2.0
THE STATION SITE

CHAPTER 2.0

TABLE OF CONTENTS

CHAPTER 2.0

THE STATION SITE

LIST OF TABLES

LIST OF FIGURES

LIST OF TABLES

LIST OF FIGURES

LIST OF TABLES

LIST OF FIGURES

LIST OF TABLES

LIST OF FIGURES

LIST OF TABLES

LIST OF FIGURES

LIST OF TABLES

LIST OF FIGURES

Section | Page

LIST OF TABLES

LIST OF FIGURES

Section		Page

LIST OF TABLES

LIST OF FIGURES

LIST OF TABLES

LIST OF TABLES (Continued)

LIST OF FIGURES

LIST OF TABLES

2.0 THE STATION SITE

2.1 LOCATION

The preferred site for the Seminole Units No. 1 and No. 2 is located in the northeast part of Putnam County, Florida, about 5 miles north of the City of Palatka (see Figure 2.1-1). The geographic coordinates of the center of the site are 29° 44' north latitude and 81° 38' west longitude. The site property (Figure 2.1-2) covers 1,976 acres.

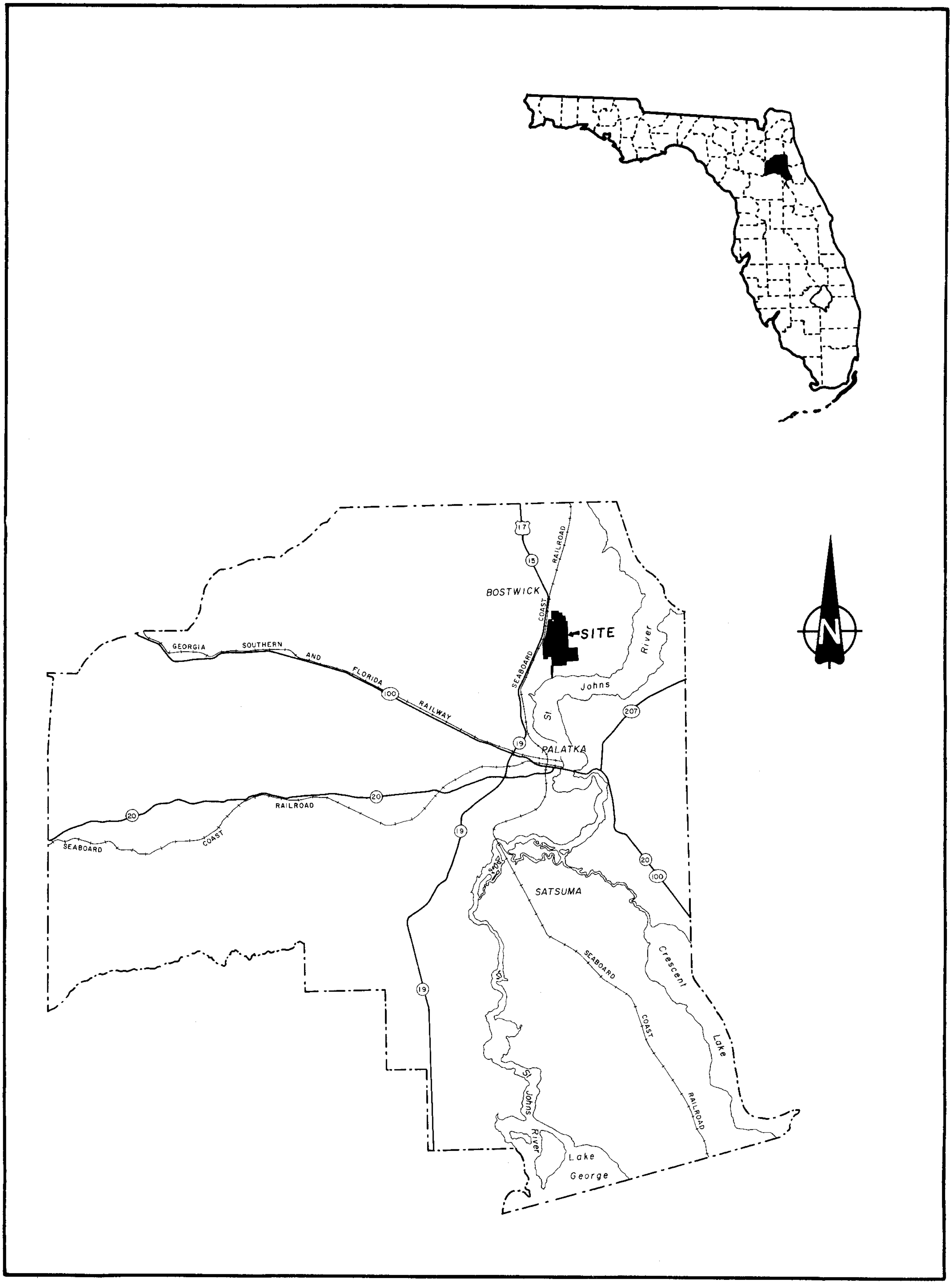


Figure 2.1-1. Site Location Map.

