

North Carolina Ground Water Resources Monitoring Well Network
2007 Annual Report



Cove City Monitoring Station R23X

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Executive Summary

The State of North Carolina Division of Water Resources has maintained and monitored a statewide network of ground water monitoring wells used to assess North Carolina's ground water supply since 1998. The existence of this well network is an integral part of DWR's mission to ensure that North Carolina has an adequate potable water supply for its citizens.

The 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, geological and geophysical borehole logs, locations of ground water monitoring stations, as well as geophysical and geologic data collected from other (non-DWR) wellsites.

Presently, the well network consists of 548 wells at 181 individual stations. Historically, the Coastal Plain region of the State has relied much more heavily on ground water supplies than either the Piedmont or Mountain regions. For this reason, most of the ground water monitoring and research has been focused on this area. In recent years however, DWR has invested more resources 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.

From July 2006 through June 2007, DWR collected ground water level data from all 536 wells within the network (12 new wells not included). This data includes manual measurements taken quarterly from all wells, plus hourly water levels collected using automatic data recorders from 287 wells. Additionally, DWR conducted 20 TDEM surveys, collected 8 chloride measurements, 3 lithologic and 3 geophysical well logs. DWR continued to digitize and make available daily water levels from thousands of archived water level recorder charts obtained from NC Division of Water Quality, with records dating from the 1960s through 1980s. DWR also began a project to install survey monuments at each of the wellsites.

During the past year, the network was expanded through the installation of 12 new monitoring wells at three new monitoring stations: Bear Grass School (Martin County), La Grange (Lenoir County) and Grifton Ballfield (Pitt County).

Introduction

Over fifty percent of North Carolina's population relies on ground water for its potable use. Additionally, the State has thousands of agricultural and industrial ground water users. Since 1998, the North Carolina Division of Water Resources (DWR) has monitored and maintained a statewide network of monitoring wells to assess North Carolina's ground water supply. The operation of this well network is an integral part of DWR's mission to ensure that the State has an adequate water supply for its citizens.

DWR collects data from this well network for several purposes:

- I. Evaluate climatic influences on the state's ground water supply, including the effects of drought and recharge-discharge relationships;
- II. Monitor human-induced effects on the state's ground water supply, particularly in the regional aquifer systems of the North Carolina Coastal Plain. These effects include local and regional water level declines as well as migration of the fresh water-salt water interfaces within the various aquifers;
- III. Provide 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
- IV. Provide 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.

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Purpose and Scope

This report is not intended to be a comprehensive narrative on the history and operation of the monitoring network. Rather, it is a status and summary report covering the period of July 2006 through June 2007 which includes the following summaries:

- ❖ Water level and water quality data statistics;
- ❖ New and replacement monitoring well installations;
- ❖ Monitoring equipment usage and evaluations; and
- ❖ Site surveys

Background

The statewide ground water resource monitoring program was initially operated by the North Carolina Division of Water Quality (DWQ) and its predecessor agencies, which installed the first network wells in the 1960s. DWQ actively monitored the network through the early 1990s, collecting a portion of the ground water data currently contained within the network database. Approximately seventy-five percent of the monitoring wells in the network were installed by DWQ. The program was transferred to DWR in 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. Currently, the cooperative well network consists of twenty-one monitoring wells, many of which are also part of the DWR statewide network.

DWR Statewide Monitoring Well Network—Overview

Description

The well network currently consists of 548 wells at 181 different monitoring stations in 56 counties (Figure 1). Twenty of these wells are located in the Piedmont and Mountains regions, while the remaining 528 wells are in the Coastal Plain region. Historically, the Coastal Plain has relied much more heavily on ground water supplies than either the Piedmont or Mountain areas, thus the focus on ground water monitoring and research in this area. In recent years however, DWR has invested more resources 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. Presently, 34 wells within the network are utilized to assess drought conditions (Figure 2).

Of the 181 monitoring stations, sixty are on State or Federal property, and forty-three are located on property owned by local governments. The remaining seventy-eight are located on private property through agreements with the landowners. 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. DWR has developed a scale to rank new and existing wellsites for the potential that the wells will have to be abandoned 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.

