

SURFACE DRAINAGE CHARACTERISTICS IN VOLUSIA COUNTY, FLORIDA

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INTRODUCTION

Volusia County is adjacent to the Atlantic Coast in east-central Florida (location map). The county comprises about 1,200 square miles of which one-half is poorly drained. The population had doubled in the last 15 years, and the area accordingly is experiencing a demand for additional land for man's use. Some of the land being used is poorly drained.

The maps in this report delineate drainage basins, show the areal distribution of rainfall and runoff, show the position of the piezometric surface relative to land surface, and indicate drainage feasibility. This information on surface drainage can be used by county planners in planning land use of the County in harmony with the natural hydrologic conditions. The purpose of the investigation on which this report is based, was to provide a scientific basis for optimum development of the county's water resources. Additional information resulting from the investigation will be published in other map reports and in a comprehensive report on the occurrence, distribution, quality, and utilization of the water resources, and effects of drainage and development on the water resources. Prior to this investigation, a description of the ground-water resources of Volusia County was published by the Florida Geological Survey as Report of Investigation 22 (1960).

DRAINAGE BASINS

The major topographic features in Volusia County that influence surface drainage are shown on figure 1. The characteristic flat marine terraces—Talbot, Pamlico, and Silver Bluff—are drained by streams that flow through large areas of swamp, have low gradients, and have poorly defined channels. The terraces are separated by narrow sand ridges and are arranged in a step-like succession toward the coast, with the Talbot terrace generally at 25 feet and the Silver Bluff at 10 feet (fig. 4).

Rima ridge, which separates the Talbot and Pamlico terraces, is 5 to 10 feet higher than the Talbot terrace in some places. The Atlantic Coastal ridge, which separates the Pamlico and Silver Bluff terraces, is as much as 50 feet higher than the Pamlico terrace. The narrow sand ridges are characteristically devoid of surface drainage, but at places are traversed by streams. Tomoka River and Spruce Creek traverse the Atlantic Coastal ridge and the Tiger Bay Canal cuts across the Rima ridge. The narrow sand ridges, aligned parallel to the coast, mark positions of ancient shorelines.

The DeLand and Crescent City ridges, in the western third of the county, are characterized by high relief, lakes and dry depressions, and the lack of surface streams. Relief of more than 100 feet is found on the DeLand ridge where the maximum elevation is slightly greater than 120 feet and some ponds are less than 20 feet in elevation. The topography of the DeLand and Crescent City ridges is similar to the topography of other major ridges in Florida and has been given the name "karst" or "modified karst" topography. Karst topography as found in Florida is characterized by numerous lakes and dry depressions in areas of high relief with little external surface drainage. Karst topography develops in an area which is underlain by limestone or other rocks susceptible to solution and where moderate to large amounts of rainfall are diverted from surface flow to routes of subsurface flow.

The drainage basins of the County are part of three major drainage systems as shown on figure 1. Fifty-eight percent of the County drains to the St. Johns River or its tributaries, 31 percent drains directly to the Atlantic Ocean, and 11 percent has no surface drainage. Rainfall on the internally drained area, is absorbed and percolates as ground water into the St. Johns basin. The drainage basins and their areas are listed in table 1.

TABLE 1.—DRAINAGE BASINS, VOLUSIA COUNTY		
BASIN NO.	BASIN DESIGNATION	AREA (SQ MI)
<i>St. Johns River Basin</i>		
1	Hull Cypress Swamp	2
2	Cow Creek	28
3	St. Johns River (Lake Harney)	30
4	St. Johns River (Lake George)	37
5	Deep Creek (Barberville)	39
6	Middle Haw Creek	41
7	St. Johns River (Puzzle Lake)	62
8	Little Haw Creek	102
9	St. Johns River (Floodplain)	133
10	Deep Creek (Osteen)	157*
<i>Atlantic Coastal Area</i>		
11	Groover Branch	13
12	Little Tomoka River	15
13	Turnbull Creek (Turnbull Bay)	17
14	Mosquito Lagoon	34
15	Turnbull Creek (Indian River)	17
16	Halifax River	48
17	Spruce Creek	96
18	Tomoka River	121**
<i>Internally Drained Area</i>		
19	Area of no surface drainage	126

* Includes area of Groover Branch and Little Tomoka River.
** Includes area of Cow Creek.