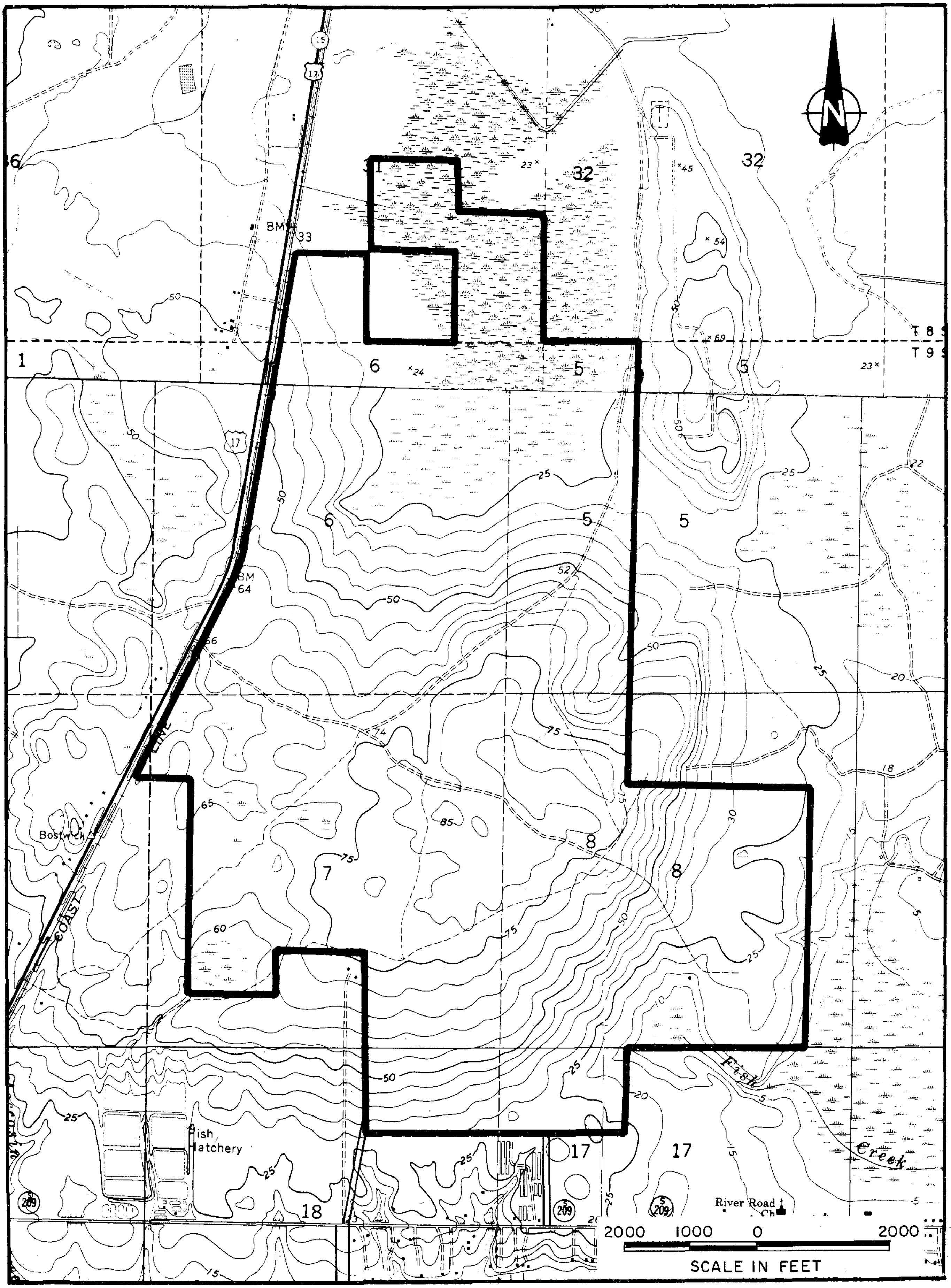


Figure 2.1-2. Putnam Site Property Boundaries.

REVISED 3/15/79

2.2 GEOLOGY AND SOILS

2.2.1 General

The Florida peninsula is the partially emerged portion of a large plateau that extends from the main mass of the North American Continent. The peninsula is considered by a number of geologists (King P.B., 1950; King E.R., 1959; Murray 1961 and 1963) to be an extension of the Appalachian and/or Ouachita structural belts, but definite relationships are as yet undetermined (Chen, 1965).

Although Florida has undergone a fairly complex geomorphologic history, the present-day landforms in the vicinity of the site are relatively simple, being dominated by the St. Johns River and a series of marine terraces. A description of these and their origins is presented in Section 2.2.3.

Stratigraphy is discussed in general terms in Section 2.2.4. The sequence, composition, characteristics, and continuity of the upper materials pertinent to the site from a groundwater and construction-development standpoint are addressed in greater detail in Sections 2.2.7 and 2.3.2.1.

The more important events of three geologic eras are introduced in the present discussions:

- Paleozoic Era: Two categories of Paleozoic rocks are distinguished and their boundary delineated by the "Applin Line." Defined by Applin, (1951) as the contact zone between the deep-seated, unmetamorphosed Paleozoic sedimentary rocks to the northwest and Paleozoic crystalline rocks to the southeast; it trends northeasterly just east of the Putnam Site.
- Mesozoic Era: The Mesozoic witnessed a major depositional phase which carried on into the Cenozoic and, in southern Florida, resulted in the accumulation of more than 18,000 feet of marine sediment, mainly carbonates. In the northern areas, in which the oceans subsided more slowly, a thinner section of mixed carbonates and terrigenous elastic sediments were deposited in shallower marine and coastal environments.

- Cenozoic Era: The formations of interest in the vicinity of the site include the Eocene limestones, which constitute the potable extent of the Floridan Aquifer, the Miocene Hawthorn Formation, which acts as an aquiclude for the Aquifer, and the post-Hawthorn to recent sand silts, silty sands, and clean sands which comprise the water table aquifer and which will become the foundation materials for the proposed station.

The Peninsular Arch, which trends south-southeast just west of the site, is one of the major regional subsurface structures. The arch slopes gently to the southeast. Formed in Paleozoic rock, it remained a topographic high until late Cretaceous time and continued to influence deposition in the Cenozoic Era. The Ocala uplift, the fault immediately west of the site, and other structural features are discussed in greater detail in Section 2.2.5.

The Florida peninsula and adjacent continental shelves have been tectonically stable throughout the Mesozoic and Cenozoic Eras (Rainwater, 1971). Moreover, the peninsula is one of the most seismically stable areas of the United States (Algermissen, 1969). Earthquake history is discussed further in Section 2.2.6, while soils and geotechnical conditions pertinent to an environmental assessment are outlined in Section 2.2.7.

