GROUND-WATER QUALITY IN GEORGIA FOR 1998

John C. Donahue

GEORGIA DEPARTMENT OF NATURAL RESOURCES
ENVIRONMENTAL PROTECTION DIVISION
GEORGIA GEOLOGIC SURVEY

ATLANTA
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1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

This report, covering the calendar year 1998, is the fourteenth in a series of summaries discussing the chemical quality of ground water in Georgia. These summaries are among the tools used by the Georgia Environmental Protection Division (EPD) to assess trends in the quality of the State's ground-water resources. EPD is the State organization with regulatory responsibility for maintaining and, where possible, improving ground-water quality and availability. EPD has implemented a comprehensive statewide ground-water management policy of anti-degradation (EPD, 1991; 1998). Five components constitute EPD's ground-water quality assessment program:

1. The Georgia Ground-Water Monitoring Network. The Geologic Survey Branch of EPD maintains this program, which is designed to evaluate the ambient ground-water quality of nine aquifer systems throughout the State of Georgia. The data collected from sampling of the Ground-Water Monitoring Network form the basis for this report.

2. Sampling of public drinking water wells as part of the Safe Drinking Water Program (Water Resources Management Branch). This program provides data on the quality of ground water that the residents of Georgia are using.

3. Special studies addressing specific water quality issues. A survey of nitrite /nitrate levels in shallow wells located throughout the State of Georgia (Shellenberger, et al., 1996; Stuart, et al., 1995) and the operation of a Pesticide Monitoring Network, currently conducted jointly by the Geologic Survey Branch and the Georgia Department of Agriculture (GDA), (Webb, 1995; Tolford, 1997) are examples of these types of studies.

4. Ground-water sampling at environmental facilities such as municipal solid waste landfills, RCRA facilities, and sludge disposal facilities. The primary agencies responsible for monitoring these facilities are EPD's Land Protection, Water Protection, and Hazardous Waste Management Branches.

5. The development of a wellhead protection program (WHP), which is designed to protect the area surrounding a municipal drinking water well from contaminants. The U.S. Environmental Protection Agency (EPA) approved Georgia's WHP Plan on September 30, 1992. The WHP Plan became a part of the Georgia Safe Drinking Water Rules, effective July 1, 1993. The protection of public water supply wells from contaminants is important not only for maintaining ground-water quality but also for ensuring that public water supplies meet health standards.

Analyses of water samples collected for the Georgia Ground-Water Monitoring Network during calendar year 1998 and from previous years form the database for this summary. The Georgia Ground-Water Monitoring Network comprises 128 wells and springs. Between January 1, 1998, and October 1, 1998, sampling at most stations in the network proceeded on a biennial basis, with recently added stations or stations showing signs of pollution being sampled annually. Effective October 1, 1998, all stations returned to an annual sampling frequency, and, testing for most stations was restricted to volatile organic compounds and nitrate/nitrite. Stations showing recent pollution or contamination may be subject to confirmatory sampling on a basis more frequent than annual. During calendar year 1998, EPD personnel collected 79 samples from 73 wells and 5 springs. A review of the calendar year 1998 data and comparison of these data with those for samples collected as early as 1984 indicate that ground-water quality at most of the 128 sampling sites generally has changed little and remains excellent.

1.2 FACTORS AFFECTING CHEMICAL GROUND-WATER QUALITY

The chemical quality of ground water drawn for sampling is the result of complex physical, chemical, and biological processes. Among the more significant controls are the chemical quality of the water entering the ground-water flow system, the reactions of infiltrating water with the soils and rocks that are encountered, and the effects of the well-and-pump system.

Most water enters the ground-water system in upland recharge areas. Water seeps through interconnected pores and joints in the soils and rocks until discharged to a surface-water body (e.g., stream, river, lake, or ocean). The initial water chemistry, the amount of recharge, and the attenuation capacity of soils have a strong influence on the quality of ground water in recharge areas. Chemical interactions between the water and the aquifer host rocks have an increasing significance with longer underground residence times. As a result, ground water from discharge areas tends to be more highly mineralized than ground water in recharge areas.

The well-and-pump system can also have a strong influence on the quality of the well water. Well casings, through compositional breakdown, can contribute metals (e.g., iron from steel casings) and organic compounds (e.g., tetrahydrofuran from PVC pipe cement) to the water. Pumps often aerate the water being discharged. An improperly constructed well can present a conduit that allows local pollutants to enter the ground-water flow system.

1.3 HYDROGEOLOGIC PROVINCES OF GEORGIA

This report defines three hydrogeologic provinces in Georgia by their general geologic and hydrologic characteristics (Figure 1-1). These provinces consist of:

1. the Coastal Plain Province of south Georgia;

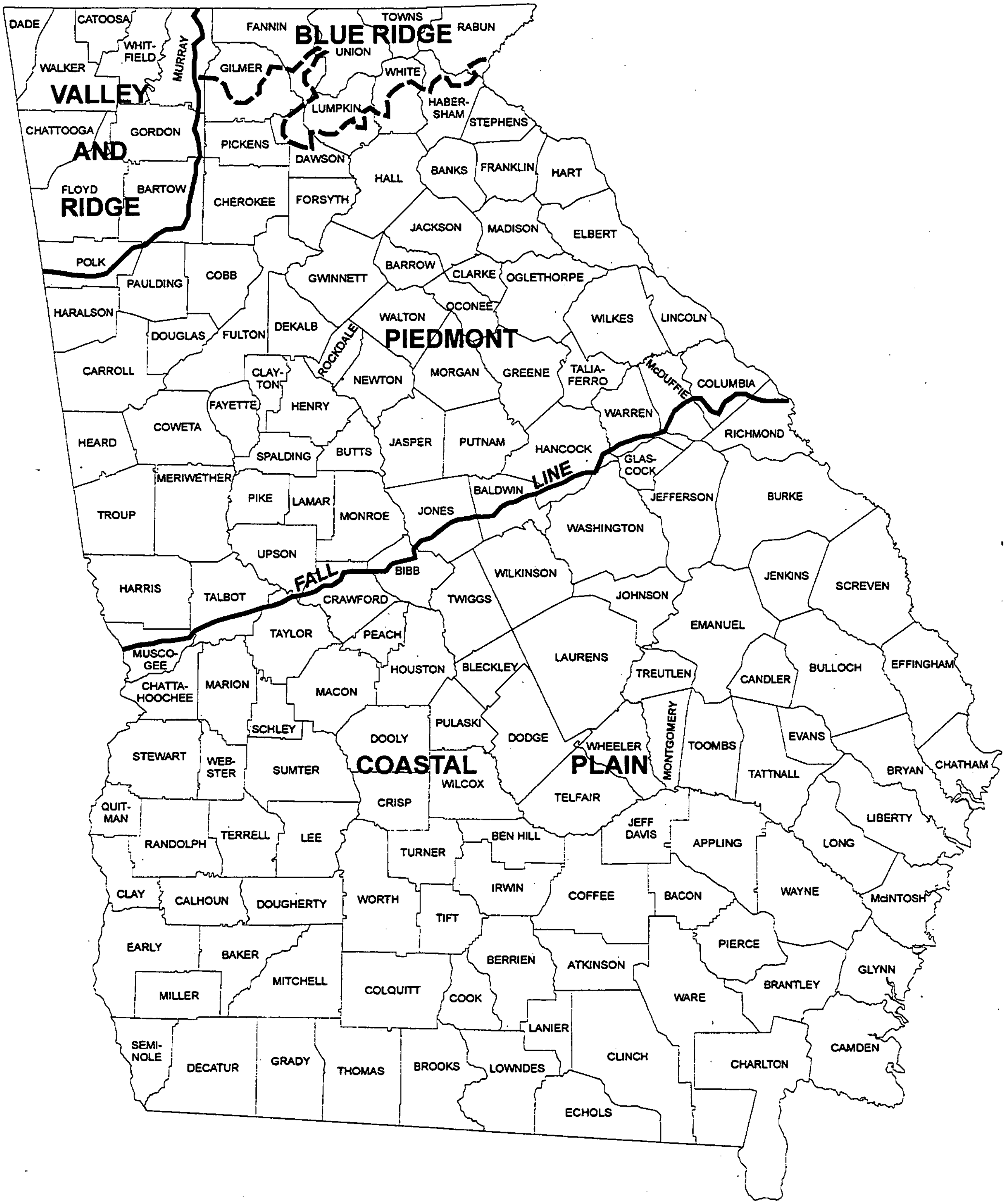


Figure 1-1. - The Hydrogeologic Provinces of Georgia

2. the Piedmont/Blue Ridge Province, which includes all but the northwest corner of Georgia; and
3. the Valley and Ridge Province of northwest Georgia.

1.3.1 Coastal Plain Province

Georgia's Coastal Plain Province generally comprises a wedge of loosely consolidated sediments that gently dip and thicken to the south and southeast. Ground water in the Coastal Plain Province flows through interconnected pore space between grains in the host rocks and through solution-enlarged voids.

The oldest outcropping sedimentary formations (Cretaceous) are exposed along the Fall Line, which is the northern limit of the Coastal Plain Province. Successively younger formations occur at the surface to the south and southeast.

The Coastal Plain contains Georgia's major confined (artesian) aquifers. Confined aquifers are those in which a layer of impermeable material (i.e., clay or shale) holds the top of the water column below the level to which it would normally rise. Water enters the aquifers in their up-dip outcrop areas, where the more permeable sediments of the aquifer tend to be exposed. Many Coastal Plain aquifers are unconfined in their up-dip outcrop areas, but become confined in down-dip areas to the southeast, where they are overlain by successively younger rock formations. Ground-water flow through confined Coastal Plain aquifers is generally to the south and southeast, in the direction of the dip of the rocks.

The sediments forming the seven major aquifers in the Coastal Plain range in age from Cretaceous to Miocene. Horizontal and vertical changes in the permeability of the rock units that form these aquifers determine the thickness and extent of the aquifers. Several aquifers may be present in a single geographic area, forming a vertical “stack”.

The Cretaceous and Jacksonian aquifer systems (primarily sands) are a common source of drinking water within a 35-mile wide band that lies adjacent to and south of the Fall Line. Southwestern Georgia relies on four vertically stacked aquifers (sands and carbonates) for drinking-water supplies: the Providence, Clayton, Claiborne and Floridan aquifer systems. The Floridan aquifer system (primarily carbonates) serves most of south-central and southeastern Georgia. The Miocene aquifer system (primarily sands) is the principal “shallow” unconfined aquifer system occupying much of the same broad area underlain by the Floridan aquifer system. It becomes confined in the coastal counties and locally in the Grady, Thomas, Brooks and Lowndes County area of south Georgia.

1.3.2 Piedmont/Blue Ridge Province

Crystalline rocks of metamorphic and igneous origin (primarily Precambrian and Paleozoic in age) underlie the Piedmont and Blue Ridge Provinces. These two provinces differ geologically but are discussed together here because they share common hydrologic properties. The principal water-bearing features are fractures, compositional layers, and other geologic discontinuities in the rock, as well as intergranular porosity in the overlying soil and saprolite horizons. Thick soils and saprolites are often important as the "reservoir" that supplies water to the water-bearing fracture and joint systems. Ground water typically flows from local highlands toward discharge areas along streams. However, during prolonged dry periods or in areas of heavy pumpage, surface water may flow from the streams into the ground-water systems.

1.3.3 Valley and Ridge Province

Consolidated Paleozoic sedimentary formations characterize the Valley and Ridge Province. The principal permeable features of the Valley and Ridge Province are fractures and solution voids; intergranular porosity also is important in some places. Locally, ground-water and surface-water systems closely interconnect. Dolostones and limestones of the Knox Group are the principal aquifers where they occur in the axes of broad valleys. The greater hydraulic conductivities of the thick carbonate sections in this Province, in part due to solution-enlarged joints, permit development of higher yielding wells than in the Piedmont and Blue Ridge Province.

1.4 REGIONAL GROUND-WATER PROBLEMS

Data from ground-water investigations in Georgia, including those from the Ground-Water Monitoring Network, indicate that virtually all of Georgia has shallow ground-water sufficient for domestic supply. Iron, aluminum, and manganese are the only constituents that occur routinely in concentrations exceeding drinking-water standards. These metals are naturally occurring and do not pose a health risk. Iron and manganese can cause reddish to brownish stains on objects.

Only a few occurrences of polluted or contaminated ground waters are known from North Georgia (see Section 4). Aquifers in the outcrop areas of Cretaceous sediments south of the Fall Line typically yield acidic water that may require treatment. The acidity occurs naturally and results both from the inability of the sandy aquifer sediments to neutralize acidic rainwater and from biologically influenced acid-producing reactions between infiltrating water and soils and sediments. Nitrite/nitrate concentrations in shallow ground water from the farm belt of southern Georgia are usually within drinking-water standards, but are somewhat higher than levels found in other areas of the State.

Besides the karst plain area (Dougherty Plain) in southwest Georgia, the Floridan aquifer system contains two other areas of naturally-occurring reduced ground-water quality. The first is the area of the Gulf Trough, a narrow, linear geological feature extending from southwestern Decatur County through central Bulloch County. Here, ground water is typically high in total dissolved solids and contains elevated levels of barium, sulfate, and radionuclides. The second is the coastal area of Georgia, where influx of water with high dissolved solids contents presents problems. In the Brunswick area, ground-water withdrawal from the upper Floridan results in up-coning of water with high dissolved solids contents from deeper parts of the aquifer. In the Savannah region, a cone of depression caused by pumping in and around Savannah induces saline ground water to flow down-gradient from the Port Royal Sound area of South Carolina toward Savannah.

2.0 GEORGIA GROUND-WATER MONITORING NETWORK

2.1 MONITORING STATIONS

Stations of the calendar year 1998 Ground-Water Monitoring Network are situated in the seven major aquifers and aquifer systems of the Coastal Plain Province and in the unconfined ground-water systems of the Piedmont and Blue Ridge Provinces and of the Valley and Ridge Province (Table 2-1). Monitoring stations are located in three critical settings:

1. areas of surface recharge;
2. areas of potential pollution related to regional activities (e.g., agricultural and industrial areas); and
3. areas of significant ground-water use.

Most of the monitoring stations are municipal, industrial, and domestic wells that have reliable well-construction data. The Monitoring Network also includes monitoring wells in specific areas where the State's aquifers are recognized to be especially susceptible to contamination or pollution (e.g., the Dougherty Plain of southwestern Georgia and the State's coastal area).

2.2 USES AND LIMITATIONS

Regular sampling of wells and springs of the Ground-Water Monitoring Network permits analysis of ground-water quality with respect to location (spatial trends) and with respect to the time of sample collection (temporal trends). Spatial trends are useful for assessing the effects of the geologic framework of the aquifer and regional land-use activities on ground-water quality. Temporal trends permit an assessment of the effects of rainfall and drought periods on ground-water quantity and quality. Both trends are useful for the detection of non-point source pollution. Non-point source pollution arises from broad-scale phenomena such as acid rain deposition and application of agricultural chemicals on crop lands.

It should be noted that the data of the Ground-Water Monitoring Network represent water quality in only limited areas of Georgia. Monitoring water quality at 128 sites located throughout Georgia provides an indication of ground-water quality at the locality sampled and at the horizon corresponding to the screened interval in the well or to the head of the spring at each station in the Monitoring Network. Caution should be exercised in drawing strict conclusions and applying any results reported in this study to ground waters that are not being monitored.

Stations of the Ground-Water Monitoring Network intentionally are located away from known point sources of pollution. The wells provide baseline data on ambient water quality in Georgia. EPD requires other forms of ground-water monitoring for activities that

Table 2-1. Georgia Ground-Water Monitoring Network, Calendar Year 1998.

AQUIFER SYSTEM	NUMBER OF MONITORING STATIONS VISITED & SAMPLES TAKEN, 1998	PRIMARY STRATIGRAPHIC EQUIVALENTS	AGE OF AQUIFER FORMATIONS
Cretaceous	10 stations (10 samples)	Ripley Formation, Cusseta Sand, Blufftown Formation, Eutaw Formation, Tuscaloosa Formation, Steel Creek Formation, Gaillard Formation, Pio Nono Formation	Late Cretaceous
Providence	None	Providence Sand	Late Cretaceous
Clayton	4 stations (4 samples)	Clayton Formation	Paleocene
Claiborne	2 stations (2 samples)	Claiborne Group	Middle Eocene
Jacksonian	5 stations (5 samples)	Barnwell Group	Late Eocene
Floridan	31 stations (32 samples)	Predominantly Suwannee Limestone and Ocala Group	Predominantly Middle Eocene to Oligocene
Miocene	5 stations (5 samples)	Predominantly Altamaha Formation and Hawthorne Group	Miocene-Recent
Piedmont/Blue Ridge	17 stations (17 samples)	Various igneous and metamorphic complexes	Predominately Paleozoic and Precambrian
Valley and Ridge	4 stations (4 samples)	Shady Dolomite, Knox Group, and Chickamauga Group	Paleozoic, mostly Cambrian and Ordovician

may result in point source pollution (e.g., landfills, hazardous waste facilities and land application sites) through its environmental facilities permit programs.

Ground-water quality changes gradually and predictably in the areally extensive aquifers of the Coastal Plain Province. The Monitoring Network allows for some definition of the chemical processes occurring in large confined aquifers. Unconfined aquifers in northern Georgia and the surface recharge areas of southern Georgia are of comparatively small areal extent and more open to interactions with land-use activities. The wide spacing of monitoring stations does not permit equal characterization of water-quality processes in these settings. The quality of water from monitoring wells completed in unconfined aquifers represents only the general nature of ground water in the vicinity of the monitoring wells. Ground water in the recharge areas of the Coastal Plain aquifers is the future drinking-water resource for down-flow areas. Monitoring wells in these recharge areas, in effect, constitute an early warning system for potential future water quality problems in confined portions of the Coastal Plain aquifers.

2.3 ANALYSES

Analyses are available for 79 water samples collected during calendar year 1998 from 73 wells and 5 springs. In 1984, the first year of the Ground-Water Monitoring Network, hydrogeologists sampled water from 39 wells in the Piedmont/Blue Ridge and Coastal Plain Provinces. Since 1984, the Ground-Water Monitoring Network has been expanded through addition of further wells and springs to cover all three hydrogeologic provinces, with most of the monitoring done in the Coastal Plain.

From January 1, 1998 through September 30, 1998, ground water from all monitoring stations was tested for the Monitoring Network's standard analysis, which included pH, conductivity, bromide, chloride, fluoride, sulfate, nitrite/nitrate, and thirty metals (Appendix, Table A-1). Where regional land-use activities had the potential to affect ground-water quality in the vicinity of a monitoring station, additional parameters consisting of volatile organic compounds (VOCs) and various groups of pesticides were tested (Appendix, Table A-2). The pH measurements are performed in the field, whereas, other parameters are typically measured in the laboratory. Tables 2-2 (cations) and 2-3 (anions) summarize the significance of some common major constituents found in ground water.

Effective October 1, 1998, the parameters included in the standard analysis changed to focus analyses on the constituents of greater concern, considering historic detections within the Monitoring Network. Routine nitrate/nitrite analyses continued as before, as did field pH measurements. Nitrate/nitrite and methyl tert-butyl ether (MTBE) were chosen as baseline indicator parameters. The EPD laboratory used two test methods to analyze for MTBE, both of which are routinely included in a broader suite of volatile organic compounds (VOCs). EPA methods 8020 and 524.2 were used; to obtain lower detection limits method 524.2 was selected for inclusion in the standard analysis for ongoing testing of samples. Electrical conductivity measurements were shifted from the laboratory to the field. Also,

Table 2-2. The Significance of Selected Parameters of a Basic Water Quality Analysis, Cations (after Wait, 1960).

<table>
<tr><th>PARAMETER(S)</th><th>SIGNIFICANCE</th></tr>
<tr><td>pH (Hydrogen ion concentration)</td><td>pH is a measure of the concentration of the hydrogen ion. Values of pH less than 7.0 denote acidity and values greater than 7.0 indicate alkalinity. Corrosiveness of water generally increases with decreasing pH. However, excessively alkaline waters may also corrode metals. A pH range between 6.0 and 8.5 is considered acceptable.</td></tr>
<tr><td>Calcium and magnesium*</td><td>Calcium and magnesium cause most of the hardness of water. Hard water consumes soap before a lather will form and deposits scale in boilers, water heaters, and pipes. Hardness is reported in terms of equivalent calcium carbonate. The hardness of a water can be estimated by the sum of multiplying the ppm of calcium by 2.5 and that of magnesium by 4.1.
<table>
<tr><th>Water Class</th><th>Hardness (parts per million)</th></tr>
<tr><td>Soft</td><td>Less than 60</td></tr>
<tr><td>Moderately Hard</td><td>60 to 120</td></tr>
<tr><td>Hard</td><td>121 to 180</td></tr>
<tr><td>Very Hard</td><td>More than 180</td></tr>
</table></td></tr>
<tr><td>Sodium and potassium*</td><td>Sodium and potassium have little effect on the use of water for most domestic purposes. Large amounts give a salty taste when combined with chloride. A high sodium content may limit the use of water for irrigation.</td></tr>
<tr><td>Iron and manganese</td><td>More than 300 ppb of iron stains objects red or reddish brown and more than 50 ppb of manganese stains objects black. Larger quantities cause unpleasant taste and promote growth of iron bacteria, but do not endanger health.</td></tr>
</table>

**Major metallic ions present in most ground waters.*

Table 2-3. The Significance of Selected Parameters of a Basic Water Quality Analysis, Anions (after Wait, 1960).

PARAMETER(S)	**SIGNIFICANCE**
Chloride	Chloride salts in excess of 100 ppm give a salty taste to water. Large quantities make the water corrosive. Water that contains excessive amounts of chloride is not suitable for irrigation. It is recommended that the chloride content should not exceed 250 ppm.
Nitrate/Nitrite	Excessive amounts of nitrate/nitrite in drinking water or formula water for infants may cause a type of methemoglobinemia ("blue babies"). Nitrate/nitrite in concentrations greater than 10 ppm (as nitrogen) is considered to be a health hazard.
Sulfate	Sulfate in hard water increases the formation of scale in boilers. In large amounts, sulfate in combination with other ions imparts a bitter taste to water. Concentrations above 250 ppm have a laxative effect, but concentrations up to 500 ppm are not considered unhealthful.

testing for metals and select anions that are subject to Primary Maximum Contaminant Levels (MCLs) continued for stations that have shown past contamination by these substances.

The Drinking Water Program of the EPD's Water Resources Management Branch has established Maximum Contaminant Levels (MCLs) for certain parameters included in the analyses done on Ground-Water Monitoring Network samples (EPD, 1997a). Primary MCLs pertain to parameters that may have adverse effects on human health when their values are exceeded. Secondary MCLs pertain to parameters that may give drinking water objectionable, though not health-threatening, properties that may cause persons served by public water systems to cease its use. Foul odor and unpleasant taste are examples of such properties. MCLs apply only to treated water offered for public consumption, nevertheless, they are useful guidelines for evaluating the quality of untreated (raw) water. Tables A-1 and A-2 in the Appendix list the Primary and Secondary MCLs for Ground Water Monitoring Network parameters.

Most of the wells originally on the Monitoring Network had in-place pumps. Using such pumps to purge the wells and collect samples reduces the potential for cross-contamination of wells. For those wells that lacked in-place pumps, EPD personnel used portable pumps for purging and sampling. In recent years, however, all wells that lacked in-place pumps were dropped from the Monitoring Network, except for a flowing well tapping the lower Floridan, GWN-PA9C (see Appendix, Table A-8).

Sampling procedures are adapted from techniques used by the USGS and the EPA. Hydrogeologists purge the wells (three to five times the volume of the water column in the well) before the collection of a sample to reduce the influence of the well, pump and distribution system on water quality. Municipal, industrial, and domestic wells typically require approximately 30 to 45 minutes of purging before sample collection.

EPD personnel monitor certain water quality parameters prior to sample collection. The personnel observe and record pH, dissolved oxygen content, electrical conductivity, and temperature using field instruments. A manifold captures flow at the pump system discharge point before the water is exposed to the atmosphere and conducts it past the instrument probes. With increased purging time, typical trends include a lowering of pH, dissolved oxygen content, and conductivity, and a transition toward the mean annual air temperature. The hydraulic flow characteristics of unconfined aquifers, the depth of withdrawal, and pump effects may alter these trends.

Samples are collected once the parameters being monitored in the field stabilize or otherwise indicate that the effects of the well have been minimized. Files at the Geologic Survey Branch contain the records of the field measurements taken during sampling (i.e., pH, dissolved oxygen content, conductivity, and temperature). EPD personnel fill the sample bottles and then promptly place them on ice to preserve the water quality. The personnel next transport the samples to the laboratories for analysis on or before the Friday of the week in which they were collected.

From January through September 1998, the EPD laboratory measured the following standard water quality parameters for all samples: conductivity, the concentrations of various metals, nitrate/nitrite concentration (results reported as ppm nitrogen), and the concentrations of chloride, fluoride, bromide, and sulfate. The EPD laboratory performed optional tests for semivolatile organic compounds, volatile organic compounds, and, with a single exception, pesticides on designated samples. The Georgia Department of Agriculture laboratory carried out analyses for organochlorine pesticides (EPA method 508.1), organophosphorus pesticides (EPA method 507), and phenoxy-acid herbicides (EPA method 515.2) on one sample (GWN-PA51). As mentioned previously, beginning October 1, 1998, conductivity measurements and testing for metals, halides, sulfate, pesticides, and semivolatile organic compounds were suspended and replaced by VOC testing.

The EPD laboratory used the EPA-approved testing methods listed in the Appendix. The conductivity test used is a standard laboratory procedure listed in <u>Standard Methods for the Evaluation of Water and Waste Water</u> (1995) (see Table A-1 in Appendix).

3.0 GROUND-WATER QUALITY IN GEORGIA

3.1 OVERVIEW

Georgia's nine major aquifers and aquifer systems are grouped into three hydrogeologic provinces for the purposes of this report.

The Coastal Plain Province comprises seven major aquifers or aquifer systems that are restricted to specific regions and depths within the province (Figure 3-1). These major aquifer systems commonly incorporate smaller aquifers that are locally confined. Ground-Water Monitoring Network wells in the Coastal Plain aquifers are generally located in three settings:

1. Recharge (or outcrop) areas that are located in regions that are geologically up-dip and generally to the north of confined portions of these aquifers.
2. Up-dip, confined areas that are located in regions that are proximal to the recharge areas, yet are confined by overlying geologic formations. These areas are generally south to southeast of the recharge areas.
3. Down-dip, confined areas, located to the south and southeast in the deeper, confined portions of the aquifers distal to the recharge areas.

Small-scale, localized ground-water flow patterns characterize the two hydrogeologic provinces of north Georgia, the Piedmont/Blue Ridge Province and the Valley and Ridge Province. Deep regional flow systems are unknown in northern Georgia. Geologic discontinuities (such as fractures) and compositional changes within the aquifer generally control ground-water flow in the Piedmont/Blue Ridge Province. Local topographic features, such as hills and valleys, influence ground-water flow patterns. Many of the factors controlling ground-water flow in the Piedmont/Blue Ridge Province also apply in the Valley and Ridge Province. The Valley and Ridge Province additionally possesses widespread karst features, which significantly enhance porosity and permeability in localized areas and exert a strong influence on local ground-water flow patterns.

