

**North Carolina
Division of Water Resources
Ground Water Management Branch
2015 Annual Report**

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Environment and Natural Resources
Division of Water Resources
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R23X, Cove City, Jones County

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 Environment and Natural Resources (DENR), 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 effects 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; 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. 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 2015 Annual Report summarizes field activities and conclusions derived from activities performed or associated with the Ground Water Management Branch during the July 1, 2014 through June 30, 2015 fiscal year (2015 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 2015 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 twenty-eight percent (233 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 636 wells at 212 monitoring stations (sites), divided into five regions, comprising 64 counties (Figure 1). There are 38 wells located in the Piedmont and Mountain physiographic provinces (Piedmont and Mountain) and 598 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 has 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 2015 FY (Figure 2).

Of the 212 monitoring stations, 72 are on State or Federal property, 51 are located on property owned by local governments, 83 are located on private property through agreements with landowners, 5 stations are located on properties where landowner indicates that the land property ownership may change, and 1 site is located on a property where there is an imminent threat of losing the site. 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



Big Flatty Creek, Pasquotank County



Kelly Station, Bertie County



Spring Creek Elementary School, Wayne County

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 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 vented or unvented submersible transducers. Hourly water level data are extremely valuable in assessing aquifer recharge,



Manual Water Level Collection



**Picture from Down Hole Camera
Approaching Water in Well**



Video-logging Densons Creek Park

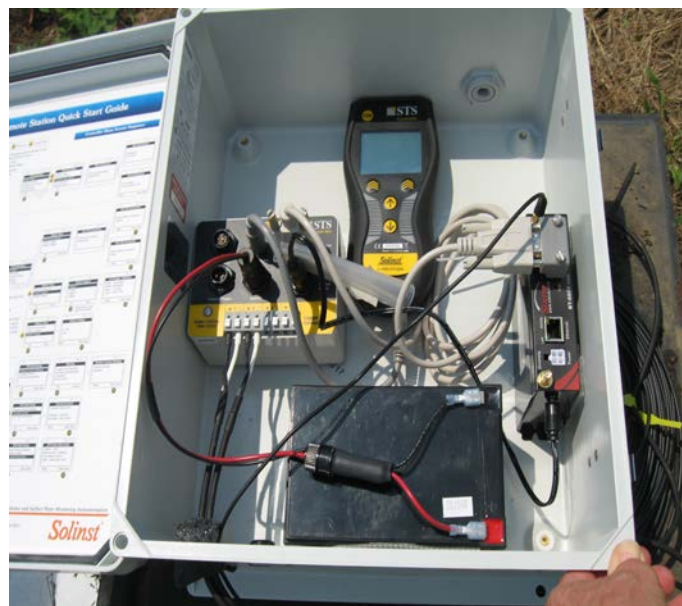
impacts of large storms on ground water conditions, and delineation of aquifer boundaries. Manual water level readings and daily automatic recorder water level data are typically published on the DWR website. However, hourly data is available upon request for specific wells. [Table 2](#) summarizes site 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 cell phone modem. DWR uses the STS system on the Drought Indicator Well network to take the place of monthly visits. Subsequently, they will be 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 STS systems were installed in the 2015 FY at the following stations:

- Monroe, Union County, U62A1 (07/02/2014);
- Troutman, Iredell County, L67U2 (08/27/2014);
- Hornets Nest, Mecklenberg County, Q66C1 (10/07/2014); and
- Como, Hertford County, B20U8 (10/14/2014).

DWR intends to add at least four STS units in the 2016 FY.



STS System

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 2015. Section 5.2 summarizes the 2012 chloride sampling event.



Chloride Sampling Equipment

5.0 Well Network Statistics

5.1 Ground Water Data Collection

Depth to ground water was measured in 630 wells in the 2015 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 2013 represents the most water level data collected in any single year since starting the monitoring well network operation. This is due to the monthly collection of drought well water levels during the 2013 FY. The 2015 data was collected from July 1, 2014 through June 30, 2015.



Quantab® Chloride Titrators

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 chloride sampling event was performed in September and October 2012. Ground water from 245 wells within the network was sampled for chlorides using Quantab® chloride titrators. Field data were collected for pH, conductivity, and salinity using YSI® portable probes.

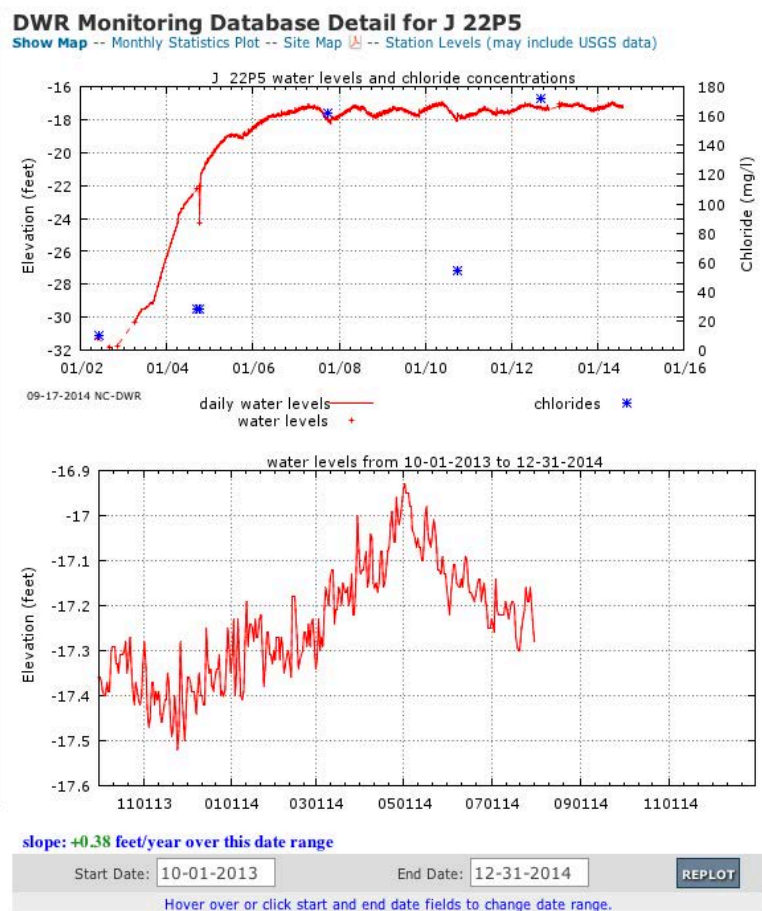
The intention of the triennial chloride sampling is to assess the position of the fresh water-salt water interface within each of the major coastal plain aquifers. Current results are compared to results of previous sampling events to evaluate potential landward migration of the fresh water-salt water 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.