Table 1: Site Susceptibility

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.

Monitoring

The statewide monitoring network is divided into five regions (Figure 1 and Table 2), with a single staff member responsible for managing each region: visiting the wells quarterly to collect water level data, performing routine site maintenance, and keeping any automatic data recorders in working condition. Site maintenance includes clearing vegetation, and ensuring the sites are kept in good working and cosmetic condition. Additional site activities are conducted as needed for special projects or situations.

DWR also collects chloride data from select wells in the Coastal Plain. These data are used to monitor the migration of the fresh-salt water interface in the Coastal Plain aquifers. Typically, synoptic chloride samples are collected every 3 years. Additional chloride data is collected when new monitoring wells are installed and as needed for special projects.

Water level information is obtained in two different ways. Manual water levels are collected using electronic water level indicators. Additionally, DWR employs automatic water level recorders to collect hourly water level data on almost 300 wells. Two types of automatic water level recorders are utilized: shaft encoders and submersible pressure transducers.

These hourly water level data are extremely valuable in assessing the nature of recharge to the aquifers, the impact large storms have on ground water conditions, delineation of aquifer boundaries, and many other purposes. However, transmitting hourly data through our website would be extremely taxing, both to our servers and to the end user's computer system. For this reason, DWR typically publishes only the manual water level readings and daily water level data from our recorders on the website. Hourly data is available upon request for specific wells.

Table 2: Site and Recorder Distribution By Region

Region	Parameter	Number	% of Region	% of Network
1	Wells	108		19.7
	Sites	36		19.8
	Sutrons	1	0.9	0.2
	WL15s	0	0.0	0.0
	WL16s	42	38.9	7.7
	All Recorders	43	39.8	7.8
2	Wells	137		25.0
	Sites	37		20.3
	Sutrons	17	12.4	3.1
	WL15s	47	34.3	8.6
	WL16s	0	0.0	0.0
	All Recorders	64	46.7	11.7
3	Wells	105		19.2
	Sites	27		14.8
	Sutrons	7	6.7	1.3
	WL15s	47	44.8	8.6
	WL16s	23	21.9	4.2
	All Recorders	77	73.3	14.1
4	Wells	127		23.2
	Sites	43		23.6
	Sutrons	5	3.9	0.9
	WL15s	30	23.6	5.5
	WL16s	17	13.4	3.1
	All Recorders	52	40.9	9.5
5	Wells	71		13.0
	Sites	39		21.4
	Sutrons	15	21.1	2.7
	WL15s	18	25.4	3.3
	WL16s	6	8.5	1.1
	All Recorders	39	54.9	7.1

2006-2007 Well Network Statistics

Ground Water Data Collection

While our budget year follows the state government fiscal year calendar (July through June), the operation of the well network is continuous. Table 3 contains water level data collection statistics for calendar years 2005, 2006, and 2007 (through the end of June).

Table 3: Ground Water Data Collection Statistics, 2005-2007

Parameter	2005	2006	2007
Wells monitored	529	536	548
Daily/manual water levels	91,695	94,787	30,265
Hourly water levels	2,143,574	2,212,128	697,449
Chloride samples	17	21	8
Geophysical & lithologic logs	2	1	3

Figure 3 compares the number of wells monitored and water level data collected from the network for the years 1967 to present. Hourly water level data is not included in this graph. Calendar year 2006 represents the most water level data collected in any single year since starting operation of the network. This is due to both a gradual increase in the number of wells monitored and to the increased use of automatic data recorders. Note that the data shown for 2007 is only from January through June.

In addition to the above data, DWR has been processing a large store of historical ground water data from the older network wells. This data was collected in the 1960s through the 1980s. In the past, this data was obtained by an earlier generation of data recorders called Stephens Recorders that utilized paper charts in lieu of saving the data digitally. DWR is presently digitizing these charts, and adding this data for inclusion in our online database.