3.2 CRETACEOUS AQUIFER SYSTEM

The Cretaceous aquifer system is a complexly interconnected group of aquifer subsystems developed in the Late Cretaceous sands of the Coastal Plain Province. These sands crop out in an extensive recharge area immediately south of the Fall Line in west and central Georgia (Figure 3-2). Overlying Tertiary sediments restrict Cretaceous outcrops to valley bottoms in parts of the northeastern Coastal Plain. Five distinct subsystems of the Cretaceous aquifer system, including the Providence aquifer system, are recognized west of the Ocmulgee River (Pollard and Vorhis, 1980). These merge into three subsystems to the east (Clarke, et al., 1985; Huddlestun and Summerour, 1996). Aquifer sands thicken south-

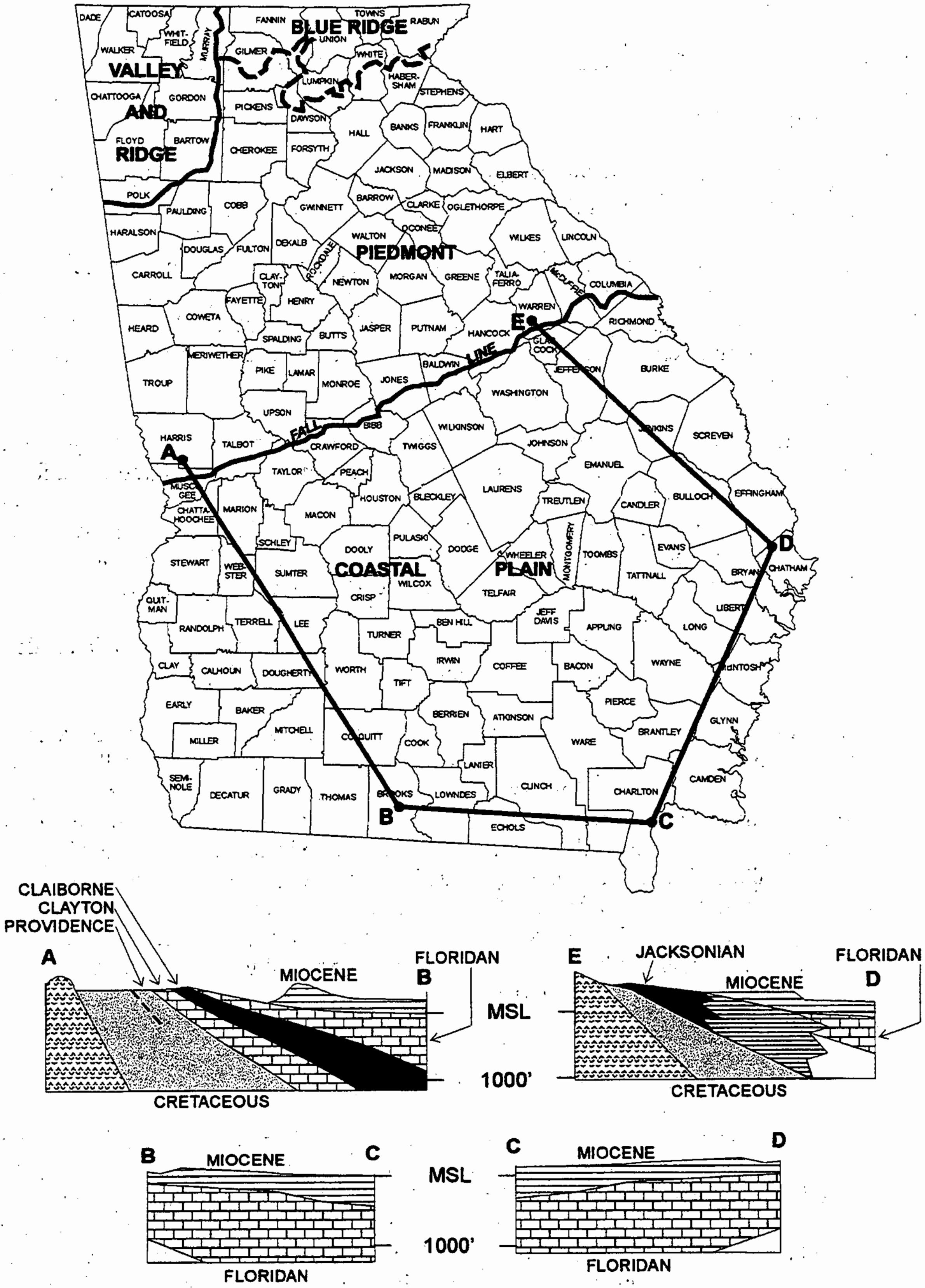


Figure 3-1. - The Seven Major Aquifer Systems of the Coastal Plain Province.

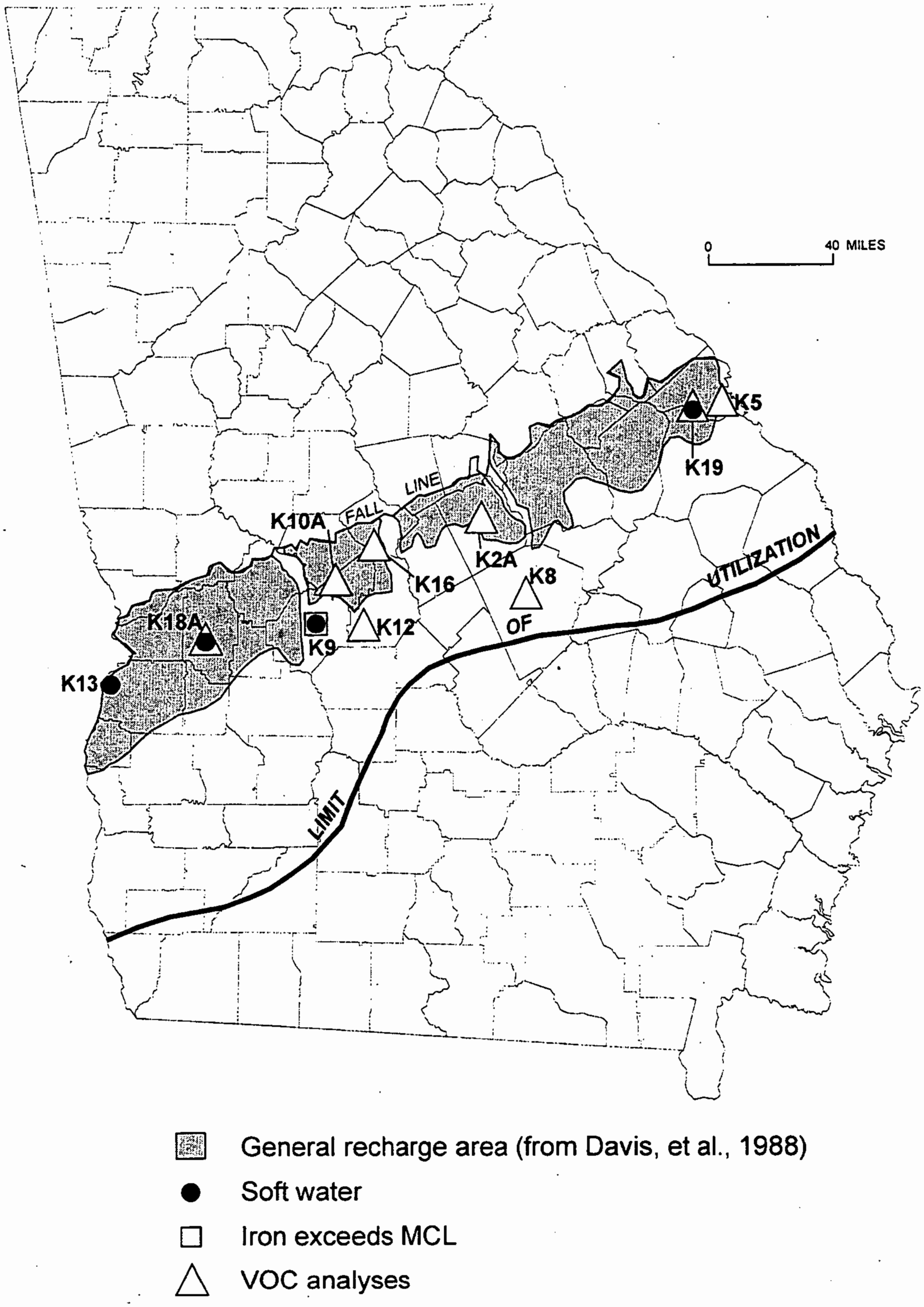


Figure 3-2. - Water Quality of Selected Wells in the Cretaceous Aquifer System.

ward from the Fall Line, from where they pinch out against crystalline Piedmont rocks, to a sequence of sand and clay approximately 2,000 feet thick at the southern limits of the main aquifer-use area (limit of utilization, Figure 3-2). Vertical leakage from overlying members of the aquifer system provides significant recharge in down-dip areas.

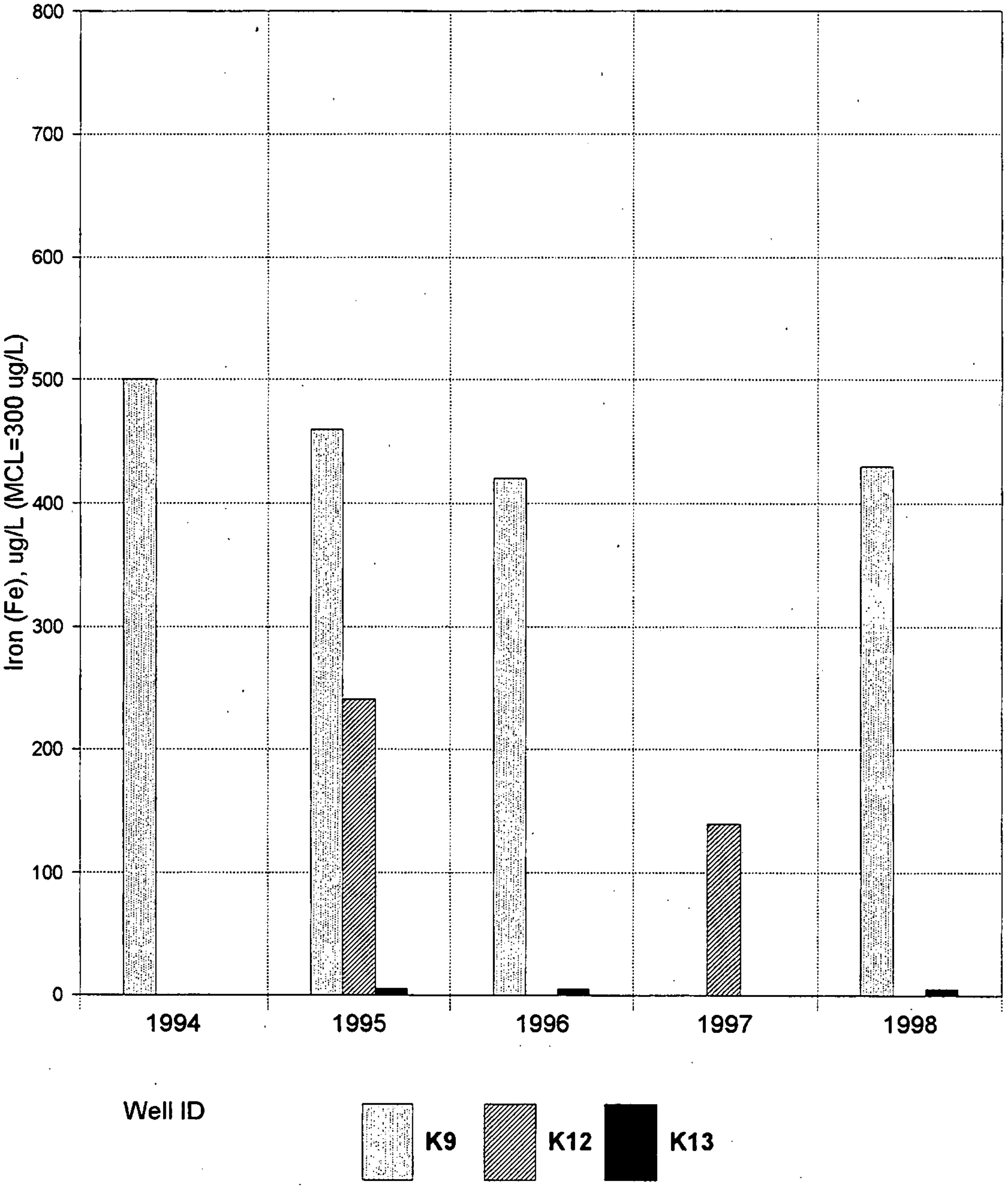
EPD sampled 10 wells in calendar year 1998 to monitor the water quality of the Cretaceous aquifer system, exclusive of the Providence aquifer system (Figure 3-2). Three of the sampled wells, GWN-K8, GWN-K9, and GWN-K12, are located away from the Cretaceous outcrop and recharge area, while the remainder lie within the general recharge area. The pHs of samples from nine of the wells were acidic; the pH of the sample from well GWN-K13 was basic. Well GWN-K13, though lying in the general outcrop area, draws water from the deeper parts of the aquifer system (apparently the A_6 subsystem of Pollard and Vorhis, 1980).

Samples from four wells, GWN-K9, GWN-K13, GWN-K18A, and GWN-K19, received testing for metals, chloride, fluoride, bromide, and sulfate. Metals data permitted the hardness classification of their waters, and all yielded soft water. None of the samples contained metals in excess of primary MCLs. One well sample (GWN-K9) had an iron concentration at 430 ppb and an aluminum concentration at 330 ppb, both in excess of the secondary MCLs. Figure 3-3 shows trends in iron concentrations for selected wells in the Cretaceous aquifer system.

Three of these samples contained low or undetectable levels of major alkali metals and alkaline earth metals (potassium, sodium, calcium, magnesium). Well GWN-K13 had a sample with elevated sodium. Water samples from various wells also had detectable levels of the following substances: strontium, fluoride, chloride, and sulfate.

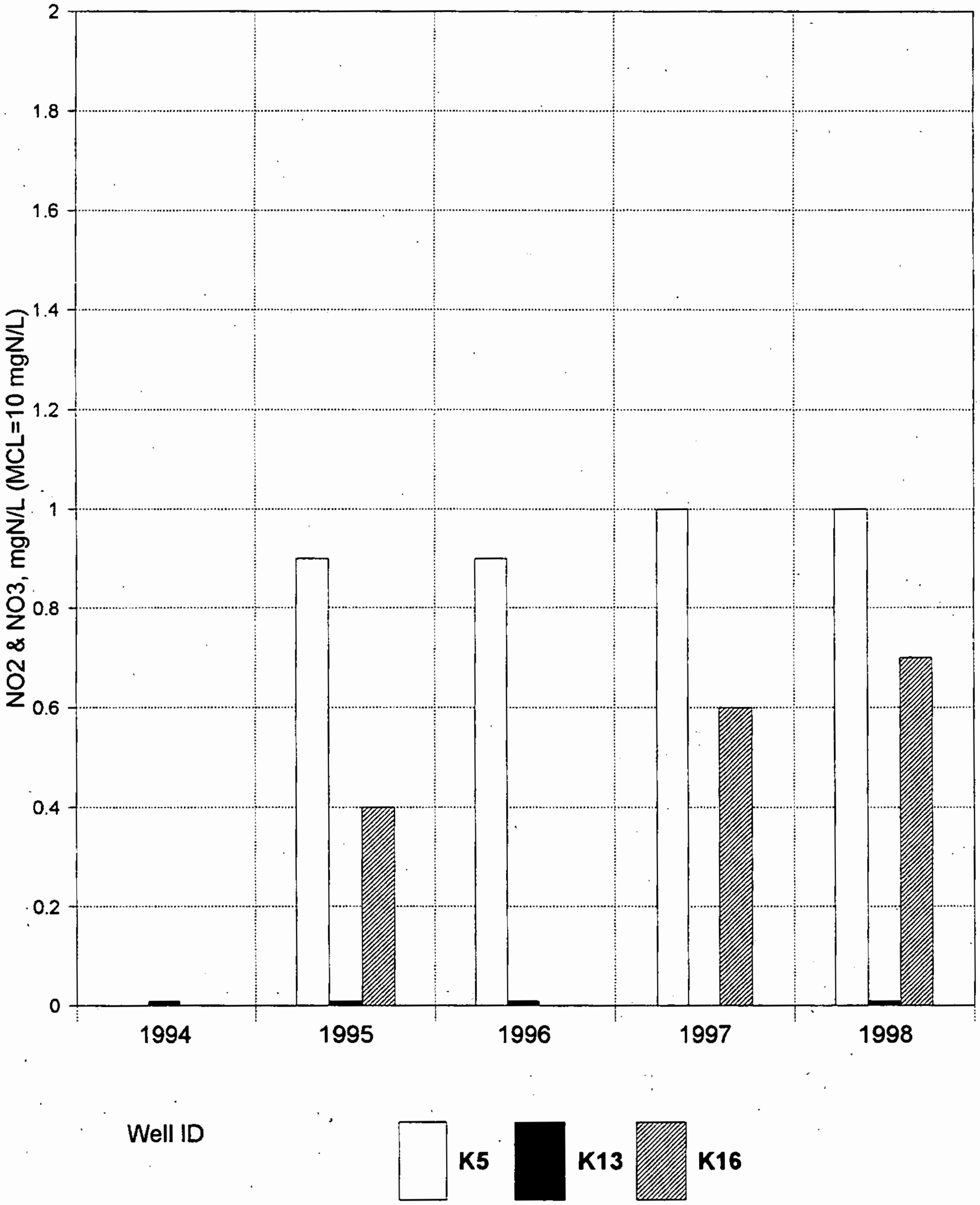
Water samples from all ten wells received testing for nitrite/nitrate. Four (GWN-K2A, GWN-K5, GWN-K10A, GWN-K16) had detectable nitrate/nitrite, with the highest concentration, 1.0 ppm as nitrogen, occurring in a sample from well GWN-K5. Detection limits changed from 0.2 ppm as nitrogen to 0.02 ppm as nitrogen for samples collected after September 30, 1998. Figure 3-4 shows trends in levels of nitrate/nitrite (reported as parts per million [ppm] nitrogen) for selected wells (GWN-K2A is a replacement for the recently abandoned GWN-K2).

Samples from eight wells underwent testing for volatile organic compounds (VOCs). Of these, three wells (GWN-K2A, GWN-K12, GWN-K16) received testing only for benzene, ethyl benzene, toluene, and xylenes (BTEX compounds). Well GWN-K2A also underwent testing for the motor fuel additive methyl tert-butyl ether (MTBE). Pollution by benzene (1.6 ppb) and by MTBE (37 ppb) was detected in a sample from one well, GWN-K2A, a public supply well at Irwinton. Subsequent sampling of this well yielded no VOC constituents. Table A-3 in the Appendix lists the analytical results for samples collected from the Cretaceous aquifer system.



Iron levels below the detection limit are assigned a value of 5.1 ppb. A missing bar indicates that samples were not collected for that year.

Figure 3-3. - Iron Concentrations for Selected Wells in the Cretaceous Aquifer System.



Nitrate/nitrite levels below the detection limit are assigned a value of 0.05 ppm. A missing bar indicates that samples were not collected for that year.

Figure 3-4. - Nitrate/Nitrite Concentrations for Selected Wells in the Cretaceous Aquifer System

3.3 PROVIDENCE AQUIFER SYSTEM

Sand and coquinoid limestones of the Late Cretaceous Providence Formation comprise the Providence aquifer system of southwestern Georgia. Outcrops of the aquifer system extend from northern Clay and Quitman Counties through eastern Houston County (Figure 3-5). At its up-dip extent, the aquifer system thickens both to the east and to the west of a broad area adjacent to the Flint River. The aquifer system also generally thickens downdip, with an area where the thickness exceeds 300 feet existing in Pulaski County and an area of similar thickness indicated in the Baker/Calhoun/Early county region (Clarke, et al., 1983). Figure 3-5 also shows the down-dip limit of the area in which the aquifer system is utilized.

The permeable Providence Formation-Clayton Formation interval forms a single aquifer in the up-dip areas (Long, 1989) and to the east of the Flint River (Clarke, et al., 1983). This same interval is recognized as the Dublin aquifer system to the east of the Ocmulgee River (Clarke, et al., 1985). Outcrop areas and adjacent covered areas to the east of the Flint River, where the aquifer is overlain by permeable sand units, are surface recharge areas. The Chattahoochee River forms the western discharge boundary for this flow system in Georgia. EPD did not collect any samples from Providence aquifer system wells in calendar year 1998, because the only two available wells were scheduled for sampling during odd-numbered years. Since October 1998, all stations will be sampled each year.

3.4 CLAYTON AQUIFER SYSTEM

The Clayton aquifer system of southwestern Georgia is developed mainly in the middle limestone unit of the Paleocene Clayton Formation. Limestones and calcareous sands of the Clayton aquifer system crop out in a narrow belt extending from northeastern Clay County to southwestern Schley County (Figure 3-6). Aquifer thickness varies, ranging from 50 feet near outcrop areas to 265 feet in southeastern Mitchell County (Clarke, et al., 1984). Both the Flint River, to the east, and the Chattahoochee River, to the west, are areas of discharge for the aquifer system in its up-dip extent. Leakage from the underlying Providence aquifer system and from permeable units in the overlying Wilcox confining zone provides significant recharge in down-dip areas (Clarke, et al., 1984). The Clayton and Providence Formations merge to form a single aquifer unit in up-dip areas (Long, 1989) as well as east of the Flint River (Clarke, et al., 1983). West of the Flint River and down dip, the Clayton/Providence confining zone, a silt and clay-bearing interval, confines the aquifer below (McFadden and Perriello, 1983). In the area east of the Ocmulgee River, the combination of these two aquifers is referred to as the Dublin aquifer system (Clarke, et al., 1985). Figure 3-6 also shows the down-dip limit of the area in which the aquifer system is used.

During calendar year 1998, EPD used four wells to monitor the water quality in the Clayton aquifer system (Figure 3-6). Three wells (GWN-CT5A, GWN-CT7A, GWN-CT8) are located in or near the recharge area, with the latter two wells being less than 100 feet deep. Well GWN-CT2A was used to sample the downdip portion of the aquifer system.

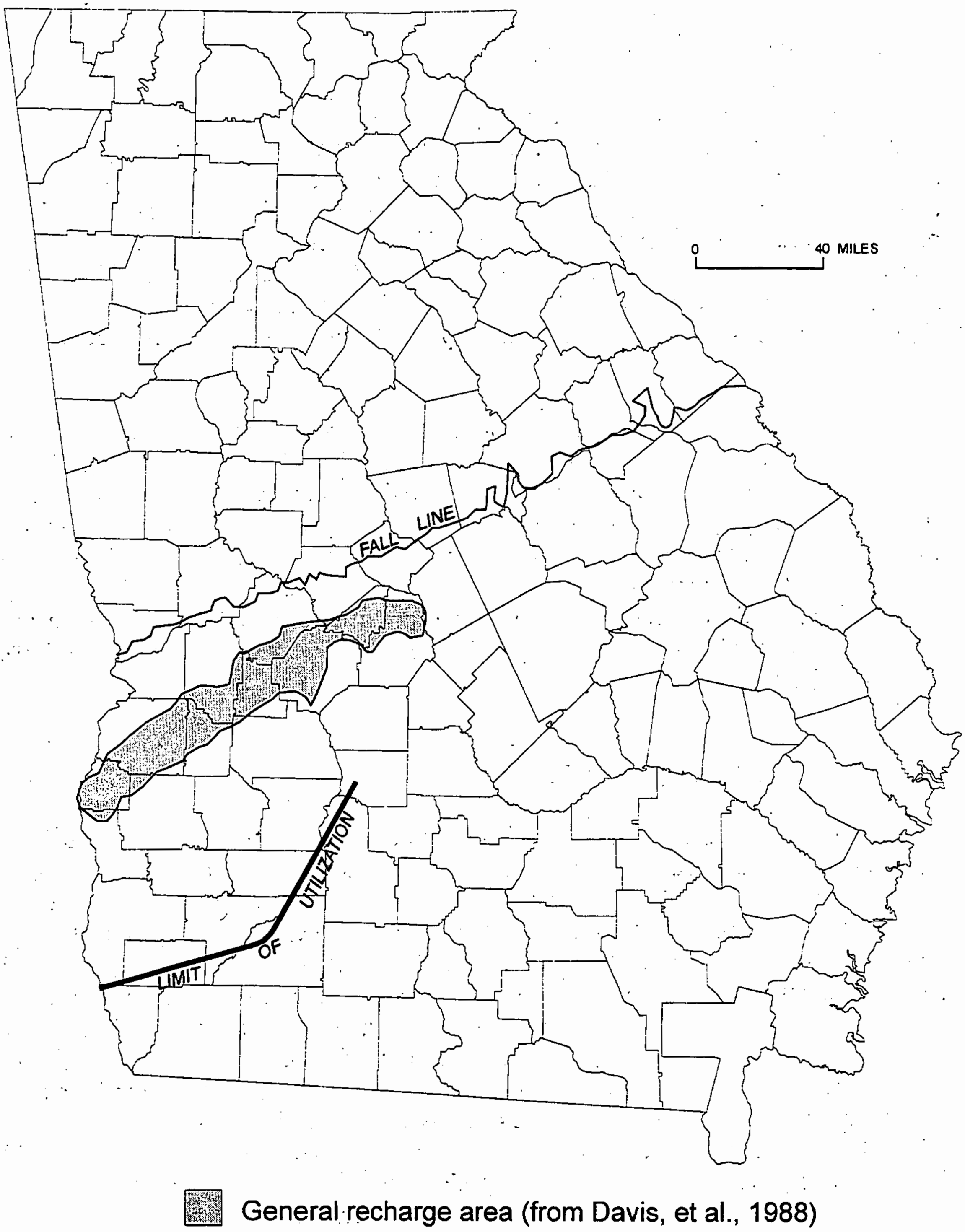
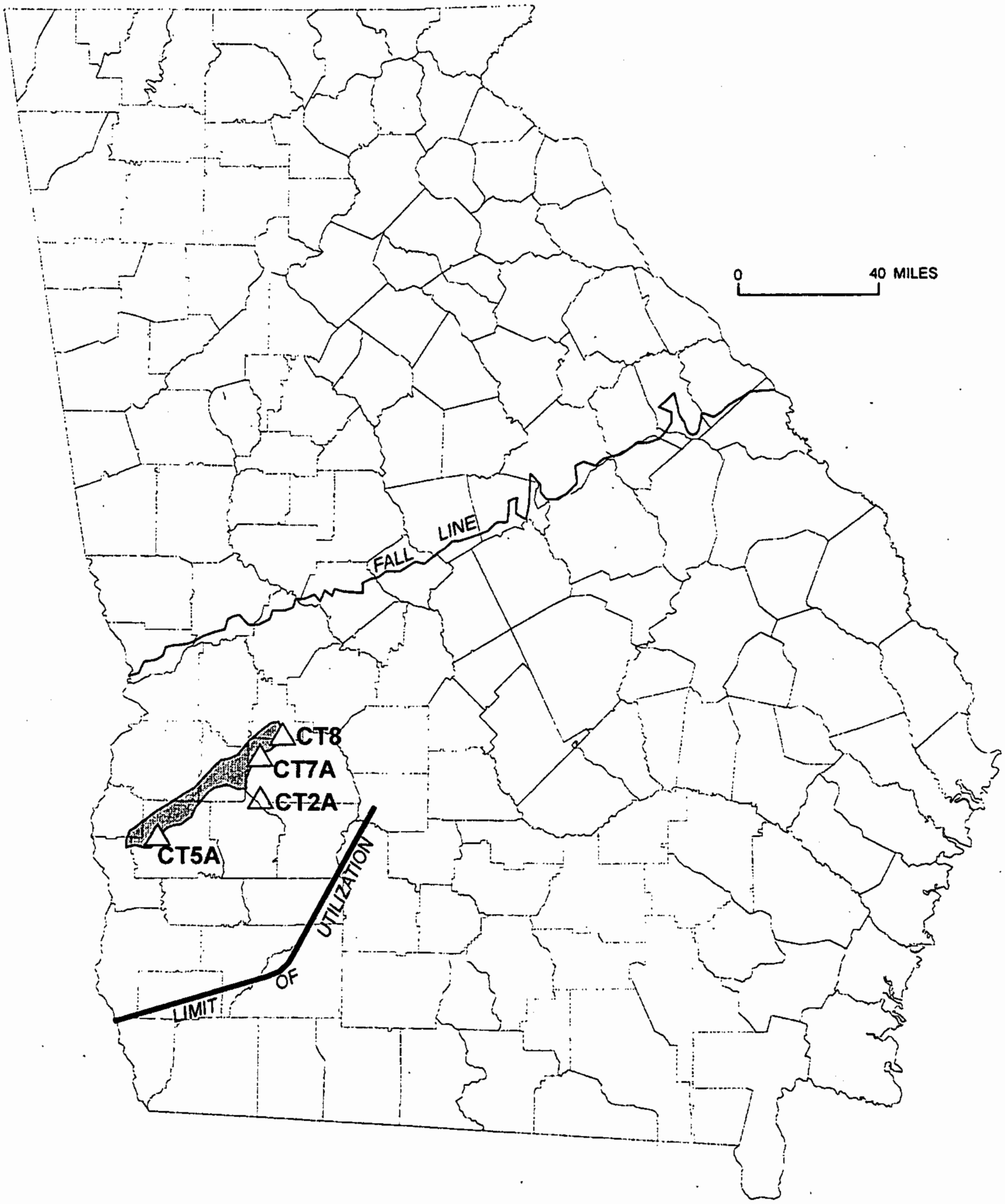


Figure 3-5. - Recharge Area and Limit of Utilization of the Providence Aquifer System.