2.2.2 Method of Investigation

The geologic investigation was undertaken in essentially two discrete phases: a preliminary study and a more detailed site-specific investigation.

The purpose of the first phase, a preliminary study, was to establish whether any geotechnical "fatal flaw" nature existed at the proposed site. The scope of work for this phase consisted of a preliminary review of the published literature, onsite studies which included three subsurface borings sampled to depths on the order of 100 feet below grade, and the analysis of site specific data within the framework of existing regional information. Favorable findings of this study established the basis for proceeding with more detailed work.

Based on a Modified Mercalli isoseismal map presented in Figure 2.2-12, it is estimated that the Charleston shocks could be projected to the site with an intensity of MM VI. A projection of the New Madrid earthquakes would be MM V or less at the site indicated in Figure 2.2-13. Effects at the Putnam Site were, therefore, not extensive.

Another area that could conceivably exert a seismic influence in the Florida peninsula is the Caribbean Seismic Belt. The most active area in this region is in and around Cuba. The fact that the strongest earthquakes in Cuba are a considerable distance from the site, and that they have not been stronger than intensity MM VIII, makes them of little consequence to the Putnam Site.

In summary, historic evidence indicates that the Putnam Site has been exposed in only a small way to seismically induced ground motions generated within Florida or in adjacent regions.

2.2.7 Soils and Geotechnical Conditions

Surface and Surficial Conditions

The central portion of the site includes approximately 150 acres of relatively level ground above 75 feet MSL, while the highest elevation attained is approximately 85 feet MSL (Figure 2.2-14). The steepest gradients from this high ground are toward the southeast and northeast. The northern extension of the property includes a swamp lowland bounded by the 25-foot contour, the lowest elevation on site. The St. Johns River is within a mile of the site and meanders east and then north so that it is both south and east of the site.

With the exception of the northern lowland (which shows a surficial cover of organic silt to a depth of approximately 4 feet) and the restricted depressions on the higher ground (which showed abundant organic material to a depth of 3 feet below surface), the property is underlain by a well drained, loose, sandy cover.

The water table is subject to precipitation fluctuations. Measurements to date have ranged from about 2 feet below surface (in upland depressions) to approximately 15 feet below surface. The northern lowland is damp even in relatively dry weather and is reported to be waterlogged in very wet weather (see Section 2.3.2).

Sinkhole and/or Cavernous Conditions

Studies undertaken to date sugest that the area surrounding the site is relatively free of major sinkhole or extensive solution-related activity, this being associated more with areas of western and southeastern Putnam County. However, since the general region is characterized in many places by typical karst features, this matter was given considerable attention.

The only surface expressions of possible sinkholes on the property were isolated circular and semi-circular shallow depressions in the southwestern portion of the site. A boring (No. 2-1, Figure 2.2-14) was located in the most obvious of these features. The correlation of subsurface layers revealed by the boring with the general lithologic profile of the site (Figure 2.2-15) indicates that these lows are not associated with sinkhole expression at depth, but are rather natural drainage features.

Because of the substantial thickness of overburden and its potential ability to support heavy foundations, the limestones have not been extensively sampled.

Engineering Nature of Subsurface Materials

The generalized profile consists of approximately 200 feet of unconsolidated sediments (over the high areas of the site property) underlain by a considerable thickness of limestones. This overburden layer showed a "draped" effect over the area sampled. Although the surface elevation of borings differed by some 30 feet, the thicknesses of the upper sediment layers intersected remained essentially constant. This would, in all probability, not extend as such into the lower-lying areas of the site, and the depressed (+25 feet MSL) northern extension of the property may be expected to be underlain by a somewhat lesser thickness of sand.

Over the area sampled, the overburden shows three broad geotechnically distinguishable and horizontally continuous layers (Figure 2.2-15): a clean medium dense to dense sand to a depth of 40 feet below surface; a transitional zone of increasing fines consisting of interbedded lenses of clean sand and silty or clayey sand between 40 and 100 feet below surface; and finally a very dense or very stiff to hard, relatively impervious layer, the Hawthorn Formation, between 100 and 200 feet below surface (-130 feet MSL). The detailed geotechnical characteristics of these layers are described in Appendix E.

Appendix E also includes data such as subsurface boring logs and laboratory test results, conclusions regarding potential ability to support foundation loads, and suggestions pertinent to an environmentally optimum layout of major plant facilities.

Conclusions

Some of the more salient conclusions regarding soils and geotechnical conditions are:

1. A preliminary evaluation suggests that, due to the magnitude of seismic events that could affect Florida, foundation stability will not be affected by the loss of shear strength due to liquefaction of the fine sand material at the site.
2. Based on studies to date, it is the opinion of Dames & Moore that, with the possible exception of the stacks (the resistance to the high overturning moments due to wind loading were not investigated), structures in the power station complex may be supported on shallow foundations at economical bearing pressures.

3. Since the ground water table onsite is relatively high and the upper sands are relatively permeable, major earthwork requiring dewatering should be kept to a minimum.

4. Other conclusions are incorporated in Section 9.3.1 Environmental Site Layout Guidelines.

APPENDIX E

GEOLOGY/SOILS

E.1 INTRODUCTION

The objective of this Appendix is to provide a broad geotechnical description of the materials underlying the Putnam Site and to present sufficient data to support this description. Although a preliminary evaluation is made of the suitability of these materials for potential foundation support, it may be emphasized that the level of effort expended was aimed at addressing those issues of relevance to an environmental analysis, and consequently should not be misconstrued as being sufficiently definitive to permit an initiation of foundation design.

It is also stressed that although the general geology of the region was taken into account in analyzing local subsurface conditions, the geologic setting of the site is not addressed in this Appendix, and the reader is referred for this information to Section 2.2 in the main body of the text.