Well Installation and Maintenance

As demand for water grows, so does the importance of an accurate and timely picture of the State's ground water resources. Additional wells are needed to assess the location of the fresh-salt water interface within the Coastal Plain aquifers, as well as in the Piedmont and Mountains to better monitor the effects of drought.

In addition, the network requires continual maintenance to keep existing monitoring stations usable. Many of the wells are over 30 years old and are constructed of materials that are susceptible to corrosion, especially in acidic or saline ground water conditions. Most older wells were constructed with outdated, less than desirable construction practices, such as backfilling boreholes with cuttings instead of neat cement or bentonite grout, or were constructed with telescoped casing, in which smaller diameter casing is used at depth in the well, ostensibly to save money during well construction. Backfilling with cuttings forms an inadequate seal and allows other aquifers to influence the water levels and water quality in that well. Telescoped wells are very susceptible to blockage at the depth of the reducer. 154 wells in the network were constructed with reducers. For these reasons, DWR has implemented a long-term program for replacing damaged or unsuitably constructed wells with new, properly-constructed wells.

Installation of new and replacement monitoring wells occupies a large portion of DWR's resources. Please refer to Table 4 for a list of new wells installed during the past fiscal year, which are also shown on Figure 1.

Table 4: New Wells Installed FY 2006-2007

Site Name (Quad ID)	No. of Wells Installed	Aquifers Screened	Installation Purpose
Bear Grass School (K21R)	7	<ul style="list-style-type: none"> ➤ Surface ➤ Yorktown ➤ Peedee ➤ Black Creek ➤ Black Creek-Upper Cape Fear ➤ Upper Cape Fear ➤ Lower Cape Fear 	Fill data gap in Martin County
La Grange (Q29I)	4	<ul style="list-style-type: none"> ➤ Surface ➤ Peedee ➤ Black Creek ➤ Upper Cape Fear 	Fill data gap in lower Pitt/upper Lenoir Counties
Grifton Ballfield (P24O)	1	<ul style="list-style-type: none"> ➤ Lower Cape Fear 	

Automatic Water Level Recorders

Automatic water level recorders (i.e., data loggers) play an integral role in the DWR monitoring program. They allow for economical collection of near-continuous data at even the remotest of well stations. DWR utilizes two primary types of recorders (Tables 2 and 5).

Table 5: Automatic Water Level Recorders

Recorder Type	Number in Service*
Sutron Corporation Model 8400A	45
Global Water Instrumentation, Inc. Model WL15	142
Global Water Instrumentation, Inc. Model WL16	88

*As of June 2007

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 refurbished. These units are not reflected in the above totals.

Site Surveys

DWR is in the process of installing concrete survey markers at each of the 181 stations within the network. Each of these markers will then be surveyed using the Global Positioning System (GPS) to calculate the most accurate horizontal and vertical location data possible. At present, 17 sites have been surveyed in this manner.

Planned Activities for FY 2007-2008

New Well Installation

As part of DWR's ongoing commitment to the cooperative Onslow County Regional Water Resources Group (RWRG), much of the monitoring well network expansion efforts for FY 2007-2008 will be focused on Onslow County. In addition, DWR plans on completing construction of the Grifton Ballfield monitoring station (P24O). Please refer to Table 6. In regards to the proposed new station in the Hubert area of Onslow County, the exact number, placement and screen intervals are to be determined upon completion of the exploratory borehole.

Chloride Sampling

The scheduled triennial chloride sampling is planned for September 2007. Ground water from a subset of wells within the network (approximately 190) will be sampled for chlorides using Quantab® chloride titrators. Additional parameters (pH, conductivity and salinity) will be collected via YSI® portable probes. In previous years, duplicate samples were analyzed via both Quantab® titrators and via standard laboratory titration methods, with very comparable results.

The purpose 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, and by comparing the results to those of previous sampling events to evaluate possible landward migration of the interface due to aquifer overuse. Chloride sample results will be posted in the database and the DWR website.

Site Surveys

It is the goal of DWR to have installed survey markers at each of the remaining 164 stations in the upcoming year, and have all stations surveyed using GPS. It is anticipated that this work will be completed by Spring 2008.

