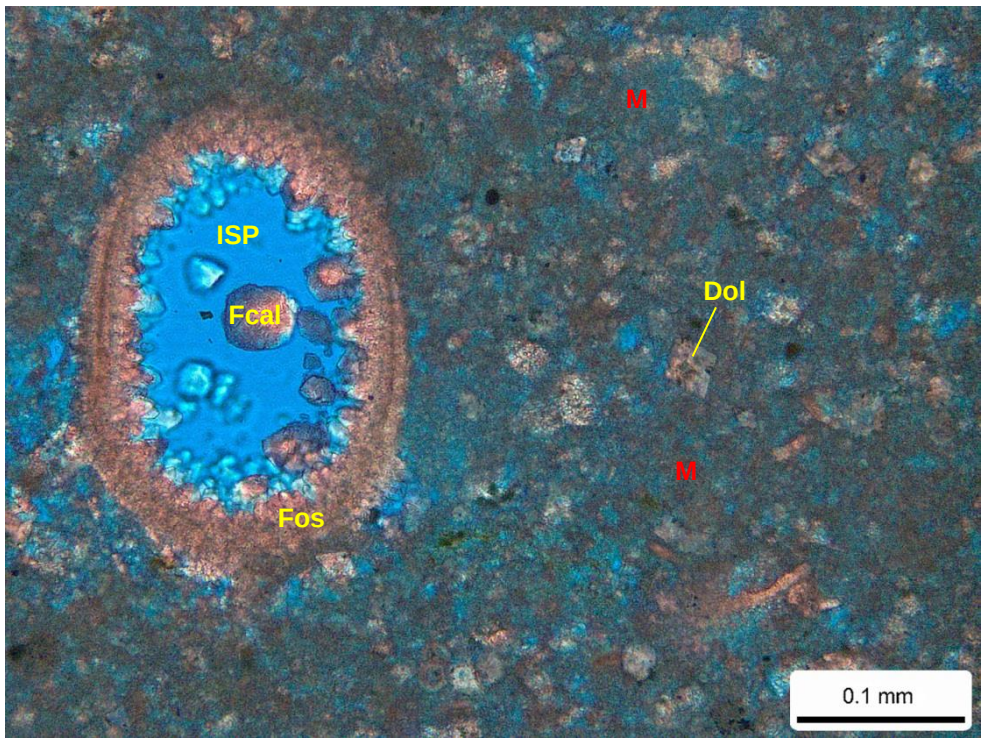


Relative Abundances:

Trace	<1%
Minor	1-5%
Moderate	5-10%
Common	10-20%
Abundant	>20%

Core Lab
RESERVOIR OPTIMIZATION

Sample Description

Lithology: Limestone

Classification (mod. Dunham 1962)
Lime mudstone

Texture and Structures:
Massive

Allochemical Grains:
Minor to moderate fossil fragments

Other Grains:
na

Matrix:
Abundant micritic matrix

Cement and Replacement:
Minor dolomite; trace calcite/Fe-calcite cement

Pore Types:
Trace to minor intercrystal and intraskeletal pores

Photo Caption:

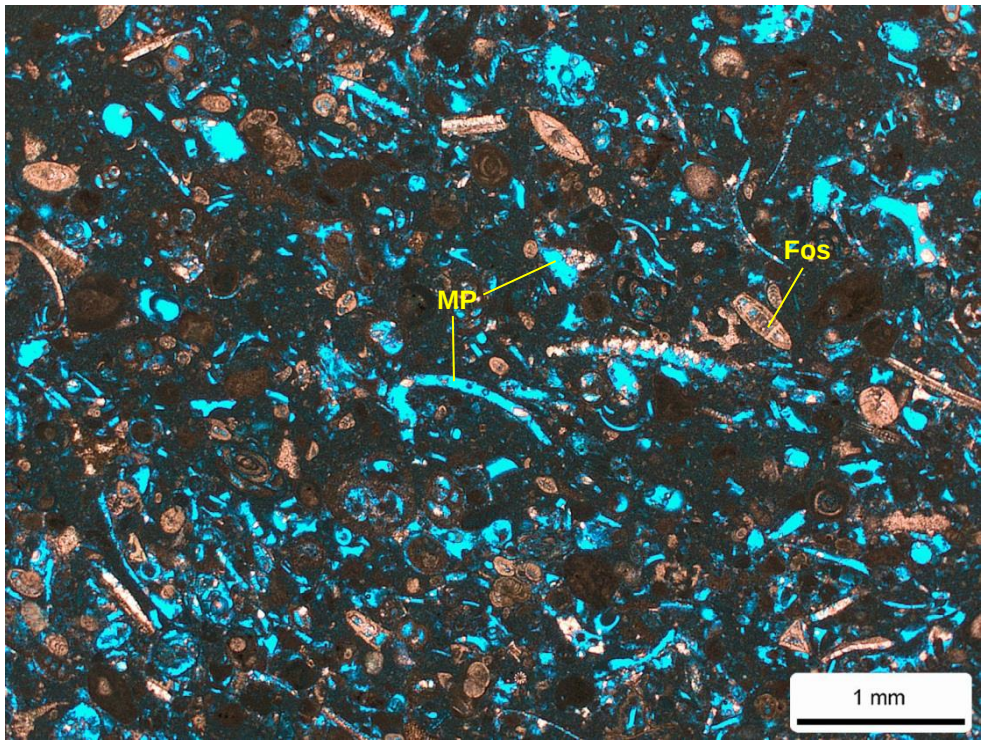
Micritic matrix (M) is the predominant constituent; fossil fragments (Fos) are scattered in the matrix. Dolomite (Dol) locally replaces the micritic matrix. Micropores associated with the matrix make up the principal pore system in this limestone sample. Visible pores (blue) are rare and poorly interconnected. Note intraskeletal pores (ISP) are partly filed with Fe-calcite cement (Fcal; stained purplish).

PLATE 5

Thin Section Petrography

Company: South Florida Water Management
Well: OSF-110
Location: na
Core Type: Conventional Core
Depth (ft): 372.60-372.75
Sample ID: 5H

A



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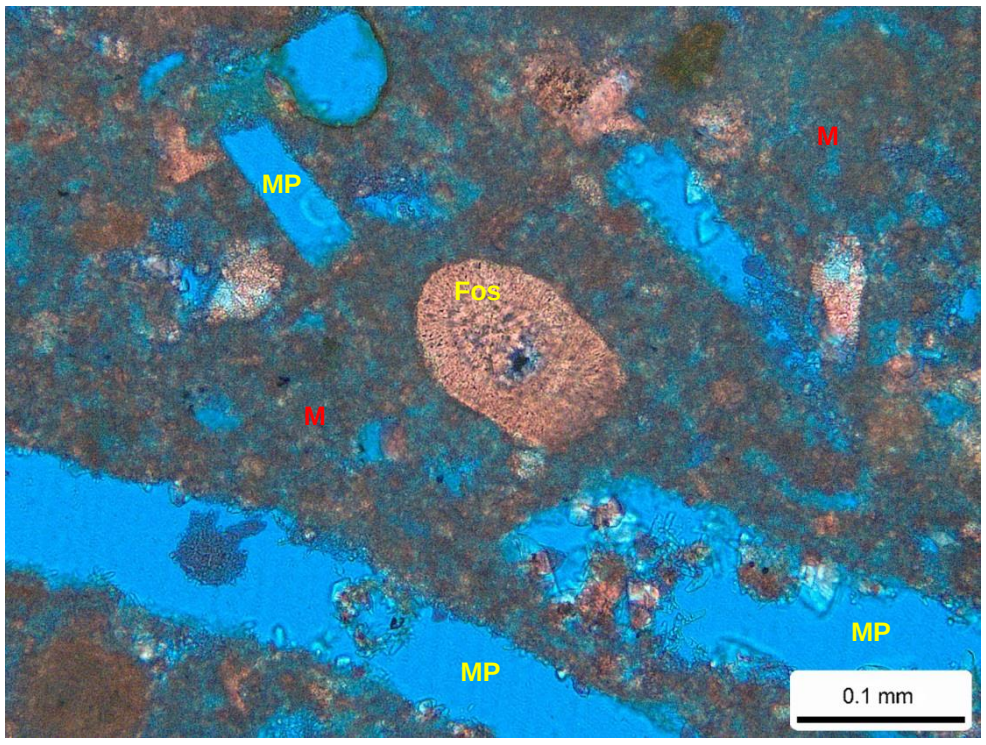

Sample Description

Lithology: Limestone

Classification (mod. Dunham 1962)
Packstone

Texture and Structures:
Massive

Allochemical Grains:
Abundant fossil fragments (dominantly foraminifers); minor to moderate peloids and other allochems

Other Grains:
na

Matrix:
Abundant micritic matrix

Cement and Replacement:
Minor calcite/Fe-calcite cement; trace chert (replacing fossils)

Pore Types:
Common to abundant moldic pores; minor to moderate interparticle, intercrystal and intraskeletal pores

Photo Caption:

Fossil fragments (Fos; mainly foraminifers) are the principal allochem grains in this limestone; interparticle areas are filled with micritic matrix (M). Visible pores (blue) are abundant and mostly moldic pores (MP), followed by intercrystal and intraskeletal pores. Note that visible pores are moderately interconnected.

Relative Abundances:

Trace	<1%
Minor	1-5%
Moderate	5-10%
Common	10-20%
Abundant	>20%

Core Lab
RESERVOIR OPTIMIZATION

CMS-300 CONVENTIONAL PLUG ANALYSIS

South Florida Water Management District

OSF-110

Florida

CL File Number: 201802884

Date: 9/11/18

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South Florida Water Management District
OSF-110
Florida

CL File No.: 201802884
Date: 9/11/18
Analyst(s): JDH-TW-IM

CMS-300 CONVENTIONAL PLUG ANALYSIS

Sample Number	Depth (ft)	Net Confining Stress (psig)	Porosity (%)	Permeability Klinkenberg (md)	Permeability Kair (md)	b(air) psi	Beta ft(-1)	Alpha (microns)	Grain Density (g/cm3)	Footnote
1H	329.10	800	33.44	290	310	1.15	7.82E+06	7.31E+00	2.697	
1V	329.10	800	35.27	224	237	0.94	1.25E+07	8.98E+00	2.694	
2H	331.80	Ambient	44.19	NA	NA	NA	NA	NA	2.694	(5)
2V	331.65	Ambient	38.37	NA	NA	NA	NA	NA	2.693	(5)
3H	343.05	Ambient	38.68	NA	NA	NA	NA	NA	2.677	(5)
3V	343.10	Ambient	33.35	NA	NA	NA	NA	NA	2.704	(5)
4H	368.80	800	41.17	6.14	9.12	9.52	1.27E+09	2.49E+01	2.702	
4V	368.65	800	41.22	9.40	13.5	8.40	9.37E+08	2.83E+01	2.705	
5H	372.60	800	40.57	92.9	111	3.26	7.66E+07	2.29E+01	2.695	
5V	372.60	800	39.61	160	188	2.89	3.06E+07	1.58E+01	2.699	
6H	389.00	800	42.07	79.8	103	5.06	8.41E+07	2.16E+01	2.697	
6V	389.00	800	39.46	17.0	25.6	9.33	1.02E+09	5.59E+01	2.694	
7H	433.70	800	36.73	93.2	129	6.57	2.20E+08	6.63E+01	2.688	
7V	433.50	800	37.88	13.8	18.3	6.19	1.26E+09	5.55E+01	2.687	
8H	448.70	800	32.82	16.3	18.7	2.83	9.10E+08	4.75E+01	2.818	
8V	448.50	800	36.45	39.5	45.6	2.72	2.22E+08	2.83E+01	2.819	
9H	582.20	800	31.43	36.6	42.6	2.89	5.94E+08	7.01E+01	2.822	
9V	582.20	800	33.85	43.4	49.3	2.37	5.91E+08	8.25E+01	2.819	
10H	589.30	800	47.20	247	271	1.62	8.87E+06	7.04E+00	2.818	
10V	589.30	800	43.62	17.9	26.8	9.14	2.58E+07	1.49E+00	2.803	

Footnotes :

(5) : Denotes sample unsuitable for measurement at stress. Porosity determined using Archimedes bulk volume at ambient conditions.

Permeability greater than 0.1 mD measured using helium gas. Permeability less than 0.1 mD measured using nitrogen gas. All b values converted to b (air)

APPENDIX A: EXPLANATION OF CMS-300 TERMS "b", "Beta, and "Alpha"

K_∞	=	Equivalent non-reactive liquid permeability, corrected for gas slippage, mD
K_{air}	=	Permeability to Air, calculated using K_∞ and b, mD
b	=	Klinkenberg slip factor, psi
β (Beta)	=	Forcheimer inertial resistance factor, ft^{-1}
α (Alpha)	=	A factor equal to the product of Beta and K_∞. This factor is employed in determining the pore level heterogeneity index, H_i.
H_i	=	$\log_{10}(\alpha ø/RQI)$ α, microns = $3.238E^{-9}\ \beta K_\infty$
Ø	=	Porosity, fraction
RQI	=	Reservoir Quality Index, microns
RQI	=	$0.0314(K/ø)^{0.5}$

For further information please refer to:

Jones, S.C.: "Two-Point Determination of Permeability and PV vs. Net Confining Stress" SPE Formation Evaluation (March 1988) 235-241.

Jones S.C.: "A Rapid Accurate Unsteady-State Klinkenberg Permeameter," Soc. Pet. Eng. J. (Oct. 1972) 383-397.

Jones, S.C.: "Using the Inertial Coefficient, β, To Characterize Heterogeneity in Reservoir Rock: SPE 16949 (September 1987).

Amaefule, J.O.; Kersey, D.G.; Marschall, D.M.; Powell, J.D.; Valencia, L.E.; Keelan, D.K.: "Reservoir Description: A Practical Synergistic Engineering and Geological Approach Based on Analysis of Core Data,: SPE Technical Conference (Oct. 1988) SPE 18167.

CMS-300 CONVENTIONAL PLUG ANALYSIS PROTOCOL

1.0" diameter plugs were drilled with water and trimmed into right cylinders with a diamond-blade trim saw.
All sample trims were archived.

Sample Drying

Samples were oven dried at 240° F to weight equilibrium (+/- 0.001 g).

Porosity

Porosity was determined using Boyle's Law technique by measuring grain volume at ambient conditions & pore volume at indicated net confining stresses (NCS)

Grain Density

Grain density values were calculated by direct measurement of grain volume and weight on dried plug samples.
Grain volume was measured by Boyle's Law technique.