The drainage basins in general have elongate shapes trending north-south, parallel to the trend of the topographic features and the seashore. Divides which separate the headwaters of the drainage basins on the marine terrace are characterized by low swampy ground rather than a ridge, and are indefinite. Such low-level divides between drainage basins actually migrate back and forth a short distance depending upon the pattern of rainfall.

The basin east of the DeLand ridge are bounded by narrow north-south trending sand ridges which prevent the development of eastward flowing streams. Rima ridge acts generally as the surface drainage divide between the Talbot and Pamlico terraces except where the headwaters of the Middle Haw Creek basin have been diverted through a low in the Rima ridge to the Tomoka River basin by Tiger Bay Canal (fig. 1).

Topographically high DeLand ridge, which has no surface drainage, is also elongate in a north-south direction, and prevents streams from flowing westward from the center of the county.

The streams in Volusia County have low gradients, large channel storage capacities in swampy areas and undefined or poorly defined channels. These characteristics describe a non-integrated system. The main stem of streams have only a few

feet of water in wells penetrating the limestone aquifer

short tributaries relative to the size of the drainage basin. Streams that drain swampy areas react slowly to heavy rains. They rise slowly during the rain and fall slowly after the storm passes. In their natural state, the streams of Volusia County react slowly to storm events, but because of channel modifications designed to speed runoff Tomoka River and Spruce Creek have become quicker acting.

RUNOFF

Runoff is the water that leaves an area via its surface streams. On figure 2, runoff is expressed as the depth of water in inches that would cover the area if all the flow from the area for a year was distributed on it. The pattern of shaded areas depicts the distribution of runoff in the County. The values of runoff shown are average annual runoff for that whole area, and not the runoff at any given point within the area. Average annual runoff was derived by adjusting short-term records to the long-term record at Spruce Creek for the period 1931 to 1966.

Factors which influence runoff are rainfall, topography, and hydrogeology. The runoff pattern of figure 2 shows significant areal differences in runoff; from no runoff from the DeLand ridge to 18 inches on parts of the Talbot and Pamlico terraces. The hydrogeologic influences of thickness of unsaturated zone, and permeability of the surficial material and underlying limestone are the controlling factors in runoff differences. Groundwater influences of areal differences in rainfall and topography. For instance, runoff is lowest from the DeLand ridge which is in the area having the highest rainfall.

Annual rainfall distribution for the climatic period 1931-60 is shown on figure 2. The normal annual rainfall for the county is 52 inches with Daytona Beach receiving 50 inches and DeLand 55 inches. Precipitation increases from about 50 inches on the coast to 54 inches along the DeLand ridge in the western part of the County.

In peninsular Florida, and especially in Volusia County, the topographic influence on runoff is subordinate to the hydrogeologic influence—areas of high relief have less runoff than areas of low relief. In general, the flat swampy marine terraces are areas of higher runoff and the ridges have lower runoff. Crescent City ridge like DeLand ridge has areas of no runoff but they are too small to map at the scale shown. Many of the lakes on the Crescent City ridge are connected by streams and have an outlet and therefore Crescent City ridge has more runoff than the DeLand ridge which has none. The Rima and Atlantic Coastal ridges have low runoff as shown on figure 2.

Hydrogeology has the greatest influence on the runoff distribution pattern in the county. The surface material is predominantly permeable sand so that rain can readily seep into the ground. The thickness of the unsaturated zone under the terraces is less than 5 feet, while it reaches 30 feet under the DeLand ridge. This unsaturated zone acts as a temporary reservoir to store infiltrating rain water. As water percolates through the terraces, it reaches the underlying limestone where solution activity has increased permeability and water transmitting capacity of the rocks. The topography of the DeLand ridge also promotes the near surface temporary storage of water. The many lakes and depressions store water until it can seep into the ground or evaporate. The permeability of the surficial materials and the thickness of the unsaturated zone are the major factors which result in the Crescent City and DeLand ridges having low or no runoff.

DRAINAGE FEASIBILITY

Volusia County receives most of its ground water from recharge of local rainfall, and in the center of the County, farthest from areas of discharge along the St. Johns River and the Atlantic Ocean, the piezometric surface is the highest. In many places the piezometric surface is less than 5 feet below the land surface (fig. 3)—a potentially beneficial situation in obtaining a ground-water supply but a detrimental factor when draining swampy areas.