Ground Water Level Database Detail

Field	Data
County	Martin
Quad link to framework	J 22P5
Name link to logs	Gold Point
Latitude	35.856521
Longitude	-77.248202
Location Accuracy	GPS
Netname (link to USGS data)	
USGS ID	
Aquifer	Upper Cape Fear
Land Surface NED elevation = 73.00 feet	72.00
Date Constructed	04/02/2002
Measuring Point (feet above land surface)	2.76
Depth	447.00
Diameter	4.00
Yield	1.00
Exists?	y
Recorder Box?	y
Top of Screen	432.00
Bottom of Screen	442.00
Number of Water Levels	4,054
(date * chlorppm * spcond_uS/cm * salin_ppt * pH * comments)	** 999.99 feet below land surface value indicates dry well -222.22 feet above land surface value indicates a flowing well
Number of Chlorides	6
(date * chlorppm * spcond_uS/cm * salin_ppt * pH * comments)	** -1 values equal no data ** a negative number other than -1 equals below detection limit of abs(number)

output files are tab-delimited text
NED = National Elevation Dataset, 1/3 arc second value
(~10 X 10 meter grid)

[return to well table](#)



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 September 2012 chloride field sampling results associated with wells near larger pumping centers illustrate these type of issues:

- Chloride concentrations from September 2012 in the lower Castle Hayne aquifer well Q16G4 at the Godley Station continue to indicate salt water intrusion with levels of 352 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 a decrease in chlorides from 296 ppm in July 2011 to 227 ppm on September 12, 2012. Since previous samples indicated salt water intrusion, this well will continue to be sampled in the future. 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 54 ppm in October 2010 to 172 ppm in September 2012. This station is located near the town of Robersonville in Martin County.
- Chloride concentrations from the Yorktown Aquifer well H4U2 increased from 160 ppm in September 2010 to 227 ppm in September 2012. This station is located at the Wright Memorial Station in Dare County.

Table 5 summarizes the chloride field analysis to date for specific wells. Chloride sampling will take place again in September and October 2015.

5.3 Well Installation and Development

From March 2015 through May 2015, the following monitoring wells were installed using the mud rotary drilling method:

- Spring Creek Elementary School Station, Wayne County, four wells, Q30R1, Q30R2, Q30R3, and Q30R4;
- Calypso Station, Duplin County, four wells, S33C1, S33C2, S33C3, and S33C4; and
- Kelly Station, Bladen County, three wells, AA35N4, AA35N5, and AA35N6.

A pilot hole was advanced at the Spring Creek Elementary School Station, Wayne County, and the Calypso Station, Duplin 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



Well Installation Using Mud Rotary Drilling

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.

A pilot hole was not advanced prior to installing the wells at the Kelly station. This station had a pilot hole advanced in 1981 and geophysical logging was conducted at that time.

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 (wells greater than 70 feet) or 4 inch .020 slot PVC screen (wells less than 70 feet). 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 overlay 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.



Geophysical Logger



Stainless Steel Slotted Screen with Tail Pipe



Pressure grouting using bentonite grout

Development removes fine-grained sediments from the vicinity of the well screen and ensures proper hydraulic connection with the aquifer. In addition, 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 well AA35N4 (Kelly Station, Bladen County) was developed by pumping, on June 17, 2015. In addition, the D Canal Road Station wells (L15T1, L15T2, L15T3, L15T4, and L15T5), Hyde County, were developed from September 23 through September 25, 2014.



Well Development



The following artesian monitoring wells were developed by opening the valve on the well and using the head pressure of the aquifer to develop the well by discharging the ground water through a hose:

- Kelly Station, Bladen County, well AA35N5 and AA35N6 (June 2015); and
- Calypso Station, Duplin County, wells S33C1, S33C2, S33C3, and S33C4 (May 2015).

Borehole advancement and well installation included well development. DWR staff will conduct additional well development in July 2015 at the Eagle Springs Elementary School station. Chloride measurements were collected in all newly constructed monitoring wells subsequent to DWR well development in the 2015 FY. DWR staff plans to redevelop several existing monitoring wells in the 2016 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 ground water 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.

5.5 Acquired Network Wells

DWR acquired one existing well and included it into monitoring well network:

- Upper Piedmont RS, Rockingham County, well D 52R1 (05/04/2015)

Table 6 includes the detailed information of the acquired monitoring well. This well is 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 vented or unvented submersible transducers.



Global Water WL 16 including iPAQ, field book and calculator

They allow for economical collection of near-continuous data at remote well stations. Three primary recorders (Global Water WL16, Hobo U20 and barometer, and STS) are utilized and are included in [Table 7](#). STS system photographs are included in Section 4.2.



**Hobo Including barometer, shuttle,
and water level indicator**



Programming Hobo in the field



Downloading Hobo data to Shuttle

5.7 Site Surveys

Concrete survey monuments continue to be installed at each of the 212 active monitoring well stations within the network. Monuments have been installed at 205 active stations and five of those stations have more than one monument. The seven remaining stations are on hold pending the results of the extremely involved process associated with monitoring wells stations located on military bases.

All of the installed monuments were surveyed using Survey Grade Global Positioning System (GPS) to calculate the most accurate horizontal and vertical location data possible. The monuments were surveyed from February through June 2015. DWR was unable to calculate elevation at one monitoring station, New Lake (M12L), due to the inability to acquire a satellite signal at the station's location. GPS surveying will be conducted again in the fall/winter of the 2016 FY to provide a second set of horizontal and vertical data on selected monitoring well stations.



Monument Installed

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



Top of monument - survey point

and a well at the former Orange County 911 Center. [Table 8](#) summarizes the OWN well information. [Figure 4](#) 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 9](#) is a summary of the OWN statistics from March 2010 through June 30, 2015. The 2011, 2012, and 2013 OWN Annual 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 Annual Reports and information provided by the DWR database, are the source 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 10](#) 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.

[Table 11](#) summarizes the Guilford County monitoring well statistics from 2008 through June 30, 2015. [Figure 5](#) is a site map of the Guilford County monitoring well locations. Currently the Guilford County water level data is being assessed and will be available to the public in the near future when it is fully uploaded to the DWR ground water database. 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 source for the Guilford County Monitoring Well Network information provided herein.

7.0 Planned Activities for the 2016 FY

7.1 [New Well Installation](#)

Monitoring well network expansion efforts for the 2016 FY will be focused on Beaufort, Edgecombe, and Pender Counties. In addition, some wells throughout the network that cannot be used due to bad construction, screening in multiple aquifers, etc., may be abandoned during this upcoming fiscal year. [Table 12](#) summarizes the possible upcoming expansion of the network in 2016 FY.

7.2 Well Abandonment

No monitoring wells were abandoned in the 2015 FY.

