S-356 Pump Station Groundwater Well Cluster Installation, Geophysical Logging and Instrumentation

Cooperative Agreement P15AC00435

Final Well Construction Report

Submitted to:

Everglades National Park
National Park Service
US Department of the Interior

April 2016

sfwmd.gov

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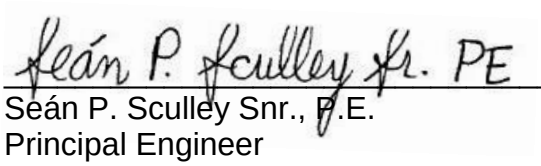
Attachments

CERTIFICATION

I certify that this Final Report contains an accurate description of tasks performed and deliverables produced.



Seán P. Sculley Snr., P.E. 4/22/2016
Date

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1.0 Introduction

The South Florida Water Management District (SFWMD) and Everglades National Park (ENP), National Park Service (NPS), of the Department of the Interior (DOI) entered into a Cooperative Agreement to drill, core, install and instrument four monitoring wells in Miami-Dade County (**Figure 1**). The drilling site is located on SFWMD right-of way immediately adjacent to the S-356 pump station (**Figure 2**). Water levels are monitored and water quality samples are collected and analyzed during the US Army Corps of Engineers' (USACE) Field Test of the S-356 pump station as part of a separate Cooperative Agreement between SFWMD and ENP. The water level data will be used to assess groundwater - surface water interactions when the pump station is operated. Water quality analyses will be used during the development of a local water budget to identify groundwater contributions of water pumped by S-356.

2.0 Summary

This Cooperative Agreement (CA) was executed in March 2015 for $49,300 with an initial period of performance from May 1 through December 31, 2015. The four wells were drilled, cored and instrumented in June 2015. The US Geological Survey (USGS) completed optical and acoustic borehole imaging and geophysical logging of the initial well in June 2015. USGS released their memorandum, "Borehole Geophysical Data Collected during Construction of Biscayne Aquifer Monitoring Well Cluster at the S-356 Pump Station, Miami-Dade County, Florida", in August 2015.

The four wells were instrumented with water level sensors and data loggers July 7, 2015. A SFWMD hydrogeologist manually downloaded the water level data during monthly site visits and provided the data to SFWMD hydrologic data management staff for processing, quality control and uploading to the DBHydro database. This practice was continued through March 2016.

The CA was modified in September 2015 to reallocate unobligated funds for acquisition and installation of equipment to allow transmission of water level data by telemetry. SFWMD did not receive an invoice from USGS for their services until January 2016. An extension of the period of performance was therefore necessary in order for SFWMD to prepare the final invoice for this Agreement. SFWMD transmitted all project deliverables including this Final Report and submitted a final invoice for this project to ENP in April 2016.

Table 1 lists deliverables of this CA and where they are located. Most information can be found in the USGS Data Release Memorandum (DRM) dated August 20, 2015, "Borehole Geophysical Data Collected during Construction of Biscayne Aquifer Monitoring Well Cluster at the S-356 Pump Station, Miami-Dade County, Florida", by Michael A. Wacker, USGS Caribbean Florida Water Science Center.

The DRM and its appendices were posted by USGS at the following location on the Internet: ftp://ftpext.usgs.gov/pub/er/fl/fort.lauderdale/SFWMD/ in the FTP directory named S-356 Data Release.

Table 1. Deliverables produced under this Cooperative Agreement.

Deliverable	Location (and filename, if applicable)
Preserved cores and unconsolidated sediments from all boreholes	Preserved at the USGS office in Davie, FL. Images of the cores are in the "App 2 Core Photos" subdirectory
Daily drilling logs	Kept on file by USGS, Davie, FL office; also as DRM Appendix 1 in the file named "App 1 S-356 Field-Log Notes.pdf"
Geophysical logs	(App3 S-356-MW-1.pdf); the data used to produce these logs is in "App 4 Raw Data" subdirectory
Optical borehole imaging	The images appear on the left-hand side of the image in the file named "App3_S-356-MW-1.pdf". A high-resolution image is the file named "900 Turns 1to1.jpg"
Observation well construction details and drawings	Construction details are found in the DRM; well screen specification drawing is shown in Figure 5 of this report; the wellhead construction diagram is shown in Figure 6 of this report.
Four instrumented wells	The Statement of Work for instrumentation is contained in the file named "RFQ S356GW Monitoring Well Installation Documentation.pdf"; site registration documents are in Attachment 1 to this report.
Well installation report characterizing geology and flow zones	Included in the DRM
Surveyed coordinates and elevations	In file named "S-356 Survey.pdf"

