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Acknowledgements

The author would like to thank colleagues in the North Carolina Division of Water Resources, Ground Water Management Branch, for providing summaries for their area of expertise, lists of work conducted in the 2016 FY including well repair and well development, and/or photographs for this report. Thanks are extended to Nat Wilson and Gabrielle Chianese for their contribution to the Central Coastal Plain Capacity Use Area Section, Amy Keyworth for her contribution to the Water Quality Section and Mark Durway for his contribution to the Chloride Section of this report. In addition a special thanks to Barbara Peck and the Ground Water Monitoring Unit staff, Tony Butz, Danny Edwards, Kevin McVerry, and Aiken Small for their part in providing information and photographs and maps to be incorporated in this report. An extended thanks goes to Aiken Small for his continued assistance in data compilation and map production. A very special thanks to Nat Wilson for creating a website/database where all needed information and statistical information were easily accessed. In addition, gratitude and appreciation are extended to Nat Wilson for his patience, time, and review of this report.
1.0 Introduction

The State of North Carolina (the State) relies on ground water for approximately 50 percent of its drinking (potable) water use. In addition, the State has thousands of agricultural and industrial ground water users. The North Carolina Department of Environmental Quality (DEQ), Division of Water Resources (DWR), and preceding agencies have operated, installed, and monitored a statewide monitoring well network from the 1960s to the present. The operation of this monitoring well network is an essential part of DWR’s mission to ensure that the State has an adequate water supply for its citizens. Information collected quarterly from this well network include the following:

- Evaluating climatic influences on the State’s ground water supply, including effects of drought and recharge-discharge relationships;
- Monitoring human-induced impacts on the State’s ground water supply, particularly in the regional aquifer systems of the Coastal Plain physiographic province. These effects include local and regional water level declines as well as migration of the fresh water-salt water interface within various aquifers;
- Providing supporting data for enforcement and creation of current and future ground water usage regulations, such as the Central Coastal Plain Capacity Use Area rules;
- Periodic sampling of the monitoring well network to establish background levels for constituents (e.g. nitrates, etc.); and
- Providing high quality ground water data to local governments, ground water professionals, and the general public to use in making informed decisions in ground water related issues.

Data collected from the network are available to the public through DWR’s internet website, [www.ncwater.org](http://www.ncwater.org). These data include ground water levels, chloride measurements, well construction information, borehole log construction (lithological and geophysical), ground water monitoring station locations, and geophysical/lithological data collection from non-DWR well sites.

2.0 Purpose and Scope

The 2016 Annual Report summarizes field activities and conclusions derived from activities performed or associated with the Ground Water Management Branch during the July 1, 2015 through June 30, 2016 fiscal year (2016 FY). These activities include the ground water monitoring well network water level and water quality data statistics, monitoring well installations including new installations and acquired wells, monitoring equipment usage and evaluations, site surveys, local monitoring well network information, and a summary of the Central Coastal Plain Capacity Use Area 2016 FY activities.

3.0 Background

DWR and its predecessor agencies have operated the statewide Ground Water Resource
Monitoring Program from the 1960s to the present. The active monitoring well network has expanded by approximately thirty-eight percent (251 monitoring wells) by either installation or acquisition of new monitoring wells since 1998.

The U.S. Geological Survey (USGS) has also contributed to the monitoring of the State’s ground water resources under a cooperative agreement between the State of North Carolina and the Federal government. The cooperative well network consists of 12 monitoring wells, many of which are also part of the DWR statewide network.

4.0 DWR Statewide Monitoring Well Network Overview

4.1 Description

The monitoring well network currently consists of 650 wells at 224 monitoring stations (sites), divided into six regions, comprising 65 counties (Figure 1). There are 49 wells located in the Piedmont and Mountain physiographic provinces (Piedmont and Mountain) and 601 wells located in the Coastal Plain physiographic province (Coastal Plain). The Coastal Plain relies more heavily on ground water supplies than either the Piedmont or Mountains. Subsequently, ground water monitoring and research have been more concentrated in the Coastal Plain.

In the past few years, more resources have been invested in monitoring the Piedmont and Mountain ground water conditions to better understand the impact of drought cycles on ground water supplies and their contribution to surface water flow. There are 40 DWR wells within the monitoring well network used to assess drought conditions in the 2016 FY (Figure 2).
Of the 224 monitoring stations, 81 are on State or Federal property, 55 are located on property owned by local governments, 85 are located on private property through agreements with landowners, and 4 stations are located on properties where the landowner indicates that the land property ownership may change. In the past, some wells have been abandoned at the landowner’s request due to changes in land use or ownership. Due to the high cost of well construction, combined with the fact that the wells are most valuable when they are monitored continuously over a period of decades, every attempt is made to put new stations in secure, stable locations. A scale has been developed to rank new and existing well sites for potential well abandonment due to land-use issues in the future (Table 1). It is preferred that new wells be installed at sites with a susceptibility rating of 1 or 2.

4.2 Monitoring

The statewide monitoring network is divided into six regions (Figure 1). One staff member is responsible for each region. Staff member responsibilities include visiting the wells quarterly to collect water level data, collecting data from drought wells monthly if needed, performing routine site maintenance, keeping automatic data recorders in working order, and keeping sites accessible and

Video-logging
Deep Creek Campground Station, O97L
Swain County

Video-logging
Stillwell Building, Q94J
WCU Campus
esthetically pleasing. Additional site activities (i.e. recorder removal/replacement, site maintenance, video-logging, etc.) are conducted on an as needed basis.

Depth to ground water level measurements are collected from the network in two different ways. Manual water levels are measured using electronic water level indicators. Hourly water level measurements are collected using unvented pressure transducers. Hourly water level data are extremely valuable in assessing aquifer recharge, impacts of large storms on ground water conditions, and delineation of aquifer boundaries. Manual water level readings and daily automatic recorder water level data are typically published on the DWR website. However, hourly data is available upon request for specific wells. Table 2 summarizes site and recorder distribution by region.

In addition to the recorders mentioned above, Solinst Telemetry System (STS) recording units have been installed in twelve wells that are included in the Drought Indicator Well network. They consist of one
pressure transducer, one barometer, and are powered by a twelve-volt battery. Data is collected by a controller unit that stores hourly readings. The readings are sent to the home station (DWR web page server) every reporting interval (currently 3 hours) via a cell phone modem. DWR uses the STS system on the Drought Indicator Well network to take the place of monthly visits. They are serviced every quarter or semi-annually depending on battery life. The STS data is especially helpful in keeping the Drought Indicator well water levels up to date (www.ncwater.org/?page=345). Table 3 summarizes STS system information.

Four additional STS systems were purchased in the 2016 FY and will be installed in September-October 2016 (2017 FY).

4.3 Chloride Sampling

Triennial chloride samples are collected from select wells in the Coastal Plain. The samples are analyzed using the Quantab® field method. Field results are used to monitor the migration of the fresh water-salt water interfaces in the Coastal Plain aquifers. Additional chloride samples are collected for field analyses when new monitoring wells are installed and as needed for special projects. The next chloride sampling event will occur September-October 2018. However, select wells will be sampled for chlorides in September-October 2017 to better assess salt water encroachment conditions in the 2018 triennial chloride sampling event. Section 5.2 summarizes the 2015 chloride sampling event.

5.0 Well Network Statistics

5.1 Ground Water Data Collection

Depth to ground water was measured in 645 wells in the 2016 FY. Table 4 contains DWR monitoring well network statistics from January 1, 2005 through June 30, 2015. Statistics may vary in comparison to previous years due to additional data entry in the DWR database as older field books are scanned and unrecorded data entered. Figure 3 compares the number of wells monitored to the water level data collected from the network from 1967 to present. Hourly water level data is not included in this graph. Calendar year 2015 represents the most water level data collected in any single year since starting the monitoring well network operation. The 2016 data was collected from July 1, 2015 through June 30, 2016.

Archived water level recorder charts obtained from DWR and its predecessor agencies, with records dating from the 1960s through 1980s, continue to be digitized and data recorded into the DWR online database. Additional continued digitized information recorded in the database includes, but is not limited to, well construction records, well development information, chloride sampling events, memorandums of agreement, and field notes.

5.2 Triennial Chloride Sampling

A triennial chloride sampling event was performed in 2015. Ground water from 258 wells within the network were sampled for chlorides using Quantab® chloride titrators between
August 24, 2015 through October 29, 2015. Field data were collected for pH, conductivity, and salinity using YSI® portable probes.

The intention of the triennial chloride sampling is to assess the position of the fresh water-salt water interface within each of the major coastal plain aquifers. Current results are compared to results of previous sampling events to evaluate potential landward migration of the fresh water-salt water interface due to aquifer overuse. Chloride sampling results are posted in the database and the DWR website. The following graph illustrates the typical database detail of parameters for a well hydrograph.

Sampling results indicate that there continues to be concern for salt-water encroachment, especially near larger pumping centers located near the fresh water-salt water interface (250 parts per million (ppm) chloride is considered salt water). The 2015 chloride field sampling results associated with wells near larger pumping centers illustrate these types of issues:

- Chloride concentrations from September 9, 2015 in the lower Castle Hayne aquifer well Q16G4 at the Godley Station continue to indicate salt water intrusion with levels of 554 ppm which exceed the 250 ppm threshold for salt
water. This station is located near PCS Phosphate Inc. at Aurora, NC in Beaufort County.

- Chloride concentrations from the PeeDee aquifer well Y25Q4 at the Folkstone Station show an increase in chlorides from 227 ppm in September 2012 to 272 ppm on September 1, 2015 exceeding the 250 ppm threshold for salt water. Even though the September 12, 2012 results indicate levels below 250 ppm, samples collected July 9, 2011 (296 ppm), September 25, 2007 (252 ppm), and September 14, 2004 (266 ppm) each indicated chloride levels exceeding the 250 ppm threshold for salt water. This station is located near the ONWASA Dixon well field in Onslow County.

- Chloride concentrations from the Upper Cape Fear aquifer well J22P5 at the Gold Point Station increased from 172 ppm on September 6, 2012 to 186 ppm on September 8, 2015. This station is located near the town of Robersonville in Martin County.

- Chloride concentrations from the Upper Cape Fear aquifer well R23X9 at the Cove City station decreased from 405 ppm on September 11, 2013 to 388 ppm on August 24, 2015. The well still exceeds the 250 ppm threshold for salt water. This well is located near the town of Cove City, North Carolina.