The main emphasis of this work relates to the following:

1. the engineering nature of subsurface materials, in particular with respect to variation both vertically and horizontally of unconsolidated materials; any anticipated foundation problems and the relative suitability of existing subsurface conditions for the proposed facilities,

2. the identification of any mitigating measures that could be implemented to either reduce environmental impacts, or improve, from a geotechnical standpoint, the design layout of major plant facilities.

E.2 GEOTECHNICAL PROGRAM

The description of the subsurface conditions of the site is based on 5 exploratory test borings ranging in depth from approximately 100 to 200 feet below existing grade and by a number of hand auger holes to a maximum depth of 8 feet.

Samples were taken at intervals of 5 feet to 100 feet and at either 5 or 10 feet between 100 feet and 200 feet below surface, and all unconsolidated materials were described in terms of the Unified Soil Classification System (Figure E-1). Standard Penetration tests furnished the bulk of samples for identification and provided the main source of quantitative data. The laboratory program consisted predominantly of index-type testing including Atterberg limit tests, moisture and density determinations, and particle size analyses. These assisted in the engineering classification of materials. A few relatively undisturbed samples were taken at selected locations for more sophisticated testing (triaxial compression, direct shear, and consolidation tests).

Boring logs presenting the data collected during the program described above are included in Figures E-2 through E-9. Legend is shown on Figure E-10.

Boring 2-1 was located in a shallow semi-circular depression to assess the depression's possible association with collapsed cavern activity at depth. No such association was found. Further, an aerial photograph analysis showed no sinkhole-related features in the immediate vicinity of the site.

E.3 DESCRIPTION OF SOILS

The surficial soil characteristics of the site are shown in a surface soil map prepared by the U. S. Soil Conservation Service (1973) (Figure E-11). Beneath surficial deposits, the area sampled showed three broad geotechnically distinguishable and horizontally continuous layers (Figure 2.2-15). The geotechnical characteristics of these layers are described below:

1. Layer 1 consists of a clean fine to medium sand extending over most of the high ground of the site, to a depth of approximately 40 feet below surface. Based on typical standard penetration test 'N' values, this sand may be described for the most part as "medium dense" to "dense."

The gradational characteristics of the layer are shown in Figure E-12. Sieve analysis showed a silt and clay size fraction of up to 15 percent. Based on typical gradational characteristics, the coefficient of permeability of these sands is estimated to be on the order of 10^{-3} cm/sec. A preliminary evaluation of a field pumping test, however, suggests a somewhat higher value of 2 x 10^{-2} cm/sec.

The natural moisture content of samples tested ranged from about 14 percent to 25 percent (with corresponding natural dry densities of 121 and 99 pcf). Laboratory direct shear tests on samples taken from 11 feet and 22 feet below surface in Boring 2-1 showed shear strengths of 900 and 1550 psf under normal pressures of 1000 and 2000 psf, respectively. Shear strengths, in general, may be expected to increase with depth or with increasing confining pressures.

This sand layer constitutes an upper, unconfined, or water table aquifer, with the water table existing at about 8 feet below surface at the time of drilling.

2. Layer 2 is an interbedded layer extending typically between about 40 feet and 100 feet below surface. This layer is distinguished from the clean sands overlying it, by its increasing content of fines and from the layer underlying it, by that layer being more cohesive in makeup.

   The unit characteristically contains interbedded silty and clayey sands and clean sands with 'N' values on the order of 15 to 50 and, as with the overlying clean sand above, may again be best described as "medium dense" to "dense." As is apparent from the logs, however, anomalies do exist in the form of low blow count materials, (less than 10 blows per foot) generally between 60 and 80 feet below surface. These few areas of low blow count material should be looked at in more detail in the foundation investigation, but may well be the result of a "quick" condition which can exist at the tip of the split spoon during driving, rather than an indication of "very loose/soft" material.

Based on limited classification tests, this layer appears to consist predominantly of granular (non-plastic) materials. With the exception of a clay lens at approximately 50 feet below surface (Figure E-5) the soils comprising Layer 2 tended to show a fine fraction (material passing the number 200 seive) of up to 25 percent (Figure E-13). The natural moisture content ranged from 22 to 41 percent (with corresponding dry densities of 104 and 80 pcf, respectively).

3. Layer 3, the lowest overburden layer identified, extends from approximately 100 feet below surface to the top of the limestone intersected at approximately 200 feet. This unit is characterized by interbedded layers containing an overall higher percentage of fines, a notable lack of clean sands and significant thicknesses of cohesive materials. Materials within unit 3 were described typically as hard sandy clays grading with lenses of clayey and silty sands, clayey silts and occasionally with hard inorganic clays. 'N' values of these materials ranged from about 30 to approximately 100 suggesting consistencies of "very stiff" to "hard" for cohesive soils and "medium dense" to "dense" for granular soils.

   Once again the individual beds within this unit appear to be lenticular and gradational in a lateral direction.

   Sieve analyses from Layer 3 typically show approximately 50 percent of material finer than the number 200 sieve (Figure E-14). These materials may be expected to show an average coefficient of permeability on the order of 10^{-8} cm/sec and are therefore relatively impermeable. Tests showed the natural water content to range from 35 to 57 percent with corresponding dry densities of 86 pcf and 68 pcf, respectively. The high 'N' values throughout the thickness of this layer should correspond with high unconfined compressive strengths in the clay zones.

Unit 3 corresponds with the Miocene Hawthorn Formation discussed in Section 2.2.4. It constitutes the major confining layer or aquiclude to the underlying limestones which comprise the Floridan Aquifer. Its effectiveness as an aquiclude demonstrates, on a large scale, its overall low permeability.

Deep borings on site show the top of the Eocene limestone dipping to the northwest as approximately 50 feet per mile. This corresponds with the direction of the near-regional trend. It is, however, somewhat steeper than average dips over the area depicted in Figure 2.2-6. In addition, a microscopic examination of the limestone sampled suggests that the uppermost limestones underlying the site belong to the Crystal River Formation. This means that the contact between the Crystal River Formation and the Williston Formation extends slightly to the south of the contact shown in Figure 2.2-6.

