SCDNR GROUNDWATER MONITORING NETWORK STATUS REPORT

JULY 2014 THROUGH JUNE 2019

by

Joshua M. Williams, Brooke Czwartacki, Jess McDaniel, and Andrew Wachob

STATE OF SOUTH CAROLINA
DEPARTMENT OF NATURAL RESOURCES

LAND, WATER AND CONSERVATION DIVISION

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CONTENTS

Page

CONTENTS (continued)

Page

FIGURES

FIGURES (continued)

Page

TABLES

PLATE

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ABSTRACT

The South Carolina Department of Natural Resources (SCDNR) maintains a network of wells to monitor groundwater levels of the major aquifers in the State. As of June 2019, this Groundwater Monitoring Network consists of 180 wells, 15 of which are in the Piedmont and Blue Ridge Provinces and 165 are in the Coastal Plain Province. Automated data recorders (ADRs), which measure and record water levels on the hour, are installed in 145 wells, and 35 wells are measured manually on a quarterly to bimonthly basis. Eleven wells along the coast also are equipped with sensors that measure and record conductivity, forming the Saltwater Intrusion Monitoring Network. Nine wells have been equipped with telemetry systems for real-time data acquisition, forming the foundation of a Groundwater Drought Monitoring Network. Data from the network are used to assess groundwater availability, monitor drought conditions, develop potentiometric maps, calibrate hydrologic models, and monitor saltwater intrusion along the coast.

This report provides an overview of the groundwater monitoring network and documents updates and enhancements to the network over the past five years. During the five years from July 2014 through June 2019, 49 wells were added to the network; 47 of which were equipped with water-level recorders, 11 were equipped with conductivity probes, and 9 were outfitted with real-time monitoring equipment for drought assessment purposes. These accomplishments—increasing the number of groundwater-level monitoring wells, developing a network of drought-assessment monitoring wells, and developing a network of saltwater-intrusion monitoring wells—satisfy goals established in the previous status report (Harder and others, 2014) for the SCDNR groundwater monitoring program.

INTRODUCTION

The South Carolina Department of Natural Resources (SCDNR) routinely collects groundwater-level and conductivity data for water-resource assessments and for management and planning purposes. These data are used to identify short- and long-term changes in groundwater levels and aquifer storage that occur because of changes in withdrawals, recharge rates, and climatic conditions; construct potentiometric maps of major aquifers; calibrate groundwater flow models; determine regional hydraulic gradients and groundwater flow patterns of the major aquifers; and monitor saltwater intrusion along the coast.

In recent years, data from the SCDNR groundwater monitoring network were used by the U.S. Geological Survey (USGS) to calibrate its updated Coastal Plain groundwater flow model; by the South Carolina Department of Health and Environmental Control (SCDHEC) to evaluate groundwater conditions and inform its decision to create the new Western Capacity Use Area; and by SCDHEC and SCDNR to investigate the major cone of depression that has been mapped in Georgetown County.

This report provides an overview of SCDNR's groundwater monitoring program, documents recent additions and other changes to the Groundwater Monitoring Network, introduces two subsets of the main network—the Saltwater Intrusion Monitoring Network and the South Carolina Groundwater Drought Monitoring Network—and presents near-term and long-term program goals. This report also includes a detailed description of the SCDNR water-level and conductivity monitoring equipment and data collection and processing procedures.

PREVIOUS REPORTS

Groundwater data collected from the monitoring network are periodically summarized in data reports and utilized in the production of potentiometric maps for the major aquifers of the Coastal Plain. The most recent data report presents water-level data from 2011 through 2019 and highlights long-term water-level trends (Wachob and others, 2020). The previous status report (Harder and others, 2014) detailed monitoring network updates from July 2009 to June 2014. These reports, as well as numerous potentiometric map reports, are available on the SCDNR website at http://hydrology.dnr.sc.gov/publications.html.

WELL IDENTIFICATION NUMBERING SYSTEM

SCDNR uses a well identification system that consists of a three-letter county-name abbreviation and a sequential number that is assigned by SCDNR in coordination with the USGS. For example, HAM-0050 represents the fiftieth well inventoried by SCDNR in Hampton County. Because all wells in the monitoring network are also included in SCDNR's main well inventory, the monitoring network wells are identified using this same system.

HYDROGEOLOGIC FRAMEWORK

A hydrogeologic framework describes the spatial distribution of the aquifers and confining units that control the occurrence and availability of groundwater throughout the South Carolina Coastal Plain. The hydrogeologic framework utilized in the groundwater monitoring program has historically been that of Aucott and others (1987), who divided the Coastal Plain sedimentary sequence into six aquifers, which in ascending order are: Cape Fear, Middendorf, Black Creek, Tertiary sand, Floridan, and surficial.

Recently, SCDNR adopted a new hydrogeologic framework first described by Gellici and Lautier (2010) in *Hydrogeologic Framework of the Atlantic Coastal Plain, North and South Carolina*, a chapter in the report *Ground-water Availability in the Atlantic Coastal Plain of North and South Carolina* (Campbell and Coes, 2010). This newer framework divides the Coastal Plain sedimentary sequence into eight major aquifers: Gramling, Charleston, McQueen Branch, Crouch Branch, Gordon, Middle Floridan, Upper Floridan, and surficial. SCDNR has been transitioning to the new framework and nomenclature since 2010. Over the past few years, starting with the 2017 publication of Coastal Plain potentiometric maps (Wachob and others, 2017), SCDNR has fully adopted the new framework and nomenclature. A comparison chart between the two nomenclatures is provided in Figure 1.

MONITORING WELL DISTRIBUTION

Groundwater-Level Monitoring

As of June 2019, the SCDNR Groundwater Monitoring Network consists of 83 monitoring sites and a total of 180 wells, of which 165 are in the Coastal Plain province and 15 in the Piedmont or Blue Ridge Provinces. Thirty-four locations are well-cluster sites, meaning two or more wells are monitored at each of those sites. The locations of all monitoring wells active as of June 2019 are shown in Figure 2; a larger version of this map is included as a plate in this report.

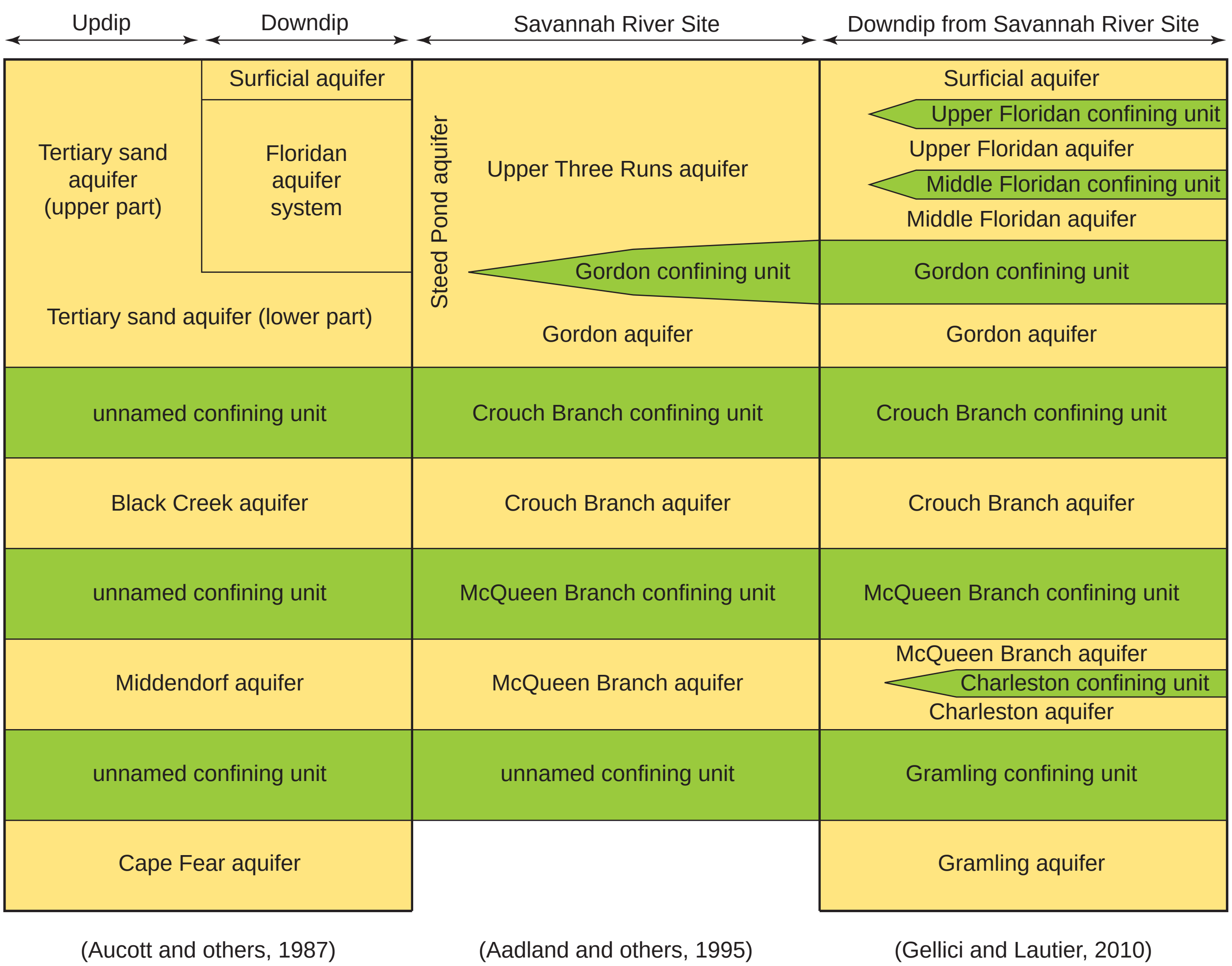

Figure 1. Comparison of hydrostratigraphic nomenclature systems in South Carolina.

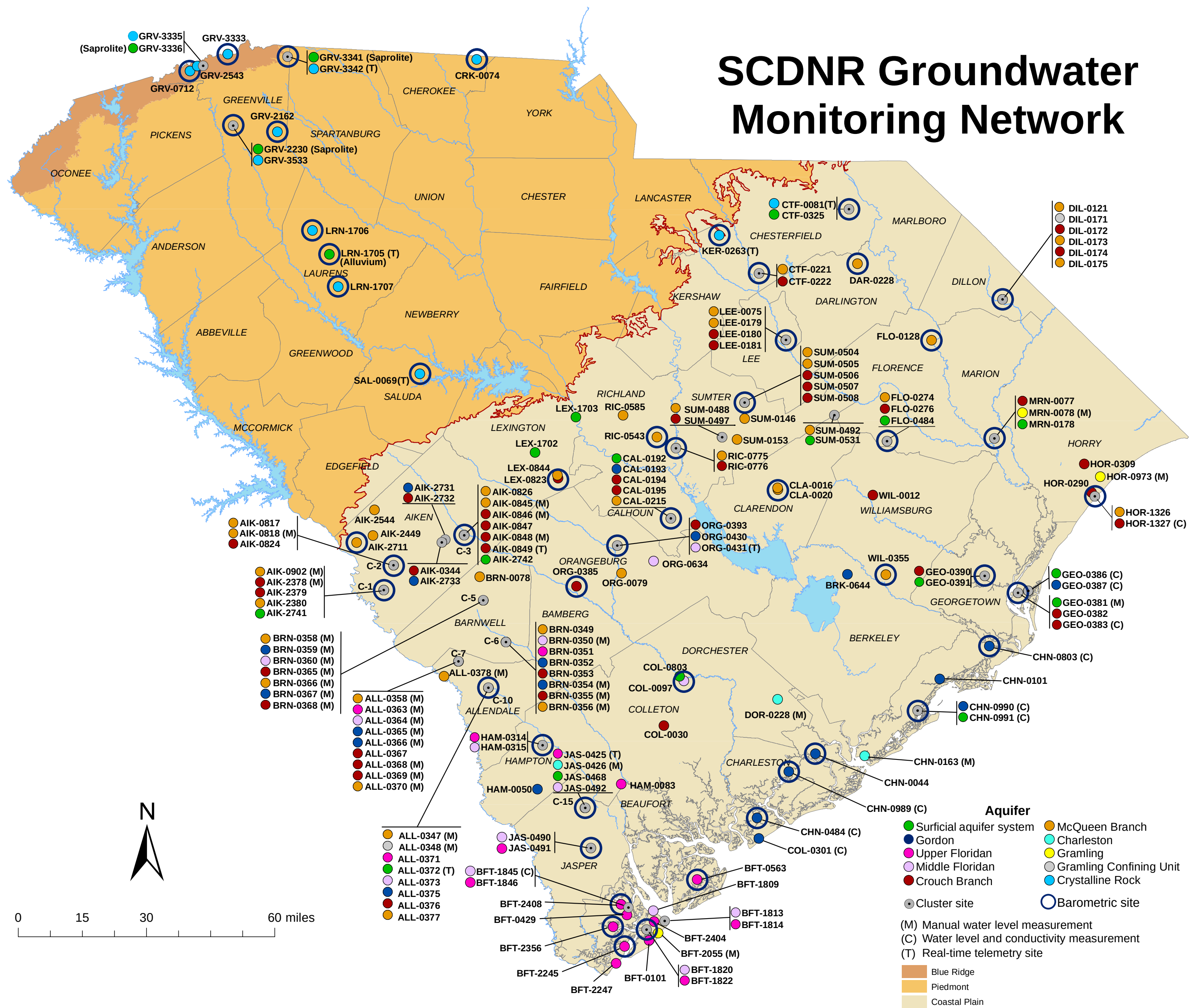

Figure 2. SCDNR Groundwater Monitoring Network (June 2019).

Figure 3 shows the distribution of monitoring wells by aquifer. Because the Floridan, Crouch Branch, and McQueen Branch aquifers are the most heavily used aquifers in the Coastal Plain, most of the wells in the network measure these aquifers. There are 43 network wells completed in the McQueen Branch aquifer, 41 in the Crouch Branch aquifer, and 33 in the Floridan aquifers.

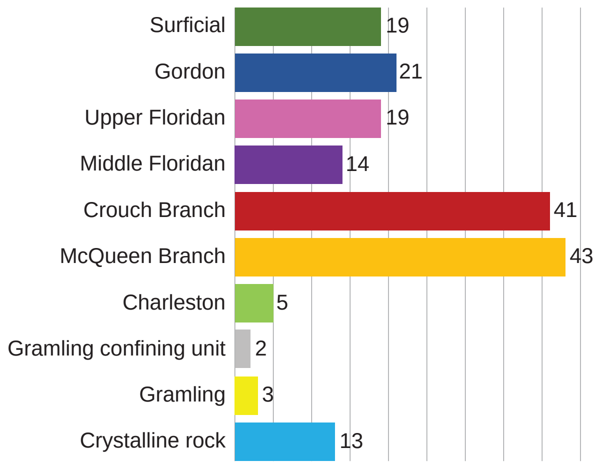

Figure 3. Distribution of monitoring wells by aquifer.

The period-of-record distribution for wells in the SCDNR network is shown in Figure 4. Sixty percent of the wells have water-level measurements with a period of record greater than ten years. Approximately forty percent of the wells have water-level data going back more than 20 years, with one as far back as 1955. Measurements prior to the mid-1990s were made primarily by the USGS in wells that were originally maintained by that agency and which later became part of the SCDNR groundwater network.

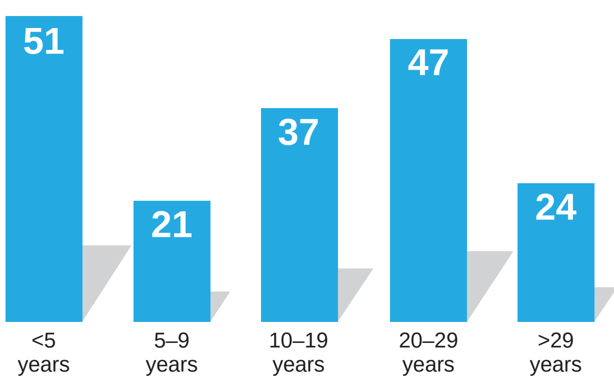

Figure 4. Distribution of periods-of-record for wells in the SCDNR monitoring network.

Table 1 lists all current network wells (as of June 2019), by county, and includes well locations, aquifer names, monitoring start dates, and type of monitoring site (manually or automatically measured). More details about each well are included in Appendix A.

Conductivity Monitoring

SCDNR's Saltwater Intrusion Monitoring Network consists of Groundwater Monitoring Network wells sited near the coast in areas where changes in the freshwater-saltwater interface can be detected. Multiple aquifers are targeted, and wells are located in several coastal counties to provide coverage along the entire coast. As of June 2019, conductivity is monitored in 11 wells at nine sites (see Figure 2). Six wells are completed in the Gordon aquifer, two in the Crouch Branch, two in the surficial, and one in the Middle Floridan.

DATA COLLECTION METHODS AND INSTRUMENTATION

Introduction

Groundwater levels are collected both manually during periodic site visits, and with automated data recorders (ADRs), which collect data on a continuous basis. About eighty percent of the wells in the Groundwater Monitoring Network (145 of 180) are equipped with ADR instruments programmed to measure and record water levels every hour. Water levels in wells not equipped with ADRs are measured manually by staff hydrologists during periodic site visits, typically every two to three months, using an electric measuring tape or pressure gage.

A small number of the instrumented wells (11 of 145) are also equipped with data recorders that measure temperature and conductivity, from which specific conductance is determined. These wells collectively form the Saltwater Intrusion Monitoring Network. Data stored in these recorders are downloaded during quarterly site visits, at which time real-time temperature and conductivity measurements are also made to verify the accuracy of the recorders.

Appendix B contains a detailed description of the different types of monitoring equipment used by SCDNR and information about the specific instrumentation for each monitoring well. Appendices C and D contain complete descriptions of standard field operating procedures followed during each site visit for groundwater-level and conductivity measurements, respectively.

Table 1. SCDNR Groundwater Monitoring Network wells (June 2019)

County	Well ID	Well Location	Aquifer[1]	Aquifer[2]	Start Year	Type[3]
Aiken	AIK-0344	Montmorenci, 3.5 miles W (Oakwood-Windsor Elementary School)	Black Creek	Crouch Branch	2016	ADR – WL
Aiken	AIK-0817	New Ellenton, 4 miles WSW (County Road 146)	Middendorf	McQueen Branch	1988	ADR – WL
Aiken	AIK-0818	New Ellenton, 4 miles WSW (County Road 146)	Middendorf	McQueen Branch	1988	Manual
Aiken	AIK-0824	New Ellenton, 4 miles WSW (County Road 146)	Black Creek	Crouch Branch	1991	ADR – WL
Aiken	AIK-0826	Windsor, 4 miles NNE (Aiken State Park)	Middendorf	McQueen Branch	1989	ADR – WL
Aiken	AIK-0845	Windsor, 4 miles NNE (Aiken State Park)	Middendorf	McQueen Branch	1993	Manual
Aiken	AIK-0846	Windsor, 4 miles NNE (Aiken State Park)	Black Creek	Crouch Branch	1993	Manual
Aiken	AIK-0847	Windsor, 4 miles NNE (Aiken State Park)	Black Creek	Crouch Branch	1993	ADR – WL
Aiken	AIK-0848	Windsor, 4 miles NNE (Aiken State Park)	Black Creek	Crouch Branch	1993	Manual
Aiken	AIK-0849	Windsor, 4 miles NNE (Aiken State Park)	Black Creek	Crouch Branch	1993	ADR – WL
Aiken	AIK-0902	Jackson, 1 mile NW (S.C. Highway 125)	Middendorf	McQueen Branch	2006	Manual
Aiken	AIK-2378	Jackson, 1 mile NW (S.C. Highway 125)	Black Creek	Crouch Branch	1996	Manual
Aiken	AIK-2379	Jackson, 1 mile NW (S.C. Highway 125)	Black Creek	Crouch Branch	1996	ADR – WL
Aiken	AIK-2380	Jackson, 1 mile NW (S.C. Highway 125)	Middendorf	McQueen Branch	1995	ADR – WL
Aiken	AIK-2449	Graniteville, 3 miles WSW (Jordantown tower test well)	Middendorf	McQueen Branch	2015	ADR – WL
Aiken	AIK-2544	Sage Mill (Sage Mill tower test well)	Middendorf	McQueen Branch	2015	ADR – WL
Aiken	AIK-2711	Clearwater, 1.7 miles NW (Woodridge tower test well)	Middendorf	McQueen Branch	2015	ADR – WL
Aiken	AIK-2731	Windsor, 3 miles NW (Benhase property)	Tertiary sand	Gordon	2016	ADR – WL
Aiken	AIK-2732	Windsor, 3 miles NW (Benhase property)	Black Creek	Crouch Branch	2016	ADR – WL
Aiken	AIK-2733	Montmorenci, 3.5 miles W (Oakwood-Windsor Elementary School)	Tertiary sand	Gordon	2017	ADR – WL
Aiken	AIK-2741	Jackson, 1 mile NW (S.C. Highway 125)	Shallow aquifer	Surficial aquifer system	2019	ADR – WL
Aiken	AIK-2742	Windsor, 4 miles NNE (Aiken State Park)	Shallow aquifer	Surficial aquifer system	2019	ADR – WL
Allendale	ALL-0347	Allendale, 3.5 miles W (County Road 52)	Middendorf	McQueen Branch	1996	Manual
Allendale	ALL-0348	Allendale, 3.5 miles W (County Road 52)	Cape Fear	Gramling confining unit	1996	Manual
Allendale	ALL-0358	Millet, 3 miles NE (County Road 24)	Middendorf	McQueen Branch	1995	Manual
Allendale	ALL-0363	Millet, 3 miles NE (County Road 24)	Floridan	Upper Floridan	1995	Manual
Allendale	ALL-0364	Millet, 3 miles NE (County Road 24)	Floridan	Middle Floridan	1995	Manual
Allendale	ALL-0365	Millet, 3 miles NE (County Road 24)	Tertiary sand	Gordon	2004	Manual
Allendale	ALL-0366	Millet, 3 miles NE (County Road 24)	Tertiary sand	Gordon	1997	Manual
Allendale	ALL-0367	Millet, 3 miles NE (County Road 24)	Black Creek	Crouch Branch	1995	ADR – WL
Allendale	ALL-0368	Millet, 3 miles NE (County Road 24)	Black Creek	Crouch Branch	2006	Manual

Table 1. SCDNR Groundwater Monitoring Network wells (June 2019) — Continued

County	Well ID	Well Location	Aquifer[1]	Aquifer[2]	Start Year	Type[3]
Allendale	ALL-0369	Millet, 3 miles NE (County Road 24)	Black Creek	Crouch Branch	2006	Manual
Allendale	ALL-0370	Millet, 3 miles NE (County Road 24)	Middendorf	McQueen Branch	2006	Manual
Allendale	ALL-0371	Allendale, 3.5 miles W (County Road 52)	Floridan	Upper Floridan	1996	ADR – WL
Allendale	ALL-0372	Allendale, 3.5 miles W (County Road 52)	Floridan	Surficial aquifer system	1996	ADR – WL
Allendale	ALL-0373	Allendale, 3.5 miles W (County Road 52)	Floridan	Middle Floridan	1996	ADR – WL
Allendale	ALL-0375	Allendale, 3.5 miles W (County Road 52)	Tertiary sand	Gordon	1996	ADR – WL
Allendale	ALL-0376	Allendale, 3.5 miles W (County Road 52)	Black Creek	Crouch Branch	1996	ADR – WL
Allendale	ALL-0377	Allendale, 3.5 miles W (County Road 52)	Middendorf	McQueen Branch	1996	ADR – WL
Allendale	ALL-0378	Millet, 2.1 miles SW (Little Hell Landing)	Middendorf	McQueen Branch	2006	Manual
Beaufort	BFT-0101	Hilton Head Island (U.S. Highway 278)	Floridan	Upper Floridan	1955	ADR – WL
Beaufort	BFT-0429	Bluffton, 2 miles NE	Floridan	Upper Floridan	1970	ADR – WL
Beaufort	BFT-0563	Frogmore, 2.3 SE (St. Helena Island)	Floridan	Upper Floridan	2015	ADR – WL
Beaufort	BFT-1809	Hilton Head Island (Hilton Head Plantation)	Floridan	Middle Floridan	1986	ADR – WL
Beaufort	BFT-1813	Hilton Head Island (Port Royal Plantation)	Floridan	Middle Floridan	2001	ADR – WL
Beaufort	BFT-1814	Hilton Head Island (Port Royal Plantation)	Floridan	Upper Floridan	1986	ADR – WL
Beaufort	BFT-1820	Hilton Head Island (Indigo Run Plantation)	Floridan	Middle Floridan	2009	ADR – WL
Beaufort	BFT-1822	Hilton Head Island (Indigo Run Plantation)	Floridan	Upper Floridan	2009	ADR – WL
Beaufort	BFT-1845	Bluffton, 2.5 miles NE (Waddell Center)	Floridan	Middle Floridan	1993	ADR – WL
Beaufort	BFT-1846	Bluffton, 2.5 miles NE (Waddell Center)	Floridan	Upper Floridan	1993	ADR – WL, C
Beaufort	BFT-2055	Hilton Head Island (near Singleton Beach)	Middendorf	Gramling	2003	Manual
Beaufort	BFT-2245	Daufuskie Island (Haig Point)	Floridan	Upper Floridan	2015	ADR – WL
Beaufort	BFT-2247	Daufuskie Island (Bloody Point)	Floridan	Upper Floridan	2015	ADR – WL
Beaufort	BFT-2356	Palmetto Bluff (Old Lodge Road)	Floridan	Upper Floridan	2015	ADR – WL
Beaufort	BFT-2404	Hilton Head Island (Leg O Mutton Road)	Floridan	Upper Floridan	2015	ADR – WL
Beaufort	BFT-2408	Belfair (Bamberg Drive)	Floridan	Upper Floridan	2015	ADR – WL
Berkeley	BRK-0644	St. Stephen (St. Stephen Middle School)	Floridan	Gordon	2001	ADR – WL
Barnwell	BRN-0078	Williston (West Street)	Middendorf	McQueen Branch	2014	ADR – WL
Barnwell	BRN-0349	Barnwell, 4 miles SE (S.C. Highway 300)	Middendorf	McQueen Branch	1988	ADR – WL
Barnwell	BRN-0350	Barnwell, 4 miles SE (S.C. Highway 300)	Floridan	Middle Floridan	1988	Manual
Barnwell	BRN-0351	Barnwell, 4 miles SE (S.C. Highway 300)	Floridan	Upper Floridan	1988	ADR – WL
Barnwell	BRN-0352	Barnwell, 4 miles SE (S.C. Highway 300)	Tertiary sand	Gordon	1989	ADR – WL

Table 1. SCDNR Groundwater Monitoring Network wells (June 2019) — Continued

County	Well ID	Well Location	Aquifer[1]	Aquifer[2]	Start Year	Type[3]
Barnwell	BRN-0353	Barnwell, 4 miles SE (S.C. Highway 300)	Black Creek	Crouch Branch	1989	ADR – WL
Barnwell	BRN-0354	Barnwell, 4 miles SE (S.C. Highway 300)	Tertiary sand	Gordon	1989	Manual
Barnwell	BRN-0355	Barnwell, 4 miles SE (S.C. Highway 300)	Black Creek	Crouch Branch	1989	Manual
Barnwell	BRN-0356	Barnwell, 4 miles SE (S.C. Highway 300)	Middendorf	McQueen Branch	1989	Manual
Barnwell	BRN-0358	Williston, 3.5 miles S	Middendorf	McQueen Branch	1993	Manual
Barnwell	BRN-0359	Williston, 3.5 miles S	Tertiary sand	Gordon	1989	Manual
Barnwell	BRN-0360	Williston, 3.5 miles S	Tertiary sand	Middle Floridan	1989	Manual
Barnwell	BRN-0365	Williston, 3.5 miles S	Black Creek	Crouch Branch	1993	Manual
Barnwell	BRN-0366	Williston, 3.5 miles S	Middendorf	McQueen Branch	1993	Manual
Barnwell	BRN-0367	Williston, 3.5 miles S	Tertiary sand	Gordon	1993	Manual
Barnwell	BRN-0368	Williston, 3.5 miles S	Black Creek	Crouch Branch	1993	Manual
Calhoun	CAL-0192	Creston (EMS/Fire Station)	Shallow aquifer	Surficial aquifer system	2013	ADR – WL
Calhoun	CAL-0193	Creston (EMS/Fire Station)	Tertiary sand	Gordon	2013	ADR – WL
Calhoun	CAL-0194	Creston (EMS/Fire Station)	Black Creek	Crouch Branch	2013	ADR – WL
Calhoun	CAL-0195	Creston (EMS/Fire Station)	Black Creek	Crouch Branch	2013	ADR – WL
Calhoun	CAL-0215	Creston (EMS/Fire Station)	Middendorf	McQueen Branch	2019	ADR – WL
Charleston	CHN-0044	Charleston (USDA site, U.S. Highway 17)	Floridan	Gordon	1980	ADR – WL
Charleston	CHN-0101	Awendaw, 2.8 miles ENE (U.S. Highway 17)	Floridan	Gordon	1980	ADR – WL
Charleston	CHN-0163	Mount Pleasant (Mt. Pleasant Waterworks RO Plant #1)	Middendorf	Charleston	2015	Manual
Charleston	CHN-0484	Edisto Beach, 5 miles N (Blue House Plantation)	Floridan	Gordon	2001	ADR – WL, C
Charleston	CHN-0803	McClellanville, 7 miles NE (Santee Coastal Reserve)	Floridan	Gordon	2000	ADR – WL, C
Charleston	CHN-0989	Hollywood, 2.5 miles E (Stono Preserve)	Floridan	Gordon	2014	ADR – WL, C
Charleston	CHN-0990	Awendaw, 7.1 miles SSW (Garris public boat landing)	Floridan	Gordon	2014	ADR – WL, C
Charleston	CHN-0991	Awendaw, 7.1 miles SSW (Garris public boat landing)	Shallow aquifer	Surficial aquifer system	2014	ADR – WL, C
Clarendon	CLA-0016	Manning (Keitt Street)	Middendorf	McQueen Branch	2015	ADR – WL
Clarendon	CLA-0020	Manning (North Boundary Street)	Middendorf	McQueen Branch	2015	ADR – WL
Colleton	COL-0030	Walterboro (Kline Street)	Black Creek	Crouch Branch	1996	ADR – WL
Colleton	COL-0097	Walterboro, 10 miles S (S.C. Highway 61)	Floridan	Middle Floridan	1977	ADR – WL
Colleton	COL-0301	Edisto Beach (Edisto Beach State Park)	Floridan	Gordon	2000	ADR – WL, C
Colleton	COL-0803	Walterboro, 11.5 miles S (Colleton State Park)	Shallow aquifer	Surficial aquifer system	2019	ADR – WL
Cherokee	CRK-0074	Blacksburg	Crystalline rock	Crystalline rock	1988	ADR – WL