Twenty samples were collected from the Cretaceous Lower Cape Fear Aquifer (Klcf). Field results indicate that between 2012 and 2015, Klcf chloride levels decreased in eleven of the twenty wells (Figure 4). The anomalous decreases may be in response to recent pumping.
reductions within North Carolina's Central Coastal Plain Capacity Use Area and International Paper in Franklin, Virginia. This deviation from previous data trends is under investigation.

Table 5 summarizes the chloride field analysis to date for specific wells. Chloride sampling will take place in September and October 2018. However, select wells will be sampled for chlorides in September-October 2017 to better assess salt water encroachment conditions in the 2018 triennial chloride sampling event.

5.3 Well Installation and Development

From April 2016 through May 2016, the following monitoring wells were installed using the mud rotary drilling method:

- Holly Shelter Station, Pender County, four wells, Z29N1, Z29N2, Z29N3, and Z29N4; and
- Castle Hayne Park Station, New Hanover County, three wells, CC30E1, CC30E2, and CC30E3.

A pilot hole was advanced at the Holly Shelter Station, Pender County, and the Castle Hayne Park Station, New Hanover County. Each pilot hole was advanced using the mud rotary drilling method. Samples of the drill cuttings were collected at ten-foot intervals in order to assess the borehole lithology. In addition, a borehole geophysical log was obtained by lowering a probe into the borehole once the borehole was completed. The geophysical log makes a detailed record of the geologic formations in the borehole. Geophysical and lithologic log interpretation enabled
the DWR staff to assess well screen intervals and the number of wells to be installed. The wells were installed using 4-inch PVC riser and 10 or 20 feet of 4 to 4.5-inch stainless steel continuous wire wrap V-slot screen. The wells were constructed of a gravel pack extending from the bottom of the screen to a minimum of five feet, but no more than ten feet, above the screen. A minimum of ten feet of bentonite overlays the top of the gravel pack in order to provide a sufficient bentonite seal in the well. Table 6 summarizes the monitoring well construction information. These wells are included in Figure 1. Well construction records for the 2016 FY installed wells are included in Appendix A.
Development removes fine-grained sediments from the vicinity of the well screen and ensures proper hydraulic connection with the aquifer. During development field data were collected for pH, conductivity, salinity, and temperature in thirty minute or hourly intervals. Field data exhibiting overall consistency was used to assist in the decision to stop well development. Monitoring wells developed in the 2016 FY are listed in Table 7.

Chloride measurements were collected in each newly constructed monitoring well at the Holly Shelter Station after DWR well development in the 2016 FY. Although some development occurred after the Castle Hayne Park Station well drilling, DWR staff plans to further develop that station as well as redevelop several other existing monitoring wells in the 2017 FY.
5.4 Well Maintenance

The well network requires continual maintenance to keep active monitoring stations usable. Many of the wells exceed 30 years in age and are constructed of materials that are susceptible to corrosion, especially in acidic or saline groundwater conditions. Some older wells were constructed with outdated, less than desirable construction practices including backfilling boreholes with cuttings instead of neat cement or bentonite grout. Boreholes backfilled with cuttings form an inadequate seal and allow other aquifers to influence the water level and water quality in that well. Another outdated practice included well construction using telescoped casing. Telescoped casing uses a reducer to trim the well to a smaller diameter casing at depth apparently to save money during well construction. Telescoped wells are very susceptible to blockage at the depth of the reducer. Approximately 152 wells in the network were constructed with reducers. DWR has implemented a long-term program for replacing...
damaged or unsuitably constructed wells with new, properly constructed wells.

Wells repaired in the 2016 FY are listed in Table 8.

5.5 Acquired Network Wells

DWR acquired eleven existing wells which were included into the monitoring well network in the 2016 FY. Table 6 includes the detailed information about the acquired monitoring wells. These wells are also included in Figure 1.
5.6 **Automatic Water Level Recorders**

Automatic water level recorders play an integral role in the DWR monitoring program. Hourly water level measurements are collected using unvented submersible pressure transducers.

They allow for economical collection of near-continuous data at remote well stations. Two primary recorders (Onset Computer's Hobo U20 and barometer, and STS) were utilized in the 2016 FY and are included in Table 2. Table 9 lists the recorders present on network wells on as of June 30, 2016. STS system photographs are included in Section 4.2.

5.7 **Site Surveys**

Concrete survey monuments continue to be installed at each of the 224 active monitoring well stations within the network. Monuments have been installed at 217 active stations and five of those stations have more than one monument. Monuments will be installed at seven stations in the Camp Lejeune military base in the 2017 FY.

All of the installed monuments, with the exception of the Holly Shelter and Castle Hayne Park stations, were surveyed using Survey Grade Global Positioning System (GPS) to calculate the most accurate horizontal and vertical location data possible. The monuments were surveyed during March, April, and December 2015 and a select number of sites were surveyed a second time in January 2016. DWR was unable to get elevations at three monitoring stations (New Lake M12L, Beach Grove School Field, M93L, and Woody Creek, M93R) due to the inability to acquire a satellite signal at the station’s location. GPS surveying will be conducted again in the fall of the 2017 FY to provide a second set of
horizontal and vertical data on selected monitoring well stations. Newly installed monitoring stations and Camp Lejeune stations where monuments have been installed will also be surveyed in the 2017 FY.

6.0 Local Monitoring Well Network Information

6.1 Orange County Monitoring Well Network

The creation of the Orange County Ground Water Observation Well Network, Orange Well Net (OWN), was proposed in May 2005. It was decided to utilize existing bedrock wells in lieu of installing new wells for monetary reasons. In March 2010, the OWN included six inactive bedrock wells for ground water data collection. In 2011, three regolith wells were added to the OWN as a result of a cooperative arrangement. In 2012, two bedrock wells, the Ray Road and Rocky Ridge wells were removed from the network and replaced with two bedrock wells, well 4D in Duke Forest and a well at the former Orange County 911 Center. The wells that were most recently added to the network are the Brumley East well, as the result of an agreement with the Triangle Land Conservancy, and the Duke Forest 4S and 4I wells, with the agreement (informal) of DWR and Duke Forest. Table 10 summarizes the OWN well information. Figure 5 is a map of the OWN well locations.

Ground water data is collected periodically from the OWN. This data is collected to assess ground water availability and concerns locally in Orange County. The data is formatted and uploaded to the DWR ground water database and is available to the public. Table 11 is a summary of the OWN statistics from March 2010 through June 30, 2016. The 2011, 2012, and 2013 OWN Annual

Monument Installation
Montford Point Station, X24E, Onslow County

Leveling
Hadnot Station, X24S, Onslow County
Reports are available on the DWR website. Tom Davis (Water Resources Coordinator for the Orange County Department of Environment, Agriculture, Parks and Recreation), the OWN Annuals Reports, and information provided by the DWR database, are the sources for the Orange County Monitoring Well Network information provided herein.

6.2 Guilford County Monitoring Well Network

The Guilford County ground water monitoring network was established in 2002 and includes eight monitoring well stations located on public properties owned by Guilford County or the City of Greensboro. Each well site was selected to represent an area of the county and to minimize the influence of any existing water supply wells nearby. Table 12 summarizes the Guilford County monitoring well information. In addition, NC A&T State University uses the Knox Road Station for their hydrology class and the students use the data from this station for their course project.

Water levels are collected manually on the same day of each month. Hourly data is collected using the Global Water WL16 submersible transducer and is downloaded at the time of manual collection of depth to ground water levels. The data is formatted and uploaded to the DWR ground water database and is available to the public.

Table 13 summarizes the Guilford County monitoring well statistics from 2008 through June 30, 2016. Figure 6 is a site map of the Guilford County monitoring well locations. Gene Mao (Guilford County Department of Health and Human Services, Division of Environmental Health, Health, Environment, & Risk Assessment Unit), and information obtained from the DWR database, are the sources for the Guilford County Monitoring Well Network information provided herein.

7.0 Planned Activities

7.1 New Well Installation

Monitoring well network expansion efforts for the 2017 FY will be focused on Pender, New Hanover, Onslow, and Sampson counties. Table 14 summarizes the potential upcoming expansion of the network in 2017 FY.

7.2 Well Abandonment

Some wells throughout the network that cannot be used due to bad construction, screening in multiple aquifers, etc., may be abandoned during the 2017 FY.
8.0 Water Quality

The Ground Water Management Branch added some ground water quality staff members in December 2015. Among the responsibilities of these employees is to comply with Tasks 5 & 6 of the North Carolina 2016 FY Workplan for the Clean Water Act Section 106 Groundwater Grant (EPA).

Task 5 - Characterize the State’s Ground Water Resources, and Task 6 - Groundwater Monitoring Program

The Division of Water Resources conducts an active program of ground water monitoring that advances the DWR mission by improving DWR’s knowledge in the following areas:

1 Impacts of land-applied wastes, artificial infiltration practices, or other human activities, including:
   • Potential impacts of these activities on the surficial aquifer and the secondary impacts to the deeper aquifers or surface waters;
   • The occurrence of "emerging contaminants" related to these activities; and
   • Effectiveness of regulations and permits for these activities.

2 Threats to ground water quality, including:
   • The existence, nature, and scope of emerging or existing threats;
   • Assessment of the causes and factors affecting naturally-occurring contamination, agricultural contamination, or contamination resulting from activities permitted by DWR; and
   • Tracking the status of ground water quality across the state.

The goal of all characterization, monitoring, and investigation efforts is to improve DWR’s understanding of the causes and extent of problems, to minimize human exposure to contaminants, and identify areas where regulations or best management practices can be improved to prevent contamination from occurring.
The state has an extensive network of ground water monitoring stations which can be utilized as an ambient ground water monitoring network. Prior to December 2015, the Piedmont-Mountain Resource Evaluation Program sampled wells annually from a well network installed and constructed for the purpose of characterizing the relationship of water quality to underlying geology in the Piedmont and Mountain physiographic provinces. Less water quality monitoring occurred in the Coastal Plain in the last two decades.