Permeability

Permeability to air was measured on each sample using unsteady-state method at indicated NCS.

APPENDIX G:
UPPER FLORIDAN AQUIFER TEST DATA

Table G-1. Upper Floridan aquifer constant-rate discharge test (330 to 600 ft bls).

Date and Time	Elapsed Time (sec)	OSF-111 Drawdown (ft)	OSF-110 Drawdown (ft)
5/3/18 17:30	0	0	0
5/3/18 17:30	0.42	0.113	-0.001
5/3/18 17:30	0.901	0.41	0.022
5/3/18 17:30	1.44	0.656	-0.018
5/3/18 17:30	1.92	0.991	0.018
5/3/18 17:30	2.52	1.379	0.019
5/3/18 17:30	3.121	1.134	0.079
5/3/18 17:30	3.72	1.168	0.003
5/3/18 17:30	4.38	1.408	0.047
5/3/18 17:30	5.1	1.444	0.049
5/3/18 17:30	5.88	1.546	0.086
5/3/18 17:30	6.66	2.239	0.105
5/3/18 17:30	7.5	2.462	0.12
5/3/18 17:30	8.4	3.086	0.196
5/3/18 17:30	9.36	3.09	0.155
5/3/18 17:30	10.32	3.796	0.25
5/3/18 17:30	11.4	4.82	0.233
5/3/18 17:30	12.541	4.522	0.302
5/3/18 17:30	13.741	5.632	0.305
5/3/18 17:30	15	6.262	0.456
5/3/18 17:30	16.32	6.837	0.489
5/3/18 17:30	17.76	7.26	0.571
5/3/18 17:30	19.26	8.145	0.739
5/3/18 17:30	20.82	10.072	0.873
5/3/18 17:30	22.5	10.338	0.981
5/3/18 17:30	24.3	10.714	1.05
5/3/18 17:30	26.16	12.289	1.359
5/3/18 17:30	28.2	12.916	1.482
5/3/18 17:30	30.3	13.88	1.61
5/3/18 17:30	32.52	14.46	1.714
5/3/18 17:30	34.92	14.65	1.924
5/3/18 17:30	37.44	14.795	2.042
5/3/18 17:30	40.08	14.755	2.246
5/3/18 17:30	42.9	15.299	2.475
5/3/18 17:30	45.9	15.419	2.542
5/3/18 17:30	49.08	14.975	2.683
5/3/18 17:30	52.44	15.107	2.827
5/3/18 17:30	56.04	15.412	2.906
5/3/18 17:31	59.666	15.57	2.944
5/3/18 17:31	63.84	15.231	3.016
5/3/18 17:31	68.04	15.38	3.151
5/3/18 17:31	72.241	15.687	3.203
5/3/18 17:31	77.04	15.38	3.194
5/3/18 17:31	82.44	15.493	3.332
5/3/18 17:31	87.24	15.591	3.332

Date and Time	Elapsed Time (sec)	OSF-111 Drawdown (ft)	OSF-110 Drawdown (ft)
5/3/18 17:31	93.24	15.91	3.539
5/3/18 17:31	99.24	15.801	3.619
5/3/18 17:31	105.24	15.938	3.692
5/3/18 17:31	111.84	15.805	3.668
5/3/18 17:32	119.04	15.593	3.813
5/3/18 17:32	126.84	16.005	3.805
5/3/18 17:32	134.64	16.043	3.873
5/3/18 17:32	143.04	15.745	3.957
5/3/18 17:32	152.04	15.9	4.002
5/3/18 17:32	161.64	15.784	4.046
5/3/18 17:32	171.241	15.915	4.024
5/3/18 17:33	182.04	16.133	4.156
5/3/18 17:33	193.44	16.187	4.172
5/3/18 17:33	205.44	16.272	4.23
5/3/18 17:33	218.04	15.899	4.318
5/3/18 17:33	231.24	16.174	4.303
5/3/18 17:34	245.64	16.09	4.35
5/3/18 17:34	260.64	16.156	4.354
5/3/18 17:34	276.24	16.135	4.406
5/3/18 17:34	293.04	16.159	4.474
5/3/18 17:35	311.04	16.42	4.539
5/3/18 17:35	329.64	16.311	4.552
5/3/18 17:35	350.04	16.133	4.728
5/3/18 17:36	371.04	16.518	4.716
5/3/18 17:36	393.24	16.216	4.687
5/3/18 17:36	417.24	16.271	4.742
5/3/18 17:37	442.44	16.327	4.774
5/3/18 17:37	468.84	16.734	4.784
5/3/18 17:38	497.04	16.474	4.803
5/3/18 17:38	527.04	16.327	4.878
5/3/18 17:39	558.84	16.521	4.966
5/3/18 17:39	592.44	16.408	4.943
5/3/18 17:40	628.44	16.427	4.968
5/3/18 17:41	664.44	16.84	4.916
5/3/18 17:41	706.44	16.502	4.931
5/3/18 17:42	748.44	16.392	5.041
5/3/18 17:43	790.44	16.437	5.081
5/3/18 17:44	838.44	16.769	5.109
5/3/18 17:44	892.44	16.697	5.132
5/3/18 17:45	940.44	16.306	5.164
5/3/18 17:46	1,000.44	16.628	5.202
5/3/18 17:47	1,060.44	16.811	5.22
5/3/18 17:48	1,120.44	16.996	5.202
5/3/18 17:49	1,186.44	16.803	5.233
5/3/18 17:51	1,258.44	16.741	5.256
5/3/18 17:52	1,336.44	16.599	5.262
5/3/18 17:53	1,414.44	16.382	5.252

Date and Time	Elapsed Time (sec)	OSF-111 Drawdown (ft)	OSF-110 Drawdown (ft)
5/3/18 17:55	1,498.44	16.675	5.335
5/3/18 17:56	1,588.44	16.376	5.294
5/3/18 17:58	1,684.44	16.628	5.326
5/3/18 17:59	1,780.44	16.769	5.573
5/3/18 18:01	1,888.44	16.775	5.399
5/3/18 18:03	2,002.44	16.383	5.211
5/3/18 18:05	2,122.44	16.501	5.227
5/3/18 18:07	2,248.44	16.276	5.212
5/3/18 18:09	2,380.44	16.66	5.259
5/3/18 18:12	2,524.44	16.252	4.997
5/3/18 18:14	2,674.44	16.659	5.47
5/3/18 18:17	2,830.44	16.629	5.486
5/3/18 18:20	2,998.44	16.243	5.528
5/3/18 18:23	3,178.44	16.716	5.566
5/3/18 18:26	3,364.44	16.651	5.508
5/3/18 18:29	3,568.44	16.445	5.588
5/3/18 18:33	3,778.44	16.442	5.583
5/3/18 18:36	4,000.44	16.431	5.617
5/3/18 18:40	4,240.44	16.388	5.597
5/3/18 18:44	4,492.44	16.235	5.642
5/3/18 18:49	4,756.44	16.507	5.686
5/3/18 18:54	5,038.44	16.576	5.659
5/3/18 18:59	5,338.44	16.366	5.623
5/3/18 19:04	5,656.44	16.268	5.606
5/3/18 19:09	5,992.44	16.451	5.606
5/3/18 19:15	6,352.44	16.727	5.676
5/3/18 19:21	6,712.44	16.239	5.685
5/3/18 19:28	7,132.44	16.416	5.712
5/3/18 19:35	7,552.44	17.035	5.682
5/3/18 19:42	7,972.44	16.452	5.777
5/3/18 19:50	8,452.44	16.465	5.749
5/3/18 19:59	8,992.44	16.647	5.765
5/3/18 20:07	9,472.44	16.47	5.839
5/3/18 20:17	10,072.44	16.676	5.795
5/3/18 20:27	10,672.44	16.824	5.844
5/3/18 20:37	11,272.44	16.746	5.828
5/3/18 20:47	11,872.44	16.54	5.89
5/3/18 20:57	12,472.44	16.619	5.897
5/3/18 21:07	13,072.44	16.477	5.832
5/3/18 21:17	13,672.44	16.922	5.804
5/3/18 21:27	14,272.44	16.788	5.841
5/3/18 21:37	14,872.44	16.707	5.769
5/3/18 21:47	15,472.44	16.695	5.947
5/3/18 21:57	16,072.88	16.614	5.801
5/3/18 22:07	16,672.44	16.352	5.695
5/3/18 22:17	17,272.44	16.713	5.758
5/3/18 22:27	17,872.44	16.429	5.778

Date and Time	Elapsed Time (sec)	OSF-111 Drawdown (ft)	OSF-110 Drawdown (ft)
5/3/18 22:37	18,472.44	16.548	5.827
5/3/18 22:47	19,072.44	16.567	5.945
5/3/18 22:57	19,672.44	16.627	6.019
5/3/18 23:07	20,272.44	16.797	6.078
5/3/18 23:17	20,872.44	16.866	5.968
5/3/18 23:27	21,472.44	16.711	6.118
5/3/18 23:37	22,072.44	16.717	6.089
5/3/18 23:47	22,672.44	16.747	6.102
5/3/18 23:57	23,272.44	16.693	6.079
5/4/18 0:07	23,872.44	16.521	6.03
5/4/18 0:17	24,472.44	16.808	6.098
5/4/18 0:27	25,072.44	16.632	6.092
5/4/18 0:37	25,672.44	16.957	6.052
5/4/18 0:47	26,272.44	16.464	6.08
5/4/18 0:57	26,872.44	16.648	6.079
5/4/18 1:07	27,472.44	16.836	6.06
5/4/18 1:17	28,072.44	16.94	6.081
5/4/18 1:27	28,672.44	16.804	6.073
5/4/18 1:37	29,272.44	16.751	6.056
5/4/18 1:47	29,872.44	16.858	6.071
5/4/18 1:57	30,472.44	16.798	6.1
5/4/18 2:07	31,072.44	17.025	6.085
5/4/18 2:17	31,672.44	16.9	6.222
5/4/18 2:27	32,272.44	16.725	6.155
5/4/18 2:37	32,872.44	16.803	6.077
5/4/18 2:47	33,472.44	16.798	6.065
5/4/18 2:57	34,072.44	17.032	6.077
5/4/18 3:07	34,672.44	16.859	6.07
5/4/18 3:17	35,272.44	16.949	6.125
5/4/18 3:27	35,872.44	16.809	6.097
5/4/18 3:37	36,472.44	16.834	6.036
5/4/18 3:47	37,072.44	16.827	6.077
5/4/18 3:57	37,672.44	17.099	6.112
5/4/18 4:07	38,272.44	16.748	6.146
5/4/18 4:17	38,872.44	16.965	6.029
5/4/18 4:27	39,472.44	16.913	6.122
5/4/18 4:37	40,072.44	17.11	6.099
5/4/18 4:47	40,672.44	16.817	6.138
5/4/18 4:57	41,272.44	16.856	6.117
5/4/18 5:07	41,872.44	17.166	6.109
5/4/18 5:17	42,472.44	16.743	6.063
5/4/18 5:27	43,072.44	16.86	6.041
5/4/18 5:37	43,672.44	17.001	6.067
5/4/18 5:47	44,272.44	16.845	6.147
5/4/18 5:57	44,872.44	16.828	6.118
5/4/18 6:07	45,472.44	17.059	6.089
5/4/18 6:17	46,072.44	16.92	6.03

Date and Time	Elapsed Time (sec)	OSF-111 Drawdown (ft)	OSF-110 Drawdown (ft)
5/4/18 6:27	46,672.44	17.027	6.058
5/4/18 6:37	47,272.44	17.003	6.098
5/4/18 6:47	47,872.44	16.885	6.052
5/4/18 6:57	48,472.44	16.801	6.072
5/4/18 7:07	49,072.44	16.742	6.056
5/4/18 7:17	49,672.44	16.675	6.099
5/4/18 7:27	50,272.44	17.093	6.089
5/4/18 7:37	50,872.44	16.944	6.113
5/4/18 7:47	51,472.44	16.95	6.099
5/4/18 7:57	52,072.44	17.039	6.131
5/4/18 8:07	52,672.44	17.168	6.181
5/4/18 8:17	53,272.44	17.005	6.128
5/4/18 8:27	53,872.44	17.062	6.161
5/4/18 8:37	54,472.44	16.994	6.104
5/4/18 8:47	55,072.44	17.027	6.162
5/4/18 8:57	55,672.44	17.061	6.189
5/4/18 9:07	56,272.44	16.856	6.136
5/4/18 9:17	56,872.44	16.757	6.15
5/4/18 9:27	57,472.44	17.254	6.195
5/4/18 9:37	58,072.44	17.036	6.15
5/4/18 9:47	58,672.44	16.97	6.145
5/4/18 9:57	59,272.44	16.757	6.222
5/4/18 10:07	59,872.44	16.834	6.17
5/4/18 10:17	60,472.44	16.679	6.162
5/4/18 10:27	61,072.44	17.374	6.193
5/4/18 10:37	61,672.44	17.041	6.25
5/4/18 10:47	62,272.44	16.85	6.211
5/4/18 10:57	62,872.44	16.664	6.231
5/4/18 11:07	63,472.44	16.778	6.269
5/4/18 11:17	64,072.44	16.913	6.204
5/4/18 11:27	64,672.44	17.129	6.132
5/4/18 11:37	65,272.44	16.75	6.166
5/4/18 11:47	65,872.44	16.628	6.126
5/4/18 11:57	66,472.44	16.919	6.177
5/4/18 12:07	67,072.44	16.689	6.134
5/4/18 12:17	67,672.44	17.014	6.108
5/4/18 12:27	68,272.44	17.183	6.174
5/4/18 12:37	68,872.44	17.069	6.15
5/4/18 12:47	69,472.44	17.212	6.249
5/4/18 12:57	70,072.44	16.643	6.196
5/4/18 13:07	70,672.44	17.216	6.231
5/4/18 13:17	71,272.44	16.485	6.181
5/4/18 13:27	71,872.44	17.123	6.16
5/4/18 13:37	72,472.44	17.03	6.224
5/4/18 13:47	73,072.44	16.704	6.215
5/4/18 13:57	73,672.44	16.695	6.259
5/4/18 14:07	74,272.44	16.744	6.191