▨ General recharge area (from Davis, et al., 1988)

△ VOC analyses

Figure 3-6. - Water Quality for Selected Wells in the Clayton Aquifer System.

The pH of the waters from the Clayton wells ranged from acidic to slightly basic. The samples were analyzed for BTEX compounds and nitrate/nitrite. Nitrate/nitrite was detected in the samples from the two shallow recharge area wells. Of the four wells sampled, GWN-CT7A yielded the sample with the highest nitrate/nitrite concentration and is located near an animal enclosure. Figure 3-7 shows trends in iron concentrations (data unavailable for calendar year 1998) and Figure 3-8 shows trends in nitrate/nitrite concentrations for selected wells in the Clayton aquifer system. Table A-4 in the Appendix lists analyses for water samples from these Clayton wells.

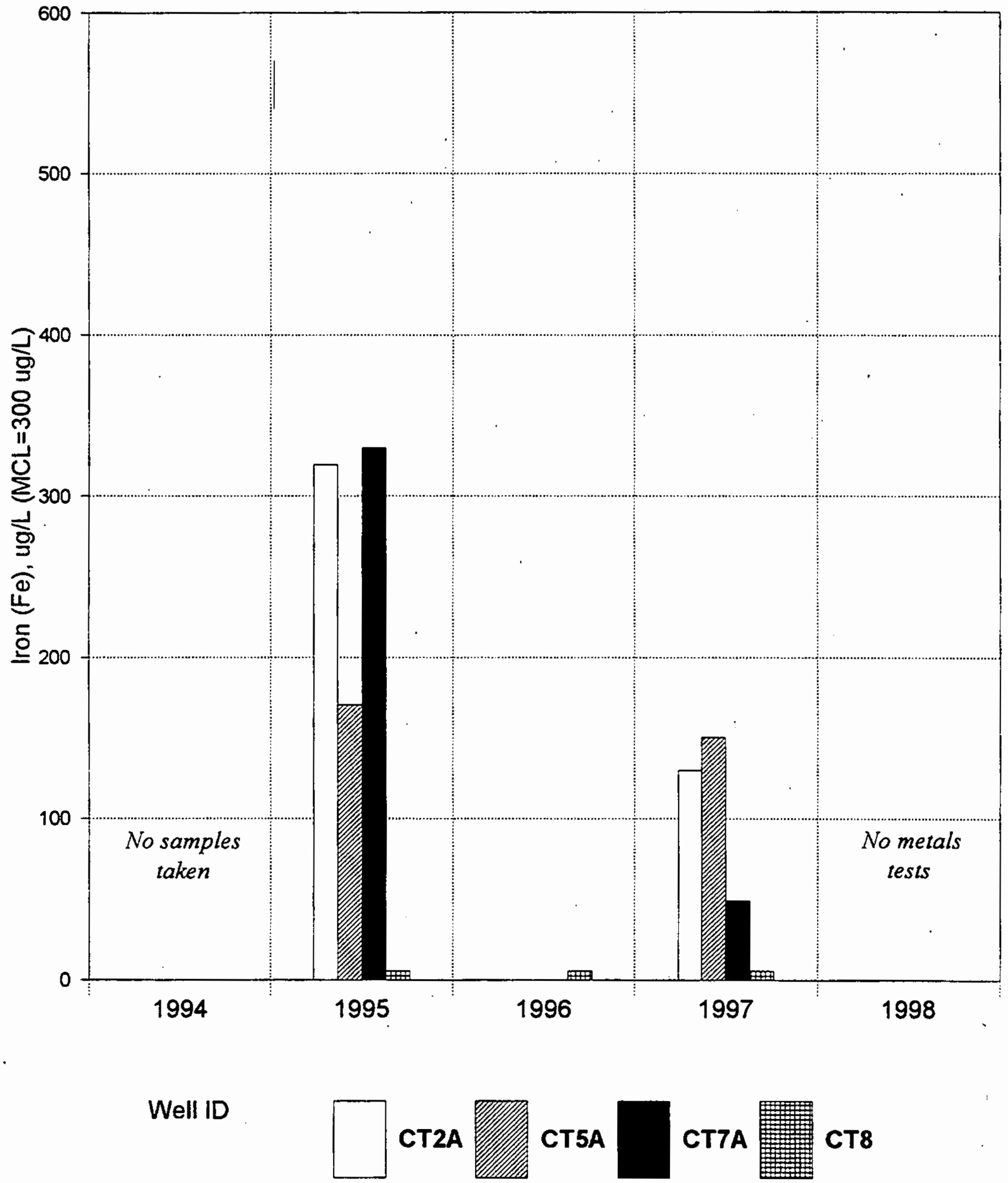
3.5 CLAIBORNE AQUIFER SYSTEM

The Claiborne aquifer system is developed primarily in the sandy units in the middle and lower portions of the Middle Eocene Claiborne Group of southwestern Georgia. (Figure 3-9). Claiborne Group sands crop out in a belt extending from northern Early County through western Dooly County. Recharge to the aquifer system occurs both as direct infiltration of precipitation in the recharge area and as leakage from the overlying Floridan aquifer system (Hicks, et al., 1981; Gorday, et al., 1997). Discharge boundaries of the aquifer system are the Ocmulgee River, to the east, and the Chattahoochee River, to the west. The aquifer is more than 350 feet thick near its down-dip limit of utilization (Figure 3-9) (Tuohy, 1984).

The aquifer generally thickens from the outcrop area toward the southeast. The clay-rich upper portion of the Claiborne Group, the Lisbon Formation, acts as a confining layer and separates the aquifer from the overlying Floridan aquifer (McFadden and Perriello, 1983; Long, 1989; Huddlestun and Summerour, 1996). The lower water-bearing parts of the group had been correlated to the Tallahatta Formation (e.g., McFadden and Perriello, 1983; Long, 1989; Clarke et al., 1996) or, more recently, have been divided into two formations, the upper one termed the Still Branch Sand and the lower one correlated to the Congaree Formation (Huddlestun and Summerour, 1996). The permeable lower units are included in the Gordon aquifer system east of the Ocmulgee River (Brooks, et al., 1985).

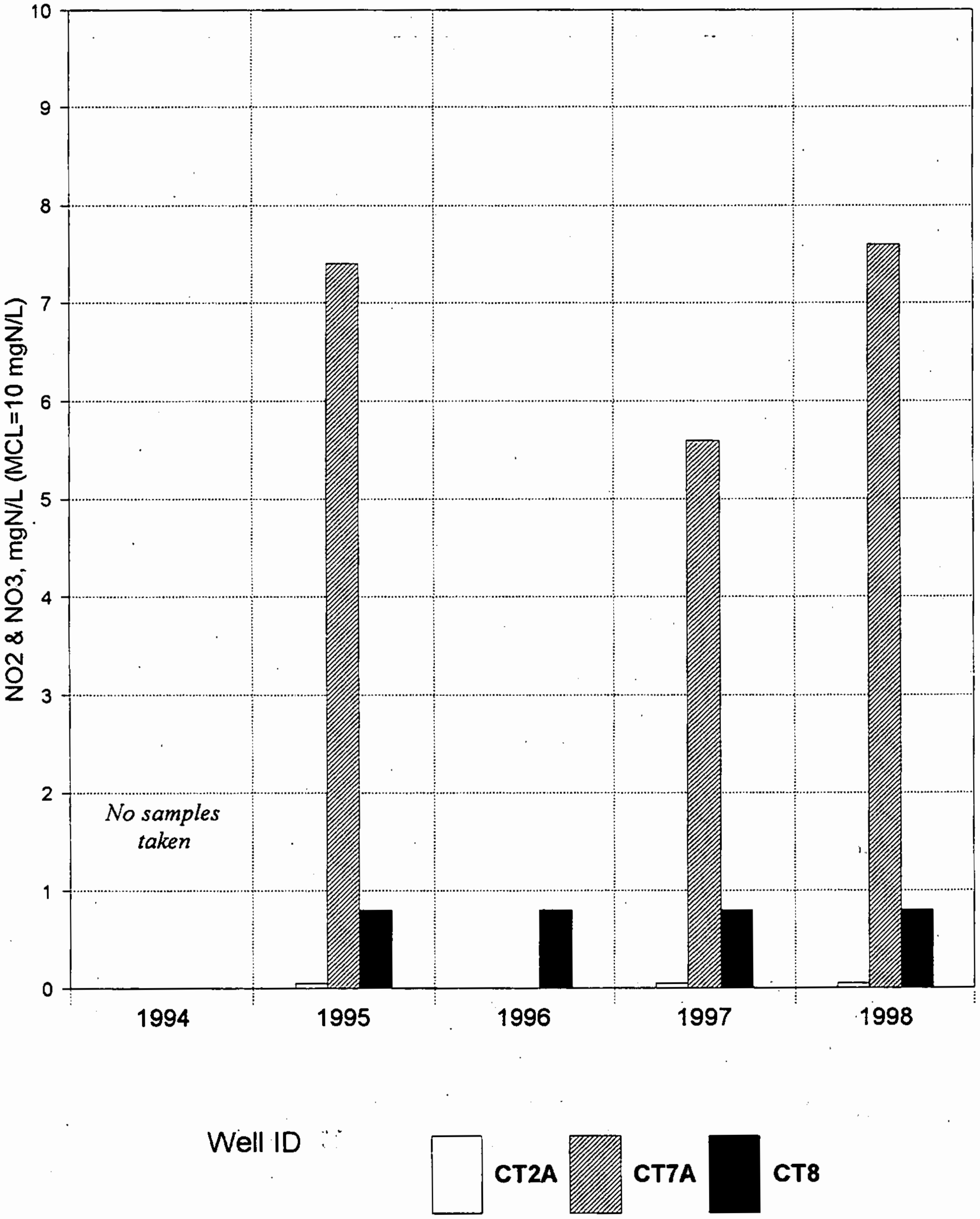
During calendar year 1998, EPD personnel used two wells to monitor the water quality of the Claiborne aquifer system. Well GWN-CL4 is relatively shallow (about 90 feet deep) and is located in the recharge area. Well GWN-CL9 is deep and draws from the down-dip portion of the aquifer, near the limit of utilization.

The recharge area well yielded acidic water, while the down-dip well yielded basic water. Samples from both wells were analyzed for BTEX compounds. The sample from well GWN-CL9 was also tested for MTBE. Benzene was reported at levels of 13 ppb for well GWN-CL4 and 1.3 ppb for well GWN-CL9. MTBE was reported at a level of 37 ppb for well GWN-CL9. The benzene level in well GWN-CL4 exceeds the primary MCL of 5 ppb.This well, a now-decommissioned public water supply well at Plains, has had a history of pollution by motor fuel components (previous EPD data; Table 7, EPD, 1997b). Well GWN-CL9, a public water supply well at Newton, has given no previous indication of motor fuel contamination. This well draws from



Iron levels below the detection limit are assigned a value of 5.1 ppb. A missing bar indicates that samples were not collected for that year.

Figure 3-7. - Iron Concentrations for Selected Wells in the Clayton Aquifer System.



Nitrate/nitrite levels below the detection limit are assigned a value of 0.05 ppm. A missing bar indicates that samples were not collected for that year.

Figure 3-8. - Nitrate/Nitrite Concentrations for Selected Wells in the Clayton Aquifer System.

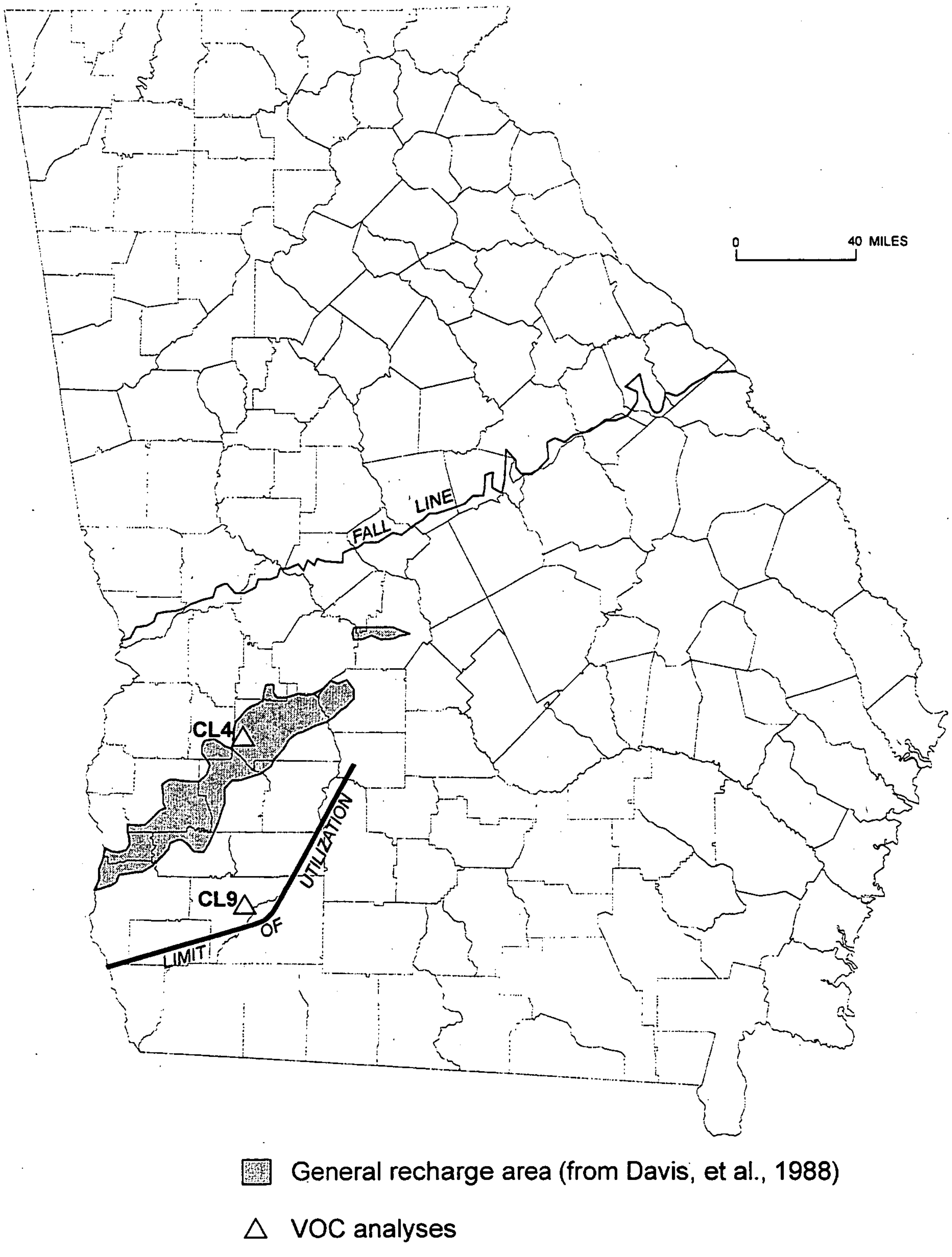


Figure 3-9. - Water Quality of Selected Wells in the Claiborne Aquifer System.

a confined portion of the aquifer, is of recent construction, and, being located at the edge of town adjacent to a row crop field, seems to lack a nearby pollution source. This well will be retested for MTBE and benzene in 1999.

Samples from both wells were tested for nitrate/nitrite, with the sample from GWN-CL4 containing 2.2 mgN/L. Figure 3-10 shows trends in iron concentrations for selected wells (calendar year 1998 data absent). Figure 3-11 shows trends in nitrite/nitrate concentrations for selected wells. Table A-5 in the Appendix gives the analytical results for the samples from Claiborne wells.

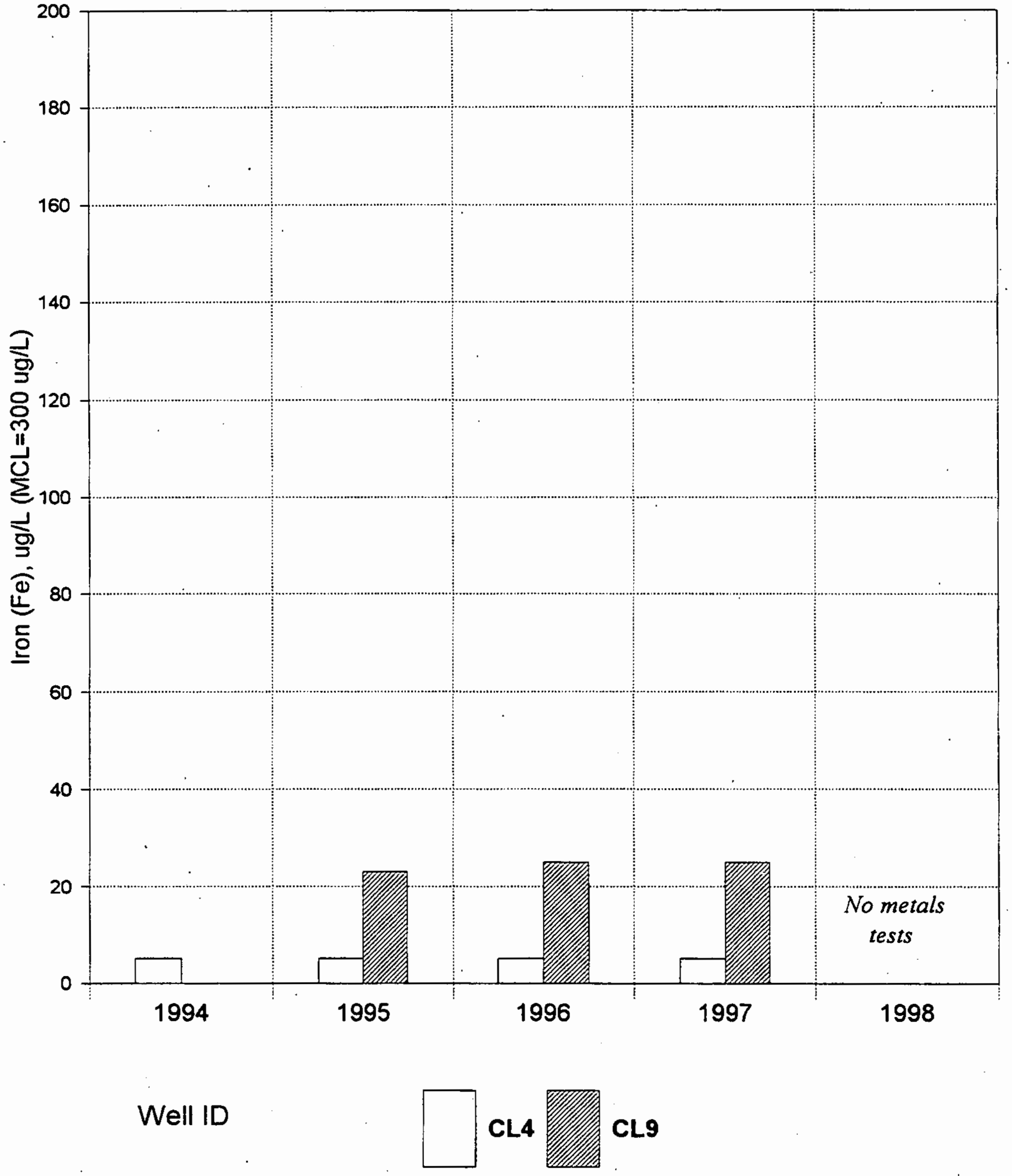
3.6 JACKSONIAN AQUIFER SYSTEM

The Jacksonian aquifer system of central and east-central Georgia comprises predominantly sands of the Eocene Barnwell Group, though, locally, isolated limestone bodies are important. Barnwell Group outcrops extend from Macon and Peach Counties eastward to Burke and Richmond Counties (Figure 3-12). Aquifer sands form a northern clastic facies of the Barnwell Group; the sands grade southward into less permeable silts and clays of a transition facies (Vincent, 1982). The water-bearing sands are relatively thin, ranging from ten to fifty feet in thickness. Limestones equivalent to the Barnwell Group form a southern carbonate facies and are included in the Floridan aquifer system. The Savannah River and Ocmulgee River are eastern and western discharge boundaries respectively for the up-dip flow system of the Jacksonian aquifer system. The Jacksonian aquifer system is equivalent to the Upper Three Runs aquifer as used in Summerour et al. (1994).

EPD monitored the water quality of five wells tapping the Jacksonian aquifer system in calendar year 1998 (Figure 3-12). Four wells are in the clastic facies (one, GWN-J2A, drawing from an isolated limestone body), and one well (GWN-J3) is in the transition facies. The pH of the water samples ranged from 4.88 to 7.72.

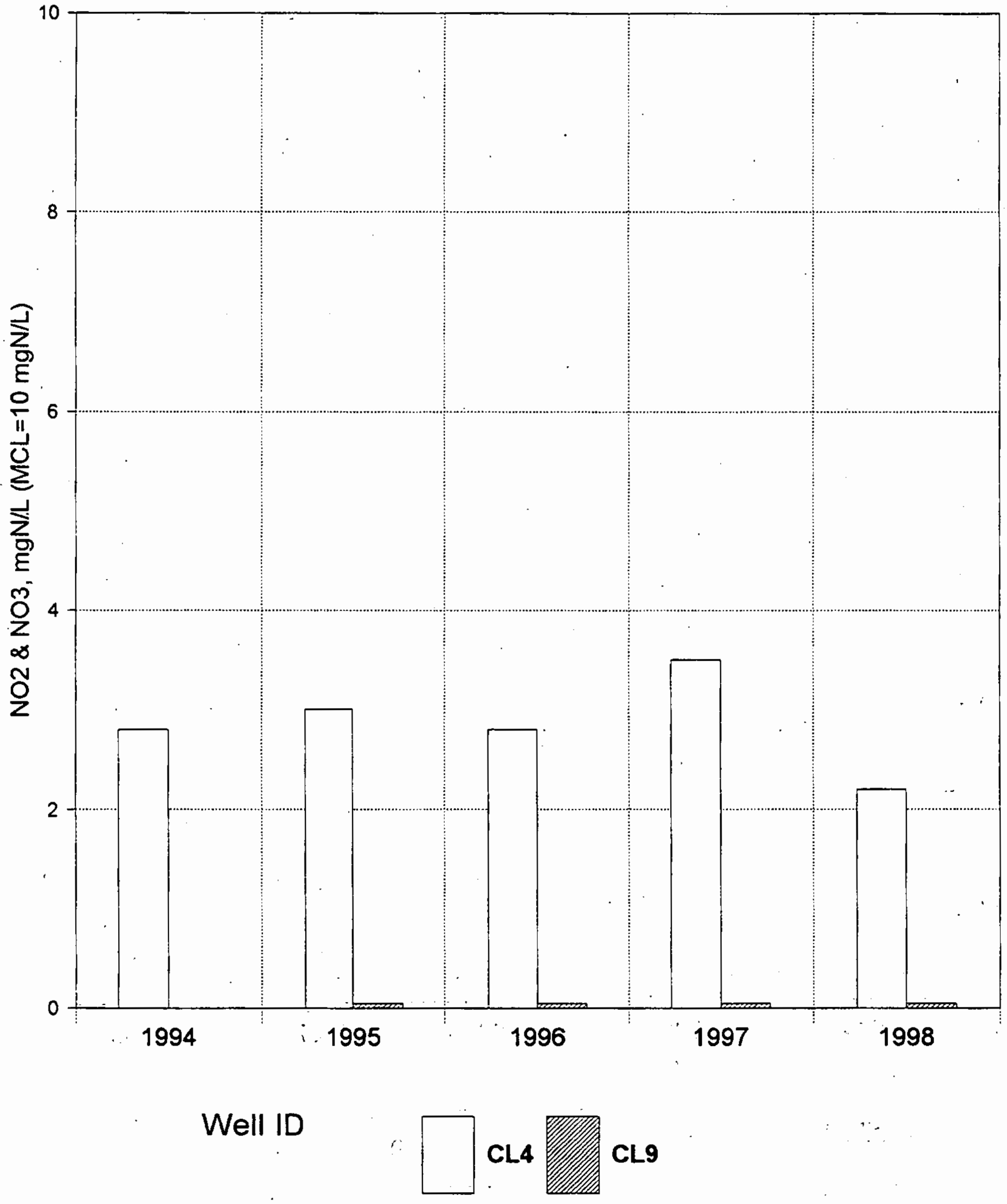
Four of the wells, including the transition facies well, received testing for metals, fluoride, chloride, bromide and sulfate. Water hardness ranged from soft to hard. The sample from domestic well GWN-J8 was analyzed for beryllium, because of occasional past findings, and 6.6 ppb beryllium was detected (above the primary MCL of 4 ppb). Manganese exceeded the secondary MCL in the sample from domestic well GWN-J3 (130 ppb).

For the samples undergoing metals analyses, sodium was generally low, with the highest concentration occurring in the transition facies sample. Calcium concentrations ranged from 3.3 ppm to 54 ppm, with the lowest in the sample from the up-dip well GWN-J7. Samples from two wells contained detectable concentrations of magnesium, with the higher level of 5.9 ppm occurring in the sample from transition well GWN-J3. Other detected substances included barium and strontium (markedly higher in the transition sample), fluoride, chloride, copper, and zinc. No sulfate was detected. Samples from all wells were analyzed for nitrite/nitrate. Concentrations ranged from undetected to 8.56 ppm as nitrogen.