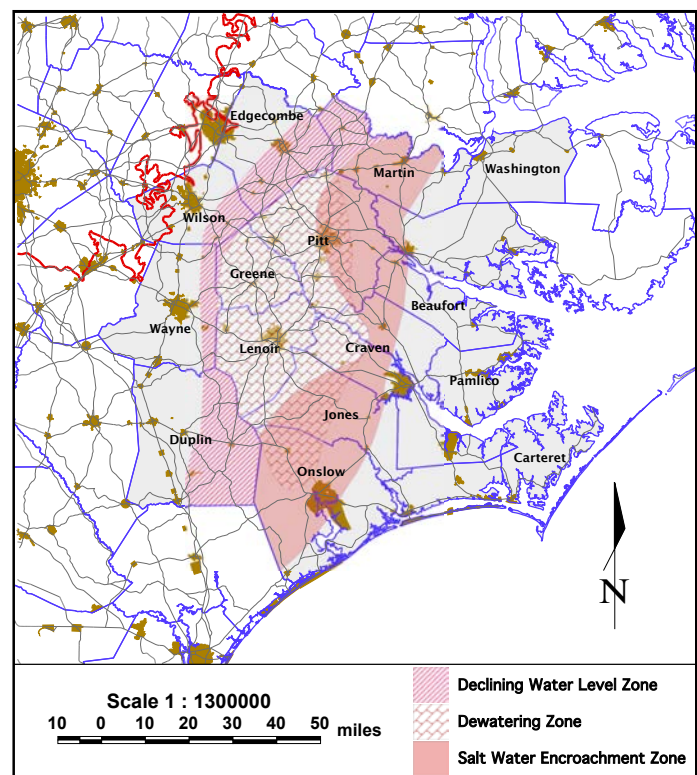
8.0 Central Coastal Plain Capacity Use Area

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. Due to significant ground water depletion, on August 1, 2002 the Central Coastal Plain Capacity Use Area rules came into effect. As stated in 15A NCAC 2E .0501, “[t]he 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 the primary source of water in the CCPCUA, at a rate that was greater than the natural recharge. 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.

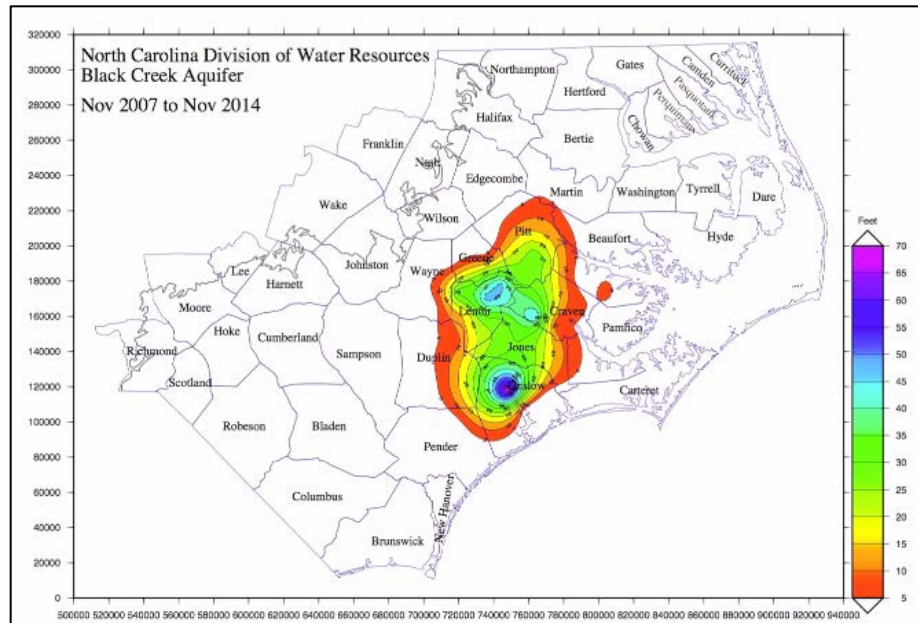
The goal of the DWR is to regulate water withdrawals in the Central Coastal Plain (CCP) under the authority of the Environmental Management Commission (EMC). The following summarizes how these withdrawals are regulated:

- 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.

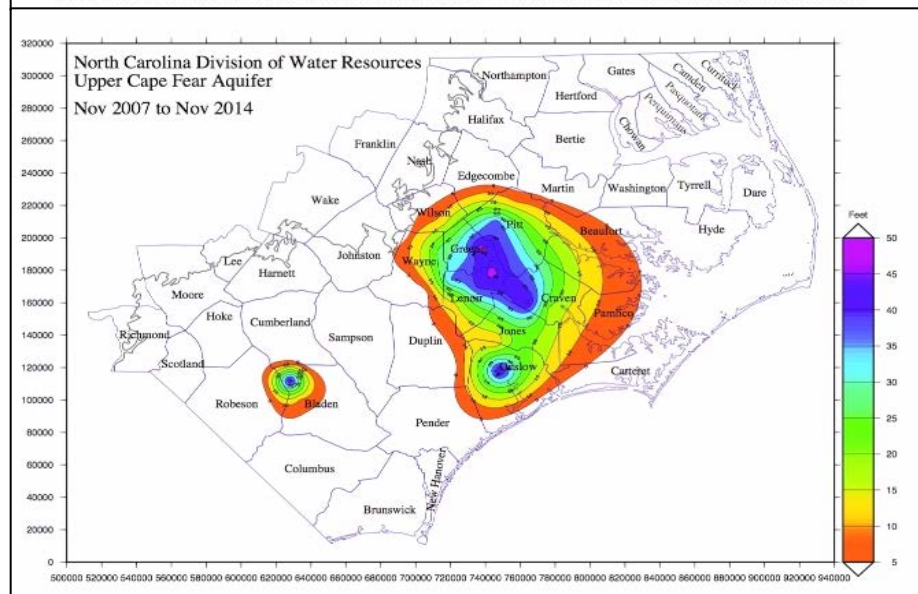
CCPCUA Cretaceous Aquifer Zones



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. These maps show the areas where ground water levels have risen between 5 feet (red) to more than 40 feet (blue) from Feb. 2008 through Nov. 2014.



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 (see Figure 6), 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 June 2015, 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.

Gabrielle Chianese and Nat Wilson of the DWR, Ground Water Management Branch, provided the information for the CCPCUA section of this report.

9.0 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 636 monitoring wells at 212 individual stations. From July 2014 through June 2015, ground water level data were collected from 630 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 2015 FY on drought monitoring network wells. The addition of the STS systems will replace monthly site visits and provide positive economic impacts. DWR intends to add four STS units in the 2016 fiscal year.