2.1 Well Installation

Installation began June 15, 2015. SFWMD retained GFA International (Contractor) install the wells. This work was completed June 22, 2015. The Contractor encountered the bottom of the Biscayne Aquifer at a much shallower depth than was estimated. As a result, the well coring, pilot hole conversion and installation of three additional wells was accomplished using 70 percent of the budgeted amount for this work. The $6,530 in cost savings were used to acquire and install telemetry equipment for the wells.

Figure 1. Location of S-356 Pump Station

Figure 2. Location of monitoring well cluster relative to S-356 pump station

Monitor wells were completed into each producing zone identified in the Biscayne Aquifer, and into the Tamiami Formation. Well names and depths (screened interval) are shown in **Table 2**. Each well was constructed of two-inch diameter schedule 40 threaded PVC casing with a two-foot screened interval. Well screens are 0.060-inch slot size and were placed within a 1/4- by 1/8-inch gravel pack. A one-foot bentonite seal was placed on top of the gravel packs, and the wells were cemented into place with a 5% bentonite-cement mixture conforming to State of Florida well construction requirements. Centralizers were installed at 20-foot intervals, except in the 12-foot deep well. The wells were finished below grade and enclosed in 16-inch diameter “meter vault” type protective boxes, which were secured in place by 30-inch by 30-inch by 10-inch reinforced concrete well pads. A PVC conduit was installed through the well pad into the protective boxes to provide access for buried transducer cables in the future. All wells were developed by air lifting to remove any sediment and drilling fluids. Photos of the completed wellheads are shown in Figures 3 and 4.

Table 2. Monitoring well information

Well Name	Label on Well Pad	Screened Interval (feet bls)
S356GW1	MW-1	52.5 – 54.5
S356GW2	MW-2	46 – 48
S356GW3	MW-3	22 – 24
S356GW4	MW-4	10 – 12

Figure 3. Completed wellheads (photo is looking east-southeast)

Figure 4. Completed monitoring well

GFA International complied with the following specifications to drill, core and develop the wells:

Pilot Hole. The pilot hole will be first drilled with a 14-inch auger bit into the uppermost part of the bedrock. Next a 10-inch casing will be set with cement to the base of the 14-inch augered hole. After the surface casing has been set, the Contractor will obtain continuous 4-inch diameter geologic core samples from the pilot hole. The 4-inch coring shall be accomplished via wireline coring with diamond surface set-face discharge system bit. Unconsolidated samples must be obtained via wireline coring (with appropriate catcher). The Contractor will provide multiple coring devices to speed the process. The site geologist will be responsible to collect and describe samples and cores obtained during pilot-hole drilling operations. The Contractor shall provide the geologist safe access to inspect the samples, and shall accommodate the geologist in retrieving samples, including moderating drill rates and circulation, if necessary.

Coring. Wireline coring is preferred to maximize the amount of core recovery. All wireline core samples are to be four inches in diameter. Core samples will be placed by the onsite geologist in 2-ft waxed-cardboard core boxes provided by the driller for retention by the USGS. Any unconsolidated samples obtained by wireline coring will be collected in clear plastic liners with caps. Liners and caps are to be new and free from cracks or other defects and washed before use. Caps must be placed on each end of the liner and secured prior to storage. The site geologist will identify and store samples as specified.

It is likely that the coring will produce a pilot hole with a diameter of approximately 6-inches. If the pilot hole is smaller than this, the Contractor will ream the entire depth of the pilot hole to a diameter of 6-inches to allow the USGS to run geophysical logs in the pilot hole.