Table 1. SCDNR Groundwater Monitoring Network wells (June 2019) — Continued

County	Well ID	Well Location	Aquifer[1]	Aquifer[2]	Start Year	Type[3]
Chesterfield	CTF-0081	Cheraw, 2.5 miles S (Cheraw State Park)	Crystalline rock	Crystalline rock	1999	ADR – WL
Chesterfield	CTF-0221	McBee, 3.2 miles SSW (McBee Wildlife Management Area)	Middendorf	McQueen Branch	2009	ADR – WL
Chesterfield	CTF-0222	McBee, 3.2 miles SSW (McBee Wildlife Management Area)	Black Creek	Crouch Branch	2008	ADR – WL
Chesterfield	CTF-0325	Cheraw, 2.5 miles S (Cheraw State Park)	Shallow aquifer	Surficial aquifer system	2019	ADR – WL
Darlington	DAR-0228	Society Hill, 3 miles SSW (Lake Darpo)	Middendorf	McQueen Branch	1999	ADR – WL
Dillon	DIL-0121	Dillon, 6.5 miles SE (Little Pee Dee State Park)	Middendorf	McQueen Branch	1999	ADR – WL
Dillon	DIL-0171	Dillon, 6.5 miles SE (Little Pee Dee State Park)	Cape Fear	Gramling confining unit	2014	ADR – WL
Dillon	DIL-0172	Dillon, 6.5 miles SE (Little Pee Dee State Park)	Black Creek	Crouch Branch	2014	ADR – WL
Dillon	DIL-0173	Dillon, 6.5 miles SE (Little Pee Dee State Park)	Middendorf	McQueen Branch	2014	ADR – WL
Dillon	DIL-0174	Dillon, 6.5 miles SE (Little Pee Dee State Park)	Black Creek	Crouch Branch	2014	ADR – WL
Dillon	DIL-0175	Dillon, 6.5 miles SE (Little Pee Dee State Park)	Middendorf	McQueen Branch	2014	ADR – WL
Dorchester	DOR-0228	Summerville, 4 miles SW (Well #5)	Middendorf	Charleston	2015	Manual
Florence	FLO-0128	Florence, 9.5 miles E (E.I. DuPont de Nemours)	Middendorf	McQueen Branch	1982	ADR – WL
Florence	FLO-0274	Lake City (Lake City Airport)	Middendorf	McQueen Branch	2000	ADR – WL
Florence	FLO-0276	Lake City (Lake City Airport)	Black Creek	Crouch Branch	2000	ADR – WL
Florence	FLO-0484	Lake City (Lake City Airport)	Shallow aquifer	Surficial aquifer system	2019	ADR – WL
Georgetown	GEO-0381	Georgetown, 4.2 miles SE (Hobcaw Barony)	Shallow aquifer	Surficial aquifer system	2014	Manual
Georgetown	GEO-0382	Georgetown, 4.2 miles SE (Hobcaw Barony)	Black Creek	Crouch Branch	2014	ADR – WL
Georgetown	GEO-0383	Georgetown, 4.2 miles SE (Hobcaw Barony)	Black Creek	Crouch Branch	2014	ADR – WL, C
Georgetown	GEO-0386	Georgetown, 4.2 miles SE (Hobcaw Barony)	Shallow aquifer	Surficial aquifer system	2015	ADR – WL, C
Georgetown	GEO-0387	Georgetown, 4.2 miles SE (Hobcaw Barony)	Tertiary sand	Gordon	2015	ADR – WL, C
Georgetown	GEO-0390	Georgetown, 5 miles W (8 Oaks Park)	Black Creek	Crouch Branch	2019	ADR – WL
Georgetown	GEO-0391	Georgetown, 5 miles W (8 Oaks Park)	Shallow aquifer	Surficial aquifer system	2019	ADR – WL
Greenville	GRV-0712	Marietta, 8 miles NW (Caesars Head State Park)	Crystalline rock	Crystalline rock	2003	ADR – WL
Greenville	GRV-2162	Greer (East Riverside Park)	Crystalline rock	Crystalline rock	2001	ADR – WL
Greenville	GRV-2230	Travelers Rest, 1.5 miles S (Furman University)	Shallow aquifer	Surficial aquifer system	2002	ADR – WL
Greenville	GRV-2543	Marietta, 7 miles NNW (Jones Gap State Park)	Crystalline rock	Crystalline rock	1997	ADR – WL
Greenville	GRV-3333	Marietta, 7.5 miles N	Crystalline rock	Crystalline rock	1997	ADR – WL
Greenville	GRV-3335	Marietta, 7 miles NNW (Jones Gap State Park)	Crystalline rock	Crystalline rock	1999	ADR – WL
Greenville	GRV-3336	Marietta, 7 miles NNW (Jones Gap State Park)	Shallow aquifer	Surficial aquifer system	1999	ADR – WL
Greenville	GRV-3341	Landrum, 1.5 miles WSW	Shallow aquifer	Surficial aquifer system	1998	ADR – WL

Table 1. SCDNR Groundwater Monitoring Network wells (June 2019) — Continued

County	Well ID	Well Location	Aquifer[1]	Aquifer[2]	Start Year	Type[3]
Greenville	GRV-3342	Landrum, 1.5 miles WSW	Crystalline rock	Crystalline rock	1998	ADR – WL
Greenville	GRV-3533	Travelers Rest, 1.5 miles S (Furman University)	Crystalline rock	Crystalline rock	2002	ADR – WL
Hampton	HAM-0050	Furman (U.S. Highway 601)	Tertiary sand	Gordon	2001	ADR – WL
Hampton	HAM-0083	Yemassee	Floridan	Upper Floridan	1977	ADR – WL
Hampton	HAM-0314	Hampton, 4 miles NE (Lake Warren State Park)	Floridan	Upper Floridan	2015	ADR – WL
Hampton	HAM-0315	Hampton, 4 miles NE (Lake Warren State Park)	Floridan	Middle Floridan	2015	ADR – WL
Horry	HOR-0290	Myrtle Beach (Blizzard Street & Deville Street)	Black Creek	Crouch Branch	2008	ADR – WL
Horry	HOR-0309	Conway, 2 miles SE (U.S. Highway 501)	Black Creek	Crouch Branch	2001	ADR – WL
Horry	HOR-0973	Myrtle Beach (surface water treatment plant)	Middendorf	Gramling	1999	Manual
Horry	HOR-1326	Myrtle Beach (Myrtle Beach State Park)	Middendorf	McQueen Branch	2016	ADR – WL
Horry	HOR-1327	Myrtle Beach (Myrtle Beach State Park)	Black Creek	Crouch Branch	2016	ADR – WL, C
Jasper	JAS-0425	Ridgeland, 9 miles NNW (U.S. Highway 278)	Floridan	Upper Floridan	2000	ADR – WL
Jasper	JAS-0426	Ridgeland, 9 miles NNW (U.S. Highway 278)	Middendorf	Charleston	2000	Manual
Jasper	JAS-0468	Ridgeland, 9 miles NNW (U.S. Highway 278)	Shallow aquifer	Surficial aquifer system	2011	ADR – WL
Jasper	JAS-0490	Ridgeland (Blue Heron Nature Center)	Floridan	Middle Floridan	2015	ADR – WL
Jasper	JAS-0491	Ridgeland (Blue Heron Nature Center)	Floridan	Upper Floridan	2015	ADR – WL
Jasper	JAS-0492	Ridgeland, 9 miles NNW (U.S. Highway 278)	Floridan	Middle Floridan	2008	ADR – WL
Kershaw	KER-0263	Bethune, 10.5 miles NW (Mt. Pisgah Elem. Sch.)	Crystalline rock	Crystalline rock	1993	ADR – WL
Lee	LEE-0075	Bishopville, 3.5 miles ESE (Lee State Park)	Middendorf	McQueen Branch	1999	ADR – WL
Lee	LEE-0179	Bishopville, 3.5 miles ESE (Lee State Park)	Black Creek	McQueen Branch	2012	ADR – WL
Lee	LEE-0180	Bishopville, 3.5 miles ESE (Lee State Park)	Black Creek	Crouch Branch	2012	ADR – WL
Lee	LEE-0181	Bishopville, 3.5 miles ESE (Lee State Park)	Black Creek	Crouch Branch	2012	ADR – WL
Lexington	LEX-0823	Swansea (South Spring Street)	Black Creek	Crouch Branch	2013	ADR – WL
Lexington	LEX-0844	Swansea (Swansea High School Freshman Academy)	Middendorf	McQueen Branch	1999	ADR – WL
Lexington	LEX-1702	Lexington, 10 miles S (Peach Tree Rock Heritage Preserve)	Shallow aquifer	Surficial aquifer system	2019	ADR – WL
Lexington	LEX-1703	Columbia, 4 miles S (Congaree Creek Heritage Preserve)	Shallow aquifer	Surficial aquifer system	2019	ADR – WL
Laurens	LRN-1705	Laurens (Joe R. Adair Outdoor Education Center)	Shallow aquifer	Surficial aquifer system	2000	ADR – WL
Laurens	LRN-1706	Gray Court, 2 miles S (former fire tower site)	Crystalline rock	Crystalline rock	2001	ADR – WL
Laurens	LRN-1707	Mountville, 1 mile NW (former fire tower site)	Crystalline rock	Crystalline rock	2001	ADR – WL
Marion	MRN-0077	Brittons Neck, 3 miles S (former fire tower site)	Black Creek	Crouch Branch	1982	ADR – WL
Marion	MRN-0078	Brittons Neck, 3 miles S (former fire tower site)	Cape Fear	Gramling	1999	Manual

Table 1. SCDNR Groundwater Monitoring Network wells (June 2019) — Continued

County	Well ID	Well Location	Aquifer[1]	Aquifer[2]	Start Year	Type[3]
Marion	MRN-0178	Brittons Neck, 3 miles S (former fire tower site)	Shallow aquifer	Surficial aquifer system	2019	ADR – WL
Orangeburg	ORG-0079	Rowesville, 3.1 miles NNW (Southern Patio)	Middendorf	McQueen Branch	2010	ADR – WL
Orangeburg	ORG-0385	Cope (Cope Power Station)	Black Creek	Crouch Branch	2015	ADR – WL
Orangeburg	ORG-0393	Orangeburg (Clark Middle School)	Black Creek	Crouch Branch	2001	ADR – WL
Orangeburg	ORG-0430	Orangeburg (Clark Middle School)	Tertiary sand	Gordon	2001	ADR – WL
Orangeburg	ORG-0431	Orangeburg (Clark Middle School)	Floridan	Middle Floridan	2001	ADR – WL
Orangeburg	ORG-0634	Orangeburg, 8.3 miles (Orangeburg Fire District)	Floridan	Middle Floridan	2015	ADR – WL
Richland	RIC-0543	Eastover (Webber Elementary School)	Middendorf	McQueen Branch	1996	ADR – WL
Richland	RIC-0585	Columbia, 6 miles ESE (Horrell Hill Elementary School)	Middendorf	McQueen Branch	1997	ADR – WL
Richland	RIC-0775	Wateree (Wateree Power Station)	Middendorf	McQueen Branch	2015	ADR – WL
Richland	RIC-0776	Wateree (Wateree Power Station)	Black Creek	Crouch Branch	2015	ADR – WL
Saluda	SAL-0069	Saluda, 7.5 miles NE (Hollywood Elementary School)	Crystalline rock	Crystalline rock	1993	ADR – WL
Sumter	SUM-0146	Sumter (Plant 1, Well 1C)	Middendorf	McQueen Branch	2015	ADR – WL
Sumter	SUM-0153	Sumter (Plant 3, Well 4)	Middendorf	McQueen Branch	2015	ADR – WL
Sumter	SUM-0488	Sumter, 3.5 miles SW (Manchester State Forest)	Middendorf	McQueen Branch	2009	ADR – WL
Sumter	SUM-0492	Olanta, 2.5 miles WNW (Woods Bay State Park)	Middendorf	McQueen Branch	2009	ADR – WL
Sumter	SUM-0497	Sumter, 3.5 miles SW (Manchester State Forest)	Black Creek	Crouch Branch	2009	ADR – WL
Sumter	SUM-0504	Sumter, 5 miles N (Central Carolina Tech Natural Resource Center)	Middendorf	McQueen Branch	2017	ADR – WL
Sumter	SUM-0505	Sumter, 5 miles N (Central Carolina Tech Natural Resource Center)	Middendorf	McQueen Branch	2017	ADR – WL
Sumter	SUM-0506	Sumter, 5 miles N (Central Carolina Tech Natural Resource Center)	Black Creek	Crouch Branch	2017	ADR – WL
Sumter	SUM-0507	Sumter, 5 miles N (Central Carolina Tech Natural Resource Center)	Black Creek	Crouch Branch	2017	ADR – WL
Sumter	SUM-0508	Sumter, 5 miles N (Central Carolina Tech Natural Resource Center)	Black Creek	Crouch Branch	2017	ADR – WL
Sumter	SUM-0531	Olanta, 2.5 miles WNW (Woods Bay State Park)	Shallow aquifer	Surficial aquifer system	2019	ADR – WL
Williamsburg	WIL-0012	Kingstree (2nd Avenue)	Black Creek	Crouch Branch	2015	ADR – WL
Williamsburg	WIL-0355	Jamestown, 9.5 miles NW (Wee Tee State Forest)	Middendorf	McQueen Branch	2012	ADR – WL

1 *Aquifer based on hydrogeologic framework of Aucott and others (1986)*
2 *Aquifer based on hydrogeologic framework of Gellici and Lautier (2010)*
3 WL: *Water level*; C: *Conductivty*

Well Location and Land Surface Elevation Data

The locations of all monitoring wells have been determined with the Global Positioning System (GPS) using the North American Datum of 1983 (NAD83).

Many of the land-surface and measuring-point elevations were surveyed from USGS or South Carolina Geodetic Survey benchmarks and are reported to the nearest tenth of a foot using the North American Vertical Datum of 1988 (NAVD88). Elevations not determined from existing benchmarks are estimated from LIDAR data and reported to the nearest foot.

Manual Water-Level Measurements

Manual water-level measurements, or "tape downs", are typically made using an electric tape (Figure 5), which consists of a pair of wires set inside an insulated sheath, the outside of which is marked in hundredths of a foot. The wires are attached to a steel probe at the bottom of the tape, but the design of the probe is such that there is a small gap between the two wires, keeping an electric circuit open. The tape is lowered into the well until the probe reaches water, which completes the electrical circuit and sounds a buzzer, indicating that the tape has reached water. The operator then reads the depth measurement on the tape, indicating depth of water below the measuring point of the well.

Manual measurements typically have an accuracy of 0.01 ft (feet). However, visibility, thermal expansion and contraction, and tape sinuosity diminish measurement accuracy in field conditions; accuracies, therefore, are assumed to be no better than 0.05 ft in practice. Less accuracy is likely where depth to water is greater than 100 ft.

At some sites, the groundwater is under enough pressure to cause the water level in a well to rise above the height of the well casing, and if the well were uncapped, water would flow freely from the well. Water levels in these flowing artesian wells cannot be measured using the typical tape-down procedure; instead, a pressure test gage is attached to the well and the water pressure inside the well is measured (Figure 6). Water pressure is then used to calculate the height that water would rise if the well casing were high enough to contain it.

Flowing artesian wells are manually measured with Bourdon-type test gages having pressure ranges of 0–30, 0–60, or 0–100 psi (pounds per square inch). The gages are calibrated once a year at a commercial testing laboratory and are rated to 0.25 percent of their respective measurement ranges. In practice, accuracy will be diminished by errors from gage-zero adjustment, parallax, readings near the extremes of gage range, and mechanical degradation after calibration. Table B1 (Appendix B) summarizes the manufacturer-rated accuracies and the authors' assumptions for measurement accuracy of these test gages.

Figure 5. Manual measurement of a water level using an electric tape.

Figure 6. Manual measurement of a water level in a flowing well using a pressure test gage.

Automated Water-Level Measurements

Water-level sensors used for automated monitoring stations have historically included pressure transducers and shaft encoders calibrated to manual measurements. By 2008, all wells in the midlands and Coastal Plain regions were instrumented with pressure transducers. Shaft encoders were used in some wells in the upstate until the summer of 2014 but have since been replaced with pressure transducers.

Pressure transducers measure the height of water above a semiconductor strain gage: electrical resistance to an input voltage and, therefore, voltage output, changes as varying water pressure deforms the crystalline lattice of the gage's silicon diaphragm (piezoresistive effect). There is a near-linear correlation between the sensor's pressure range and output-voltage range, and total pressure is computed from the voltage measurement.

Three brands of pressure transducers were utilized in the network during the July 2014 through June 2019 period: Solinst® Leveloggers®, Schlumberger® Divers®, and In-Situ® Trolls®. Since August 2016, however, the only brand of pressure transducer deployed in the network has been Solinst® Leveloggers® (Figure 7). Table B2 (Appendix B) lists specifications for the various transducers utilized in the network during the July 2014 to June 2019 period. Most transducers in the network have a measurement range of 0–65 ft and accuracies better than ± 0.07 ft. Details of the specific water-level and barometric instrumentation installed at each ADR well are included in Table B3 (Appendix B).

Nearly all transducers deployed over the July 2014 through June 2019 period were not vented to the atmosphere and thus measure the combined pressure of both the water column and the atmosphere. Because unvented transducers require barometric pressure for the calculation of depth to water, barometric data are collected at strategic sites throughout the State (see Figures 2 and 8). Efforts are made to ensure that a barometric monitoring site is located within 20 miles of each unvented monitoring well. The internal clocks of the water-level and barometric transducers are synchronized with one another and record data hourly.

Vented transducers (In-Situ® Trolls®), which have sensors open to the atmosphere via a vent tube, were installed in a few sites along the coast until August 2016, and data collected from these loggers required no barometric compensation.

Pressure transducers are installed in wells at fixed depths, below the lowest expected water level, and are deployed using direct-read cables, allowing for real-time water-level measurements and eliminating the need to remove sensors from wells to download data.

Figure 7. Two types of automated data recorders used in the SCDNR network: Solinst® Levelogger® (left) measures water-level; In-Situ® Aqua TROLL® (right) measures conductivity and temperature.

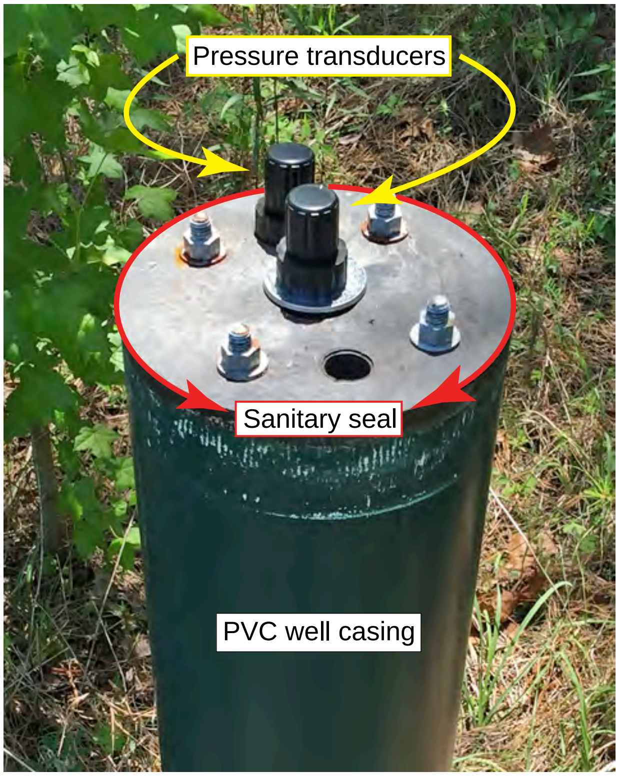

Figure 8. Pressure transducer installation at monitoring well HAM-0315 near Hampton, SC. Center probe measures water levels; rear probe measures barometric pressure.

Figure 9. Saltwater Intrusion Monitoring Network well CHN-0803 at Santee Coastal Reserve, McClellanville, SC (Charleston County).

Specific Conductance Measurements

Conductivity and temperature probes are used to monitor saltwater intrusion in select wells near the coast. Conductivity is a measurement of the ability of a solution to conduct an electrical charge and is related to the concentration of ions (i.e., salts). Specific conductance is electrical conductivity referenced to 25°C and is a standardized way of reporting conductivity across a wide range of temperatures.

Wells are equipped with In-Situ® Aqua TROLL® data loggers (see Figure 7), recording conductivity and temperature on the hour, from which specific conductance is calculated. A Schlumberger® CTD Diver® was briefly installed in one monitoring well (CHN-0990), but was replaced with an In-Situ® logger in early 2015. Probes are installed in wells with a direct-read cable at a specified depth within the lower portion of the screened interval, or near the bottom of the well if it is of open-hole construction. If saltwater intrusion occurs, it typically is first detected near the base of the aquifer owing to saltwater's increased density. Figure 9 shows an example saltwater intrusion monitoring well in Charleston County. Additional details regarding conductivity instrumentation for the network are included in Appendix B.

Site Visits and Quality Control

Most SCDNR monitoring network sites are typically visited at least four times per year, with only a few visited less frequently because of accessibility issues. During each site visit and for every well, a manual water-level measurement is taken from the designated measuring point and recorded in a field book along with the date and time of the measurement. For wells equipped with ADRs, current or real-time readings are obtained from the ADRs (water-level sensors and barometric sensors or conductivity probes, if applicable) and recorded in a field book. Measurements and sensor settings are made relative to a specified measurement point, and the methods used generally follow those of USGS Stand Along Procedure Documents (see Table B4, Appendix B).

Data are downloaded from ADRs and evaluated for quality control and instrument performance. Pressure transducer performance is assessed during each site visit by calculating the sum of the sensor's current water-level reading (height of water above probe, corrected for barometric pressure, if applicable) and corresponding manual measurement (depth to water). This sum, called the cable length, should be the same value for each site visit. Comparing cable length values from consecutive site visits is a means of assessing transducer performance. A minor change in cable length (0.20 ft is the tolerance for transducers having a 0–65 ft pressure range) indicates that potential instrument fault may exist, but the ADR is not typically replaced. When cable-length tolerances are exceeded repeatedly during additional site visits, the transducer is replaced and the associated records are not added to the groundwater database. For newer transducers, the cable-length variations observed between consecutive site visits during the past 5 years is typically less than 0.10 ft.

Field maintenance procedures also include checking for battery failure, communication errors, and spurious data spikes caused by lightning or other electromagnetic interference. Malfunctioning equipment—either ADRs or direct-read cables—are diagnosed and replaced or repaired as needed. Any issues or changes to instrumentation are documented in a field book. A complete description of standard field operating procedures (SOPs) is presented in Appendix C.

Specific conductance data are checked in the field by comparing a current or real-time measurement taken from the probe and the most recent time-stamped automated value. These readings fluctuate seasonally or in response to weather events, but generally stay within a narrow range. Data are inspected on a site-by-site basis to determine if observed changes have occurred from these external factors or due to equipment malfunction. If erroneous data are suspected, a calibration check procedure is followed. The probe is then either replaced or calibrated to within 0.5% tolerance of a known calibration standard. All conductivity probes in the network are calibrated at least twice a year or at every other site visit under normal procedures. Sensor calibration follows the manufacturer's operator's manual using a conductivity standard similar to the observed values. A complete description of standard field operating procedures (SOPs) for wells in the Saltwater Intrusion Monitoring Network is presented in Appendix D.

DATA PROCESSING AND STORAGE

Collected data are typically processed and further reviewed for quality assurance within two weeks after a site visit. All water-level data that pass quality assurance checks are entered into an Oracle database that uses Microsoft Access as a user interface. The instrumentation history of each well is documented in the database. Documentation includes the type and model of instrument deployed, dates of operation, and performance history. In addition, the original field notes are kept and maintained for each well site, and copies are periodically produced in case field books are lost or damaged.

Real-time specific conductance measurements (from site visits) and associated continuous data files are reviewed and exported to Microsoft Excel tables where there they are stored in a local database. An instrumentation history for saltwater intrusion monitoring wells also is tabulated along with real-time measurements.

The process for data processing and storage of manual measurements and automatically recorded data is described in the following sections.

Manual Water-Level Measurements

Manual measurements, along with the date and time of the measurement, are entered into the Oracle database. These measurements indicate the depth to water from a specific measuring point on the well. The measuring point height (MPH) in feet above or below land surface for each well is stored in the database. An Access query is used to subtract the MPH from the raw manual measurement to compute a water level in feet below or above land surface. Changes in the MPH, if any, are documented within the database.

Automated Measurements

Water Level

The logged hourly measurements are stored in both raw-data and processed-data files. The raw-data files contain uncorrected (uncompensated) hourly measurements and reflect the readings and the performance of various sensors as they were originally stored in data loggers. Raw data are stored mainly "as is" and are archived at SCDNR for insight into hardware conditions and for quality assurance. Processed-data files consist of hourly water-level data that have been corrected (compensated) for barometric pressure for sites equipped with unvented pressure transducers. Computer software, specific to each brand of instrument, is used to generate barometrically compensated files, which are also archived at SCDNR. The software is also used to plot and review both the raw and compensated data at each ADR site as an additional quality assurance check prior to entering the data in the database. When appropriate, data are winnowed of anomalous measurements and unreliable data thought to be the result of hardware failures.

The real-time ADR reading (after barometric compensation, where applicable) is entered into the database and is used along with the corresponding manual measurement to compute a cable length value. The computed cable length value is confirmed to be within the allowed tolerance (typically ± 0.20 ft) before any hourly data are added to the database. A history of the cable length values for each site is permanently stored in the database to document instrument performance.

Compensated hourly water-level measurements are imported into the Oracle database. These measurements reflect the height of the water column above the sensor and are permanently stored in the database. The well's MPH and the transducer's cable length value are used to convert the hourly readings to water levels in feet below land surface, which are also permanently stored in the database.

Daily average water levels, in feet below land surface, are calculated from the hourly data for those days missing 7 or fewer hourly measurements. Monthly average water levels are calculated for each month having 5 or fewer days of missing record, while monthly high and low water-level values are recorded for each month having at least one day of data. Yearly averages are computed for each calendar year having 60 or fewer missing days of record, while yearly highs and lows are recorded for each year with at least one day of data. No statistics are calculated for wells that are manually measured owing to the relatively small number of data values available for such wells. Data collected from the network can be viewed and downloaded on the SCDNR website (http://hydrology.dnr.sc.gov/groundwater-data/). Figures 10 and 11 show hydrographs created using both ADR and manually collected water-level data available on the SCDNR website.

Specific Conductance

The conductivity and temperature probes store hourly measurements of conductivity and temperature, and calculated specific conductance. The logged measurements are reviewed for quality assurance, exported to Excel tables, and stored essentially as-is in a local database. Currently, no further processing of specific conductance data is done on a routine basis. The original field notes documenting instrumentation history and real-time measurements are kept and maintained for each well site in paper and spreadsheet format. Figure 12 shows specific conductance and water levels measured in a well in Charleston County.

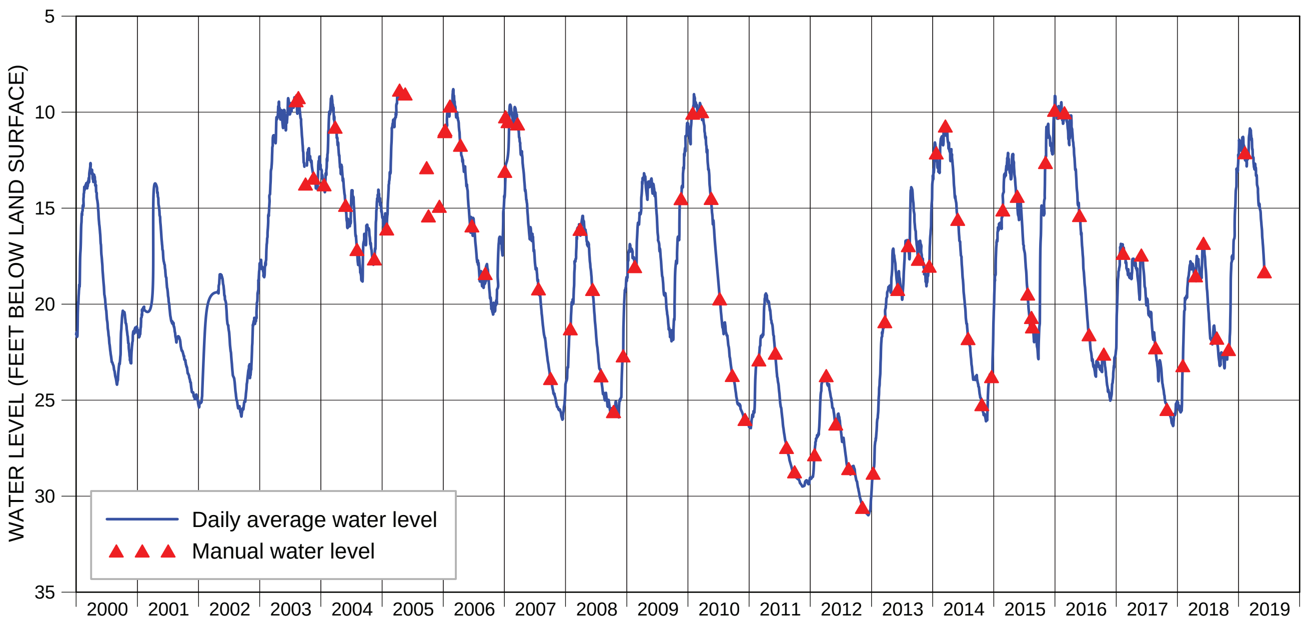

Figure 10. Daily average water levels in well SAL-0069 (Saluda County) calculated from hourly ADR data. Manual measurements made during site visits verify the accuracy of the ADR data.

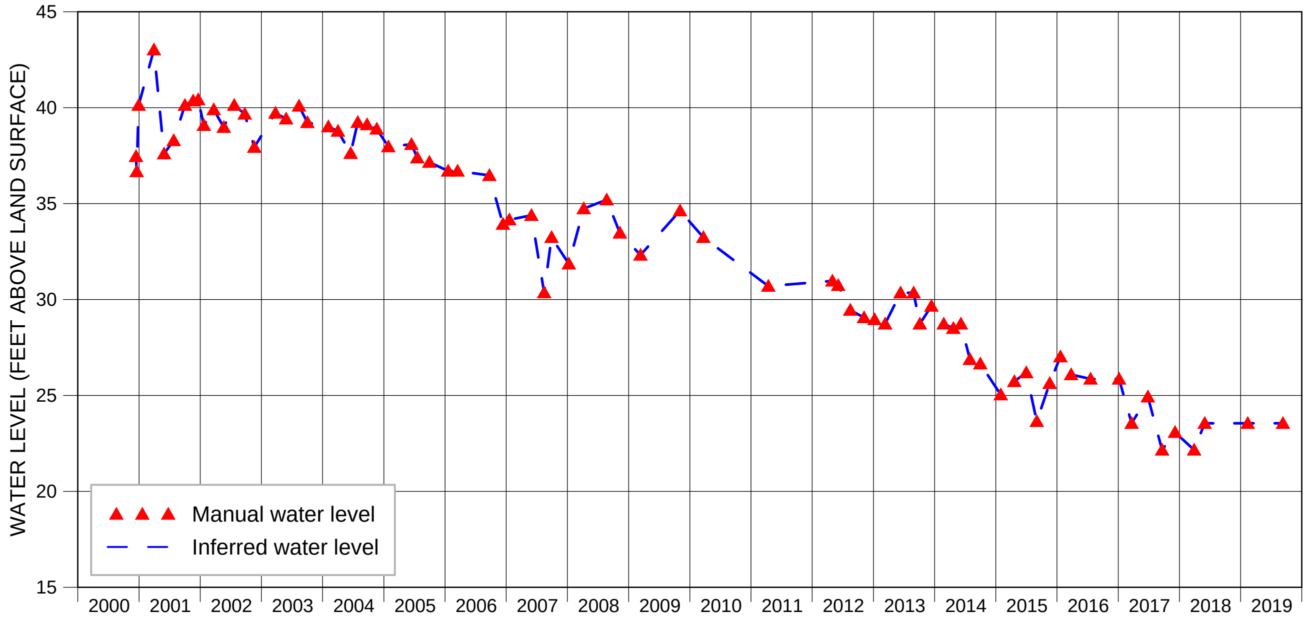

Figure 11. Manual water-level measurements in well MRN-0078 (Marion County). Because the water level in this well is above land surface, an ADR is not used, and measurements are made using a pressure test gage.

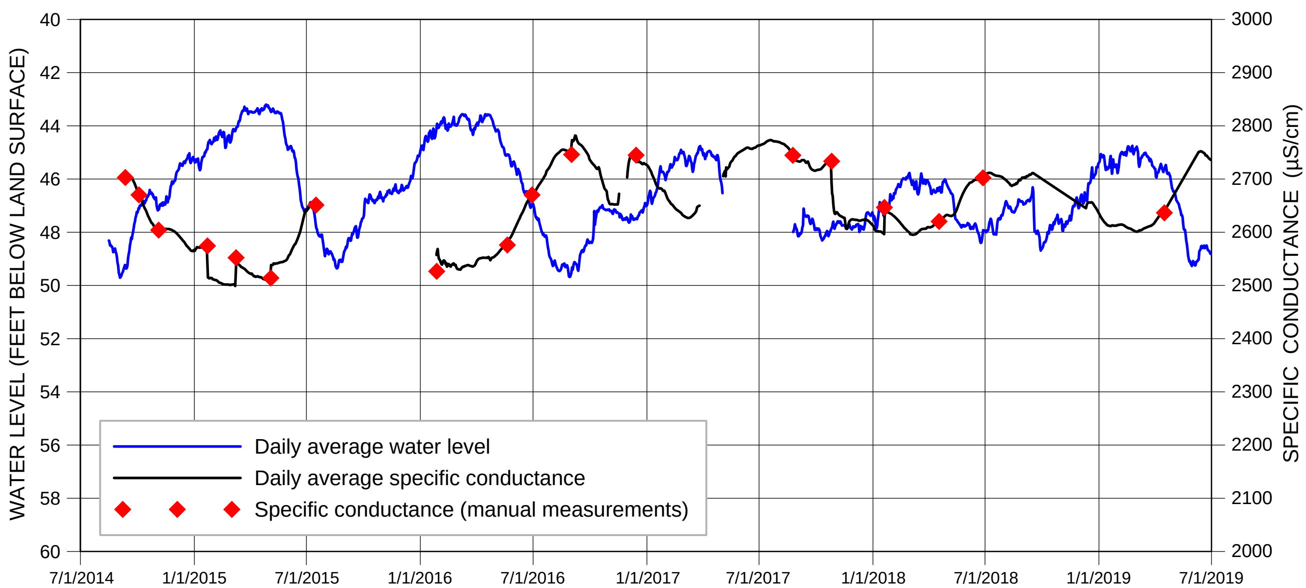

Figure 12. Daily average water level and specific conductance for the Gordon aquifer well CHN-0989 in Charleston County. Manual measurements of specific conductance made during site visits verify the accuracy of the ADR data.