The hydrogeologic section in figure 4 shows the land surface, piezometric surface, and generalized geology. As is shown, the areas just east of the DeLand, Rima, and Atlantic Coastal ridges are low relative to the adjacent ridges and the piezometric surface is at or above the land surface. These areas are poorly drained not only because they are low in elevation and collect surface water but also because the high piezometric surface allows no downward percolation of water. At times there is even an upward movement of water which keeps the area water logged. The sediments above the Floridan aquifer are semi-permeable and allow water to move up or down depending on the differences in elevation between the shallow ground water and the piezometric surface.

Rainfall is more than sufficient to keep the aquifer full and the piezometric surface near the top of the ground under the flat terraces. The excess water either runs off or evaporates from the swamps.

A map (fig. 5) showing drainage feasibility was drawn from figure 3 which shows the relative position of the piezometric surface to the land surface. Figure 5 depicts areas which would be difficult to drain, areas which could be drained where needed, and areas where drainage is not needed. The two maps are similar in that, where the piezometric surface is near the land surface the area would be difficult to drain using surface canals. Where the piezometric surface is at some distance below the top of the ground the land is essentially well drained and drainage is not needed.

The land is wet and swampy where the piezometric surface is near land surface. Where this hydraulic condition exists, drainage by surface canals would be essentially ineffective. When the shallow ground water is lowered a little, upward movement of deeper ground water is increased nullifying any substantial lowering of shallow water levels.

Effective drainage of difficult-to-drain areas can be accomplished only by lowering the piezometric surface—perhaps by pumping water from the underlying aquifer. As the piezometric surface is lowered, the shallow ground water will percolate downward and relieve the water logging condition.

REFERENCES

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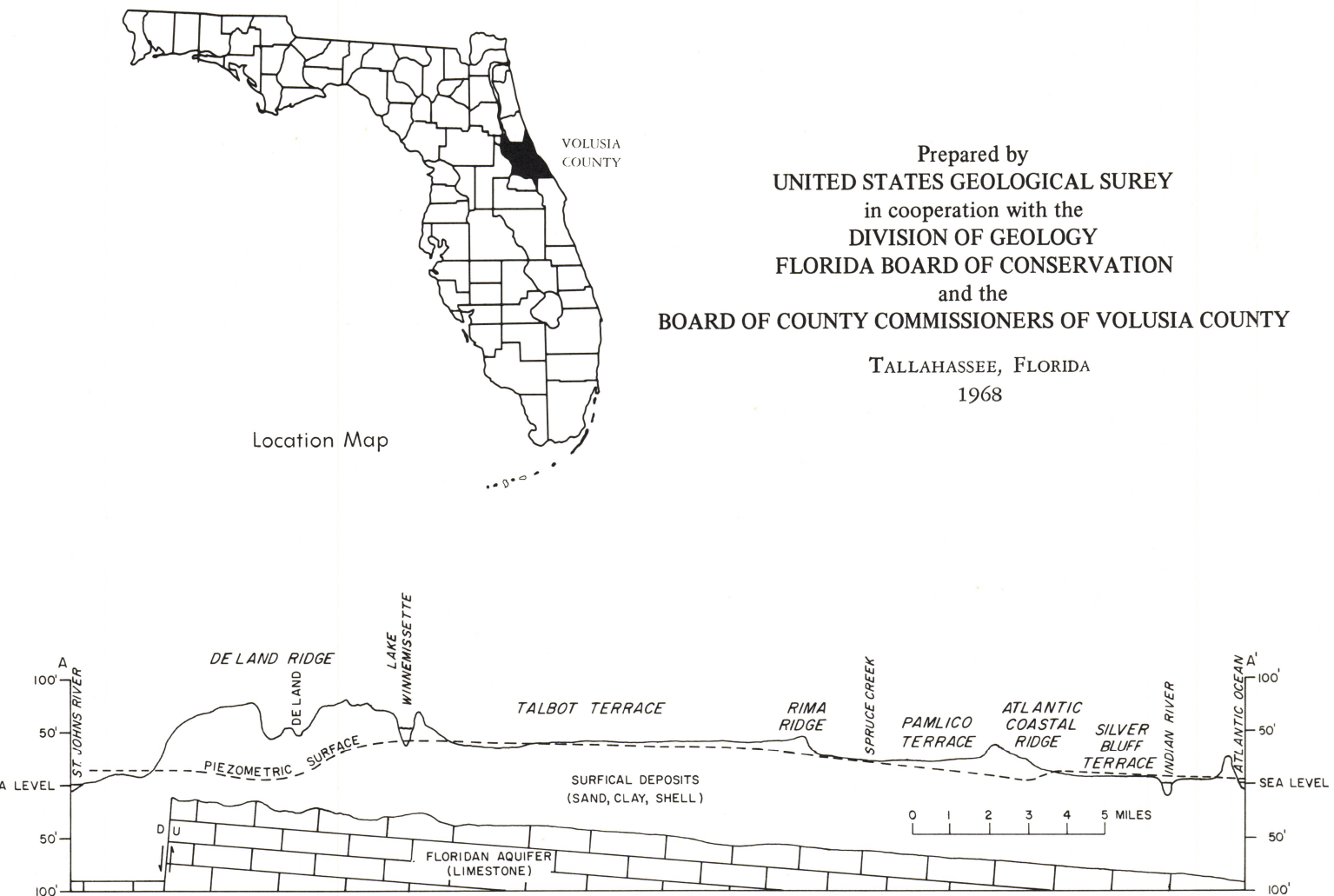