The Ground Water Management Branch intends to collect samples from each active well in the statewide monitoring well network. In the 2016 FY, samples were collected from the Rose Hill, and Chinquapin monitoring stations in Duplin County, and the Six Runs, Halls, Turkey, and Ivanhoe monitoring stations in Sampson County. The samples were analyzed for the following parameters:

- Standard private well parameters – arsenic (As), barium (Ba), cadmium (Cd), chromium (Cr), copper (Cu), fluoride (Fl), lead, (Pb) iron (Fe), magnesium (Mg), mercury (Hg), nitrates (NO₃), selenium (Se), silver (Ag), sodium (Na), zinc (Zn), pH, and bacterial indicators;
- Ammonium (NH₄), Total Kjeldahl Nitrogen (TKN), organic Nitrogen, and Phosphate (PO₄);
- Volatile Organic Compounds (VOCs), and Pesticides (also consult with area agricultural experts on local practices);
- Major ions (Na, calcium (Ca), potassium (K), manganese (Mn), sulfate (SO₄), (carbon trioxide (CO₃), bicarbonate (HCO₃) and chlorides (Cl);
- Metals
  - Dissolved (filtered in field) (geochemistry applications require dissolved metals)
  - Total (drinking water standards are based on total metals)
  - Cu and Zn, (in both swine permits and the standard private well suite)
  - Coal Ash Metals – this would incur only minor additional costs yet would increase our knowledge of naturally occurring contaminants of interest to the coal ash program.
• Note, at this time chromium analysis performed by the DWR lab is not sufficiently precise enough to satisfy coal ash program needs. Analysis for hexavalent chromium would need to be sent to a private lab at some cost.
• Note, at this time the DWR lab analyzes for total vanadium. The 2L standard for vanadium (V) is under review and will probably be based on particular species of V, not total V.

- Field parameters
  - Specific Conductivity, pH, Dissolved Oxygen (DO), Temperature (°C), Oxidation-Reduction Potential (ORP)

Analytical results will be presented in the forthcoming report "An Analysis of Water Quality in Division of Water Resources Network Wells in Sampson and Duplin Counties." A preliminary review of the data indicates no results of concern.

Ground water sampling protocol is included in Appendix B. Field data information for the 2016 FY are included in Table 15. Laboratory analytical results received for the 2016 FY are available upon request. In the 2017 FY, ground water samples will continue to be collected from wells in the monitoring well network and analyzed for the parameters referenced above. Analytical data will be available to the public through the DWR website in the 2017 FY.

9.0 Central Coastal Plain Capacity Use Area

The Central Coastal Plain Capacity Use Area (CCPCUA) is a 15-county region in the coastal plain that is an example of a water overuse situation. On August 1, 2002 the CCPCUA rules came into effect because of significant ground water depletion problems. As stated in 15A NCAC 2E .0501, “the intent of this Section [the CCPCUA rules] is to protect the long term productivity of aquifers within the designated area and to allow the use of ground water for beneficial uses at rates which do not exceed the recharge rate of the aquifers…” For many years, water was withdrawn from the deep confined aquifers, which are a primary source of water in the CCPCUA, at a rate that was greater than they were natural recharged. If this situation had been allowed to continue indefinitely, the aquifers
could have been permanently damaged, impairing their ability to function as a water supply.

The goal of the DWR is to regulate water withdrawals in the Central Coastal Plain (CCP) under the authority of the Environmental Management Commission (EMC). The following summarizes how these withdrawals are regulated:

- Water withdrawal permits are required for ground water users who withdraw greater than 100,000 gallons of water per day;
- Annual registration and reporting of withdrawals is required for surface and ground water withdrawals greater than 10,000 gallons per day;
- Counties included in the CCPCUA are Beaufort, Carteret, Craven, Duplin, Edgecombe, Greene, Jones, Lenoir, Martin, Onslow, Pamlico, Pitt, Washington, Wayne, and Wilson.

DWR collects depth to water level measurements and chloride sampling event data from monitor wells within the state’s well network and CCPCUA permitted wells to assess aquifer conditions. 15A NCAC 2E .0503 requires that DWR assess aquifer conditions in 2008, 2013 and 2018 to determine if CCPCUA rule changes are necessary. Through the CCPCUA permitting system, large ground water users (>100,000 gpd) in some parts of the capacity use area are required to progressively reduce withdrawals in 2008, 2013, and 2018 to allow the aquifers to recover. The managed withdrawals from these aquifers have allowed the aquifers to recover as depicted in the following recovery maps of the Upper Cape Fear Aquifer and the Black Creek Aquifer.

The map of the Black Creek Aquifer shows the areas where ground water levels have risen between 5 feet (red) to more than 75 feet (purple) from Nov. 2007 through Feb. 2016.
The map of the Upper Cape Fear Aquifer shows the areas where ground water levels have risen between 5 feet (red) to more than 55 feet (blue) from Nov. 2007 through Feb. 2016.

Based on analysis of water level and chloride concentration data gathered through January 2013 in the CCPCUA, and a thorough review of aquifer conditions, DWR concluded that no action needed to be taken by the EMC to alter either the reduction zone boundaries or rule language in 15A NCAC 2E .0503, but recommended the use of temporary permits under rule .0502. This may give certain permit holders a stable withdrawal rate which is higher than indicated by their reduction schedule and reduction zone, provided that all well construction and reporting criteria are met as specified in the 2013 CCPCUA Assessment Report.

DWR uses a series of criteria to judge each production well and aquifer conditions by individual permit in the permitting process. This enhanced permit application review allows the division to alter an individual permit holder’s reduction requirements if the permit holder can demonstrate they are using the ground water at a sustainable rate. As of September 2016, the following six permit holders have acquired temporary permits: Greene County Regional Water System, Town of La Grange, Belfast-Patetown Sanitary District, Northwestern Wayne Sanitary District, Southeastern Wayne Sanitary District, and Fork Township Sanitary District.

Although the CCPCUA rules require assessments to be produced in 2008, 2013, and 2018, the DWR staff will continue to constantly track aquifer conditions so as to best serve the permit holders in the region and to provide awareness of potential ground water supply issues. Another formal assessment will be conducted in 2018. Reports referencing the CCPCUA rules can be viewed by visiting the DWR website, [www.ncwater.org/CCPCUA](http://www.ncwater.org/CCPCUA).
10.0 Summary and Conclusions

DWR and its predecessor agencies have maintained and monitored a statewide network of ground water monitoring wells used to assess North Carolina’s ground water supply since the 1960s.

Data collected from the monitoring well network are available to the public through DWR’s Internet website, www.ncwater.org. These data include, but are not limited to, ground water levels, chloride measurements, well construction information, borehole log construction (lithological and geophysical), ground water monitoring station locations, and geophysical/lithological data collected from other (non-DWR) well sites.

The monitoring well network consists of 650 monitoring wells at 224 individual stations. From July 2015 through June 2016, ground water level data were collected from 645 wells within the network. These data include manual measurements taken quarterly from wells, plus hourly water levels collected using automatic data recorders from 508 wells.

Twelve STS systems have been installed as of 2016 FY on drought monitoring network wells. The addition of the STS systems replaces monthly site visits and improves the division's depiction of drought conditions. DWR intends to add four STS units in the 2017 fiscal year.

The triennial chloride sampling was performed on 258 wells in September-October 2015. Four additional samples were collected from the new well installation at Holly Shelter in June 2016. Sampling results indicated that there continues to be concern for saltwater encroachment especially near larger pumping centers located near the fresh-salt water interface. Decreases were observed in the Cretaceous, Lower Cape Fear aquifer in eleven of twenty wells. The anomalous decreases may be in response to recent pumping reductions within the CCPCUA and at International Paper in Franklin, Virginia. Triennial chloride sampling will occur again in September-October 2018.

Seven monitor wells have been installed at two different stations during the 2016 FY. Four monitoring wells were installed at Holly Shelter (Pender County) and three wells were installed at Castle Hayne Park (New Hanover County). At each site, borehole advancement, geophysical logging and well installation occurred. Chloride measurements were collected at Holly Shelter after well development by DWR. The Castle Hayne Park is scheduled for development and chloride sampling in the 2017 FY.

Eleven wells were acquired and added to the monitoring well network in the 2016 FY: Tater Hill, (E 76Q1 and E 76Q2) in Watauga County; Beach Grove School Field Well (M 93L1) and Woody Creek (M 93L1) in Haywood County; Oconaluftee Overlook (M 97S1), Smokemont Campground G1 (N 95G1), Smokemont Ranger Station (N 95G2), Clingmans Dome (N 97F1), and Deep Creek Campground (O 97L1) in Swain County; and CC Old Well (Q 94I1) and Stillwell Building (Q 94J1) in Jackson County.

No wells were abandoned during the 2016 FY.
There are two local networks whose water level data are currently being uploaded to the DWR database. The OWN in Orange County, and the Guilford County water level data can be viewed by the public on the DWR website.

Survey monuments continue to be installed at each of the well stations. Survey Grade GPS was performed on all active wells with installed monuments during the 2016 FY. Plans are to survey the newly installed stations, monuments installed at Camp Lejeune stations, and resurvey selected stations in the fall of the 2017 FY.

DWR has tentative plans to expand the monitoring well network by installing up to 23 wells at five sites in the 2017 FY.

Ground Water Management added ground water quality staff in December 2015. A main focus of these employees is to comply with Tasks 5 & 6 of the North Carolina 2016 FY workplan for the Clean Water Act Section 106 Ground Water Grant (EPA). Staff intends to collect samples from each active well in the statewide monitoring well network. In the 2016 FY, samples were collected from the Rose Hill, and Chinquapin monitoring stations in Duplin County, and the Six Runs, Halls, Turkey, and Ivanhoe monitoring stations in Sampson County. A preliminary review of the data indicates no results of concern.