RECENT CHANGES TO THE SCDNR GROUNDWATER MONITORING NETWORK

Overview: July 2014 through June 2019

- A total of 49 wells were added to the SCDNR Groundwater Monitoring Network between July 2014 and June 2019 (see Figure 13 and Table 2).
- Nine wells were outfitted with real-time monitoring equipment and, along with a set of wells from the USGS, will collectively serves as the foundation for a new real-time South Carolina Groundwater Drought Monitoring Network.
- A Saltwater Intrusion Monitoring Network was established along the coast.
- SCDNR became a data provider to the National Ground-Water Monitoring Network (NGWMN) in 2015.
- Five wells were completed as a new well-cluster site in Sumter County near the City of Sumter. Two wells were completed in the McQueen Branch aquifer and three in the Crouch Branch aquifer. Sumter is one of the largest groundwater users in the State.
- Two new wells were constructed in Horry County at Myrtle Beach State Park. One well was screened in the Crouch Branch aquifer and the other in the McQueen Branch aquifer. Both wells monitor water level and conductivity.
- Two shallow wells were drilled at North Inlet Winyah Bay near Hobcaw Barony in Georgetown County for a University of South Carolina graduate student project. The wells, one completed in the Gordon aquifer and one in the surficial aquifer, were added to both the Groundwater Monitoring Network and the Saltwater Intrusion Monitoring Network.
- Twenty-four wells previously monitored by the SCDHEC were added to the SCDNR network. SCDNR installed ADRs in the wells and have taken over monitoring responsibilities. Three wells were added in Aiken County, six in Beaufort County, one in Charleston County, two in Clarendon County, one in Dorchester County, two in Hampton County, two in Jasper County, two in Orangeburg County, two in Richland County, two in Sumter County, and one in Williamsburg County.
- An existing, unused supply well at Oakwood-Windsor Elementary School in Aiken County was added to the network. This well is screened in the Crouch Branch aquifer and provides much needed water-level data in an area of increased crop irrigation and local concern regarding water resources. Water-level data from this well were referenced in the 2017 SCDHEC report, *A Preliminary Assessment of the Groundwater Conditions in Aiken, Allendale, Bamberg, Barnwell, Calhoun, Lexington, and Orangeburg Counties, South Carolina*, (SCDHEC, 2017) to help justify the establishment and development of the state's Western Capacity Use Area.
- A new well was constructed at Oakwood-Windsor Elementary School in Aiken County. This well is screened in the Gordon aquifer.
- Two existing wells located adjacent to large-scale irrigation farming operation near the Town of Windsor (Aiken County) were added to the network. One of these wells is screened in the Gordon aquifer and the other is screened in the Crouch Branch aquifer.
- Twelve wells were drilled as part of a NGWMN grant through a cooperative agreement with the USGS. Two deep wells were drilled, one in Calhoun County completed in the McQueen Branch aquifer, and one in Georgetown County completed in the Crouch Branch aquifer. Ten shallow water-table wells were also drilled: two in Aiken County, one in Colleton County, one in Chesterfield County, one in Florence County, one in Georgetown County, two in Lexington County, one in Marion County, and one in Sumter County.
- The monitoring responsibilities for two wells—AND-0326 in Anderson County and SUM-0355 in Sumter County—were transferred to the USGS, and these wells were removed from the SCDNR network.

Details regarding recent drilling projects, new monitoring networks, and other changes to the groundwater monitoring network that occurred during each fiscal year from July 2014 through June 2019 are provided in the following sections of this report. Well construction diagrams for the 22 newly-drilled wells added to the network can be found in Appendix E.

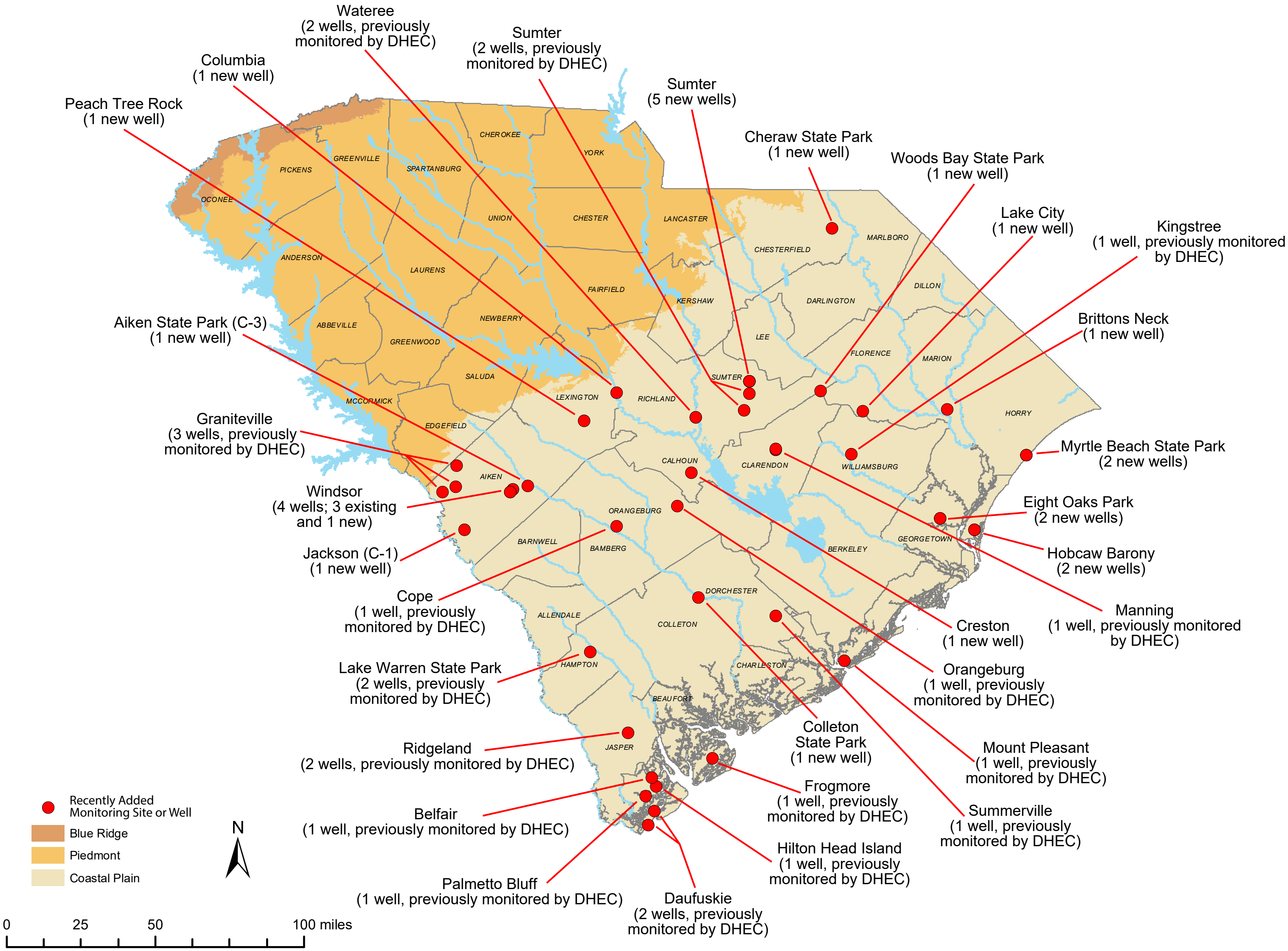

Figure 13. Sites and wells added to the SCDNR Groundwater Monitoring Network from July 2014 through June 2019.

Table 2. Wells added to the SCDNR Groundwater Monitoring Network (July 2014 through June 2019)

County	Well ID	Remarks	Screen Interval (ft)*	Aquifer	Well Location
Aiken	AIK-0344	Former water supply well	338 – 404	Crouch Branch	Montmorenci, 3.5 miles W (Oakwood-Windsor Elementary School)
Aiken	AIK-2449	Formerly monitored by DHEC	289 – 309	McQueen Branch	Graniteville, 3 miles WSW (Jordantown tower test well)
Aiken	AIK-2544	Formerly monitored by DHEC	100 – 130	McQueen Branch	Sage Mill (Sage Mill tower test well)
Aiken	AIK-2711	Formerly monitored by DHEC	220 – 320	McQueen Branch	Clearwater, 1.7 miles NW (Woodridge tower test well)
Aiken	AIK-2731	Former private well	100 – 120	Gordon	Windsor, 3 miles NW (Benhase)
Aiken	AIK-2732	Former private well	unknown	Crouch Branch	Windsor, 3 miles NW (Benhase)
Aiken	AIK-2733	New well	160 – 170	Gordon	Montmorenci, 3.5 miles W (Oakwood-Windsor Elementary School)
Aiken	AIK-2741	New well	60 – 80	Surficial aquifer system	Jackson, 1 mile NW (S.C. Highway 125)
Aiken	AIK-2742	New well	30 – 50	Surficial aquifer system	Windsor, 4 miles NNE (Aiken State Park)
Beaufort	BFT-0563	Formerly monitored by DHEC	78 – 212	Upper Floridan	Frogmore, 2.3 SE (St. Helena Island)
Beaufort	BFT-2245	Formerly monitored by DHEC	152 – 335 oh	Upper Floridan	Daufuskie Island (Haig Point)
Beaufort	BFT-2247	Formerly monitored by DHEC	176 – 263 oh	Upper Floridan	Daufuskie Island (Bloody Point)
Beaufort	BFT-2356	Formerly monitored by DHEC	90 – 206 oh	Upper Floridan	Palmetto Bluff (Old Lodge Road)
Beaufort	BFT-2404	Formerly monitored by DHEC	125 – 261 oh	Upper Floridan	Hilton Head Island (Leg O Mutton Road)
Beaufort	BFT-2408	Formerly monitored by DHEC	125 – 232 oh	Upper Floridan	Belfair (Bamberg Drive)
Calhoun	CAL-0215	New well	689 – 699	McQueen Branch	Creston (EMS/Fire Station)
Charleston	CHN-0163	Formerly monitored by DHEC	1,829 – 1,912	Charleston	Mount Pleasant (Mt. Pleasant Waterworks RO plant #1)
Clarendon	CLA-0016	Formerly monitored by DHEC	565 – 605	McQueen Branch	Manning (Keitt Street)
Clarendon	CLA-0020	Formerly monitored by DHEC	590 – 640	McQueen Branch	Manning (North Boundary Street)
Colleton	COL-0803	New well	14 – 24	Surficial aquifer system	Walterboro, 11.5 miles S (Colleton State Park)
Chesterfield	CTF-0325	New well	20 – 40	Surficial aquifer system	Cheraw, 2.5 miles S (Cheraw State Park)
Dorchester	DOR-0228	Formerly monitored by DHEC	1,658 – 1,824	Charleston	Summerville, 4 miles SW (Well #5)
Florence	FLO-0484	New well	20 – 40	Surficial aquifer system	Lake City (Lake City Airport)
Georgetown	GEO-0386	New well	38 – 40	Surficial aquifer system	Georgetown, 4.2 miles SE (Hobcaw Barony)
Georgetown	GEO-0387	New well	91 – 96	Gordon	Georgetown, 4.2 miles SE (Hobcaw Barony)

Table 2. Wells added to the SCDNR Groundwater Monitoring Network (July 2014 through June 2019) — Continued

County	Well ID	Remarks	Screen Interval (ft)*	Aquifer	Well Location
Georgetown	GEO-0390	New well	620 – 640	Crouch Branch	Georgetown, 5 miles W (8 Oaks Park)
Georgetown	GEO-0391	New well	20 – 40	Surficial aquifer system	Georgetown, 5 miles W (8 Oaks Park)
Hampton	HAM-0314	Formerly monitored by DHEC	88 – 122 oh	Upper Floridan	Hampton, 4 miles NE (Lake Warren State Park)
Hampton	HAM-0315	Formerly monitored by DHEC	200 – 568 oh	Middle Floridan	Hampton, 4 miles NE (Lake Warren State Park)
Horry	HOR-1326	New well	590 – 600	McQueen Branch	Myrtle Beach (Myrtle Beach State Park)
Horry	HOR-1327	New well	430 – 440	Crouch Branch	Myrtle Beach (Myrtle Beach State Park)
Jasper	JAS-0490	Formerly monitored by DHEC	288 – 558 oh	Middle Floridan	Ridgeland (Blue Heron Nature Center)
Jasper	JAS-0491	Formerly monitored by DHEC	144 – 220 oh	Upper Floridan	Ridgeland (Blue Heron Nature Center)
Lexington	LEX-1702	New well	20 – 40	Surficial aquifer system	Lexington, 10 miles S (Peach Tree Rock Heritage Preserve)
Lexington	LEX-1703	New well	22 – 32	Surficial aquifer system	Columbia, 4 miles S (Congaree Creek Heritage Preserve)
Marion	MRN-0178	New well	20 – 40	Surficial aquifer system	Brittons Neck, 3 miles S (former fire tower site)
Orangeburg	ORG-0385	Formerly monitored by DHEC	475 – 535	Crouch Branch	Cope (Cope Power Station)
Orangeburg	ORG-0634	Formerly monitored by DHEC	??? – 228 oh	Middle Floridan	Orangeburg, 8.3 miles (Orangeburg Fire District)
Richland	RIC-0775	Formerly monitored by DHEC	437 – 600	McQueen Branch	Wateree (Wateree Power Station)
Richland	RIC-0776	Formerly monitored by DHEC	95 – 160	Crouch Branch	Wateree (Wateree Power Station)
Sumter	SUM-0146	Formerly monitored by DHEC	394 – 545	McQueen Branch	Sumter (Plant 1, Well 1C)
Sumter	SUM-0153	Formerly monitored by DHEC	533 – 633	McQueen Branch	Sumter (Plant 3, Well 4)
Sumter	SUM-0504	New well	383 – 393	McQueen Branch	Sumter, 5 miles N (Central Carolina Tech Natural Resource Center)
Sumter	SUM-0505	New well	320 – 330	McQueen Branch	Sumter, 5 miles N (Central Carolina Tech Natural Resource Center)
Sumter	SUM-0506	New well	245 – 255	Crouch Branch	Sumter, 5 miles N (Central Carolina Tech Natural Resource Center)
Sumter	SUM-0507	New well	162 – 172	Crouch Branch	Sumter, 5 miles N (Central Carolina Tech Natural Resource Center)
Sumter	SUM-0508	New well	82 – 92	Crouch Branch	Sumter, 5 miles N (Central Carolina Tech Natural Resource Center)
Sumter	SUM-0531	New well	20 – 40	Surficial aquifer system	Olanta, 2.5 miles WNW (Woods Bay State Park)
Williamsburg	WIL-0012	Formerly monitored by DHEC	455 – 520	Crouch Branch	Kingstree (2nd Avenue)

***** oh: *Open-hole interval*

Development of the South Carolina Groundwater Drought Monitoring Network

SCDNR routinely provides hydrologic information to the State Climatology Office for drought assessment purposes. The data are used by the State Drought Response Committee to support drought designations in the state's four Drought Management Areas. To improve SCDNR's ability to monitor drought conditions in a timely manner, real-time (telemetry) groundwater monitoring systems have been installed at sites that meet specific criteria discussed below. Telemetry systems allow for water-level data to be transmitted to the office via a cellular modem on an automated schedule. These nine sites, along with a subset of wells from the USGS groundwater monitoring network, form the foundation of a new South Carolina Groundwater Drought Monitoring Network (Figure 14).

The well ORG-0431 at an existing well-cluster site in Orangeburg County was outfitted with the Solinst 9100 STS Edge telemetry system in October 2014 (Figure 15). This site was established as a pilot site to test the feasibility and performance of the real-time monitoring equipment. The telemetry system was set up with little difficulty and has been operating successfully since installation. Based on the success of this pilot study, eight more systems were installed throughout the SCDNR Groundwater Monitoring Network.

Wells selected for inclusion in the drought-assessment network met the following requirements:

1. The well has a minimum of ten years of data that show the impacts of past droughts.
2. Groundwater levels from the well are not significantly influenced by any local groundwater pumping, current or historic, which might complicate the review of drought conditions.
3. The well is screened in the surficial aquifer or in an unconfined aquifer, or otherwise responds relatively quickly to changing climate conditions.
4. The well is located where reliable cellular phone coverage exists.
5. The well is located in a secure area.

All SCDNR groundwater drought monitoring wells are equipped with the 9100 STS Gold Telemetry System manufactured by Solinst Canada Ltd. (Figure 16). The ADRs currently deployed are the Levelogger Edge and Barologger, also manufactured by Solinst, thereby avoiding potential compatibility issues.

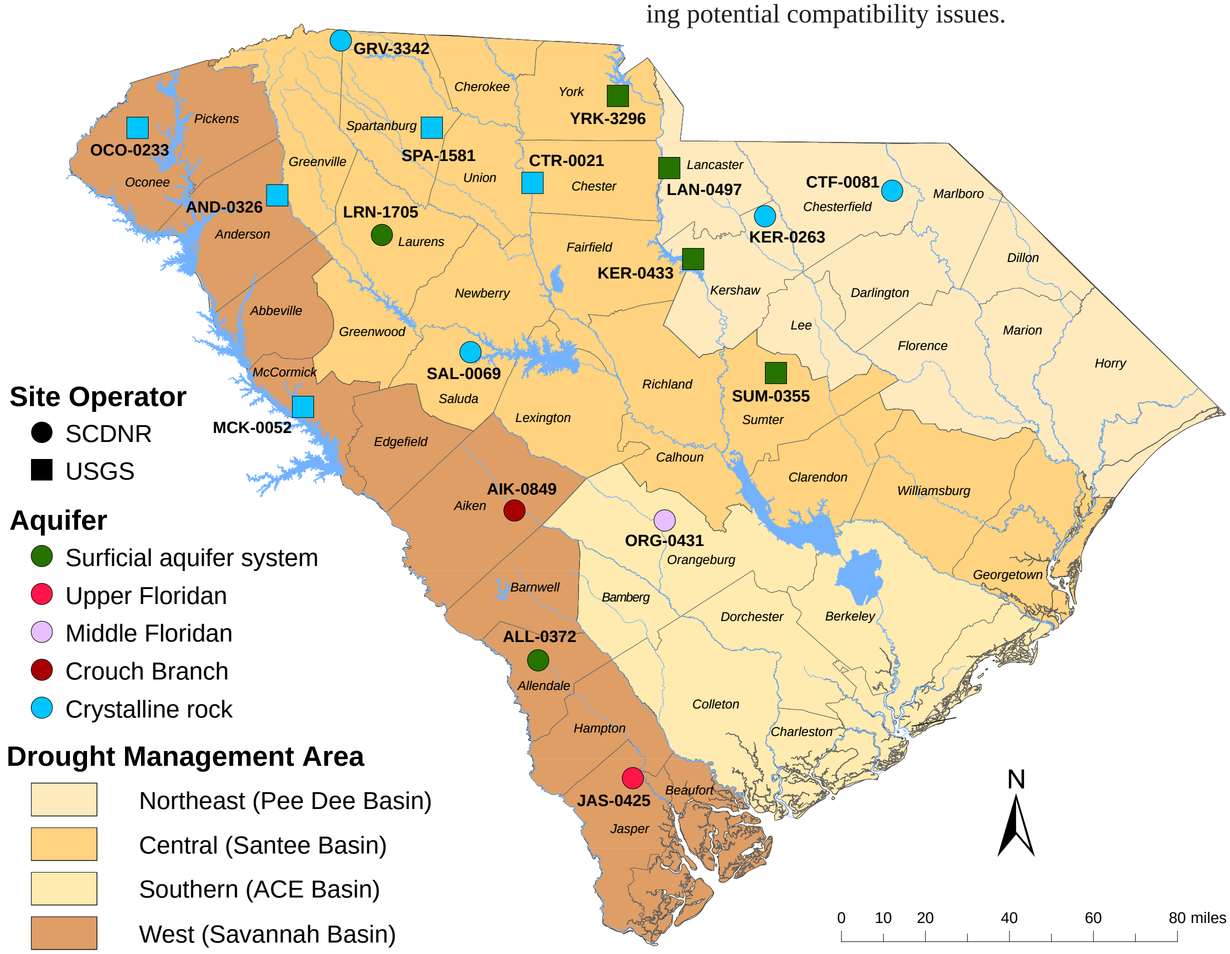

Figure 14. Real-time monitoring wells in the South Carolina Groundwater Drought Monitoring Network.

Figure 15. Real-time data system installation in Orangeburg County (ORG-0431).

Figure 16. 9100 STS Gold Telemetry system manufactured by Solinst Canada Ltd.

Development of a Saltwater Intrusion Monitoring Network

Saltwater intrusion—the inland movement of saltwater through an aquifer—is occurring along the South Carolina coast. Many coastal communities depend on groundwater for domestic, municipal, industrial, or agricultural supply, but prolonged groundwater pumping has lowered aquifer water levels and altered the natural regional groundwater flow, thereby causing a landward migration of the freshwater-saltwater interface. The freshwater-saltwater interface is a transitional zone in an aquifer where freshwater mixes with intruding seawater and is characterized by an increase of total dissolved solids, namely chloride ions. The Environmental Protection Agency considers chloride to be a secondary (non-enforceable) drinking-water contaminant at concentrations equal to or greater than 250 mg/L (milligrams per liter). Because excessive chlorides can cause an aquifer to become unpotable, and because desalinization is a costly water management option, saltwater intrusion is a significant concern along the coast.

Historical water-level and groundwater-chemistry data provided guidance on areas susceptible to saltwater intrusion. This information helped SCDNR select existing wells in the Groundwater Monitoring Network to form the Saltwater Intrusion Monitoring Network, whose wells are monitored for saltwater intrusion. The Saltwater Intrusion Monitoring Network targeted multiple aquifers along the entire coast (Figure 17). Because specific conductance has been well demonstrated to be a good proxy for chloride ion concentration, wells were equipped with continuously recording water-level, temperature, and conductivity sensors. Saltwater Intrusion Monitoring Network wells were purged and sampled during 2016 to test well network suitability, determine major ion chemistry, and to establish a relationship between the continuously recorded specific conductance data and direct measurements of chloride. Periodic purging and sampling on a five-year schedule will confirm the network wells are functioning properly and collecting reliable data. Additional groundwater analyses will create a record of historical data to identify changes in water chemistry or shifts in the landward location of the freshwater-saltwater interface over time.

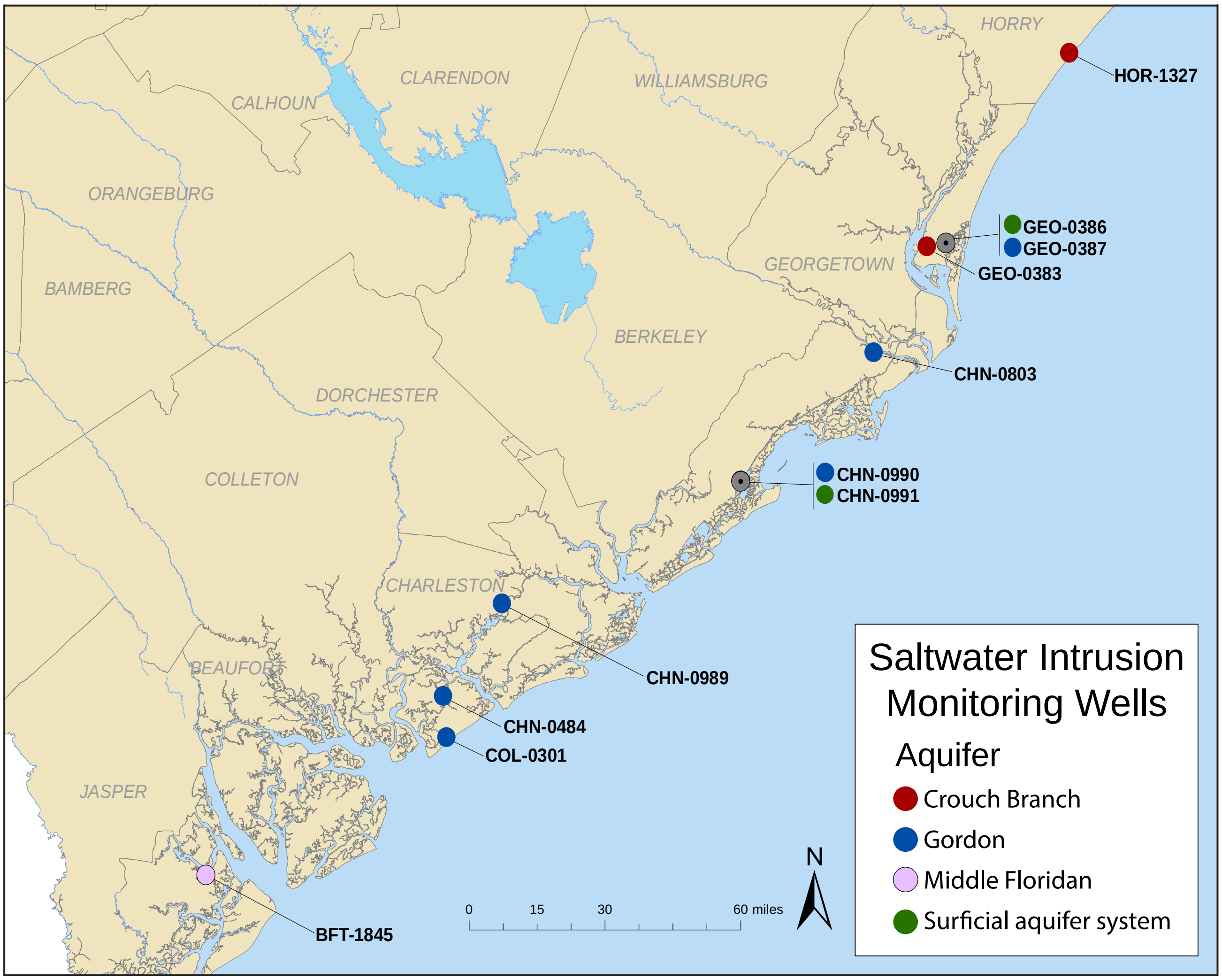

Figure 17. SCDNR Saltwater Intrusion Monitoring Network (June 2019).

July 2014 – June 2015 (FY14–15)

Hobcaw Barony, Georgetown County

In collaboration with the University of South Carolina's Department of Geology, two wells (Figure 18) were completed at Hobcaw Barony, one (GEO-0386) in the surficial aquifer and one (GEO-0387) in the Gordon aquifer. The surficial aquifer well is 39 feet deep and screened between 37–39 feet; the deeper Gordon aquifer well is 95 feet deep and screened from 90–95 feet.

In addition to drilling wells, resistivity surveys were completed in the immediate area to determine the stratigraphy to a depth of 39 feet. The purpose of the project was, in part, to create a conceptual model for coastal groundwater flow, salinity, and groundwater exchange at the nearshore and embayment scales. The wells were instrumented with automatic water-level and conductivity probes to evaluate tidal amplitude and salinity distribution in the confined and unconfined aquifers. Results

Figure 18. New monitoring wells at Hobcaw Barony in Georgetown County. GEO-0387 (left) is screened in the Gordon aquifer (95 feet deep) and GEO-0386 (right) is screened in the surficial aquifer (39 feet deep).

from the field study and subsequent model development identified different groundwater dynamics in unconfined versus confined aquifers and at the near-shore and embayment scales. This study emphasized that susceptibility to saltwater intrusion from sea level rise differs between the two aquifers owing to the presence of the confining layer extending offshore. The methods and results of this study were included in a PhD dissertation (Evans, 2016). At the completion of the study, both wells were added to the Groundwater and Saltwater Intrusion Monitoring Networks.

Myrtle Beach State Park, Horry County

An area of low potentiometric pressure exists near Myrtle Beach, and recent potentiometric maps indicate groundwater levels are declining in eastern Horry County, raising concerns about saltwater intrusion in the coastal aquifers. In September 2015, two wells were completed at Myrtle Beach State Park, one (HOR-1326) in the McQueen Branch aquifer and one (HOR-1327) in the Crouch Branch aquifer (Figure 19). The Crouch Branch aquifer well is 440 feet deep with a screened interval between 430–440 feet. The McQueen Branch aquifer well is 600 feet deep with a screened interval between 590–600 feet. Both wells have water level probes installed, and the Crouch Branch well (HOR-1327) also is equipped with a continuously-recording conductivity and temperature probe and is part of the Saltwater Intrusion Monitoring Network.

Figure 19. New monitoring wells at Myrtle Beach State Park in Horry County. HOR-1326 (left) is screened in the McQueen Branch aquifer (600 feet deep) and HOR-1327 (right) is screened in the Crouch Branch aquifer (440 feet deep). HOR-1327 is also part of the Saltwater Intrusion Monitoring Network.

Installation of ADRs in Existing Network Wells

In June 2015, ADRs were installed in two existing network wells previously measured only manually. These installations were made in wells AIK-2379 (Crouch Branch aquifer) and AIK-2380 (McQueen Branch aquifer), both at the C-1 well cluster site in Aiken County.

SCDHEC Wells

Owing to reduced funding, SCDHEC discontinued its monitoring of 24 unused public supply wells in the Coastal Plain Province. SCDNR agreed to take over the monitoring of the 24 wells, with equipment costs for new pressure transducers covered by SCDHEC. These wells are completed in the most heavily used aquifers of the state (McQueen Branch, Crouch Branch, and Floridan aquifers) and are located in the following counties: Aiken, Beaufort, Charleston, Clarendon, Dorchester, Hampton, Jasper, Orangeburg, Richland, Sumter, and Williamsburg. A list of these wells, along with construction details and aquifer information, is provided in Table 2.

July 2015 – June 2016 (FY15–16)

National Groundwater Monitoring Network

In October 2015, SCDNR entered into a cooperative agreement with the USGS to become a new data provider for the NGWMN. The NGWMN is a compilation of data from selected trend (continuously monitored) and surveillance (periodically monitored) groundwater monitoring wells from Federal, State, and local monitoring networks across the nation. The NGWMN data portal provides access to these data from multiple, dispersed databases in a web-based mapping application. The portal contains current and historical water level, water quality, lithology, and well construction data.

The initial award in the amount of $51,613 was for a one-year period to identify and classify wells in South Carolina that could be integrated into the NGWMN and to establish web services to provide the data to the NGWMN web portal. A total 438 wells—the majority of which are not dedicated monitoring wells, but whose water levels are occasionally measured by SCDNR—were integrated into the NGWMN. Basic information was provided for these wells, such as location, depth, aquifer, water-level data and water-level characteristics. A report describing the NGWMN program and SCDNR data added to the national network was completed and is available upon request.

Oakwood-Windsor Elementary School, Aiken County

The recent increase in large-scale irrigation operations surrounding the Town of Windsor in southeastern Aiken County has caused concern among local citizens about potential impacts to groundwater supplies in the area. Oakwood-Windsor Elementary School, near the

Town of Windsor, gave approval for SCDNR to monitor a deep, unused well (AIK-0344) drilled on the property in 1991 (Figure 20). The well is 404 ft deep and screened from 338–404 ft in the Crouch Branch aquifer. An ADR was installed in the well in March 2016. Because the monitoring well is located within a mile of several center pivots, it should indicate what impacts the nearby irrigation wells are having on the aquifer

Figure 20. Unused supply well AIK-0344 at Oakwood-Windsor Elementary School in Aiken County. The well is 404 feet deep well and is screened in the Crouch Branch aquifer.

July 2016 – June 2017 (FY16–17)

National Groundwater Monitoring Network

A second cooperative agreement under the USGS's NGWMN program was established in October 2016. The second grant, in the amount of $43,930, was used to fill data gaps for the 438 selected wells identified in the previous NGWMN grant (FY15–16). Tasks included digitizing paper lithology records and adding lithology data, well-construction information and historical water-level measurements to the NGWMN database.

Tidal correction factors were determined for 26 surveillance wells. Water levels in wells near tidal water bodies fluctuate in response to the compression and expansion of the aquifer owing to the changing weight of the incoming and outgoing tide. Tidal corrections were developed by calculating a tidal lag time and a tidal efficiency for each well, allowing for the correction of static water-level measurements collected during different times of the tide cycle to approximate a midpoint water-level between the high and low tide.

Williamston Site, Anderson County

In September 2016, the ADR was removed from the well AND-0326 in the Town of Williamston in Anderson County. Monitoring responsibilities for this well were transferred to the USGS, and the well was added to their real-time groundwater data network and removed from the SCDNR network.

Benhase Property Site, Aiken County

Recent increases in groundwater use for crop irrigation in Aiken County has some citizen groups concerned that the increased pumping may be affecting water levels in aquifers used for domestic supplies. Two unused domestic wells (AIK-2731 and AIK-2732), located on the same property, were offered to the SCDNR for groundwater-level monitoring purposes. The shallower of the two wells is 126 ft deep and screened in the Gordon aquifer from 100–120 ft. The deeper of the two is 394 ft deep and screened in the Crouch Branch aquifer, although with an unknown screen interval. Caliper logs and gamma logs were collected for each well by SCDNR, and ADRs were installed in October 2016.

Oakwood-Windsor Elementary School, Aiken County

SCDNR added a shallower monitoring well (AIK-2733) at the Oakwood-Windsor Elementary School site in Aiken County, where the Crouch Branch aquifer well AIK-0344 had been monitored since March 2016. In April 2017, Dixie Well & Pump was contracted to drill a 170 ft monitoring well (Figure 21), screened in the Gordon aquifer from 160–170 ft. Gamma logs were collected for the well by SCDNR, and an ADR was installed in April 2017.