Table 6: FY 2007-2008 Network Expansion

Station Name/Quad	County	Existing Well Screens	Aquifer	Proposed New Well Screens	Aquifer
Deppe V23X	Onslow	90-100	Unconfined		
		620-630	Peedee		
		290-300	Beaufort		
				20-30	Surficial
				210-220	Lower Castle Hayne
				858-868	Black Creek
Folkstone Y25Q	Onslow	58-80	Unconfined		
		150-240	Castle Hayne		
		524-534	Peedee		
		18-22	Surficial		
				444-454	Lower Castle Hayne
				782-792	Black Creek
Grifton Ballfield P24O	Pitt	690-700	Lower Cape Fear		
				20-30	Surficial
				113-123	Beaufort
				253-263	Peedee?
				475-485	Black Creek?
NEW	Onslow— In the vicinity of Hubert & NC 24			TBD	TBD

Figure 1: NCDWR Monitoring Stations June 2007

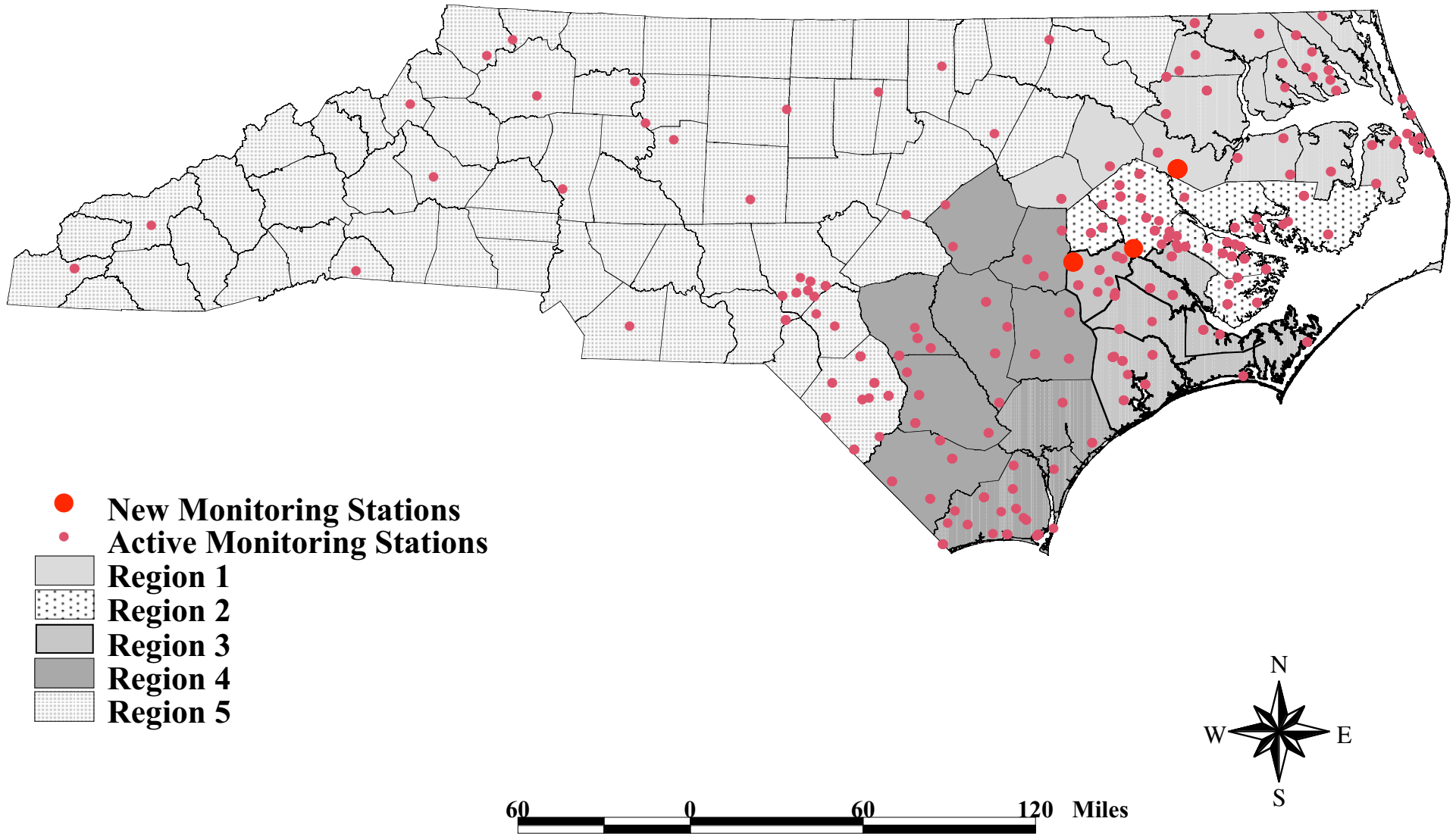
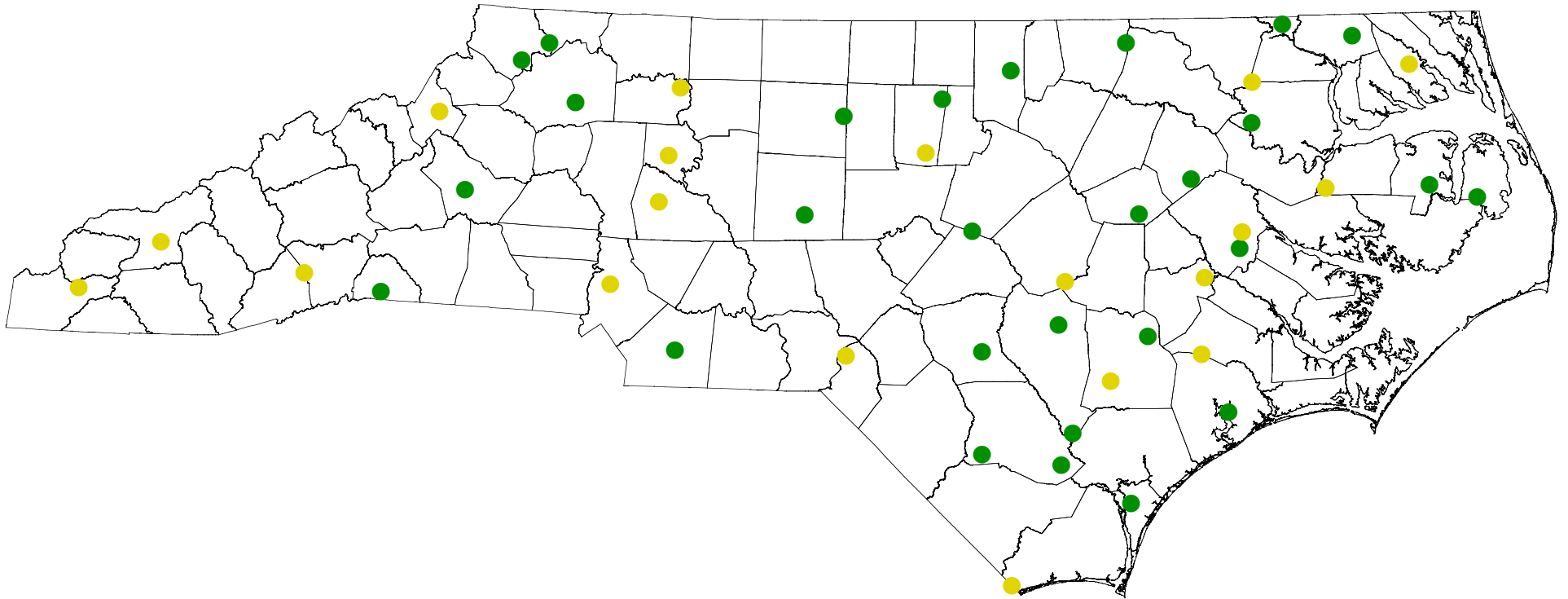