Fifteen counties in the Central Coastal Plain are governed by the Central Coastal Plain Capacity Use Area rules. Data collected from the monitoring well network is being used to assess aquifer conditions and determine whether or not changes to the rules are warranted. Based on the results of the 2013 data assessment, DWR did not pursue rule changes. Instead, DWR is issuing temporary permits under rule .0502 which can ease withdrawal reduction requirements for certain permit holders, but adds other permit conditions.
FIGURES
Figure 2: Drought Indicator Wells
FIGURE 3
Water Level Data Collected from 1967-2016 (Plot includes both DWR and USGS Data)
During the 2015 triennial sampling event, chloride samples were collected from approximately 276 wells. Of these samples, 20 were collected from the Cretaceous Lower Cape Fear Aquifer (Klcf). Testing showed that between 2012 and 2015, Klcf chloride levels decreased in eleven of the twenty wells. The anomalous decreases may be in response to recent pumping reductions within North Carolina’s Central Coastal Plain Capacity Use Area and at International Paper in Franklin, Virginia. This deviation from previous data trends is under investigation.
Figure 5
Site Map
Orange Well Net
Orange County
June 2016
Figure 6
Site Map
Monitoring Well Network
Guilford County
June 2016
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<td><strong>Secure</strong>—station is located on local government or school property</td>
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<td><strong>Moderately secure</strong>—station is located on private property, but landowner does not give any indication that land use or property ownership may change</td>
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<td><strong>Tenuous</strong>—station is located on public or private property and landowner is giving indications that land use or property ownership may change</td>
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<td><strong>Imminent threat</strong>—station is on public or private property and landowner desires abandonment of well station.</td>
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### Table 3

Solinst Telemetry System (STS) Distribution by Region as of 6/30/16

North Carolina Division of Water Resources
Ground Water Management Branch
2016 Annual Report

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<td>Troutman</td>
<td>L67U2</td>
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<td>Como</td>
<td>B20U8</td>
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### TABLE 4
Monitoring Well Network Statistics (01-01-2005 through 06-30-2016)
North Carolina Division of Water Resources
Ground Water Management Branch
2016 Annual Report

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Chloride Level for Salt Water 250

**Collected after well development
# TABLE 6

Well Construction Information for 2016 FY Well Installation and Acquired Wells

North Carolina Division of Water Resources

Ground Water Management Branch

2016 Annual Report

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<thead>
<tr>
<th>Well ID</th>
<th>Station Name</th>
<th>Date Installed</th>
<th>Well Diameter (inches)</th>
<th>Well Depth (ft lbs)</th>
<th>Screened Interval (x to y ft lbs)</th>
<th>Measuring Pt. (MP) (ft)</th>
<th>Aquifer</th>
<th>Water Level Date Measured (from MP) (ft)</th>
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Wells Construction Information for Wells Acquired in 2016 FY

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<th>Measuring Point (ft)</th>
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<td>E 76Q1</td>
<td>Tater Hill</td>
<td>8/13/2015*</td>
<td>6.25</td>
<td>350</td>
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<td>2.80</td>
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<td>64.13 (05/02/2016)</td>
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<tr>
<td>E 76Q2</td>
<td>Tater Hill</td>
<td>8/13/2015*</td>
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<td>20-40</td>
<td>3.25</td>
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<td>32.91 (05-02-2016)</td>
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<tr>
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<td>Beach Grove School Field Well</td>
<td>12/08/2015*</td>
<td>8</td>
<td>172</td>
<td>74-174</td>
<td>1.50</td>
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<tr>
<td>M 93R1</td>
<td>Woody Creek</td>
<td>12/08/2015*</td>
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<td>70</td>
<td>35-70</td>
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<td>8.62 (04/20/2016)</td>
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<tr>
<td>M 97S1</td>
<td>Oconaluftee Overlook</td>
<td>12/08/2015*</td>
<td>6</td>
<td>50</td>
<td>24-50</td>
<td>1.25</td>
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<td>35.39 (05/04/2016)</td>
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<td>94</td>
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<tr>
<td>N 97F1</td>
<td>Clingmans Dome</td>
<td>12/08/2015*</td>
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<td>112</td>
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<td>Deep Creek Campground</td>
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<td>21</td>
<td>1-21</td>
<td>2.70</td>
<td>Bs</td>
<td>5.99 (05/03/2016)</td>
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<tr>
<td>Q 94I1</td>
<td>CC Old Well</td>
<td>01/29/2016*</td>
<td>4</td>
<td>201</td>
<td>85-201</td>
<td>2.16</td>
<td>Br</td>
<td>19.22 (05/03/2016)</td>
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<td>Stillwell Building</td>
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<td>201</td>
<td>85-201</td>
<td>2.16</td>
<td>Br</td>
<td>19.22 (05/03/2016)</td>
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NDY – Not Determined Yet

* Date of start of water level collection
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<tr>
<th>Well ID</th>
<th>Station Name</th>
<th>Date Developed</th>
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<td>Q30R1</td>
<td>Spring Creek Elementary School</td>
<td>07/06/2015 through 07/09/2015</td>
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<td>Q30R3</td>
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<tr>
<td>Q30R4</td>
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<td>M97S1</td>
<td>Oconaluftee Overlook</td>
<td>03/07/2016</td>
</tr>
<tr>
<td>N95G1</td>
<td>Smokemont Campground G1</td>
<td>03/08/2016</td>
</tr>
<tr>
<td>N95G2</td>
<td>Smokemont Rangers Station</td>
<td>03/08/2016</td>
</tr>
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<td>M93R1</td>
<td>Woody Creek</td>
<td>04/13/2016</td>
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<td>M93L1</td>
<td>Beach Grove School Field Well</td>
<td>04/14/2016</td>
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<td>S35Q5</td>
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<td>S35Q8</td>
<td>Halls</td>
<td>06/06/2016 through 06-08-2016</td>
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<td>S35Q9</td>
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<td>ZZ29N1</td>
<td>Holly Shelter</td>
<td>06/13/2016 through 06/15/2016</td>
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<td>ZZ29N2</td>
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<td>ZZ29N3</td>
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</tr>
<tr>
<td>ZZ29N4</td>
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</tr>
<tr>
<td>Y34P3</td>
<td></td>
<td>06/29/2016</td>
</tr>
<tr>
<td>Y34P4</td>
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<tr>
<td>Well</td>
<td>Station</td>
<td>Date Repair Completed</td>
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<tr>
<td>Y40G1</td>
<td>Dublin</td>
<td>7/30/15</td>
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<tr>
<td>V35T5</td>
<td>Six Runs</td>
<td>8/25/15</td>
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<tr>
<td>BB28J2</td>
<td>Topsail Beach</td>
<td>10/6/15</td>
</tr>
<tr>
<td>BB28J4</td>
<td>Topsail Beach</td>
<td>10/6/15</td>
</tr>
<tr>
<td>CC38B5</td>
<td>Lake Waccamaw</td>
<td>10/7/15</td>
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<tr>
<td>T29G4</td>
<td>Pink Hill</td>
<td>5/9/16</td>
</tr>
<tr>
<td>T29G5</td>
<td>Pink Hill</td>
<td>5/25/16</td>
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## TABLE 9
Automatic Water Level Recorders as of 6/30/2016
North Carolina Division of Water Resources
Ground Water Management Branch
2016 Annual Report

<table>
<thead>
<tr>
<th>Recorder Type</th>
<th>Number in Service*</th>
</tr>
</thead>
<tbody>
<tr>
<td>HOBO U20 Water Level Logger (including separate barometer per station installed)</td>
<td>712 (includes 185 barometers)</td>
</tr>
<tr>
<td>Solinst Telemetry System (STS)</td>
<td>12</td>
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</tbody>
</table>

*As of June 30, 2016

Note: Due to the large number of recorders employed by DWR, there are, at any given time, a number of units that are being serviced or replaced. These units are not reflected in the above totals.
### TABLE 10
Orange Well Net Monitoring Well Information
Orange County, NC
North Carolina Division of Water Resources
Ground Water Management Branch
2016 Annual Report

<table>
<thead>
<tr>
<th>Well No.</th>
<th>Well Name</th>
<th>Total Depth (ft bgs)</th>
<th>Casing Depth (ft bgs)</th>
<th>Top of Casing Elevation (ft)</th>
<th>Aquifer</th>
<th>Geology</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Millhouse Rd.</td>
<td>67</td>
<td>164.7</td>
<td>515.22</td>
<td>Br</td>
<td>Epiclastics</td>
</tr>
<tr>
<td>2</td>
<td>Eno Confluence Property</td>
<td>37</td>
<td>175.5</td>
<td>609.27</td>
<td>Br</td>
<td>Felsic Tuff</td>
</tr>
<tr>
<td>3</td>
<td>Former 911 Center</td>
<td>85</td>
<td>400</td>
<td>582**</td>
<td>Br</td>
<td>Altered Tuff</td>
</tr>
<tr>
<td>4</td>
<td>Blackwood Farm</td>
<td>100</td>
<td>302</td>
<td>557.44</td>
<td>Br</td>
<td>Felsic Lavas and Tuffs (Dacite)</td>
</tr>
<tr>
<td>5</td>
<td>Duke Forest 4D</td>
<td>85</td>
<td>400</td>
<td>427.82</td>
<td>Br</td>
<td>Felsic Plutonics</td>
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<tr>
<td>6</td>
<td>Duke Forest 4I</td>
<td>28.97</td>
<td>43.97</td>
<td>429.74</td>
<td>Br</td>
<td>Felsic Plutonics</td>
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<tr>
<td>7</td>
<td>Brumley East</td>
<td>108</td>
<td>605</td>
<td>-</td>
<td>Br</td>
<td>Mafic Lavas and Tuffs</td>
</tr>
<tr>
<td>8</td>
<td>Eubanks Road</td>
<td>33</td>
<td>145.7</td>
<td>531.15</td>
<td>Br</td>
<td>Mafic Intrusives (Gabbro)</td>
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<tr>
<td>9</td>
<td>Andrews Rd. (COL-1)</td>
<td>33</td>
<td>-</td>
<td>528</td>
<td>Bs</td>
<td>Felsic Tuff</td>
</tr>
<tr>
<td>10</td>
<td>Hwy 54 (COL-3)</td>
<td>43.7</td>
<td>-</td>
<td>528.18</td>
<td>Bs</td>
<td>Epiclastics</td>
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<tr>
<td>11</td>
<td>Orange Grove Rd (COL-4)</td>
<td>35.2</td>
<td>-</td>
<td>504.86</td>
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<td>Epiclastics</td>
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<tr>
<td>12</td>
<td>Duke Forest DF-4S</td>
<td>17.9</td>
<td>-</td>
<td>428.81</td>
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<td>Felsic Plutonics</td>
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<tr>
<td>13</td>
<td>Blackwood Farm (BFS)</td>
<td>45</td>
<td>-</td>
<td>556**</td>
<td>Bs</td>
<td>Felsic Lavas and Tuffs (Dacite)</td>
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<tr>
<td>14</td>
<td>Northeast Park (NES)</td>
<td>45</td>
<td>-</td>
<td>624**</td>
<td>Bs</td>
<td>Epiclastics</td>
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</table>

bgs – below ground surface
* Ray Road Well – removed from network in 2012
* Rocky Ridge Well – removed from network in 2012
** Estimated Elevation
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<td>Manual water levels</td>
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<td>18</td>
<td>49</td>
<td>68</td>
<td>59</td>
<td>54</td>
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<td>(tapedowns)</td>
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<tr>
<td>Daily water levels</td>
<td>-</td>
<td>-</td>
<td>1,612</td>
<td>2,783</td>
<td>3,095</td>
<td>3,281</td>
<td>3,468</td>
<td>4,286</td>
<td>2,414</td>
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<td>(automatic recorders)</td>
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<tr>
<td>Total hourly water</td>
<td>-</td>
<td>-</td>
<td>38,802</td>
<td>66,689</td>
<td>74,065</td>
<td>78,636</td>
<td>83,090</td>
<td>102,643</td>
<td>57,630</td>
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<tr>
<td>levels</td>
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TABLE 12
Guilford County Monitoring Well Information
North Carolina Division of Water Resources
Ground Water Management Branch
2016 Annual Report

