UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

FLORIDA DEPARTMENT OF NATURAL RESOURCES
published by BUREAU OF GEOLOGY

CHEMICAL QUALITY OF WATER USED FOR MUNICIPAL SUPPLY IN FLORIDA, 1975

By
G. G. Phelps

Prepared by
UNITED STATES GEOLOGICAL SURVEY
in cooperation with
FLORIDA DEPARTMENT OF
ENVIRONMENTAL REGULATION
BUREAU OF WATER RESOURCES MANAGEMENT

Tallahassee, Florida
1978

INTRODUCTION

All surface and ground waters contain dissolved chemical constituents. The rocks at and near land surface, through such processes as solution and erosion, are the principal source of these chemical constituents. Not only rock type, but also solubility, size and purity of mineral crystals, rock texture, porosity, and regional structure control the chemical composition of the hydrologic environment. However, only a few (generally less than 10) chemical constituents are present in water in appreciable concentrations. Among the most abundant constituents are calcium, magnesium, sodium, potassium, bicarbonate, sulfate, and chloride. Of these, calcium, magnesium, sodium and potassium are termed cations (positively charged) and the others are termed anions (negatively charged). Many other elements or combinations of elements (compounds) occur in water but—except where sometimes introduced by man—usually are present in very low concentrations.

In 1975, the Geological Survey collected water samples from wells and streams used by more than 120 Florida municipalities. Included in the collection program was a sample at each county seat in the state. Water samples were analyzed mainly for the common chemical constituents given above; the concentration of several selected trace constituents were also determined.

The large map shows the proportions of major constituents in water from each county in Florida. The concentrations are plotted in percentages of milliequivalents per liter, a valid procedure inasmuch as in all water the positive and negative ions are in balance. This graphical method of representation is sometimes referred to as a "pie diagram." When several water supplies in the same county were sampled, the sample with the highest dissolved solids concentration is shown. This was done only to emphasize areas where the poorest quality water is found, at least with regard to dissolved solids. Therefore, the dissolved solids in water from other parts of a particular county is probably equal or less in concentration.

QUALITY OF UNTREATED WATER

Throughout virtually all of Florida, water is of a mixed anion-cation type with calcium and bicarbonate generally predominating. Such a predominance of calcium and bicarbonate gives rise to a water with a fairly high hardness. As figure 1 shows, most of the water in the state has a hardness of at least 180 mg/L (milligrams per liter) The rocks at and near land surface—those that are a major influence on chemical composition of water—are of limestone ($CaCO_3$) and therefore the fact that Florida's water is high in hardness is to be expected.

As discussed earlier, water contains a large number of chemical constituents. Information about some of them, and their significance, is summarized in table 1.

BASIS FOR QUALITY RECOMMENDATIONS

Information about the quality of surface and ground water used for municipal supply is important to the public and to water managers alike. When the dissolved solids concentration in a water is high some of the material can come out of solution (precipitate) during transport, or storage, resulting in a buildup of scale on the inside surface of piping—sometimes so thick that flow ceases. Water containing high concentrations of some constituents can corrode pipes and exposed metal surfaces, or at least stain plumbing fixtures. Staining is common when porcelain plumbing fixtures are exposed to a water whose concentration of iron is more than 0.3 mg/L (fig. 2).

The EPA (Environmental Protection Agency) has defined water-quality recommendations for untreated (raw) water in order to allow the production of a "safe, clear, potable, esthetically pleasing and acceptable public water supply after treatment" (National Academy of Sciences and National Academy of Engineering, 1973, p. 50–51).

The need for such recommendations is obvious: the chemical quality of untreated water is important because often its quality determines the quality of the treated water piped to a home for drinking and for domestic use. For example, water treatment by most municipalities consists of filtration, aeration, and disinfection with chlorine; procedures that do not, for example, cause the dissolved solids concentration in the treated water to be significantly less than what it was in the untreated water. A high concentration of dissolved solids is undesirable because of taste, possible physiological effects, economic consequences of corrosion, scale buildup, and excessive consumption of soap. In 1962, the U.S. Public Health Service recommended a limit of 500 mg/L of dissolved solids in water intended for domestic use. The basis for that limit, along with the foregoing, was the assumption that if the concentration were higher, the water might contain some constituents undesirable to some users. However, because in many areas it is not economically feasible to provide water with a dissolved solids concentration as low as 500 mg/L and because no ill effects have been observed from the use of water exceeding 500 mg/L in dissolved solids, no recommendation has been made to limit the concentration of dissolved solids (National Academy of Sciences and National Academy of Engineering, 1973, p. 90).