Figure 21. New monitoring well AIK-2733 at Oakwood-Windsor Elementary School in Aiken County. The well is screened in the Gordon aquifer (170 ft deep).

Central Carolina Technical College, Sumter County

One objective of the SCDNR groundwater monitoring program is to establish monitoring wells in areas where increased groundwater usage may be having an adverse effect on the resource. Monitoring wells will be used to assess changes in groundwater storage and to evaluate the long-term impacts that droughts and groundwater pumping have on the State's water resources.

In early 2017, SCDNR established a long-term groundwater monitoring well cluster site at the Central Carolina Technical College Natural Resources Center in Sumter County. The location was selected based on its proximity to a core hole previously drilled at the Sumter Municipal Airport and its availability for long-term access. SCDNR, in partnership with SCDHEC, developed a proposal for drilling five monitoring wells to be completed in different aquifers or in different zones of the same aquifer.

AAA Well Drilling, Inc. of Lexington County was awarded the contract to drill the five new wells (Figures 22 and 23). Three wells (SUM-0506, SUM-0507, and SUM-0508) are screened in the Crouch Branch aquifer and two (SUM-0504 and SUM-0505) in the McQueen Branch aquifer. The wells were drilled to depths of 92, 172, 255, 330, and 393 ft. ADRs were installed in February 2017 (Figure 24).

Figure 22. Installation of the 2" PVC well casings at the Sumter cluster site.

Figure 23. The five monitoring wells that make up the Sumter cluster site at the Central Carolina Technical College Natural Resources Center.

July 2017 – June 2018 (FY17–18)

Ebenezer Elementary School, Sumter County

In July 2017, the ADR was removed from the well SUM-0355 near the Town of Dalzell of Sumter County. Monitoring responsibilities for this well were transferred to the USGS, and the well was added to their real-time groundwater data network and removed from the SCDNR network.

July 2018 – June 2019 (FY18–19)

National Groundwater Monitoring Network

A third cooperative agreement with the USGS NGWMN program was established in October 2018. SCDNR was awarded $107,780 to construct monitoring wells in the water-table aquifer and to construct several deep wells in areas where increased groundwater use may be negatively affecting aquifers. All the projects described for this fiscal year were funded under this agreement.

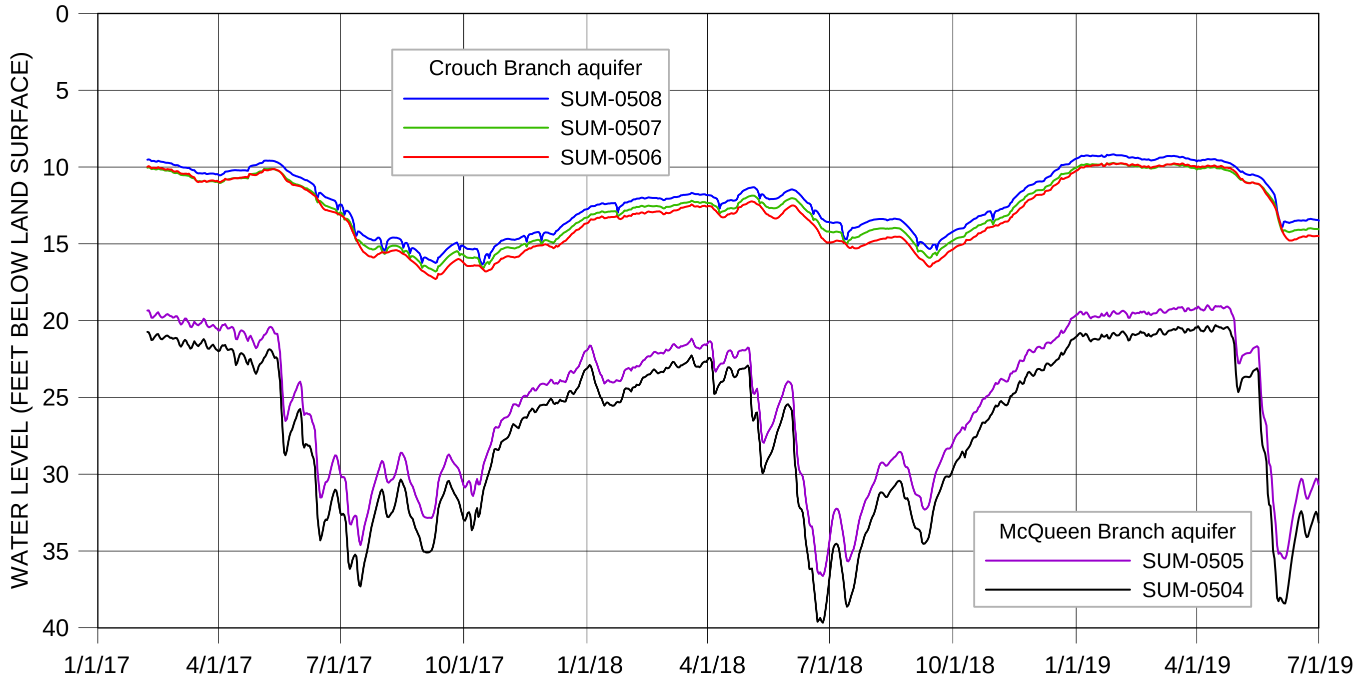

Figure 24. Daily average water levels measured in the five network wells at the Sumter cluster site in Sumter County. The seasonal water level declines observed during the summer each year are the result of local groundwater pumping for agricultural irrigation.

8 Oaks Park, Georgetown County

The Crouch Branch is a major aquifer, occurring throughout most of the Coastal Plain, and used as a source of water for municipal, agricultural, and industrial users across much of South Carolina. A regional cone of depression in the Crouch Branch aquifer in Georgetown County (Figure 25) has been identified and monitored primarily with data obtained every three years from water-level measurements made in public supply and industrial wells in the area. Data collected for the construction of potentiometric surface maps indicate water levels near the cone of depression are declining at a rate of approximately 2 feet per year. Because access to production wells can be unreliable, the addition of a dedicated monitoring well allows for continuous monitoring to better understand the ongoing water-level decline, as well as seasonal water-level variations within the aquifer.

A 4-inch well (GEO-0390) was constructed by AAA Well Drilling, Inc. in November 2018 to a total depth of 640 feet with a screened interval of 620–640 ft, open to the Crouch Branch aquifer (Figure 26). Prior to setting the casing, geophysical logs were obtained from the borehole. An ADR was installed in February 2019.

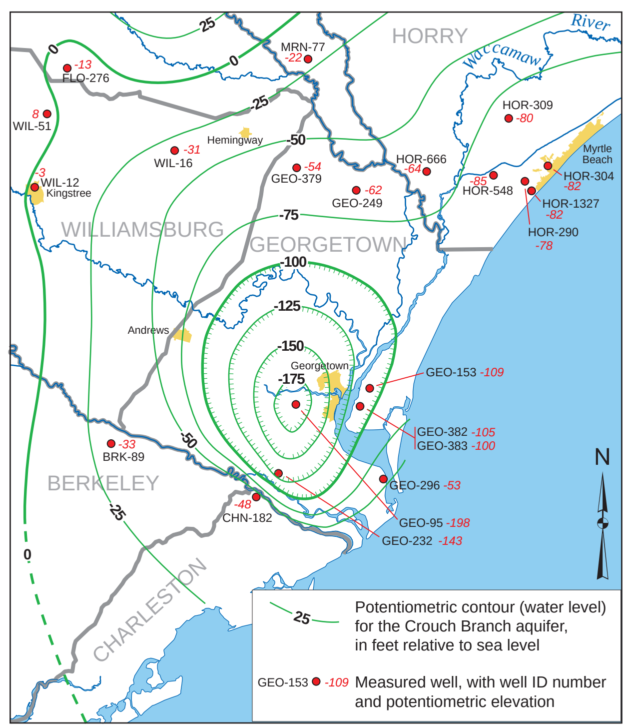

Figure 25. Potentiometric map showing regional cone of depression in the Crouch Branch aquifer in Georgetown County in 2016.

Figure 26. Two new monitoring wells at 8 Oaks Park in Georgetown County. GEO-0390 (right) is a 4-inch well, 640 feet deep and screened in the Crouch Branch aquifer. GEO-0391 (left) is one of the 10 monitoring wells drilled in late 2018 and early 2019 to monitor the surficial aquifer system throughout the Coastal Plain.

Creston Site, Calhoun County

Increasing groundwater use for crop irrigation in Calhoun County has raised concern that the increase may be affecting water levels in aquifers used for domestic supplies. Reported irrigation use increased from 1,559 MG (million gallons) in 2001 to 3,298 MG in 2012, and the number of registered irrigation wells increased from 25 to 71 during this same period, and in 2018, 164 irrigation wells reported a total use of 5,349 MG. In 2013, SCDNR, in collaboration with the USGS, drilled a core hole to 1,058 ft in the Town of Creston in south-central Calhoun County to better understand the hydrogeology of the area and the impact of groundwater withdrawals on local aquifers. Four aquifers were delineated at the site and are, in descending order: 1) the surficial aquifer; 2) Gordon aquifer; 3) Crouch Branch aquifer; and 4) McQueen Branch aquifer. In 2014, monitoring wells were completed at the site in the surficial, Gordon, and Crouch Branch aquifers and were equipped with automated water level recorders. These wells are included in the NGWMN.

Owing to a lack of funding, and because most of the irrigation water used in the county is pumped from the Crouch Branch aquifer, a monitoring well in the McQueen Branch aquifer was not constructed in 2014. Funding from the NGWMN grant allowed for the construction of a McQueen Branch monitoring well at the Creston site in early 2019.

A 4-inch well (CAL-0215) was completed by AAA Well Drilling, Inc. in January 2019 to a total depth of 699 ft and screened from 689–699 ft (Figures 27 and 28). A suite of geophysical logs was obtained from the borehole prior to setting the casing, and an ADR was installed in February 2019.

Figure 27. Drilling the new deep well (CAL-0215) at the Creston cluster site.

Figure 28. The new monitoring well CAL-0215, screened in the McQueen Branch aquifer, at the Creston cluster site. In the background are the four monitoring wells installed in 2014.

Surficial Aquifer Monitoring

The surficial aquifer system is the primary source of water for recharge of deeper aquifers, and it can be a significant source of stream baseflow. Changing climatic conditions (regarding the frequency and severity of drought, for example) coupled with land use changes, such as urbanization or the conversion from forest to agriculture, could impact hydrologic conditions in the surficial aquifer system. A network of shallow, water-table wells located throughout the Coastal Plain can provide valuable information about conditions in the surficial aquifer and how those conditions change over time.

A network of 10 shallow monitoring wells were drilled and instrumented in the following counties: Aiken, Colleton, Chesterfield, Florence, Georgetown, Lexington, Marion, and Sumter (Figures 29 and 30). Wells range in depth from 32 to 80 ft with screens set in the lowermost 10 to 20 ft of the wells. Data from these wells will be used to monitor the impacts of climate variability and land use change on water levels in the surficial aquifer. Many of these wells are expected to be added to the Groundwater Drought Monitoring Network once enough data (10 years) become available.

Figure 29. Collecting a gamma-ray log through the 2-inch PVC casing of the new shallow well LEX-1703 at the Congaree Creek Heritage Preserve in Lexington County.

Figure 30. The South Carolina Geological Survey assisted in drilling a water-table well (COL-0803) at Colleton State Park in Colleton County.

GOALS OF THE SCDNR GROUNDWATER MONITORING PROGRAM

The overall goal of the SCDNR groundwater monitoring program is to collect accurate, reliable information about the condition of South Carolina's groundwater resources and to communicate that information effectively with the public. Maintenance of the groundwater monitoring network is dependent upon adequate recurring funding, and expansion of the network can only occur when additional funding becomes available.

Expand the Groundwater Monitoring Network

A long-term goal of the program is to have an adequate number of wells in the network to generate accurate, statewide potentiometric maps of each aquifer. Because there are currently not enough wells in the existing network, the development of potentiometric maps is dependent upon water-level data collected from wells owned by outside entities, such as municipalities, industries, and private citizens. These additional wells are not always available to be measured and can be permanently lost to abandonment over time. Currently, about 100 wells are used to make each potentiometric map for the McQueen Branch/Charleston, Crouch Branch, Floridan, and Gordon aquifers. It is expected to take many years to accomplish this goal. A shorter-term goal would be to increase the number of Charleston and Gramling aquifer monitoring wells.

Another shorter-term goal is to establish at least one complete well-cluster site in each of the 28 Coastal Plain counties (Table 3; Figure 31). A complete cluster site is one that has a core to bedrock, and nearby wells screened in each of the major aquifers. A partial cluster site is one that has a core but does not have wells completed in each aquifer, or a site that has several wells but no corehole. Several counties—Clarendon, Hampton, Kershaw, Marlboro, and Williamsburg—have neither a corehole nor any site containing several wells completed in different aquifers.

Perform Well Maintenance and Rehabilitation

Another short-term goal is to assess the structural integrity of each network well and perform appropriate repairs or replacements of protective well-head covers to provide adequate protection of the aquifers. Over time, well enclosures endure a lot of exterior forces and begin to deteriorate. Damaged or under-protected wellheads can lead to contamination of an aquifer due to the chance of accidental or intentional debris falling or being thrown into the well. Wells that can no longer be locked are at a greater risk for theft or vandalism.

To ensure that wells are connected to the aquifer and are collecting accurate data, wells need to be periodically purged to ensure that the well screens are clear, and that hydraulic connectivity exists between the well and aquifer. Wells that show little to no seasonal fluctuation and generally have a consistent downward trend will be targeted first. The goal is for each network well to be pumped every five years to maintain the connection to the aquifer.

Expand the Groundwater Drought Monitoring Network

Another long-term goal is to add real-time monitoring sites to the Groundwater Drought Monitoring Network. The current network has notable real-time data gaps in the central and Coastal Plain regions of the state. There are currently too few surficial wells or wells with an appropriate drought response having enough data for inclusion in the network. As funding becomes available, real-time monitoring equipment will be added to wells that are located in areas of coverage gaps and are suitable for inclusion in the Groundwater Drought Monitoring Network. In addition, the ten surficial wells added to the Groundwater Monitoring Network in FY18–19 are expected to meet Drought Monitoring Network requirements by 2029, and long-term plans include equipping these sites with real-time equipment. Sites likely to be added to the Groundwater Drought Monitoring Network are shown in Figure 32.

Improve the Saltwater Intrusion Monitoring Network

Finally, a near- and long-term goal is to improve the Saltwater Intrusion Monitoring Network. This goal includes adding new wells and maintaining those in the existing network. Spatial data gaps in the current network should be filled. Currently, all wells are sited east of SC Highway 17; a second tier of monitoring wells inland from Highway 17 will provide additional information as the freshwater-saltwater interface moves landward. Wells should be purged and sampled periodically to look for changes in major ion chemistry and to confirm well screens are clear. Periodic repeated sampling for chloride will improve the linear regression developed to relate in-situ specific conductance and chloride concentration.

Table 3. Coreholes and cluster sites in the SCDNR Groundwater Monitoring Network (June 2019)

County	Site name	Corehole ID	Location	Number of wells	Complete (C) or Incomplete (I) cluster site	Depth of core (ft)	Cored to bedrock?
Aiken	C-1	AIK-0902	Jackson, 1 mile NW (S.C. Highway 125)	5	C	574	Yes
	C-2	AIK-0817	New Ellenton, 4 miles WSW (County Road 146)	5	C	561	Yes
	C-3	AIK-0826	Windsor, 4 miles NNE (Aiken State Park)	7	C	540	Yes
Allendale	C-7	ALL-0358	Millet, 3 miles NE (County Road 24)	9	C	1,416	Yes
	C-10	ALL-0348	Allendale, 3.5 miles W (County Road 52)	9	C	1,734	Yes
Bamberg	River's Bridge State Park	BAM-0068	Ehrhardt, 5.7 miles SW (River's Bridge State Park)	0	I	415	No
Barnwell	C-5	BRN-0358	Williston, 3.5 miles S	7	C	1,084	Yes
	C-6	BRN-0349	Barnwell, 4 miles SE (S.C. Highway 300)	8	C	1,385	Yes
Beaufort	Hilton Head	BFT-2055	Hilton Head Island (near Singleton Beach)	1	I	3,833*	Yes
Berkeley	St. Stephen	BRK-0644	St. Stephen (St. Stephen Middle School)	1	I	1,826	Yes
Calhoun	Creston	CAL-0190	Creston (EMS/Fire Station)	5	C	1,058	Yes
Charleston	Cannon Park	CHN-0800	Charleston (downtown at Cannon Park)	0	I	1,012	No
	Garris Landing	CHN-0802	Awendaw, 7.1 miles SSW (public boat landing)	2	I	369	No
	Santee Coastal Reserve	CHN-0803 CHN-0820	McClellanville, 7 miles NE (Santee Coastal Reserve)	1	I	1,539	No
Chesterfield	McBee WMA	CTF-0321	McBee, 3.2 miles SSW (McBee Wildlife Management Area)	2	I	400	Yes
	Cheraw State Park	CTF-0081	Cheraw, 2.5 miles S (Cheraw State Park)	2	I	245	Yes
Clarendon	— — —						
Colleton	Edisto Beach	COL-0364	Edisto Beach (Edisto Beach State Park)	1	I	977	No
Darlington	Lake Darpo	DAR-0228	Society Hill, 3 miles SSW (Lake Darpo)	1	I	447	Yes
Dillon	Little Pee Dee State Park	DIL-0121	Dillon, 6.5 miles SE (Little Pee Dee State Park)	6	C	647	Yes
Dorchester	St. George #1	DOR-0211	St. George, 3.0 miles SE (U.S. Highway 78)	0	I	2,063	Yes
	Clubhouse Crossroads #1	DOR-0037	Cottageville, 7.8 miles SE (County Road 163)	0	I	2,599	Yes
Florence	Florence	FLO-0268	Florence (downtown)	0	I	716	Yes
	Lake City	FLO-0274	Lake City (Lake City Airport)	3	I	1,090	Yes
Georgetown	Hobcaw Barony	GEO-0380	Georgetown, 4.2 miles SE (Hobcaw Barony)	3	I	830	No
Hampton	— — —						

* Side-wall cores approximately every 10 ft.

Table 3. Coreholes and cluster sites in the SCDNR Groundwater Monitoring Network (June 2019) — Continued

County	Site name	Corehole ID	Location	Number of wells	Complete (C) or Incomplete (I) cluster site	Depth of core (ft)	Cored to bedrock?
Horry	Myrtle Beach	HOR-0973	Myrtle Beach (surface water treatment plant)	2	I	1,427	Yes
Jasper	C-15	JAS-0426	Ridgeland, 9 miles NNW (U.S. Highway 278)	4	I	2,900*	Yes
Kershaw	— — —						
Lee	Lee State Park	LEE-0075	Bishopville, 3.5 miles ESE (Lee State Park)	4	C	554	Yes
Lexington	Swansea	LEX-0844	Swansea (Swansea High School Freshman Academy)	1	I	548	Yes
Marion	Brittons Neck	MRN-0078	Brittons Neck, 3 miles S (former fire tower site)	3	I	1,230	Yes
Marlboro	— — —						
Orangeburg	Clark Middle School	ORG-0393	Orangeburg (Clark Middle School)	3	I	1,138	Yes
Richland	Eastover	RIC-0543	Eastover (Webber Elementary School)	1	I	557	Yes
	Horrell Hill	RIC-0585	Columbia, 6 miles ESE (Horrell Hill Elementary School)	1	I	469	Yes
Sumter	MAN-1	SUM-0296	Rimini, 3.4 miles NW (Manchester State Forest)	0	I	725	No
	Airport	SUM-0340	Sumter, 5.0 miles NNW (Sumter Airport)	5	C	690	Yes
Williamsburg	— — —						

* Side-wall cores approximately every 10 ft.

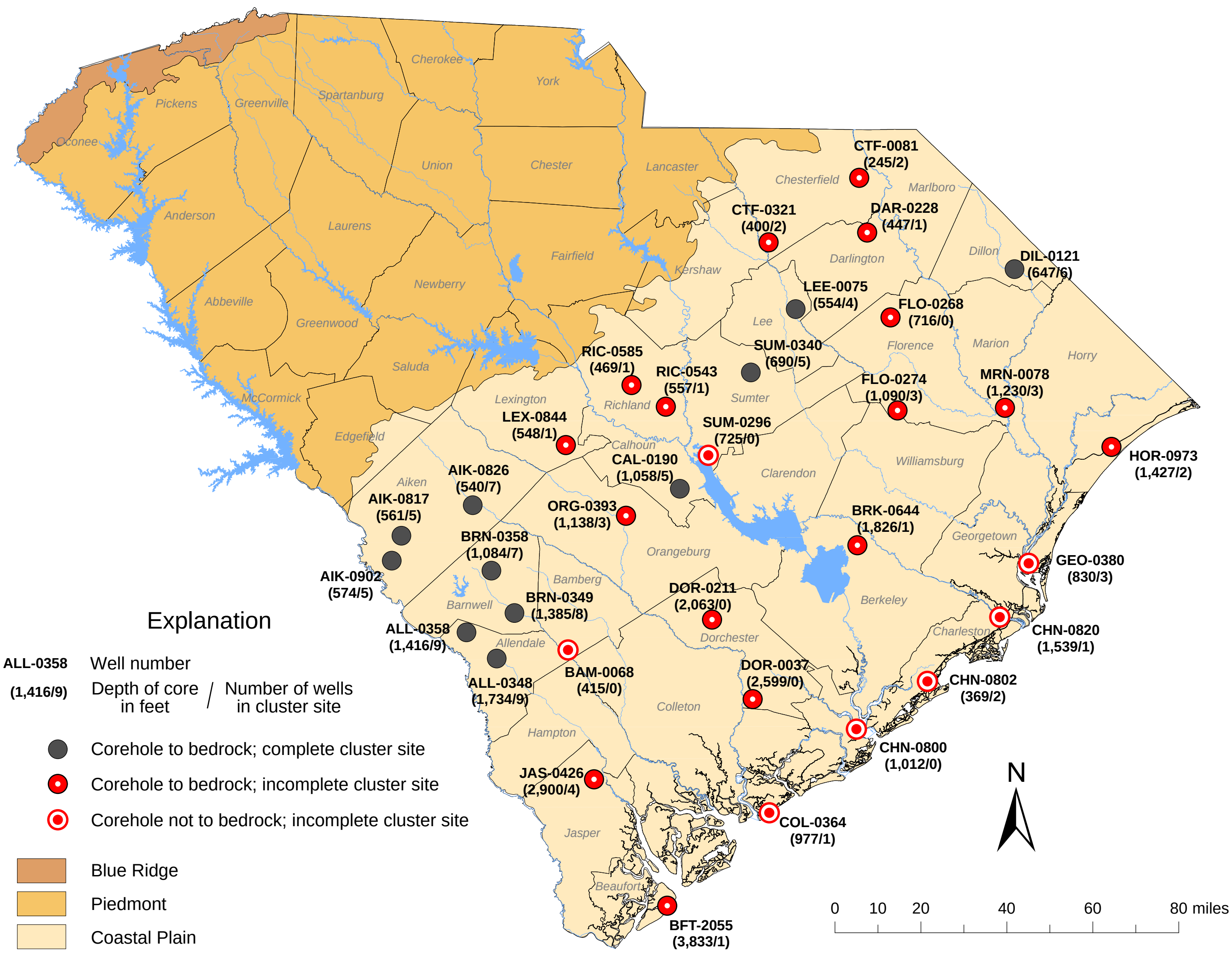

Figure 31. Locations of coreholes and complete and incomplete monitoring well cluster sites in the SCDNR Ground-water Monitoring Network.

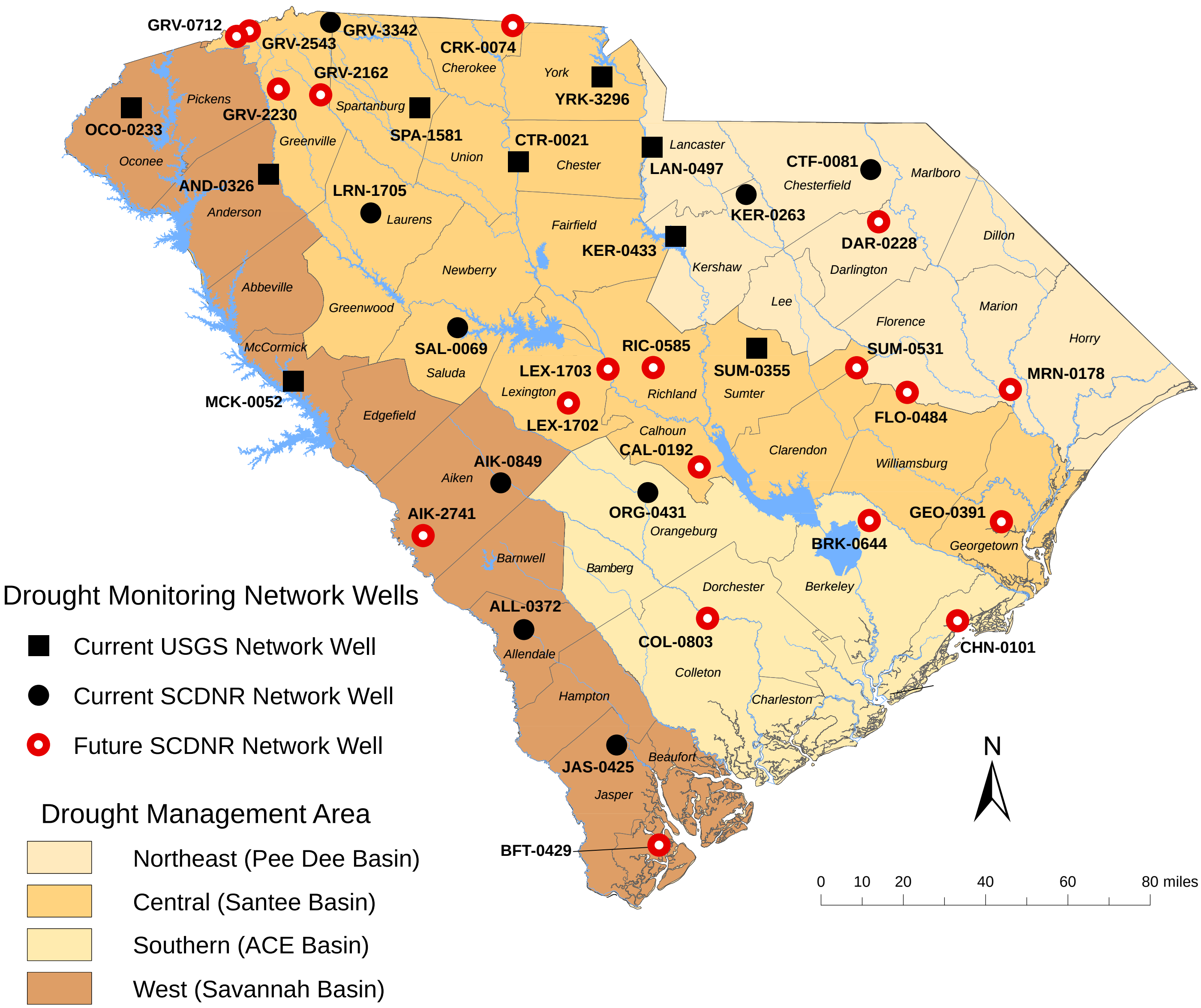

Figure 32. Locations of wells currently in the Groundwater Drought Monitoring Network and other wells likely to be added to the Groundwater Drought Monitoring Network within the next 10 years.

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APPENDIX A

SCDNR Groundwater Monitoring Network Wells

Table A1. SCDNR Groundwater Monitoring Network wells (as of June 2019)

Well ID	Measuring Point Description	Measuring Point Height (ft)	Latitude Longitude	Land Surface Elevation (ft)	Elevation Method	Well Depth (ft)	Screen or Open-Hole Interval (ft)*	Aquifer[1]	Aquifer[2]
AIK-0344	Top of PVC cap	1.95	33.51682 -81.57557	423	LIDAR	404	338 – 404	Black Creek	Crouch Branch
AIK-0817	Top of sanitary seal	2.94	33.43785 -81.77037	418.2	Survey	535	520 – 530	Middendorf	McQueen Branch
AIK-0818	Top of sanitary seal	3.06	33.43783 -81.77026	417.5	Survey	425	410 – 420	Middendorf	McQueen Branch
AIK-0824	Top of sanitary seal	2.60	33.43779 -81.77036	417.8	Survey	365	350 – 360	Black Creek	Crouch Branch
AIK-0826	Top of sanitary seal	2.10	33.54241 -81.48574	294.0	Survey	500	485 – 495	Middendorf	McQueen Branch
AIK-0845	Top of sanitary seal	2.88	33.54252 -81.48568	296.0	Survey	356	341 – 351	Middendorf	McQueen Branch
AIK-0846	Top of sanitary seal	3.02	33.54234 -81.48559	296.9	Survey	255	240 – 250	Black Creek	Crouch Branch
AIK-0847	Top of sanitary seal	2.79	33.54246 -81.48554	298.1	Survey	193	178 – 188	Black Creek	Crouch Branch
AIK-0848	Top of sanitary seal	3.05	33.54230 -81.48541	298.8	Survey	131	116 – 126	Black Creek	Crouch Branch
AIK-0849	Top of sanitary seal	3.05	33.54238 -81.48540	300.7	Survey	97	82 – 92	Black Creek	Crouch Branch
AIK-0902	Top of sanitary seal	2.70	33.35352 -81.80880	231.1	Survey	511	496 – 506	Middendorf	McQueen Branch
AIK-2378	Top of sanitary seal	1.54	33.35329 -81.80902	219.4	Survey	185	170 – 180	Black Creek	Crouch Branch
AIK-2379	Top of sanitary seal	1.88	33.35339 -81.80895	222.9	Survey	266	251 – 261	Black Creek	Crouch Branch
AIK-2380	Top of sanitary seal	2.29	33.35343 -81.80890	227.4	Survey	385	370 – 380	Middendorf	McQueen Branch
AIK-2449	Top of sanitary seal	3.25	33.53938 -81.85513	492	LIDAR	340	289 – 309	Middendorf	McQueen Branch
AIK-2544	Top of sanitary seal	3.14	33.62523 -81.84996	492	LIDAR	142	100 – 130	Middendorf	McQueen Branch
AIK-2711	Top of sanitary seal	2.05	33.51377 -81.92097	427	LIDAR	239	220 – 239	Middendorf	McQueen Branch

Table A1. SCDNR Groundwater Monitoring Network wells (as of June 2019) — Continued

Well ID	Measuring Point Description	Measuring Point Height (ft)	Latitude Longitude	Land Surface Elevation (ft)	Elevation Method	Well Depth (ft)	Screen or Open-Hole Interval (ft)*	Aquifer[1]	Aquifer[2]
AIK-2731	Top of sanitary seal	1.55	33.52662 -81.56168	401	LIDAR	120	100 – 120	Tertiary sand	Gordon
AIK-2732	Top of sanitary seal	2.92	33.52653 -81.56170	401	LIDAR	400	unknown	Black Creek	Crouch Branch
AIK-2733	Top of sanitary seal	3.15	33.51682 -81.57557	423	LIDAR	170	160 – 170	Tertiary sand	Gordon
AIK-2741	Top of sanitary seal	4.00	33.35350 -81.80884	221	LIDAR	80	60 – 80	Shallow aquifer	Surficial aquifer system
AIK-2742	Top of sanitary seal	2.79	33.54233 -81.48542	231	LIDAR	50	30 – 50	Shallow aquifer	Surficial aquifer system
ALL-0347	Top of sanitary seal	2.25	33.02473 -81.38425	280.8	Survey	1,423	1,408 – 1,418	Middendorf	McQueen Branch
ALL-0348	Top of sanitary seal	2.80	33.02499 -81.38475	279.6	Survey	1,605	1,575 – 1,600	Cape Fear	Gramling confining unit
ALL-0358	Top of sanitary seal	2.27	33.11328 -81.50613	242.2	Survey	1,123	1,108 – 1,118	Middendorf	McQueen Branch
ALL-0363	Top of sanitary seal	2.96	33.11376 -81.50619	245.2	Survey	105	90 – 100	Floridan	Upper Floridan
ALL-0364	Top of sanitary seal	2.82	33.11363 -81.50615	244.3	Survey	225	210 – 220	Floridan	Middle Floridan
ALL-0365	Top of sanitary seal	3.19	33.11354 -81.50614	243.4	Survey	333	318 – 328	Tertiary sand	Gordon
ALL-0366	Top of sanitary seal	2.76	33.11339 -81.50615	242.6	Survey	400	385 – 395	Tertiary sand	Gordon
ALL-0367	Top of sanitary seal	3.04	33.11342 -81.50597	244.9	Survey	566	551 – 561	Black Creek	Crouch Branch
ALL-0368	Top of sanitary seal	2.98	33.11353 -81.50601	245.7	Survey	691	676 – 686	Black Creek	Crouch Branch
ALL-0369	Top of sanitary seal	2.82	33.11316 -81.50609	241.2	Survey	800	785 – 795	Black Creek	Crouch Branch
ALL-0370	Top of sanitary seal	2.72	33.11330 -81.50596	244.2	Survey	975	960 – 970	Middendorf	McQueen Branch
ALL-0371	Top of sanitary seal	3.00	33.02484 -81.38469	281.4	Survey	217	192 – 212	Floridan	Upper Floridan