Well Development for Logging. After the coring/reaming of the pilot hole is complete, the Contractor will develop the borehole to allow the USGS to run geophysical logs. This development is needed to remove all visible particulate matter prior to logging. The Contractor will develop the borehole with an air-lift system until the site geologist approves the borehole for logging. After the

USGS has completed the geophysical logging in the pilot hole, the Contractor will install the monitor well in the pilot holes.

All boreholes must be developed using an air lift method. The Contractor shall furnish all equipment, pumps, oil/water separators for use on the compressors, piping, and appurtenances required to successfully develop each borehole.

Mud Rotary/Reverse Air/Dual Wall Drilling. After the geophysical logging of pilot hole has been completed, the Contractor will drill the remaining three monitor wells. These will be drilled using the mud rotary, reverse air, or dual wall methods. If sufficient sediment samples were obtained from the deep monitor well, no samples will be needed from these wells. No discharge of cuttings or drilling fluids will be permitted into proximal surface waters (Tamiami Canal) or surface drains.

Drilling Logs. The Contractor shall furnish SFWMD with a daily drilling record. The log shall accurately describe the following: geologic materials and depths encountered, depths of lost circulation zone(s) and methods of regaining circulation, drilling rate, time, depth and description of any unusual occurrences or problems during drilling, diameters and lengths of drill rod and casing, and any other work performed at the site. The drilling logs will include a list of all personnel on site during installation, including agency and position. The drilling logs must be available on site for review by SFWMD and the logs will become the property of the SFWMD upon completion of the wells.

Borehole Casing (PVC). The site geologist will specify the depth of the casing and the screen intervals. The cluster will have wells of approximately 18 feet, 30 feet, 44 feet, and 75 to 90 feet below land surface. The Contractor shall provide two-inch diameter, schedule 40 PVC Tri-Loc riser (or equivalent). Well screens will be 0.060-inch slot size for the three shallow wells and 0.010-inch slot for the deepest well. Screen manufacturers and design shall be approved by the SFWMD prior to purchasing of the screens. The well screens shall be two feet long in each well. All monitor wells will be completed below grade with a 16” diameter bolt-down, sealing, manhole cover. All well casing joints shall be connected by threaded connections with manufacturer-supplied "O" rings, cleaned and sealed in plastic at the factory. The casing must be installed to the actual depth and grouted into place back to land surface. All casing shall be of new, first quality material and free of defects in manufacturing and handling.

Well Casing Centralizers. All monitor wells shall be fitted with centralizers constructed of PVC. If different material is proposed, it must be approved by the SFWMD prior to commencement of fieldwork. The centralizers will be spaced about every 20 feet beginning 2-feet above the top of the screen. All centralizers must be installed in alignment to allow insertion of a tremie pipe to the total depth of the well.

Well Installation / Cement Grouting. All work performed shall conform to State of Florida well drilling practices and to American Water Works Association standards. The Contractor shall be responsible for calculating volumes pumped during installation / grouting operations. The site geologist will review methods and volumes prior to commencement of pumping cement grout. The gravel pack must be dropped into the annular space using a tremie line and should be hard tagged at 1 to 2 feet above the top of the screen. The Contractor will then pump about 1 foot of bentonite on top of the sand pack. The method used must completely fill grout from the bottom of the annular space to the surface. A minimum of eight (8) hours setting time shall be required between successive cement lifts. All subsequent cement lifts shall be tagged by the tremie method prior to installing an additional stage.

Wellhead Completion. All monitor wells will be recessed below grade. These will be enclosed in a 16-inch diameter ‘meter vault’ type protective box with bolt down access lids. These boxes

must be made of steel or cast iron and dipped in primer once and in Rustoleum brand red paint twice before installation. The well recesses will have a 1-inch diameter drain hole to remove excess water in the recess. Several feet of clean sand should be placed below the protective box to facilitate drainage. Additionally, the Contractor will install a 2-inch 90 sweep made of gray electrical conduit that extends one inch above the concrete and extends several inches below and to the side of the concrete pad. This will provide access for a transducer cable. The well will be completed and sealed at the surface with a 30"x 30"'x 10" cement pad (with #8 reinforcing bars) that slopes slightly away from the well. The reinforcing bar must be centered within the depth of the cement pad.