Water hardness is another property of interest to consumers, but for which no recommended limits have been established. Calcium and magnesium ions are the primary causes of hardness, which is usually reported as equivalent concentrations of calcium carbonate.

The pH of water (hydrogen ion activity) is important because it affects the rate and magnitude of many chemical reactions in water, which can affect treatment processes. The pH of most untreated (raw) waters ranges from 5.0 to 9.0 and it is recommended (National Academy of Sciences and National Academy of Engineering, 1973) that water whose pH is outside this range should not be used for public supplies. All the samples of untreated water supplying municipalities had a pH that is within the recommended range.

The physical properties of untreated water, such as color and turbidity, are also important quality characteristics, particularly from an esthetic standpoint. Frequently, color is caused by humic, fulvic, and other acids similar in structure, and their removal is generally expensive and impractical. Sometimes color at an esthetically objectionable level can be reduced by coagulation, sedimentation, and filtration. Because color in water is esthetically undesirable, a maximum of 75 platinum-cobalt color units is recommended (National Academy of Sciences and National Academy of Engineering, p. 63). Because many factors determine the ease with which turbidity can be removed from water, and also because it has been found not practicable in most circumstances to establish a turbidity recommendation in terms of turbidity units, no turbidity limit has been established for untreated water. For example, a water with 30 turbidity units may coagulate more rapidly than one with 5 or 10 units. Conversely, water with 30 turbidity units sometimes may be more difficult to coagulate than water with 100 units (National Academy of Sciences and National Academy of Engineering, 1973, p. 90).

In summary, nearly all the untreated water from both surface-water and ground-water sources in Florida meets the recommended limits of the EPA for chemical and physical properties as described in National Academy of Sciences and National Academy of Engineering (1973) and cited in table 1. Those counties where exceptions occur, with respect to iron and ammonia concentrations, are shown in figure 2. In a few counties some of the water supply contains more than 0.3 mg/L of iron and 0.5 mg/L of ammonia (as nitrogen); however, this does not necessarily mean that the water from these counties is not usable for most purposes after adequate treatment.

SELECTED REFERENCES

Causey, L. V.
1965 Availability of ground water in Talladega County, Alabama: Geol. Survey of Alabama Bull. 81, 63 p.

Durfor, C. N., and Becker, Edith
1964 Public water supplies of the 100 largest cities in the United States, 1963: U.S. Geol. Survey Water-Supply Paper 1812, 364 p.

Healy, H. G.
1977 Public water supplies of selected municipalities of Florida, 1975: U.S. Geol. Survey Water-Resources Inv. 77-53, 309 p.