The triennial chloride sampling was performed on 245 wells in September/October 2012. One additional sample was collected from the new well installation at Ivanhoe in March 2013. Three additional samples were collected, one from each of the new wells installed at Nakina. Sampling results indicated that there continues to be concern for saltwater encroachment especially near larger pumping centers located near the fresh-salt water interface. Chloride sampling will occur again in September/October 2015.

Eleven monitor wells have been installed at three different stations during the 2015 FY. Four monitoring wells were installed at Spring Creek Elementary School (Wayne County), four wells were installed at Calypso (Duplin County) and three wells were installed at Kelly (Bladen County). Borehole advancement and well installation included, but not limited to, well development and collection of chloride measurements.

One well was acquired and added to the monitoring well network in the 2015 FY: Upper Piedmont RS in Rockingham County.

No wells were abandoned during the 2015 FY.

There are two local networks whose water level data are currently being uploaded to the DWR database. The OWN, Orange County, water level data can be viewed by the public on the DWR website. The Guilford County water level data will be available for public view in the near future.

Archived water level recorder charts obtained from the DWQ with records dating from the 1960s through 1980s continue to be digitized and data recorded into the DWR online database. 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 2015 FY. There are plans to resurvey selected wells in the fall/winter of the 2016 FY.

DWR continues to collect depth to water level measurements and chloride sampling event data from monitor wells within the well network and permitted withdrawal wells to assess aquifer conditions.

DWR has tentative plans to expand the monitoring well network by installing up to 16 wells at four sites in the 2016 FY. In addition several wells in the network may be scheduled for abandonment, replacement, and repair.

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 rule are warranted. Based on the results of data assessment, DWR does not recommend rule changes, but is recommending the use of temporary permits under rule .0502.

FIGURES

Figure 1: North Carolina Division of Water Resources Monitoring Stations July 2015