Iron levels below the detection limit are assigned a value of 5.1 ppb. A missing bar indicates that samples were not collected for that year.

Figure 3-10. - Iron Concentrations for Selected Wells in the Claiborne Aquifer System.



Nitrate/nitrite levels below the detection limit are assigned a value of 0.05 ppm. A missing bar indicates that samples were not collected for that year.

Figure 3-11. - Nitrate/Nitrite Concentrations for Selected Wells in the Claiborne Aquifer System.

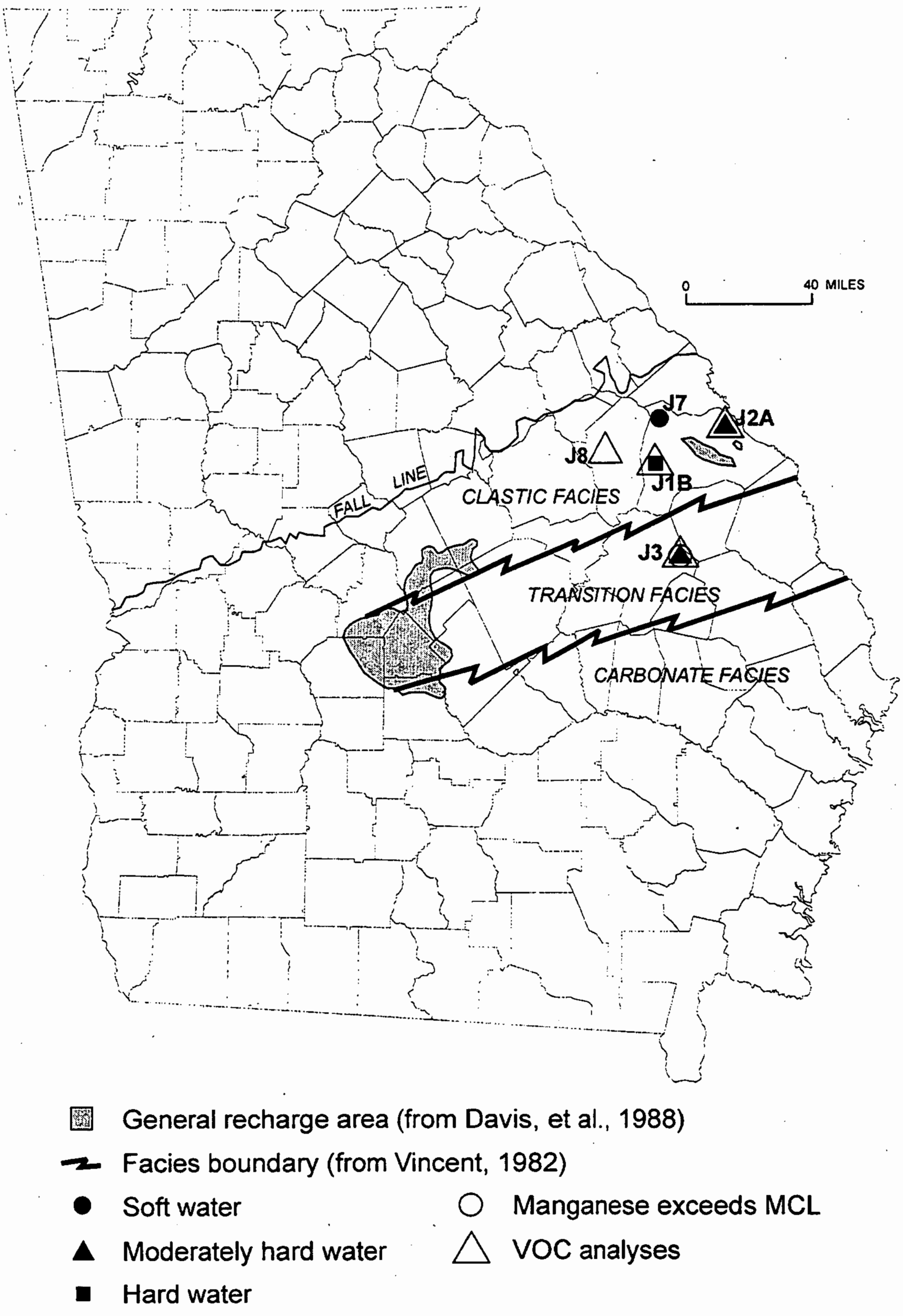


Figure 3-12. - Water Quality of Selected Wells in the Jacksonian Aquifer System.

The highest occurred in up-dip well GWN-J8, a domestic well in a row-crop area. Four well samples were tested for VOC's; none were detected. Figures 3-13 and 3-14 depict trends in iron and nitrite/nitrate concentrations for selected wells. Table A-6 in the Appendix lists the analytical results for all the Jacksonian aquifer wells sampled.

3.7 FLORIDAN AQUIFER SYSTEM

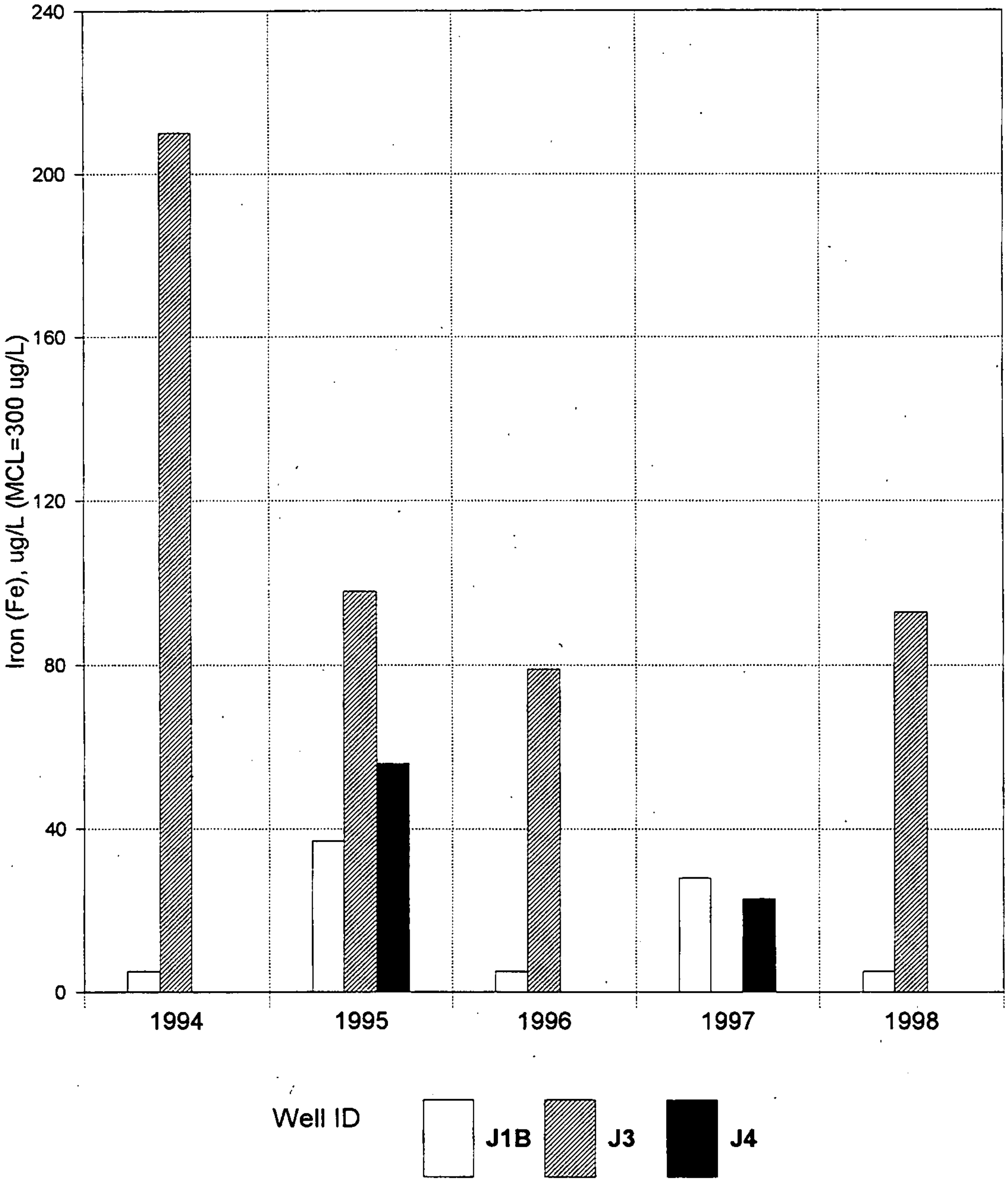
The Floridan aquifer system consists predominantly of Eocene and Oligocene limestones and dolostones that underlie most of the Coastal Plain Province. The aquifer is a major source of ground water for much of its outcrop area and throughout its down-dip extent to the south and east.

The upper water-bearing units of the Floridan are the Eocene Ocala Group and the Oligocene Suwanee Limestone (Crews and Huddlestun, 1984). These limestones crop out in the Dougherty Plain (a karstic area in southwestern Georgia) and in adjacent areas along a strike to the northeast. In Camden and Wayne counties the Oligocene unit is absent, and the upper part of the Floridan is restricted to units of Eocene age (Clarke, et al., 1990). The lower portion of the Floridan consists mainly of dolomitic limestone of middle and early Eocene age and pelletal, vuggy, dolomitic limestone of Paleocene age but extends into the late Cretaceous in Glynn County. The lower Floridan is deeply buried and not widely used, except in several municipal and industrial wells in the Savannah area (Clarke, et al., 1990). From its up-dip limit, defined in the east by clays of the Barnwell Group, the aquifer thickens to well over 700 feet in coastal Georgia. A dense limestone facies along the trend of the Gulf Trough locally limits ground-water quality and availability (Kellam and Gorday, 1990). The Gulf Trough is a linear depositional feature in the Coastal Plain that extends from southwestern Decatur County through central Bulloch County.

A ground-water divide separates a smaller southwestward flow regime in the Floridan aquifer system in the Dougherty Plain from the larger southeastward flow regime in the remainder of Georgia. Rainfall infiltration in outcrop areas and downward leakage from extensive surficial residuum recharge the Dougherty Plain flow system (Hayes, et al., 1983). The main body of the Floridan aquifer system, to the east, is recharged by leakage from the Jacksonian aquifer system and by rainfall infiltration in outcrop areas and in areas where overlying strata are thin. Significant recharge also occurs in the area of Brooks, Echols and Lowndes counties, where the Withlacoochee River and numerous sinkholes breach upper confining beds (Krause, 1979).

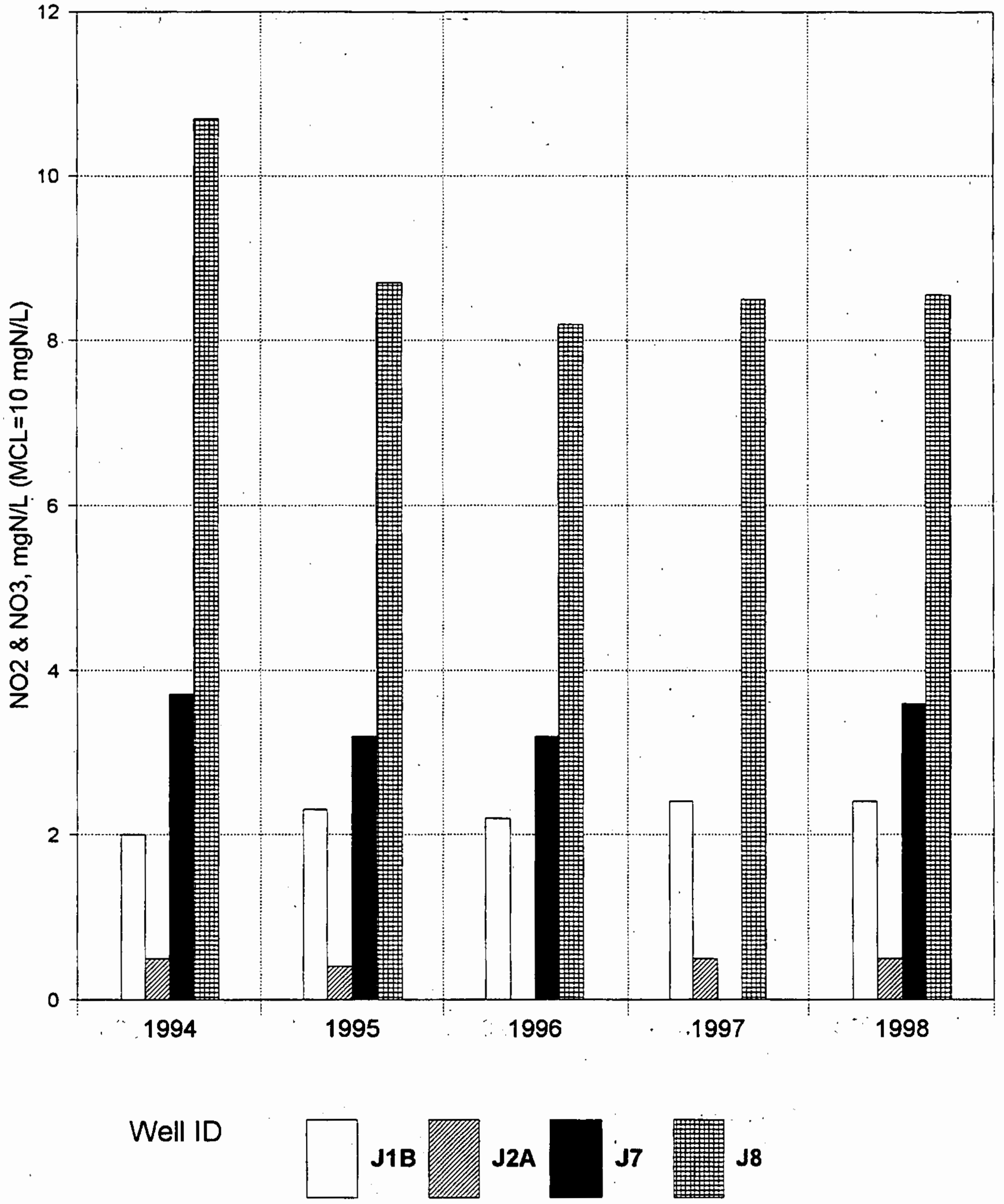
During calendar year 1998, EPD collected 32 samples from 31 wells in the Floridan aquifer system (Figure 3-15). The pH levels in all samples were basic.

Twenty-four samples were tested for metals, chloride, fluoride, bromide and sulfate. The hardness of these samples ranged from moderately hard to very hard. None of the samples had concentrations exceeding applicable MCLs.



Iron levels below the detection limit are assigned a value of 5.1 ppb. A missing bar indicates that samples were not collected for that year.

Figure 3-13. - Iron Concentrations for Selected Wells in the Jacksonian Aquifer System.



Nitrate/nitrite levels below the detection limit are assigned a value of 0.05 ppm. A missing bar indicates that samples were not collected for that year.

Figure 3-14. - Nitrate/Nitrite Concentrations for Selected Wells in the Jacksonian Aquifer System.

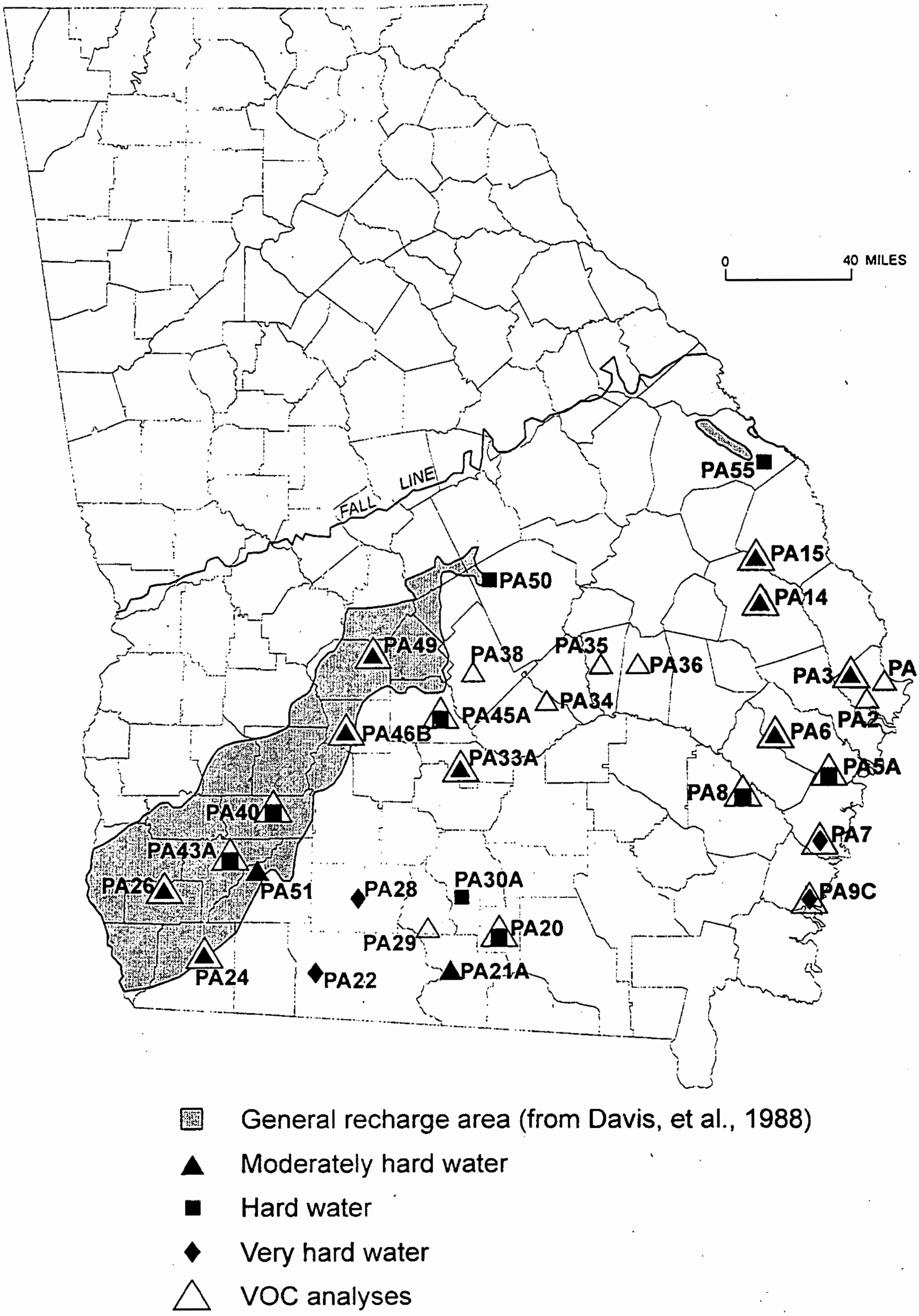


Figure 3-15. - Water Quality of Selected Wells in the Floridan Aquifer System.

Sodium concentrations ranged from 1.6 ppm to 27 ppm. This element is more abundant in samples from wells in the coastal area. Magnesium ranged from undetected to 28 ppm; calcium ranged from 24 ppm to 62 ppm. Chloride occurred in all samples analyzed and ranged from 2.3 ppm to 22.3 ppm. Sulfate ranged from undetected to 133 ppm. Other substances detected in measurable concentrations included iron, manganese, barium, strontium, fluoride, and zinc. Trends in iron levels from selected wells in the Floridan aquifer are shown on Figure 3-16.

Samples from all wells were tested for nitrate/nitrite. Most of the samples collected from the confined portions of the Floridan aquifer contained no detectable nitrite/nitrate, whereas, most samples in the unconfined portion contained detectable concentrations of nitrite/nitrate. The highest level, 3.9 ppm as nitrogen, was in a sample from well GWN-PA46B in the Dougherty Plain. Figure 3-17 presents trends in nitrate levels from selected wells in the Floridan Aquifer.

Twenty-four wells were tested for VOCs. The sample from well GWN-PA33A contained a trace of chloroform. The Appendix (Table A-7) gives the analytical results for samples from the Floridan aquifer system.

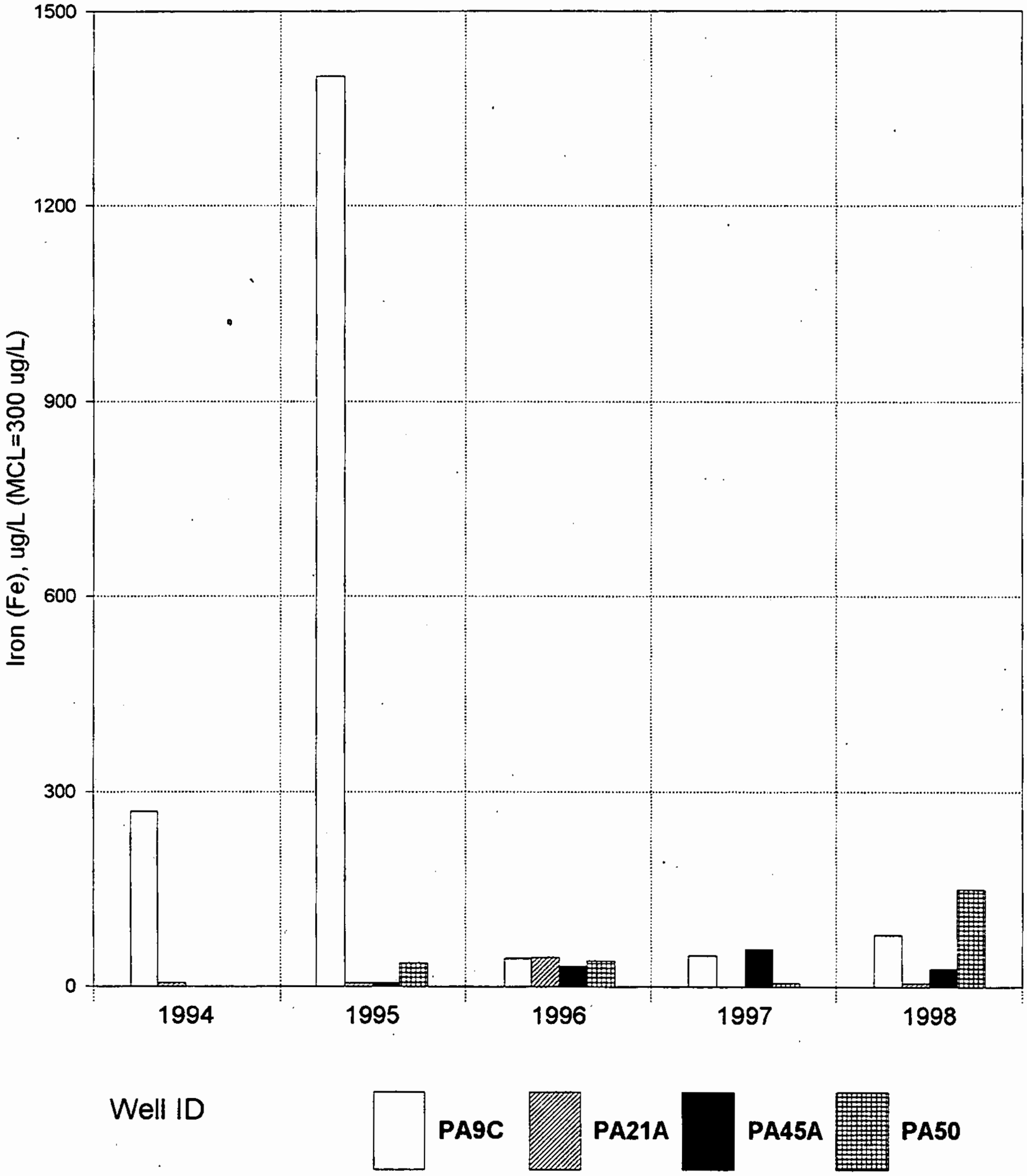
3.8 MIOCENE AQUIFER SYSTEM

Much of south-central and southeastern Georgia lies within outcrop areas of the Miocene Altamaha Formation and Hawthorne Group. Discontinuous lens-shaped bodies of sand, 50 to 80 feet thick, are the main permeable units. Miocene clays and sandy clays are thickest, more than 500 feet, in Wayne County (Watson, 1982).

Areas of confinement exist in the coastal counties. Leakage from overlying surface aquifers into the Miocene aquifer system and, in some areas, from the underlying Floridan aquifer system is significant in the coastal counties (Watson, 1982). Here, two principal aquifer units are present (Joiner, et al., 1988). Clarke (et. al., 1990) use the names upper and lower Brunswick aquifers to refer to these two sandy aquifer units.

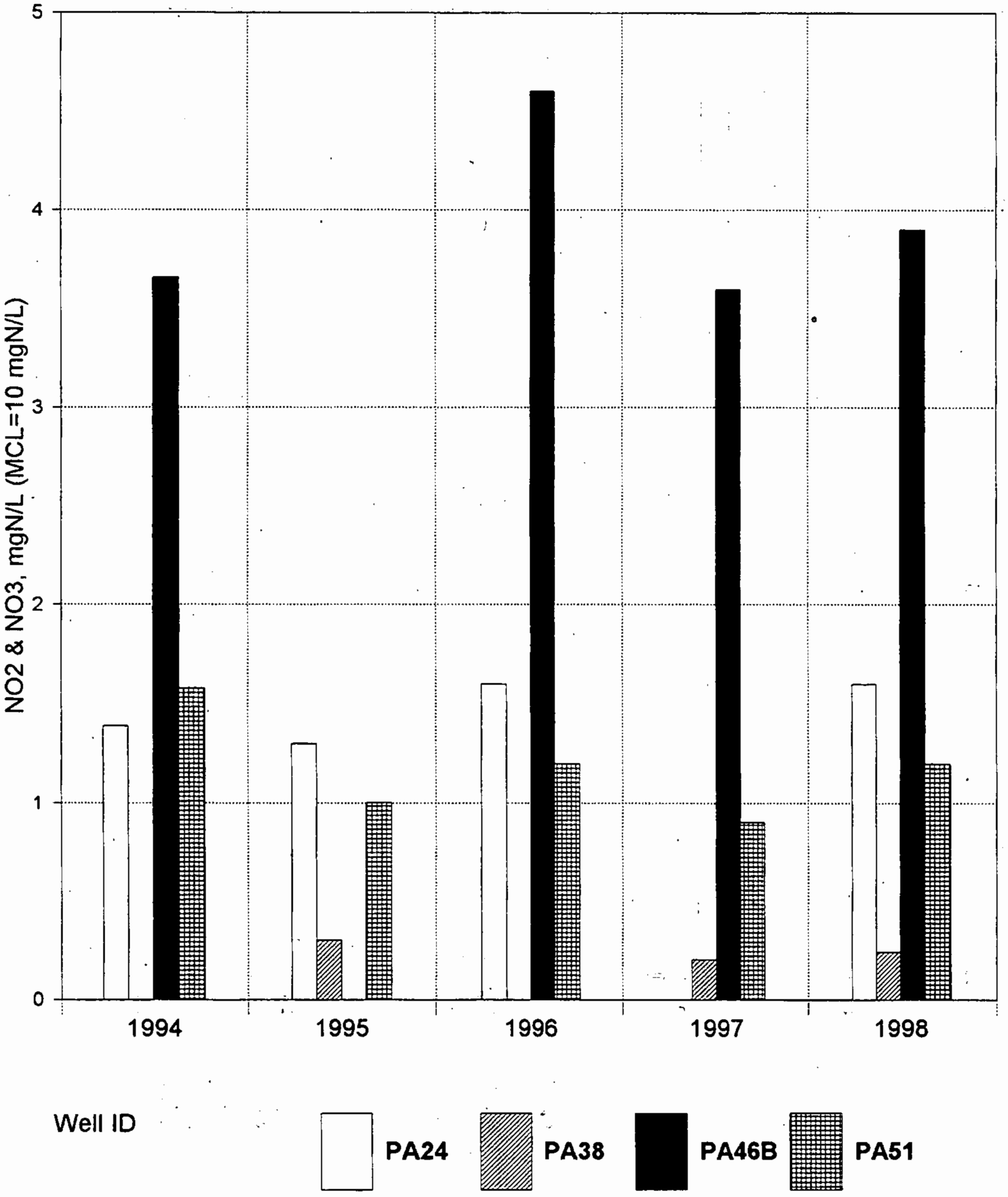
EPD collected water samples from five wells to monitor the water quality in the Miocene aquifer system (Figure 3-18). The pH of the samples ranged from 4.24 to 7.91, with four being acidic.