FIGURE 4—Generalized Profile Along Line A-A'

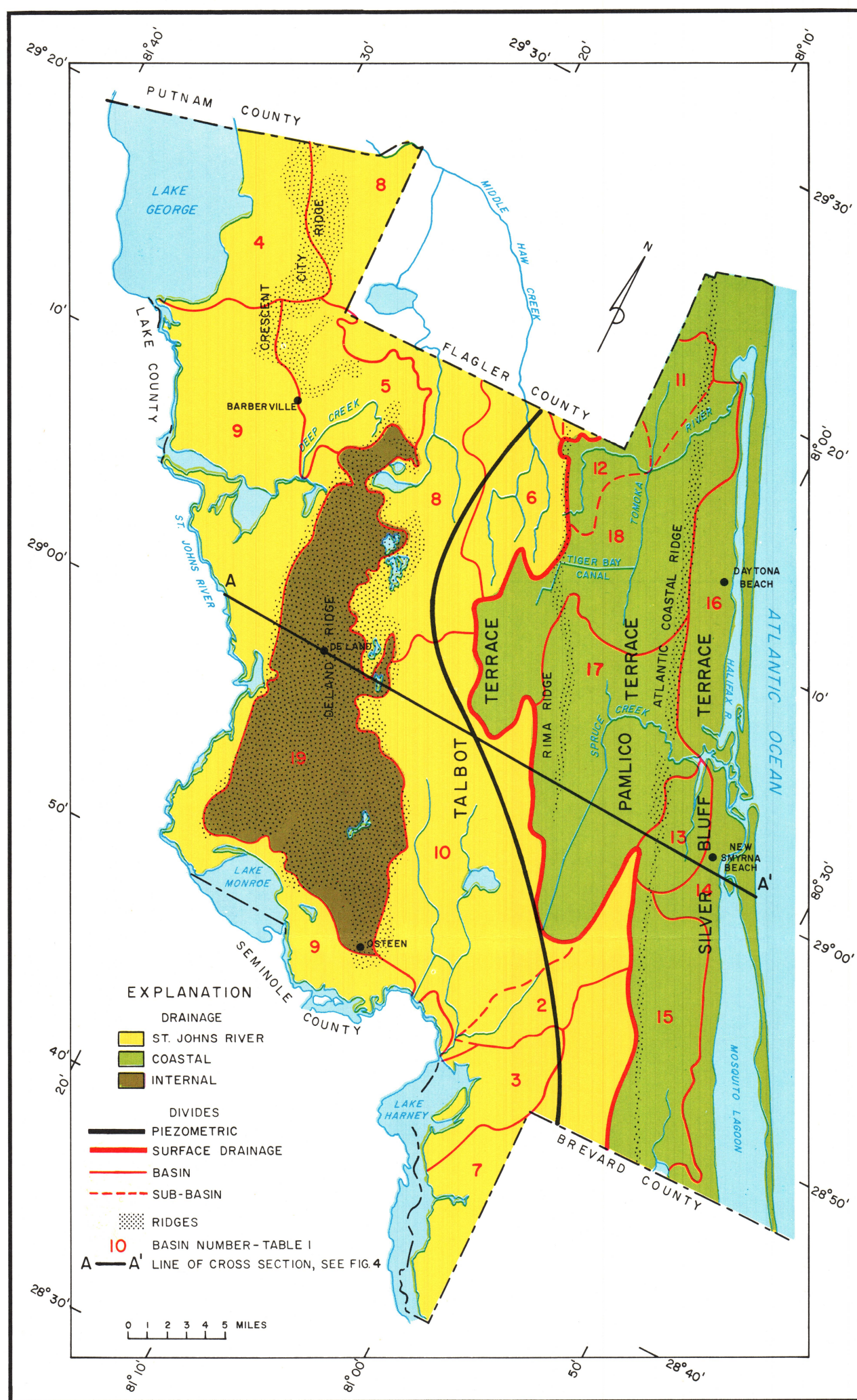