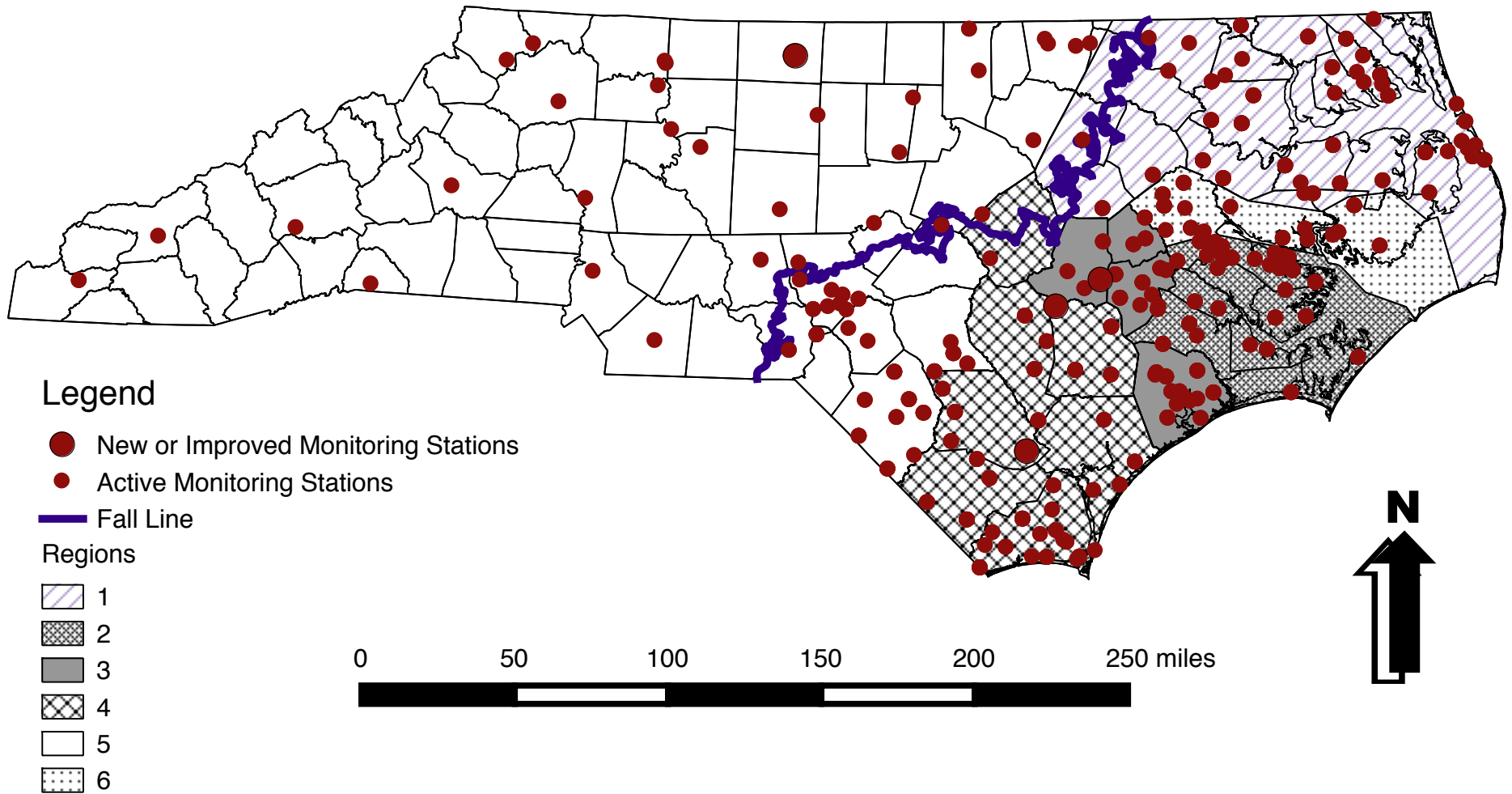


Figure 2: Drought Indicator Wells

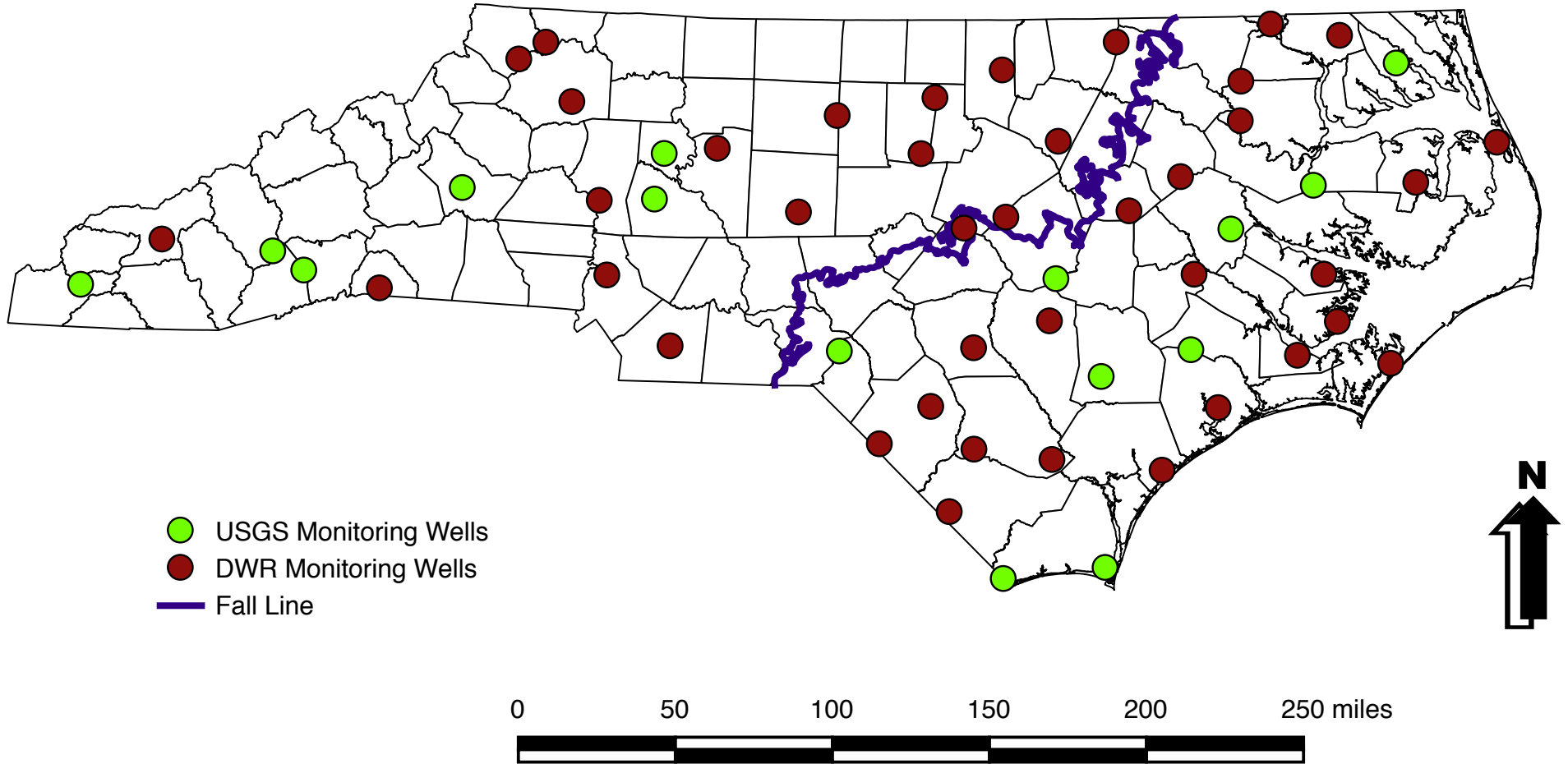


FIGURE 3

Water Level Data Collected from 1967-2015
(Plot includes both DWR and USGS Data)