Date and Time	Elapsed Time (sec)	OSF-111 Drawdown (ft)	OSF-110 Drawdown (ft)
5/4/18 14:17	74,872.44	18.137	6.169
5/4/18 14:27	75,472.44	18.079	6.386
5/4/18 14:37	76,072.44	18.039	6.463
5/4/18 14:47	76,672.44	18.206	6.437
5/4/18 14:57	77,272.44	18.345	6.43
5/4/18 15:07	77,872.44	18.06	6.432
5/4/18 15:17	78,472.44	18.215	6.515
5/4/18 15:27	79,072.44	17.957	6.498
5/4/18 15:37	79,672.44	18.477	6.459
5/4/18 15:47	80,272.44	17.753	6.488
5/4/18 15:57	80,872.44	18.087	6.493
5/4/18 16:07	81,472.44	18.163	6.466
5/4/18 16:17	82,072.44	18.257	6.486
5/4/18 16:27	82,672.44	18.183	6.507
5/4/18 16:37	83,272.44	18.266	6.542
5/4/18 16:47	83,872.44	18.345	6.544
5/4/18 16:57	84,472.44	18.231	6.556
5/4/18 17:07	85,072.44	18.291	6.54
5/4/18 17:17	85,672.44	18.051	6.49
5/4/18 17:27	86,272.44	18.16	6.495
5/4/18 17:37	86,872.44	18.228	6.528
5/4/18 17:47	87,472.44	18.062	6.497
5/4/18 17:57	88,072.44	18.117	6.526
5/4/18 18:07	88,672.44	18.147	6.483
5/4/18 18:17	89,272.44	18.124	6.449
5/4/18 18:27	89,872.44	18.346	6.492
5/4/18 18:37	90,472.44	18.244	6.524
5/4/18 18:47	91,072.44	18.137	6.481
5/4/18 18:57	91,672.44	18.102	6.435
5/4/18 19:07	92,272.44	18.03	6.538
5/4/18 19:17	92,872.44	18.249	6.475
5/4/18 19:27	93,472.44	18.551	6.539
5/4/18 19:37	94,072.44	18.152	6.535
5/4/18 19:47	94,672.44	18.083	6.468
5/4/18 19:57	95,272.44	18.123	6.509
5/4/18 20:07	95,872.44	18.017	6.537
5/4/18 20:17	96,472.44	18.266	6.44
5/4/18 20:27	97,072.44	18.285	6.512
5/4/18 20:37	97,672.44	18.238	6.457
5/4/18 20:47	98,272.44	18.48	6.53
5/4/18 20:57	98,872.44	18.365	6.499
5/4/18 21:07	99,472.44	18.212	6.526
5/4/18 21:17	100,072.4	18.027	6.471
5/4/18 21:27	100,672.4	17.819	6.513
5/4/18 21:37	101,272.4	17.922	6.438
5/4/18 21:47	101,872.4	18.077	6.481
5/4/18 21:57	102,472.4	18.327	6.514

Date and Time	Elapsed Time (sec)	OSF-111 Drawdown (ft)	OSF-110 Drawdown (ft)
5/4/18 22:07	103,072.4	18.305	6.51
5/4/18 22:17	103,672.4	18.05	6.46
5/4/18 22:27	104,272.4	18.269	6.484
5/4/18 22:37	104,872.4	18.292	6.474
5/4/18 22:47	105,472.4	18.113	6.443
5/4/18 22:57	106,072.4	18.624	6.454
5/4/18 23:07	106,672.4	17.967	6.466
5/4/18 23:17	107,272.4	18.222	6.496
5/4/18 23:27	107,872.4	18.156	6.506
5/4/18 23:37	108,472.4	18.396	6.483
5/4/18 23:47	109,072.4	17.948	6.49
5/4/18 23:57	109,672.4	18.177	6.494
5/5/18 0:07	110,272.4	18.157	6.411
5/5/18 0:17	110,872.4	18.514	6.441
5/5/18 0:27	111,472.4	18.157	6.46
5/5/18 0:37	112,072.4	18.285	6.451
5/5/18 0:47	112,672.4	18.001	6.466
5/5/18 0:57	113,272.4	17.779	6.444
5/5/18 1:07	113,872.4	17.973	6.487
5/5/18 1:17	114,472.4	18.128	6.535
5/5/18 1:27	115,072.4	18.365	6.5
5/5/18 1:37	115,672.4	18.288	6.463
5/5/18 1:47	116,272.4	18.364	6.556
5/5/18 1:57	116,872.4	18.109	6.445
5/5/18 2:07	117,472.4	18.243	6.48
5/5/18 2:17	118,072.4	18.239	6.453
5/5/18 2:27	118,672.4	18.252	6.472
5/5/18 2:37	119,272.4	17.908	6.415
5/5/18 2:47	119,872.4	18.188	6.498
5/5/18 2:57	120,472.4	18.002	6.464
5/5/18 3:07	121,072.4	18.374	6.444
5/5/18 3:17	121,672.4	17.981	6.422
5/5/18 3:27	122,272.4	17.864	6.44
5/5/18 3:37	122,872.4	17.911	6.441
5/5/18 3:47	123,472.4	17.871	6.46
5/5/18 3:57	124,072.4	18.574	6.439
5/5/18 4:07	124,672.4	18.103	6.396
5/5/18 4:17	125,272.4	18.021	6.464
5/5/18 4:27	125,872.4	18.182	6.381
5/5/18 4:37	126,472.5	18.057	6.458
5/5/18 4:47	127,072.4	18.209	6.443
5/5/18 4:57	127,672.4	18.146	6.496
5/5/18 5:07	128,272.4	18.041	6.433
5/5/18 5:17	128,872.4	18.142	6.443
5/5/18 5:27	129,472.4	18.464	6.433
5/5/18 5:37	130,072.4	17.95	6.469
5/5/18 5:47	130,672.4	18.211	6.425

Date and Time	Elapsed Time (sec)	OSF-111 Drawdown (ft)	OSF-110 Drawdown (ft)
5/5/18 5:57	131,272.4	18.369	6.522
5/5/18 6:07	131,872.4	18.341	6.46
5/5/18 6:17	132,472.4	18.119	6.412
5/5/18 6:27	133,072.4	18.104	6.396
5/5/18 6:37	133,672.4	18.227	6.435
5/5/18 6:47	134,272.4	18.044	6.476
5/5/18 6:57	134,872.4	18.271	6.412
5/5/18 7:07	135,472.4	18.28	6.36
5/5/18 7:17	136,072.4	18.172	6.395
5/5/18 7:27	136,672.4	18.279	6.451
5/5/18 7:37	137,272.4	17.938	6.438
5/5/18 7:47	137,872.4	17.618	6.425
5/5/18 7:57	138,472.4	17.908	6.38
5/5/18 8:07	139,072.4	18.454	6.427
5/5/18 8:17	139,672.4	18.262	6.442
5/5/18 8:27	140,272.4	17.777	6.471
5/5/18 8:37	140,872.4	17.971	6.472
5/5/18 8:47	141,472.4	17.964	6.463
5/5/18 8:57	142,072.4	18.162	6.487
5/5/18 9:07	142,672.4	18.404	6.42
5/5/18 9:17	143,272.4	18.269	6.465
5/5/18 9:27	143,872.4	18.451	6.408
5/5/18 9:37	144,472.4	18.179	6.422
5/5/18 9:47	145,072.4	18.097	6.448
5/5/18 9:57	145,672.4	18.006	6.399
5/5/18 10:07	146,272.4	17.776	6.342
5/5/18 10:17	146,872.4	18.057	6.406
5/5/18 10:27	147,472.4	18.319	6.378
5/5/18 10:37	148,072.4	18.245	6.404
5/5/18 10:47	148,672.4	17.878	6.363
5/5/18 10:57	149,272.4	18.349	6.406
5/5/18 11:07	149,872.4	17.858	6.31
5/5/18 11:17	150,472.4	18.24	6.394
5/5/18 11:27	151,072.4	18.171	6.321
5/5/18 11:29	151,072.4	16.314	6.381
5/5/18 11:29	151,072.7	15.664	6.381
5/5/18 11:29	151,072.9	15.482	6.381
5/5/18 11:29	151,073.2	15.886	6.381
5/5/18 11:29	151,073.4	16.656	6.381
5/5/18 11:29	151,073.7	15.88	6.381
5/5/18 11:29	151,073.9	15.817	6.381
5/5/18 11:29	151,074.2	16.196	6.381
5/5/18 11:29	151,074.4	16.066	6.381
5/5/18 11:29	151,074.7	15.153	6.381
5/5/18 11:29	151,074.9	15.325	6.381
5/5/18 11:29	151,075.2	15.225	6.381
5/5/18 11:29	151,075.4	14.597	6.381

Date and Time	Elapsed Time (sec)	OSF-111 Drawdown (ft)	OSF-110 Drawdown (ft)
5/5/18 11:29	151,075.7	14.69	6.381
5/5/18 11:29	151,075.9	14.954	6.381
5/5/18 11:29	151,076.2	14.153	6.381
5/5/18 11:30	151,076.4	14.153	6.381
5/5/18 11:30	151,076.7	13.924	6.381
5/5/18 11:30	151,076.9	13.261	6.381
5/5/18 11:30	151,077.2	13.377	6.381
5/5/18 11:30	151,077.4	13.436	6.381
5/5/18 11:30	151,077.7	12.747	6.381
5/5/18 11:30	151,077.9	12.744	6.381
5/5/18 11:30	151,078.2	12.413	6.381
5/5/18 11:30	151,078.4	11.886	6.381
5/5/18 11:30	151,078.8	11.573	6.381
5/5/18 11:30	151,079.2	11.312	6.381
5/5/18 11:30	151,079.6	10.852	6.258
5/5/18 11:30	151,080.0	9.786	6.195
5/5/18 11:30	151,080.4	9.445	6.228
5/5/18 11:30	151,080.9	8.864	6.174
5/5/18 11:30	151,081.4	7.921	6.133
5/5/18 11:30	151,081.9	7.624	6.117
5/5/18 11:30	151,082.5	6.145	6.076
5/5/18 11:30	151,083.1	5.937	6.006
5/5/18 11:30	151,083.7	5.121	5.971
5/5/18 11:30	151,084.4	4.295	5.88
5/5/18 11:30	151,085.1	2.997	5.8
5/5/18 11:30	151,085.9	2.298	5.746
5/5/18 11:30	151,086.7	1.703	5.644
5/5/18 11:30	151,087.5	0.924	5.54
5/5/18 11:30	151,088.4	0.274	5.419
5/5/18 11:30	151,089.4	-0.187	5.325
5/5/18 11:30	151,090.3	-0.834	5.12
5/5/18 11:30	151,091.4	-1.297	4.888
5/5/18 11:30	151,092.5	-1.615	4.738
5/5/18 11:30	151,093.7	-1.751	4.459
5/5/18 11:30	151,095.0	-1.633	4.31
5/5/18 11:30	151,096.6	-1.13	3.971
5/5/18 11:30	151,097.8	-0.672	3.795
5/5/18 11:30	151,099.3	-0.06	3.618
5/5/18 11:30	151,100.8	0.662	3.307
5/5/18 11:30	151,102.5	1.367	3.11
5/5/18 11:30	151,104.3	1.885	2.985
5/5/18 11:30	151,106.2	2.251	2.803
5/5/18 11:30	151,108.2	2.369	2.734
5/5/18 11:30	151,110.3	2.312	2.69
5/5/18 11:30	151,112.5	1.883	2.659
5/5/18 11:30	151,114.9	1.475	2.693
5/5/18 11:30	151,117.4	1.028	2.733

Date and Time	Elapsed Time (sec)	OSF-111 Drawdown (ft)	OSF-110 Drawdown (ft)
5/5/18 11:30	151,120.1	0.77	2.727
5/5/18 11:30	151,122.9	0.634	2.71
5/5/18 11:30	151,125.9	0.699	2.682
5/5/18 11:30	151,129.1	0.9	2.595
5/5/18 11:30	151,132.4	1.093	2.529
5/5/18 11:30	151,136.0	1.236	2.277
5/5/18 11:31	151,139.6	1.113	2.318
5/5/18 11:31	151,143.8	0.924	2.296
5/5/18 11:31	151,148.0	0.779	2.288
5/5/18 11:31	151,152.2	0.832	2.265
5/5/18 11:31	151,157.0	0.73	2.201
5/5/18 11:31	151,162.4	0.812	2.154
5/5/18 11:31	151,167.2	0.727	2.094
5/5/18 11:31	151,173.2	0.689	2.062
5/5/18 11:31	151,179.2	0.644	2.028
5/5/18 11:31	151,185.2	0.588	1.986
5/5/18 11:31	151,191.8	0.674	1.945
5/5/18 11:32	151,199.0	0.774	1.824
5/5/18 11:32	151,206.8	1.433	1.828
5/5/18 11:32	151,214.6	2.024	1.866
5/5/18 11:32	151,223.0	1.91	1.995
5/5/18 11:32	151,232.0	1.411	2.107
5/5/18 11:32	151,241.6	1.614	2.058
5/5/18 11:32	151,251.2	1.727	2.034
5/5/18 11:33	151,262.0	1.606	2.001
5/5/18 11:33	151,273.4	1.586	2.026
5/5/18 11:33	151,285.4	1.649	2.006
5/5/18 11:33	151,298.0	1.575	2.006
5/5/18 11:33	151,311.2	1.601	1.993
5/5/18 11:34	151,325.6	1.572	1.948
5/5/18 11:34	151,340.6	1.546	1.949
5/5/18 11:34	151,356.2	1.594	1.927
5/5/18 11:34	151,373.0	1.538	1.913
5/5/18 11:35	151,391.0	1.492	1.872
5/5/18 11:35	151,409.6	1.492	1.882
5/5/18 11:35	151,430.0	1.468	1.854
5/5/18 11:36	151,451.0	1.446	1.844
5/5/18 11:36	151,473.2	1.436	1.822
5/5/18 11:37	151,497.2	1.426	1.803
5/5/18 11:37	151,522.4	1.411	1.758
5/5/18 11:37	151,548.8	1.43	1.774
5/5/18 11:38	151,577.0	1.372	1.758
5/5/18 11:38	151,607.0	1.364	1.719
5/5/18 11:39	151,638.8	1.336	1.708
5/5/18 11:39	151,672.4	1.314	1.677
5/5/18 11:40	151,708.4	1.306	1.677
5/5/18 11:41	151,744.4	1.292	1.664