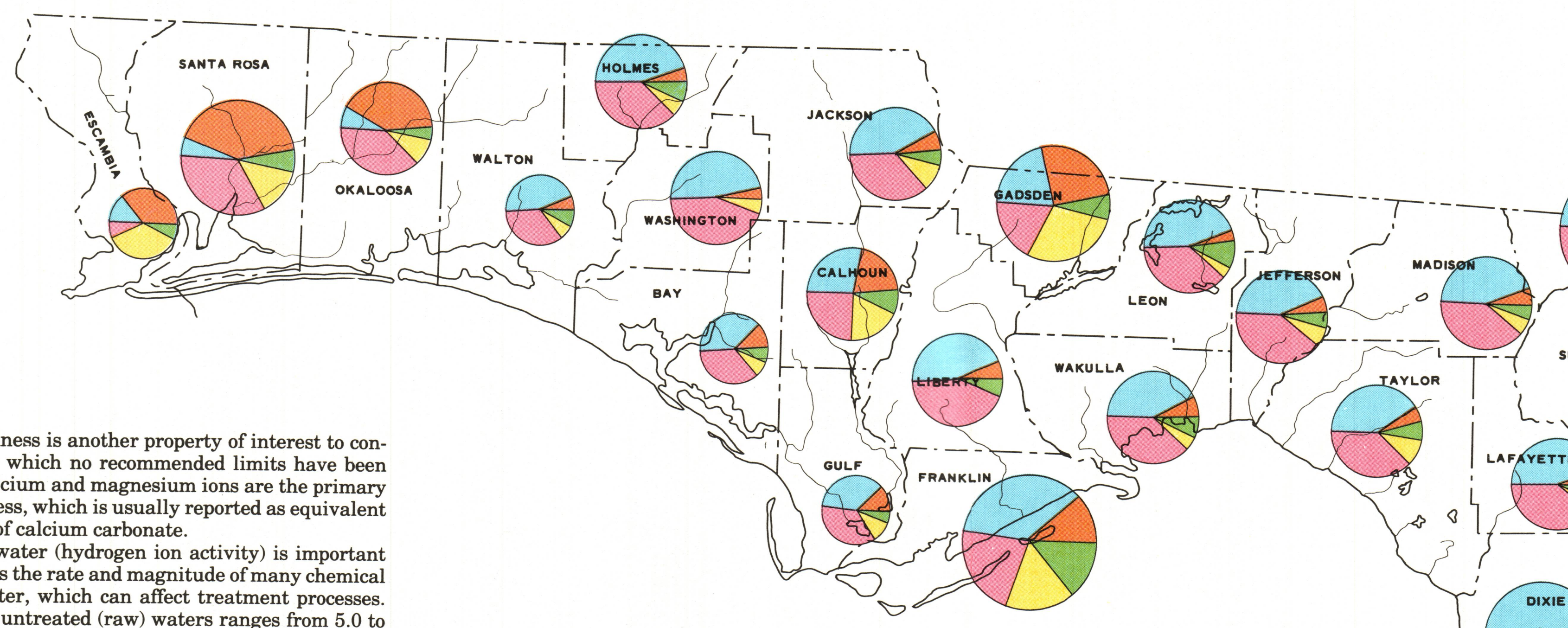
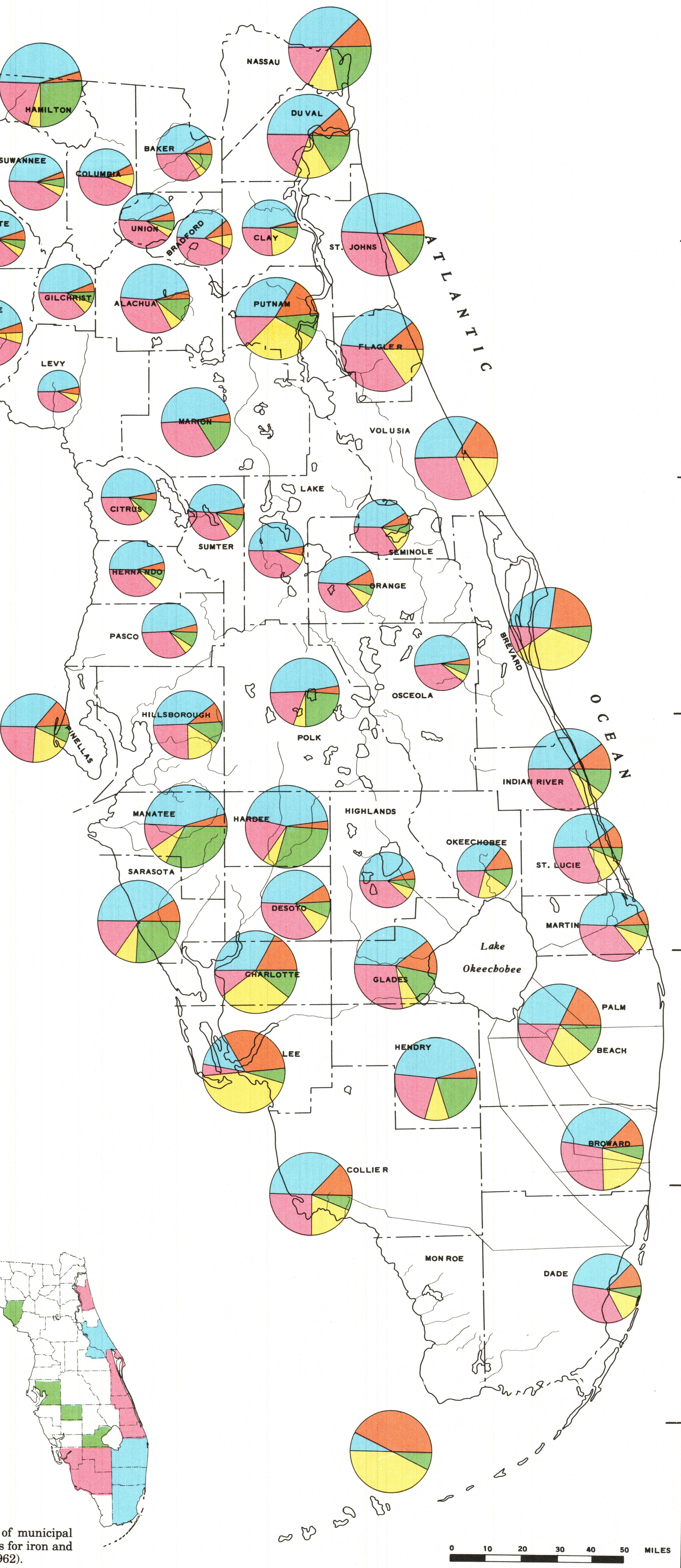
Hem, J. D.
1970 Study and interpretation of the chemical characteristics of natural water: U.S. Geol. Survey Water-Supply Paper 1473, 363 p.