<table>
<thead>
<tr>
<th>Station Name</th>
<th>Date Installed</th>
<th>Well Diameter (inches)</th>
<th>Well Depth (ft)</th>
<th>Screened interval (ft)</th>
<th>Aquifer</th>
<th>Measuring Point (MP) (ft)</th>
<th>Water Level Measured from MP (ft) Including Date Measured</th>
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<tbody>
<tr>
<td>Gibson Park</td>
<td>04/15/2003</td>
<td>6.25</td>
<td>205</td>
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<td>24.20 (07/22/2015)</td>
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<tr>
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<td>bedrock</td>
<td>2.45</td>
<td>24.11 (07/22/2015)</td>
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<tr>
<td>Knox Road</td>
<td>10/09/2002</td>
<td>6.25</td>
<td>*</td>
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<td>bedrock</td>
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<td>22.39 (07/22/2015)</td>
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<td>Prison Farm</td>
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<td>18.64 (07/22/2015)</td>
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<tr>
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<td>7</td>
<td>7</td>
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<td>Manual water levels (tapedowns)</td>
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<td>28</td>
<td>14</td>
<td>28</td>
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<td>77</td>
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<tr>
<td>Station Name/Quad</td>
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<td>Proposed New Well Screens (ft bls)</td>
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<td>Vicinity of Currie</td>
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<td>52-64</td>
<td>Peedee</td>
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<td>Black Creek</td>
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<td>602-612</td>
<td>Upper Cape Fear</td>
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<td>797-807</td>
<td>Lower Cape Fear</td>
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<td>Pilot Hole (Top of Basement)</td>
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<td>Vicinity of Myrtle Grove Rd and Indian Cove Ave.</td>
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<td></td>
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<td>96-106</td>
<td>Castle Hayne</td>
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<td>163-173</td>
<td>Peedee</td>
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<td>Peedee (Salty)</td>
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<td>Vicinity of River Park Rd.</td>
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<td>86-96</td>
<td>Castle Hayne</td>
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<td>119-129</td>
<td>Peedee</td>
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<td>460-470</td>
<td>Peedee (Salty)</td>
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<td>478</td>
<td>Pilot Hole (Top of Black Creek CU)</td>
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<td>Wellfield 258</td>
<td>Onslow</td>
<td>720-730</td>
<td>Black Creek</td>
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<td>824-834</td>
<td>Upper Cape Fear</td>
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<td>20-30</td>
<td>Surficial</td>
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<td>82-92</td>
<td>Black Creek</td>
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<td>Vicinity of Clinton</td>
<td>Sampson</td>
<td>256-266</td>
<td>Upper Cape Fear</td>
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<td>350-360</td>
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<td>Date</td>
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<td>pH</td>
<td>Conductivity (mS/cm)</td>
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APPENDICES
APPENDIX A

WELL CONSTRUCTION RECORDS
WELL CONSTRUCTION RECORD

This form can be used for single or multiple wells

1. Well Contractor Information:
   Jonathan Kamionka
   Well Contractor Name
   3465-A
   NC Well Contractor Certification Number
   Bill's Well Drilling Co.
   Company Name

2. Well Construction Permit #:
   (List all applicable well permits (i.e., County, State, Variance, Injection, etc.))

3. Well Use (check well use):
   Water Supply Well:
   □ Agricultural
   □ Municipal/Public
   □ Geothermal (Heating/Cooling Supply)
   □ Residential Water Supply (single)
   □ Industrial/Commercial
   □ Residential Water Supply (shared)
   □ Irrigation
   Other: Monitoring
   Recovery
   Injection Well:
   □ Aquifer Recharge
   □ Groundwater Remediation
   □ Aquifer Storage and Recovery
   □ Saliency Barrier
   □ Aquifer Test
   □ Stormwater Drainage
   □ Geothermal (Closed Loop)
   □ Other: Geothermal (Heating/Cooling Return)
   □ Tracer
   □ Other (explain under #21 Remarks)

4. Date Well(s) Completed: 5-10-16, Surfacial
   Well ID#: 

5a. Well Location:
   NC-DENR
   Facility/Owner Name
   Holly Shelter Wildlife Boat Ramp
   Facility ID#: 
   7271 Shaw Hwy Burgaw, NC 28457
   Physical Address, City, and Zip
   Pender
   County
   Parcel Identification No. (PIN)

5b. Latitude and Longitude in degrees/minutes/seconds or decimal degrees:
   (if well field, one lat/long is sufficient)
   ________ N
   ________ W

6. Is (are) the well(s): □ Permanent or □ Temporary

7. Is this a repair to an existing well?: □ Yes or □ No
   If this is a repair, fill out known well construction information and explain the nature of the
   repair under #21 remarks section or on the back of this form.

8. Number of wells constructed: 1
   For multiple injection or non-water supply wells ONLY with the same construction, you can
   submit one form.

9. Total well depth below land surface: 47 (ft.)
   For multiple wells for all depths if different (example: 3 at 200' and 2 at 100')

10. Static water level below top of casing: 4 (ft.)
    If water level is above casing, use " + "

11. Borehole diameter: 9-7/8 (in.)

12. Well construction method:
    □ Mud Rotary
    (indicate auger, rotary, cable, direct push, etc.)

FOR WATER SUPPLY WELLS ONLY:

13a. Yield (gpm): 10
    Method of test: pump

13b. Disinfection type: HTH
    Amount: 1 cup

14. WATER ZONES
    FROM TO DESCRIPTION
    32 ft. 42 ft. sands

15. OUTER CASING (for multi-cased wells) OR LINER (if applicable)
    FROM TO DIAMETER THICKNESS MATERIAL
    32 ft. 42 ft. SDR17 PVC

16. INNER CASING OR TUBING (geothermal closed-loop)
    FROM TO DIAMETER THICKNESS MATERIAL
    42 ft. 47 ft. sch80 PVC

17. SCREEN
    FROM TO DIAMETER SLOT SIZE THICKNESS MATERIAL
    32 ft. 42 ft. 4 in. .020 SS

18. GROUT
    FROM TO MATERIAL EMPLACEMENT METHOD & AMOUNT
    0 ft. 25 ft. bentonite poured

19. SAND/GRAVEL PACK (if applicable)
    FROM TO MATERIAL EMPLACEMENT METHOD
    25 ft. 47 ft. #3 gravel poured

20. DRILLING LOG (attach additional sheets if necessary)
    FROM TO DESCRIPTION ( sober, hardness, tillrock type, grain size, etc.)

21. REMARKS

22. Certification:
   Signature of Certified Well Contractor 5-10-16
   Date
   By signing this form, I hereby certify that the well(s) was (were) constructed in accordance
   with 15A NCAC 02C.0160 or 15A NCAC 02C.0260 Well Construction Standards and that a
   copy of this record has been provided to the well owner.

23. Site diagram or additional well details:
   You may use the back of this page to provide additional well site details or well
   construction details. You may also attach additional pages if necessary.

SUBMITTAL INSTRUCTIONS

24a. For All Wells: Submit this form within 30 days of completion of well
   construction to the following:
   Division of Water Resources, Information Processing Unit, 1617 Mail Service Center, Raleigh, NC 27699-1617

24b. For Injection Wells ONLY: In addition to sending the form to the address in
   24a above, also submit a copy of this form within 30 days of completion of well construction to the following:
   Division of Water Resources, Underground Injection Control Program, 1636 Mail Service Center, Raleigh, NC 27699-1636

24c. For Water Supply & Injection Wells:
   Also submit one copy of this form within 30 days of completion of well
   construction to the county health department of the county where constructed.
WELL CONSTRUCTION RECORD

This form can be used for single or multiple wells

1. Well Contractor Information:

Jonathan Kamionka

3465-A

NC Well Contractor Certification Number

Bill's Well Drilling Co.

Company Name

2. Well Construction Permit #: List all applicable well permits (i.e. County, State, Variance, Injection, etc.)

3. Well Use (check well use):

Water Supply Well:
- [ ] Agricultural
- [ ] Geothermal (Heating/cooling)
- [ ] Industrial/Commercial
- [ ] Irrigation

Non-Water Supply Well:
- [ ] Monitoring
- [ ] Recovery

Injection Well:
- [ ] Aquifer Recharge
- [ ] Groundwater Remediation
- [ ] Aquifer Storage and Recovery
- [ ] Salinity Barrier
- [ ] Aquifer Test
- [ ] Stormwater Drainage
- [ ] Experimental Technology
- [ ] Subsidence Control
- [ ] Geothermal (Closed Loop)
- [ ] Tracer
- [ ] Geothermal (Heating/Cooling Return)
- [ ] Other (explain under #21 Remarks)

4. Date Well(s) Completed: 5-6-16 Well IDs: Black Creek

5a. Well Location:

NC-DENR

7271 Shaw Hwy Burgaw, NC 28457

Physical Address, City, and Zip

Pender

5b. Latitude and Longitude in degrees/minutes/seconds or decimal degrees:

6. Is (are) the well(s): [ ] Permanent or [ ] Temporary

7. Is this a repair to an existing well? [ ] Yes or [ ] No

8. Number of wells constructed: 1

9. Total well depth below land surface: 445 (ft.)

10. Static water level below top of casing: 5 (ft.)

11. Borehole diameter: 9-7/8 (in.)

12. Well construction method: Mud Rotary

FOR WATER SUPPLY WELLS ONLY:

13a. Yield (gpm) 20 Method of test: pump

13b. Disinfection type: HTH Amount: 1 cup

14. WATER ZONES

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15. OUTER CASING (for multi-cased wells) OR LINER (if applicable)

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16. INNER CASING OR TUBING (geothermal closed-loop)

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17. SCREEN

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<td>bentonite</td>
<td>pumped</td>
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19. SAND/GRAVEL PACK (if applicable)

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20. DRILLING LOG (attach additional sheets if necessary)

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<th>DESCRIPTION (color, hardness, well vec type, grain size, etc.)</th>
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21. REMARKS

22. Certification:

Signature of Certified Well Contractor: 5-6-16

By signing this form, I hereby certify that the well(s) was (were) constructed in accordance with 15A NCAC 02C: 0.010 or 15A NCAC 02C: 0.020 and that a copy of this record has been provided to the well owner.