Date and Time	Elapsed Time (sec)	OSF-111 Drawdown (ft)	OSF-110 Drawdown (ft)
5/5/18 11:41	151,786.4	1.268	1.644
5/5/18 11:42	151,828.4	1.298	1.618
5/5/18 11:43	151,870.4	1.228	1.613
5/5/18 11:44	151,918.4	1.22	1.589
5/5/18 11:44	151,972.4	1.222	1.555
5/5/18 11:45	152,020.4	1.219	1.537
5/5/18 11:46	152,080.4	1.182	1.519
5/5/18 11:47	152,140.4	1.2	1.5
5/5/18 11:48	152,200.4	1.188	1.456
5/5/18 11:49	152,266.4	1.13	1.47
5/5/18 11:51	152,338.4	1.137	1.434
5/5/18 11:52	152,416.4	1.14	1.394
5/5/18 11:53	152,494.4	1.075	1.383
5/5/18 11:55	152,578.4	1.06	1.354
5/5/18 11:56	152,668.4	1.051	1.362
5/5/18 11:58	152,764.4	1.036	1.329
5/5/18 11:59	152,860.4	1.044	1.32
5/5/18 12:01	152,968.4	0.997	1.289
5/5/18 12:03	153,082.4	1.02	1.256
5/5/18 12:05	153,202.4	1.009	1.23
5/5/18 12:07	153,328.4	0.994	1.243
5/5/18 12:09	153,460.4	0.923	1.193
5/5/18 12:12	153,604.4	0.913	1.177
5/5/18 12:14	153,754.4	0.9	1.146
5/5/18 12:17	153,910.4	0.924	1.144
5/5/18 12:20	154,078.4	0.86	1.105
5/5/18 12:23	154,258.4	0.848	1.082
5/5/18 12:26	154,444.4	0.839	1.037
5/5/18 12:29	154,648.4	0.8	1.021
5/5/18 12:33	154,858.4	0.78	0.965
5/5/18 12:36	155,080.4	0.805	0.967
5/5/18 12:40	155,320.4	0.76	0.936
5/5/18 12:44	155,572.4	0.744	0.913
5/5/18 12:49	155,836.4	0.73	0.882
5/5/18 12:54	156,118.4	0.696	0.882
5/5/18 12:59	156,418.4	0.692	0.847
5/5/18 13:04	156,736.4	0.657	0.832
5/5/18 13:09	157,072.4	0.662	0.779
5/5/18 13:15	157,432.4	0.646	0.797
5/5/18 13:21	157,792.4	0.631	0.785
5/5/18 13:28	158,212.4	0.61	0.736
5/5/18 13:35	158,632.4	0.58	0.715
5/5/18 13:42	159,052.4	0.574	0.682
5/5/18 13:50	159,532.4	0.563	0.654
5/5/18 13:59	160,072.4	0.543	0.633
5/5/18 14:07	160,552.4	0.52	0.598
5/5/18 14:17	161,152.4	0.51	0.589

Date and Time	Elapsed Time (sec)	OSF-111 Drawdown (ft)	OSF-110 Drawdown (ft)
5/5/18 14:27	161,752.4	0.486	0.557
5/5/18 14:37	162,352.4	0.461	0.536
5/5/18 14:47	162,952.4	0.44	0.496
5/5/18 14:57	163,552.4	0.411	0.478
5/5/18 15:07	164,152.4	0.4	0.445
5/5/18 15:17	164,752.4	0.386	0.435
5/5/18 15:27	165,352.4	0.381	0.444
5/5/18 15:37	165,952.4	0.355	0.432
5/5/18 15:47	166,552.4	0.355	0.388
5/5/18 15:57	167,152.4	0.333	0.375
5/5/18 16:07	167,752.4	0.322	0.365
5/5/18 16:17	168,352.4	0.3	0.339
5/5/18 16:27	168,952.4	0.308	0.333
5/5/18 16:37	169,552.4	0.279	0.293
5/5/18 16:47	170,152.4	0.257	0.293
5/5/18 16:57	170,752.4	0.259	0.272
5/5/18 17:07	171,352.4	0.24	0.269
5/5/18 17:17	171,952.4	0.229	0.241
5/5/18 17:27	172,552.4	0.218	0.225
5/5/18 17:37	173,152.4	0.209	0.233
5/5/18 17:47	173,752.4	0.21	0.238
5/5/18 17:57	174,352.4	0.187	0.203
5/5/18 18:07	174,952.4	0.184	0.167
5/5/18 18:17	175,552.4	0.17	0.167
5/5/18 18:27	176,152.4	0.17	0.154
5/5/18 18:37	176,752.4	0.154	0.143
5/5/18 18:47	177,352.4	0.152	0.153
5/5/18 18:57	177,952.4	0.138	0.117
5/5/18 19:07	178,552.4	0.127	0.119
5/5/18 19:17	179,152.4	0.12	0.102
5/5/18 19:27	179,752.4	0.129	0.063
5/5/18 19:37	180,352.4	0.103	0.035
5/5/18 19:47	180,952.4	0.091	0.023
5/5/18 19:57	181,552.4	0.097	0.013
5/5/18 20:07	182,152.4	0.096	0.023
5/5/18 20:17	182,752.4	0.045	-0.014
5/5/18 20:27	183,352.4	0.071	0.019
5/5/18 20:37	183,952.4	0.071	-0.02
5/5/18 20:47	184,552.4	0.015	-0.033
5/5/18 20:57	185,152.4	0.008	-0.035
5/5/18 21:07	185,752.4	0.06	-0.035
5/5/18 21:17	186,352.4	0.013	-0.06
5/5/18 21:27	186,952.4	0.047	-0.035
5/5/18 21:37	187,552.4	0.05	-0.054
5/5/18 21:47	188,152.4	0.037	-0.036
5/5/18 21:57	188,752.4	-0.013	-0.057
5/5/18 22:07	189,352.4	0.033	-0.054

Date and Time	Elapsed Time (sec)	OSF-111 Drawdown (ft)	OSF-110 Drawdown (ft)
5/5/18 22:17	189,952.4	-0.015	-0.087
5/5/18 22:27	190,552.4	-0.023	-0.09
5/5/18 22:37	191,152.4	0.012	-0.08
5/5/18 22:47	191,752.4	-0.041	-0.094
5/5/18 22:57	192,352.4	-0.003	-0.087
5/5/18 23:07	192,952.4	-0.041	-0.064
5/5/18 23:17	193,552.4	-0.04	-0.098
5/5/18 23:27	194,152.4	-0.051	-0.112
5/5/18 23:37	194,752.4	-0.069	-0.126
5/5/18 23:47	195,352.4	-0.06	-0.143
5/5/18 23:57	195,952.4	-0.075	-0.109
5/6/18 0:07	196,552.4	-0.079	-0.135
5/6/18 0:17	197,152.4	-0.083	-0.139
5/6/18 0:27	197,752.4	-0.082	-0.117
5/6/18 0:37	198,352.4	-0.092	-0.131
5/6/18 0:47	198,952.4	-0.096	-0.157
5/6/18 0:57	199,552.4	-0.106	-0.14
5/6/18 1:07	200,152.4	-0.119	-0.095
5/6/18 1:17	200,752.4	-0.121	-0.173
5/6/18 1:27	201,352.4	-0.135	-0.18
5/6/18 1:37	201,952.4	-0.135	-0.219
5/6/18 1:47	202,552.4	-0.138	-0.206
5/6/18 1:57	203,152.4	-0.138	-0.209
5/6/18 2:07	203,752.4	-0.154	-0.148
5/6/18 2:17	204,352.4	-0.151	-0.07
5/6/18 2:27	204,952.4	-0.175	-0.227
5/6/18 2:37	205,552.4	-0.178	-0.251
5/6/18 2:47	206,152.4	-0.179	-0.238
5/6/18 2:57	206,752.4	-0.18	-0.214
5/6/18 3:07	207,352.4	-0.188	-0.241
5/6/18 3:17	207,952.4	-0.174	-0.176
5/6/18 3:27	208,552.4	-0.174	-0.258
5/6/18 3:37	209,152.4	-0.192	-0.243
5/6/18 3:47	209,752.4	-0.193	-0.255
5/6/18 3:57	210,352.4	-0.185	-0.261
5/6/18 4:07	210,952.4	-0.21	-0.27
5/6/18 4:17	211,552.4	-0.191	-0.263
5/6/18 4:27	212,152.4	-0.211	-0.25
5/6/18 4:37	212,752.4	-0.216	-0.216
5/6/18 4:47	213,352.4	-0.185	-0.2
5/6/18 4:57	213,952.4	-0.223	-0.242
5/6/18 5:07	214,552.4	-0.213	-0.274
5/6/18 5:17	215,152.4	-0.223	-0.27
5/6/18 5:27	215,752.4	-0.226	-0.258
5/6/18 5:37	216,352.4	-0.223	-0.304
5/6/18 5:47	216,952.4	-0.228	-0.248
5/6/18 5:57	217,552.4	-0.226	-0.23

Date and Time	Elapsed Time (sec)	OSF-111 Drawdown (ft)	OSF-110 Drawdown (ft)
5/6/18 6:07	218,152.4	-0.231	-0.248
5/6/18 6:17	218,752.4	-0.232	-0.298
5/6/18 6:27	219,352.4	-0.234	-0.232
5/6/18 6:37	219,952.4	-0.233	-0.235
5/6/18 6:47	220,552.4	-0.236	-0.223
5/6/18 6:57	221,152.4	-0.243	-0.239
5/6/18 7:07	221,752.4	-0.243	-0.227
5/6/18 7:17	222,352.4	-0.241	-0.314
5/6/18 7:27	222,952.4	-0.237	-0.279
5/6/18 7:37	223,552.4	-0.238	-0.301
5/6/18 7:47	224,152.4	-0.242	-0.289
5/6/18 7:57	224,752.4	-0.256	-0.274
5/6/18 8:07	225,352.4	-0.251	-0.305
5/6/18 8:17	225,952.4	-0.254	-0.224
5/6/18 8:27	226,552.4	-0.252	-0.272
5/6/18 8:37	227,152.4	-0.259	-0.24
5/6/18 8:47	227,752.4	-0.248	-0.293
5/6/18 8:57	228,352.4	-0.257	-0.294
5/6/18 9:07	228,952.4	-0.264	-0.302
5/6/18 9:17	229,552.4	-0.304	-0.306
5/6/18 9:27	230,152.4	-0.262	-0.264
5/6/18 9:37	230,752.4	-0.26	-0.325
5/6/18 9:47	231,352.4	-0.262	-0.295
5/6/18 9:57	231,952.4	-0.242	-0.3
5/6/18 10:07	232,552.4	-0.26	-0.262
5/6/18 10:17	233,152.4	-0.285	-0.308
5/6/18 10:27	233,752.4	-0.271	-0.313
5/6/18 10:37	234,352.4	-0.279	-0.326
5/6/18 10:47	234,952.4	-0.281	-0.33
5/6/18 10:57	235,552.4	-0.29	-0.285
5/6/18 11:07	236,152.4	-0.283	-0.179
5/6/18 11:17	236,752.4	-0.298	-0.28
5/6/18 11:27	237,352.4	-0.289	-0.28
5/6/18 11:37	237,952.4	-0.315	-0.285
5/6/18 11:47	238,552.4	-0.324	-0.326
5/6/18 11:57	239,152.4	-0.334	-0.341
5/6/18 12:07	239,752.4	-0.325	-0.302
5/6/18 12:17	240,352.4	-0.293	-0.297
5/6/18 12:27	240,952.4	-0.301	-0.345
5/6/18 12:37	241,552.4	-0.337	-0.375
5/6/18 12:47	242,152.4	-0.338	-0.325
5/6/18 12:57	242,752.4	-0.336	-0.353
5/6/18 13:07	243,352.4	-0.353	-0.309
5/6/18 13:17	243,952.4	-0.337	-0.377
5/6/18 13:27	244,552.4	-0.296	-0.31
5/6/18 13:37	245,152.4	-0.341	-0.356
5/6/18 13:47	245,752.4	-0.348	-0.359

Date and Time	Elapsed Time (sec)	OSF-111 Drawdown (ft)	OSF-110 Drawdown (ft)
5/6/18 13:57	246,352.4	-0.352	-0.387
5/6/18 14:07	246,952.4	-0.316	-0.384
5/6/18 14:17	247,552.4	-0.316	-0.395
5/6/18 14:27	248,152.4	-0.369	-0.381
5/6/18 14:37	248,752.4	-0.369	-0.4
5/6/18 14:47	249,352.4	-0.321	-0.377
5/6/18 14:57	249,952.4	-0.368	-0.376
5/6/18 15:07	250,552.4	-0.33	-0.383
5/6/18 15:17	251,152.4	-0.377	-0.354
5/6/18 15:27	251,752.4	-0.379	-0.378
5/6/18 15:37	252,352.4	-0.375	-0.375
5/6/18 15:47	252,952.4	-0.369	-0.369
5/6/18 15:57	253,552.4	-0.38	-0.369
5/6/18 16:07	254,152.4	-0.385	-0.397
5/6/18 16:17	254,752.4	-0.33	-0.424
5/6/18 16:27	255,352.4	-0.385	-0.403
5/6/18 16:37	255,952.4	-0.347	-0.412
5/6/18 16:47	256,552.4	-0.392	-0.434
5/6/18 16:57	257,152.4	-0.401	-0.423
5/6/18 17:07	257,752.4	-0.365	-0.412
5/6/18 17:17	258,352.4	-0.397	-0.417
5/6/18 17:27	258,952.4	-0.37	-0.421
5/6/18 17:37	259,552.4	-0.412	-0.43
5/6/18 17:47	260,152.4	-0.411	-0.425
5/6/18 17:57	260,752.4	-0.405	-0.441
5/6/18 18:07	261,352.4	-0.412	-0.437
5/6/18 18:17	261,952.4	-0.404	-0.435
5/6/18 18:27	262,552.4	-0.413	-0.43
5/6/18 18:37	263,152.4	-0.415	-0.43
5/6/18 18:47	263,752.4	-0.411	-0.42
5/6/18 18:57	264,352.4	-0.421	-0.239
5/6/18 19:07	264,952.4	-0.411	-0.429
5/6/18 19:17	265,552.4	-0.401	-0.438
5/6/18 19:27	266,152.4	-0.407	-0.402
5/6/18 19:37	266,752.4	-0.412	-0.429
5/6/18 19:47	267,352.4	-0.424	-0.443
5/6/18 19:57	267,952.4	-0.415	-0.44
5/6/18 20:07	268,552.4	-0.421	-0.439
5/6/18 20:17	269,152.4	-0.42	-0.429
5/6/18 20:27	269,752.4	-0.411	-0.427
5/6/18 20:37	270,352.4	-0.412	-0.42
5/6/18 20:47	270,952.4	-0.412	-0.431
5/6/18 20:57	271,552.4	-0.419	-0.444
5/6/18 21:07	272,152.4	-0.418	-0.414
5/6/18 21:17	272,752.4	-0.417	-0.448
5/6/18 21:27	273,352.4	-0.426	-0.459
5/6/18 21:37	273,952.4	-0.435	-0.431