Samples from two of the wells were analyzed for metals, chloride, fluoride, bromide, and sulfate. One of the wells yielded basic, moderately hard water; the other had soft, acidic water. None of the metals or cations exceeded any MCLs for either sample. The substances detected included manganese, aluminum, sodium, calcium, magnesium, strontium, barium, copper, zinc, chloride, fluoride, and sulfate. Figure 3-19 shows trends in iron concentrations for selected Miocene wells.



Iron levels below the detection limit are assigned a value of 5.1 ppb. A missing bar indicates that samples were not collected for that year.

Figure 3-16. - Iron Concentrations for Selected Wells in the Floridan Aquifer System.



Nitrate/nitrite levels below the detection limit are assigned a value of 0.05 ppm. A missing bar indicates that samples were not available for that year.

Figure 3-17. - Nitrate/Nitrite Concentrations for Selected Wells in the Floridan Aquifer System.

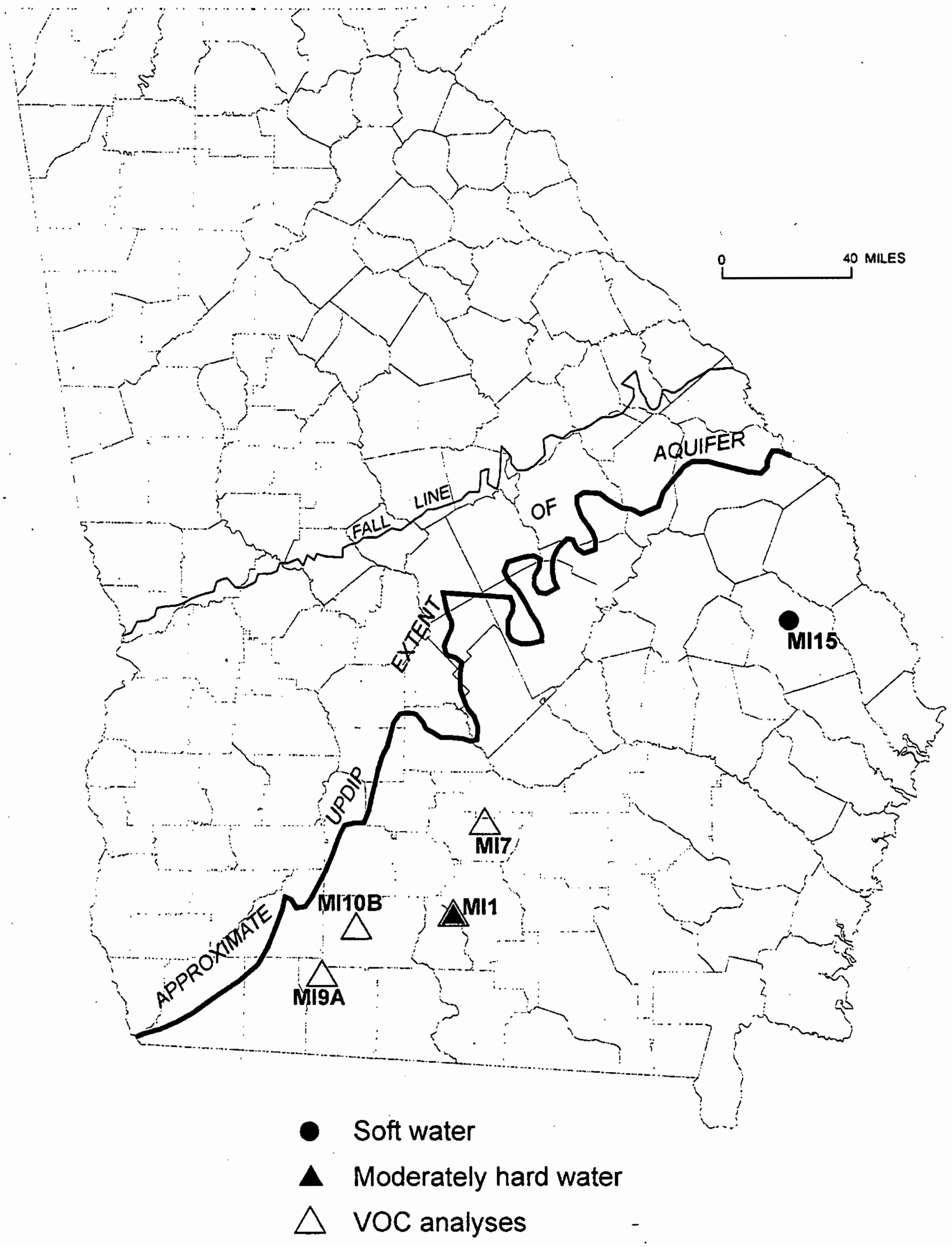
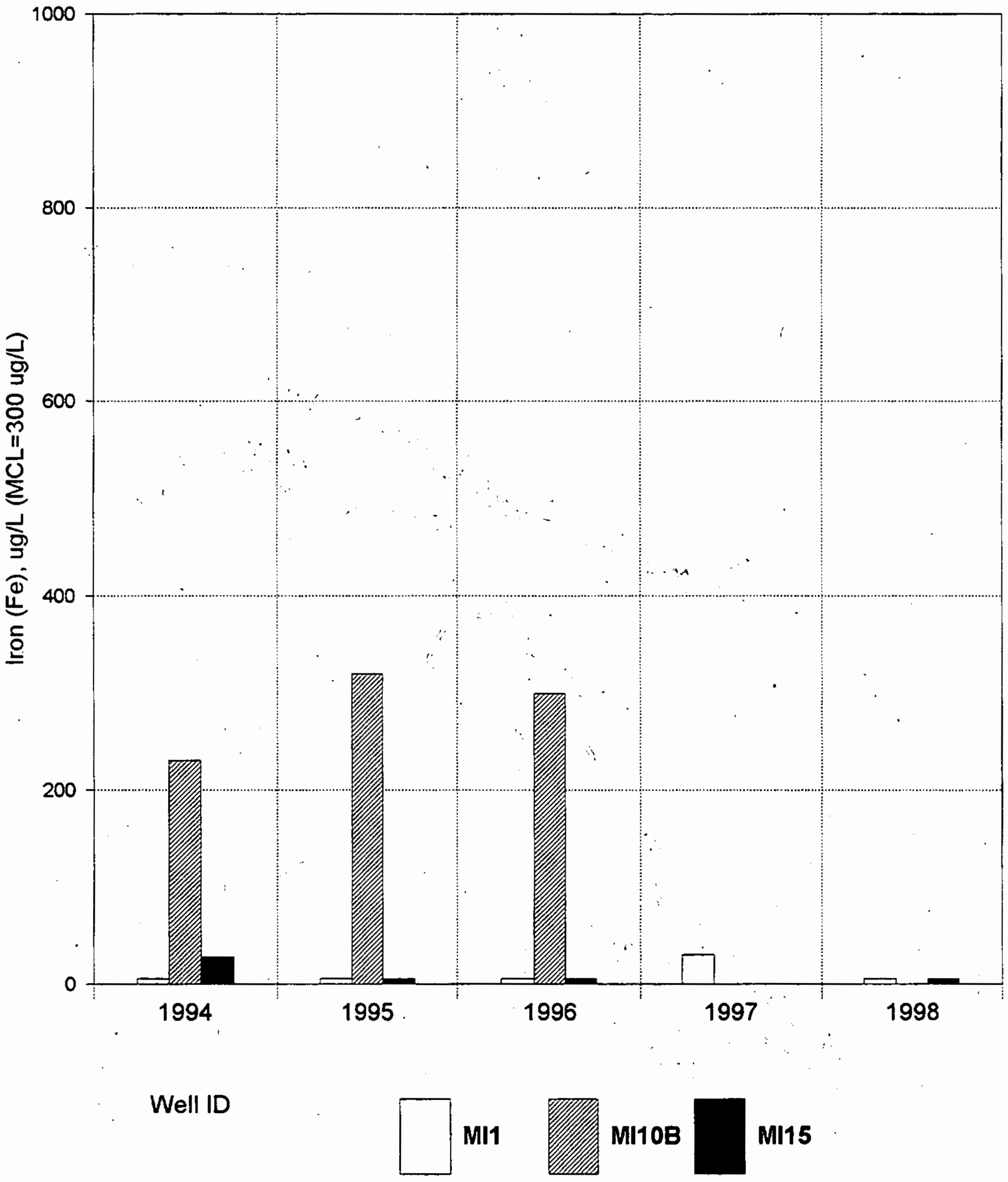


Figure 3-18. - Water Quality of Selected Wells in the Miocene Aquifer System.



Iron levels below the detection limit are assigned a value of 5.1 ppb. A missing bar indicates that samples were not collected for that year.

Figure 3-19. - Iron Concentrations for Selected Wells in the Miocene Aquifer System.

All samples were tested for nitrate/nitrite. Samples from two wells, GWN-MI9A and GWN-MI15, both contained nitrate/nitrite in excess of the primary MCL. The first well is in domestic use for watering gardens, while the second is used as a domestic drinking water source. Another well (GWN-MI7), also a domestic drinking water source, had an elevated nitrate/nitrite content (9.31 ppm as nitrogen). Figure 3-20 shows trends in nitrate/nitrite concentrations for selected Miocene wells.

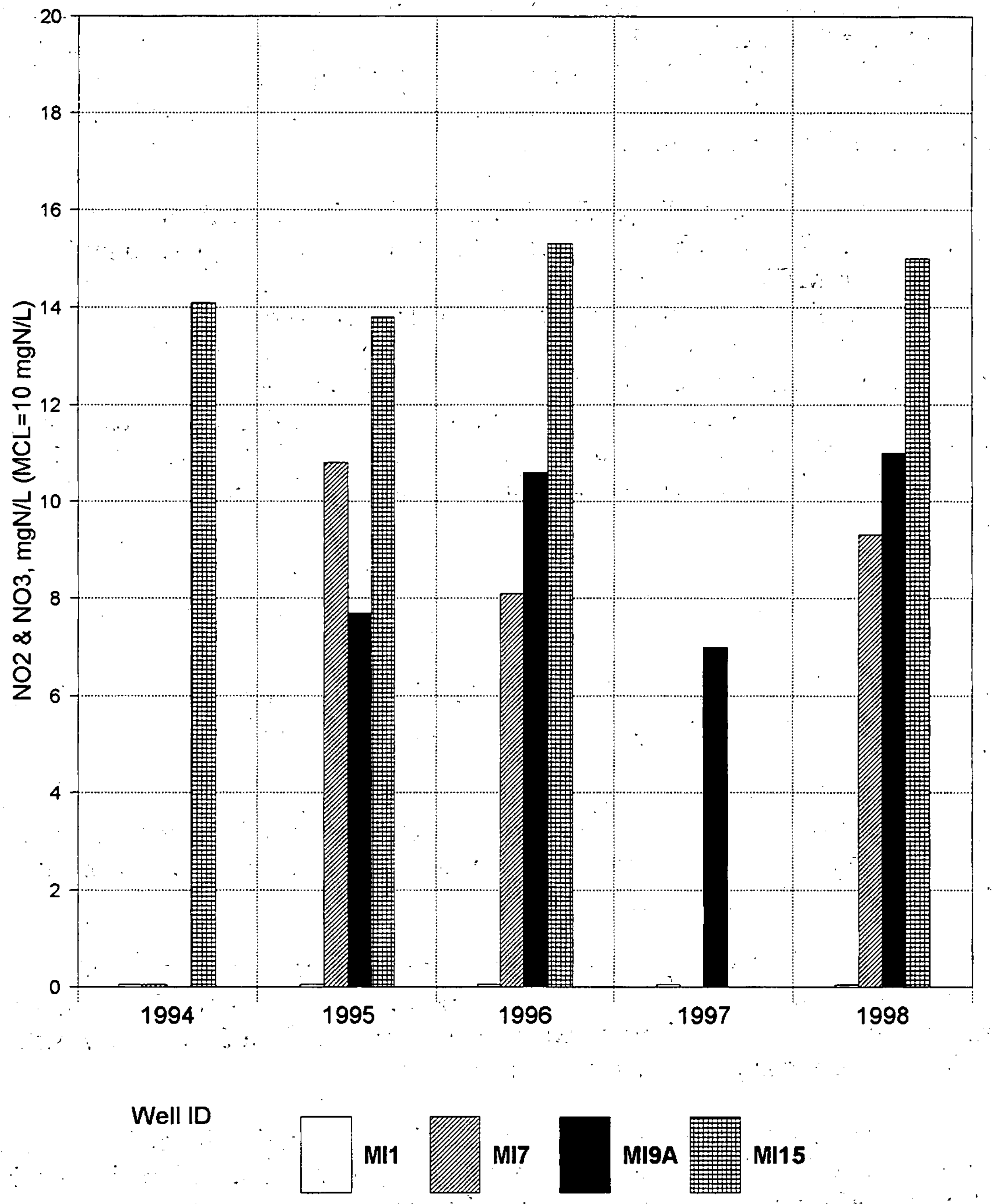
Samples from four wells (GWN-MI1, GWN-MI7, GWN-MI9A, and GWN-MI10B) were tested for VOC's, with samples from the latter two receiving tests only for BTEX compounds plus MTBE. The analytical results indicated benzene in excess of the primary MCL in samples from two wells, garden well GWN-MI9A and domestic drinking water well GWN-MI10B. Ethylbenzene, toluene, and MTBE were also detected. The reported VOC data for these two wells are questionable. No potential source of pollution is obvious for either well, as GWN-MI9A is located at a farm house and GWN-MI10B is located in a low-density residential setting (the second well was later retested, with no VOCs detected). Table A-8 in the Appendix gives analytical data for samples drawn from Miocene aquifer system wells.

3.9 PIEDMONT/BLUE RIDGE UNCONFINED AQUIFERS

Georgia's Piedmont and Blue Ridge Physiographic Provinces are developed on metamorphic and igneous rocks that are predominantly Precambrian and Paleozoic in age. Soil and saprolite horizons, compositional layers, and openings along fractures and joints in the rocks are the major water-bearing features. Fracture density and interconnection provide the primary controls on the rate of water flow into wells completed in crystalline rocks. The permeability and thickness of soils and saprolite horizons determine the amount of well yield that can be sustained.

EPD used fourteen wells and three springs to monitor water quality in the Piedmont/Blue Ridge unconfined aquifers. Figure 3-21 shows the locations of the monitoring stations. The pH of the water samples ranged from 5.09 to 7.77, with the majority of the stations yielding slightly acidic water.

Twelve samples were analyzed for metals, chloride, fluoride, bromide, and sulfate. The sample from GWN-P10B was also analyzed for beryllium, because of previous findings. Hardness ranged from soft to moderately hard. Iron and manganese ranged from undetected to 2100 ppb and 100 ppb, respectively. Iron exceeded the secondary MCL (300 ppb) in water samples taken at three stations, and manganese exceeded the secondary MCL (50 ppb) at five stations. Fluoride exceeded the primary MCL at one station (GWN-P12A). Water at this location is not used for public consumption. Other substances detected in various samples consisted of chloride, sulfate, sodium, calcium, magnesium, barium, strontium, aluminum, zinc, and molybdenum. Figures 3-22 and 3-23 respectively show trends in iron concentrations for selected stations in the Piedmont and Blue Ridge sectors of the Piedmont/Blue Ridge aquifer system.



Nitrate/nitrite levels below the detection limit are assigned a value of 0.05 ppm. A missing bar indicates that samples were not collected for that year.

Figure 3-20. - Nitrate/Nitrite Concentrations for Selected Wells in the Miocene Aquifer System.

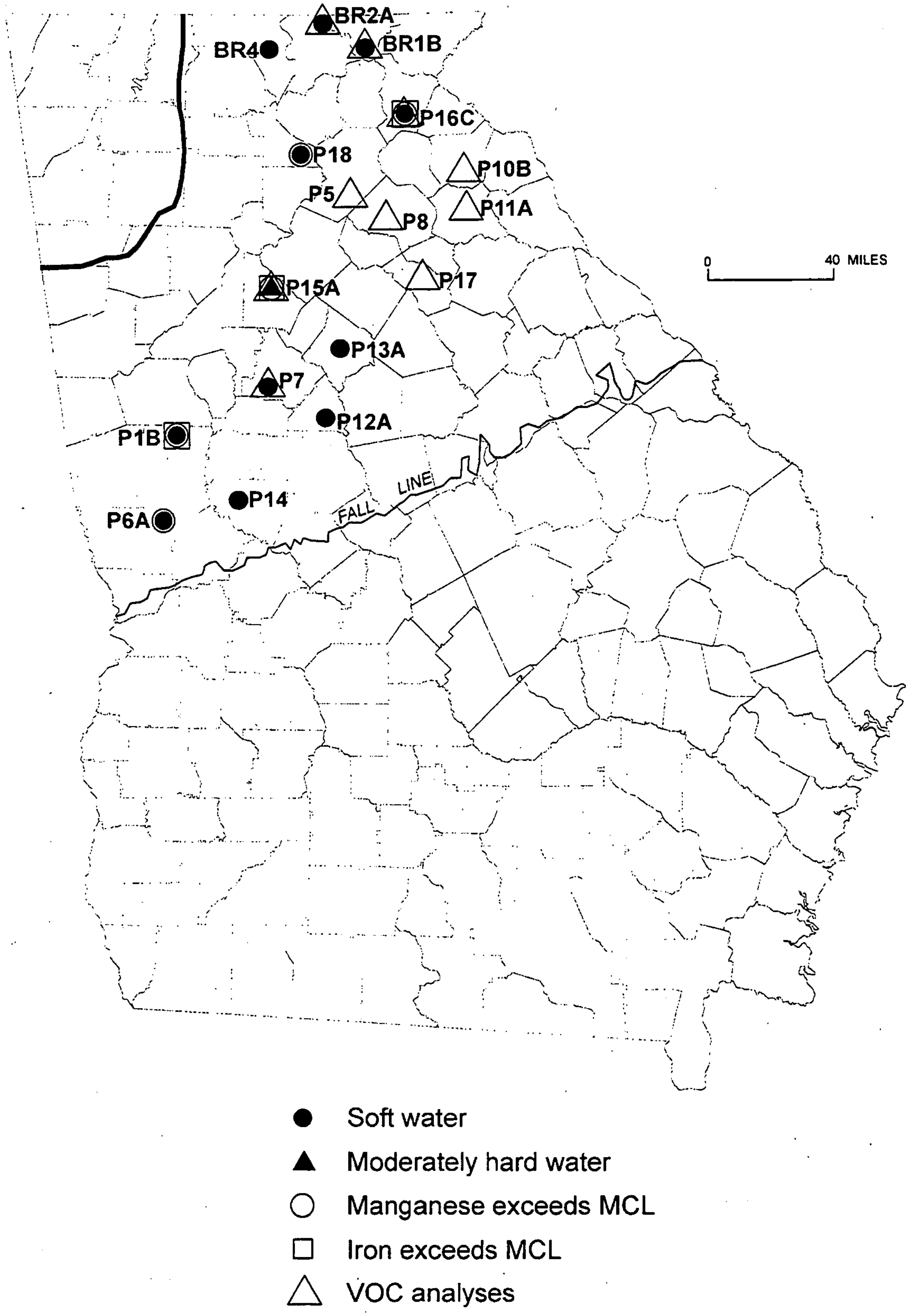
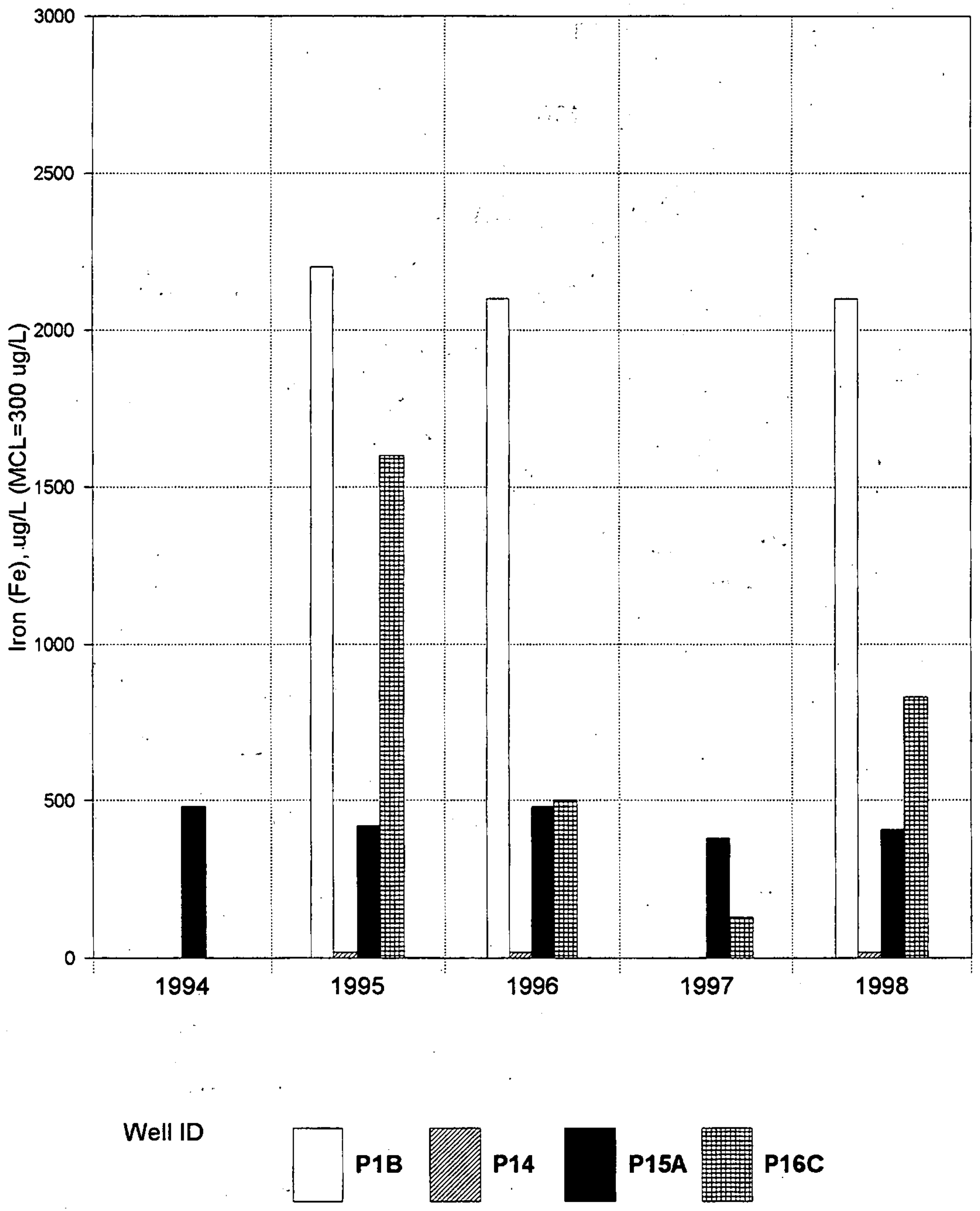
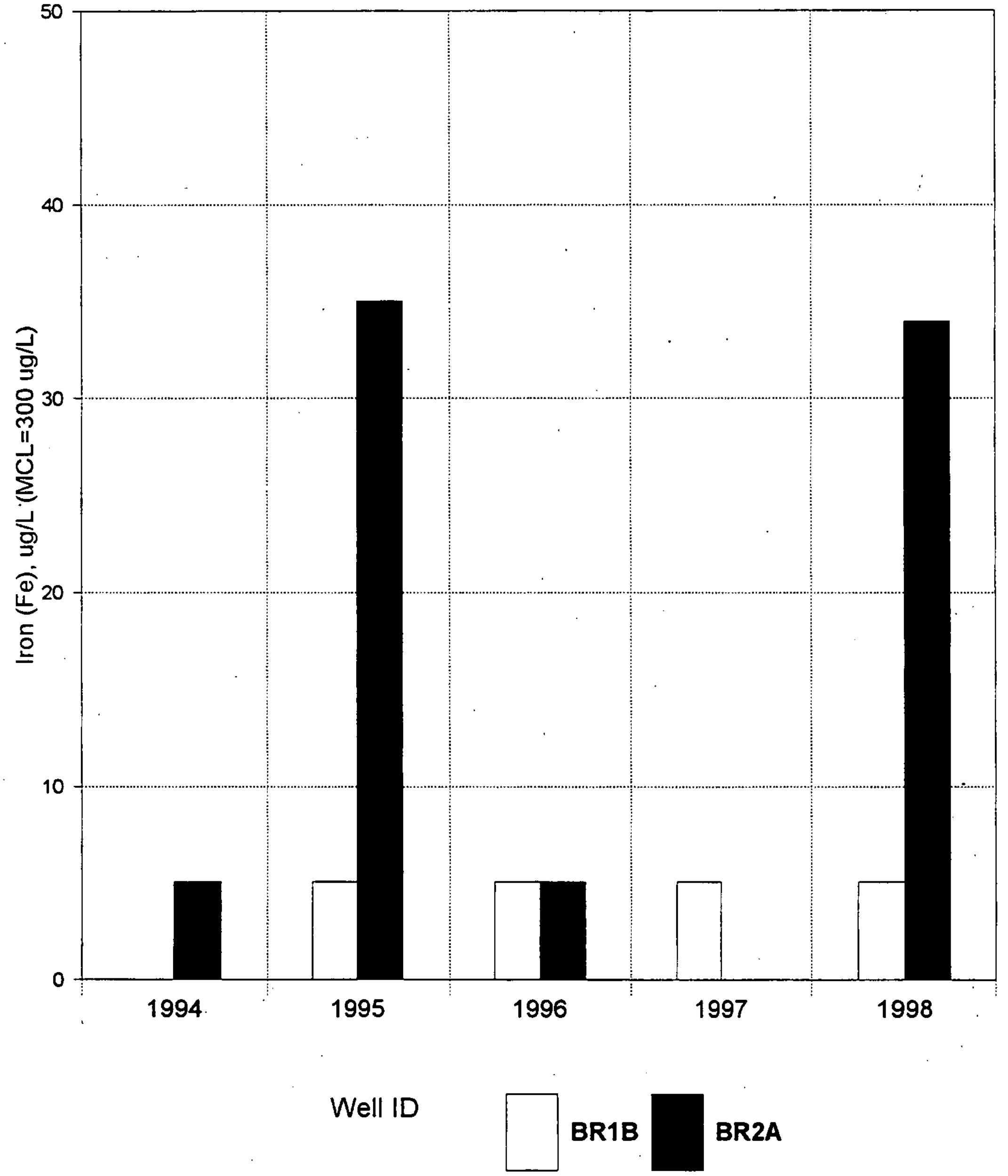


Figure 3-21. - Water Quality for Selected Wells and Springs in the Piedmont/Blue Ridge Unconfined Aquifers.