E.4 FOUNDATION SUITABILITY

Liquefaction Potential

An assessment of liquefaction potential is not a requirement for the licensing of a steam-electric generating plant. However, good engineering practice dictates that any condition which might reasonably be expected to affect the stability of the foundation materials should be examined. Thus, the liquefaction potential of the soils at the site has been reviewed, using the simplified Seed & Idriss approach.

This approach, first presented in Seed & Idriss (1971) was updated and modified slightly as more data became available (Seed, 1976). This is an empirical method based on field observations of the performance of sites at which liquefaction has, or has not occurred during previous earthquakes. Briefly, the procedure is to compare blow counts from the standard penetration tests, which have been corrected to an effective overburden pressure of 1 ton/sq. ft., with an empirical relationship of corrected blow count for which liquefaction may occur. This empirical relationship is a function of peak ground acceleration and earthquake magnitude.

As described in Section 2.2.6, the Florida peninsula is one of the least seismically active regions in the United States. For the purpose of the analysis of liquefaction potential, a conservative peak ground acceleration of 0.1g was assumed.

The variation of blow count with depth is shown in Figure E-15. This plot shows overall high values, a few low values and a general scatter of results. Figure E-16, a plot of 'N' values against elevation, shows a similar trend, with the scatter of results indicating neither high nor low value material showing lateral continuity.

Since Boring 1 is nearest to the probable location of major foundation bearing structures, the standard penetration values from this bore hole were corrected to allow for effective overburden pressure, and plotted against depth below surface (Figure E-17). The fact that corrected blow counts to a depth of 50 feet (the range of depth for which the empirical relationship is valid) plotted outside of the zone where liquefaction is likely to take place, shows that liquefaction will not occur. Consequently, it is Dames & Moore's opinion that foundation stability will not be affected by the loss of shear strength due to liquefaction of the fine sand material at the site due to a 0.1g peak ground acceleration.

Foundation Assessment

The type of foundation most appropriate for a given structure depends upon several factors: (1) the function of the structure and its size; (2) the type and magnitude of the imposed load; (3) the subsurface conditions; (4) the tolerance of the structure to differential settlements; and (5) relative costs of foundation types.

Using preliminary information provided by Burns and Roe, Inc. as to the anticipated size and loading conditions of the structures in the power plant complex, the generalized soil profile, and the basic engineering properties determined during the field and laboratory program discussed previously, the suitability of different foundation types was assessed for the support of these structures.

Based on present knowledge, it is Dames & Moore's opinion that, with perhaps one exception to be discussed later in this section, the structures in the power plant complex may be supported on shallow foundations at economical bearing pressures and that construction may be undertaken with minimal dewatering.

For a given soil profile, the anticipated performance of a particular building foundation type and size is evaluated by considering both bearing capacity and settlement. In almost all cases, the allowable contact pressure is governed by settlement considerations rather than bearing capacity. A preliminary evaluation of the foundation conditions of this site indicates this to be the case; that is, the design allowable bearing pressure will be a function of the allowable settlement. The permissible contact stress will depend also on the size of the foundation, but will probably range from 6.0 kips/sq. ft. to 10.0 kips/sq. ft.

The settlement of the structures may be divided into two categories; namely, elastic settlement and consolidation settlement. The distinction between these two components of the total settlement is important because the elastic settlement is essentially "built out" during the construction process, while the consolidation settlement can be expected to continue after the plant is operational. For a given soil profile, the magnitude of both types of settlement increases with increasing contact pressure, and for equal contact pressure with increasing foundation size.

It is anticipated that the more heavily loaded structures in the plant complex will undergo elastic settlements on the order of 2 to 4 inches. It is again emphasized that this settlement will take place during construction and should not affect the integrity of structures. Consolidation settlement under the major structures on the order of one inch or less may be expected. This is within the tolerance of all but the most sensitive structures.

Depending on the preferred plant grade and final foundation design elevations, it may be necessary to densify the surficial soils (upper 5 to 8 feet) to reduce the contribution of this upper material to the total settlement. This may be accomplished by in situ compaction or by excavation and replacement with compacted fill. Densification may also be required to a slightly greater depth under foundations which are subject to vibration; for instance, the turbine mat.

On the basis of this preliminary assessment, there is one loading condition for which a shallow foundation may not be adequate, or, if adequate, not economical. It is very possible that piles may be necessary to provide uplift resistance sufficient to withstand the high overturning moments due to wind loading on the stacks.

Alternate Foundation Types

The information presented in this section is based on the relatively small body of data available at this time. If subsequent analyses of field and laboratory data gathered for the actual foundation design indicated conditions less suitable than those encountered in this set of borings, other foundation types may have to be considered. Such alternative foundations include piles (friction or end bearing), caissons, or, perhaps, some form of soil stabilization in conjunction with deep foundations. It is emphasized that deeper foundations do have several inherent drawbacks, including, for example, the need for engineering data at proportionally greater depths. Also, if the centroid of loads in pile groups is in, or quite close to, the limestone (causing an increase in stress in the limestone), the question of possible solution features in the rock mass becomes a significant consideration.