Date and Time	Elapsed Time (sec)	OSF-111 Drawdown (ft)	OSF-110 Drawdown (ft)
5/6/18 21:47	274,552.4	-0.416	-0.457
5/6/18 21:57	275,152.4	-0.429	-0.44
5/6/18 22:07	275,752.4	-0.425	-0.463
5/6/18 22:17	276,352.4	-0.42	-0.454
5/6/18 22:27	276,952.4	-0.424	-0.412
5/6/18 22:37	277,552.4	-0.427	-0.393
5/6/18 22:47	278,152.4	-0.428	-0.434
5/6/18 22:57	278,752.4	-0.427	-0.437
5/6/18 23:07	279,352.4	-0.439	-0.437
5/6/18 23:17	279,952.4	-0.428	-0.422
5/6/18 23:27	280,552.4	-0.43	-0.431
5/6/18 23:37	281,152.4	-0.449	-0.434
5/6/18 23:47	281,752.4	-0.444	-0.442
5/6/18 23:57	282,352.4	-0.439	-0.45
5/7/18 0:07	282,952.4	-0.449	-0.448
5/7/18 0:17	283,552.4	-0.451	-0.447
5/7/18 0:27	284,152.4	-0.453	-0.464
5/7/18 0:37	284,752.4	-0.444	-0.424
5/7/18 0:47	285,352.4	-0.455	-0.455
5/7/18 0:57	285,952.4	-0.464	-0.446
5/7/18 1:07	286,552.4	-0.463	-0.434
5/7/18 1:17	287,152.4	-0.472	-0.431
5/7/18 1:27	287,752.4	-0.458	-0.452
5/7/18 1:37	288,352.4	-0.468	-0.455
5/7/18 1:47	288,952.4	-0.465	-0.432
5/7/18 1:57	289,552.4	-0.47	-0.444
5/7/18 2:07	290,152.4	-0.473	-0.441
5/7/18 2:17	290,752.4	-0.477	-0.448
5/7/18 2:27	291,352.4	-0.472	-0.45
5/7/18 2:37	291,952.4	-0.464	-0.474
5/7/18 2:47	292,552.4	-0.48	-0.475
5/7/18 2:57	293,152.4	-0.48	-0.488
5/7/18 3:07	293,752.4	-0.484	-0.484
5/7/18 3:17	294,352.4	-0.483	-0.459
5/7/18 3:27	294,952.4	-0.491	-0.479
5/7/18 3:37	295,552.4	-0.477	-0.477
5/7/18 3:47	296,152.4	-0.494	-0.49
5/7/18 3:57	296,752.4	-0.48	-0.511
5/7/18 4:07	297,352.4	-0.492	-0.463
5/7/18 4:17	297,952.4	-0.489	-0.49
5/7/18 4:27	298,552.4	-0.474	-0.472
5/7/18 4:37	299,152.4	-0.489	-0.483
5/7/18 4:47	299,752.4	-0.49	-0.467
5/7/18 4:57	300,352.4	-0.498	-0.486
5/7/18 5:07	300,952.4	-0.49	-0.502
5/7/18 5:17	301,552.4	-0.489	-0.46
5/7/18 5:27	302,152.4	-0.499	-0.508

Date and Time	Elapsed Time (sec)	OSF-111 Drawdown (ft)	OSF-110 Drawdown (ft)
5/7/18 5:37	302,752.4	-0.488	-0.516
5/7/18 5:47	303,352.4	-0.496	-0.532
5/7/18 5:57	303,952.4	-0.485	-0.507
5/7/18 6:07	304,552.4	-0.493	-0.497
5/7/18 6:17	305,152.4	-0.482	-0.472
5/7/18 6:27	305,752.4	-0.486	-0.491
5/7/18 6:37	306,352.4	-0.49	-0.508
5/7/18 6:47	306,952.4	-0.481	-0.497
5/7/18 6:57	307,552.4	-0.479	-0.504
5/7/18 7:07	308,152.4	-0.489	-0.481
5/7/18 7:17	308,752.4	-0.471	-0.498
5/7/18 7:27	309,352.4	-0.485	-0.48
5/7/18 7:37	309,952.4	-0.482	-0.514
5/7/18 7:47	310,552.4	-0.474	-0.504
5/7/18 7:57	311,152.4	-0.492	-0.529
5/7/18 8:07	311,752.4	-0.494	-0.498
5/7/18 8:17	312,352.4	-0.488	-0.51

bls = below land surface; ft = foot; sec = second.
Note: Pumping rate was 3,300 gallons per minute.

APPENDIX H:
LOWER FLORIDAN AQUIFER TEST DATA

Table H-1. Lower Floridan aquifer upper permeable zone step-drawdown test (1,145 to 1,403 ft bls) at OSF-111, performed August 8, 2018.

Time	Observation Number	Elapsed Time (sec)	Drawdown (ft)	Q (gpm)
9:09:59	1	0	0.00	0
9:09:59	2	0.274	-0.10	0
9:10:00	2	0.5	0.55	725
9:10:00	3	0.75	1.50	725
9:10:00	3	1	0.08	725
9:10:00	4	1.25	0.70	725
9:10:01	4	1.5	1.80	725
9:10:01	5	1.75	0.92	725
9:10:01	5	2	1.74	725
9:10:01	6	2.25	1.89	725
9:10:02	7	2.5	1.34	725
9:10:02	8	2.75	1.80	725
9:10:02	9	3	1.91	725
9:10:02	10	3.25	1.94	725
9:10:03	11	3.5	2.46	725
9:10:03	12	3.75	2.15	725
9:10:03	13	4	2.45	725
9:10:03	14	4.25	2.83	725
9:10:04	15	4.5	2.89	725
9:10:04	16	4.75	3.13	725
9:10:04	17	5	3.29	725
9:10:04	18	5.25	3.17	725
9:10:05	19	5.5	3.60	725
9:10:05	20	5.75	3.30	725
9:10:05	21	6	3.34	725
9:10:05	22	6.36	3.42	725
9:10:06	23	7.231	3.76	725
9:10:07	24	7.454	3.93	725
9:10:07	25	7.674	3.67	725
9:10:07	26	7.98	3.19	725
9:10:08	27	8.46	4.00	725
9:10:08	28	9	3.90	725
9:10:09	29	9.48	3.39	725
9:10:09	30	10.08	3.56	725
9:10:10	31	10.68	3.35	725
9:10:10	32	11.28	3.18	725
9:10:11	33	11.94	3.30	725
9:10:12	34	12.66	2.64	725
9:10:13	35	13.44	2.30	725
9:10:13	36	14.22	2.45	725
9:10:14	37	15.06	2.04	725
9:10:15	38	15.96	1.74	725
9:10:16	39	16.92	2.12	725
9:10:17	40	17.88	1.67	725

Time	Observation Number	Elapsed Time (sec)	Drawdown (ft)	Q (gpm)
9:10:18	41	18.96	1.10	725
9:10:19	42	20.1	1.18	725
9:10:20	43	21.3	0.87	725
9:10:22	44	22.56	0.34	725
9:10:23	45	23.88	-0.13	725
9:10:24	46	25.32	-1.28	725
9:10:26	47	26.82	-1.28	725
9:10:27	48	28.38	-2.00	725
9:10:29	49	30.06	-2.18	725
9:10:31	50	31.86	-2.34	725
9:10:33	51	33.72	-2.07	725
9:10:35	52	35.76	-1.97	725
9:10:37	53	37.86	-1.37	725
9:10:39	54	40.08	-1.06	725
9:10:42	55	42.48	-0.74	725
9:10:44	56	45	-0.33	725
9:10:47	57	47.64	-0.34	725
9:10:50	58	50.46	-0.27	725
9:10:53	59	53.46	-0.69	725
9:10:56	60	56.64	-0.37	725
9:10:59	61	60	-0.33	725
9:11:03	62	63.6	-0.86	725
9:11:06	63	67.2	-0.27	725
9:11:10	64	71.4	-0.46	725
9:11:15	65	75.6	1.87	725
9:11:19	66	79.8	4.77	725
9:11:24	67	84.6	5.93	725
9:11:29	68	90	6.77	725
9:11:34	69	94.8	6.73	725
9:11:40	70	100.8	6.38	725
9:11:46	71	106.811	5.76	725
9:11:52	72	112.8	2.82	725
9:11:59	73	119.4	-1.89	725
9:12:06	74	126.6	-3.22	725
9:12:13	75	134.4	-0.96	725
9:12:21	76	142.2	0.63	725
9:12:30	77	150.6	0.18	725
9:12:39	78	159.6	-0.56	725
9:12:48	79	169.2	-0.68	725
9:12:58	80	178.8	0.09	725
9:13:09	81	189.599	-0.10	725
9:13:20	82	201	-0.30	725
9:13:32	83	213	0.00	725
9:13:45	84	225.599	0.35	725
9:13:58	85	238.8	-0.03	725
9:14:12	86	253.2	0.39	725
9:14:27	87	268.2	-0.34	725

Time	Observation Number	Elapsed Time (sec)	Drawdown (ft)	Q (gpm)
9:14:43	88	283.799	0.00	725
9:15:00	89	300.599	0.15	725
9:15:18	90	318.599	0.13	725
9:15:36	91	337.2	0.20	725
9:15:57	92	357.599	0.04	725
9:16:18	93	378.599	0.28	725
9:16:40	94	400.799	0.46	725
9:17:04	95	424.799	0.55	725
9:17:29	96	450	0.23	725
9:17:56	97	476.4	0.64	725
9:18:24	98	504.599	0.70	725
9:18:54	99	534.599	0.32	725
9:19:25	100	566.4	0.75	725
9:19:59	101	599.999	0.17	725
9:20:35	102	635.999	0.73	725
9:21:11	103	671.999	0.72	725
9:21:53	104	713.999	0.42	725
9:22:35	105	755.999	0.55	725
9:23:17	106	797.999	0.42	725
9:24:05	107	845.999	0.54	725
9:24:59	108	899.999	0.50	725
9:25:47	109	947.999	0.78	725
9:26:47	110	1,007.999	0.69	725
9:27:47	111	1,067.999	0.71	725
9:28:47	112	1,127.999	0.63	725
9:29:47	113	1,187.999	0.93	725
9:30:47	114	1,247.999	0.83	725
9:31:47	115	1,307.999	0.84	725
9:32:47	116	1,367.999	0.65	725
9:33:47	117	1,427.999	0.92	725
9:34:47	118	1,487.999	0.98	725
9:35:47	119	1,547.999	0.84	725
9:36:47	120	1,607.999	0.46	725
9:37:47	121	1,667.999	0.61	725
9:38:47	122	1,727.999	0.69	725
9:39:47	123	1,787.999	0.64	725
9:40:47	124	1,847.999	0.76	725
9:41:47	125	1,907.999	0.93	725
9:42:47	126	1,967.999	0.59	725
9:43:47	127	2,027.999	0.75	725
9:44:47	128	2,087.999	0.76	725
9:45:47	129	2,147.999	0.75	725
9:46:47	130	2,208.014	0.60	725
9:47:47	131	2,267.999	1.08	725
9:48:47	132	2,327.999	0.83	725
9:49:47	133	2,387.999	0.68	725
9:50:47	134	2,447.999	0.49	725

Time	Observation Number	Elapsed Time (sec)	Drawdown (ft)	Q (gpm)
9:51:47	135	2,507.999	0.62	725
9:52:47	136	2,567.999	0.74	725
9:53:47	137	2,627.999	0.68	725
9:54:47	138	2,687.999	0.58	725
9:55:47	139	2,747.999	0.72	725
9:56:47	140	2,807.999	0.80	725
9:57:47	141	2,867.999	0.48	725
9:58:47	142	2,927.999	0.60	725
9:59:47	143	2,987.999	0.78	725
10:00:47	144	3,047.999	0.44	725
10:01:47	145	3,107.999	0.80	725
10:02:47	146	3,167.999	0.67	725
10:03:47	147	3,227.999	0.74	725
10:04:47	148	3,287.999	0.43	725
10:05:47	149	3,347.999	0.63	725
10:06:47	150	3,407.999	0.97	725
10:07:47	151	3,467.999	0.67	725
10:08:47	152	3,527.999	0.92	725
10:09:47	153	3,587.999	5.04	725
10:09:47	154	3,587.999	5.49	725
10:09:47	155	3,588.25	5.32	725
10:09:48	156	3,588.5	5.34	725
10:09:48	157	3,588.75	5.76	725
10:09:48	158	3,589.0	5.23	725
10:09:48	159	3,589.25	5.58	725
10:09:49	160	3,589.5	5.47	725
10:09:49	161	3,589.75	5.24	725
10:09:49	162	3,589.754	5.28	725
10:09:49	163	3,589.977	5.53	725
10:09:49	164	3,590.227	5.44	725
10:09:50	165	3,590.478	5.57	725
10:09:50	166	3,590.728	5.67	725
10:09:50	167	3,590.978	5.55	725
10:09:50	168	3,591.228	5.32	725
10:09:51	169	3,591.478	5.39	725
10:09:51	170	3,591.739	5.51	725
10:09:51	171	3,591.978	5.93	725
10:09:51	172	3,592.228	5.69	725
10:09:52	173	3,592.478	5.37	725
10:09:52	174	3,592.728	5.80	725
10:09:52	175	3,592.978	5.94	725
10:09:52	176	3,593.228	5.65	725
10:09:53	177	3,593.478	5.75	725
10:09:53	178	3,593.728	5.39	725
10:09:53	179	3,593.978	5.53	725
10:09:53	180	3,594.228	5.65	725
10:09:54	181	3,594.478	5.67	725