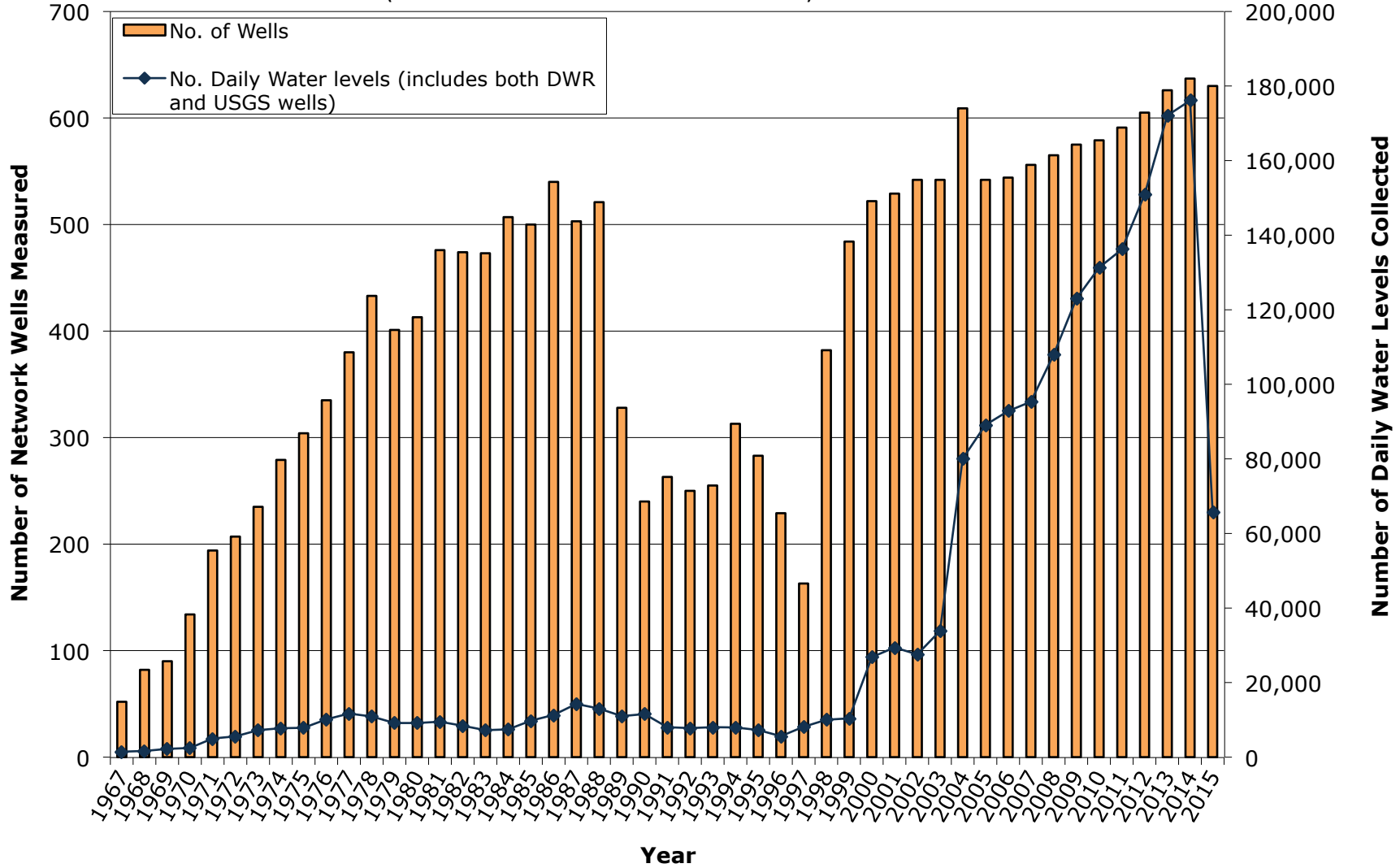


Figure 4 Site Map Orange Well Net Orange County June 2015

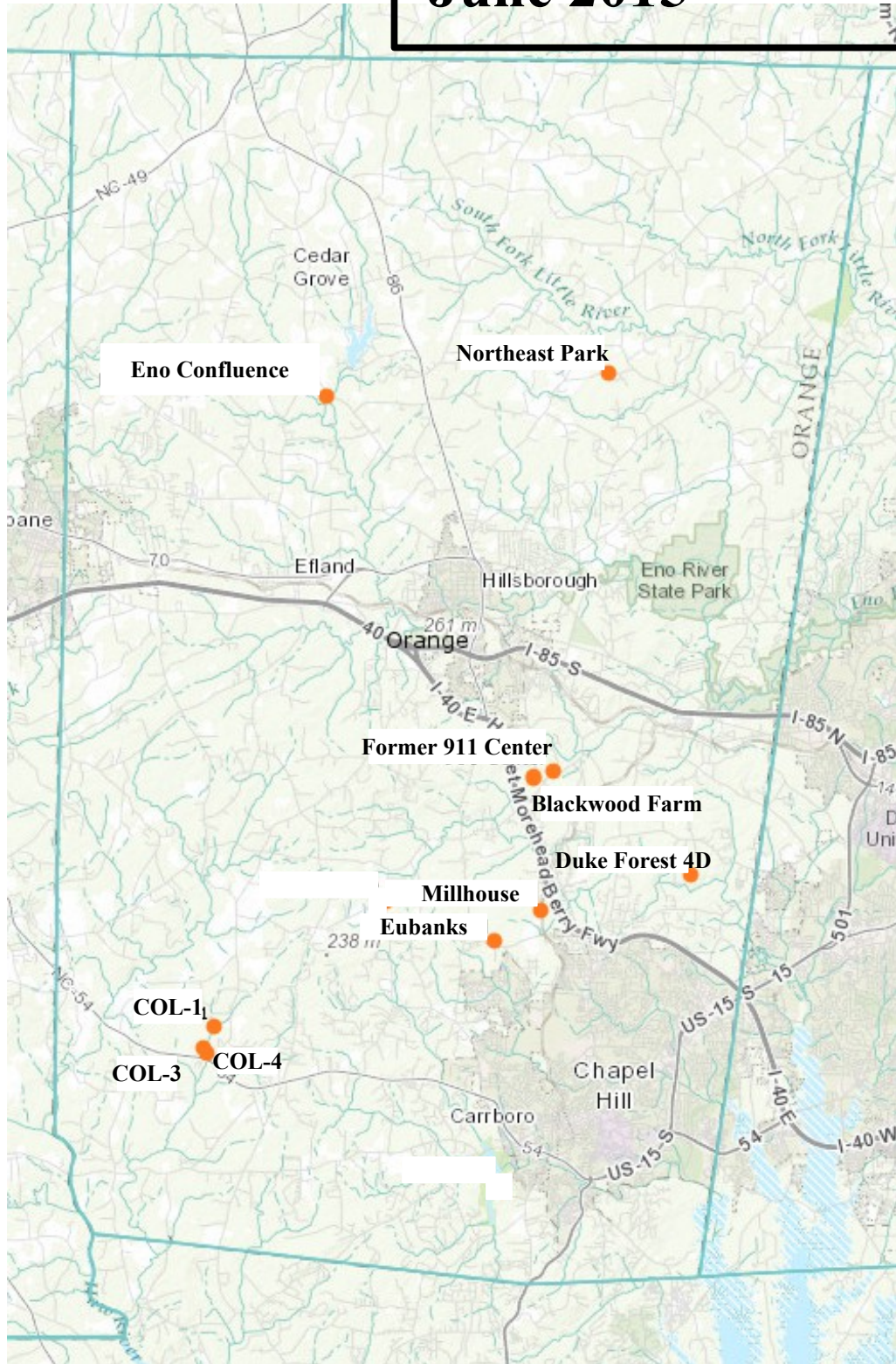
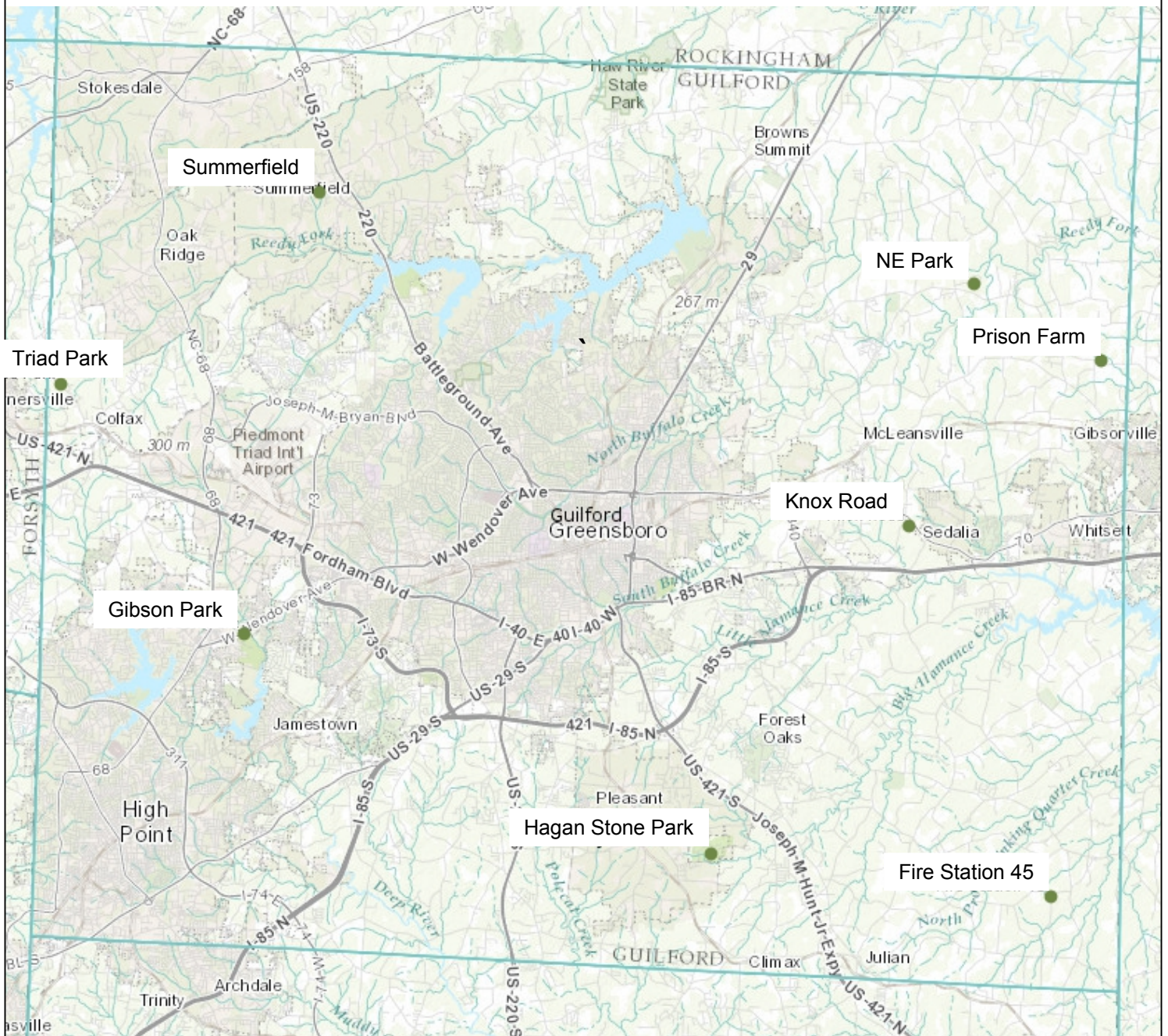