Table 2.2-1

GEOLOGIC AND HYDROGEOLOGIC CHARACTERISTICS OF STRATIGRAPHIC UNITS

Geologic age	Stratigraphic unit		Approximate thickness (feet)		General lithologic character		Water-bearing properties
	Western Putnam Co.	Remainder of area	Western Putnam Co.	Remainder of area	Western Putnam Co.	Remainder of area	
Recent and Pleistocene; Pliocene(?)	Post-Hawthorn to Recent deposits	Pleistocene and Recent deposits	40 to 140	20–140	Poorly sorted fine to very coarse sand, kaolin, and sandy clays	Fine to medium quartz sand, coquina, and shell and clay lenses	Nonartesian aquifer; zones of relatively high average permeability, generally supplies small to moderate amounts of water to rural domestic wells and municipal wells tapping coquina or medium to coarse sand beds; yields vary locally depending upon texture and extent of deposits.
Miocene		Late Miocene or Pliocene deposits		20–100		Fine to medium sand, shell and green calcareous silty clay	Nonartesian and secondary artesian aquifers; zones of relatively low average permeability, locally yield small amounts of nonartesian water to wells tapping medium to fine grained sands in the Pleistocene and Recent deposits, Late Miocene or Pliocene deposits and in the Hawthorn Formation; locally yield moderate amounts of artesian water to wells tapping shell bed in the late Miocene or Pliocene deposits and sand and limestone lenses in the Hawthorn Formation.
	Hawthorn Formation		0-120		Gray to bluish-green, plastic phosphatic, sandy clay; and thin beds of sand and sandy limestone		Impermeable clays and marls in both the Late Miocene or Pliocene deposits and in the Hawthorn Formation confines the artesian water in the Eocene Limestones and in the thin, lenticular sand, shell, and limestone beds above the Eocene Limestone.
Eocene	Ocala Group[1]	Crystal River Formation	0–120		White to cream, chalky, massive fossiliferous, marine, limestone		Floridan aquifer; yields large quantities of water to wells; utilized as the primary source of ground water in the project area. The formations that comprise the Ocala Group are similar in lithology and hydrologic properties and are considered to be a single hydrologic unit.
		Williston Formation	0–50		Tan to buff, granular, marine limestone		
		Inglis Formation	55(-) – 110		Tan to buff, coarsely granular to mealy, marine limestone; contains thin beds of dolomite and zones of foraminiferal coquina		
	Avon Park Limestone		150–245		White to reddish-brown, hard, dense limestone and dolomite; contains restricted zones of soft, porous, and locally chalky limestone; formation more completely dolomitized west of St. Johns River		Yields large amounts of water from soft, porous zones but dense, indurated zones restrict permeability so that generally yields are not as large as from overlying Ocala Group.
	Lake City Limestone		225+		Alternating beds of brown to buff, porous limestone; brown to white, massive limestone; bluish-gray to tan, dense, crystalline dolomite		

AFTER: B. J. BERMES, G. W. LEVE, AND G. R. TARVER 1963

Table 2.2-2

SIGNIFICANT EARTHQUAKES THAT HAVE AFFECTED THE FLORIDA PENINSULA

Year	Date	Time	MM Intensity	Location	N. Lat.*	W. Long*	Felt Area (Sq. Miles)
1811	Dec. 16	02:00	XII	New Madrid, Mo.	36.6	89.6	2,000,000
1812	Jan. 23	-	XII	New Madrid, Mo.	36.6	89.6	-
	Feb. 07	-	XII	New Madrid, Mo.	36.6	89.6	-
1868	Mar. 26	-	VI-VII**	Havana, Cuba	23.1	82.4	-
1879	Jan. 12	23:45 23:55	VI	Northern Florida	29.6	82.0	25,000
1880	Jan. 27 Jan. 23	22:33 04:00	VIII	Vuelto Abajo, Cuba	22.8	80.8	65,000
1886	Aug. 31	21:51 21:59	IX-X	Charleston, S. C.	32.9	80.0	2,000,000
1900	Oct. 31	11:15	V	Jacksonville, Florida	30.4	81.7	Local
1930	Jul. 19	13:53	IV**	Ft. Myers-Everglades, Florida	25.8	81.4	Local
1942	Jan. 19	14:05	IV**	Ft. Myers-Everglades, Florida	25.9	81.0	-
1945	Dec. 22	11:25	I-III	Miami-Hollywood, Fla.	25.9	80.1	Local
1973	Oct. 27	02:22	V	Orlando, Florida	28.7	81.0	25,000
1975	Dec. 04	06:57	III-IV	Near Daytona Beach	29.2	81.0	Local

* Approximate epicentral location
** Seismic origin questionable

References: Earthquake Information Bulletin, 1971
Coffman and Von Hake, 1973

Table 2.2-3

MODIFIED MERCALLI INTENSITY (DAMAGE) SCALE
(Abridged)

I. Not felt except by a very few under especially favorable circumstances. (I Rossi-Forel Scale.)

II. Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing. (I to II Rossi-Forel Scale.)

III. Felt quite noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing motorcars may rock slightly. Vibration like passing of truck. Duration estimated. (III Rossi-Forel Scale.)

IV. During the day felt indoors by many, outdoors by few. At night some awakened. Dishes, windows, doors disturbed; walls make creaking sound. Sensation like heavy truck striking building. Standing motorcars rocked noticeably. (IV to V Rossi-Forel Scale.)

V. Felt by nearly everyone, many awakened. Some dishes, windows, etc., broken; a few instances of cracked plaster; unstable objects overturned. Disturbances of trees, poles, and other tall objects sometimes noticed. Pendulum clocks may stop. (V to VI Rossi-Forel Scale.)

VI. Felt by all, many frightened and run outdoors. Some heavy furniture moved; a few instances of fallen plaster or damaged chimneys. Damage slight. (VI to VII Rossi-Forel Scale.)

VII. Everybody runs outdoors. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable in poorly built or badly designed structures; some chimneys broken. Noticed by persons driving motorcars. (VIII Rossi-Forel Scale.)

VIII. Damage slight in specially designed structures; considerable in ordinary substantial buildings with partial collapse; great in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. Persons driving motorcars disturbed. (VIII+ to IX- Rossi-Forel Scale.)

IX. Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb; great in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken. (IX+ Rossi-Forel Scale.)

X. Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Rails bent. Landslides considerable from river banks and steep slopes. Shifted sand and mud. Water splashed (slopped) over banks. (X Rossi-Forel Scale.)