Figure 2: Drought Indicator Wells



- USGS Drought Indicator Wells
- DWR Drought Indicator Wells

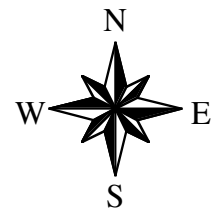
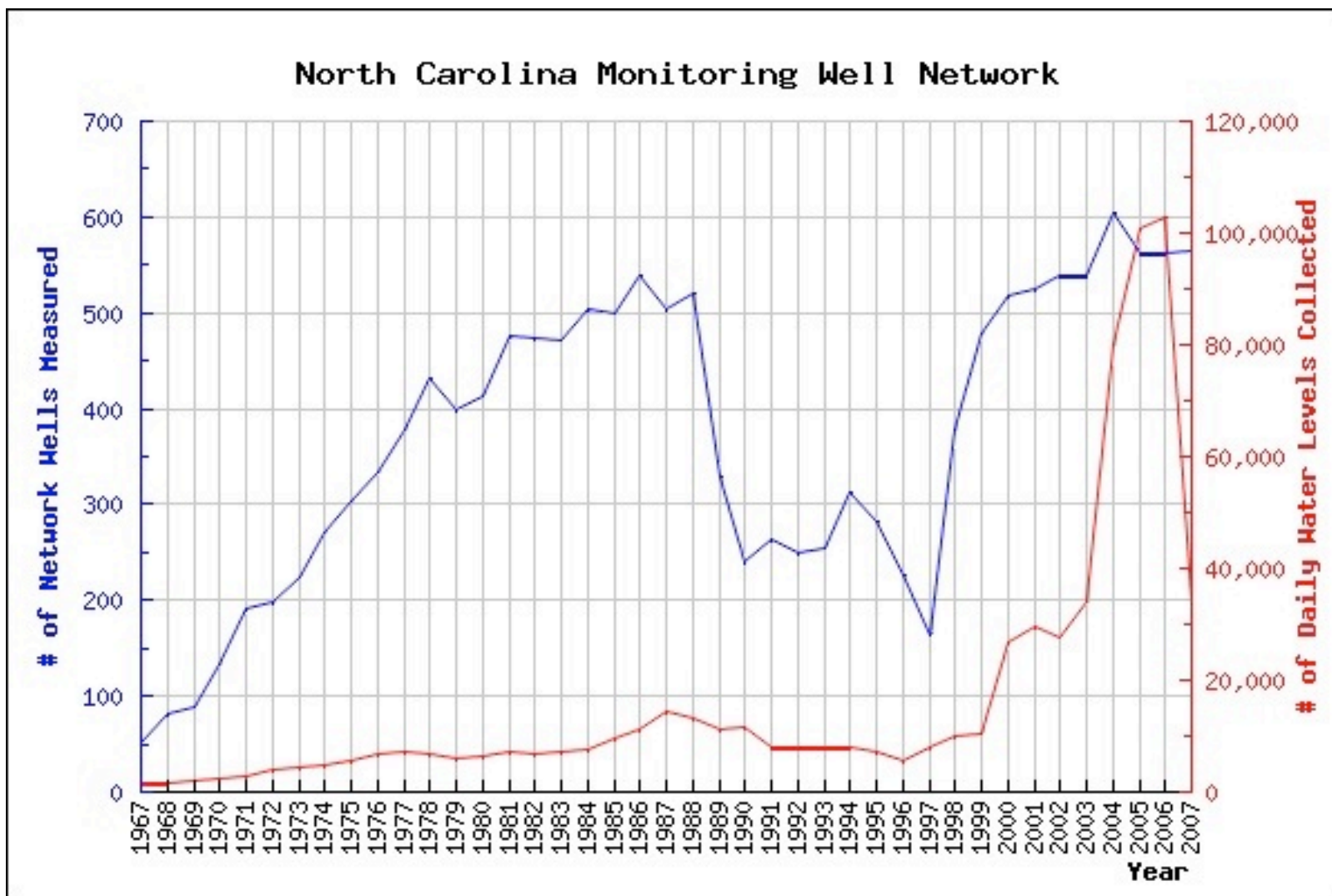


Figure 3: Water Level Data Collected 1967-2007



Note: Plot includes both DWR and USGS data