FIGURE 1—Drainage Basins

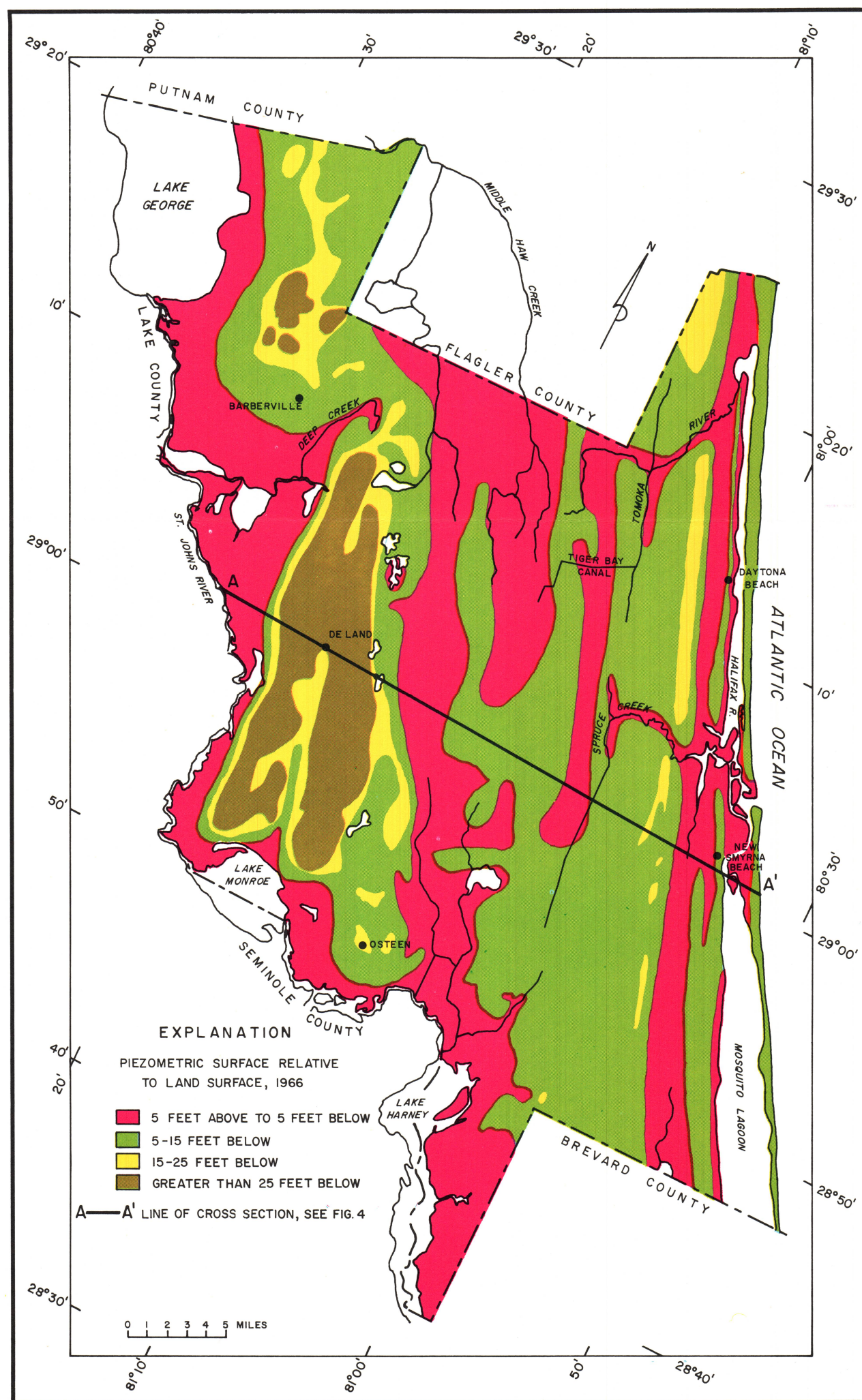


FIGURE 3—Piezometric Surface