Table A1. SCDNR Groundwater Monitoring Network wells (as of June 2019) — Continued

Well ID	Measuring Point Description	Measuring Point Height (ft)	Latitude Longitude	Land Surface Elevation (ft)	Elevation Method	Well Depth (ft)	Screen or Open-Hole Interval (ft)*	Aquifer[1]	Aquifer[2]
ALL-0372	Top of sanitary seal	2.96	33.02482 -81.38456	281.2	Survey	155	140 – 150	Floridan	Surficial aquifer system
ALL-0373	Top of sanitary seal	2.74	33.02485 -81.38425	278.8	Survey	372	327 – 367	Floridan	Middle Floridan
ALL-0375	Top of sanitary seal	3.46	33.02490 -81.38493	282.0	Survey	583	453 – 578	Tertiary sand	Gordon
ALL-0376	Top of sanitary seal	3.33	33.02488 -81.38481	281.4	Survey	994	784 – 989	Black Creek	Crouch Branch
ALL-0377	Top of sanitary seal	3.52	33.02477 -81.38439	280.7	Survey	1,199	1,174 – 1,194	Middendorf	McQueen Branch
ALL-0378	Top of outer metal enclosure	4.75	33.06203 -81.56419	75	LIDAR	1,060	845 – 1,055	Middendorf	McQueen Branch
BFT-0101	Bottom surface of instrument housing	3.39	32.16878 -80.74064	13.4	Survey	442	129 – 442	Floridan	Upper Floridan
BFT-0429	Top of polyboard support platform	1.85	32.26406 -80.81964	20.6	Survey	300	119 – 300 oh	Floridan	Upper Floridan
BFT-0563	Top of PVC insert	1.45	32.37491 -80.54688	19	LIDAR	212	78 – 212	Floridan	Upper Floridan
BFT-1809	Bottom surface of instrument housing	1.20	32.26714 -80.72277	10.8	Survey	890	227 – 890 oh	Floridan	Middle Floridan
BFT-1813	Top of casing	0.60	32.23310 -80.67702	10.5	Survey	600	276 – 600 oh	Floridan	Middle Floridan
BFT-1814	Top of sanitary seal	0.72	32.23313 -80.67703	11	LIDAR	210	120 – 210	Floridan	Upper Floridan
BFT-1820	Top of PVC insert	0.82	32.20396 -80.74958	8.9	Survey	600	316 – 600 oh	Floridan	Middle Floridan
BFT-1822	Top of PVC insert	0.61	32.20394 -80.74942	8.7	Survey	260	091 – 260 oh	Floridan	Upper Floridan
BFT-1845	Top of PVC insert	2.86	32.28043 -80.82156	11.3	Survey	600	255 – 600	Floridan	Middle Floridan
BFT-1846	Top of PVC insert	3.10	32.28050 -80.82153	11.3	Survey	180	85 – 180 oh	Floridan	Upper Floridan
BFT-2055	Valve nearest quick connect	2.82	32.19138 -80.70385	11.2	Survey	3,708	2,782 – 3,688	Middendorf	Gramling

Table A1. SCDNR Groundwater Monitoring Network wells (as of June 2019) — Continued

Well ID	Measuring Point Description	Measuring Point Height (ft)	Latitude Longitude	Land Surface Elevation (ft)	Elevation Method	Well Depth (ft)	Screen or Open-Hole Interval (ft)*	Aquifer[1]	Aquifer[2]
BFT-2245	Top of PVC insert	1.30	32.14631 -80.83817	11	LIDAR	335	152 – 335 oh	Floridan	Upper Floridan
BFT-2247	Top of PVC insert	1.30	32.08854 -80.87239	7	LIDAR	263	165 – 263 oh	Floridan	Upper Floridan
BFT-2356	Top of sanitary seal	0.82	32.20329 -80.88032	15	LIDAR	206	90 – 206 oh	Floridan	Upper Floridan
BFT-2404	Top of PVC insert	0.97	32.21305 -80.71754	12	LIDAR	261	125 – 261 oh	Floridan	Upper Floridan
BFT-2408	Top of sanitary seal	2.23	32.28463 -80.85147	20	LIDAR	232	125 – 232 oh	Floridan	Upper Floridan
BRK-0644	Top of aluminum collar	3.00	33.40431 -79.93389	71	LIDAR	93	53 – 93	Floridan	Gordon
BRN-0078	Top of sanitary seal	3.63	33.39988 -81.42187	340	LIDAR	775	568 – 770	Middendorf	McQueen Branch
BRN-0349	Top of sanitary seal	3.33	33.17868 -81.31448	207.7	Survey	1,045	1,030 – 1,040	Middendorf	McQueen Branch
BRN-0350	Top of sanitary seal	2.74	33.17917 -81.31417	206.5	Survey	170	155 – 165	Floridan	Middle Floridan
BRN-0351	Top of sanitary seal	2.75	33.17910 -81.31405	206.4	Survey	95	80 – 90	Floridan	Upper Floridan
BRN-0352	Top of sanitary seal	2.49	33.17899 -81.31415	206.3	Survey	293	278 – 288	Tertiary sand	Gordon
BRN-0353	Top of sanitary seal	2.61	33.17889 -81.31420	206.8	Survey	588	573 – 583	Black Creek	Crouch Branch
BRN-0354	Top of sanitary seal	2.85	33.17900 -81.31428	206.7	Survey	411	396 – 406	Tertiary sand	Gordon
BRN-0355	Top of sanitary seal	2.59	33.17899 -81.31439	207.1	Survey	701	686 – 696	Black Creek	Crouch Branch
BRN-0356	Top of sanitary seal	2.47	33.17880 -81.31448	207.7	Survey	929	914 – 924	Middendorf	McQueen Branch
BRN-0358	Top of sanitary seal	2.00	33.32134 -81.40707	264.7	Survey	847	832 – 842	Middendorf	McQueen Branch
BRN-0359	Top of sanitary seal	2.12	33.32182 -81.40658	264.6	Survey	214	199 – 209	Tertiary sand	Gordon

Table A1. SCDNR Groundwater Monitoring Network wells (as of June 2019) — Continued

Well ID	Measuring Point Description	Measuring Point Height (ft)	Latitude Longitude	Land Surface Elevation (ft)	Elevation Method	Well Depth (ft)	Screen or Open-Hole Interval (ft)*	Aquifer[1]	Aquifer[2]
BRN-0360	Top of sanitary seal	2.06	33.32170 -81.40671	263.4	Survey	140	125 – 134	Tertiary sand	Middle Floridan
BRN-0365	Top of sanitary seal	3.00	33.32160 -81.40680	262.6	Survey	539	524 – 534	Black Creek	Crouch Branch
BRN-0366	Top of sanitary seal	3.00	33.32136 -81.40691	265.8	Survey	715	700 – 710	Middendorf	McQueen Branch
BRN-0367	Top of sanitary seal	3.00	33.32150 -81.40692	262.9	Survey	285	270 – 280	Tertiary sand	Gordon
BRN-0368	Top of sanitary seal	3.05	33.32145 -81.40680	264.2	Survey	443	428 – 438	Black Creek	Crouch Branch
CAL-0192	Top of PVC instrument support	3.39	33.59850 -80.64775	190.1	Survey	49	28 – 48	Shallow aquifer	Surficial aquifer system
CAL-0193	Top of PVC instrument support	3.52	33.59864 -80.64789	190.5	Survey	100	85 – 95	Tertiary sand	Gordon
CAL-0194	Top of PVC instrument support	3.08	33.59858 -80.64786	189.9	Survey	254	239 – 249	Black Creek	Crouch Branch
CAL-0195	Top of PVC instrument support	3.03	33.59858 -80.64786	189.6	Survey	360	345 – 355	Black Creek	Crouch Branch
CAL-0215	Top of sanitary seal	3.40	33.59869 -80.64795	187	LIDAR	699	689 – 699	Middendorf	McQueen Branch
CHN-0044	Top of polyboard support platform	0.65	32.79662 -80.07011	8.4	Survey	434	180 – 425	Floridan	Gordon
CHN-0101	Top of polyboard support platform	0.46	33.04604 -79.56674	23	LIDAR	91	82 – 91	Floridan	Gordon
CHN-0163	Sanitary seal inside PVC riser	2.17	32.78826 -79.87184	26	LIDAR	1,919	1,829 – 1,912	Middendorf	Charleston
CHN-0484	Bottom surface of instrument housing	1.70	32.58133 -80.30547	13.5	Survey	548	84 – 548 oh	Floridan	Gordon
CHN-0803	Bottom surface of instrument housing	2.29	33.15578 -79.36386	9.9	Survey	113	48 – 113	Floridan	Gordon
CHN-0989	Top of sanitary seal	3.02	32.73733 -80.17766	15	LIDAR	531	160 – 531 oh	Floridan	Gordon
CHN-0990	Top of sanitary seal	2.88	32.94069 -79.65687	6	LIDAR	268	188 – 263	Floridan	Gordon

Table A1. SCDNR Groundwater Monitoring Network wells (as of June 2019) — Continued

Well ID	Measuring Point Description	Measuring Point Height (ft)	Latitude Longitude	Land Surface Elevation (ft)	Elevation Method	Well Depth (ft)	Screen or Open-Hole Interval (ft)*	Aquifer[1]	Aquifer[2]
CHN-0991	Top of sanitary seal	3.05	32.94065 -79.65689	6	LIDAR	48	33 – 43	Shallow aquifer	Surficial aquifer system
CLA-0016	Top of PVC instrument support	2.53	33.69406 -80.21245	124	LIDAR	618	565 – 605	Middendorf	McQueen Branch
CLA-0020	Top of PVC instrument support	1.33	33.70015 -80.21331	129	LIDAR	650	590 – 640	Middendorf	McQueen Branch
COL-0030	Top of sanitary seal	0.30	32.89588 -80.67786	60.4	Survey	1,340	unknown	Black Creek	Crouch Branch
COL-0097	Top of sanitary seal	1.78	33.04772 -80.59758	80	LIDAR	342	134 – 342 oh	Floridan	Middle Floridan
COL-0301	Bottom surface of instrument housing	2.65	32.51162 -80.29925	9.0	Survey	545	516 – 545	Floridan	Gordon
COL-0803	top of sanitary seal	3.31	33.06194 -80.61500	81	LIDAR	35	14 – 24	Shallow aquifer	Surficial aquifer system
CRK-0074	Top of casing	1.30	35.15529 -81.44278	821	LIDAR	265	99 – 265	Crystalline rock	Crystalline rock
CTF-0081	Bottom surface of instrument housing	1.80	34.64317 -79.91156	192	LIDAR	244	231 – 244	Crystalline rock	Crystalline rock
CTF-0221	Top of instrument housing	3.69	34.42875 -80.28281	409.1	Survey	260	235 – 255	Middendorf	McQueen Branch
CTF-0222	Top of instrument housing	4.25	34.42287 -80.28281	409.1	Survey	175	150 – 170	Black Creek	Crouch Branch
CTF-0325	Top of sanitary seal	2.89	34.64318 -79.91166	191	LIDAR	40	20 – 40	Shallow aquifer	Surficial aquifer system
DAR-0228	Bottom surface of instrument housing	1.70	34.45890 -79.87992	168	LIDAR	186	175 – 185	Middendorf	McQueen Branch
DIL-0121	Bottom surface of instrument housing	2.98	34.32855 -79.28301	92	LIDAR	294	269 – 284	Middendorf	McQueen Branch
DIL-0171	Top of PVC instrument support	3.00	34.33027 -79.28692	82	LIDAR	555	540 – 550	Cape Fear	Gramling confining unit
DIL-0172	Top of PVC instrument support	2.94	34.33028 -79.28697	82	LIDAR	175	160 – 170	Black Creek	Crouch Branch
DIL-0173	Top of PVC instrument support	2.96	34.33029 -79.28698	82	LIDAR	380	370 – 375	Middendorf	McQueen Branch

Table A1. SCDNR Groundwater Monitoring Network wells (as of June 2019) — Continued

Well ID	Measuring Point Description	Measuring Point Height (ft)	Latitude Longitude	Land Surface Elevation (ft)	Elevation Method	Well Depth (ft)	Screen or Open-Hole Interval (ft)*	Aquifer[1]	Aquifer[2]
DIL-0174	Top of PVC instrument support	2.90	34.33030 -79.28701	82	LIDAR	75	60 – 70	Black Creek	Crouch Branch
DIL-0175	Top of PVC instrument support	2.94	34.33032 -79.28702	82	LIDAR	325	315 – 320	Middendorf	McQueen Branch
DOR-0228	Top of metal access pipe	1.75	32.98360 -80.21829	51	LIDAR	1,830	1,658 – 1,824	Middendorf	Charleston
FLO-0128	Top of sanitary seal	2.75	34.19567 -79.58037	94	LIDAR	695	265 – 690	Middendorf	McQueen Branch
FLO-0274	Bottom surface of instrument housing	1.34	33.85585 -79.76662	77.6	Survey	560	540 – 560	Middendorf	McQueen Branch
FLO-0276	Bottom surface of instrument housing	1.31	33.85583 -79.76662	78.0	Survey	250	230 – 250	Black Creek	Crouch Branch
FLO-0484	Top of sanitary seal	2.90	33.85588 -79.76659	78	LIDAR	40	20 – 40	Shallow aquifer	Surficial aquifer system
GEO-0381	Top of PVC instrument support	3.15	33.33582 -79.24464	9	LIDAR	43	23 – 43	Shallow aquifer	Surficial aquifer system
GEO-0382	Top of sanitary seal	3.09	33.33581 -79.24460	9	LIDAR	730	700 – 720	Black Creek	Crouch Branch
GEO-0383	Top of sanitary seal	2.90	33.33581 -79.24456	9	LIDAR	560	530 – 550	Black Creek	Crouch Branch
GEO-0386	Top of sanitary seal	2.20	33.34131 -79.20311	6	LIDAR	39	37 – 39	Shallow aquifer	Surficial aquifer system
GEO-0387	Top of sanitary seal	2.60	33.34136 -79.20310	6	LIDAR	95	90 – 95	Tertiary sand	Gordon
GEO-0390	port in sanitary seal	3.20	33.39442 -79.37804	18	LIDAR	640	620 – 640	Black Creek	Crouch Branch
GEO-0391	Top of sanitary seal	3.20	33.39432 -79.37804	18	LIDAR	40	20 – 40	Shallow aquifer	Surficial aquifer system
GRV-0712	Top of sanitary seal	0.60	35.10655 -82.62637	3,179	LIDAR	450	28 – 450	Crystalline rock	Crystalline rock
GRV-2162	Top of plywood support platform	2.29	34.90461 -82.26334	872	LIDAR	281	83 – 289	Crystalline rock	Crystalline rock
GRV-2230	Bottom surface of instrument housing	2.40	34.92440 -82.44460	982	LIDAR	20	4 – 20	Shallow aquifer	Surficial aquifer system

Table A1. SCDNR Groundwater Monitoring Network wells (as of June 2019) — Continued

Well ID	Measuring Point Description	Measuring Point Height (ft)	Latitude Longitude	Land Surface Elevation (ft)	Elevation Method	Well Depth (ft)	Screen or Open-Hole Interval (ft)*	Aquifer[1]	Aquifer[2]
GRV-2543	Top of sanitary seal	1.65	35.12633 -82.57135	1,328.6	Survey	50	unknown	Crystalline rock	Crystalline rock
GRV-3333	Top of sanitary seal	-1.24	35.16612 -82.47139	1,872.7	Survey	264	58 – 264 oh	Crystalline rock	Crystalline rock
GRV-3335	Top of sanitary seal	1.05	35.12500 -82.57371	1,353.4	Survey	110	62 – 110 oh	Crystalline rock	Crystalline rock
GRV-3336	Top of sanitary seal	2.08	35.12500 -82.57371	1,353.2	Survey	20	14 – 20 oh	Shallow aquifer	Surficial aquifer system
GRV-3341	Top of sanitary seal	2.58	35.16075 -82.22469	1,030.4	Survey	80	70 – 80 oh	Shallow aquifer	Surficial aquifer system
GRV-3342	Top of sanitary seal	1.09	35.16075 -82.22469	1,030.4	Survey	334	132 – 334 oh	Crystalline rock	Crystalline rock
GRV-3533	Bottom surface of instrument housing	2.23	34.92440 -82.44460	982	LIDAR	243	45 – 243	Crystalline rock	Crystalline rock
HAM-0050	Top of white PVC instrument support fitting	2.25	32.67979 -81.18712	114	LIDAR	968	unknown	Tertiary sand	Gordon
HAM-0083	Top of plywood support platform	2.05	32.69766 -80.85081	45	LIDAR	113	85 – 113 oh	Floridan	Upper Floridan
HAM-0314	Top of sanitary seal	3.26	32.83051 -81.16566	106	LIDAR	122	88 – 122 oh	Floridan	Upper Floridan
HAM-0315	Top of sanitary seal	3.21	32.83051 -81.16566	105	LIDAR	568	200 – 568 oh	Floridan	Middle Floridan
HOR-0290	Top of of PVC insert	0.00	33.67080 -78.93918	22	LIDAR	459	unknown	Black Creek	Crouch Branch
HOR-0309	Top of white PVC instrument support fitting	3.74	33.76762 -78.96632	41.8	Survey	375	360 – 375	Black Creek	Crouch Branch
HOR-0973	Top of well head blind flange	3.37	33.72265 -78.90305	15	LIDAR	1,331	1,012 – 1,328	Middendorf	Gramling
HOR-1326	top of sanitary seal	2.90	33.65721 -78.92680	17	LIDAR	600	590 – 600	Middendorf	McQueen Branch
HOR-1327	top of sanitary seal	2.90	33.65709 -78.92686	17	LIDAR	440	430 – 440	Black Creek	Crouch Branch
JAS-0425	Bottom surface of instrument housing	1.97	32.61801 -80.99534	64.1	Survey	225	150 – 225 oh	Floridan	Upper Floridan

Table A1. SCDNR Groundwater Monitoring Network wells (as of June 2019) — Continued

Well ID	Measuring Point Description	Measuring Point Height (ft)	Latitude Longitude	Land Surface Elevation (ft)	Elevation Method	Well Depth (ft)	Screen or Open-Hole Interval (ft)*	Aquifer[1]	Aquifer[2]
JAS-0426	Top of well head blind flange	2.74	32.61820 -80.99539	62.3	Survey	1,994	1,949 – 1,994	Middendorf	Charleston
JAS-0468	Top of white PVC instrument support fitting	2.97	32.61778 -80.99583	64.1	Survey	24	17 – 22	Shallow aquifer	Surficial aquifer system
JAS-0490	Top of sanitary seal	2.93	32.48161 -80.97231	30	LIDAR	558	288 – 558 oh	Floridan	Middle Floridan
JAS-0491	Top of sanitary seal	3.20	32.48161 -80.97231	30	LIDAR	220	144 – 220 oh	Floridan	Upper Floridan
JAS-0492	Bottom surface of instrument housing	2.89	32.61809 -80.99528	65	LIDAR	600	300 – 600 oh	Floridan	Middle Floridan
KER-0263	Top of sanitary seal	1.45	34.55893 -80.44523	467	LIDAR	455	103 – 455 oh	Crystalline rock	Crystalline rock
LEE-0075	Bottom surface of instrument housing	3.55	34.20239 -80.17501	196	LIDAR	356	306 – 356	Middendorf	McQueen Branch
LEE-0179	Top of sanitary seal	2.97	34.20225 -80.17436	196	LIDAR	243	228 – 238	Black Creek	McQueen Branch
LEE-0180	Top of sanitary seal	3.00	34.20221 -80.17448	197	LIDAR	202	127 – 197	Black Creek	Crouch Branch
LEE-0181	Top of sanitary seal	2.78	34.20222 -80.17451	197	LIDAR	75	50 – 70	Black Creek	Crouch Branch
LEX-0823	Top of sanitary seal	3.11	33.73578 -81.10539	305	LIDAR	225	150 – 220	Black Creek	Crouch Branch
LEX-0844	Bottom surface of instrument housing	3.35	33.74603 -81.10758	366	LIDAR	522	392 – 502	Middendorf	McQueen Branch
LEX-1702	Top of sanitary seal	2.90	33.82296 -81.19880	542	LIDAR	56	36 – 56	Shallow aquifer	Surficial aquifer system
LEX-1703	Top of sanitary seal	3.48	33.94297 -81.03225	128	LIDAR	32	22 – 32	Shallow aquifer	Surficial aquifer system
LRN-1705	Bottom surface of instrument housing	2.82	34.49074 -82.04290	638.3	Survey	39	29 – 39 oh	Shallow aquifer	Surficial aquifer system
LRN-1706	Top of steel washer	0.00	34.57085 -82.11377	847	LIDAR	168	unknown	Crystalline rock	Crystalline rock
LRN-1707	Top of steel washer	0.75	34.38128 -82.00628	660	LIDAR	223	unknown	Crystalline rock	Crystalline rock

Table A1. SCDNR Groundwater Monitoring Network wells (as of June 2019) — Continued

Well ID	Measuring Point Description	Measuring Point Height (ft)	Latitude Longitude	Land Surface Elevation (ft)	Elevation Method	Well Depth (ft)	Screen or Open-Hole Interval (ft)*	Aquifer[1]	Aquifer[2]
MRN-0077	Top of white PVC instrument support fitting	1.70	33.86175 -79.33063	34.7	Survey	356	325 – 355	Black Creek	Crouch Branch
MRN-0078	Top of well head blind flange	2.76	33.86178 -79.33030	33.6	Survey	1,038	1,008 – 1,028	Cape Fear	Gramling
MRN-0178	Top of sanitary seal	2.90	33.86175 -79.33037	30	LIDAR	40	20 – 40	Shallow aquifer	Surficial aquifer system
ORG-0079	Top of outer casing	0.67	33.41319 -80.84757	184	LIDAR	995	843 – 974	Middendorf	McQueen Branch
ORG-0385	Top of PVC insert	1.67	33.36904 -81.03065	175	LIDAR	535	475 – 535	Black Creek	Crouch Branch
ORG-0393	Bottom surface of instrument housing	3.51	33.50826 -80.86494	257	LIDAR	463	423 – 463	Black Creek	Crouch Branch
ORG-0430	Bottom surface of instrument housing	3.25	33.50827 -80.86493	257	LIDAR	275	205 – 265	Tertiary sand	Gordon
ORG-0431	Bottom surface of instrument housing	3.13	33.50827 -80.86493	257	LIDAR	93	83 – 88	Floridan	Middle Floridan
ORG-0634	Top of PVC instrument support	0.85	33.45434 -80.71843	165	LIDAR	256	228 – 256 oh	Floridan	Middle Floridan
RIC-0543	Bottom surface of instrument housing	3.44	33.87502 -80.70243	184.8	Survey	420	370 – 410	Middendorf	McQueen Branch
RIC-0585	Top of 2-inch casing	4.20	33.94894 -80.84095	327.0	Survey	403	363 – 393	Middendorf	McQueen Branch
RIC-0775	Top of instrument housing	2.36	33.83744 -80.62550	151	LIDAR	607	437 – 600	Middendorf	McQueen Branch
RIC-0776	Top of sanitary seal	1.55	33.83714 -80.62544	150	LIDAR	107	95 – 160	Black Creek	Crouch Branch
SAL-0069	Topy of plywood support platform	2.76	34.08786 -81.66992	453	LIDAR	480	92 – 480 oh	Crystalline rock	Crystalline rock
SUM-0146	Top of casing	1.05	33.93608 -80.34513	171	LIDAR	554	394 – 545	Middendorf	McQueen Branch
SUM-0153	Highest tip of PVC	2.00	33.86524 -80.37647	178	LIDAR	643	533 – 633	Middendorf	McQueen Branch
SUM-0488	Top of sanitary seal	2.00	33.87429 -80.43789	178	LIDAR	546	511 – 541	Middendorf	McQueen Branch

Table A1. SCDNR Groundwater Monitoring Network wells (as of June 2019) — Continued

Well ID	Measuring Point Description	Measuring Point Height (ft)	Latitude Longitude	Land Surface Elevation (ft)	Elevation Method	Well Depth (ft)	Screen or Open-Hole Interval (ft)*	Aquifer[1]	Aquifer[2]
SUM-0492	Top of sanitary seal	2.10	33.94567 -79.97974	121	LIDAR	522	502 – 517	Middendorf	McQueen Branch
SUM-0497	Bottom surface of instrument housing	3.27	33.87417 -80.43777	178	LIDAR	100	70 – 100	Black Creek	Crouch Branch
SUM-0504	Top of sanitary seal	2.58	33.99099 -80.34578	166	LIDAR	393	383 – 393	Middendorf	McQueen Branch
SUM-0505	Top of sanitary seal	2.51	33.99099 -80.34578	166	LIDAR	330	320 – 330	Middendorf	McQueen Branch
SUM-0506	Black dot on PVC cap	2.48	33.99099 -80.34577	166	LIDAR	255	245 – 255	Black Creek	Crouch Branch
SUM-0507	Top of sanitary seal	2.50	33.99099 -80.34577	166	LIDAR	172	162 – 172	Black Creek	Crouch Branch
SUM-0508	Top of sanitary seal	2.61	33.99099 -80.34576	166	LIDAR	92	82 – 92	Black Creek	Crouch Branch
SUM-0531	Top of sanitary seal	3.00	33.94559 -79.97976	123	LIDAR	40	20 – 40	Shallow aquifer	Surficial aquifer system
WIL-0012	Top of casing	1.58	33.67303 -79.82716	63	LIDAR	525	455 – 520	Black Creek	Crouch Branch
WIL-0355	Bottom surface of instrument housing	3.90	33.40252 -79.77819	56	LIDAR	869	824 – 864	Middendorf	McQueen Branch

***** oh: *Open-hole interval*
1 *Aquifer based on hydrogeologic framework of Aucott and others (1986)*
2 *Aquifer based on hydrogeologic framework of Gellici and Lautier (2010)*

APPENDIX B

Instrumentation Specifications and Equipment Installation Details

Table B1. Ranges and accuracies of Bourdon-type test gages used by SCDNR

Gage Range (psi)	Rated Gage Accuracy (psi)	Rated Gage Accuracy (ft)	Measurement Accuracy (ft)
0 – 30	0.075	0.17	0.4
0 – 60	0.15	0.34	0.5
0 – 100	0.25	0.57	0.8

Table B2. Specifications for ADR groundwater-level and conductivity equipment installed in the SCDNR Groundwater Monitoring Network, July 2014 through June 2019

Brand Model	Variables	Pressure Range	Accuracy	Housing Material
In-Situ Aqua TROLL 100	conductivity	0 – 100,000 µS/cm	± 0.5% of reading	titanium
In-Situ Aqua TROLL 200	water level	0 – 692 ft (0 – 210 m)	± 0.35 ft	titanium
	conductivity	0 – 100,000 µS/cm	± 0.5% of reading	
In-Situ Aqua TROLL 500	water level	0 – 65 ft (0 – 21 m)	± 0.03 ft	titanium
Schlumberger DI501 Baro Diver	barometric pressure	0 – 5 ft (0 – 1.5 m)	± 0.02 ft	stainless steel
Schlumberger DI502 Mini Diver	water level	0 – 65 ft (0 – 20 m)	± 0.03 ft	stainless steel
Schlumberger DI602 Micro Diver	water level	0 – 65 ft (0 – 20 m)	± 0.07 ft	stainless steel
Schlumberger DI273 CTD Diver	water level	0 – 328 ft (0 – 100 m)	± 0.16 ft	ceramic
	conductivity	0 – 120,000 µS/cm	± 1% of reading	
Solinst 3001 Barologger Edge	barometric pressure	0 – 3 ft (0 – 1 m)	± 0.02 ft	stainless steel / titanium coating
Solinst 3001 Levelogger Edge	water level	0 – 16 ft (0 – 5 m)	± 0.01 ft	stainless steel / titanium coating
Solinst 3001 Levelogger Edge	water level	0 – 65 ft (0 – 20 m)	± 0.03 ft	stainless steel / titanium coating
Solinst 3001 Levelogger Edge	water level	0 – 98 ft (0 – 30 m)	± 0.05 ft	stainless steel / titanium coating
Solinst 3001 Barologger Gold	barometric pressure	0 – 3 ft (0 – 1 m)	± 0.003 ft	stainless steel / zirconium
Solinst 3001 Levelogger Gold	water level	0 – 65 ft (0 – 20 m)	± 0.03 ft	stainless steel / zirconium

Table B3. Water-level and barometric equipment installed in ADR wells (June 2019)

Well ID	Brand	Water Level Logger	Barometer Model
AIK-0344	Solinst	3001 Levelogger Edge 20m	
AIK-0817	Solinst	3001 Levelogger Edge 20m	
AIK-0818	Solinst		3001 Barologger
AIK-0824	Solinst	3001 Levelogger Edge 20m	
AIK-0826	Solinst	3001 Levelogger Edge 20m	
AIK-0847	Solinst	3001 Levelogger Edge 20m	
AIK-0849	Solinst	3001 Levelogger Edge 20m	3001 Barologger
AIK-2379	Solinst	3001 Levelogger Edge 20m	
AIK-2380	Solinst	3001 Levelogger Edge 20m	3001 Barologger
AIK-2449	Solinst	3001 Levelogger Edge 20m	
AIK-2544	Solinst	3001 Levelogger Edge 20m	
AIK-2711	Solinst	3001 Levelogger Edge 20m	3001 Barologger
AIK-2731	Solinst	3001 Levelogger Edge 20m	
AIK-2732	Solinst	3001 Levelogger Edge 20m	
AIK-2733	Solinst	3001 Levelogger Edge 20m	
AIK-2741	Solinst	3001 Levelogger Edge 20m	
AIK-2742	Solinst	3001 Levelogger Edge 20m	
ALL-0367	Solinst	3001 Levelogger Edge 20m	
ALL-0371	Solinst	3001 Levelogger Edge 20m	
ALL-0372	Solinst	3001 Levelogger Edge 20m	
ALL-0373	Solinst	3001 Levelogger Edge 30m	3001 Barologger
ALL-0375	Solinst	3001 Levelogger Edge 20m	
ALL-0376	Solinst	3001 Levelogger Edge 20m	
ALL-0377	Solinst	3001 Levelogger Edge 20m	
AND-0326	Solinst	3001 Levelogger Edge 20m	
BRN-0078	Solinst	3001 Levelogger Edge 20m	
BRN-0349	Solinst	3001 Levelogger Edge 20m	
BRN-0351	Solinst	3001 Levelogger Edge 20m	
BRN-0352	Solinst	3001 Levelogger Edge 30m	
BRN-0353	Solinst	3001 Levelogger Edge 20m	
BFT-0101	Solinst	3001 Levelogger Edge 20m	
BFT-0429	Solinst	3001 Levelogger Edge 20m	
BFT-0563	Solinst	3001 Levelogger Edge 20m	3001 Barologger
BFT-1809	Solinst	3001 Levelogger Edge 20m	
BFT-1813	Solinst	3001 Levelogger Edge 20m	

Table B3. Water-level and barometric equipment installed in ADR wells — Continued

Well ID	Brand	Water Level Logger	Barometer Model
BFT-1814	Solinst	3001 Levelogger Edge 20m	
BFT-1820	Solinst	3001 Levelogger Edge 20m	
BFT-1822	Solinst	3001 Levelogger Edge 20m	3001 Barologger
BFT-1845	Solinst	3001 Levelogger Edge 20m	
BFT-1846	Solinst	3001 Levelogger Edge 20m	
BFT-2245	Solinst	3001 Levelogger Edge 20m	3001 Barologger
BFT-2247	Solinst	3001 Levelogger Edge 20m	
BFT-2356	Solinst	3001 Levelogger Edge 20m	3001 Barologger
BFT-2404	Solinst	3001 Levelogger Edge 20m	
BFT-2408	Solinst	3001 Levelogger Edge 20m	3001 Barologger
BRK-0644	Solinst	3001 Levelogger Edge 20m	
CAL-0192	Solinst	3001 Levelogger Edge 20m	
CAL-0193	Solinst	3001 Levelogger Edge 20m	3001 Barologger
CAL-0194	Solinst	3001 Levelogger Edge 20m	
CAL-0195	Solinst	3001 Levelogger Edge 20m	
CAL-0215	Solinst	3001 Levelogger Edge 20m	
CHN-0044	Solinst	3001 Levelogger Edge 20m	3001 Barologger
CHN-0101	Solinst	3001 Levelogger Edge 20m	
CHN-0484	Solinst	3001 Levelogger Edge 20m	3001 Barologger
CHN-0803	Solinst	3001 Levelogger Edge 20m	3001 Barologger
CHN-0989	Solinst	3001 Levelogger Edge 20m	3001 Barologger
CHN-0990	Solinst	3001 Levelogger Edge 20m	3001 Barologger
CHN-0991	Solinst	3001 Levelogger Edge 20m	
CRK-0074	Solinst	3001 Levelogger Edge 30m	3001 Barologger
CTF-0081	Solinst	3001 Levelogger Edge 20m	3001 Barologger
CTF-0221	Solinst	3001 Levelogger Edge 20m	
CTF-0222	Solinst	3001 Levelogger Edge 20m	3001 Barologger
CTF-0325	Solinst	3001 Levelogger Edge 20m	
CLA-0016	Solinst	3001 Levelogger Edge 20m	
CLA-0020	Solinst	3001 Levelogger Edge 20m	3001 Barologger
COL-0030	Solinst	3001 Levelogger Edge 20m	
COL-0097	Solinst	3001 Levelogger Edge 20m	3001 Barologger
COL-0301	Solinst	3001 Levelogger Edge 20m	
COL-0803	Solinst	3001 Levelogger Edge 20m	
DAR-0228	Solinst	3001 Levelogger Edge 20m	3001 Barologger