XI. Few, if any, (masonry) structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly.

XII. Damage total. Waves seen on ground surface. Lines of sight and level distorted. Objects thrown upward into the air.

Image Quality
As you review the next group of images, Please note that the original documents
were of poor quality.

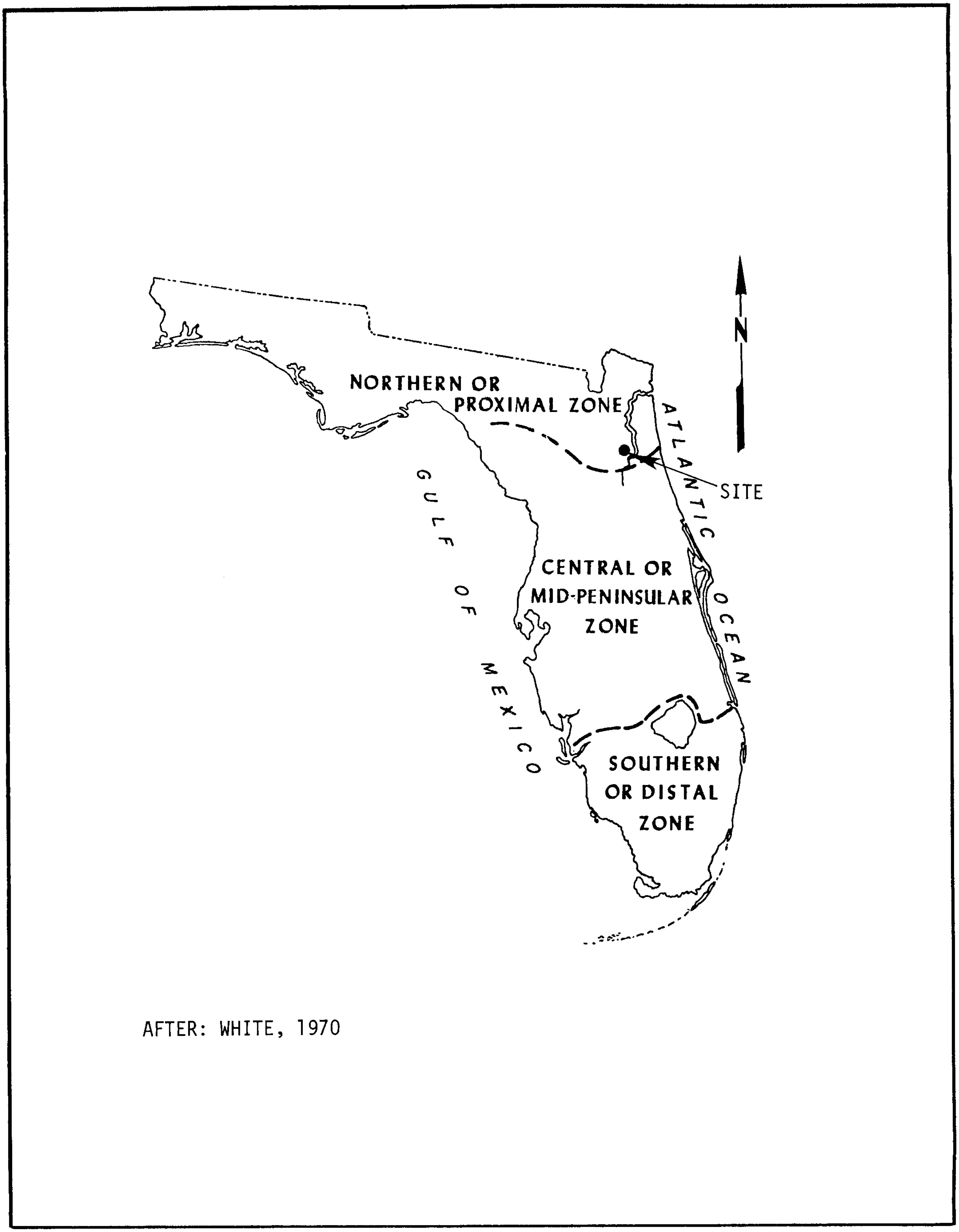
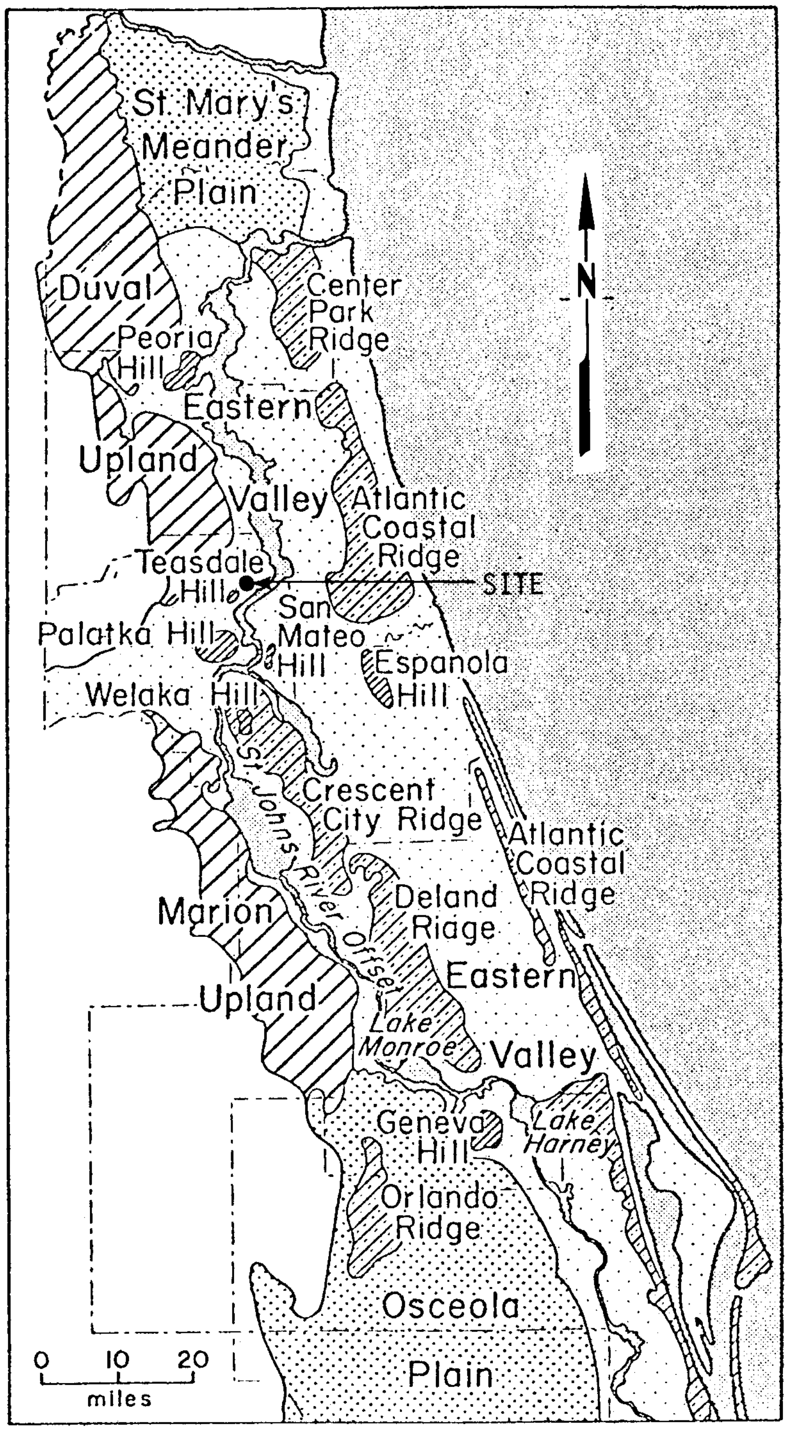