Relative to Land Surface

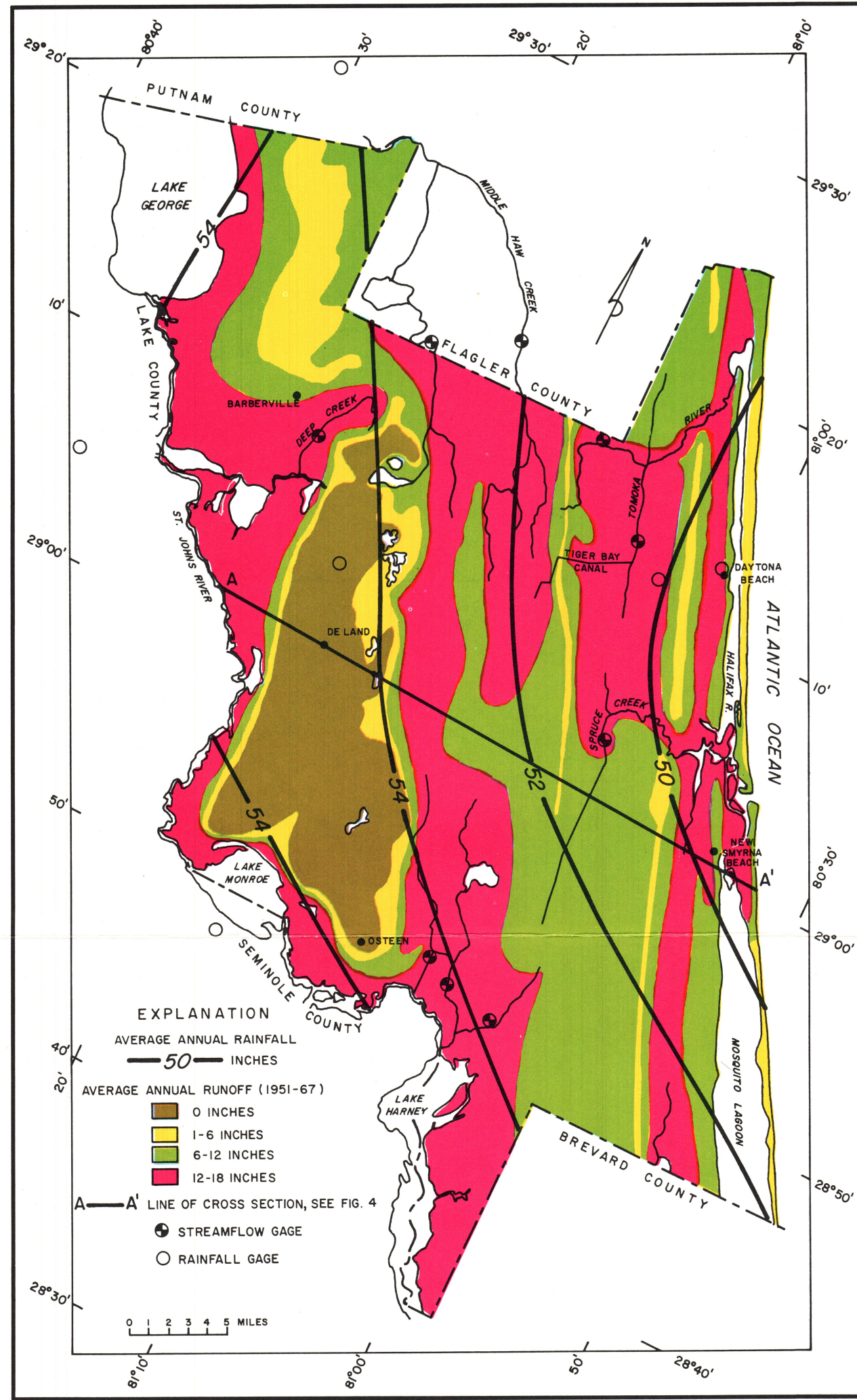


FIGURE 2—Average Annual