Time	Observation Number	Elapsed Time (sec)	Drawdown (ft)	Q (gpm)
10:09:54	182	3,594.728	5.55	725
10:09:54	183	3,594.978	5.54	725
10:09:54	184	3,595.228	5.52	725
10:09:55	185	3,595.478	5.64	725
10:09:55	186	3,595.728	5.47	725
10:09:55	187	3,595.978	5.44	725
10:09:55	188	3,596.338	5.41	725
10:09:56	189	3,596.698	5.78	725
10:09:56	190	3,597.118	5.75	725
10:09:57	191	3,597.538	5.74	725
10:09:57	192	3,597.958	5.56	725
10:09:58	193	3,598.438	5.82	725
10:09:58	194	3,598.978	5.62	725
10:09:59	195	3,599.458	5.72	725
10:09:59	196	3,600.058	5.73	725
10:10:00	197	3,600.658	5.91	1,891
10:10:00	198	3,601.258	5.70	1,891
10:10:01	199	3,601.917	5.85	1,891
10:10:02	200	3,602.637	5.59	1,891
10:10:03	201	3,603.417	5.64	1,891
10:10:03	202	3,604.198	5.57	1,891
10:10:04	203	3,605.038	5.93	1,891
10:10:05	204	3,605.938	5.78	1,891
10:10:06	205	3,606.897	5.48	1,891
10:10:07	206	3,607.857	5.55	1,891
10:10:08	207	3,608.938	5.65	1,891
10:10:09	208	3,610.078	5.56	1,891
10:10:10	209	3,611.278	5.57	1,891
10:10:12	210	3,612.538	5.51	1,891
10:10:13	211	3,613.857	5.65	1,891
10:10:14	212	3,615.324	5.43	1,891
10:10:16	213	3,616.798	5.79	1,891
10:10:17	214	3,618.357	5.59	1,891
10:10:19	215	3,620.038	5.58	1,891
10:10:21	216	3,621.837	5.68	1,891
10:10:23	217	3,623.698	5.34	1,891
10:10:25	218	3,625.738	5.48	1,891
10:10:27	219	3,627.837	5.78	1,891
10:10:29	220	3,630.057	5.54	1,891
10:10:32	221	3,632.458	5.52	1,891
10:10:34	222	3,634.977	5.69	1,891
10:10:37	223	3,637.617	5.48	1,891
10:10:40	224	3,640.438	5.53	1,891
10:10:43	225	3,643.438	5.48	1,891
10:10:46	226	3,646.617	5.51	1,891
10:10:49	227	3,649.977	5.79	1,891
10:10:53	228	3,653.577	5.97	1,891

Time	Observation Number	Elapsed Time (sec)	Drawdown (ft)	Q (gpm)
10:10:56	229	3,657.177	5.63	1,891
10:11:00	230	3,661.377	5.44	1,891
10:11:05	231	3,665.577	5.63	1,891
10:11:09	232	3,669.777	5.76	1,891
10:11:14	233	3,674.577	5.87	1,891
10:11:19	234	3,679.977	5.79	1,891
10:11:24	235	3,684.777	5.85	1,891
10:11:30	236	3,690.777	5.40	1,891
10:11:36	237	3,696.777	5.81	1,891
10:11:42	238	3,702.777	5.71	1,891
10:11:48	239	3,709.377	5.87	1,891
10:11:56	240	3,716.577	5.75	1,891
10:12:03	241	3,724.377	5.87	1,891
10:12:11	242	3,732.177	5.83	1,891
10:12:20	243	3,740.577	5.78	1,891
10:12:29	244	3,749.577	5.97	1,891
10:12:38	245	3,759.177	5.96	1,891
10:12:48	246	3,768.777	5.89	1,891
10:12:59	247	3,779.577	5.56	1,891
10:13:10	248	3,790.977	5.70	1,891
10:13:22	249	3,802.977	5.44	1,891
10:13:35	250	3,815.577	5.99	1,891
10:13:48	251	3,828.777	5.80	1,891
10:14:02	252	3,843.177	5.83	1,891
10:14:17	253	3,858.177	5.78	1,891
10:14:33	254	3,873.777	5.87	1,891
10:14:50	255	3,890.577	5.77	1,891
10:15:08	256	3,908.577	5.92	1,891
10:15:26	257	3,927.177	5.89	1,891
10:15:47	258	3,947.577	5.78	1,891
10:16:08	259	3,968.577	5.89	1,891
10:16:30	260	3,990.777	5.91	1,891
10:16:54	261	4,014.777	5.50	1,891
10:17:19	262	4,039.977	5.82	1,891
10:17:45	263	4,066.377	5.83	1,891
10:18:14	264	4,094.577	4.32	1,029
10:18:44	265	4,124.577	3.39	1,029
10:19:15	266	4,156.377	2.34	1,029
10:19:49	267	4,189.977	2.89	1,029
10:20:25	268	4,225.977	2.97	1,029
10:21:01	269	4,261.977	2.23	1,029
10:21:43	270	4,303.977	2.14	1,029
10:22:25	271	4,345.977	2.51	1,029
10:23:07	272	4,387.977	2.45	1,029
10:23:55	273	4,435.977	2.35	1,029
10:24:49	274	4,489.977	2.18	1,029
10:25:37	275	4,537.977	2.50	1,029

Time	Observation Number	Elapsed Time (sec)	Drawdown (ft)	Q (gpm)
10:26:37	276	4,597.977	2.27	1,029
10:27:37	277	4,657.977	2.07	1,029
10:28:37	278	4,717.977	2.24	1,029
10:29:37	279	4,777.977	2.35	1,029
10:30:37	280	4,837.977	2.46	1,029
10:31:37	281	4,897.977	2.18	1,029
10:32:37	282	4,957.977	2.32	1,029
10:33:37	283	5,017.98	1.91	1,029
10:34:37	284	5,077.977	2.28	1,029
10:35:37	285	5,137.977	2.36	1,029
10:36:37	286	5,197.977	2.53	1,029
10:37:37	287	5,257.977	1.69	1,029
10:38:37	288	5,317.977	2.59	1,029
10:39:37	289	5,377.977	2.77	1,029
10:40:37	290	5,437.977	2.33	1,029
10:41:37	291	5,497.977	2.28	1,029
10:42:37	292	5,557.977	2.00	1,029
10:43:37	293	5,617.977	2.38	1,029
10:44:37	294	5,677.977	2.03	1,029
10:45:37	295	5,737.977	1.85	1,029
10:46:37	296	5,797.977	2.35	1,029
10:47:37	297	5,857.977	2.25	1,029
10:48:37	298	5,917.977	2.25	1,029
10:49:37	299	5,977.977	2.40	1,029
10:50:37	300	6,037.977	2.40	1,029
10:51:37	301	6,097.977	2.71	1,029
10:52:37	302	6,157.977	2.25	1,029
10:53:37	303	6,217.977	2.52	1,029
10:54:37	304	6,277.977	2.39	1,029
10:55:37	305	6,337.977	2.30	1,029
10:56:37	306	6,397.977	1.93	1,029
10:57:37	307	6,457.977	1.97	1,029
10:58:37	308	6,517.977	2.76	1,029
10:59:37	309	6,577.977	2.28	1,029
11:00:37	310	6,637.977	2.47	1,029
11:01:37	311	6,697.977	2.09	1,029
11:02:37	312	6,757.977	1.95	1,029
11:03:37	313	6,817.977	1.76	1,029
11:04:37	314	6,877.977	2.40	1,029
11:05:37	315	6,937.977	2.20	1,029
11:06:37	316	6,997.977	1.89	1,029
11:07:37	317	7,057.977	1.79	1,029
11:08:37	318	7,117.977	2.33	1,029
11:09:37	319	7,177.977	2.11	1,029
11:09:47	320	7,187.767	2.45	1,029
11:09:47	321	7,188.018	2.12	1,029
11:09:47	322	7,188.268	2.13	1,029

Time	Observation Number	Elapsed Time (sec)	Drawdown (ft)	Q (gpm)
11:09:48	323	7,188.518	2.43	1,029
11:09:48	324	7,188.768	1.96	1,029
11:09:48	325	7,189.018	1.78	1,029
11:09:48	326	7,189.268	2.44	1,029
11:09:49	327	7,189.518	2.51	1,029
11:09:49	328	7,189.536	2.22	1,029
11:09:49	329	7,189.786	2.13	1,029
11:09:49	330	7,190.036	1.93	1,029
11:09:49	331	7,190.286	1.81	1,029
11:09:50	332	7,190.536	2.33	1,029
11:09:50	333	7,190.786	2.13	1,029
11:09:50	334	7,191.036	1.61	1,029
11:09:50	335	7,191.286	1.96	1,029
11:09:51	336	7,191.536	1.89	1,029
11:09:51	337	7,191.786	1.79	1,029
11:09:51	338	7,192.036	2.11	1,029
11:09:51	339	7,192.286	2.49	1,029
11:09:52	340	7,192.536	2.14	1,029
11:09:52	341	7,192.786	2.26	1,029
11:09:52	342	7,193.036	2.27	1,029
11:09:52	343	7,193.286	2.02	1,029
11:09:53	344	7,193.536	1.73	1,029
11:09:53	345	7,193.895	2.19	1,029
11:09:53	346	7194.256	2.20	1,029
11:09:54	347	7,194.675	1.94	1,029
11:09:54	348	7,195.095	2.31	1,029
11:09:55	349	7,195.515	2.06	1,029
11:09:55	350	7,195.996	2.24	1,029
11:09:56	351	7,196.535	2.12	1,029
11:09:56	352	7,197.015	2.20	1,029
11:09:57	353	7,197.615	2.07	1,029
11:09:57	354	7,198.216	2.12	1,029
11:09:57	355	7,198.221	2.11	1,029
11:09:58	356	7,198.439	2.24	1,029
11:09:58	357	7,198.658	2.00	1,029
11:09:58	358	7,198.909	2.37	1,029
11:09:58	359	7,199.159	1.84	1,029
11:09:59	360	7,199.409	1.87	1,029
11:09:59	361	7,199.659	1.81	1,029
11:09:59	362	7,199.909	2.16	1,029
11:09:59	363	7,200.159	2.06	1,029
11:10:00	364	7,200.409	2.26	1,370
11:10:00	365	7,200.659	2.25	1,370
11:10:00	366	7,200.909	2.50	1,370
11:10:00	367	7,201.159	2.24	1,370
11:10:01	368	7,201.409	2.45	1,370
11:10:01	369	7,201.659	2.59	1,370

Time	Observation Number	Elapsed Time (sec)	Drawdown (ft)	Q (gpm)
11:10:01	370	7,201.909	2.51	1,370
11:10:01	371	7,202.159	2.31	1,370
11:10:02	372	7,202.409	2.26	1,370
11:10:02	373	7,202.659	2.56	1,370
11:10:02	374	7,202.909	2.11	1,370
11:10:02	375	7,203.159	2.45	1,370
11:10:03	376	7,203.409	2.54	1,370
11:10:03	377	7,203.659	2.61	1,370
11:10:03	378	7,203.909	2.39	1,370
11:10:03	379	7,204.159	2.41	1,370
11:10:04	380	7,204.409	2.10	1,370
11:10:04	381	7,204.659	2.26	1,370
11:10:04	382	7,205.019	2.80	1,370
11:10:04	383	7,205.379	2.70	1,370
11:10:05	384	7,205.799	2.65	1,370
11:10:05	385	7,206.219	2.32	1,370
11:10:06	386	7,206.639	2.97	1,370
11:10:06	387	7,207.119	3.31	1,370
11:10:07	388	7,207.659	3.29	1,370
11:10:07	389	7,208.139	3.13	1,370
11:10:08	390	7,208.739	3.33	1,370
11:10:08	391	7,209.339	3.26	1,370
11:10:09	392	7,209.939	3.40	1,370
11:10:10	393	7,210.599	3.06	1,370
11:10:10	394	7,211.319	3.70	1,370
11:10:11	395	7,212.128	3.86	1,370
11:10:12	396	7,212.879	3.77	1,370
11:10:13	397	7,213.719	3.84	1,370
11:10:14	398	7,214.619	3.79	1,370
11:10:15	399	7,215.579	4.06	1,370
11:10:16	400	7,216.539	4.24	1,370
11:10:17	401	7,217.619	4.46	1,370
11:10:18	402	7,218.759	4.03	1,370
11:10:19	403	7,219.959	3.98	1,370
11:10:20	404	7,221.219	4.18	1,370
11:10:22	405	7,222.539	3.88	1,370
11:10:23	406	7,223.979	3.89	1,370
11:10:25	407	7,225.479	3.72	1,370
11:10:26	408	7,227.04	3.80	1,370
11:10:28	409	7,228.719	3.15	1,370
11:10:30	410	7,230.519	3.42	1,370
11:10:31	411	7,232.379	3.24	1,370
11:10:34	412	7,234.419	3.52	1,370
11:10:36	413	7,236.519	3.11	1,370
11:10:38	414	7,238.739	2.99	1,370
11:10:40	415	7,241.139	3.20	1,370
11:10:43	416	7,243.659	3.05	1,370

Time	Observation Number	Elapsed Time (sec)	Drawdown (ft)	Q (gpm)
11:10:45	417	7,246.299	3.22	1,370
11:10:48	418	7,249.119	3.26	1,370
11:10:51	419	7,252.119	3.20	1,370
11:10:54	420	7,255.299	3.54	1,370
11:10:58	421	7,258.659	3.34	1,370
11:11:01	422	7,262.259	3.20	1,370
11:11:05	423	7,265.859	3.19	1,370
11:11:09	424	7,270.059	3.20	1,370
11:11:13	425	7,274.259	3.23	1,370
11:11:18	426	7,278.459	3.42	1,370
11:11:22	427	7,283.259	3.79	1,370
11:11:28	428	7,288.659	3.18	1,370
11:11:33	429	7,293.459	3.50	1,370
11:11:39	430	7,299.459	3.30	1,370
11:11:45	431	7,305.459	3.39	1,370
11:11:51	432	7,311.459	3.38	1,370
11:11:57	433	7,318.059	3.01	1,370
11:12:04	434	7,325.259	3.37	1,370
11:12:12	435	7,333.059	3.54	1,370
11:12:20	436	7,340.859	3.92	1,370
11:12:28	437	7,349.259	3.87	1,370
11:12:37	438	7,358.259	3.85	1,370
11:12:47	439	7,367.859	3.22	1,370
11:12:57	440	7,377.459	3.50	1,370
11:13:07	441	7,388.259	3.65	1,370
11:13:19	442	7,399.659	3.55	1,370
11:13:31	443	7,411.659	3.35	1,370
11:13:43	444	7,424.259	3.86	1,370
11:13:57	445	7,437.459	3.45	1,370
11:14:11	446	7,451.859	3.69	1,370
11:14:26	447	7,466.859	3.71	1,370
11:14:42	448	7,482.459	3.50	1,370
11:14:58	449	7,499.259	3.76	1,370
11:15:16	450	7,517.259	3.68	1,370
11:15:35	451	7,535.859	3.56	1,370
11:15:55	452	7,556.259	3.73	1,370
11:16:16	453	7,577.259	3.84	1,370
11:16:39	454	7,599.459	4.03	1,370
11:17:03	455	7,623.459	3.48	1,370
11:17:28	456	7,648.659	3.28	1,370
11:17:54	457	7,675.059	3.76	1,370
11:18:22	458	7,703.259	3.58	1,370
11:18:52	459	7,733.259	3.54	1,370
11:19:24	460	7,765.059	3.47	1,370
11:19:58	461	7,798.659	3.67	1,370
11:20:34	462	7,834.659	5.53	1,666
11:21:10	463	7,870.659	4.78	1,666