National Academy of Sciences and National Academy of Engineering
1973 Water quality criteria 1972: (U.S.) Environmental Protection Agency rept. EPA R3 73 033, 594 p.

U.S. Public Health Service
1962 Drinking water standards, 1962: U.S. Public Health Service Pub. 956, 61 p.

DEPARTMENT OF NATURAL RESOURCES
BUREAU OF GEOLOGY

This public document was promulgated at a total cost of $792.00 or a per copy cost of $.39 for the purpose of disseminating hydrologic data.

EXPLANATION

The symbols show the dissolved solids concentrations of the poorest quality municipal supply water sampled in each county (see text). The size of the symbol indicates dissolved solids concentration according to the following scale:

less than 100 mg/L	100–300 mg/L	301–500 mg/L	More than 500 mg/L

Colors show the relative proportions of the following major constituents:

- Calcium + Magnesium
- Sodium + Potassium
- Bicarbonate
- Sulfate
- Chloride

The concentration of a constituent is not shown if less than 1 percent. Concentrations are in milliequivalents per liter. The location of the symbol is not necessarily that of the sampling point. Data for Monroe County represents analysis of saline water pumped for use by desalination plant.

Table 1.—*Some elements and compounds found in water and their significance*[a,b]

Constituent	Source and (or) solubility	Effects	Recommended limit[b] (mg/L)
Silica	Most abundant element in earth's crust, resistant to solution.	Causes scale in boilers and deposits on turbine blades.	—
Iron	Very abundant element, readily precipitates as hydroxide.	Stains laundry and porcelain, imparts unpleasant taste.	0.3
Manganese	Less abundant than iron, present in lower concentration.	Stains laundry and porcelain, imparts unpleasant taste.	0.05
Calcium	Dissolved from most rock, especially limestone and dolomite.	Causes hardness, forms boiler scale.	
Magnesium	Dissolved from rocks, industrial wastes.	Helps maintain good soil structure and permeability.	—
Sodium	Dissolved from rocks, industrial wastes, sea water and natural brines.	Injurious to soils and crops, and may cause certain physiological conditions (such as high blood pressure) in man.	—
Potassium	Abundant in rocks and soils, not very soluble.	Causes foaming in boilers, stimulates plankton growth.	—
Bicarbonate Carbonate	Abundant and soluble from limestone, dolomite and soils.	Causes foaming in boilers and embrittlement of boiler steel.	—
Sulfate	Sedimentary rocks, mine water, and industrial wastes.	Excess amount: cathartic, imparts unpleasant taste.	250
Chloride	Rocks, soils, industrial wastes, sewage, brines, seawater.	Imparts unpleasant taste, increases corrosiveness.	250
Fluoride	Sparingly soluble, seldom found in industrial wastes, except as spillage, some sewage.	Small amounts aid in preventing tooth decay. High concentrations may cause mottling of children's teeth.	1.4–2.4 depending on water temperature
Nitrate (as N)	Rocks, soil, sewage, industrial waste, normal decomposition, bacteria.	Causes methemoglobinemia in infants. Concentrations higher than recommended limit indicate pollution.	10
Ammonia	Animal wastes, sewage or industrial wastes.	Hinders the ability of chlorine to disinfect.	0.5
Arsenic	Dissolved from rocks.	Insufficient data but prolonged use of water containing 0.21 mg/L has proved to be poisonous to humans.	0.1
Chromium	Usually from industrial pollution.	Insufficient data.	0.05
Copper	Widely distributed element.	Trace amounts essential to plant and animal nutrition. Small amounts added to reservoirs to retard algae growth. Imparts unpleasant taste.	1.0
Lead	Dissolved from pipe and pipe fittings, also from some rocks.	Poisonous to humans; children especially vulnerable.	0.05
Mercury	Mining and industrial wastes.	Poisonous to humans.	0.002
Phosphorus	Dissolved from rocks, mining wastes, also sewage.	Sudden enrichments cause algae blooms and eutrophication of water.	No recommendation because of complex interaction caused by other properties of the water.
Strontium	Sr^{90} nuclear fission. Sr^{87} natural decay of rubidium.	Replaces Ca or K in some rocks. Very high concentrations of radioactive Sr^{90} are harmful.	No recommendation. Highest reported concentration in potable water 52 mg/L.
Zinc	Industrial waste, galvanized pipe, dissolved from carbonate rocks.	Unpleasant taste.	5.0
Color	Caused by humic, fulvic, and other acids similar in organic structure. Generally difficult to remove from water.	Can be esthetically objectionable when water is highly colored.	75 PTU
Turbidity	Caused by material in suspension.	Can be esthetically objectionable.	None recommended.