Iron levels below the detection limit are assigned a value of 17.9 ppb. A missing bar indicates that samples were not collected for that year.

Figure 3-22. - Iron Concentrations for Selected Wells in the Piedmont/Blue Ridge Unconfined Aquifer System: Piedmont Sector.



Iron levels below the detection limit are assigned a value of 5.1 ppb. A missing bar indicates that samples were not collected for that year.

Figure 3-23. - Iron Concentrations for Selected Wells in the Piedmont/Blue Ridge Unconfined Aquifer System: Blue Ridge Sector.

All samples were tested for nitrate/nitrite and contained concentrations below the primary MCL (10 ppm as N). Figures 3-24 and 3-25 show nitrite/nitrate concentrations in selected stations from the Piedmont and Blue Ridge sectors, respectively.

Samples from ten stations were tested for VOCs. A trace of tetrachloroethylene was detected in the sample from well GWN-P15A. No other samples contained any synthetic or volatile organic compounds. An analytical summary for the Piedmont/Blue Ridge sampling stations is in Appendix Table A-9.

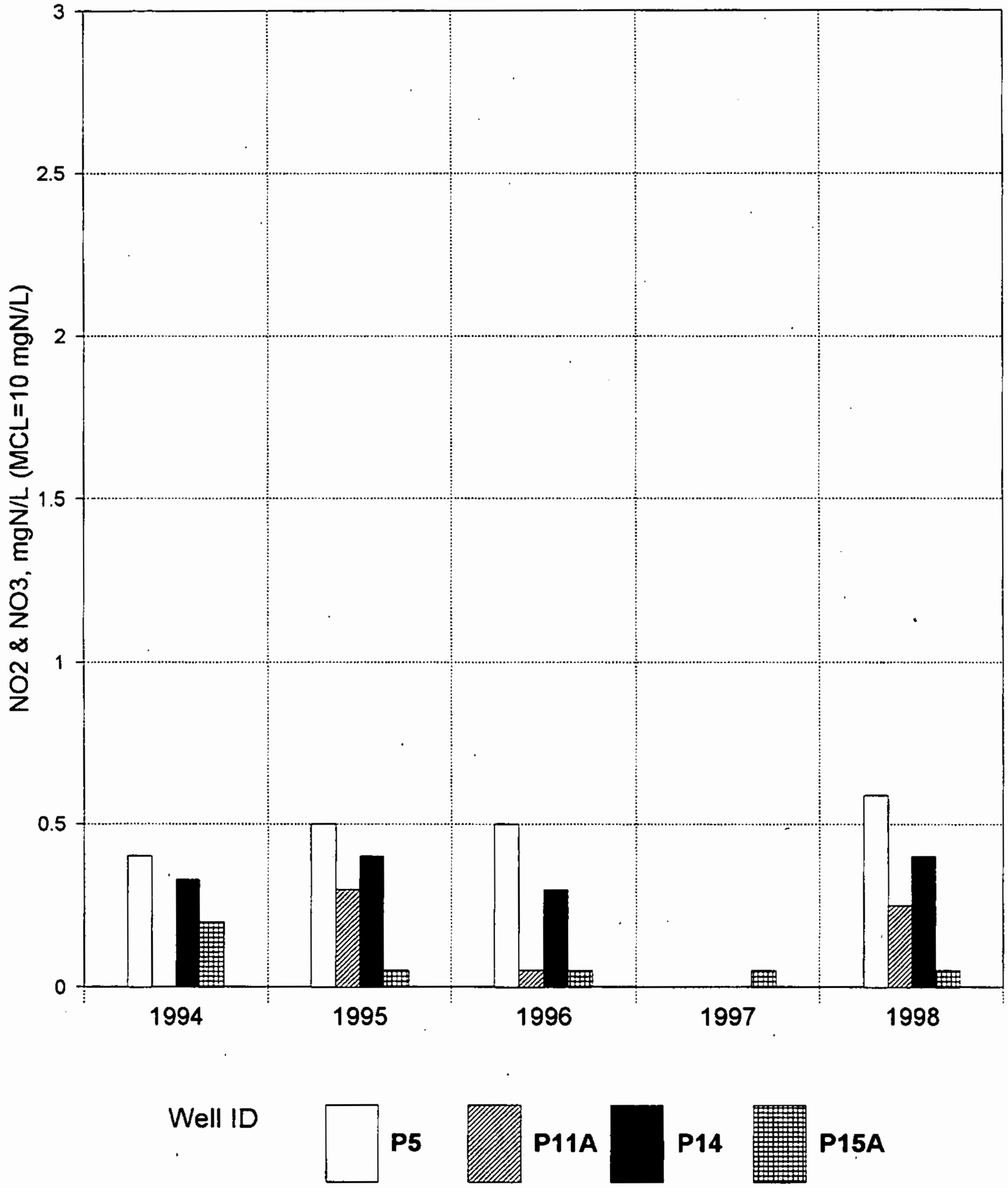
3.10 VALLEY AND RIDGE UNCONFINED AQUIFERS

Soil and residuum form low-yield unconfined aquifers across most of the Valley and Ridge Province of northwestern Georgia. Valley bottoms underlain by dolostones and limestones of the Cambro-Ordovician Knox Group are the locations of most higher-yielding wells and springs that are suitable for municipal supplies.

Two wells and two springs were used to monitor the water quality in the Valley and Ridge unconfined aquifers (Figure 3-26). One of the wells (GWN-VR5) and both springs produced water from Knox Group carbonates. The other well (GWN-VR4) is representative of water from the Ordovician Chickamauga Group. Water from these samples ranged in pH from 7.15 to 8.04.

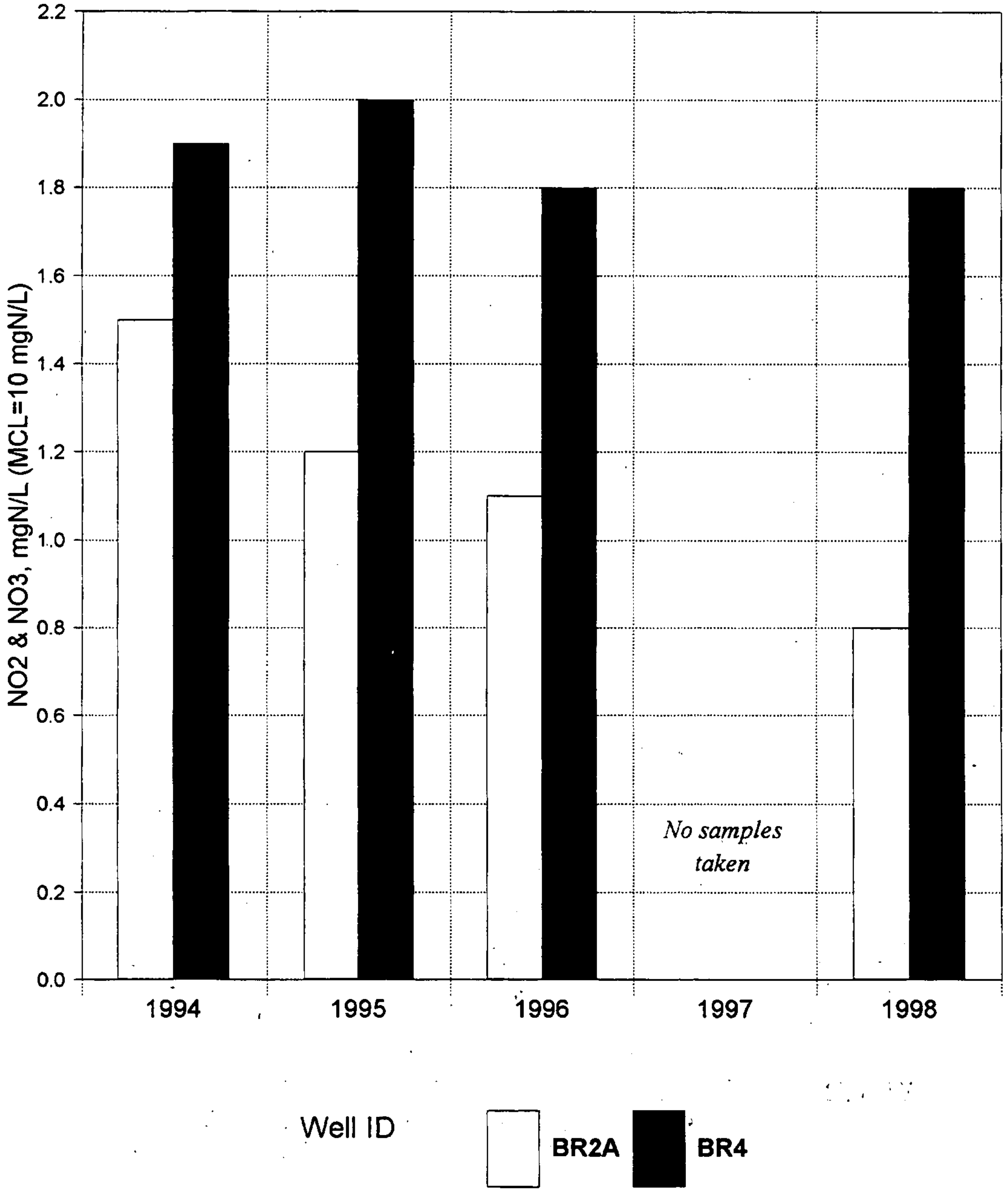
Samples from all four stations were tested for metals, chloride, fluoride, bromide, and sulfate. Hardness ranged from hard to very hard. One station (GWN-VR4) yielded a sample containing detectable iron and manganese at concentrations greater than the secondary MCLs. Calcium, ranging from 29 ppm to 76 ppm, and magnesium, ranging from 3.9 ppm to 18 ppm, occurred in samples from all stations. Sodium, strontium, barium, aluminum, chloride and sulfate were also detected.

All samples were analyzed for nitrate/nitrite and for VOCs. Nitrate/nitrite ranged from undetected to 3.2 ppm as nitrogen. No VOCs were detected. Figures 3-27 and 3-28 show iron and nitrite/nitrate levels, respectively, for selected sampling stations in the Valley and Ridge aquifers. Appendix Table A-10 presents the analytical summary for the wells and springs located in the Valley and Ridge unconfined aquifers.



Nitrate/nitrite levels below the detection limit are assigned a value of 0.05 ppm. A missing bar indicates that samples were not collected for that year.

Figure 3-24. - Nitrate/Nitrite Concentrations for Selected Wells in the Piedmont/Blue Ridge Unconfined Aquifer System: Piedmont Sector.



A missing bar indicates that samples were not collected for that year.

Figure 3-25. - Nitrate/Nitrite Concentrations for Selected Wells in the Piedmont/Blue Ridge Unconfined Aquifer System: Blue Ridge Sector.

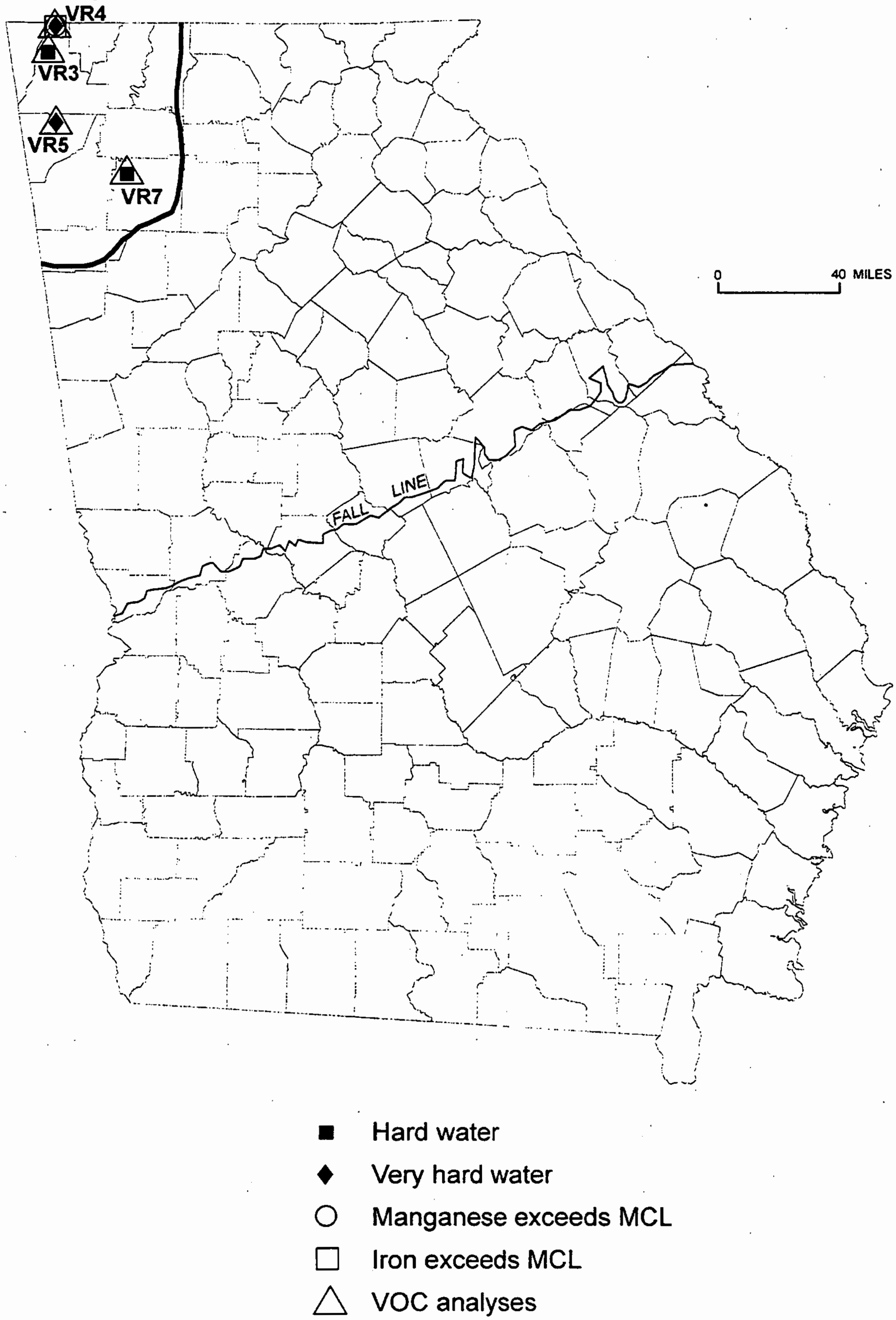
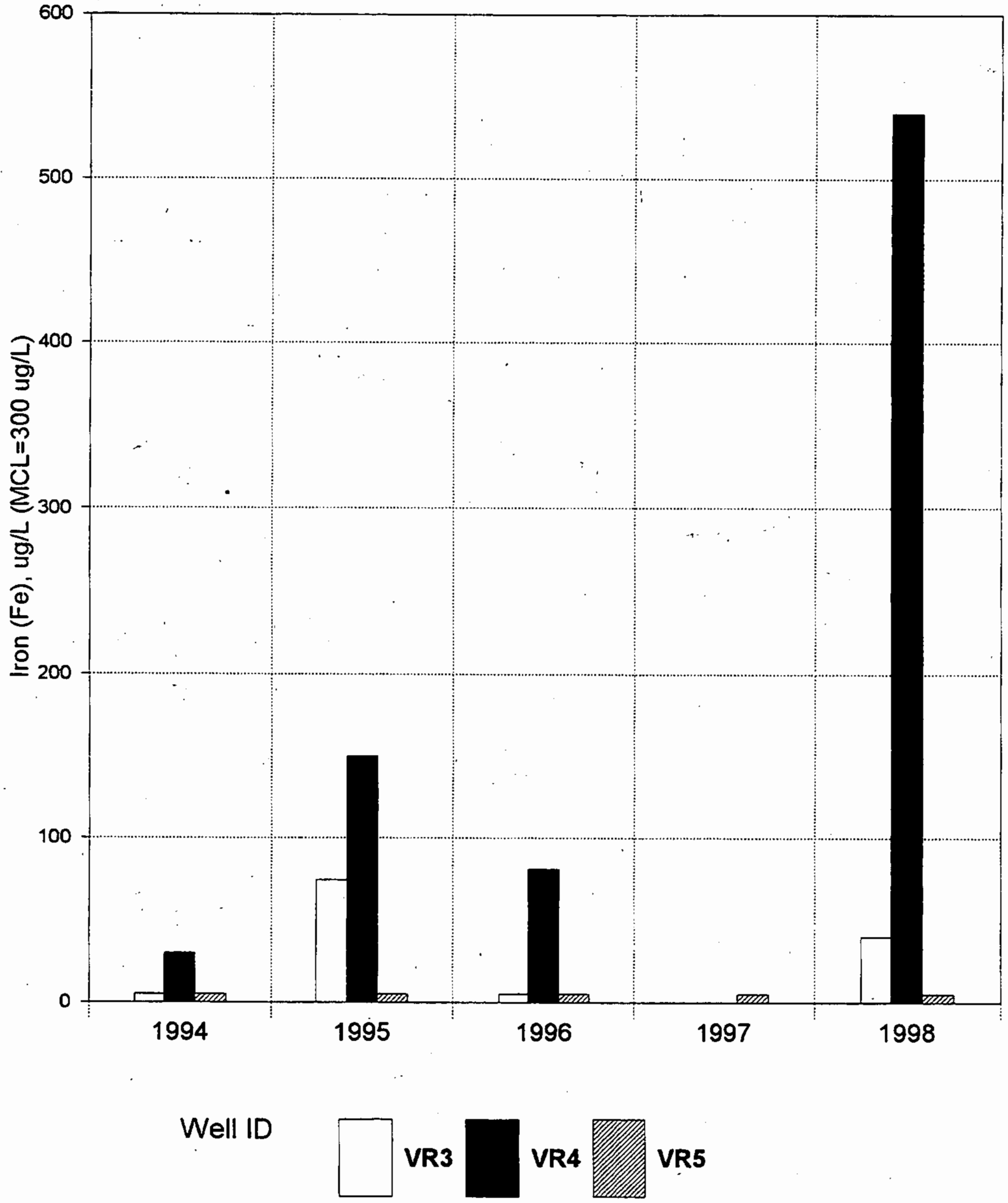
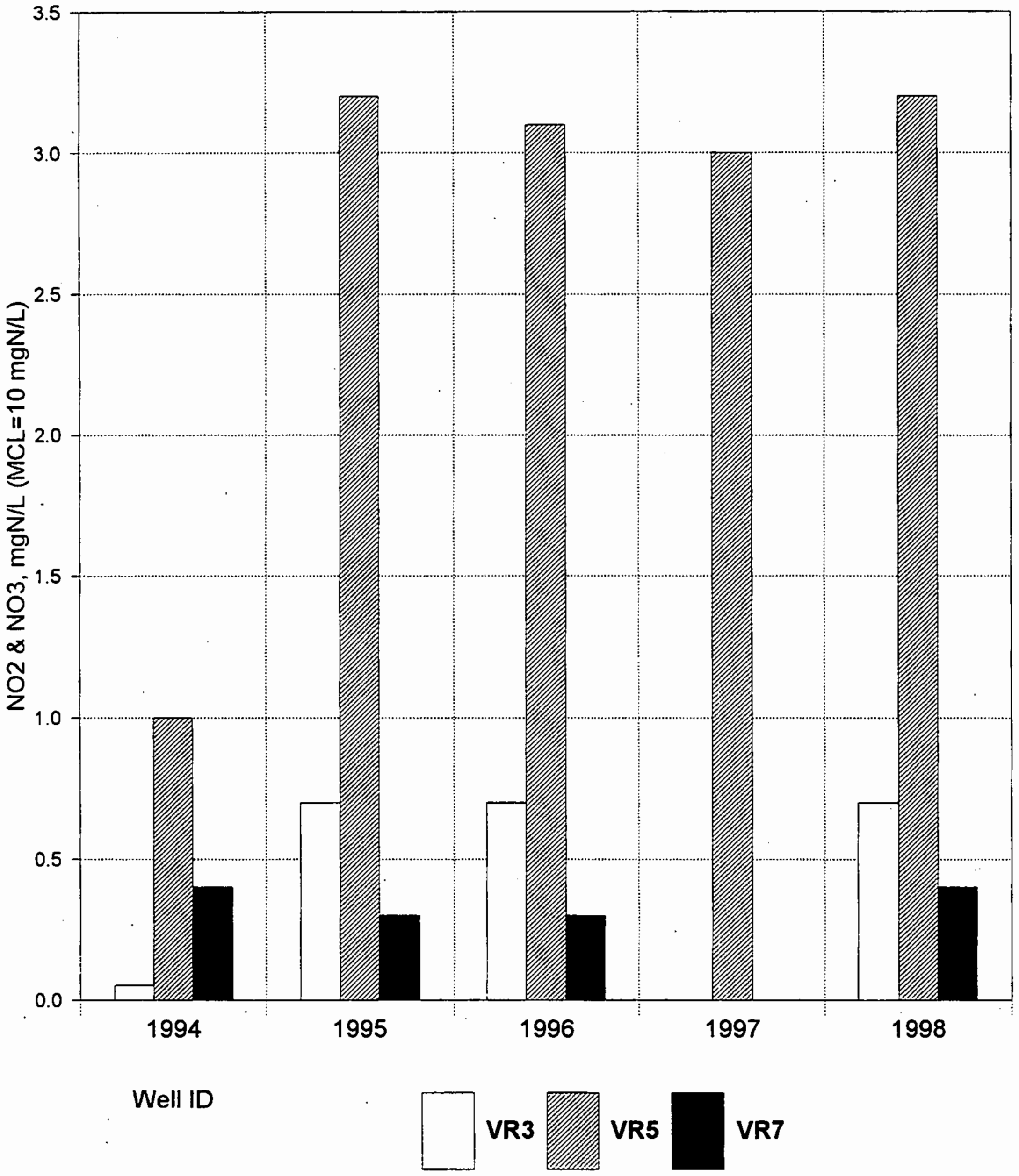


Figure 3-26. - Water Quality of Selected Wells and Springs in the Valley and Ridge Unconfined Aquifers.



Iron levels below the detection limit are assigned a value of 5.1 ppb. A missing bar indicates that samples were not collected for that year.

Figure 3-27. - Iron Concentrations for Selected Wells and Springs in the Valley and Ridge Unconfined Aquifers.



Nitrate/nitrite levels below the detection limit are assigned a value of 0.05 ppm. A missing bar indicates that samples were not collected for that year.

Figure 3-28. - Nitrate/Nitrite Concentrations for Selected Wells and Springs in the Valley and Ridge Unconfined Aquifers.

4.0 SUMMARY AND CONCLUSIONS

EPD personnel collected 79 raw water samples from 73 wells and five springs on the Ground-Water Monitoring Network during calendar year 1998 for inorganic and organic analysis. These wells and springs monitor the water quality of nine aquifer systems in Georgia:

- Cretaceous aquifer system
- Providence aquifer system
- Clayton aquifer system
- Claiborne aquifer system
- Jacksonian aquifer system
- Floridan aquifer system
- Miocene aquifer system
- Piedmont/Blue Ridge unconfined aquifers
- Valley and Ridge unconfined aquifers

Comparisons of analyses of water samples collected during calendar year 1998 were made with analyses for the Ground-Water Monitoring Network dating back to 1984, permitting the recognition of temporal trends. Table 4-1 lists the major contaminants and pollutants detected at the stations of the Ground-Water Monitoring Network during 1998. Although isolated water quality problems existed at specific localities, the quality of water from most of the Ground-Water Monitoring Network stations remains excellent.

Nitrate/nitrite are the most common substances present in ground water in Georgia that can have adverse health effects. Two wells (GWN-MI9A and GWN-MI15), both shallow domestic wells tapping the Miocene aquifer system and located adjacent to row crop fields, yielded water samples with nitrite/nitrate concentrations exceeding the primary MCL of 10 ppm as nitrogen (Table 4-1). (The owners of these wells received notification about the excess nitrate/nitrite, and all well owners receive copies of the analytical results.) Samples from three other wells (GWN-CT7A, GWN-J8, and GWN-MI7) also had nitrate/nitrite levels that were elevated though not greater than the primary MCL. All three are shallow domestic-type wells, with two being located near row crop fields and the third located near a livestock enclosure.

Spatial and temporal limitations of the Ground-Water Monitoring Network preclude the identification of the exact sources of the increasing levels of nitrogen compounds in some of Georgia's ground water. Nitrite/nitrate originates in ground water from direct sources and through oxidation of other forms of dissolved nitrogen, deriving from both natural and manmade sources. The most common sources of manmade dissolved nitrogen in Georgia usually consist of septic systems, agricultural wastes, and storage or application of fertilizers (Robertson, et. al., 1993). Dissolved nitrogen also is present in rainwater and can be derived from terrestrial vegetation and volatilization of fertilizers (Drever, 1988). The conversion of other nitrogen species to nitrate occurs in aerobic environments such as recharge areas. Anaerobic conditions in ground water, which commonly develop along the flow path of

Table 4-1. Pollution and Contamination Incidents, Calendar Year 1998.

Station	**Contaminant/ Pollutant**	**Primary MCL**	**Secondary MCL**
GWN-K2A	benzene=1.6ppb MTBE=37ppb	benzene=5ppb	
GWN-K9	Fe=430ppb Al=330ppb		Fe=300ppb Al=200ppb
GWN-CL4	benzene=13ppb	benzene=5ppb	
GWN-CL9	benzene=1.3ppb MTBE=37ppb	benzene=5ppb	
GWN-J3	Mn=130ppb		Mn=50ppb
GWN-J8	Be=6.6ppb	Be=4ppb	
GWN-PA33A	$CHCl_3$=tr.	trihalomethanes=100ppb	
GWN-MI9A	NO_x=11ppm as N benzene=8.8ppb toluene=1.3ppb MTBE=61ppb	NO_x=10ppm as N benzene=5ppb toluene=1000ppb	
GWN-MI10B	benzene=7.8ppb toluene=1.4ppb ethylbenzene=1.3 MTBE=51ppb	benzene=5ppb toluene=1000ppb ethylbenzene=700ppb	
GWN-MI15	NO_x=15ppm asN	NO_x=10ppm as N	
GWN-P1B	Fe=2100ppb Mn=60ppb		Fe=300ppb Mn=50ppb
GWN-P6A	Mn=100ppb		Mn=50ppb
GWN-P12A	F=4.6ppm	F=4ppm	
GWN-P15A	Fe=410ppb Mn=91ppb C_2Cl_4=tr.	C_2Cl_4=5ppb	Fe=300ppb Mn=50ppb
GWN-P16C	Fe=830ppb Mn=59ppb		Fe=300ppb Mn=50ppb
GWN-P18	Mn=61ppb		Mn=50ppb

Notes:

tr. = trace; see Appendix
NO_x = Nitrate/Nitrite

Table 4-1 (continued). Pollution and Contamination Incidents, Calendar Year 1998.

Station	**Contaminant/ Pollutant**	**Primary MCL**	**Secondary MCL**
GWN-VR4	Fe=540ppb Mn=110ppb		Fe=300ppb Mn=50ppb

ground water, foster the denitrification process. However, the lack of denitrifying bacteria in ground water may inhibit this process (Freeze and Cherry, 1979).