Well Development. The boreholes will be developed several times. The final development will take place after the wells are constructed. The Contractor will develop the wells until all visible particulate matter is removed and the water quality field parameters (pH, temperature, specific conductivity) are stable. At a minimum, each well shall be developed for one hour. The Contractor will use a YSI (or similar type) water quality sensor to monitor field parameters during development. A geologist or technician will be on site to provide and use the water quality sensor. It is anticipated that the discharge water from well development will be pumped onto the ground surface.

All boreholes and wells will be developed using an air lift method. The Contractor shall furnish all equipment, pumps, oil / water separators for use on the compressors, piping, and appurtenances required to successfully develop each borehole and well.

Figure 5 shows well screen specifications and **Figure 6** is a wellhead construction diagram used for this project.

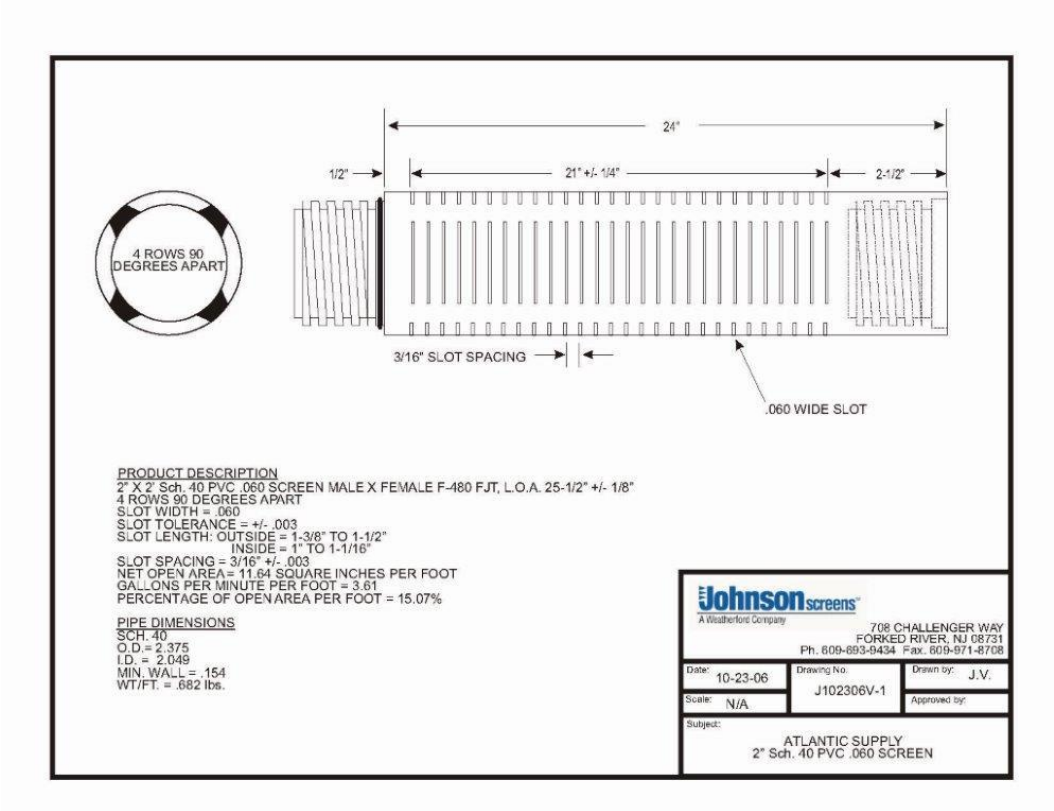


Figure 5. Well screen specifications.