Table B3. Water-level and barometric equipment installed in ADR wells — Continued

Well ID	Brand	Water Level Logger	Barometer Model
DIL-0121	Solinst	3001 Levelogger Edge 20m	
DIL-0171	Solinst	3001 Levelogger Edge 20m	3001 Barologger
DIL-0172	Solinst	3001 Levelogger Edge 20m	
DIL-0173	Solinst	3001 Levelogger Edge 20m	
DIL-0174	Solinst	3001 Levelogger Edge 20m	
DIL-0175	Solinst	3001 Levelogger Edge 20m	
FLO-0128	Solinst	3001 Levelogger Edge 20m	3001 Barologger
FLO-0274	Solinst	3001 Levelogger Edge 20m	3001 Barologger
FLO-0276	Solinst	3001 Levelogger Edge 20m	
FLO-0484	Solinst	3001 Levelogger Edge 20m	
GEO-0382	Solinst	3001 Levelogger Edge 20m	3001 Barologger
GEO-0383	Solinst	3001 Levelogger Edge 20m	
GEO-0386	Solinst	3001 Levelogger Edge 20m	
GEO-0387	Solinst	3001 Levelogger Edge 20m	
GEO-0390	Solinst	3001 Levelogger Edge 20m	3001 Barologger
GEO-0391	Solinst	3001 Levelogger Edge 20m	
GRV-0712	Solinst	3001 Levelogger Edge 20m	3001 Barologger
GRV-2162	Solinst	3001 Levelogger Edge 20m	3001 Barologger
GRV-2230	Solinst	3001 Levelogger Edge 20m	
GRV-2543	Solinst	3001 Levelogger Edge 20m	
GRV-3333	Solinst	3001 Levelogger Edge 20m	3001 Barologger
GRV-3335	Solinst	3001 Levelogger Edge 20m	
GRV-3336	Solinst	3001 Levelogger Edge 5m	
GRV-3341	Solinst	3001 Levelogger Edge 20m	3001 Barologger
GRV-3342	Solinst	3001 Levelogger Edge 20m	
GRV-3533	Solinst	3001 Levelogger Edge 5m	3001 Barologger
HAM-0050	Solinst	3001 Levelogger Edge 20m	
HAM-0083	Solinst	3001 Levelogger Edge 20m	
HAM-0314	Solinst	3001 Levelogger Edge 20m	
HAM-0315	Solinst	3001 Levelogger Edge 20m	3001 Barologger
HOR-0290	Solinst	3001 Levelogger Edge 20m	
HOR-0309	Solinst	3001 Levelogger Edge 20m	
HOR-1326	Solinst	3001 Levelogger Edge 20m	3001 Barologger
HOR-1327	Solinst	3001 Levelogger Edge 20m	
JAS-0425	Solinst	3001 Levelogger Edge 20m	3001 Barologger

Table B3. Water-level and barometric equipment installed in ADR wells — Continued

Well ID	Brand	Water Level Logger	Barometer Model
JAS-0468	Solinst	3001 Levelogger Edge 20m	
JAS-0490	Solinst	3001 Levelogger Edge 20m	3001 Barologger
JAS-0491	Solinst	3001 Levelogger Edge 20m	
JAS-0492	Solinst	3001 Levelogger Edge 20m	
KER-0263	Solinst	3001 Levelogger Edge 20m	3001 Barologger
LRN-1705	Solinst	3001 Levelogger Edge 20m	3001 Barologger
LRN-1706	Solinst	3001 Levelogger Edge 20m	3001 Barologger
LRN-1707	Solinst	3001 Levelogger Edge 20m	3001 Barologger
LEE-0075	Solinst	3001 Levelogger Edge 20m	
LEE-0179	Solinst	3001 Levelogger Edge 20m	3001 Barologger
LEE-0180	Solinst	3001 Levelogger Edge 20m	
LEE-0181	Solinst	3001 Levelogger Edge 20m	
LEX-0823	Solinst	3001 Levelogger Edge 20m	3001 Barologger
LEX-0844	Solinst	3001 Levelogger Edge 20m	
LEX-1702	Solinst	3001 Levelogger Edge 20m	
LEX-1703	Solinst	3001 Levelogger Edge 20m	
MRN-0077	Solinst	3001 Levelogger Edge 20m	3001 Barologger
MRN-0178	Solinst	3001 Levelogger Edge 20m	
ORG-0079	Solinst	3001 Levelogger Edge 20m	
ORG-0385	Solinst	3001 Levelogger Edge 20m	3001 Barologger
ORG-0393	Solinst	3001 Levelogger Edge 20m	
ORG-0430	Solinst	3001 Levelogger Edge 20m	
ORG-0431	Solinst	3001 Levelogger Edge 20m	3001 Barologger
ORG-0634	Solinst	3001 Levelogger Edge 20m	
RIC-0543	Solinst	3001 Levelogger Edge 20m	3001 Barologger
RIC-0585	Solinst	3001 Levelogger Edge 20m	
RIC-0775	Solinst	3001 Levelogger Edge 20m	3001 Barologger
RIC-0776	Solinst	3001 Levelogger Edge 20m	
SAL-0069	Solinst	3001 Levelogger Edge 20m	3001 Barologger
SUM-0146	Solinst	3001 Levelogger Edge 20m	
SUM-0153	Solinst	3001 Levelogger Edge 20m	
SUM-0488	Solinst	3001 Levelogger Edge 20m	
SUM-0492	Solinst	3001 Levelogger Edge 20m	
SUM-0497	Solinst	3001 Levelogger Edge 20m	
SUM-0504	Solinst	3001 Levelogger Edge 20m	

Table B3. Water-level and barometric equipment installed in ADR wells — Continued

Well ID	Brand	Water Level Logger	Barometer Model
SUM-0505	Solinst	3001 Levelogger Edge 20m	
SUM-0506	Solinst	3001 Levelogger Edge 20m	
SUM-0507	Solinst	3001 Levelogger Edge 20m	
SUM-0508	Solinst	3001 Levelogger Edge 20m	3001 Barologger
SUM-0531	Solinst	3001 Levelogger Edge 20m	
WIL-0012	Solinst	3001 Levelogger Edge 20m	
WIL-0355	Solinst	3001 Levelogger Edge 20m	3001 Barologger

Table B4. USGS Stand Alone Documents applied to the SCDNR groundwater monitoring program

Document Number	Title
GWPD-1	Water-level measurement using graduated steel tape
GWPD-3	Establishing a permanent measuring point
GWPD-4	Water-level measurement using an electric tape
GWPD-5	Locating a well
GWPD-12	Water-level measurement in a flowing well

APPENDIX C

Standard Operating Procedures for the SCDNR Groundwater Monitoring Network

Standard Operating Procedures for the SCDNR Groundwater Monitoring Network

Updated July 2021

1. Site visits should be made a minimum of 4 times per year, approximately once every 3 months. Additional site visits may be necessary to repair/replace malfunctioning equipment or do perform additional site maintenance.

2. Appropriate quality control and quality assurance measures should be implemented during each site visit:
    a. For sites with pressure transducers, cable length values should be determined during the time of visit and compared to previous cable length estimates to evaluate the sensor's performance. The cable length value is the sum of 1) the depth of water above probe as measured by the transducer and 2) the depth to water from the measuring point (manual measurement).
    b. For sites with unvented pressure transducers and no barometric instrument installed on site, a measurement must be taken from a spare barometric instrument that is transported from site to site. This measurement will allow an estimate of the depth of water above probe, and thus, an estimate of the cable length value during each site visit.
    c. For transducers with pressure ranges rated at 65 feet (20 meters) or less, ADRs should be replaced if cable length values deviate by more than plus or minus 0.20 ft for two consecutive downloads.
    d. Clock accuracy should be checked during each site visit for each ADR instrument. In most cases, a one or two minute error is acceptable. Clocks off by more than a few minutes should be reset.
    e. For wells that are tidally influenced, the manual measurement and the real-time ADR reading must be collected as close to the same time as possible in order to compute an accurate cable length value.

3. Model numbers and serial numbers should be documented for all installed ADRs and associated equipment (direct read cables, for example). Any changes to instrumentation must be clearly documented (date and time of change, reason for change, model and serial numbers of any instrumentation removed along with model and serial numbers of any instrumentation added).

4. Efforts should be made to ensure that enough inventory is immediately available in the field to replace ADR equipment when needed to avoid the additional loss of data.

5. Under normal circumstances, data collected during a site visit should be checked for quality control and quality assurance within two weeks of the site visit.

6. Under normal circumstances, downloaded ADR data and manual measurements should be entered into the ADR database within two weeks of the site visit.

7. If ADR instrumentation at a given site is determined to be malfunctioning while reviewing data in the office, efforts should be made to replace or repair the ADR instruments as soon as possible. This may require additional site visits.

8. Clocks for all instrumentation will be programmed in Eastern Standard Time. Do not correct for Daylight Savings.

9. Pressure test gages used to measure water levels at freely-flowing wells (wells in which water levels are above ground surface elevation) should be calibrated once per year by a licensed or certified company.

APPENDIX D

Standard Operating Procedures for the SCDNR Saltwater Intrusion Monitoring Network

Standard Operating Procedures for the SCDNR Saltwater Intrusion Monitoring Network

Updated July 2021

1. Site visits should be made a minimum of 4 times per year, or approximately once every three months. Visits to conductivity monitoring sites coincide with manual water-level measurement visits. Additional site visits may be necessary to repair/replace malfunctioning equipment or to perform additional site maintenance.

2. Appropriate quality control and quality assurance measures should be implemented during each site visit.

3. Desiccant packs used for vented cables should be replaced with fresh desiccant packs during every site visit.

4. Routine calibrations are done on a 6-month schedule, or approximately twice a year. Off-schedule calibrations may be performed if sensor error tolerance range is greater than 0.5% during a calibration check. A calibration check would be warranted if incorrect measurements (as compared to normal trends) or sensor drift are suspected.

5. Calibration checks and full calibration procedures follow manufacturer's instructions per the Aqua TROLL Operators Manual.

6. If a probe is not communicating or is not operational, try troubleshooting each part of the connection/communication process. Contacting In-Situ technical support may be helpful. If the probe is found to be faulty, retrieve it for return to In-Situ for evaluation. If a replacement is available, install a replacement probe.

7. Model numbers and serial numbers should be documented for all installed ADRs and associated equipment (direct read cables, for example). Any changes to instrumentation must be clearly documented (date and time of change, model and serial numbers of any instrumentation removed along with model and serial numbers of any instrumentation added).

8. Efforts should be made to ensure enough inventory is immediately available in the field to replace ADR equipment when needed to avoid additional data loss.

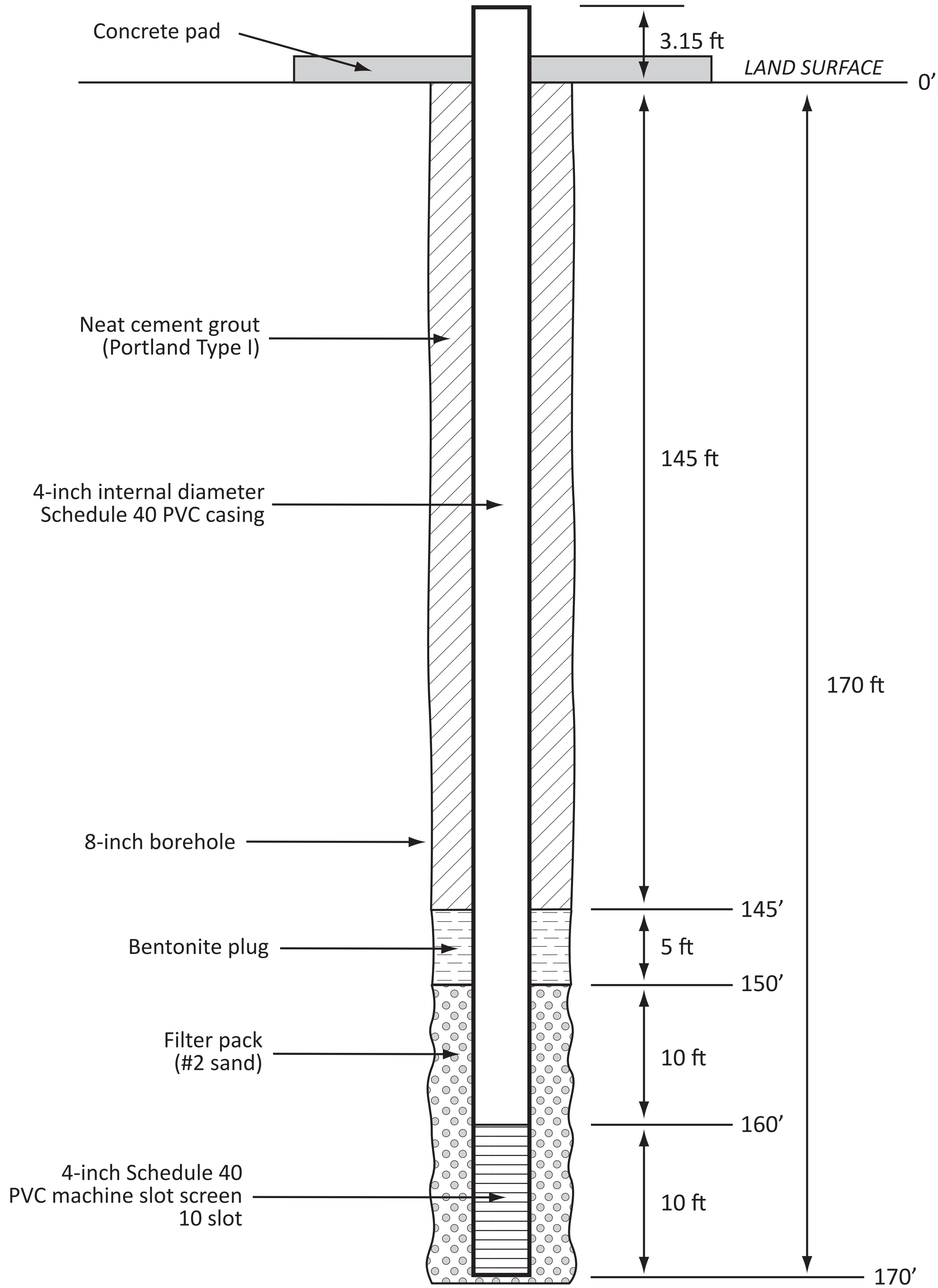
9. Under normal circumstances, data collected during a site visit should be checked for quality control and quality assurance within two weeks of the site visit.

10. If ADR instrumentation at a given site is determined to be malfunctioning while reviewing data in the office, efforts should be made to replace or repair the ADR instruments as soon as possible. This may require additional site visits.

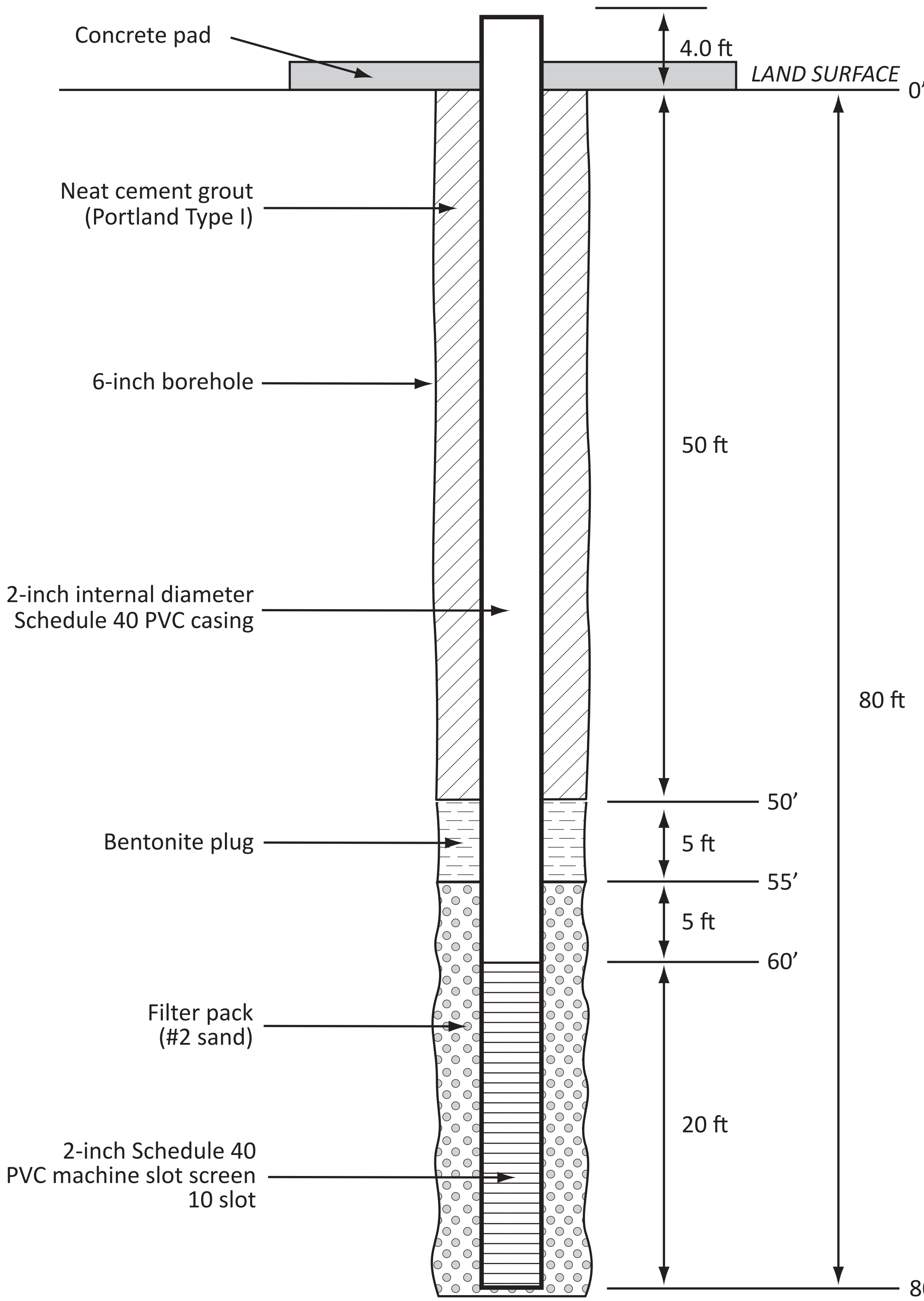
11. Clocks for all instrumentation will be programmed in Eastern Standard Time. Do not adjust for Daylight Savings.

APPENDIX E

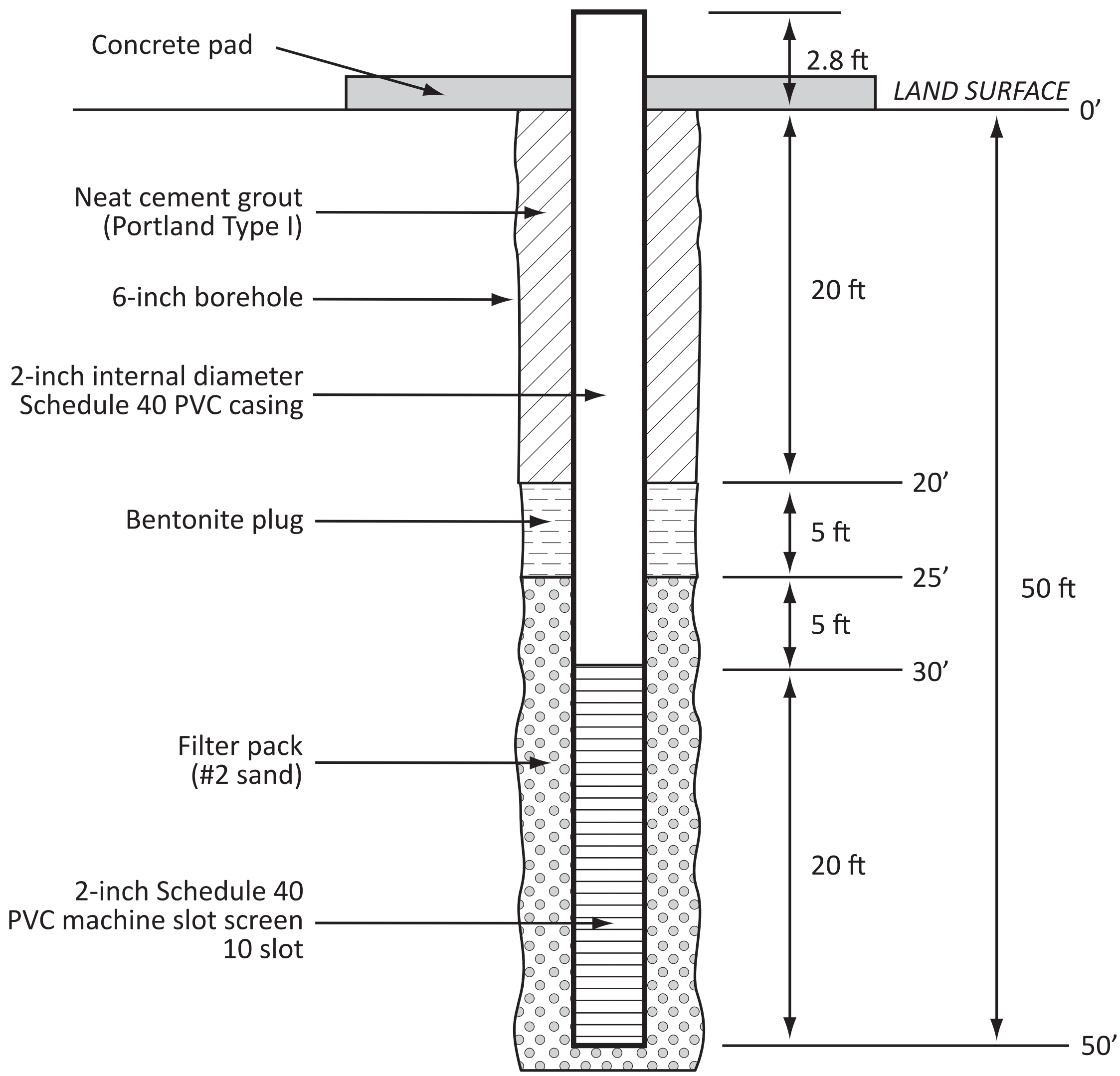
Well Construction Diagrams
for Newly-Drilled Wells Added to the
SCDNR Groundwater Monitoring Network
between July 2014 and June 2019



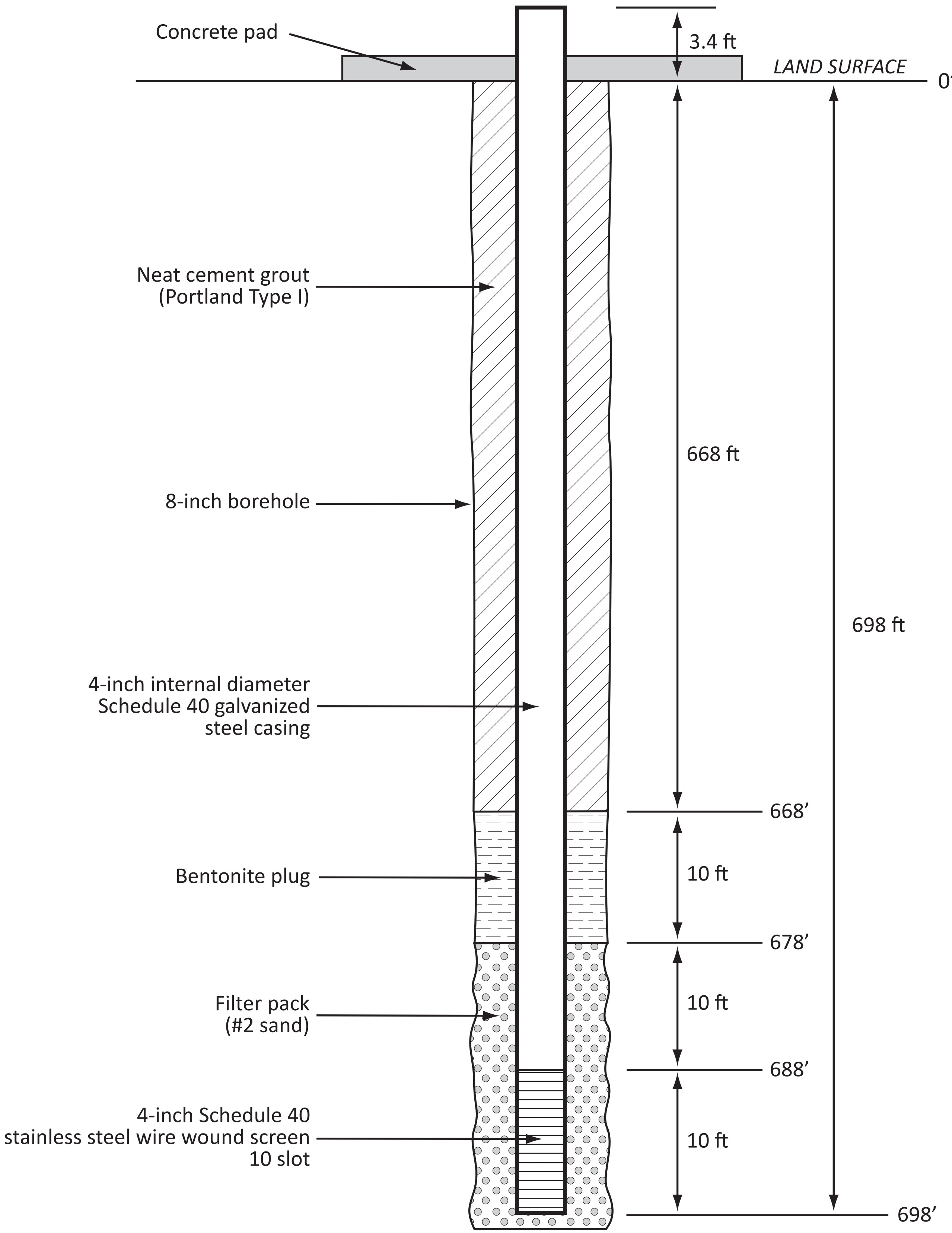
AIK-2733 well construction diagram.



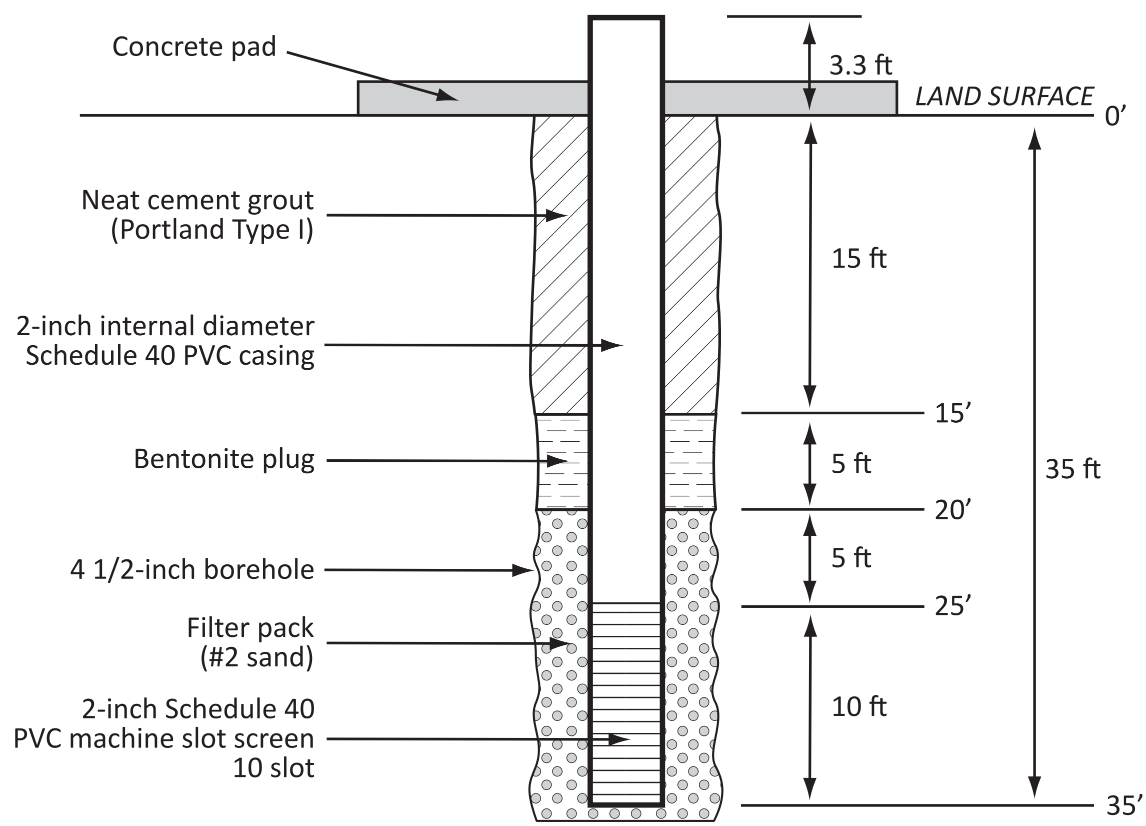
AIK-2741 well construction diagram.



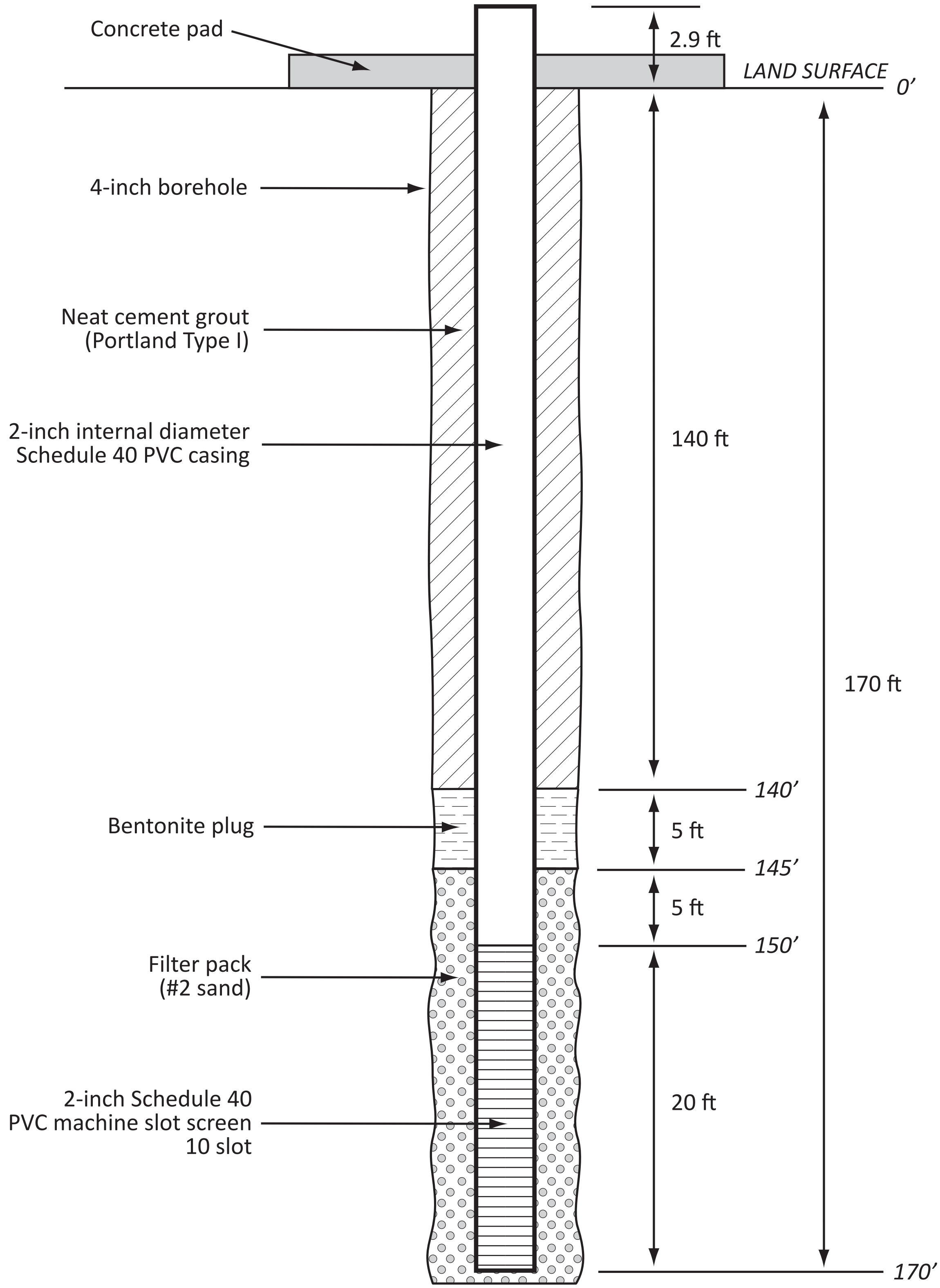
AIK-2742 well construction diagram.