Volatile organic compounds were detected in samples from seven wells. MTBE was detected in samples from four wells, and benzene was reported in samples from five wells. For four of the wells, no readily available source for the pollutants was apparent. Subsequent sampling at two of the four wells (GWN-K2A and GWN-MI10B) found no VOCs. The presence of benzene in the sample from well GWN-CL4 is not unreasonable as this well has had a history of pollution by motor fuel components. Benzene in excess of the primary MCL has been found in samples from this well before (the well has been removed from service and is scheduled for abandonment). Two instances (GWN-PA33A and GWN-P15A) of slight pollution by chlorinated organic compounds occurred. Both stations are located in urban settings. The occurrence at station GWN-PA33A, a public supply well, probably resulted when treated water leaked back into the well and the chlorine in it reacted with naturally-occurring dissolved organic matter.

Beryllium exceeded the primary MCL in the sample from well GWN-J8, and fluoride exceeded the primary MCL in the sample from spring GWN-P12A. Well GWN-J8 is a domestic water well located in the Coastal Plain, which has intermittently yielded samples with excessive beryllium in the past. Spring GWN-P12A is located on the Piedmont and has always given samples containing excessive fluoride. A sign placed near the spring advises against consuming the water. The sources of the beryllium and the fluoride are both almost certainly natural.

Iron, manganese and aluminum are the three naturally occurring substances responsible for the greatest incidence of ground-water quality problems in Georgia (Table 4-1). Although minor increases or decreases in iron, manganese, and aluminum occurred at some stations, no long-term trends in concentrations of these metals were documented for most of the wells and springs sampled.

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APPENDIX

Laboratory Data

LABORATORY DATA

All water quality samples that were collected for the Georgia Ground-Water Monitoring Network prior to October 1, 1998 were subjected to a standard analysis that included tests for pH, conductivity, certain inorganic anions, and thirty metals (Table A-1). Analyses for additional parameters had been included for samples collected from areas where the possibility of ground-water pollution exists due to regional activities. These optional tests consisted of those for mercury, agricultural chemicals, and volatile organic compounds (Table A-2). In previous editions of Circular 12, the metals analyses and the various organic chemical analyses were referred to as screens.

After October 1, 1998, testing for nitrate/nitrite and for volatile organic compounds (VOC s) became the standard testing regimen. Tests for metals, anions (other than nitrate and/or nitrite), and other substances were discontinued unless primary MCL exceedances were involved. The VOC testing procedure at the EPD laboratory also changed from EPA method 8260 to EPA method 8020. Accompanying this change was a lowering of detection limits and a restriction of analytes to the BTEX compounds and MTBE. By late November 1998, upgrades in equipment and a change in the VOC testing procedure from EPA method 8020 to EPA method 524.2 further reduced detection limits and considerably expanded the number of analytes.

EPA has set forth a series of (serially numbered) analytical methods officially recognized as suitable for environmental purposes. The EPD laboratory cite EPA method numbers along with analysis results, and Tables A-1 and A-2 list the method numbers appropriate to the various analytes. Regarding analyses for carbamate and urea-derivative pesticides, the EPD laboratory became capable of using EPA method 8321M early in calendar year 1998. This method does not give acceptable results for the carbamate pesticide aldicarb and its oxidation products.

Tables A-3 through A-11 regularly list results for the following parameters: pH, conductivity, four of the major anions and nine of the metals. Other parameters are listed in these tables only if they were detected. The conductivity measurements in these tables are all field-measured if taken after September 30, 1998.

For this appendix, the following abbreviations are used:

AAS = atomic absorption spectrophotometry
SU = standard units
mg/L = milligrams per liter (parts per million)
mg/L as N = milligrams per liter (parts per million), as nitrogen
ug/L = micrograms per liter (parts per billion)
ICPOES = ion coupled plasma optical emission spectroscopy
umho/cm = micromhos per centimeter
ND = not detected
tr. = trace (an indication of a low concentration below the Practical Quantitation Limit [PQL])

a = EPA method 8141 (organophosphorus pesticides)
b = EPA methods 8081(organochlorine pesticides and PCBs)
c = EPA methods 8015 (chlorinated+acid-phenoxy herbicides)
d = EPA method 8321M (urea-derivative and certain carbamate pesticides)
v = volatile organic compounds (EPA method number follows in parentheses)
X = laboratory-measured conductivity
-- =not analyzed

Note:

The detection limit for the same substance can vary among different laboratories and can vary for a single laboratory if a sample is diluted to lower the concentration of interfering substances, or if the array of standards used to develop the detection limit is revised.

Table A-1. Standard Water Quality Analyses: ICPOES Metals, AAS Metals, Anions, and Other Parameters.

ICPOES METALS TEST

Parameter	Test Method	Practical Quantitation Limit	Max.Contaminant Level
Silver (Ag)	EPA 200.7	30 ug/L	100 ug/L_2
Aluminum (Al)	EPA 200.7	50 ug/L	200 ug/L_2
Gold (Au)	EPA 200.7	10 ug/L	None
Barium (Ba)	EPA 200.7	10 ug/L	2000 ug/L_1
Bismuth (Bi)	EPA 200.7	30 ug/L	None
Calcium (Ca)	EPA 200.7	1.0 mg/L	None
Cobalt (Co)	EPA 200.7	10 ug/L	None
Chromium (Cr)	EPA 200.7	20 ug/L	100 ug/L_1
Copper (Cu)	EPA 200.7	20 ug/L	1000 ug/L_2
Iron (Fe)	EPA 200.7	20 ug/L	300 ug/L_2
Potassium (K)	EPA 200.7	5.0 mg/L	None
Magnesium (Mg)	EPA 200.7	1.0 mg/L	None
Manganese (Mn)	EPA 200.7	10 ug/L	50 ug/L_2
Molybdenum (Mo)	EPA 200.7	10 ug/L	None
Sodium (Na)	EPA 200.7	1.0 mg/L	None
Nickel (Ni)	EPA 200.7	20 ug/L	100 ug/L_1
Lead (Pb)	EPA 200.7	50 ug/L	None
Tin (Sn)	EPA 200.7	75 ug/L	None
Strontium (Sr)	EPA 200.7	10 ug/L	None
Titanium (Ti)	EPA 200.7	10 ug/L	None
Vanadium (V)	EPA 200.7	10 ug/L	None
Yttrium (Y)	EPA 200.7	10 ug/L	None
Zinc (Zn)	EPA 200.7	20 ug/L	5000 ug/L_2

ICPOES METALS TEST (continued)

Parameter	**Test Method**	**Practical Quantitation Limit**	**Max.Contaminant Level**
Zirconium (Zr)	EPA 200.7	10 ug/L	None

AAS METALS TESTS

Parameter	**Test Method**	**Practical Quantitation Limit**	**Max.Contaminant Level**
Arsenic (As)	EPA 206.2	25 ug/L	50 ug/L$_1$
Beryllium (Be)	EPA 210.2	2 ug/L	4 ug/L$_1$
Cadmium (Cd)	EPA 213.2	0.7 ug/L	5 ug/L$_1$
Antimony (Sb)	EPA 204.2	3 ug/L	6 ug/L$_1$
Selenium (Se)	EPA 270.2	5 ug/L	50 ug/L$_1$
Thallium (Tl)	EPA 279.2	1 ug/L	2 ug/L$_1$

ANIONS TESTS

Parameter	**Test Method**	**Method Detection Limit**	**Max.Contaminant Level**
Bromide (Br$^-$)	EPA 300.0	0.1 mg/L	None
Chloride (Cl$^-$)	EPA 300.0	0.1 mg/L	250 mg/L$_2$
Sulfate (SO$_4^=$)	EPA 300.0	2.0 mg/L	250 mg/L$_2$
Nitrate/Nitrite (NO$_x^-$)	EPA 353.2	0.2 mg/L as N 0.02mg/L as N after Sep. 30, 1998	10 mg/L as N$_1$
Fluoride (F$^-$)	EPA 300.0	0.1 mg/L	4.0 mg/L$_1$, 2.0 mg/L$_2$

OTHER PARAMETERS*		
Parameter	**Units**	**Maximum Contaminant Level**
pH	0.01 SU	None
Conductivity	1.0 umho/cm	None

Notes:

Detection limits for analyses are Practical Quantitation Limits (PQLs) except for Anions Tests, for which Method Detection Limits (MDLs) are used.

MCL's from Georgia Rules for Safe Drinking Water, October 1997 edition (EPD, 1997):

$_1$=Primary Maximum Contaminant Level (MCL).

$_2$=Secondary MCL.

*pH is measured in the field (see Chapter 2). Before Oct. 1, 1998, conductivity was typically measured in the laboratory according to Standard Methods of Water Quality Analysis method 2510B. (Franson, ed., 1995). After that date, it was measured in the field.

Table A-2. Additional Water Quality Analyses: Organophosphorus Pesticides, Organochlorine Pesticides/PCB's, Phenoxy Herbicides, Carbamate/Urea-Derived Pesticides, Volatile Organic Compounds, and Mercury.

ORGANOPHOSPHORUS PESTICIDES			
Parameter	**Test Method**	**Practical Quantitation Limit**	**Primary Maximum Contaminant Level**
Alachlor	EPA 8141 EPA 507	1.0 ug/L 2.0 ug/L	2.0 ug/L
Ametrin	EPA 507	0.3 ug/L	None
Atraton	EPA 507	0.2 ug/L	None
Atrazine	EPA 8141 EPA 507	0.3 ug/L 3.0 ug/L	3.0 ug/L
Azodrin	EPA 8141	1.0 ug/L	None
Bromacil	EPA 507	0.6 ug/L	None
Butachlor	EPA 507	0.5 ug/L	None
Chlorpropham	EPA 507	0.5 ug/L	None
Chlorpyrifos	EPA 8141	0.8 ug/L	None
Cyanazine	EPA 8141	1.0 ug/L	None
Cycloate	EPA 507	1.0 ug/L	None
Dacthal	EPA 8141	0.1 ug/L	None
Dasanit	EPA 8141	0.6 ug/L	None
Demeton-O	EPA 8141	1.0 ug/L	None
Diazinon	EPA 8141 EPA 507	1.0 ug/L 1.0 ug/L	None
Dichlorvos	EPA 507	1.0 ug/L	None
Dimethoate	EPA 8141	0.5 ug/L	None
Disyston	EPA 8141 EPA 507	1.0 ug/L 1.0 ug/L	None
Disyston sulfone	EPA 507	1.0 ug/L	None
Disyston sulfoxide	EPA 507	1.0 ug/L	None

ORGANOPHOSPHORUS PESTICIDES (continued)			
Parameter	**Type of Test**	**Practical Quantitation Limit**	**Primary Maximum Contaminant Level**
Eptam	EPA 8141 EPA 507	0.5 ug/L 0.5 ug/L	None
Ethoprop	EPA 8141 EPA 507	0.5 ug/L 0.5 ug/L	None
Fenamiphos	EPA 507	1.0 ug/L	None
Fenarimol	EPA 507	1.0 ug/L	None
Fonophos	EPA 8141	0.5 ug/L	None
Fluridone	EPA 507	1.0 ug/L	None
Guthion	EPA 8141	2.0 ug/L	None
Hexazinone	EPA 507	1.0 ug/L	None
Isopropalin	EPA 8141	1.0 ug/L	None
Malathion	EPA 8141	1.4 ug/L	None
Merphos	EPA 507	1.0 ug/L	None
Metolachlor	EPA 8141 EPA 507	1.0 ug/L 1.0 ug/L	None
Metribuzin	EPA 8141 EPA 507	1.25 ug/L 1.13 ug/L	None
Mevinphos	EPA 8141 EPA 507	1.4 ug/L 1.0 ug/L	None
MGK264	EPA 507	1.0 ug/L	None
Molinate	EPA 507	1.0 ug/L	None
Methyl Paraoxon	EPA 507	1.0 ug/L	None
Napropamide	EPA 507	0.1 ug/L	None
Norflurazon	EPA 507	0.1 ug/L	None
Parathion	EPA 8141	0.1 ug/L	None
Methyl Parathion	EPA 8141	0.1 ug/L	None
Pendimethalin	EPA 8141	0.8 ug/L	None

ORGANOPHOSPHORUS PESTICIDES (continued)			
Parameter	**Type of Test**	**Practical Quantitation Limit**	**Primary Maximum Contaminant Level**
Pebulate	EPA 8141 EPA 507	0.6 ug/L 0.5 ug/L	None
Phorate	EPA 8141	1.0 ug/L	None
Profluralin	EPA 8141	0.9 ug/L	None
Prometon	EPA 507	1.0 ug/L	None
Prometryn	EPA 507	1.0 ug/L	None
Pronamide	EPA 507	0.5 ug/L	None
Propazine	EPA 507	1.0 ug/L	None
Simazine	EPA 8141 EPA 507	0.9 ug/L 1.0 ug/L	4.0 ug/L
Simetryn	EPA 507	1.0 ug/L	None
Stirophos	EPA 507	1.0 ug/L	None
Sutan	EPA 8141 EPA 507	0.7 ug/L 0.4 ug/L	None
Tebuthiuron	EPA 507	0.1 ug/L	None
Terbacil	EPA 507	0.2 ug/L	None
Terbufos	EPA 8141 EPA 507	3.0 ug/L 1.0 ug/L	None
Terbutryn	EPA 507	1.0 ug/L	None
Triademefon	EPA 507	0.2 ug/L	None
Tricyclazole	EPA 507	0.6 ug/L	None
Trifluralin	EPA 8141	1.0 ug/L	None
Vernam	EPA 8141 EPA 507	0.5 ug/L 1.0 ug/L	None

ORGANOCHLORINE PESTICIDES/PCB'S			
Parameter	**Type of Test**	**Practical Quantitation Limit**	**Primary Maximum Contaminant Level**
4,4-DDD	EPA 508.1	1 ug/L	None
4,4-DDE	EPA 508.1	1 ug/L	None
4,4-DDT	EPA 508.1	1 ug/L	None
Alachlor	EPA 508.1	2 ug/L	None
Aldrin	EPA 508.1	1 ug/L	None
Atrazine	EPA 508.1	3 ug/L	3 ug/L
Chlorobenzilate	EPA 508.1	1 ug/L	None
Chloroneb	EPA 508.1	1 ug/L	None
Chlorothanionil	EPA 508.1	1 ug/L	None
Cyanazine	EPA 508.1	40 ug/L	None
Dacthal	EPA 508.1	0.01 ug/L	None
Dieldrin	EPA 508.1	1 ug/L	None
Dicofol	EPA8081	0.1 ug/L	None
Endosulfan I	EPA 508.1	1 ug/L	None
Endosulfan II	EPA 508.1	1 ug/L	None
Endosulfan Sulfate	EPA 508.1	1 ug/L	None
Endrin	EPA8081 EPA 508.1	0.03 ug/L 2 ug/L	2.0 ug/L
Endrin Aldehyde	EPA 508.1	1 ug/L	None
Etridiazole	EPA 508.1	1 ug/L	None
Heptachlor	EPA 508.1	0.4 ug/L	0.004 ug/L
Heptachlorepoxide	EPA 508.1	0.2 ug/L	0.002 ug/L
Hexachlorobenzene	EPA 508.1	1 ug/L	1.0 ug/L
Hexachlorocyclo-pentadiene	EPA 508.1	100 ug/L	50 ug/L

ORGANOCHLORINE PESTICIDES/PCB'S (continued)

Parameter	Type of Test	Practical Quantitation Limit	Primary Maximum Contaminant Level
Methoxychlor	EPA8081 EPA 508.1	0.3 ug/L 40 ug/L	40.0 ug/L
Metolachlor	EPA 508.1	1 ug/L	None
Metribuzin	EPA 508.1	1.13 ug/L	None
PCB 1016	EPA8081	0.5 ug/L	0.5 ug/L(total PCB's)
PCB 1221	EPA8081	0.5 ug/L	0.5 ug/L(total PCB's)
PCB 1232	EPA8081	0.5 ug/L	0.5 ug/L(total PCB's)
PCB 1242	EPA8081	0.5 ug/L	0.5 ug/L(total PCB's)
PCB 1248	EPA8081	0.5 ug/L	0.5 ug/L(total PCB's)
PCB 1254	EPA8081	0.5 ug/L	0.5 ug/L(total PCB's)
PCB 1260	EPA8081	0.5 ug/L	0.5 ug/L(total PCB's)
PCB 1262	EPA8081	0.5 ug/L	0.5 ug/L(total PCB's)
Permethrin	EPA8081	0.3 ug/L	None
Propachlor	EPA 508.1	1 ug/L	None
Simazine	EPA 508.1	1 ug/L	4.0 ug/L
Toxaphene	EPA8081	1.0 ug/L	3.0 ug/L
Trifluralin	EPA 508.1	1 ug/L	None
α-HCH	EPA 508.1	0.2 ug/L	None
β-HCH	EPA 508.1	0.2 ug/L	None
δ-HCH	EPA 508.1	0.2 ug/L	None
γ-HCH (Lindane)	EPA8081 EPA 508.1	0.01 ug/L 2 ug/L	0.2 ug/L
α-Chlordane	EPA 508.1	2 ug/L	2 ug/L (total α+γ)
γ-Chlordane	EPA 508.1	2 ug/L	2 ug/L (total α+γ)

ORGANOCHLORINE PESTICIDES/PCB'S (continued)			
Parameter	**Type of Test**	**Practical Quantitation Limit**	**Primary Maximum Contaminant Level**
cis-Permethrin	EPA 508.1	0.1 ug/L	None
trans-Permethrin	EPA 508.1	0.1 ug/L	None

PHENOXY HERBICIDES			
Parameter	**Type of Test**	**Practical Quantitation Limit**	**Primary Maximum Contaminant Level**
2,4-D	EPA 8015 EPA 515.2	5.0 ug/L 70 ug/L	70.0 ug/L
2,4-DB	EPA 515.2	1.9 ug/L	None
2,4,5-T	EPA 515.2	0.11 ug/L	None
3,5-Dichlorobenzoic Acid	EPA 515.2	1.0 ug/L	None
Acifluorfen	EPA 8015 EPA 515.2	1.0 ug/L 1.0 ug/L	None
Bentazon	EPA 515.2	1.9 ug/L	None
Chloramben	EPA 8015	0.2 ug/L	None
Dacthal	EPA 515.2	0.01 ug/L	None
Dicamba	EPA 515.2	0.2 ug/L	None
5-hydroxy-Dicamba	EPA 515.2	1 ug/L	None
Dichloroprop	EPA 515.2	1.0 ug/L	None
Dinoseb	EPA 8015 EPA 515.2	0.1 ug/L 0.1 ug/L	7 ug/L
Pentachlorophenol	EPA 515.2	1 ug/L	1.0 ug/L
Picloram	EPA 515.2	500 ug/L	500 ug/L
Silvex	EPA 8015 EPA 515.2	0.1 ug/L 50 ug/L	50.0 ug/L
Trichlorfon	EPA 8015	2.0 ug/L	None

CARBAMATE/UREA-DERIVATIVE PESTICIDES

Parameter	Type of Test	Practical Quantitation Limit	Primary Maximum Contaminant Level
Carbaryl	EPA 8321M	10 ug/L	None
Carbofuran	EPA 8321M	2.0 ug/L	40.0 ug/L
Diuron	EPA 8321M	1.0 ug/L	None
Fluometron	EPA 8321M	1.0 ug/L	None
Linuron	EPA 8321M	1.0 ug/L	None
Methomyl	EPA 8321M	3.0 ug/L	None
Monuron	EPA 8321M	1.0 ug/L	None

VOLATILE ORGANIC COMPOUNDS

Parameter	Type of Test	Practical Quantitation Limit	Primary Maximum Contaminant Level
1,1,1,2-Tetra-chloroethane	EPA 8260 EPA 524.2	5.0 ug/L 0.5 ug/L	None
1,1,1-Trichloro-ethane	EPA 8260 EPA 524.2	5.0 ug/L 0.5 ug/L	200 ug/L
1,1,2,2,-Tetra-chloroethane	EPA 8260 EPA 524.2	5.0 ug/L 0.5 ug/L	None
1,1,2-Trichloroethane	EPA 8260 EPA 524.2	5.0 ug/L 0.5 ug/L	5.0 ug/L
1,1-Dichloroethane	EPA 8260 EPA 524.2	5.0 ug/L 0.5 ug/L	None
1,1-Dichloro-ethylene	EPA 8260 EPA 524.2	5.0 ug/L 0.5 ug/L	7.0 ug/L
1,1-Dichloro-propylene	EPA 8260 EPA 524.2	5.0 ug/L 0.5 ug/L	None
1,2,3-Trichlorobenzene	EPA 8260 EPA 524.2	5.0 ug/L 0.5 ug/L	None
1,2,3-Trichloro-propane	EPA 8260 EPA 524.2	5.0 ug/L 0.5 ug/L	None

VOLATILE ORGANIC COMPOUNDS (continued)			
Parameter	**Type of Test**	**Practical Quantitation Limit**	**Primary Maximum Contaminant Level**
1,3,5-Trimethylbenzene	EPA 8260 EPA 524.2	5.0 ug/L 0.5 ug/L	None
1,2,4-Trichlorobenzene	EPA 8260 EPA 524.2	5.0 ug/L 0.5 ug/L	70.0 ug/L
1,2,4-Trimethylbenzene	EPA 8260 EPA 524.2	5.0 ug/L 0.5 ug/L	None
1,2-Dibromo-3-Chloropropane	EPA 8260 EPA 524.2	5.0 ug/L 0.5 ug/L	0.2 ug/L
1,2-Dichloroethane	EPA 8260 EPA 524.2	5.0 ug/L 0.5 ug/L	5.0 ug/L
1,2-Dichloropropane	EPA 8260 EPA 524.2	5.0 ug/L 0.5 ug/L	5.0 ug/L
1,2-Dibromoethane	EPA 8260 EPA 524.2	5.0 ug/L 0.5 ug/L	None
1,2-Dichlorobenzene (O)	EPA 8260 EPA 524.2	5.0 ug/L 0.5 ug/L	600 ug/L
1,3-Dichlorobenzene (M)	EPA 8260 EPA 524.2	5.0 ug/L 0.5 ug/L	None
1,4-Dichlorobenzene (P)	EPA 8260 EPA 524.2	5.0 ug/L 0.5 ug/L	75.0 ug/L
1,3-Dichloropropane	EPA 8260 EPA 524.2	5.0 ug/L 0.5 ug/L	None
2,2-Dichloropropane	EPA 8260 EPA 524.2	5.0 ug/L 0.5 ug/L	None
2-Chlorotoluene	EPA 8260 EPA 524.2	5.0 ug/L 0.5 ug/L	None
2-Chloroethyl Vinyl Ether	EPA 8260	5.0 ug/L	None
4-Chlorotoluene	EPA 8260 EPA 524.2	5.0 ug/L 0.5 ug/L	None
Acetone	EPA 8260	100 ug/L	None

VOLATILE ORGANIC COMPOUNDS (continued)

Parameter	Type of Test	Practical Quantitation Limit	Primary Maximum Contaminant Level
Benzene	EPA 8260 EPD 8020 EPA 524.2	5.0 ug/L 1.0 ug/L 0.5 ug/L	5.0 ug/L
Bromobenzene	EPA 8260 EPA 524.2	5.0 ug/L 0.5 ug/L	None
Bromochloromethane	EPA 8260 EPA 524.2	5.0 ug/L 0.5 ug/L	None
Bromodichloromethane	EPA 8260 EPA 524.2	5.0 ug/L 0.5 ug/L	100 ug/L*
Bromoform	EPA 8260 EPA 524.2	5.0 ug/L 0.5 ug/L	100 ug/L*
Bromomethane	EPA 8260 EPA 524.2	10.0 ug/L 0.5 ug/L	None
Carbon Disulfide	EPA 8260	5.0 ug/L	None
Carbon Tetrachloride	EPA 8260 EPA 524.2	5.0 ug/L 0.5 ug/L	5.0 ug/L
Chlorobenzene	EPA 8260 EPA 524.2	5.0 ug/L 0.5 ug/L	100 ug/L
Chloroethane	EPA 8260 EPA 524.2	10.0 ug/L 0.5 ug/L	None
Chloroform	EPA 8260 EPA 524.2	5.0 ug/L 0.5 ug/L	100 ug/L*
Chloromethane	EPA 8260 EPA 524.2	10.0 ug/L 0.5 ug/L	None
Dibromochloromethane	EPA 8260 EPA 524.2	5.0 ug/L 0.5 ug/L	100 ug/L*
Dibromomethane	EPA 8260 EPA 524.2	5.0 ug/L 0.5 ug/L	None
Dichlorodifluoromethane	EPA 8260 EPA 524.2	5.0 ug/L 0.5 ug/L	None

VOLATILE ORGANIC COMPOUNDS (continued)			
Parameter	**Type of Test**	**Practical Quantitation Limit**	**Primary Maximum Contaminant Level**
Dichloromethane	EPA 8260 EPA 524.2	5.0 ug/L 0.5 ug/L	5.0 ug/L
Ethylbenzene	EPA 8260 EPA 8020 EPA 524.2	5.0 ug/L 1.0 ug/L 0.5 ug/L	700 ug/L
Hexachlorobutadiene	EPA 8260 EPA 524.2	5.0 ug/L 0.5 ug/L	None
Iodomethane	EPA 8260	5.0 ug/L	None
Isopropylbenzene	EPA 8260 EPA 524.2	5.0 ug/L 0.5 ug/L	None
Methyl Ethyl Ketone	EPA 8260	100 ug/L	None
Methyl Isobutyl Ketone	EPA 8260	50 ug/L	None
Methyl N-butyl Ketone	EPA 8260	50 ug/L	None
Methyl Tert-butyl Ether	EPA 8260 EPA 8020 EPA 524.2	None** 10 ug/L 0.5 ug/L	None
Naphthalene	EPA 8260 EPA 524.2	5.0 ug/L 0.5 ug/L	None
Styrene	EPA 8260 EPA 524.2	5.0 ug/L 0.5 ug/L	100 ug/L
Tetrachloroethylene	EPA 8260 EPA 524.2	5.0 ug/L 0.5 ug/L	5.0 ug/L
Toluene	EPA 8260 EPA 8020 EPA 524.2	5.0 ug/L 1.0 ug/L 0.5 ug/L	1000 ug/L
Trichloroethylene	EPA 8260 EPA 524.2	5.0 ug/L 0.5 ug/L	5.0 ug/L
Trichlorofluoromethane	EPA 8260 EPA 524.2	5.0 ug/L 0.5 ug/L	None

VOLATILE ORGANIC COMPOUNDS (continued)			
Parameter	**Type of Test**	**Practical Quantitation Limit**	**Primary Maximum Contaminant Level**
Vinyl Acetate	EPA 8260	50 ug/L	None
Vinyl Chloride	EPA 8260 EPA 524.2	2.0 ug/L 0.5 ug/L	2.0 ug/L
Cis-1,2-Dichloroethylene	EPA 8260 EPA 524.2	5.0 ug/L 0.5 ug/L	70.0 ug/L
Cis-1,3-Dichloropropylene	EPA 8260 EPA 524.2	5.0 ug/L 0.5 ug/L	None
N-Butylbenzene	EPA 8260 EPA 524.2	5.0 ug/L 0.5 ug/L	None
N-Propylbenzene	EPA 8260 EPA 524.2	5.0 ug/L 0.5 ug/L	None
O-Xylene,	EPA 8260 EPA 8020	5.0 ug/L 1.0 ug/L	10,000 ug/L (total o,p,m-xylenes)
P,M-Xylenes	EPA 8260 EPA 8020	5.0 ug/L 1.0 ug/L	10,000 ug/L (total o,p,m-xylenes)
Total Xylenes	EPA 524.2	0.5 ug/L	10,000 ug/L (total o,p,m-xylenes)
P-Isopropyltoluene	EPA 8260 EPA 524.2	5.0 ug/L 0.5 ug/L	None
Sec-Butylbenzene	EPA 8260 EPA 524.2	5.0 ug/L 0.5 ug/L	None
Tert-Butylbenzene	EPA 8260 EPA 524.2	5.0 ug/L 0.5 ug/L	None
Trans-1,2-Dichloroethylene	EPA 8260 EPA 524.2	5.0 ug/L 0.5 ug/L	100 ug/L
Trans-1,3-Dichloropropylene	EPA 8260 EPA 524.2	5.0 ug/L 0.5 ug/L	None

MERCURY			
Parameter	**Test Method**	**Practical Quantitation Limit**	**Primary Maximum Contaminant Level**
Mercury (Hg)	EPA 245.2	0.2 ug/L	2.0 ug/L

Notes:

Detection limits for analyses are Practical Quantitation Limits (PQLs) except for Anions Tests, for which Method Detection Limits (MDLs) are used.