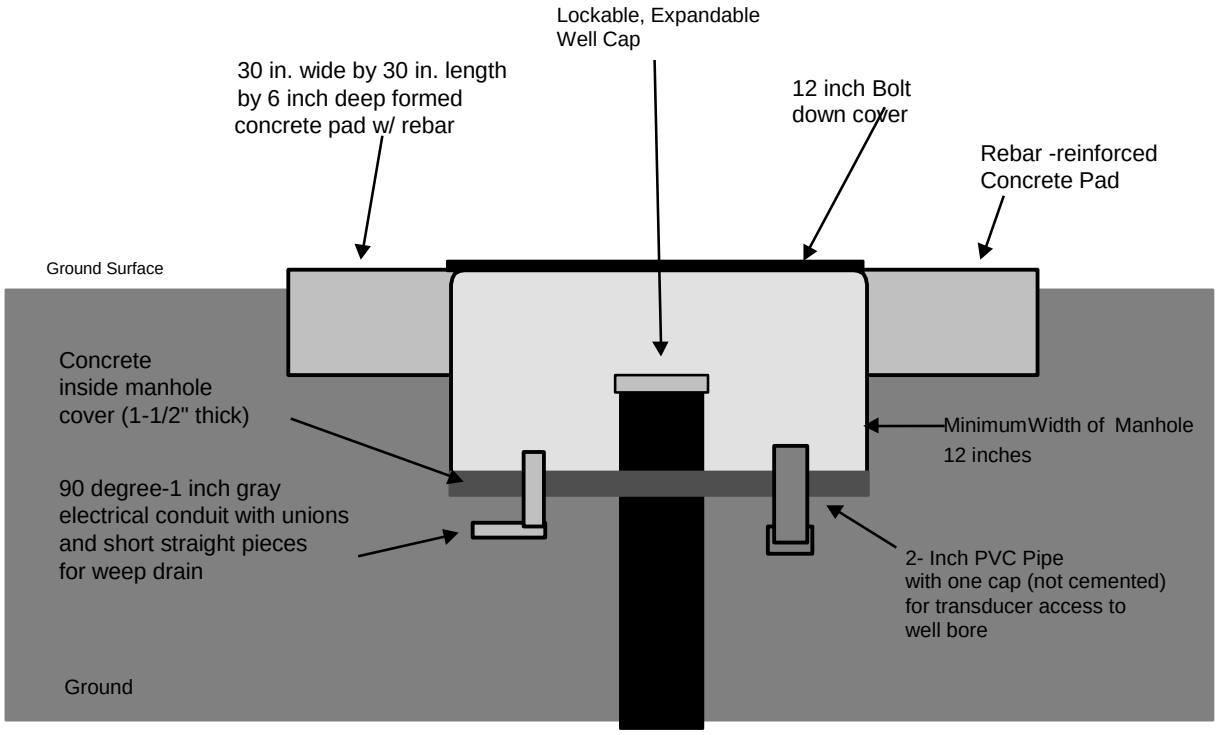


Figure 6. Wellhead construction diagram (not to scale)

2.2 Optical Borehole Imaging and Geophysical Logging

The USGS Data Release Memorandum (DRM) describes the borehole geophysical data collected, coring, drilling, and methods used during installation of the monitoring well cluster.

2.3 Instrumentation

Data loggers were installed in each of the wells. The data loggers collect data on pressure, uncorrected head, and temperature. The data loggers were programmed to collect data at 15-minute increments, and data collection started on July 6, 2015. Data is downloaded from the data loggers approximately once a month. Once the wells are surveyed, reference elevations will be established and water levels will be converted to elevations. Unobligated funds from well drilling were used to enable transmittal of well water level elevations to SFWMD headquarters via telemetry. Data from the wells will be able to be accessed remotely in real-time. Since telemetry was already established at the S-356 site for the existing stilling wells (to transmit the pump station headwater and tailwater elevations), modifications were simple and included modifying the wellheads to allow for permanent installation of the data loggers in each well, connecting them to the existing remote terminal unit (RTU) at the site, and reprogramming the RTU to recognize the data loggers. Surveying the wells and establishing reference elevations are included as part the installation of telemetry. Once reference elevations were established, the

water level data for each well was imported into the District's DBHydro database. **Figures 7** and **8** show the well heads equipped with telemetry.