Figure 5 Site Map Monitoring Well Network Guilford County June 2015



TABLES

TABLE 1
Site Susceptibility Rating
North Carolina Division of Water Resources
Ground Water Management Branch
2015 Annual Report

Susceptibility Rating	Description
1	Secure —station is located on State or Federal government property
2	Secure —station is located on local government or school property
3	Moderately secure —station is located on private property, but landowner does not give any indication that land use or property ownership may change
4	Tenuous —station is located on public or private property and landowner is giving indications that land use or property ownership may change
5	Imminent threat —station is on public or private property and landowner desires abandonment of well station.

TABLE 2
Site and Recorder Distribution by Region as of 6/30/15
North Carolina Division of Water Resources
Ground Water Management Branch
2015 Annual Report

Region	Parameter	Number	% of Region	% of Network
	Wells	130		20.4
	Sites	43		20.3
1	WL16s	2	1.5	0.3
	Hobos	106	81.5	16.7
	All Recorders	108	83.1	17.0
	Wells	142		22.3
	Sites	31		14.6
2	WL16s	0	0.0	0.0
	Hobos	130	91.5	20.4
	All Recorders	130	91.5	20.4
	Wells	94		14.8
	Sites	27		12.7
3	WL16s	0	0.0	0.0
	Hobos	77	81.9	12.1
	All Recorders	77	81.9	12.1
	Wells	133		20.9
	Sites	39		18.4
4	WL16s	0	0.0	0.0
	Hobos	79	59.4	12.4
	All Recorders	79	59.4	12.4
	Wells	90		14.2
	Sites	55		25.9
5	WL16s	16	17.8	2.5
	Hobos	59	65.6	9.3
	All Recorders	75	83.3	11.8
	Wells	47		7.4
	Sites	16		7.5
6	WL16s	0	0.0	0.0
	Hobos	39	83.0	6.1
	All Recorders	39	83.0	6.1

TABLE 3
Solinst Telemetry System (STS) Distribution by Region as of 6/30/15
North Carolina Division of Water Resources
Ground Water Management Branch
2015 Annual Report

Region	Station Name	Well Number	Date Installed
1	Lewiston	H22I3	6/20/2013
5	Bryson City	O97W2	2/18/2014
5	Columbus	R82I1	2/19/2014
5	Rowland	Z47R5	4/24/2014
4	Clarendon	DD42N1	4/24/2014
1	Manteo Airport	I4W5	6/4/2014
4	Topsail Beach	BB28J5	6/12/2014
5	NC Zoo	M53L1	6/19/2014
5	Monroe	U62A1	7/2/2014
5	Troutman	L67U2	8/27/2014
5	Hornets Nest	Q66C1	10/7/2014
1	Como	B20U8	10/14/2014

TABLE 4
Monitoring Well Network Statistics (01-01-2005 through 06-30-2015)
North Carolina Division of Water Resources
Ground Water Management Branch
2015 Annual Report

Parameter	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Number of monitored wells	542	544	556	565	575	579	591	605	626	637
Manual water levels (tapedowns)	2,633	2,744	2,627	2,468	2,558	2,911	2,628	2,955	3,269	2706
Daily water levels (automatic recorders)	89,088	92,827	95,329	107,969	122,962	131,317	136,208	150,912	172,111	176,111
Total hourly water levels	2,141,368	2,229,355	2,294,909	2,593,630	2,961,371	3,163,188	3,276,496	3,622,891	4,128,993	4,225,684
Chloride Samples	17	22	175	12	17	251	21	274	13	10
Geophysical & lithologic logs at new stations	2	1	3	1	1	0	2	1	1	1

TABLE 4 (Continued)
Monitoring Well Network Statistics (01-01-2005 through 06-30-2015)
North Carolina Division of Water Resources
Ground Water Management Branch
2015 Annual Report

Parameter	2015
Number of monitored wells	630
Manual water levels (tapedowns)	1427
Daily water levels (automatic recorders)	65,682
Total hourly water levels	1,570,200
Chloride Samples	7
Geophysical & lithologic logs at new stations	2

TABLE 5 Chloride Field Analysis from 2012 Sampling Event Wells Q16G4, Y25Q4, J22P5 and R23X9 North Carolina Division of Water Resources Ground Water Management Branch 2015 Annual Report		
Station	Date	Chlorides (ppm)
	09/21/2012	352
	10/04/2010	531
Godley	10/01/2007	564
Station	09/15/2004	137
Q16G4	10/07/1999	91
	07/14/1998	174
	02/23/1981	No Reading Available
	09/12/2012	227
	07/09/2011	296
Folkstone	09/25/2007	252
Station	09/14/2004	266
Y25Q4	10/12/1999	35
	08/06/1998	11
	09/25/1982	No Reading Available
	09/06/2012	172
Gold Point	10/04/2010	54
Station	09/24/2007	162
J22P5	09/30/2004	BDL of 28 **
	09/15/2004	BDL of 28
	06/10/2002	10
	09/11/2012	405
Cove City	09/20/2010	463
Station	10/05/2007	352
R23X9	09/13/2004	309
	10/04/2000	30
Chloride Level for Salt Water		250

**Collected after well development

TABLE 6
Well Construction Information for 2015 FY Well Installation
Spring Creek Elementary School (Q30R), Calypso (S33C), and Kelly (AA35N)
North Carolina Division of Water Resources
Ground Water Management Branch
2015 Annual Report