MCL's from Georgia Rules for Safe Drinking Water, October 1997 edition (EPD, 1997).

* Indicates a trihalomethane compound. The primary MCL for total trihalomethanes is 100 ug/L.

** No actual Practical Quantitation Limit for compound. Concentration is estimated.

Table A-3. 1998 Ground-Water Quality Analyses of the Cretaceous Aquifer System.

PARAMETER		pH	Na	K	Ca	Mg	Sr	Ba	Fe	Mn	Al	Cl	F	SO4	Nitrate/ Nitrite	Conduc- tivity	Other Parameters	Other Tests
Well ID#	UNITS	SU	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	mg/L	mg/L	mgN/L	umho/cm	ug/L	
GWN-K2A		5.83	--	--	--	--	--	--	--	--	--	--	--	--	0.06	95	MTBE=37 benzene=1.6	v (8020)
	Well Name:		Irwinton #303															
	County:		Wilkinson															
	Date Sampled:		1998/10/28															
GWN-K5		4.99	--	--	--	--	--	--	--	--	--	--	--	--	1.00	20		v (524.2)
	Well Name:		Richmond County #101															
	County:		Richmond															
	Date Sampled:		1998/12/08															
GWN-K8		6.79	--	--	--	--	--	--	--	--	--	--	--	--	ND	240		v (524.2)
	Well Name:		Mohawk Carpet #3															
	County:		Laurens															
	Date Sampled:		1998/12/18															
GWN-K9		4.29	ND	ND	ND	ND	ND	ND	430	ND	330	1.7	ND	9.1	ND	53X		
	Well Name:		Marshallville #1															
	County:		Macon															
	Date Sampled:		1998/06/11															
GWN-K10A		4.87	--	--	--	--	--	--	--	--	--	--	--	--	0.4	17		v (524.2)
	Well Name:		Fort. Valley #5															
	County:		Peach															
	Date Sampled:		1998/11/18															
GWN-K12		4.13	--	--	--	--	--	--	--	--	--	--	--	--	ND	49		v (8020)
	Well Name:		Perry/Holiday Inn Well															
	County:		Houston															
	Date Sampled:		1998/11/18															
GWN-K13		8.93	46	ND	2.2	ND	38	ND	ND	ND	ND	8.9	0.3	7.4	ND	187X		
	Well Name:		Omaha #1															
	County:		Stewart															
	Date Sampled:		1998/06/25															
GWN-K16		5.36	--	--	--	--	--	--	--	--	--	--	--	--	0.7	27		v (8020)
	Well Name:		Tenneco Packaging North Well															
	County:		Bibb															
	Date Sampled:		1998/11/18															

Table A-3 (Continued). 1998 Ground-Water Quality Analyses of the Cretaceous Aquifer System.

PARAMETER		pH	Na	K	Ca	Mg	Sr	Ba	Fe	Mn	Al	Cl	F	SO4	Nitrate/ Nitrite	Conduc- tivity	Other Parameters Detected	Other Tests
Well ID#	UNITS	SU	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	mg/L	mg/L	mgN/L	umho/cm	ug/L	
GWN-K18A		4.72	1	ND	1.2	ND	ND	ND	39	ND	ND	1.8	ND	4.0	ND	22X		b,c v (8260)
	Well Name:	Buena Vista #6																
	County:	Marion																
	Date Sampled:	1998/06/25																
GWN-K19		5.01	1.2	ND	ND	ND	ND	ND	ND	ND	ND	1.8	ND	ND	ND	23X		b,c v (8260)
	Well Name:	Hephzibah Murphy St. Well																
	County:	Richmond																
	Date Sampled:	1998/09/23																

Table A-4. 1998 Ground-Water Quality Analyses of the Clayton Aquifer System.

PARAMETER		pH	Na	K	Ca	Mg	Sr	Ba	Fe	Mn	Al	Cl	F	SO4	Nitrate/ Nitrite	Conduc- tivity	Other Parameters	Other Tests
Well ID#	UNITS	SU	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	mg/L	mg/L	mgN/L	umho/cm	ug/L	
GWN-CT2A		7.75	--	--	--	--	--	--	--	--	--	--	--	--	ND	234		v (8020)
	Well Name:		Burton Thomas Residence Well															
	County:		Sumter															
	Date Sampled:		1998/11/19															
GWN-CT5A		7.65	--	--	--	--	--	--	--	--	--	--	--	--	ND	242		v (8020)
	Well Name:		Cuthbert #3															
	County:		Randolph															
	Date Sampled:		1998/11/20															
GWN-CT7A		4.70	--	--	--	--	--	--	--	--	--	--	--	--	7.6	108		v (8020)
	Well Name:		St. John Farm Well															
	County:		Sumter															
	Date Sampled:		1998/11/19															
GWN-CT8		4.65	--	--	--	--	--	--	--	--	--	--	--	--	0.8	24		v (8020)
	Well Name:		Weathersby house well															
	County:		Schley															
	Date Sampled:		1998/11/18															

Table A-5. 1998 Ground-Water Quality Analyses of the Claiborne Aquifer System.

PARAMETER		pH	Na	K	Ca	Mg	Sr	Ba	Fe	Mn	Al	Cl	F	SO4	Nitrate/ Nitrite	Conduc- tivity	Other Parameters	Other Tests
Well ID#	UNITS	SU	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	mg/L	mg/L	mgN/L	umho/cm	ug/L	
GWN-CL4		4.83	--	--	--	--	--	--	--	--	--	--	--	--	2.2	44	benzene=13	v (8020)
	Well Name:	Plains #3																
	County:	Sumter																
	Date Sampled:	1998/11/19																
GWN-CL9		7.99	--	--	--	--	--	--	--	--	--	--	--	--	ND	268	MTBE= 37 benzene=1.3	v (8020)
	Well Name:	Newton #3																
	County:	Baker																
	Date Sampled:	1998/10/29																

Table A-6. 1998 Ground-Water Quality Analyses of the Jacksonian Aquifer System.

PARAMETER Well ID#	UNITS	pH SU	Na mg/L	K mg/L	Ca mg/L	Mg mg/L	Sr ug/L	Ba ug/L	Fe ug/L	Mn ug/L	Al ug/L	Cl mg/L	F mg/L	SO4 mg/L	Nitrate/ Nitrite mgN/L	Conduc- tivity umho/cm	Other Parameters Detected ug/L	Other Tests
GWN-J1B		7.20	3.7	ND	54	ND	23	20	ND	ND	ND	8.3	ND	ND	2.4	281X		a,b,c,d v (8260)
	Well Name:		Quick house well															
	County:		Burke															
	Date Sampled:		1998/09/01															
GWN-J2A		7.43	1.3	ND	48	ND	56	60	ND	ND	ND	1.9	ND	ND	0.5	227X		a,b,c,d v (8260)
	Well Name:		Oakwood Village Mobile Home Park #2															
	County:		Burke															
	Date Sampled:		1998/09/23															
GWN-J3		7.72	10	ND	35	5.9	290	690	93	130	ND	6.8	0.1	ND	ND	238X		a,b,c,d v (8260)
	Well Name:		Black house well															
	County:		Emanuel															
	Date Sampled:		1998/09/23															
GWN-J7		4.88	3.9	ND	3.3	1.9	21	31	ND	20	ND	7.1	ND	ND	3.6	66X	Cu=40 Zn=110	a,b,c,d
	Well Name:		Templeton livestock well															
	County:		Burke															
	Date Sampled:		1998/09/23															
GWN-J8		5.05	--	--	--	--	--	--	--	--	--	--	--	--	8.56	110	Be=6.6	v (524.2) Be
	Well Name:		Kahn house well															
	County:		Jefferson															
	Date Sampled:		1998/12/08															

Table A-7. 1998 Ground-Water Quality Analyses of the Floridan Aquifer System.

PARAMETER		pH	Na	K	Ca	Mg	Sr	Ba	Fe	Mn	Al	Cl	F	SO4	Nitrate/ Nitrite	Conduc-tivity	Other Parameters Detected	Other Tests
Well ID#	UNITS	SU	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	mg/L	mg/L	mgN/L	umho/cm	ug/L	
GWN-PA1		7.94	--	--	--	--	--	--	--	--	--	--	--	--	ND	1052		v (524.2)
	Well Name:		Thunderbolt #1															
	County:		Chatham															
	Date Sampled:		1998/12/09															
GWN-PA2		8.04	--	--	--	--	--	--	--	--	--	--	--	--	ND	253		v (524.2)
	Well Name:		Savannah #13															
	County:		Chatham															
	Date Sampled:		1998/12/09															
GWN-PA3		8.41	8.6	ND	28	7.0	290	21	170	ND	ND	5.3	0.3	6.2	ND	226X		
	Well Name:		Grist Equipment Co. shop well															
	County:		Chatham															
	Date Sampled:		1998/03/26															
GWN-PA3		7.94	--	--	--	--	--	--	--	--	--	--	--	--	ND	242		v (524.2)
	Well Name:		Grist Equipment Co. shop well															
	County:		Chatham															
	Date Sampled:		1998/12/09															
GWN-PA5A		7.94	16	ND	26	14	430	29	ND	ND	ND	5.6	0.5	35.1	ND	303X		v (8260)
	Well Name:		Interstate Paper #2															
	County:		Liberty															
	Date Sampled:		1998/03/25															
GWN-PA6		7.79	14	ND	24	12	370	22	ND	ND	ND	4.5	0.5	23.2	ND	269X		v (8260)
	Well Name:		Hinesville #5															
	County:		Liberty															
	Date Sampled:		1998/03/26															
GWN-PA7		7.75	25	ND	47	28	750	51	110	ND	ND	22.3	0.60	133	ND	541X		v (8260)
	Well Name:		Darien #2 South															
	County:		McIntosh															
	Date Sampled:		1998/03/25															
GWN-PA8		7.89	17	ND	32	17	530	69	ND	ND	ND	7.0	0.5	49.5	ND	345X		v (8260)
	Well Name:		ITT Rayonier #4D															
	County:		Wayne															
	Date Sampled:		1998/03/25															

Table A-7 (Continued). 1998 Ground-Water Quality Analyses of the Floridan Aquifer System.

PARAMETER		pH	Na	K	Ca	Mg	Sr	Ba	Fe	Mn	Al	Cl	F	SO4	Nitrate/ Nitrite	Conduc-tivity	Other Parameters Detected	Other Tests
	UNITS	SU	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	mg/L	mg/L	mgN/L	umho/cm	ug/L	
Well ID#																		
GWN-PA9C		8.06	18	ND	36	27	760	37	79	32	ND	22.2	0.6	91.4	ND	456X	Zn=21	v (8260)
	Well Name:		Miller Ball Park TW25															
	County:		Glynn															
	Date Sampled:		1998/03/26															
GWN-PA14		7.98	6.4	ND	33	5.0	200	29	ND	ND	ND	2.8	0.5	6.1	ND	224X		v (8260)
	Well Name:		Statesboro #7															
	County:		Bulloch															
	Date Sampled:		1998/09/02															
GWN-PA15		8.22	8.0	ND	27	8.5	410	ND	24	ND	ND	2.4	0.3	7.1	ND	230X		v (8260)
	Well Name:		King Finishing Co. fire well															
	County:		Screven															
	Date Sampled:		1998/09/02															
GWN-PA20		7.69	4.5	ND	43	16	180	26	ND	ND	ND	3.2	0.3	65.3	ND	301X		v (8260)
	Well Name:		Lakeland #2															
	County:		Lanier															
	Date Sampled:		1998/02/25															
GWN-PA21A		8.03	2.7	ND	34	7.7	100	14	ND	ND	ND	3.2	0.2	21.2	ND	206X		
	Well Name:		Valdosta New #4															
	County:		Lowndes															
	Date Sampled:		1998/02/25															
GWN-PA22		7.78	7.6	ND	46	21	330	21	ND	ND	ND	6.8	0.4	72.5	ND	434X		
	Well Name:		Thomasville #6															
	County:		Thomas															
	Date Sampled:		1998/06/10															
GWN-PA24		7.87	1.8	ND	40	3.2	32	ND	ND	ND	ND	3.2	ND	ND	1.6	204X		a,b,c,d v (8260)
	Well Name:		Bainbridge #1															
	County:		Decatur															
	Date Sampled:		1998/06/24															
GWN-PA26		7.48	1.9	ND	47	ND	16	ND	ND	ND	ND	4.2	ND	ND	2.4	217X		a,b,c,d v (8260)
	Well Name:		Colquitt #3															
	County:		Miller															
	Date Sampled:		1998/06/24															

Table A-7 (Continued). 1998 Ground-Water Quality Analyses of the Floridan Aquifer System.

PARAMETER		pH	Na	K	Ca	Mg	Sr	Ba	Fe	Mn	Al	Cl	F	SO4	Nitrate/ Nitrite	Conduc- tivity	Other Parameters Detected	Other Tests
	UNITS	SU	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	mg/L	mg/L	mgN/L	umho/cm	ug/L	
Well ID#																		
GWN-PA28		7.97	27	ND	38	21	1900	88	27	ND	ND	9.4	0.6	116	ND	505X		
	Well Name:		Moultrie #1															
	County:		Colquitt															
	Date Sampled:		1998/06/10															
GWN-PA29		7.66	--	--	--	--	--	--	--	--	--	--	--	--	ND	343		v (524.2)
	Well Name:		Adel #6															
	County:		Cook															
	Date Sampled:		1998/12/17															
GWN-PA30A		7.82	4.6	ND	41	16	230	24	ND	ND	ND	3.9	0.3	68.5	ND	291X		
	Well Name:		Amoco/Nashville Mills #1															
	County:		Berrien															
	Date Sampled:		1998/02/25															
GWN-PA33A		7.83	2.8	ND	32	6.0	180	330	ND	ND	ND	2.7	0.2	ND	ND	182X	CHCl3=tr	v (8260)
	Well Name:		Fitzgerald Well G															
	County:		Ben Hill															
	Date Sampled:		1998/02/26															
GWN-PA34		7.24	--	--	--	--	--	--	--	--	--	--	--	--	ND	333		v (524.2)
	Well Name:		McRae Telfair Ave. Well															
	County:		Telfair															
	Date Sampled:		1998/12/10															
GWN-PA35		7.61	--	--	--	--	--	--	--	--	--	--	--	--	ND	277		v (524.2)
	Well Name:		Mt. Vernon New Well															
	County:		Montgomery															
	Date Sampled:		1998/12/10															
GWN-PA36		7.35	--	--	--	--	--	--	--	--	--	--	--	--	ND	236		v (524.2)
	Well Name:		Vidalia #1															
	County:		Toombs															
	Date Sampled:		1998/12/10															
GWN-PA38		7.73	--	--	--	--	--	--	--	--	--	--	--	--	0.24	227		v (524.2)
	Well Name:		Eastman #4															
	County:		Dodge															
	Date Sampled:		1998/12/10															

Table A-7 (Continued). 1998 Ground-Water Quality Analyses of the Floridan Aquifer System.

PARAMETER		pH	Na	K	Ca	Mg	Sr	Ba	Fe	Mn	Al	Cl	F	SO4	Nitrate/ Nitrite	Conduc- tivity	Other Parameters Detected	Other Tests
Well ID#	UNITS	SU	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	mg/L	mg/L	mgN/L	umho/cm	ug/L	
GWN-PA40		7.38	2.4	ND	60	1.2	45	14	ND	ND	ND	4.1	ND	ND	2.2	324X		v (8260)
	Well Name:		Merck and Co. #8															
	County:		Dougherty															
	Date Sampled:		1998/06/10															
GWN-PA43A		7.63	2.3	ND	54	ND	33	ND	ND	ND	ND	6.2	ND	ND	3.2	264X		a,b,c,d
	Well Name:		Pineland Fish Farm office well															v (8260)
	County:		Baker															
	Date Sampled:		1998/09/24															
GWN-PA45A		7.58	1.7	ND	51	ND	59	61	27	ND	ND	2.5	ND	ND	0.5	223X		v (8260)
	Well Name:		Abbeville #1															
	County:		Wilcox															
	Date Sampled:		1998/02/26															
GWN-PA46B		7.69	2.6	ND	43	1.0	26	36	ND	ND	ND	6.0	ND	2.2	3.9	207X		a,b,c,d
	Well Name:		Wenona Mobile Home Park Well															v (8260)
	County:		Crisp															
	Date Sampled:		1998/02/26															
GWN-PA49		7.78	1.6	ND	38	ND	21	17	ND	ND	ND	2.7	0.1	ND	1.6	176X		a,b,c,d
	Well Name:		Harmony Church well															v (8260)
	County:		Dooly															
	Date Sampled:		1998/02/26															
GWN-PA50		7.64	2.8	ND	62	1.4	180	41	150	ND	ND	4.4	ND	5.4	1.2	275X	Zn=20	a,b,c,d
	Well Name:		Reynolds house well															
	County:		Laurens															
	Date Sampled:		1998/09/30															
GWN-PA51		7.71	2.3	ND	46	ND	16	ND	ND	ND	ND	3.4	ND	ND	1.2	252X		d
	Well Name:		J.L. Adams house well															507
	County:		Mitchell															508.1
	Date Sampled:		1998/06/10															515.2
GWN-PA55		7.71	3.1	ND	47	2.3	220	160	ND	ND	ND	2.3	0.1	4.6	ND	239X	Zn=28	a,b,c
	Well Name:		W.A. Holland house well															
	County:		Burke															
	Date Sampled:		1998/09/30															

Table A-8. 1998 Ground-Water Quality Analyses of the Miocene Aquifer System.

PARAMETER		pH	Na	K	Ca	Mg	Sr	Ba	Fe	Mn	Al	Cl	F	SO4	Nitrate/ Nitrite	Conduc- tivity	Other Parameters Detected	Other Tests
Well ID#	UNITS	SU	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	mg/L	mg/L	mgN/L	umho/cm	ug/L	
GWN-MI1		7.91	6.6	ND	23	13	120	19	ND	20	ND	2.8	0.4	4.4	ND	221X		a,b,c,d
	Well Name:		McMillan house well															v (8260)
	County:		Cook															
	Date Sampled:		1998/09/24															
GWN-MI7		4.24	--	--	--	--	--	--	--	--	--	--	--	--	9.31	133		v (524.2)
	Well Name:		Chaudoin house well															
	County:		Irwin															
	Date Sampled:		1998/12/18															
GWN-MI9A		5.22	--	--	--	--	--	--	--	--	--	--	--	--	11.0	156	MTBE= 61	v (524.2)
	Well Name:		Murphy garden well														benzene= 8.8	
	County:		Thomas														toluene= 1.3	
	Date Sampled:		1998/10/29															
GWN-MI10B		6.55	--	--	--	--	--	--	--	--	--	--	--	--	ND	126	MTBE= 51	v (524.2)
	Well Name:		Calhoun house well														benzene= 7.8	
	County:		Colquitt														ethylbenzene= 1.3	
	Date Sampled:		1998/10/29														toluene= 1.4	
GWN-MI15		4.58	1.1	ND	10	8.0	100	62	ND	16	180	8.8	ND	ND	15.0	166X	Cu= 24	a,b,c,d
	Well Name:		Aldrich house well														Zn= 33	
	County:		Bulloch															
	Date Sampled:		1998/09/02															

Table A-9. 1998 Ground-Water Quality Analyses of the Piedmont/Blue Ridge Unconfined Aquifers.

PARAMETER		pH	Na	K	Ca	Mg	Sr	Ba	Fe	Mn	Al	Cl	F	SO4	Nitrate/ Nitrite	Conduc-tivity	Other Parameters Detected	Other Tests
Well ID#	UNITS	SU	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	mg/L	mg/L	mgN/L	umho/cm	ug/L	
GWN-BR1B		7.77	3.6	ND	14	3.0	130	82	ND	ND	ND	1.4	ND	13.4	ND	119X	Mo= 15	v (8260)
	Well Name:		Young Harris New Well															
	County:		Towns															
	Date Sampled:		1998/08/12															
GWN-BR2A		5.56	3.2	ND	3.3	1.2	36	40	34	ND	ND	2.8	ND	ND	0.8	50X	Mo= 12	v (8260)
	Well Name:		Notla Water Auth. #3															
	County:		Union															
	Date Sampled:		1998/08/12															
GWN-BR4		6.07	7.2	ND	11	2.4	100	ND	ND	ND	ND	4.0	ND	2.0	1.8	119X		
	Well Name:		Morganton Old Well															
	County:		Fannin															
	Date Sampled:		1998/08/20															
GWN-P1B		5.86	9.4	ND	8.2	2.6	97	10	2100	60	ND	6.7	0.1	16.3	ND	73X		
	Well Name:		Luthersville New Well															
	County:		Meriwether															
	Date Sampled:		1998/07/29															
GWN-P5		6.84	--	--	--	--	--	--	--	--	--	--	--	--	0.59	138		v (524.2)
	Well Name:		Flowery Branch #1															
	County:		Hall															
	Date Sampled:		1998/12/16															
GWN-P6A		7.33	8.2	ND	18	2.7	46	10	40	100	ND	2.3	0.2	6.2	ND	87X	Mo= 18 Zn= 88	
	Well Name:		Shiloh #1															
	County:		Harris															
	Date Sampled:		1998/07/29															
GWN-P7		6.48	8.2	ND	13	4.8	73	52	ND	ND	ND	2.3	ND	4.5	0.3	82X	Mo= 10	v (8260)
	Well Name:		Hampton #6															
	County:		Henry															
	Date Sampled:		1998/07/29															
GWN-P8		6.91	--	--	--	--	--	--	--	--	--	--	--	--	0.41	210		v (524.2)
	Well Name:		Wayne Poultry #4															
	County:		Jackson															
	Date Sampled:		1998/12/28															

Table A-9 (Continued). 1998 Ground-Water Quality Analyses of the Piedmont/Blue Ridge Unconfined Aquifers.

PARAMETER		pH	Na	K	Ca	Mg	Sr	Ba	Fe	Mn	Al	Cl	F	SO4	Nitrate/ Nitrite	Conduc-tivity	Other Parameters Detected	Other Tests
Well ID#	UNITS	SU	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	mg/L	mg/L	mgN/L	umho/cm	ug/L	
GWN-P10B		6.53	--	--	--	--	--	--	--	--	--	--	--	--	0.1	20		v (524.2) Be
	Well Name:		Franklin Springs #9															
	County:		Franklin															
	Date Sampled:		1998/12/16															
GWN-P11A		6.53	--	--	--	--	--	--	--	--	--	--	--	--	0.25	97		v (524.2)
	Well Name:		Danielsville #2															
	County:		Madison															
	Date Sampled:		1998/12/16															
GWN-P12A		6.52	36	ND	16	2.5	150	ND	ND	20	ND	9.9	4.6	26.4	ND	281X		
	Well Name:		Indian Spring															
	County:		Butts															
	Date Sampled:		1998/06/11															
GWN-P13A		5.92	6.0	ND	4.5	1.1	35	25	ND	ND	ND	7.7	ND	ND	0.5	74X		
	Well Name:		Covington/Academy Spring															
	County:		Newton															
	Date Sampled:		1998/06/11															
GWN-P14		5.09	1.4	ND	ND	ND	ND	29	ND	ND	60	1.8	ND	ND	0.4	11X	Mo=12	
	Well Name:		Upson County Sunset Village well															
	County:		Upson															
	Date Sampled:		1998/07/29															
GWN-P15A		7.07	8.0	ND	21	4.8	99	65	410	91	ND	6.7	0.1	7.1	ND	121X	Zn=73 C2Cl4=tr	v (8260)
	Well Name:		Bolton garden well															
	County:		DeKalb															
	Date Sampled:		1998/07/30															
GWN-P16C		6.16	2.0	ND	6.1	1.5	39	ND	830	59	ND	1.0	ND	5.8	ND	57X		v (8260)
	Well Name:		Mt. Airy #4															
	County:		Habersham															
	Date Sampled:		1998/08/11															
GWN-P17		7.22	--	--	--	--	--	--	--	--	--	--	--	--	ND	182		v (524.2)
	Well Name:		Oconee County Hillcrest #2															
	County:		Oconee															
	Date Sampled:		1998/12/15															

Table A-9 (Continued). 1998 Ground-Water Quality Analyses of the Piedmont/Blue Ridge Unconfined Aquifers.

PARAMETER		pH	Na	K	Ca	Mg	Sr	Ba	Fe	Mn	Al	Cl	F	SO4	Nitrate/ Nitrite	Conduc- tivity	Other Parameters Detected	Other Tests
	UNITS	SU	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	mg/L	mg/L	mgN/L	umho/cm	ug/L	
Well ID#																		
GWN-P18		5.62	4.0	ND	2.8	1.4	23	24	ND	61	60	4.3	ND	ND	1.6	54X	Mo= 14	
	Well Name:	Dawsonville City Spring																
	County:	Dawson																
	Date Sampled:	1998/08/12																

Table A-10. 1998 Ground-Water Quality Analyses of the Valley and Ridge Unconfined Aquifers.

PARAMETER		pH	Na	K	Ca	Mg	Sr	Ba	Fe	Mn	Al	Cl	F	SO4	Nitrate/ Nitrite	Conduc- tivity	Other Parameters Detected	Other Tests
Well ID#	UNITS	SU	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	mg/L	mg/L	mgN/L	umho/cm	ug/L	
GWN-VR3		8.04	1.1	ND	31	13	23	77	40	ND	91	1.8	ND	2.7	0.7	249X		v (8260)
	Well Name:		Chickamauga Crawfish Spring															
	County:		Walker															
	Date Sampled:		1998/08/13															
GWN-VR4		7.22	19	ND	76	18	510	90	540	110	ND	6.8	ND	71.8	ND	554X		v (8260)
	Well Name:		Coats-American #3															
	County:		Walker															
	Date Sampled:		1998/08/13															
GWN-VR5		7.15	5.2	ND	76	3.9	170	100	ND	ND	ND	7.0	ND	4.4	3.2	404X		v (8260)
	Well Name:		Chattooga County #4															
	County:		Chattooga															
	Date Sampled:		1998/08/13															
GWN-VR7		7.86	ND	ND	29	14	23	31	ND	ND	ND	1.5	ND	ND	0.4	247X		v (8260)
	Well Name:		Adairsville/Lewis Spring															
	County:		Bartow															
	Date Sampled:		1998/08/13															