Figure 7. S-356 Well heads installed with service platforms and telemetry, looking east.

Figure 8. S-356 well heads equipped with service platforms and telemetry, close-up.

Attachment 1. Well Site Reports

Site Name S-356 MW1		**Date of Field Work 10/1/2015**
Party Chief Ebanks/Rodriguez	**Field Book Name/Number** SCADA FB #11	**Page Number(s)** Pg. 78
Site Benchmark Name S-334 1984	**Benchmark Elevation (NAVD88)** 12.215ft	**Datum Offset to NGVD29** +1.55
Reference Elevation (NAVD 88) 6.91ft		**Existing Tag Elevation (Datum)** N/A (New Well)
Latitude **25° 45’ 41.2”**		**Longitude** **80° 30’ 04.7”**
Notes: New GW Wells.		

Photographs

Overall Site

Benchmark Location

Benchmark Close Up

Well Close Up

Well + Reference Mark

Staff Gauge (Front View)

Staff Gauge (Side View)

Site Name S-356 MW2		**Date of Field Work 10/1/2015**
Party Chief Ebanks/Rodriguez	**Field Book Name/Number** SCADA FB #11	**Page Number(s)** Pg. 78
Site Benchmark Name S-334 1984	**Benchmark Elevation (NAVD88)** 12.215ft	**Datum Offset to NGVD29** +1.55
Reference Elevation (NAVD 88) 6.685ft		**Existing Tag Elevation (Datum)** N/A (New Well)
Latitude **25° 45’ 41.2”**		**Longitude** **80° 30’ 04.6”**
Notes: New GW Wells.		

Photographs

Overall Site

Benchmark Location

Benchmark Close Up

Well Close Up

Well + Reference Mark

Staff Gauge (Front View)

Staff Gauge (Side View)

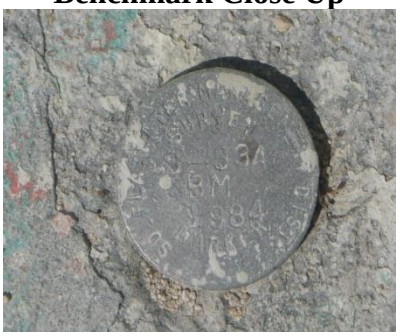
Site Name S-356 MW3		**Date of Field Work 10/1/2015**
Party Chief Ebanks/Rodriguez	**Field Book Name/Number** SCADA FB #11	**Page Number(s)** Pg. 78
Site Benchmark Name S-334 1984	**Benchmark Elevation (NAVD88)** 12.215ft	**Datum Offset to NGVD29** +1.55
Reference Elevation (NAVD 88) 6.44ft		**Existing Tag Elevation (Datum)** N/A (New Well)
Latitude **25° 45' 41.3"**		**Longitude** **80° 30' 04.5"**
Notes: New GW Wells.		

Photographs

Overall Site

Benchmark Location

Benchmark Close Up



Well Close Up

Well + Reference Mark

Staff Gauge (Front View)

Staff Gauge (Side View)

Site Name S-356 MW4		**Date of Field Work 10/1/2015**
Party Chief Ebanks/Rodriguez	**Field Book Name/Number** SCADA FB #11	**Page Number(s)** Pg. 78
Site Benchmark Name S-334 1984	**Benchmark Elevation (NAVD88)** 12.215ft	**Datum Offset to NGVD29** +1.55
Reference Elevation (NAVD 88) 7.01ft		**Existing Tag Elevation (Datum)** N/A (New Well)
Latitude **25° 45’ 41.3”**		**Longitude** **80° 30’ 04.8”**
Notes: New GW Wells.		

Photographs

Overall Site

Benchmark Location

Benchmark Close Up

Well Close Up

Well + Reference Mark

Staff Gauge (Front View)

Staff Gauge (Side View)