Rainfall and Runoff

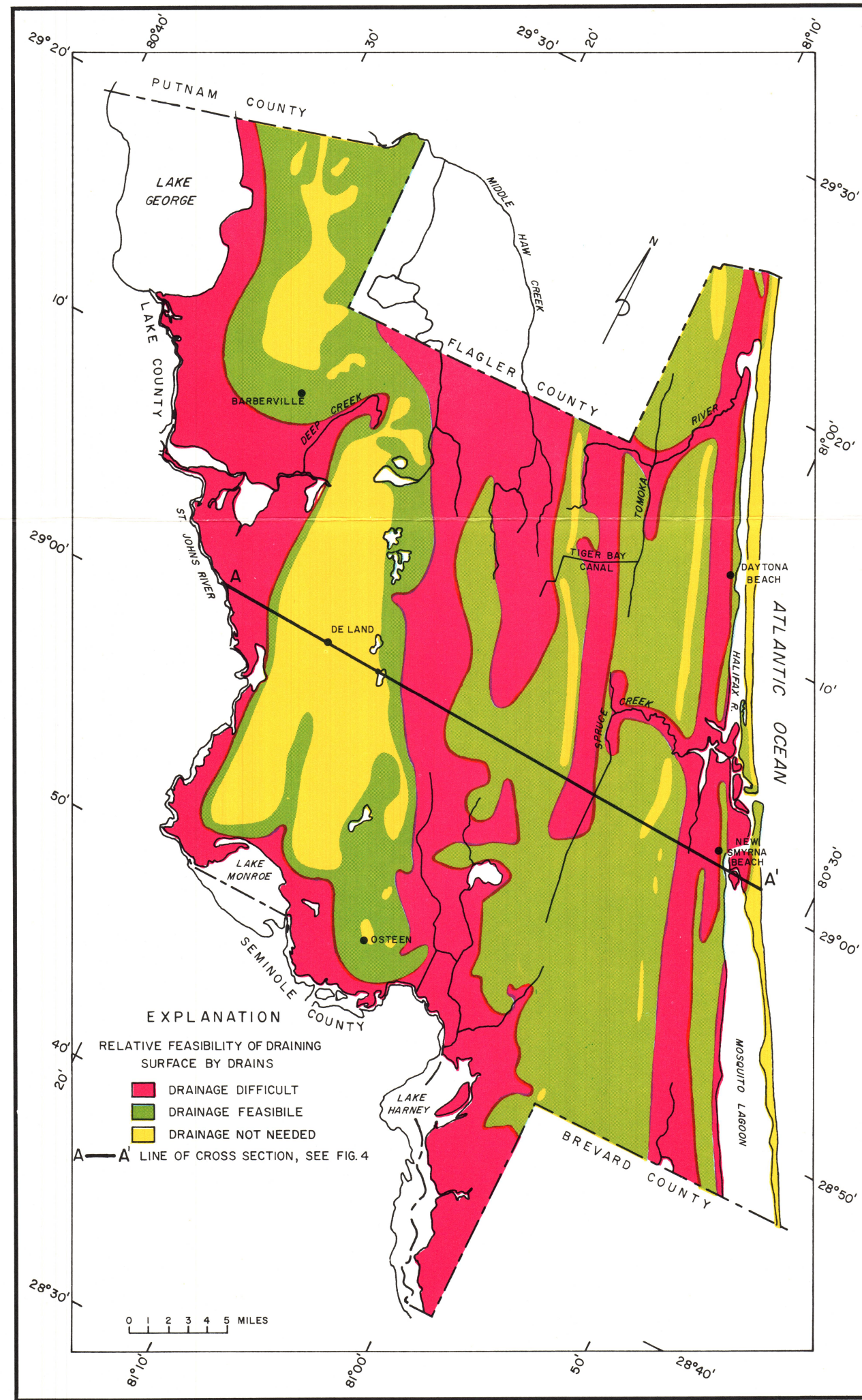


FIGURE 5—Drainage Feasibility