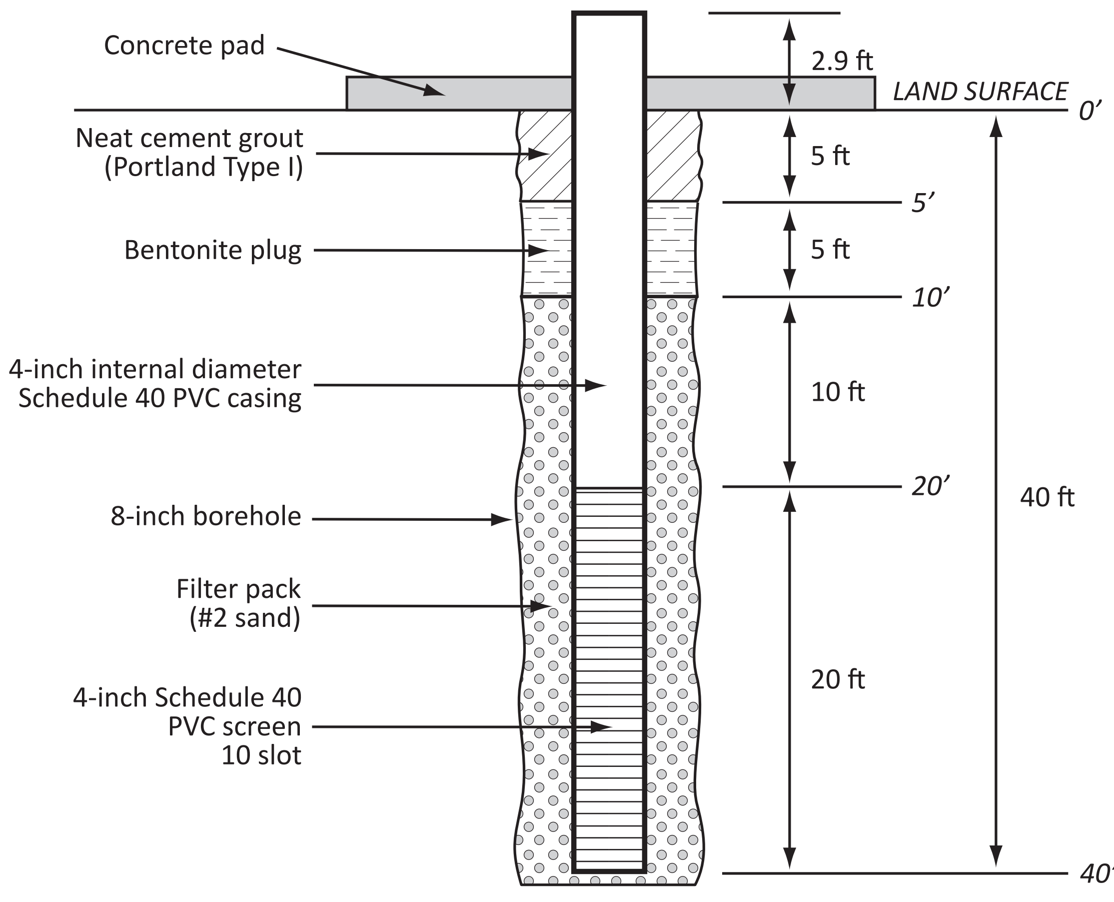
CAL-0215 well construction diagram.



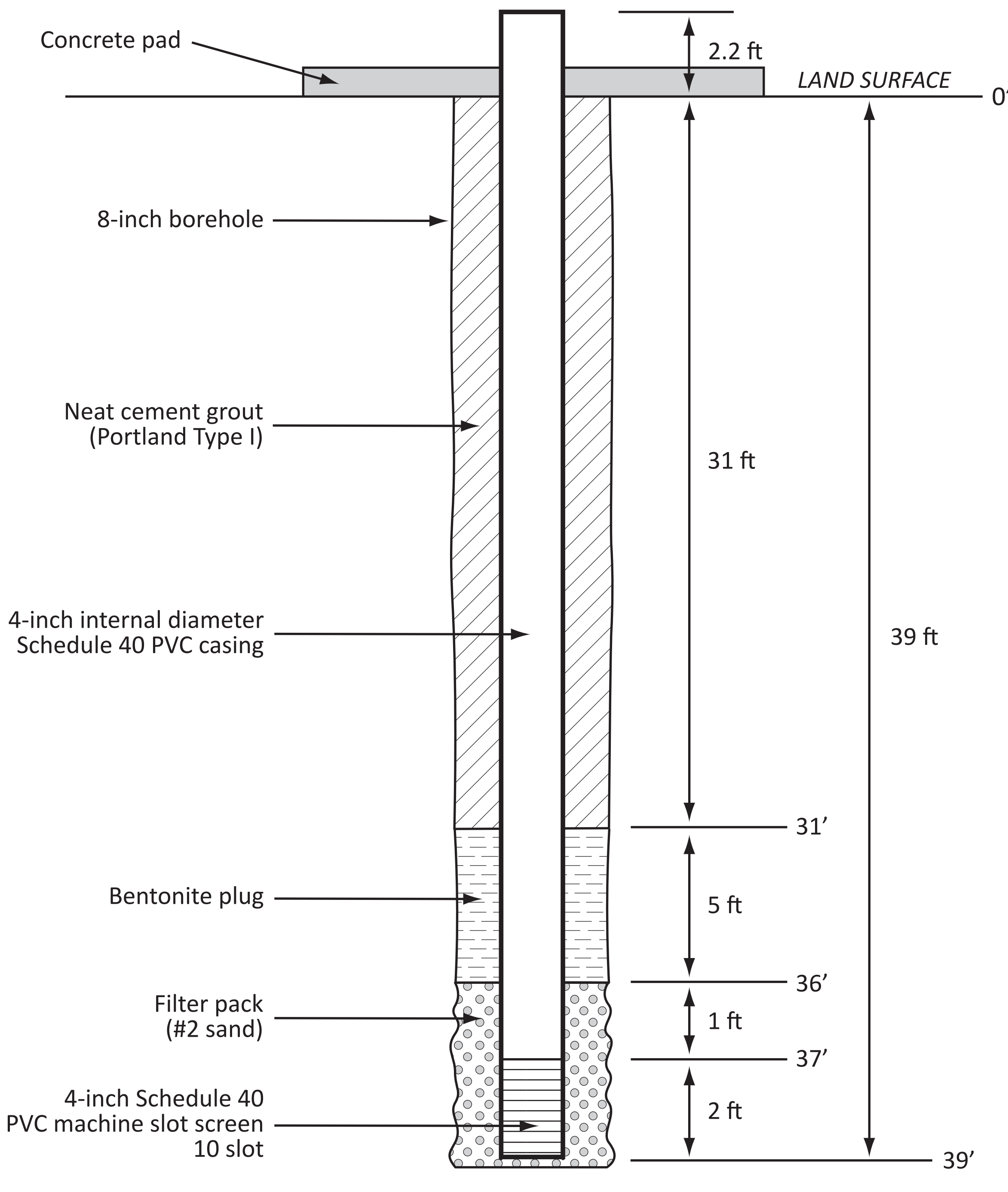
COL-0803 well construction diagram.



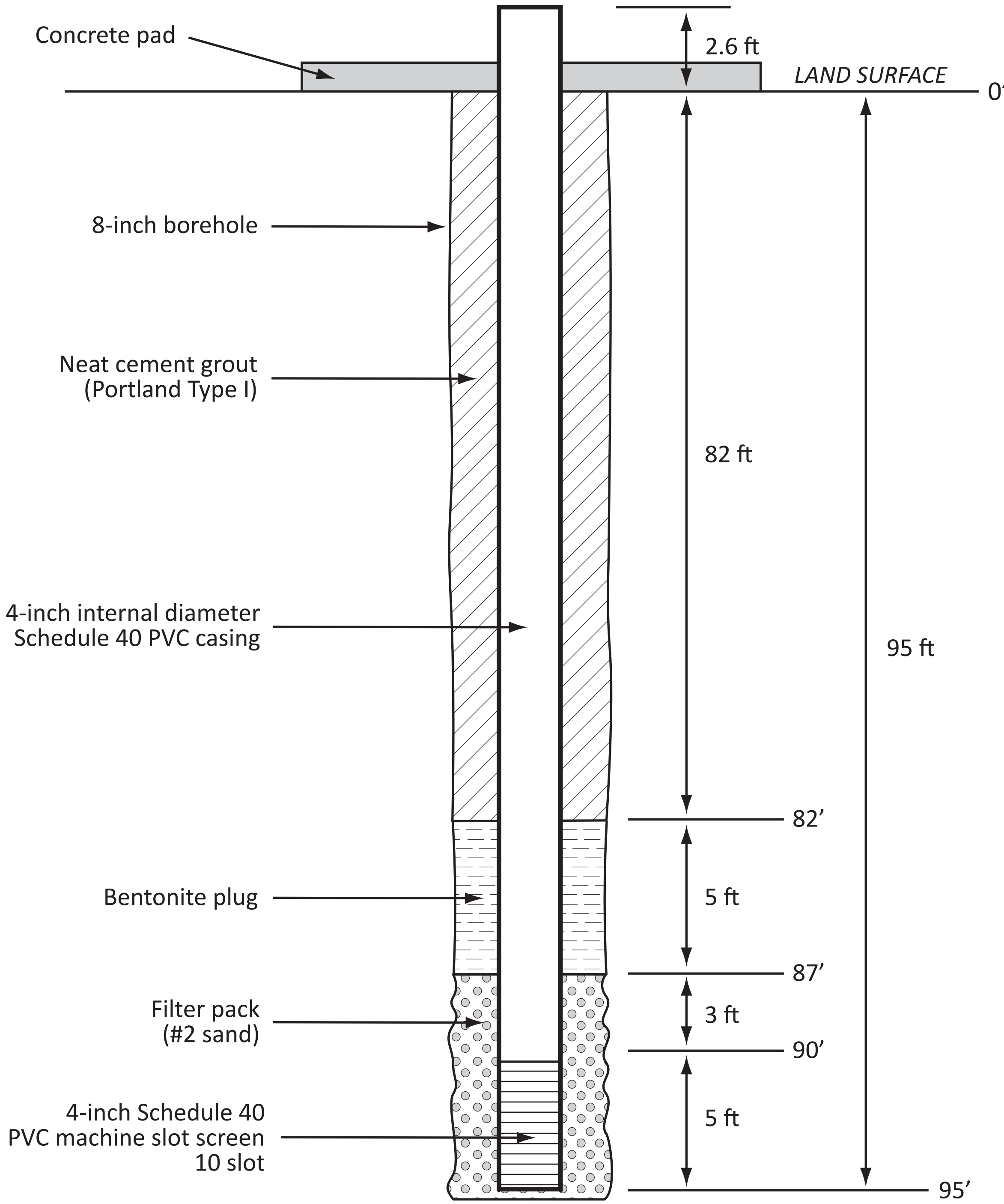
CTF-0325 well construction diagram.



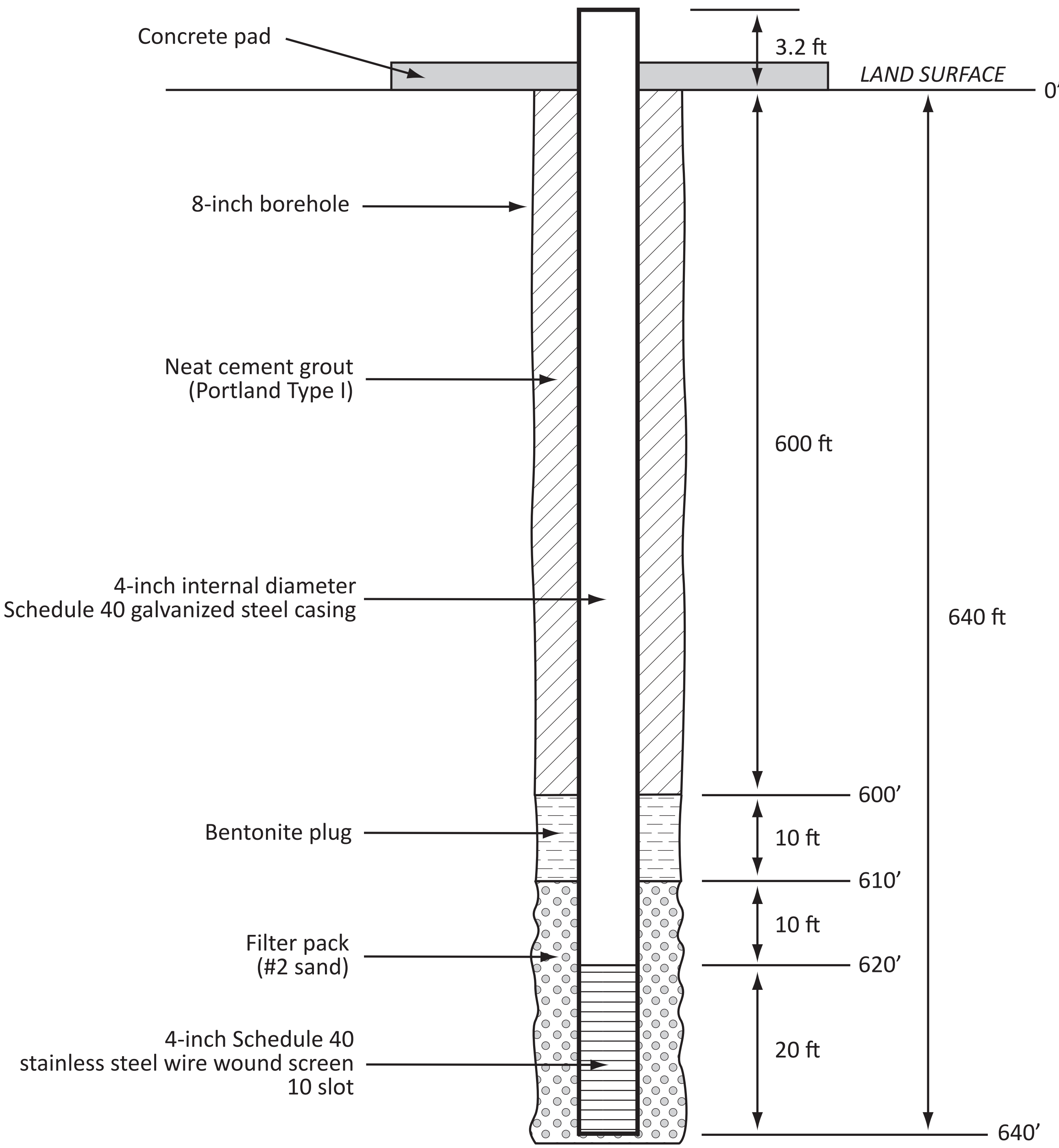
FLO-0484 well construction diagram.



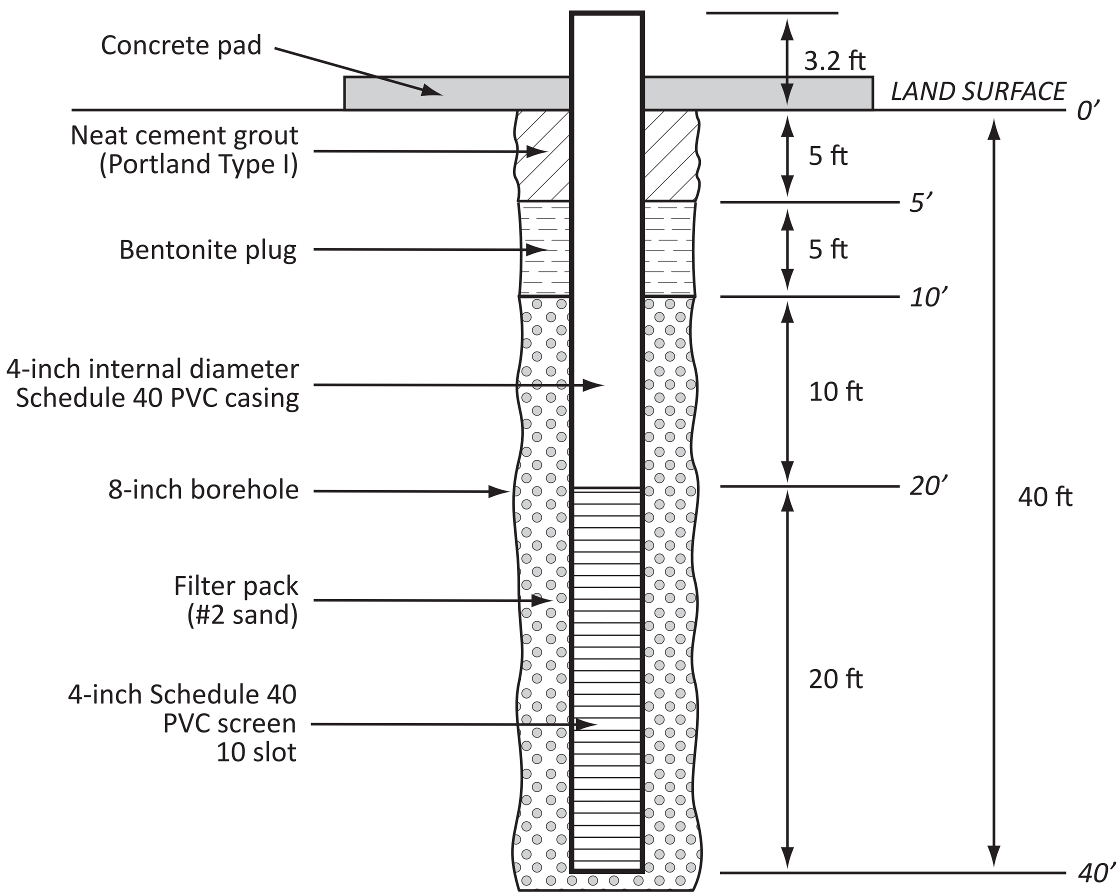
GEO-0386 well construction diagram.



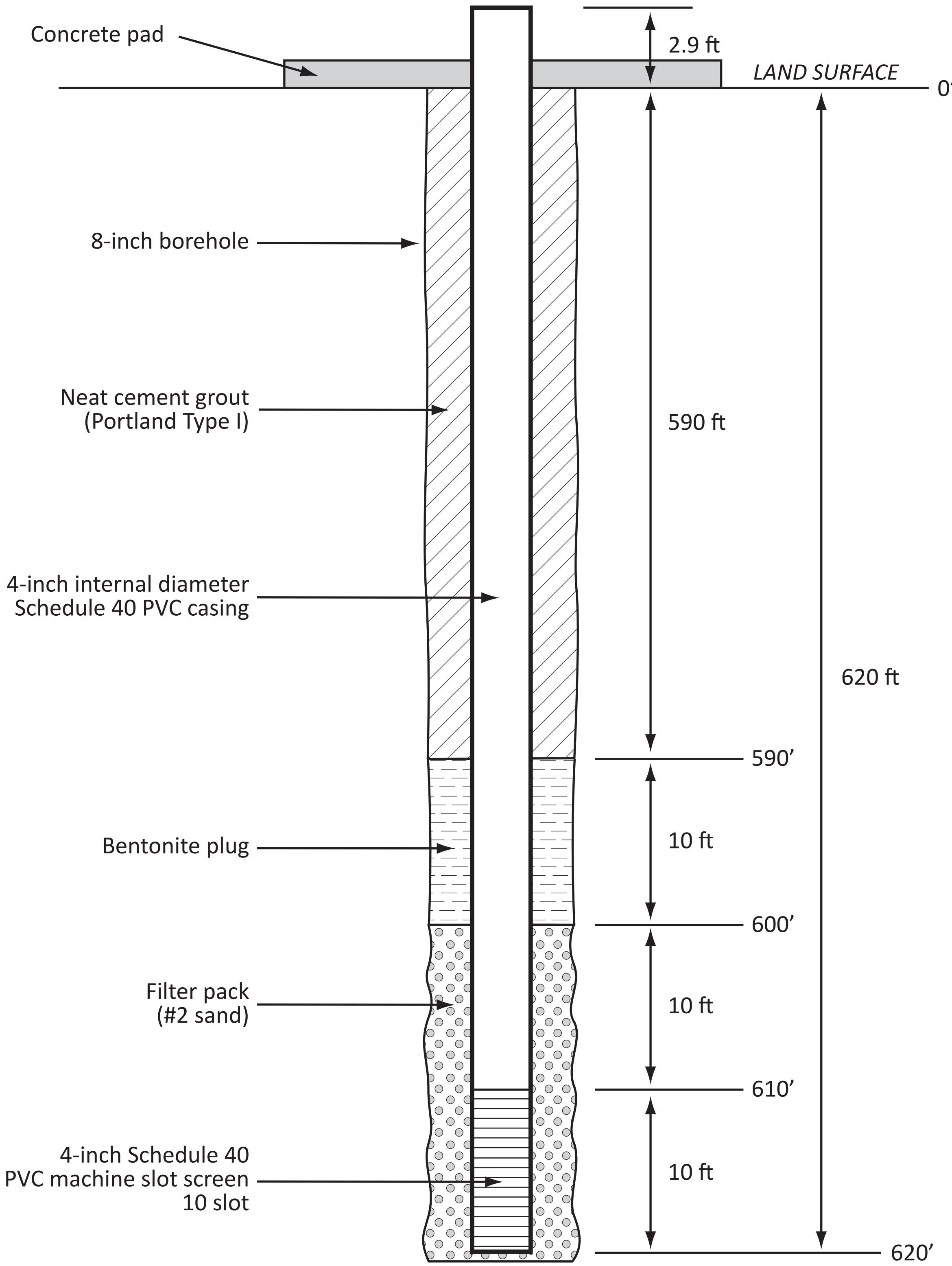
GEO-0387 well construction diagram.



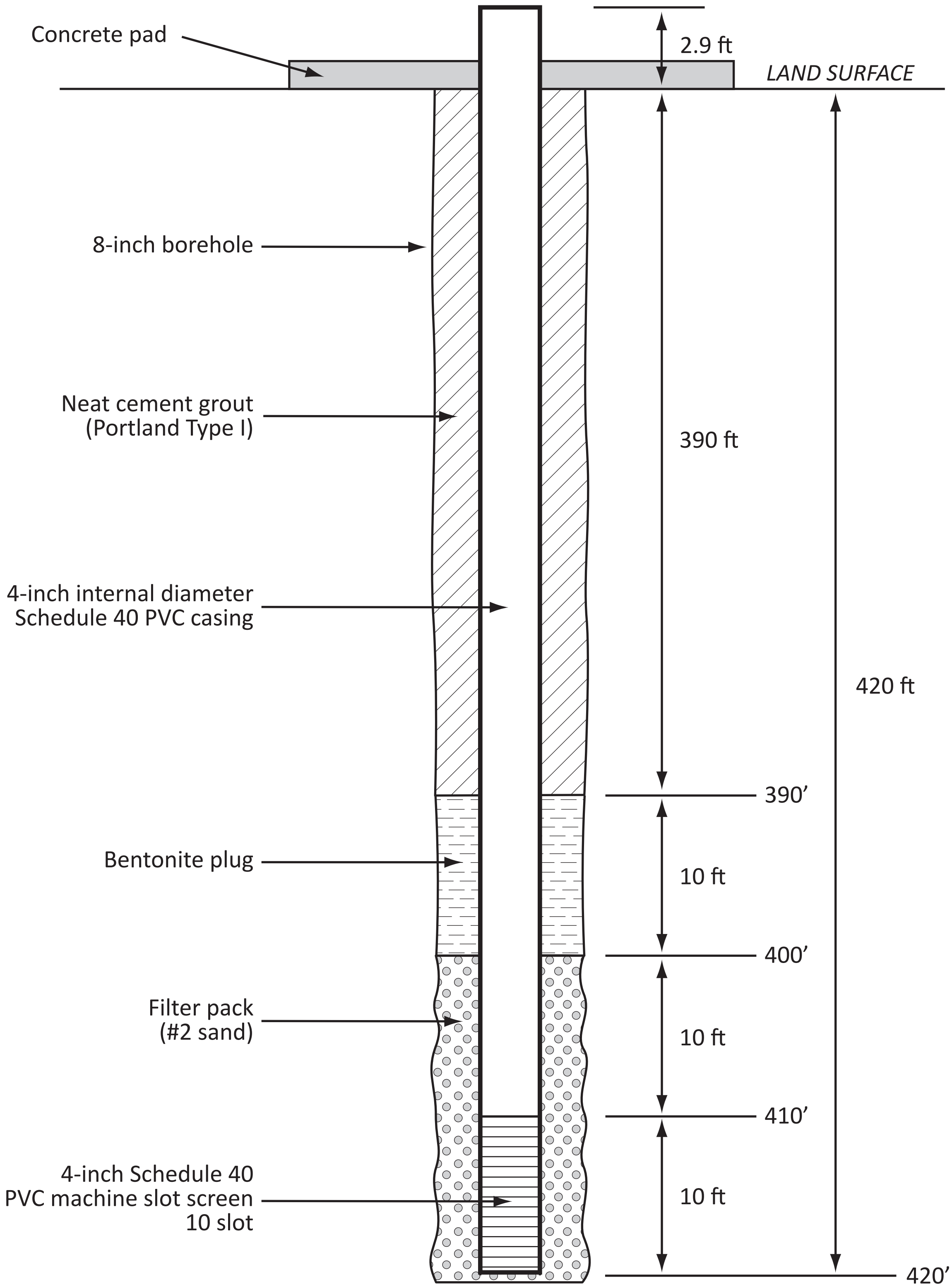
GEO-0390 well construction diagram.



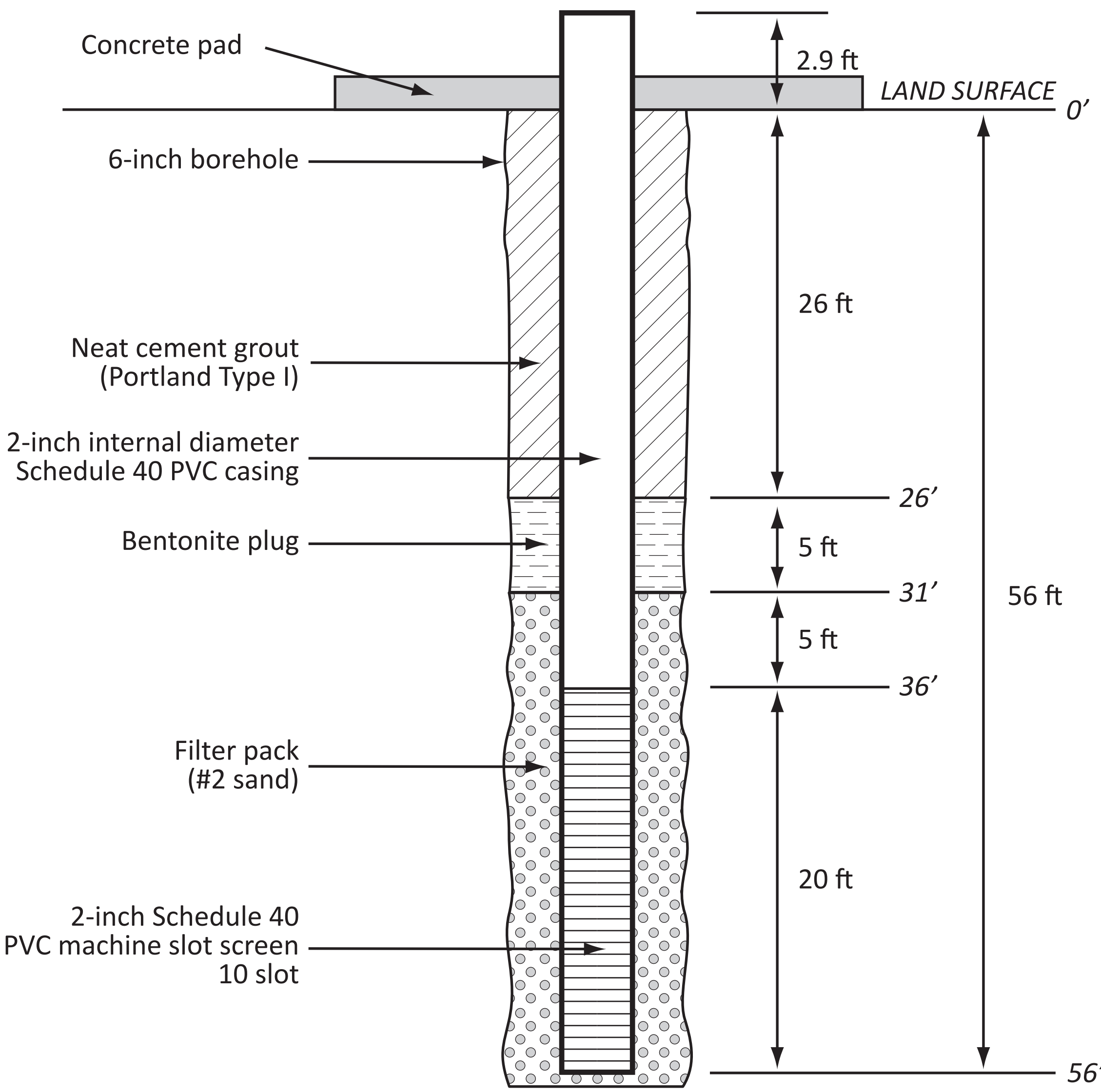
GEO-0391 well construction diagram.



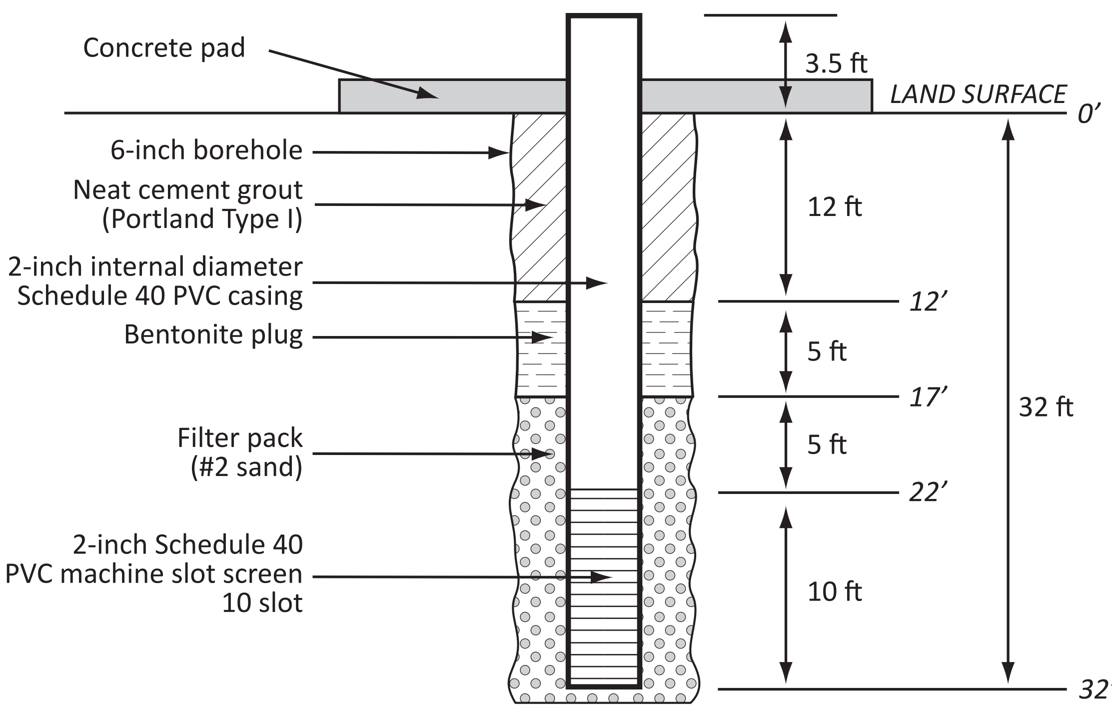
HOR-1326 well construction diagram.