23. Site diagram or additional well details:

You may use the back of this page to provide additional well site details or well construction details. You may also attach additional pages if necessary.

SUBMITTAL INSTUCTIONS

24a. For All Wells: Submit this form within 30 days of completion of well construction to the following:

Division of Water Resources, Information Processing Unit, 1617 Mail Service Center, Raleigh, NC 27699-1617

24b. For Injection Wells ONLY: In addition to sending the form to the address in 24a above, also submit a copy of this form within 30 days of completion of well construction to the following:

Division of Water Resources, Underground Injection Control Program, 1636 Mail Service Center, Raleigh, NC 27699-1636

24c. For Water Supply & Injection Wells: Also submit one copy of this form within 30 days of completion of well construction to the county health department of the county where constructed.

Form GW-1
North Carolina Department of Environment and Natural Resources – Division of Water Resources
Revised August 2013
WELL CONSTRUCTION RECORD

This form can be used for single or multiple wells

1. Well Contractor Information:
   Jonathan Kamionka
   Well Contractor Name
   3465-A
   NC Well Contractor Certification Number
   Bill's Well Drilling Co.
   Company Name

2. Well Construction Permit #:
   List all applicable well permits (i.e. County, State, Variance, Injection, etc.)

3. Well Use (check well use):
   Water Supply Well:
   Agricultural
   Municipal/Public
   Geothermal (Heating/Cooling Supply)
   Residential Water Supply (single)
   Industrial/Commercial
   Residential Water Supply (shared)
   Irrigation

   Non-Water Supply Well:
   Monitoring
   Recovery

   Injection Well:
   Aquifer Recharge
   Groundwater Remediation
   Aquifer Storage and Recovery
   Salinity Barrier
   Aquifer Test
   Stormwater Drainage
   Experimental Technology
   Subsidence Control
   Geothermal (Closed Loop)
   Tracer
   Geothermal (Heating/Cooling Return)
   Other (explain under #21 Remarks)

4. Date Well(s) Completed: 5-9-16
   Well ID#: Peedee

5a. Well Location:
   NC-DENR
   Holly Shelter Wildlife Boat Ramp
   Facility/Owner Name
   7271 Shaw Hwy Burgaw, NC 28457
   Physical Address, City, and Zip
   Pender
   County
   Parcel Identification No. (PIN)

5b. Latitude and Longitude in degrees/minutes/seconds or decimal degrees:
   (if well field, one lat/long is sufficient)

6. Is (are) the well(s): ☐ Permanent or ☐ Temporary

7. Is this a repair to an existing well: ☐ Yes or ☐ No
   If this is a repair, fill out known well construction information and explain the nature of the
   repair under #21 remarks section or on the back of this form.

8. Number of wells constructed: 1
   For multiple injection or non-water supply wells ONLY with the same construction, you can
   submit one form.

9. Total well depth below land surface: 145 (ft.)
   For multiple wells set all depths if different (example: 30, 200, and 20, 100)

10. Static water level below top of casing: 4 (ft.)
    If water level is above casing, use "+"

11. Borehole diameter: 9-7/8 (in.)

12. Well construction method: Mud Rotary
    (i.e. auger, rotary, cable, direct push, etc.)

FOR WATER SUPPLY WELLS ONLY:

13a. Yield (gpm) 10 Method of test: pump
13b. Disinfection type: HTH Amount: 1 cup

14. WATER ZONES
   FROM TO DESCRIPTION
   130 ft. 140 ft. sands
   140 ft. 150 ft.

15. OUTER CASING (for multi-cased wells) OR LINER (if applicable)
   FROM TO DIAMETER THICKNESS MATERIAL
   130 ft. 140 ft. 12 in. PVC
   140 ft. 150 ft. 4 in. PVC

17. SCREEN
   FROM TO DIAMETER SLOT SIZE THICKNESS MATERIAL
   130 ft. 140 ft. 4 in. .020 PVC
   140 ft. 150 ft. 4 in. .010 PVC

18. GROUT
   FROM TO MATERIAL EMPLACEMENT METHOD & AMOUNT
   0 ft. 100 ft.
   100 ft. 200 ft.

19. SAND/GRAVEL PACK (if applicable)
   FROM TO MATERIAL EMPLACEMENT METHOD
   120 ft. 130 ft.

20. DRILLING LOG (attach additional sheets if necessary)
   FROM TO DESCRIPTION (color, hardness, soil, rock type, grain size, etc.)
   130 ft. 140 ft.
   140 ft. 150 ft.

21. REMARKS

22. Certification:
   Signature of Certified Well Contractor
   Date

23. Site diagram or additional well details:
    You may use the back of this page to provide additional well site details or well
    construction details. You may also attach additional pages if necessary.

SUBMITTAL INSTRUCTIONS

24a. For All Wells: Submit this form within 30 days of completion of well
    construction to the following:
    Division of Water Resources, Information Processing Unit,
    1617 Mail Service Center, Raleigh, NC 27699-1617

24b. For Injection Wells ONLY: In addition to sending the form to the address in
    24a above, also submit a copy of this form within 30 days of completion of well
    construction to the following:
    Division of Water Resources, Underground Injection Control Program,
    1636 Mail Service Center, Raleigh, NC 27699-1636

24c. For Water Supply & Injection Wells:
    Also submit one copy of this form within 30 days of completion of well
    construction to the county health department of the county where
    constructed.

Form GW-1
North Carolina Department of Environment and Natural Resources – Division of Water Resources
Revised August 2013
**WELL CONSTRUCTION RECORD**

This form can be used for single or multiple wells

1. **Well Contractor Information:**
   Jonathan Kamionka
   
   **Well Contractor Name:**
   3465-A
   
   **NC Well Contractor Certification Number:**
   Bill's Well Drilling Co.
   
   **Company Name**
   
2. **Well Construction Permit #:**
   List all applicable well permits (i.e. County, State, Variance, Injection, etc.)
   
3. **Well Use (check well use):**
   - Water Supply Well:
     - Agricultural
     - Geothermal (Heating/Cooling Supply)
     - Industrial/Commercial
     - Irrigation
   - Non-Water Supply Well:
     - Monitoring
     - Recovery
   - Injection Well:
     - Aquifer Recharge
     - Groundwater Remediation
     - Aquifer Storage and Recovery
     - Salinity Barrier
   - Aquifer Test
   - Stormwater Drainage
   - Experimental Technology
   - Subsidence Control
   - Geothermal (Closed Loop)
   - Geothermal (Heating/Cooling Return)
   - Other (explain under #21 Remarks)

4. **Date Well(s) Completed:** 5-4-16
   **Well ID#:** UpperCapeFear

5a. **Well Location:**
   Holly Shelter Wildlife Boat Ramp
   **NC-DENR Facility/Owner Name**
   7271 Shaw Hwy Burgaw, NC 28457
   **County**
   **Parcel Identification No. (PIN)**

5b. **Latitude and Longitude in degrees/minutes/seconds or decimal degrees:**
   - N
   - W

6. **Is (are) the well(s):**
   - Permanent
   - Temporary

7. **Is this a repair to an existing well:**
   - Yes
   - No

8. **Number of wells constructed:** 1
   **For multiple injection or non-water supply wells ONLY with the same construction, you can submit one form.**

9. **Total well depth below land surface:** 690 ft.
   **For multiple wells list all depths if different (example: 350, 200’ and 2500’)**

10. **Static water level below top of casing:** 15 ft.
    **If water level is above casing, use “-”**

11. **Borehole diameter:** 9-7/8 in.

12. **Well construction method:** Mud Rotary
    - (e.g., auger, rotary, cable, direct push, etc.)

**FOR WATER SUPPLY WELLS ONLY:**

13a. **Yield (gpm):** 20
    **Method of test:** pump

13b. **Disinfection type:** HTH
    **Amount:** 2 cup

**14. WATER ZONES**

<table>
<thead>
<tr>
<th>FROM</th>
<th>TO</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>675</td>
<td>685</td>
<td>sands</td>
</tr>
<tr>
<td>685</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**15. OUTER CASING (for multi-cased wells) OR LINER (if applicable)**

<table>
<thead>
<tr>
<th>FROM</th>
<th>TO</th>
<th>DIAMETER</th>
<th>THICKNESS</th>
<th>MATERIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>64</td>
<td>10</td>
<td>sch80</td>
<td>PVC</td>
</tr>
</tbody>
</table>

**16. INNER CASING OR TUBING (geothermal closed-loop)**

<table>
<thead>
<tr>
<th>FROM</th>
<th>TO</th>
<th>DIAMETER</th>
<th>THICKNESS</th>
<th>MATERIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>675</td>
<td>675</td>
<td>4.5</td>
<td>SDR17</td>
<td>PVC</td>
</tr>
<tr>
<td>685</td>
<td>690</td>
<td>4</td>
<td>sch80</td>
<td>PVC</td>
</tr>
<tr>
<td>685</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**17. SCREEN**

<table>
<thead>
<tr>
<th>FROM</th>
<th>TO</th>
<th>DIAMETER</th>
<th>SLOT SIZE</th>
<th>THICKNESS</th>
<th>MATERIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>675</td>
<td>685</td>
<td>.020</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>685</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**18. GROUT**

<table>
<thead>
<tr>
<th>FROM</th>
<th>TO</th>
<th>MATERIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>645</td>
<td>bentonite</td>
</tr>
<tr>
<td>645</td>
<td>660</td>
<td>bentonite</td>
</tr>
</tbody>
</table>

**19. SAND/GRAVEL PACK (if applicable)**

<table>
<thead>
<tr>
<th>FROM</th>
<th>TO</th>
<th>MATERIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>660</td>
<td>690</td>
<td>#3 gravel</td>
</tr>
</tbody>
</table>

**20. DRILLING LOG (attach additional sheets if necessary)**

For Internal Use ONLY:

**21. REMARKS**

**22. Certification:**

 **5-4-16**

Signature of Certified Well Contractor

By signing this form, I hereby certify that the wells(s) was (were) constructed in accordance with 15A NCAC 02C. 0010 or 15A NCAC 02C. 0200 Well Construction Standards and that a copy of this record has been provided to the well owner.