Time	Observation Number	Elapsed Time (sec)	Drawdown (ft)	Q (gpm)
11:21:52	464	7,912.659	4.99	1,666
11:22:34	465	7,954.659	5.27	1,666
11:23:16	466	7,996.659	5.18	1,666
11:24:04	467	8,044.659	5.19	1,666
11:24:58	468	8,098.659	5.06	1,666
11:25:46	469	8,146.659	5.38	1,666
11:26:46	470	8,206.659	5.08	1,666
11:27:46	471	8266.659	5.49	1,666
11:28:46	472	8,326.659	5.14	1,666
11:29:46	473	8,386.659	5.87	1,666
11:30:46	474	8,446.659	5.21	1,666
11:31:46	475	8,506.659	5.27	1,666
11:32:46	476	8,566.659	5.28	1,666
11:33:46	477	8,626.659	5.05	1,666
11:34:46	478	8,686.659	5.34	1,666
11:35:46	479	8,746.659	5.25	1,666
11:36:46	480	8,806.659	5.23	1,666
11:37:46	481	8,866.659	5.41	1,666
11:38:46	482	8,926.659	5.34	1,666
11:39:46	483	8,986.659	5.31	1,666
11:40:46	484	9,046.659	5.12	1,666
11:41:46	485	9,106.659	5.16	1,666
11:42:46	486	9,166.659	5.16	1,666
11:43:46	487	9,226.659	5.40	1,666
11:44:46	488	9,286.659	5.43	1,666
11:45:46	489	9,346.66	4.97	1,666
11:46:46	490	9,406.659	4.92	1,666
11:47:46	491	9,466.659	5.28	1,666
11:48:46	492	9,526.659	5.13	1,666
11:49:46	493	9,586.659	5.35	1,666
11:50:46	494	9,646.659	5.27	1,666
11:51:46	495	9,706.659	5.10	1,666
11:52:46	496	9,766.659	5.07	1,666
11:53:46	497	9,826.659	5.24	1,666
11:54:46	498	9,886.659	5.13	1,666
11:55:46	499	9,946.659	5.34	1,666
11:56:46	500	10,006.66	5.38	1,666
11:57:46	501	10,066.66	5.03	1,666
11:58:46	502	10,126.66	5.41	1,666
11:59:46	503	10,186.66	5.55	1,666
12:00:46	504	10,246.66	5.36	1,666
12:01:46	505	10,306.66	5.26	1,666
12:02:46	506	10,366.66	5.16	1,666
12:03:46	507	10,426.66	5.09	1,666
12:04:46	508	10,486.66	5.06	1,666
12:05:46	509	10,546.66	5.06	1,666
12:06:46	510	10,606.66	5.28	1,666

Time	Observation Number	Elapsed Time (sec)	Drawdown (ft)	Q (gpm)
12:07:46	511	10,666.66	5.29	1,666
12:08:46	512	10,726.66	5.15	1,666
12:09:46	513	10,786.66	5.25	1,666
12:09:46	514	10,787.12	5.01	1,666
12:09:46	515	10,787.37	5.06	1,666
12:09:47	516	10,787.62	5.32	1,666
12:09:47	517	10,787.87	5.26	1,666
12:09:47	518	10,788.12	5.71	1,666
12:09:47	519	10,788.37	5.62	1,666
12:09:48	520	10,788.62	5.74	1,666
12:09:48	521	10,788.87	5.60	1,666
12:09:48	522	10,789.12	5.40	1,666
12:09:48	523	10,789.37	5.57	1,666
12:09:49	524	10,789.62	5.53	1,666
12:09:49	525	10,789.87	5.33	1,666
12:09:49	526	10,790.12	5.59	1,666
12:09:49	527	10,790.37	5.78	1,666
12:09:49	528	10,790.37	5.80	1,666
12:09:50	529	10,790.60	5.99	1,666
12:09:50	530	10,790.82	6.18	1,666
12:09:50	531	10,791.04	5.89	1,666
12:09:50	532	10,791.29	6.08	1,666
12:09:51	533	10,791.54	6.34	1,666
12:09:51	534	10,791.79	5.78	1,666
12:09:51	535	10,792.04	6.06	1,666
12:09:51	536	10,792.29	6.15	1,666
12:09:52	537	10,793.05	6.49	1,666
12:09:52	538	10,793.27	6.46	1,666
12:09:53	539	10,793.49	6.68	1,666
12:09:53	540	10,793.71	6.74	1,666
12:09:53	541	10,793.93	6.99	1,666
12:09:53	542	10,794.15	6.50	1,666
12:09:53	543	10,794.37	6.93	1,666
12:09:54	544	10,794.58	7.29	1,666
12:09:54	545	10,794.80	7.29	1,666
12:09:54	546	10,795.02	7.43	1,666
12:09:54	547	10,795.24	7.78	1,666
12:09:55	548	10,795.46	7.51	1,666
12:09:55	549	10,795.68	7.58	1,666
12:09:55	550	10,795.90	7.71	1,666
12:09:55	551	10,796.12	7.75	1,666
12:09:55	552	10,796.34	7.81	1,666
12:09:56	553	10,796.56	8.30	1,666
12:09:56	554	10,796.79	8.14	1,666
12:09:56	555	10,797.04	8.79	1,666
12:09:56	556	10,797.40	8.14	1,666
12:09:57	557	10,797.76	8.66	1,666

Time	Observation Number	Elapsed Time (sec)	Drawdown (ft)	Q (gpm)
12:09:57	558	10,798.18	8.93	1,666
12:09:58	559	10,798.60	9.36	1,666
12:09:58	560	10,799.02	9.61	1,666
12:09:59	561	10,799.50	9.66	1,666
12:09:59	562	10,800.04	10.02	1,666
12:10:00	563	10,800.52	10.13	4,000
12:10:00	564	10,801.12	10.92	4,000
12:10:01	565	10,801.72	10.95	4,000
12:10:01	566	10,802.32	11.44	4,000
12:10:02	567	10,802.98	12.07	4,000
12:10:03	568	10,803.70	12.51	4,000
12:10:04	569	10,804.48	13.44	4,000
12:10:04	570	10,805.26	13.67	4,000
12:10:05	571	10,806.11	14.18	4,000
12:10:06	572	10,807.00	14.17	4,000
12:10:07	573	10,807.96	15.05	4,000
12:10:08	574	10,808.92	15.66	4,000
12:10:10	575	10,810.52	16.04	4,000
12:10:10	576	10,811.14	15.95	4,000
12:10:11	577	10,812.34	16.35	4,000
12:10:13	578	10,813.60	16.30	4,000
12:10:14	579	10,814.92	16.35	4,000
12:10:15	580	10,816.36	16.16	4,000
12:10:17	581	10,817.86	15.67	4,000
12:10:19	582	10,819.42	16.01	4,000
12:10:20	583	10,821.10	15.86	4,000
12:10:22	584	10,822.90	15.00	4,000
12:10:24	585	10,824.76	14.62	4,000
12:10:26	586	10,826.80	14.64	4,000
12:10:28	587	10,828.90	14.14	4,000
12:10:30	588	10,831.12	13.55	4,000
12:10:33	589	10,833.52	13.38	4,000
12:10:35	590	10,836.04	13.12	4,000
12:10:38	591	10,838.68	13.17	4,000
12:10:41	592	10,841.50	13.72	4,000
12:10:44	593	10,844.50	13.64	4,000
12:10:47	594	10,847.68	13.64	4,000
12:10:50	595	10,851.04	13.93	4,000
12:10:54	596	10,854.64	13.61	4,000
12:10:57	597	10,858.24	13.82	4,000
12:11:02	598	10,862.44	14.17	4,000
12:11:06	599	10,866.64	13.57	4,000
12:11:10	600	10,870.84	13.71	4,000
12:11:15	601	10,875.64	13.74	4,000
12:11:20	602	10,881.04	13.63	4,000
12:11:25	603	10,885.84	13.82	4,000
12:11:31	604	10,891.84	13.76	4,000

Time	Observation Number	Elapsed Time (sec)	Drawdown (ft)	Q (gpm)
12:11:37	605	10,897.84	13.60	4,000
12:11:43	606	10,903.84	13.55	4,000
12:11:50	607	10,910.44	14.09	4,000
12:11:57	608	10,917.64	13.44	4,000
12:12:05	609	10,925.44	13.41	4,000
12:12:12	610	10,933.24	13.66	4,000
12:12:21	611	10,941.64	13.75	4,000
12:12:30	612	10,950.64	14.04	4,000
12:12:39	613	10,960.24	13.78	4,000
12:12:49	614	10,969.84	13.43	4,000
12:13:00	615	10,980.64	14.16	4,000
12:13:11	616	10,992.04	13.68	4,000
12:13:23	617	11,004.04	13.67	4,000
12:13:36	618	11,016.64	13.46	4,000
12:13:49	619	11,029.84	14.22	4,000
12:14:03	620	11,044.24	13.95	4,000
12:14:18	621	11,059.24	14.12	4,000
12:14:34	622	11,074.84	13.90	4,000
12:14:51	623	11,091.64	14.23	4,000
12:15:09	624	11,109.64	13.57	4,000
12:15:27	625	11,128.24	13.61	4,000
12:15:48	626	11,148.64	13.92	4,000
12:16:09	627	11,169.64	13.92	4,000
12:16:31	628	11,191.84	13.83	4,000
12:16:55	629	11,215.84	13.81	4,000
12:17:20	630	11,241.04	-19.39	0
12:17:47	631	11,267.44	-0.83	0
12:18:15	632	11,295.64	-3.29	3,000
12:18:45	633	11,325.65	9.86	3,000
12:19:17	634	11,357.44	10.00	3,000
12:19:50	635	11,391.04	8.49	3,000
12:20:26	636	11,427.04	7.97	3,000
12:21:02	637	11,463.04	10.19	3,000
12:21:44	638	11,505.04	10.27	3,000
12:22:26	639	11,547.04	10.03	3,000
12:23:08	640	11,589.04	10.16	3,000
12:23:56	641	11,637.04	10.21	3,000
12:24:50	642	11,691.04	10.21	3,000
12:25:38	643	11,739.04	10.00	3,000
12:26:38	644	11,799.04	10.03	3,000
12:27:38	645	11,859.04	10.13	3,000
12:28:38	646	11,919.04	10.16	3,000
12:29:38	647	11,979.04	10.17	3,000
12:30:38	648	12,039.04	10.24	3,000
12:31:38	649	12,099.04	9.99	3,000
12:32:38	650	12,159.04	10.04	3,000
12:33:38	651	12,219.04	10.61	3,000

Time	Observation Number	Elapsed Time (sec)	Drawdown (ft)	Q (gpm)
12:34:38	652	12,279.04	10.39	3,000
12:35:38	653	12,339.04	10.12	3,000
12:36:38	654	12,399.04	10.19	3,000
12:37:38	655	12,459.04	10.20	3,000
12:38:38	656	12,519.04	10.20	3,000
12:39:38	657	12,579.04	10.14	3,000
12:40:38	658	12,639.04	10.18	3,000
12:41:38	659	12,699.04	9.91	3,000
12:42:38	660	12,759.04	10.00	3,000
12:43:38	661	12,819.04	10.34	3,000
12:44:38	662	12,879.04	10.42	3,000
12:45:38	663	12,939.04	10.37	3,000
12:46:38	664	12,999.04	10.01	3,000
12:47:38	665	13,059.04	10.22	3,000
12:48:38	666	13,119.04	9.98	3,000
12:49:38	667	13,179.04	10.40	3,000
12:50:38	668	13,239.04	10.26	3,000
12:51:38	669	13,299.04	10.02	3,000
12:52:38	670	13,359.04	9.90	3,000
12:53:38	671	13,419.04	10.17	3,000
12:54:38	672	13,479.04	10.09	3,000
12:55:38	673	13,539.04	10.04	3,000
12:56:38	674	13,599.04	10.31	3,000
12:57:38	675	13,659.04	10.33	3,000
12:58:38	676	13,719.04	10.07	3,000
12:59:38	677	13,779.04	10.09	3,000
13:00:38	678	13,839.04	9.90	3,000
13:01:38	679	13,899.04	10.26	3,000
13:02:38	680	13,959.04	10.31	3,000
13:03:38	681	14,019.04	10.04	3,000
13:04:38	682	14,079.04	9.82	3,000
13:05:38	683	14,139.04	10.33	3,000
13:06:38	684	14,199.04	9.58	3,000
13:07:38	685	14,259.04	10.01	3,000
13:08:38	686	14,319.04	10.15	3,000
13:09:38	687	14,379.04	10.22	3,000
13:10:27	688	14,427.71	10.18	3,000
13:11:27	689	14,487.71	10.09	3,000
13:12:27	690	14,547.71	10.25	3,000
13:13:27	691	14,607.71	9.82	3,000
13:14:27	692	14,667.71	9.68	3,000
13:15:27	693	14,727.71	10.45	3,000
13:16:27	694	14,787.71	10.32	3,000
13:17:27	695	14,847.71	10.02	3,000
13:18:27	696	14,907.71	9.78	3,000
13:19:27	697	14,967.71	10.07	3,000
13:20:27	698	15,027.71	10.43	3,000