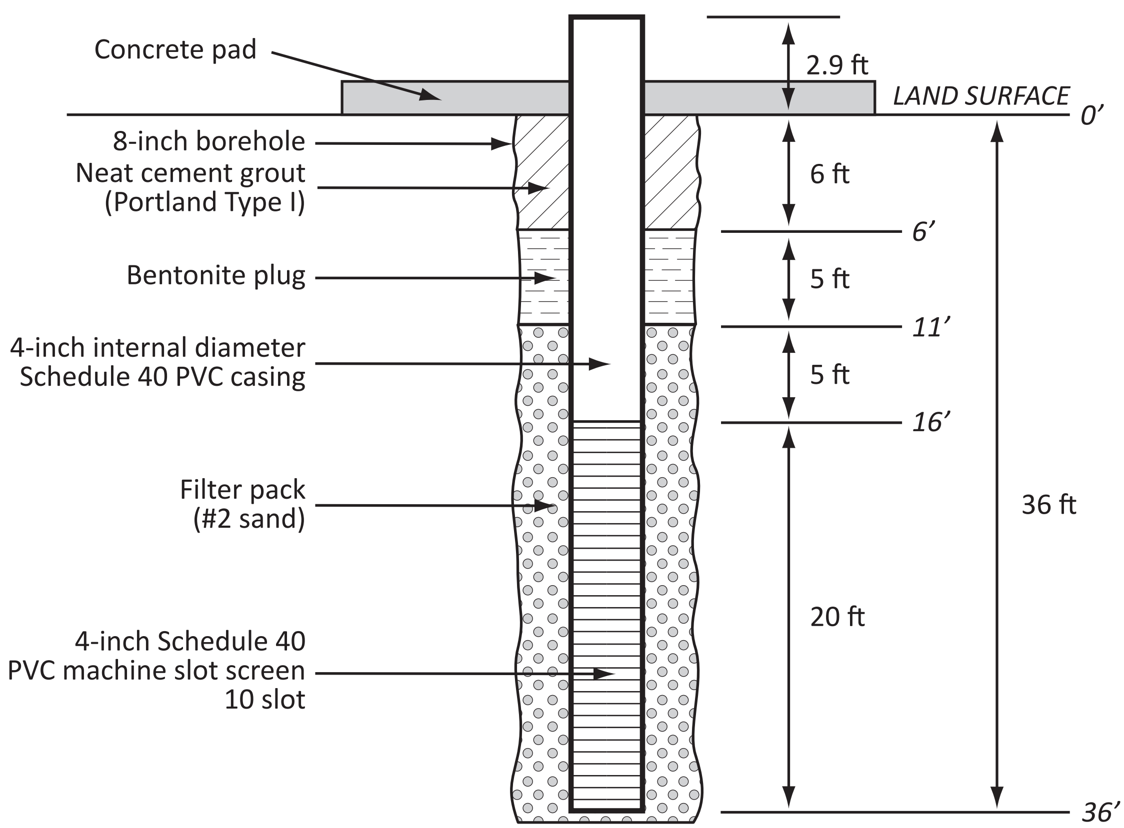
HOR-1327 well construction diagram.



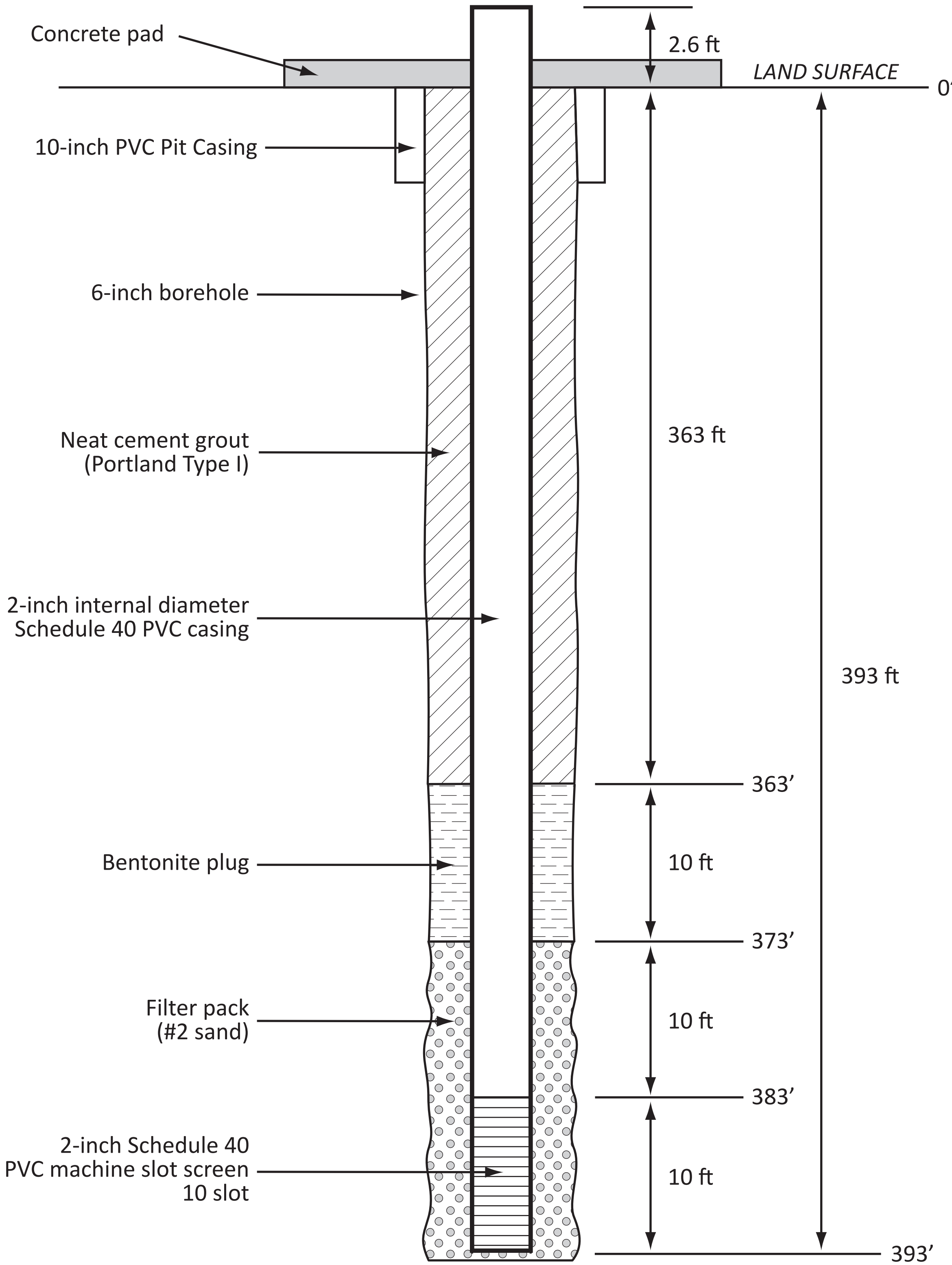
LEX-1702 well construction diagram.



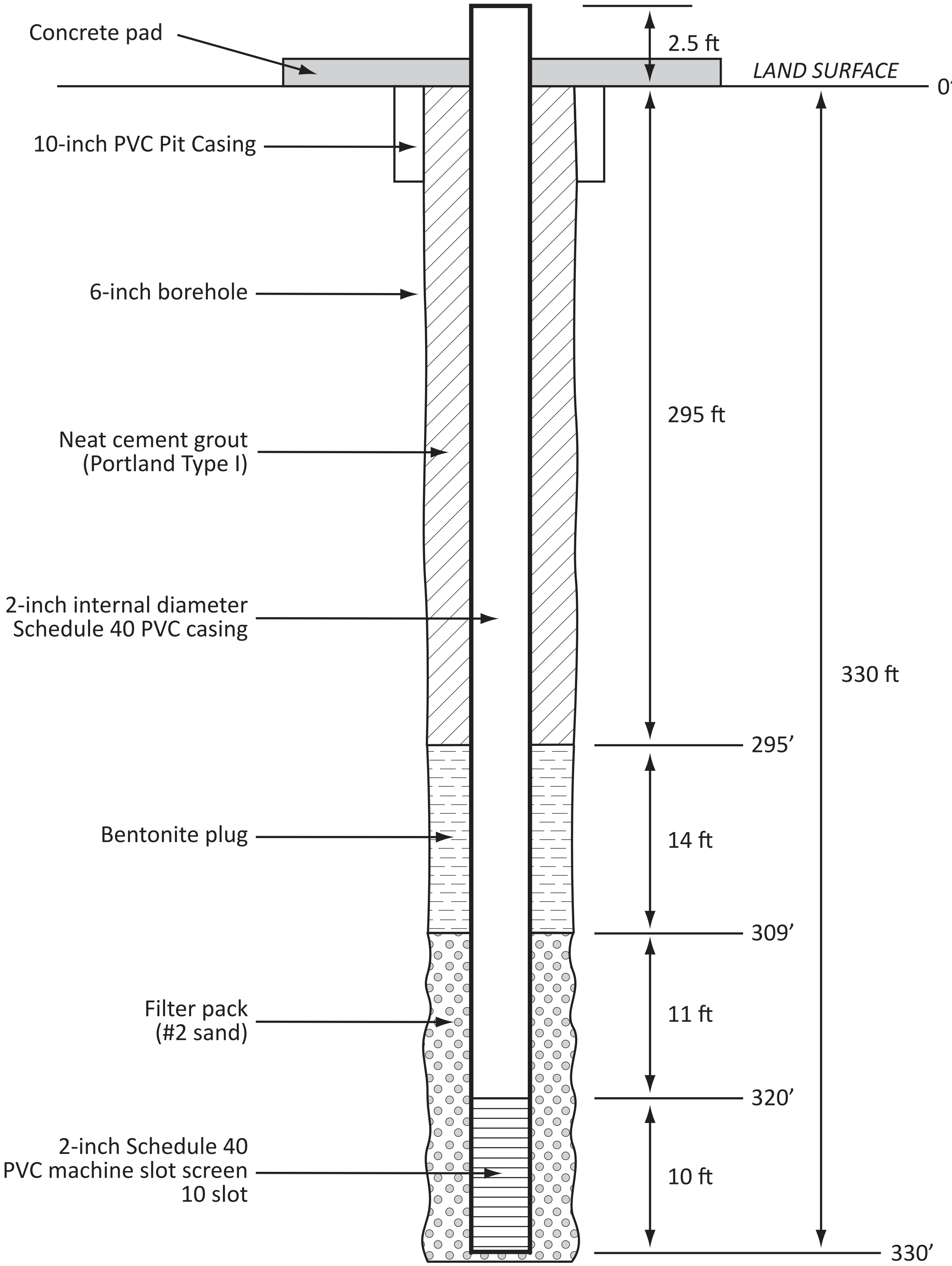
LEX-1703 well construction diagram.



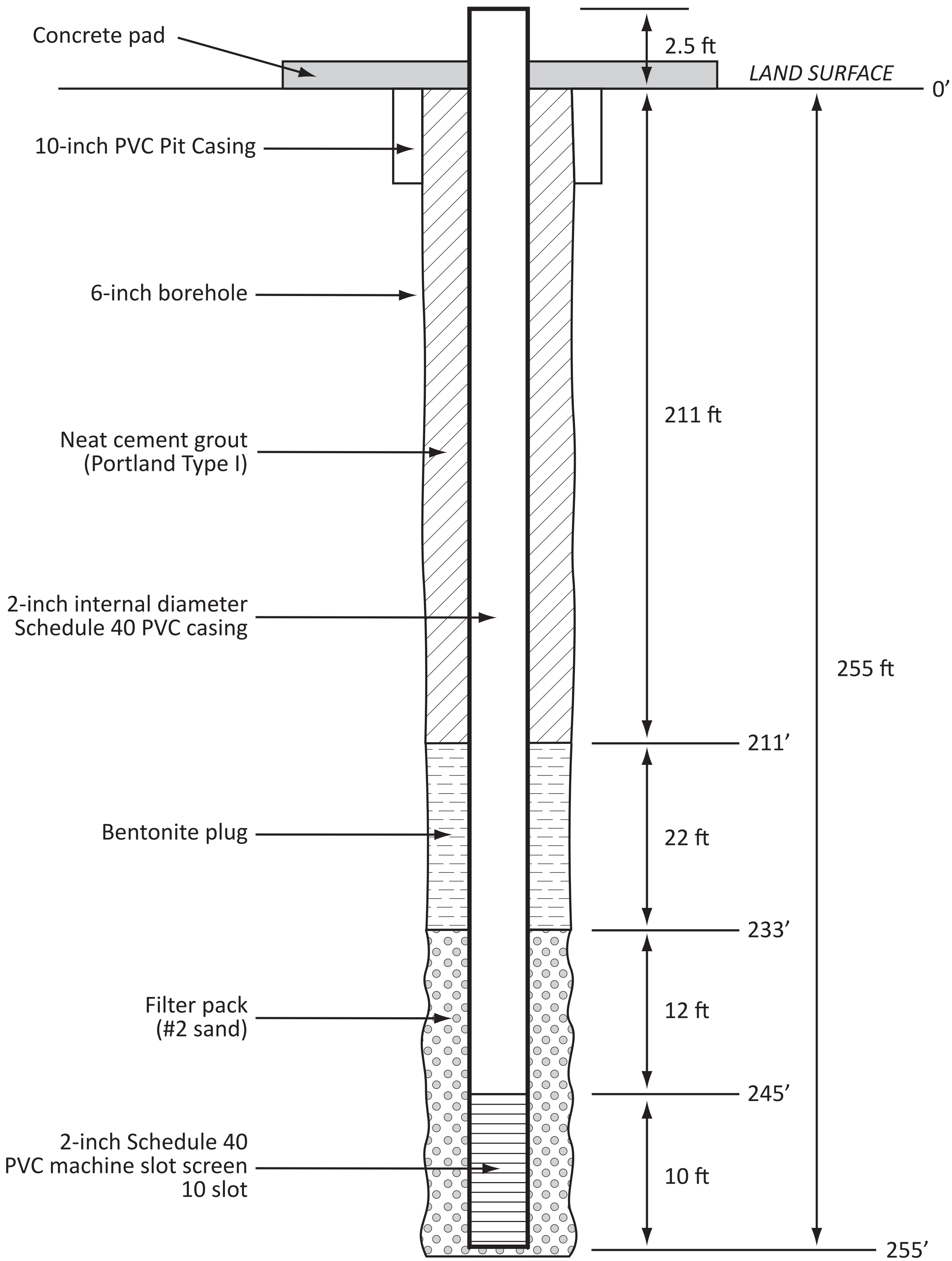
MRN-0178 well construction diagram.



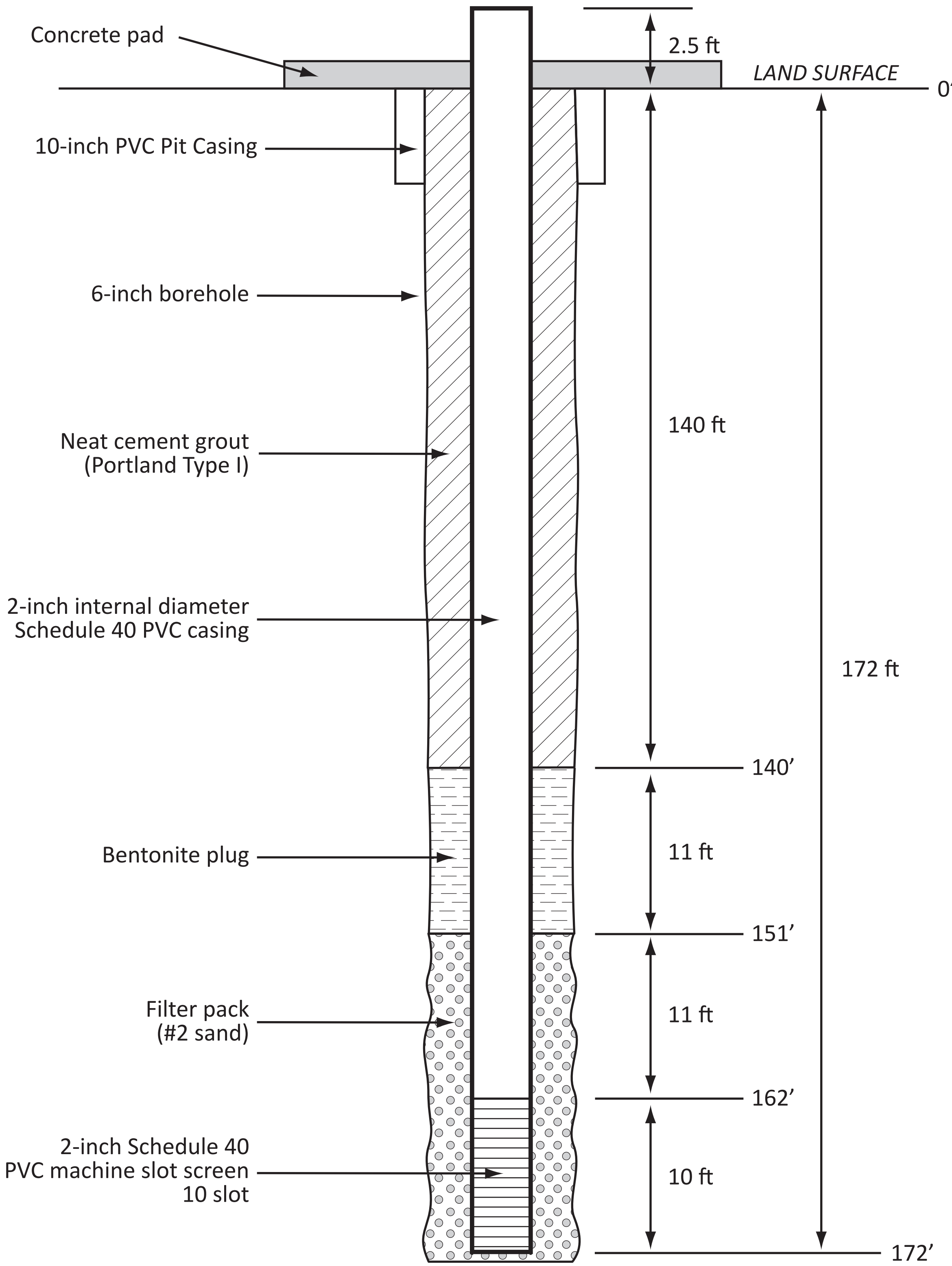
SUM-0504 well construction diagram.



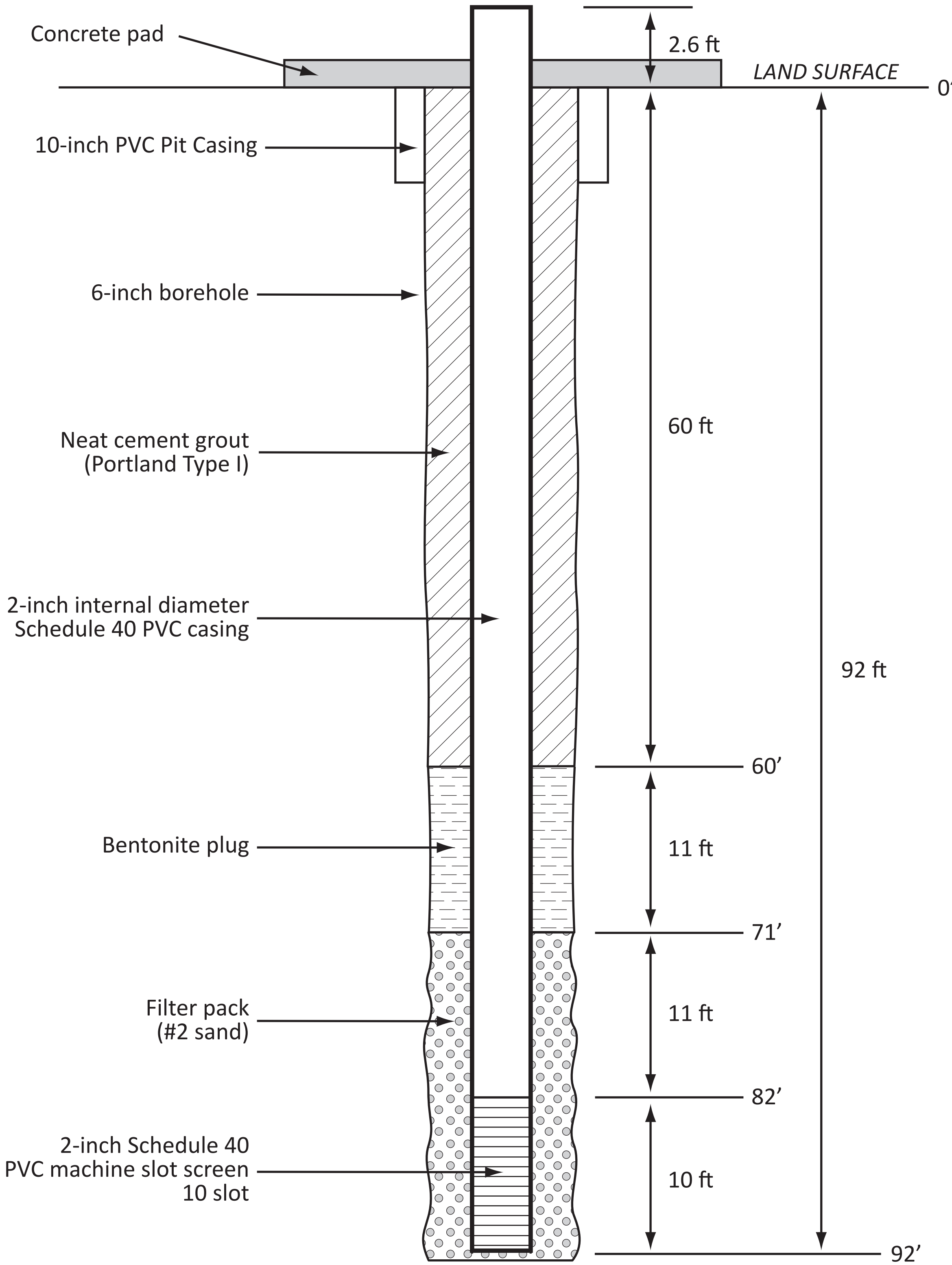
SUM-0505 well construction diagram.



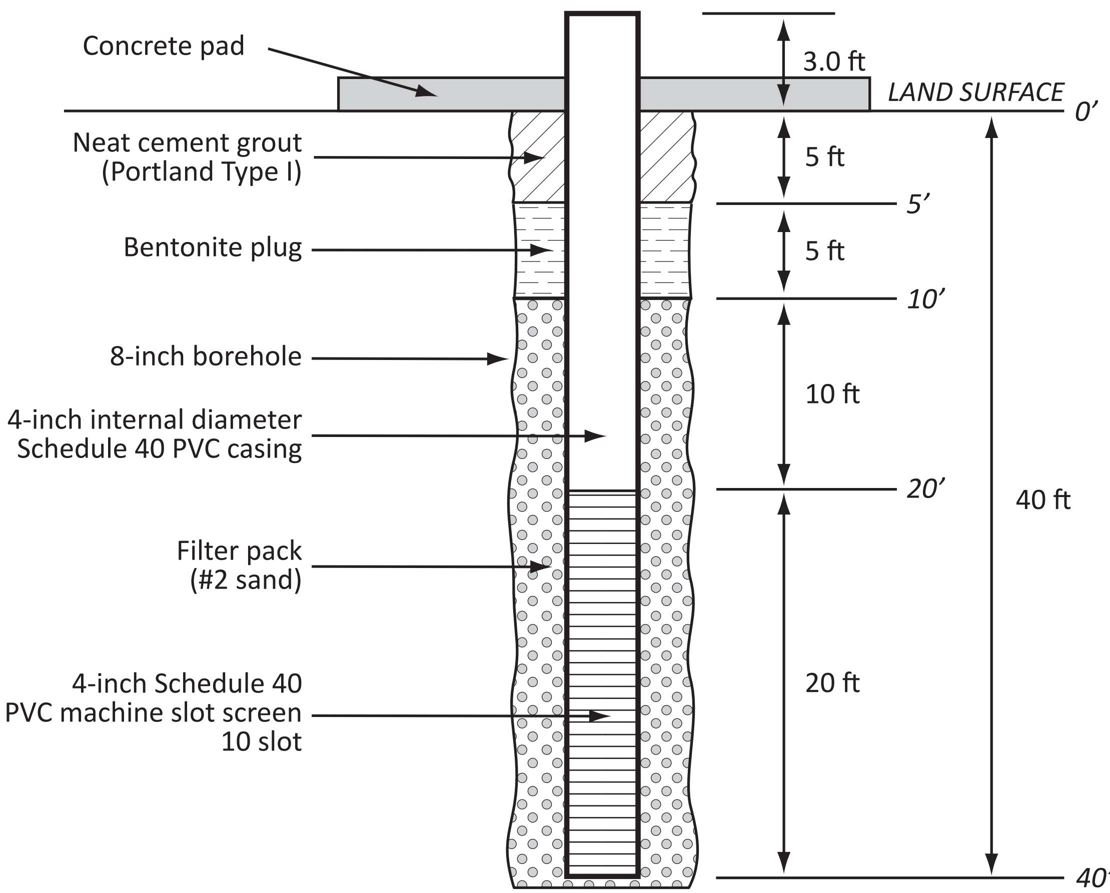
SUM-0506 well construction diagram.



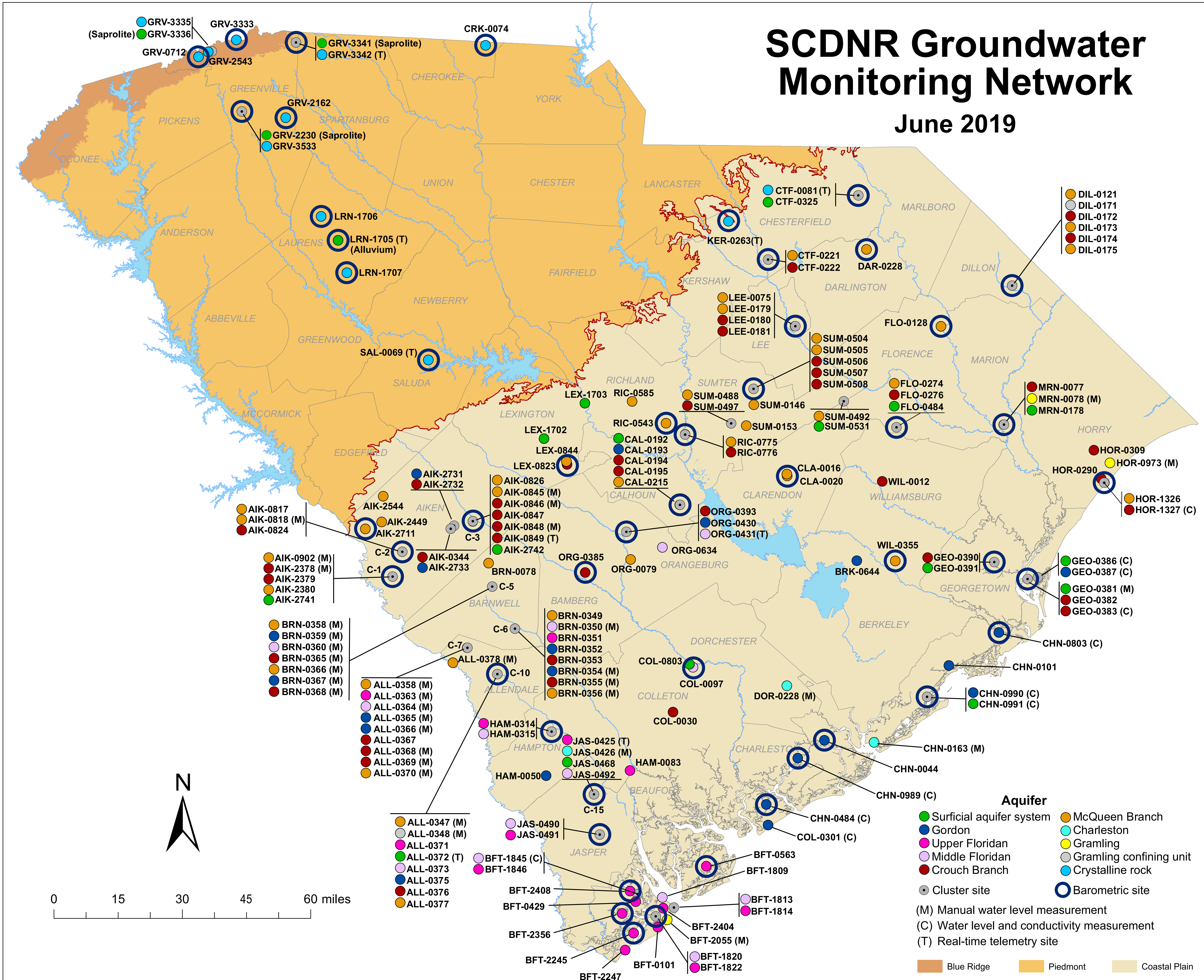
SUM-0507 well construction diagram.



SUM-0508 well construction diagram.



SUM-0531 well construction diagram.


SCDNR Groundwater Monitoring Network
June 2019
GRV-3335
(Saprolite) GRV-3336
GRV-3333
GRV-0712
GRV-2543
GRV-3341 (Saprolite)
GRV-3342 (T)
CRK-0074
CHEROKEE
YORK
GREENVILLE
PICKENS
OCONEE
GRV-2162
SPARTANBURG
GRV-2230 (Saprolite)
GRV-3533
UNION
CHESTER
LANCASTER
CTF-0081 (T)
CTF-0325
MARLBORO
ANDERSON
LRN-1706
LRN-1705 (T)
(Alluvium)
LAURENS
LRN-1707
KER-0263(T)
CHESTERFIELD
CTF-0221
CTF-0222
DAR-0228
DIL-0121
DIL-0171
DIL-0172
DIL-0173
DIL-0174
DIL-0175
DILLON
FAIRFIELD
KERSHAW
DARLINGTON
NEWBERRY
ABBEVILLE
GREENWOOD
LEE-0075
LEE-0179
LEE-0180
LEE-0181
LEE
FLO-0128
SUM-0504
SUM-0505
SUM-0506
SUM-0507
SUM-0508
FLORENCE
MARION
SAL-0069 (T)
SALUDA
RICHLAND
SUMTER
LEX-1703
RIC-0585
SUM-0488
SUM-0497
SUM-0146
FLO-0274
FLO-0276
FLO-0484
MRN-0077
MRN-0078 (M)
MRN-0178
MCCORMICK
LEXINGTON
SUM-0492
SUM-0531
SUM-0153
RIC-0543
HORRY
LEX-1702
CAL-0192
CAL-0193
CAL-0194
CAL-0195
CAL-0215
RIC-0775
RIC-0776
EDGEFIELD
LEX-0844
LEX-0823
HOR-0309
HOR-0973 (M)
AIK-2731
AIK-2732
AIK-0826
AIK-0845 (M)
AIK-0846 (M)
AIK-0847
AIK-0848 (M)
AIK-0849 (T)
AIK-2742
CLA-0016
CLA-0020
WIL-0012
HOR-0290
CALHOUN
CLARENDON
WILLIAMSBURG
HOR-1326
HOR-1327 (C)
AIK-2544
AIKEN
AIK-0817
AIK-0818 (M)
AIK-0824
AIK-2449
AIK-2711
C-3
ORG-0393
ORG-0430
ORG-0431(T)
C-2
AIK-0344
AIK-2733
ORG-0634
WIL-0355
AIK-0902 (M)
AIK-2378 (M)
AIK-2379
AIK-2380
AIK-2741
C-1
ORG-0385
ORG-0079
ORANGEBURG
GEO-0390
GEO-0391
GEO-0386 (C)
GEO-0387 (C)
BRN-0078
BRK-0644
C-5
BARNWELL
BAMBERG
GEORGETOWN
GEO-0381 (M)
GEO-0382
GEO-0383 (C)
BRN-0358 (M)
BRN-0359 (M)
BRN-0360 (M)
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BRN-0366 (M)
BRN-0367 (M)
BRN-0368 (M)
BRN-0349
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BRN-0352
BRN-0353
BRN-0354 (M)
BRN-0355 (M)
BRN-0356 (M)
C-6
BERKELEY
DORCHESTER
CHN-0803 (C)
C-7
ALL-0378 (M)
C-10
COL-0803
COL-0097
CHN-0101
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ALL-0363 (M)
ALL-0364 (M)
ALL-0365 (M)
ALL-0366 (M)
ALL-0367
ALL-0368 (M)
ALL-0369 (M)
ALL-0370 (M)
ALLENDALE
COLLETON
DOR-0228 (M)
CHN-0990 (C)
CHN-0991 (C)
COL-0030
HAM-0314
HAM-0315
JAS-0425 (T)
JAS-0426 (M)
JAS-0468
JAS-0492
HAMPTON
HAM-0083
CHARLESTON
CHN-0163 (M)
CHN-0044
HAM-0050
C-15
BEAUFORT
CHN-0989 (C)
CHN-0484 (C)
COL-0301 (C)
N
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ALL-0348 (M)
ALL-0371
ALL-0372 (T)
ALL-0373
ALL-0375
ALL-0376
ALL-0377
JAS-0490
JAS-0491
JASPER
BFT-1845 (C)
BFT-1846
BFT-0563
BFT-1809
BFT-2408
BFT-0429
BFT-1813
BFT-1814
BFT-2404
BFT-2055 (M)
BFT-2356
BFT-2245
BFT-0101
BFT-1820
BFT-1822
BFT-2247
0 15 30 45 60 miles
Aquifer
Surficial aquifer system
Gordon
Upper Floridan
Middle Floridan
Crouch Branch
McQueen Branch
Charleston
Gramling
Gramling confining unit
Crystalline rock
Cluster site
Barometric site
(M) Manual water level measurement
(C) Water level and conductivity measurement
(T) Real-time telemetry site
Blue Ridge
Piedmont
Coastal Plain