23. Site diagram or additional well details:

You may use the back of this page to provide additional well site details or well construction details. You may also attach additional pages if necessary.

**SUBMITTAL INSTRUCTIONS**

24a. **For All Wells:** Submit this form within 30 days of completion of well construction to the following:

Division of Water Resources, Information Processing Unit,
1017 Mail Service Center, Raleigh, NC 27699-1017

24b. **For Injection Wells ONLY:** In addition to sending the form to the address in 24a above, also submit a copy of this form within 30 days of completion of well construction to the following:

Division of Water Resources, Underground Injection Control Program,
1636 Mail Service Center, Raleigh, NC 27699-1636

24c. **For Water Supply & Injection Wells:**

Also submit one copy of this form within 30 days of completion of well construction to the county health department of the county where constructed.

**Form GW-1**

North Carolina Department of Environment and Natural Resources – Division of Water Resources

Revised August 2013
### WELL CONSTRUCTION RECORD

**This form can be used for single or multiple wells**

**1. Well Contractor Information:**

Jonathan Kamionka

Well Contractor Name

3465-A

NC Well Contractor Certification Number

Bill's Well Drilling Co.

Company Name

**2. Well Construction Permit #:**

List all applicable well permits (i.e. County, State, Variance, Injection, etc.)

**3. Well Use (check well use):**

<table>
<thead>
<tr>
<th>Water Supply Well:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Agricultural</td>
<td>□ Municipal/Public</td>
</tr>
<tr>
<td>□ Geothermal</td>
<td>□ Residential Water Supply (single)</td>
</tr>
<tr>
<td>□ Industrial/Commercial</td>
<td>□ Residential Water Supply (shared)</td>
</tr>
<tr>
<td>□ Irrigation</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Non-Water Supply Well:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Monitoring</td>
<td>□ Recovery</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Injection Well:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Aquifer Recharge</td>
<td>□ Groundwater Remediation</td>
</tr>
<tr>
<td>□ Aquifer Storage and Recovery</td>
<td>□ Salinity Barrier</td>
</tr>
<tr>
<td>□ Aquifer Test</td>
<td>□ Stormwater Drainage</td>
</tr>
<tr>
<td>□ Experimental Technology</td>
<td>□ Subsidence Control</td>
</tr>
<tr>
<td>□ Geothermal (Closed Loop)</td>
<td>□ Tracer</td>
</tr>
<tr>
<td>□ Geothermal (Heating/Cooling Return)</td>
<td>□ Other (explain under #21 Remarks)</td>
</tr>
</tbody>
</table>

**4. Date Well(s) Completed:**

5-18-16 Well ID#: Surficial

**5a. Well Location:**

NC-DENR Castle Hayne Park

Facility/Owner Name

4700 Old Ave, Castle Hayne, NC 28429

Physical Address, City, and Zip

New Hanover

County

**5b. Latitude and Longitude in degrees/minutes/seconds or decimal degrees:**

E N W

**6. Is (are) the well(s):**

□ Permanent or □ Temporary

**7. Is this a repair to an existing well:**

□ Yes or □ No

If this is a repair, fill out known well construction information and explain the nature of the repairs under #21 remarks section or on the back of this form.

**8. Number of wells constructed:**

1

For multiple injection or non-water supply wells ONLY with the same construction, you can submit one form.

**9. Total well depth below land surface:**

45 (ft)

For multiple wells list all depths if different (example: 3@200' and 2@100')

**10. Static water level below top of casing:**

1 (ft)

If water level is above casing, use "+"

**11. Borehole diameter:**

9-7/8 (in.)

**12. Well construction method:**

Mud Rotary

**FOR WATER SUPPLY WELLS ONLY:**

**13a. Yield (gpm):**

30

**Method of test:**

pump

**13b. Disinfection type:**

HTH

**Amount:**

1 cup

**For Internal Use ONLY:**

**14. WATER ZONES**

<table>
<thead>
<tr>
<th>FROM</th>
<th>TO</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 ft</td>
<td>40 ft</td>
<td>sands</td>
</tr>
</tbody>
</table>

**15. OUTER CASING (for multi-cased wells) OR LINER (if applicable)**

<table>
<thead>
<tr>
<th>FROM</th>
<th>TO</th>
<th>DIAMETER</th>
<th>THICKNESS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**16. INNER CASING OR TUBING (geothermal only)**

<table>
<thead>
<tr>
<th>FROM</th>
<th>TO</th>
<th>DIAMETER</th>
<th>THICKNESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>+3 ft</td>
<td>30 ft</td>
<td>4.5 in.</td>
<td>SDR17 PVC</td>
</tr>
<tr>
<td>40 ft</td>
<td>45 ft</td>
<td>4 in.</td>
<td>sch80 PVC</td>
</tr>
</tbody>
</table>

**17. SCREEN**

<table>
<thead>
<tr>
<th>FROM</th>
<th>TO</th>
<th>DIAMETER</th>
<th>SLOT SIZE</th>
<th>THICKNESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 ft</td>
<td>40 ft</td>
<td>4 in.</td>
<td>.020 PVC</td>
<td></td>
</tr>
</tbody>
</table>

**18. GROUT**

<table>
<thead>
<tr>
<th>FROM</th>
<th>TO</th>
<th>MATERIAL</th>
<th>EMPLACEMENT METHOD &amp; AMOUNT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>bentonite</td>
<td>pumped</td>
</tr>
</tbody>
</table>

**19. SAND/GRAVEL PACK (if applicable)**

<table>
<thead>
<tr>
<th>FROM</th>
<th>TO</th>
<th>MATERIAL</th>
<th>EMPLACEMENT METHOD</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 ft</td>
<td>45 ft</td>
<td>#2 gravel</td>
<td>poured</td>
</tr>
</tbody>
</table>

**20. DRILLING LOG (attach additional sheets if necessary)**

<table>
<thead>
<tr>
<th>FROM</th>
<th>TO</th>
<th>DESCRIPTION (color, hardness, soil/rock type, grain size, etc.)</th>
</tr>
</thead>
</table>

**21. REMARKS**

**22. Certification:**

5-18-16

Signature of Certified Well Contractor

Date

By signing this form, I certify that the work was (were) constructed in accordance with 15A NCAC 02C.0100 or 15A NCAC 02C.0200 Well Construction Standards and that a copy of this record has been provided to the well owner.

**23. Site diagram or additional well details:**

You may use the back of this page to provide additional well site details or well construction details. You may also attach additional pages if necessary.

**SUBMITTAL INSTRUCTIONS**

**24a. For All Wells:**

Submit this form within 30 days of completion of well construction to the following:

Division of Water Resources, Information Processing Unit, 1617 Mail Service Center, Raleigh, NC 27699-1617

**24b. For Injection Wells ONLY:**

In addition to sending the form to the address in 24a above, also submit a copy of this form within 30 days of completion of well construction to the following:

Division of Water Resources, Underground Injection Control Program, 1636 Mail Service Center, Raleigh, NC 27699-1636

**24c. For Water Supply & Injection Wells:**

Also submit one copy of this form within 30 days of completion of well construction to the county health department of the county where constructed.
WELL CONSTRUCTION RECORD

This form can be used for single or multiple wells.

1. Well Contractor Information:

Jonathan Kamionka

Well Contractor Name

3465-A

NC Well Contractor Certification Number

Bill's Well Drilling Co.

Company Name

2. Well Construction Permit #:

List all applicable well permits (i.e. County, State, Variance, Injection, etc.)

3. Well Use (check well use):

Water Supply Well:

☐Agricultural

☐Municipal/Public

☐Geothermal (Heating/Cooling Supply)

☐Residential Water Supply (single)

☐Industrial/Commercial

☐Residential Water Supply (shared)

☐Irrigation

Non-Water Supply Well:

☐Monitoring

☐Recovery

Injection Well:

☐Aquifer Recharge

☐Groundwater Remediation

☐Aquifer Storage and Recovery

☐Salinity Barrier

☐Aquifer Test

☐Stormwater Draining

☐Experimental Technology

☐Subsidence Control

☐Geothermal (Closed Loop)

☐Tracer

☐Geothermal (Heating/Cooling Return)

☐Other (explain under #21 Remarks)

4. Date Well(s) Completed: 5-17-16

Well ID# UpperCapeFear

5a. Well Location:

NC-DENR

Castle Hayne Park

4700 Old Ave, Castle Hayne, NC 28429

Facility/Owner Name

Facility ID# (if applicable)

Physical Address, City, and Zip

New Hanover

County

Parcel Identification No. (PIN)

5b. Latitude and Longitude in degrees/minutes/seconds or decimal degrees:

N

W

6. Is (are) the well(s): ☐Permanent or ☐Temporary

7. Is this a repair to an existing well: ☐Yes or ☐No

If this is a repair, fill out known well construction information and explain the nature of the repair under #21 Remarks section or on the back of this form.

8. Number of wells constructed: 1

For multiple injection or non-water supply wells ONLY with the same construction, you can submit one form.

9. Total well depth below land surface: 110 (ft.)

For multiple wells for all depths if different (example: 3 @ 200' and 2 @ 100')

10. Static water level below top of casing: 5 (ft.)

If water level is above casing, use "+"

11. Borehole diameter: 9-7/8 (in.)

12. Well construction method: Mud Rotary

☐ For WATER SUPPLY WELLS ONLY:

13a. Yield (gpm) 20

Method of test: pumping

13b. Disinfection type: HTH

Amount: 1 cup

14. WATER ZONES

FROM TO DESCRIPTION

95 ft. 105 ft. sands

15. OUTER CASING (for multi-cased wells) OR LINER (if applicable)

FROM TO DIAMETER THICKNESS MATERIAL

16. INNER CASING OR TUBING (geothermal closed-loop)

FROM TO DIAMETER THICKNESS MATERIAL

17. SCREEN

FROM TO DIAMETER SLOT SIZE THICKNESS MATERIAL

18. GROUT

FROM TO MATERIAL EMPLACEMENT METHOD & AMOUNT

19. SAND/GRAVEL PACK (if applicable)

FROM TO MATERIAL EMPLACEMENT METHOD

20. DRILLING LOG (attach additional sheets if necessary)

FROM TO DESCRIPTION (color, hardness, mil/rank type, grain size, etc.)