[a]From Causey (1965, table 2).
[b]Recommended limits of the Environmental Protection Agency (National Academy of Sciences and National Academy of Engineering, 1973). (To avoid confusion, the recommended limits here cited are only from the Environmental Protection Agency standards of 1972, and they are given only for purposes of general information. The author is fully aware of some differences between the above standards and those stated in Public Law 93-523 which became effective in June 1977.)

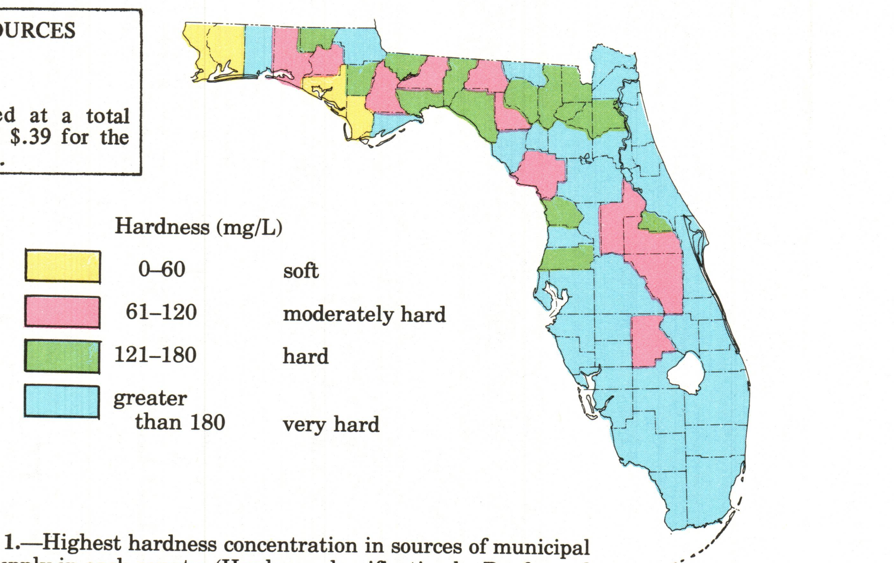


Figure 1.—Highest hardness concentration in sources of municipal water supply in each county. (Hardness classification by Durfor and Becker, 1964.)

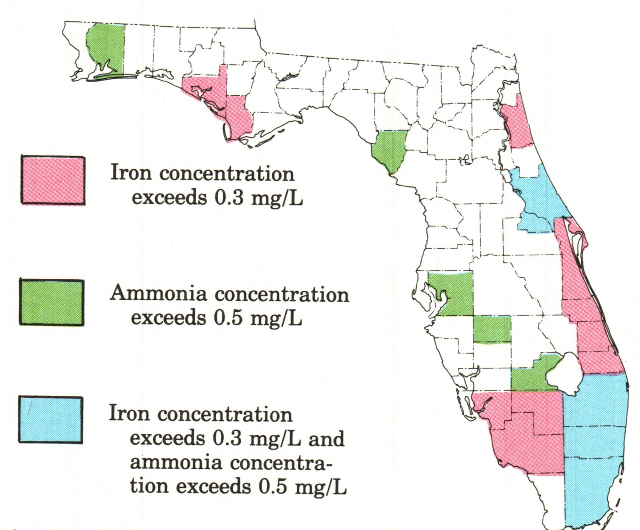


Figure 2.—Counties in which one or more sources of municipal water supply exceed recommended concentration limits for iron and ammonia (see Table 1) (U.S. Public Health Service, 1962).