Time	Observation Number	Elapsed Time (sec)	Drawdown (ft)	Q (gpm)
13:21:27	699	15,087.71	10.18	3,000
13:22:27	700	15,147.71	10.16	3,000
13:23:27	701	15,207.71	10.02	3,000
13:24:27	702	15,267.71	10.06	3,000
13:25:27	703	15,327.71	10.04	3,000
13:26:27	704	15,387.71	10.19	3,000
13:27:27	705	15,447.71	10.01	3,000
13:28:27	706	15,507.71	10.56	3,000
13:29:27	707	15,567.71	10.15	3,000
13:30:27	708	15,627.71	10.30	3,000
13:31:27	709	15,687.71	10.20	3,000
13:32:27	710	15,747.71	10.08	3,000
13:33:27	711	15,807.71	10.55	3,000
13:34:27	712	15,867.71	9.84	3,000
13:35:27	713	15,927.71	10.13	3,000
13:36:27	714	15,987.71	9.88	3,000
13:37:27	715	16,047.71	10.30	3,000
13:38:27	716	16,107.71	10.33	3,000
13:39:27	717	16,167.71	9.91	3,000
13:40:27	718	16,227.71	10.08	3,000
13:41:27	719	16,287.71	10.29	3,000
13:42:27	720	16,347.71	10.14	3,000
13:43:27	721	16,407.71	10.04	3,000
13:44:27	722	16,467.71	10.18	3,000
13:45:27	723	16,527.71	10.20	3,000
13:46:27	724	16,587.71	10.05	3,000
13:47:27	725	16,647.71	10.23	3,000
13:48:27	726	16,707.71	10.14	3,000
13:49:27	727	16,767.71	10.20	3,000
13:50:27	728	16,827.71	10.35	3,000
13:51:27	729	16,887.71	10.14	3,000
13:52:27	730	16,947.71	9.97	3,000
13:53:27	731	17,007.71	10.39	3,000
13:54:27	732	17,067.71	10.01	3,000
13:55:27	733	17,127.71	10.30	3,000
13:56:27	734	17,187.71	10.20	3,000
13:57:27	735	17,247.71	10.13	3,000
13:58:27	736	17,307.71	10.23	3,000
13:59:27	737	17,367.71	10.32	3,000
14:00:27	738	17,427.71	10.16	3,000
14:01:27	739	17,487.71	10.26	3,000
14:02:27	740	17,547.71	10.19	3,000
14:03:27	741	17,607.71	9.91	3,000
14:04:27	742	17,667.71	10.12	3,000
14:05:27	743	17,727.71	9.94	3,000
14:06:27	744	17,787.71	10.39	3,000
14:07:27	745	17,847.71	9.76	3,000

Time	Observation Number	Elapsed Time (sec)	Drawdown (ft)	Q (gpm)
14:08:27	746	17,907.71	10.11	3,000
14:09:27	747	17,967.71	10.00	3,000
14:09:35	748	17,975.55	10.06	3,000
14:09:35	749	17,975.81	10.10	3,000
14:09:35	750	17,976.06	9.82	3,000
14:09:35	751	17,976.31	10.14	3,000
14:09:36	752	17,976.56	10.23	3,000
14:09:36	753	17,976.81	9.95	3,000
14:09:36	754	17,977.06	10.08	3,000
14:09:36	755	17,977.31	10.53	3,000
14:09:37	756	17,977.56	10.35	3,000
14:09:37	757	17,977.81	10.24	3,000
14:09:37	758	17,978.06	10.08	3,000
14:09:37	759	17,978.31	9.93	3,000
14:09:38	760	17,978.56	10.19	3,000
14:09:38	761	17,978.81	10.14	3,000
14:09:38	762	17,978.82	10.03	3,000
14:09:38	763	17,979.07	10.01	3,000
14:09:38	764	17,979.32	10.26	3,000
14:09:39	765	17,979.57	9.85	3,000
14:09:39	766	17,979.82	10.31	3,000
14:09:39	767	17,980.07	10.15	3,000
14:09:39	768	17,980.32	10.00	3,000
14:09:40	769	17,980.57	9.93	3,000
14:09:40	770	17,980.82	10.37	3,000
14:09:40	771	17,981.07	10.10	3,000
14:09:40	772	17,981.32	10.46	3,000
14:09:41	773	17,981.68	10.24	3,000
14:09:41	774	17,982.04	10.31	3,000
14:09:42	775	17,982.46	10.36	3,000
14:09:42	776	17,982.88	9.90	3,000
14:09:42	777	17,983.30	10.28	3,000
14:09:43	778	17,983.78	10.56	3,000
14:09:43	779	17,984.32	10.48	3,000
14:09:44	780	17,984.80	9.74	3,000
14:09:45	781	17,985.40	9.91	3,000
14:09:45	782	17,986.00	10.22	3,000
14:09:46	783	17,986.60	10.25	3,000
14:09:46	784	17,987.26	9.98	3,000
14:09:47	785	17,987.98	10.37	3,000
14:09:48	786	17,988.76	9.92	3,000
14:09:49	787	17,989.54	9.80	3,000
14:09:49	788	17,990.38	10.26	3,000
14:09:50	789	17,991.28	10.27	3,000
14:09:51	790	17,992.24	10.28	3,000
14:09:52	791	17,993.20	10.38	3,000
14:09:53	792	17,994.28	10.36	3,000

Time	Observation Number	Elapsed Time (sec)	Drawdown (ft)	Q (gpm)
14:09:55	793	17,995.42	9.78	3,000
14:09:56	794	17,996.62	10.14	3,000
14:09:57	795	17,997.88	10.38	3,000
14:09:58	796	17,999.20	10.34	3,000
14:10:00	797	18,000.68	10.19	3,000
14:10:01	798	18,002.14	9.84	3,000
14:10:03	799	18,003.70	10.11	3,000
14:10:04	800	18,005.38	10.24	3,000
14:10:06	801	18,007.18	9.99	3,000
14:10:08	802	18,009.04	9.98	3,000
14:10:10	803	18,011.08	10.29	0
14:10:12	804	18,013.18	8.81	0
14:10:15	805	18,015.40	8.60	0
14:10:17	806	18,017.80	6.65	0
14:10:19	807	18,020.32	2.95	0
14:10:22	808	18,022.96	-0.44	0
14:10:25	809	18,025.78	-4.74	0
14:10:28	810	18,028.78	-7.63	0
14:10:31	811	18,031.96	-10.80	0
14:10:34	812	18,035.32	-12.28	0
14:10:38	813	18,038.92	-12.80	0
14:10:42	814	18,042.52	-12.20	0
14:10:46	815	18,046.72	-9.22	0
14:10:50	816	18,050.92	-5.53	0
14:10:54	817	18,055.12	-1.83	0
14:10:54	818	18,055.13	0.12	0
14:10:54	819	18,055.35	0.25	0
14:10:55	820	18,055.57	-0.04	0
14:10:55	821	18,055.79	0.37	0
14:10:55	822	18,056.01	0.79	0
14:10:55	823	18,056.26	1.11	0
14:10:56	824	18,056.51	1.31	0
14:10:56	825	18,056.76	1.13	0
14:10:56	826	18,057.01	1.78	0
14:10:56	827	18,057.26	1.66	0
14:10:57	828	18,057.51	1.24	0
14:10:57	829	18,057.76	2.01	0
14:10:57	830	18,058.01	1.81	0
14:10:57	831	18,058.26	1.90	0
14:10:58	832	18,058.51	2.19	0
14:10:58	833	18,058.76	2.19	0
14:10:58	834	18,059.01	2.25	0
14:10:58	835	18,059.26	2.64	0
14:10:59	836	18,059.51	2.10	0
14:10:59	837	18,059.76	2.39	0
14:10:59	838	18,060.01	2.72	0
14:10:59	839	18,060.26	2.54	0

Time	Observation Number	Elapsed Time (sec)	Drawdown (ft)	Q (gpm)
14:11:00	840	18,060.51	2.53	0
14:11:00	841	18,060.76	2.80	0
14:11:00	842	18,061.01	2.85	0
14:11:00	843	18,061.26	2.85	0
14:11:01	844	18,061.51	3.03	0
14:11:01	845	18,061.76	3.04	0
14:11:01	846	18,062.01	2.51	0
14:11:01	847	18,062.37	3.69	0
14:11:02	848	18,062.73	2.83	0
14:11:02	849	18,063.15	3.77	0
14:11:03	850	18,063.57	2.91	0
14:11:03	851	18,063.99	3.66	0
14:11:04	852	18,064.47	3.93	0
14:11:04	853	18,065.01	3.68	0
14:11:05	854	18,065.49	3.61	0
14:11:05	855	18,066.09	3.48	0
14:11:06	856	18,066.69	4.35	0
14:11:06	857	18,067.29	3.83	0
14:11:07	858	18,067.95	3.52	0
14:11:08	859	18,068.67	3.09	0
14:11:09	860	18,069.45	3.35	0
14:11:09	861	18,070.23	3.32	0
14:11:10	862	18,071.07	3.51	0
14:11:11	863	18,071.97	2.75	0
14:11:12	864	18,072.93	2.55	0
14:11:13	865	18,073.89	3.05	0
14:11:14	866	18,074.99	2.27	0
14:11:15	867	18,076.11	3.34	0
14:11:16	868	18,077.31	3.60	0
14:11:18	869	18,078.57	3.09	0
14:11:19	870	18,079.89	2.64	0
14:11:20	871	18,081.33	2.84	0
14:11:22	872	18,082.83	2.70	0
14:11:23	873	18,084.39	2.27	0
14:11:25	874	18,086.07	2.31	0
14:11:27	875	18,087.87	2.05	0
14:11:29	876	18,089.73	1.81	0
14:11:31	877	18,091.77	1.53	0
14:11:33	878	18,093.87	1.14	0
14:11:35	879	18,096.09	0.64	0
14:11:38	880	18,098.49	0.19	0
14:11:40	881	18,101.01	-0.23	0
14:11:43	882	18,103.65	-0.63	0
14:11:46	883	18,106.47	-1.02	0
14:11:49	884	18,109.47	-1.36	0
14:11:52	885	18,112.65	-1.50	0
14:11:55	886	18,116.01	-1.41	0

Time	Observation Number	Elapsed Time (sec)	Drawdown (ft)	Q (gpm)
14:11:59	887	18,119.61	-1.11	0
14:12:02	888	18,123.21	-0.69	0
14:12:07	889	18,127.41	-0.10	0
14:12:11	890	18,131.61	0.48	0
14:12:15	891	18,135.81	1.01	0
14:12:20	892	18,140.61	1.34	0
14:12:25	893	18,146.01	1.31	0
14:12:30	894	18,150.81	1.09	0
14:12:36	895	18,156.81	0.61	0
14:12:42	896	18,162.81	-0.04	0
14:12:48	897	18,168.81	-0.60	0
14:12:55	898	18,175.41	-0.84	0
14:13:02	899	18,182.61	-0.61	0
14:13:10	900	18,190.41	-0.03	0
14:13:17	901	18,198.21	0.55	0
14:13:26	902	18,206.61	0.90	0
14:13:35	903	18,215.61	0.65	0
14:13:44	904	18,225.21	0.03	0
14:13:54	905	18,234.81	-0.45	0
14:14:05	906	18,245.61	-0.40	0
14:14:16	907	18,257.01	0.19	0
14:14:28	908	18,269.01	0.60	0
14:14:41	909	18,281.61	0.30	0
14:14:54	910	18,294.81	-0.23	0
14:15:08	911	18,309.21	-0.23	0
14:15:23	912	18,324.21	0.28	0
14:15:39	913	18,339.81	0.34	0
14:15:56	914	18,356.61	-0.08	0
14:16:14	915	18,374.61	-0.04	0
14:16:32	916	18,393.21	0.30	0
14:16:53	917	18,413.61	0.08	0
14:17:14	918	18,434.61	-0.04	0
14:17:36	919	18,456.81	0.13	0
14:18:00	920	18,480.81	0.02	0
14:18:25	921	18,506.01	0.06	0
14:18:52	922	18,532.41	0.10	0
14:19:20	923	18,560.61	0.00	0
14:19:50	924	18,590.61	0.13	0
14:20:22	925	18,622.41	0.04	0
14:20:55	926	18,656.01	0.12	0
14:21:31	927	18,692.01	0.10	0
14:22:07	928	18,728.01	0.11	0
14:22:49	929	18,770.01	0.10	0
14:23:31	930	18,812.01	0.07	0
14:24:13	931	18,854.01	0.08	0
14:25:01	932	18,902.01	0.07	0
14:25:55	933	18,956.01	0.06	0

Time	Observation Number	Elapsed Time (sec)	Drawdown (ft)	Q (gpm)
14:26:43	934	19,004.01	0.02	0
14:27:43	935	19,064.01	0.01	0
14:28:43	936	19,124.01	0.03	0
14:29:43	937	19,184.01	0.03	0
14:30:43	938	19,244.01	0.02	0
14:31:43	939	19,304.01	0.02	0
14:32:43	940	19,364.01	0.02	0
14:33:43	941	19,424.01	0.01	0
14:34:43	942	19,484.01	0.01	0
14:35:43	943	19,544.01	0.01	0
14:36:43	944	19,604.01	0.03	0
14:37:43	945	19,664.01	0.01	0
14:38:43	946	19,724.01	0.00	0
14:39:43	947	19,784.01	0.01	0
14:40:43	948	19,844.01	0.01	0
14:41:43	949	19,904.01	0.03	0
14:42:43	950	19,964.01	0.04	0
14:43:43	951	20,024.01	0.02	0
14:44:43	952	20,084.01	0.03	0
14:45:43	953	20,144.01	0.03	0
14:46:43	954	20,204.01	0.02	0
14:47:43	955	20,264.01	0.03	0
14:48:43	956	20,324.01	0.03	0
14:49:43	957	20,384.01	0.03	0
14:50:43	958	20,444.01	0.01	0
14:51:43	959	20,504.01	0.02	0
14:52:43	960	20,564.01	0.02	0
14:53:43	961	20,624.01	-0.01	0
14:54:43	962	20,684.01	0.01	0
14:55:43	963	20,744.01	0.01	0
14:56:43	964	20,804.01	0.01	0
14:57:43	965	20,864.01	0.01	0
14:58:43	966	20,924.01	-0.02	0
14:59:43	967	20,984.01	-0.04	0

bls = below land surface; ft = foot; gpm = gallons per minute; Q = pumping rate; sec = second.