Well ID	Station Name	Date Installed	Well Diameter (inches)	Well Depth (ft bls)	Screened Interval (x to y ft bls)	Measuring Pt. (MP) (ft)	Aquifer	Water Level Date Measured (from MP) (ft)
Q30R1	Spring Creek Elementary School	03/12/2015	4	318	243-253	-	NDY	-
Q30R2		03/13/2015	4	132	117-127	-	NDY	-
Q30R3		03/16/2015	4	100	85-95	-	NDY	-
Q30R4		03/16/2015	4	35	20-30	-	NDY	-
S33C1	Calypso	03/20/2015	4.5	60	45-55	-	NDY	-
S33C2		03/26/2015	4.5	267	181-191	-	NDY	-
S33C3		03/26/2015	4.5	35	20-30	-	NDY	-
S33C4		03/27/2015	4.5	156	141-151	-	NDY	-
AA35N4	Kelly	05/12/2015	4	39	24-34	-	NDY	-
AA35N5		05/13/2015	4	290	275-285	-	NDY	-
AA35N6		05/20/2015	4	463	448-458	-	NDY	-
Wells Construction Information for Wells Acquired in 2015 FY								
Well ID	Station Name	Date Acquired	Well Diameter (inches)	Well Depth (ft bls)	Screened Interval (x to y ft bls)	Measuring Pt. (MP) (ft)	Aquifer	Water Level Date Measured (from MP) (ft)
D52L1	Upper Piedmont RS	05/04/2015	4	38	23-38	2.99	Bedrock Surficial	26.51 (05/04/2015)

NDY – Not Determined Yet

TABLE 7 Automatic Water Level Recorders as of 6/30/2015 North Carolina Division of Water Resources Ground Water Management Branch 2015 Annual Report	
Recorder Type	Number in Service*
Global Water Instrumentation, Inc. Model WL16	18
HOBO U20 Water Level Logger (including separate barometer per station installed)	643 (includes 153 barometers)
Solinst Telemetry System (STS)	12

***As of June 30, 2015**

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 8
Orange Well Net Monitoring Well Information
Orange County, NC
North Carolina Division of Water Resources
Ground Water Management Branch
2015 Annual Report

Well No.	Well Name	Total Depth (ft bgs)	Casing Depth (ft bgs)	Top of Casing Elevation (ft)	Aquifer	Geology
1	Millhouse Rd.	67.0	164.7	515.22	Br	Metasedimentary rocks (Epiclastics)
2	Eno Confluence	37.0	175.5	609.27	Br	Pyroclastic rocks (Felsic Tuff)
3	Former 911 Center	85.0	400.0	581.00	Br	Altered Pyroclastic rocks (Altered Tuff)
4	Blackwood Farm	100.0	302.0	557.44	Br	Felsic lavas and tuffs (Dacite)
5	Duke Forest 4D	87.9	402.9	427.82	Br	Felsic plutonics-E. Farrington Granite
6	Eubanks Road	33.0	145.7	531.15	Br	Mafic intrusives (Gabbro)
7	Andrews Rd. (COL-1)	33.0	-	528.00	Bs	Regolith overlying felsic tuff bedrock
8	Hwy 54 (COL-3)	43.7	-	528.18	Bs	Regolith overlying diabase bedrock
9	Orange Grove Rd (COL-4)	35.2	-	504.86	Bs	Regolith overlying diabase bedrock

bgs – below ground surface; Br – basement rock; Bs – basement saprolite

* Ray Road Well – removed from network in 2012

* Rocky Ridge Well – removed from network in 2012

TABLE 9 Orange Well Net Network Statistics (2008 through 06-30-2015) North Carolina Division of Water Resources Ground Water Management Branch 2015 Annual Report								
Parameter	2008	2009	2010	2011	2012	2013	2014	2015
Number of monitored wells								
Manual water levels (tapedowns)	3	18	49	68	59	54	52	33
Daily water levels (automatic recorders)	-	-	1,612	2,783	3,095	3,281	3,468	1,404
Total hourly water levels	-	-	38,802	66,68	74,065	78,636	83,090	33,519

TABLE 10
Guilford County Monitoring Well Information
North Carolina Division of Water Resources
Ground Water Management Branch
2015 Annual Report

Station Name	Date Installed	Well Diameter (inches)	Well Depth (ft)	Screened interval (ft)	Aquifer	Measuring Point (MP) (ft)	Water Level Measured from MP (ft) Including Date Measured
Gibson Park	04/15/2003	6.25	205	none	bedrock	2.2	24.20 (07/22/2015)
Hagan Stone Park	05/17/2003	6.125	100	none	bedrock	2.45	24.11 (07/22/2015)
Knox Road	10/09/2002	6.25	*	none	bedrock	1.8	22.39 (07/22/2015)
Prison Farm	05/14/2004	6.25	120	none	bedrock	3.0	15.03 (07/22/2015)
Station 45	12/15/2004	6.25	180	none	bedrock	2.8	27.09 (07/22/2015)
Summerfield	10/09/2002	6.25	103	none	bedrock	2.3	66.92 (07/22/2015)
Triad Park	10/02/2002	6.25	140	none	bedrock	1.7	35.05 (07/22/2015)
Northeast Park	06/24/2015	6.125	100	none	bedrock	2.2	18.64 (07/22/2015)

TABLE 11
Guilford County Monitoring Well Network Statistics (2005 through 06-30-2015)
North Carolina Division of Water Resources
Ground Water Management Branch
2015 Annual Report

Parameter	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Number of monitored wells											
Manual water levels (tapedowns)	-	28	14	28	35	77	77	56	63	49	29
Daily water levels (automatic recorders)	2,106	1,884	1,922	1,892	2,000	2,592	2,561	2,474	2,585	2,562	1,076
Total hourly water levels											

**TABLE 12
2016 FY Network Expansion
North Carolina Division of Water Resources
Ground Water Management Branch
2015 Annual Report**

Station Name/Quad	County	Proposed New Well Screens (ft bls)	Aquifer
Burgaw Station	Pender	20-30	Surficial
Additional Wells		630-640	Upper Cape Fear
		20-30	Surficial
Near Town of		60-70	Yorktown
Macclesfield	Edgecombe	120-130	Upper Cape Fear
		260-270	Lower Cape Fear
		292	Pilot Hole (Top of Basement)
		20-30	Surficial
Moore's Creek		110-120	Peedee
National Park	Pender	330-340	Black Creek
		590-600	Upper Cape Fear
		630	Pilot Hole
		20-30	Surficial
Between Godley Farms		80-90	Yorktown
Station and Town	Beaufort	250-260	Castle Hayne upper screen
of Aurora		440-450	Castle Hayne lower screen
		610-620	Beaufort
		650-660	PeeDee
		700	Pilot Hole