21. REMARKS

☐ 22. Certification:

Signed of Certified Well Contractor 5-17-16

Date

By signing this form, I hereby certify that the well(s) was (were) constructed in accordance with 15A NCAC 02C.0110 or 15A NCAC 02C.0200 Well Construction Standards and that a copy of this record has been provided to the well owner.

23. Site diagram or additional well details:

You may use the back of this page to provide additional well site details or well construction details. You may also attach additional pages if necessary.

SUBMITTAL INSTRUCTIONS:

24a. For All Wells: Submit this form within 30 days of completion of well construction to the following:

Division of Water Resources, Information Processing Unit,
1617 Mail Service Center, Raleigh, NC 27699-1617

24b. For Injection Wells ONLY: In addition to sending the form to the address in 24a above, also submit a copy of this form within 30 days of completion of well construction to the following:

Division of Water Resources, Underground Injection Control Program,
1636 Mail Service Center, Raleigh, NC 27699-1636

24c. For Water Supply & Injection Wells:

Also submit one copy of this form within 30 days of completion of well construction to the county health department of the county where constructed.
WELL CONSTRUCTION RECORD
This form can be used for single or multiple wells

1. Well Contractor Information:
Jonathan Kamionka
Well Contractor Name
3465-A
NC Well Contractor Certification Number
Bill's Well Drilling Co.
Company Name

2. Well Construction Permit #:
List all applicable well permits (i.e. County, State, Variance, Injection, etc.)

3. Well Use (check well use):
- Water Supply Well:
  - [ ] Agricultural
  - [ ] Municipal/Public
  - [ ] Geothermal (Heating/Cooling Supply)
  - [ ] Residential Water Supply (single)
  - [ ] Industrial/Commercial
  - [ ] Residential Water Supply (shared)
  - [ ] Irrigation
- Non-Water Supply Well:
  - [ ] Monitoring
  - [ ] Recovery
- Injection Well:
  - [ ] Aquifer Recharge
  - [ ] Groundwater Remediation
  - [ ] Aquifer Storage and Recovery
  - [ ] Salinity Barrier
  - [ ] Aquifer Test
  - [ ] Stormwater Drainage
  - [ ] Experimental Technology
  - [ ] Subsidence Control
  - [ ] Geothermal (Closed Loop)
  - [ ] Tracer
  - [ ] Geothermal (Heating/Cooling Return)
  - [ ] Other (explain under #21 Remarks)

4. Date Wells(s) Completed: 5-16-16  Well ID# #2

5a. Well Location:
NC-DENR Castle Hayne Park
Facility/Owner Name  Facility ID# (if applicable)
4700 Old Ave, Castle Hayne, NC 28429
Physical Address, City, and Zip
New Hanover

County

5b. Latitude and Longitude in degrees/minutes/seconds or decimal degrees:
(if well field, one lat/long is sufficient)


6. Is (are) the well(s): [ ] Permanent or [ ] Temporary

7. Is this a repair to an existing well: [ ] Yes or [ ] No
If this is a repair, fill out known well construction information and explain the nature of the repair under #21 remarks section or on the back of this form.

8. Number of wells constructed: 1
For multiple injection or non-water supply wells ONLY with the same construction, you may submit one form.

9. Total well depth below land surface: 270 (ft.)
For multiple wells list all depths if different (example: 8'@200' and 25'@100')

10. Static water level below top of casing: 8 (ft.)
If water level is above casing, use "-" or "-

11. Borehole diameter: 9-7/8 (in.)

12. Well construction method: Mud Rotary
(i.e. suger, rotary, cable, direct push, etc.)

FOR WATER SUPPLY WELLS ONLY:


13b. Disinfection type: HTH Amount: 1 cup

14. WATER ZONES

<table>
<thead>
<tr>
<th>FROM</th>
<th>TO</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>245 ft.</td>
<td>265 ft.</td>
<td>sands</td>
</tr>
</tbody>
</table>

15. OUTER CASING (for multi-cased wells) OR LINER (if applicable)

<table>
<thead>
<tr>
<th>FROM</th>
<th>TO</th>
<th>DIAMETER</th>
<th>THICKNESS</th>
<th>MATERIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 ft.</td>
<td>65 ft.</td>
<td>10 in.</td>
<td>sch80</td>
<td>PVC</td>
</tr>
</tbody>
</table>

16. INNER CASING OR TUBING (geothermal closed loop)

<table>
<thead>
<tr>
<th>FROM</th>
<th>TO</th>
<th>DIAMETER</th>
<th>LENGTH</th>
<th>THICKNESS</th>
<th>MATERIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>+3 ft.</td>
<td>245 ft.</td>
<td>4.5 in.</td>
<td>SDR17</td>
<td>PVC</td>
<td></td>
</tr>
<tr>
<td>265 ft.</td>
<td>270 ft.</td>
<td>4 in.</td>
<td>sch80</td>
<td>PVC</td>
<td></td>
</tr>
</tbody>
</table>

17. SCREEN

<table>
<thead>
<tr>
<th>FROM</th>
<th>TO</th>
<th>DIAMETER</th>
<th>SLOT SIZE</th>
<th>THICKNESS</th>
<th>MATERIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>245 ft.</td>
<td>265 ft.</td>
<td>4 in.</td>
<td>.020</td>
<td>SS</td>
<td></td>
</tr>
</tbody>
</table>

18. GROUT

<table>
<thead>
<tr>
<th>FROM</th>
<th>TO</th>
<th>MATERIAL</th>
<th>EMPLACEMENT METHOD &amp; AMOUNT</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 ft.</td>
<td>225 ft.</td>
<td>bentonite</td>
<td>pumped</td>
</tr>
<tr>
<td>225 ft.</td>
<td>235 ft.</td>
<td>bentonite</td>
<td>poured</td>
</tr>
</tbody>
</table>

19. SAND/GRAVEL PACK (if applicable)

<table>
<thead>
<tr>
<th>FROM</th>
<th>TO</th>
<th>MATERIAL</th>
<th>EMPLACEMENT METHOD</th>
</tr>
</thead>
<tbody>
<tr>
<td>235 ft.</td>
<td>330 ft.</td>
<td>#3 gravel</td>
<td>poured</td>
</tr>
</tbody>
</table>

20. DRILLING LOG (attach additional sheets if necessary)

| FROM | TO | DESCRIPTION (color, hardness, soil type, grain size, etc.) |

21. REMARKS

22. Certification

Signature of Certified Well Contractor
Date 5-16-16

By signing this form, I certify that the wells(s) was (were) constructed in accordance with 15A NCAC 02C. 0100 or 15A NCAC 02C. 0200 Well Construction Standards and that a copy of this record has been provided to the well owner.

23. Site diagram or additional well details:
You may use the back of this page to provide additional well site details or well construction details. You may also attach additional pages if necessary.

SUBMITTAL INSTRUCTIONS

24a. For All Wells: Submit this form within 30 days of completion of well construction to the following:
Division of Water Resources, Information Processing Unit,
1617 Mail Service Center, Raleigh, NC 27699-1617

24b. For Injection Wells ONLY: In addition to sending the form to the address in 24a above, also submit a copy of this form within 30 days of completion of well construction to the following:
Division of Water Resources, Underground Injection Control Program,
1636 Mail Service Center, Raleigh, NC 27699-1636

24c. For Water Supply & Injection Wells:
Also submit one copy of this form within 30 days of completion of well construction to the county health department of the county where constructed.
APPENDIX B

GROUND WATER SAMPLING PROTOCOL
Ground Water Sampling Protocol

Samples for the ambient monitoring program were collected in accordance with DWR procedures outlined in NCDWQ/APS 2006 in order to ensure that high quality, defensible data was collected. To ensure that only newly recharged ground water was being sampled, wells were pumped until three well volumes had been removed. Where a well’s total volume was too high to feasibly pump out three volumes, wells were purged until water quality parameters that can be measured in the field (temperature, pH, specific conductance, and dissolved oxygen) stabilized. Both submersible and peristaltic pumps were used in the field at the sampler’s discretion depending on the total depth of the well and the hydraulic head difference to be overcome. To prevent contamination introduced while sampling, nitrile gloves were worn during all sampling events. Pumps were decontaminated after each use. In addition, blanks and duplicate samples were collected to provide quality assurance information. Trip blanks were collected for each sampling trip, and equipment blanks were collected for each pump. Duplicate well samples were collected at 10% of all wells sampled.

The ground water was analyzed for a broad suite of water quality and water chemistry parameters. Data from the ambient monitoring program may be used to characterize ground water throughout the state as well as to address the concerns other programs and projects. Some examples of concerns within programs in DWR are saltwater intrusion due to over-pumping, the source of organic nitrogen found in surface water bodies, the impact of concentrated farming activities on drinking water supplies, and the levels of naturally occurring contaminants such as metals. Since most of these wells are somewhat geographically isolated from human activities, the water collected is more likely to represent ambient conditions and not contamination.

<table>
<thead>
<tr>
<th>Parameter Group</th>
<th>Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private Well Analytes</td>
<td>arsenic, barium, cadmium, chromium, copper, fluoride, lead, iron, magnesium, manganese, mercury, nitrate, nitrite, selenium, silver, sodium, zinc, pH</td>
</tr>
<tr>
<td>Nutrients*</td>
<td>Ammonia, total kjeldahl nitrogen, organic nitrogen, phosphorus</td>
</tr>
<tr>
<td>Metals (Dissolved and Total)*</td>
<td>Aluminum, antimony, beryllium, boron, calcium, cobalt, lithium, molybdenum, nickel, potassium, strontium, thallium, tin, titanium, vanadium</td>
</tr>
<tr>
<td>Major Ions</td>
<td>Bromide, chloride, fluoride, sulfate, carbonate, bicarbonate</td>
</tr>
<tr>
<td>Field Parameters</td>
<td>Specific conductivity, pH, dissolved oxygen (DO), oxidation-reduction potential (ORP), temperature</td>
</tr>
<tr>
<td>Organic Compounds</td>
<td>Volatile organic compounds, Semi-volatile organic compounds, Pesticides</td>
</tr>
<tr>
<td>Other</td>
<td>Alkalinity, total organic carbon, turbidity, total dissolved solids, silica, sulfide</td>
</tr>
</tbody>
</table>

*In addition to those required by 15A NCAC 18A .3803
References:

15A NCAC 18A Section .3800 - Private Drinking Water Well Sampling, .3803 - Sample Analysis