Figure 2.2-1. Major Transpeninsular Physiographic Divisions.



AFTER: PURI AND VERNON, 1964

Figure 2.2-2. Landforms in the Region of the St. Johns River.

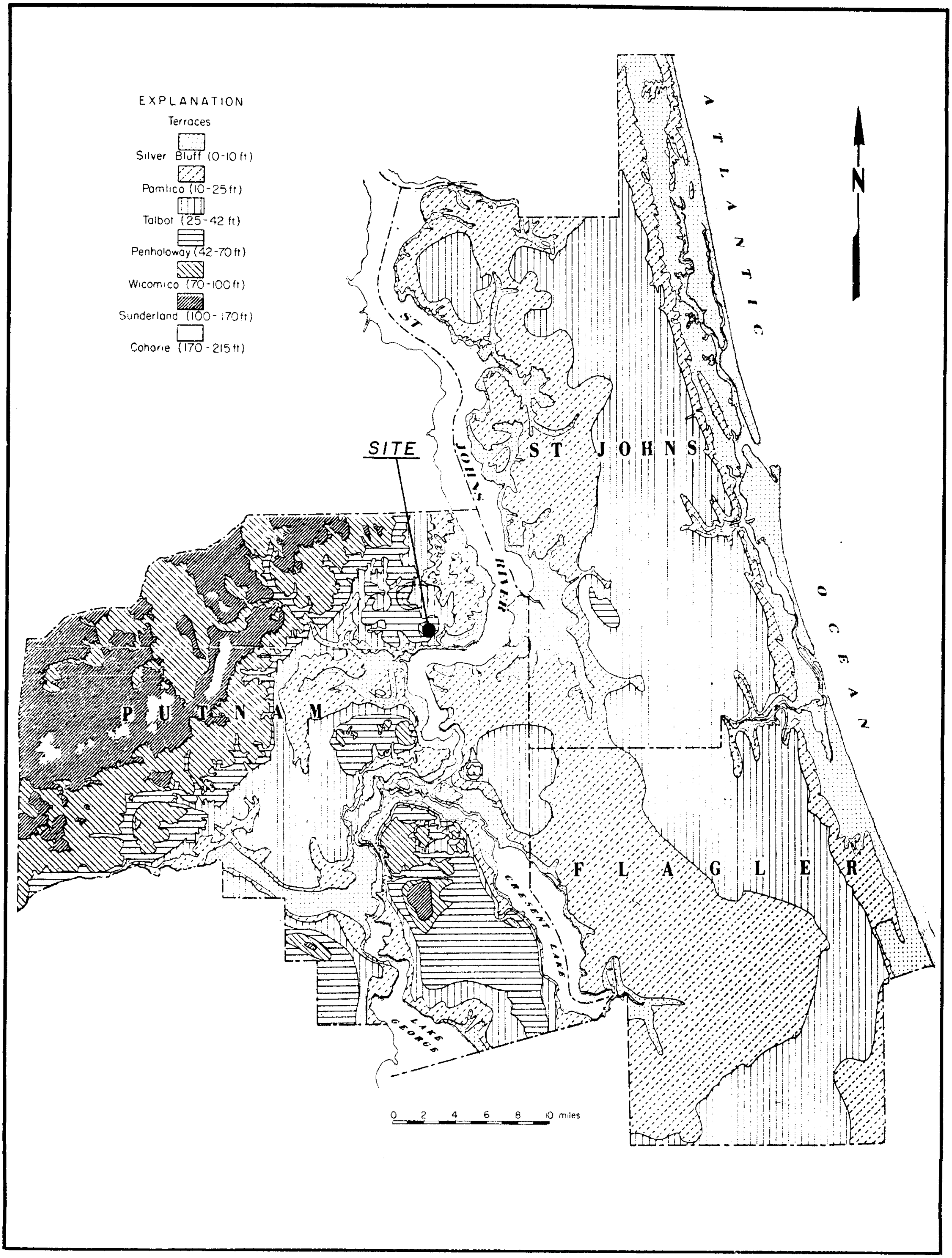
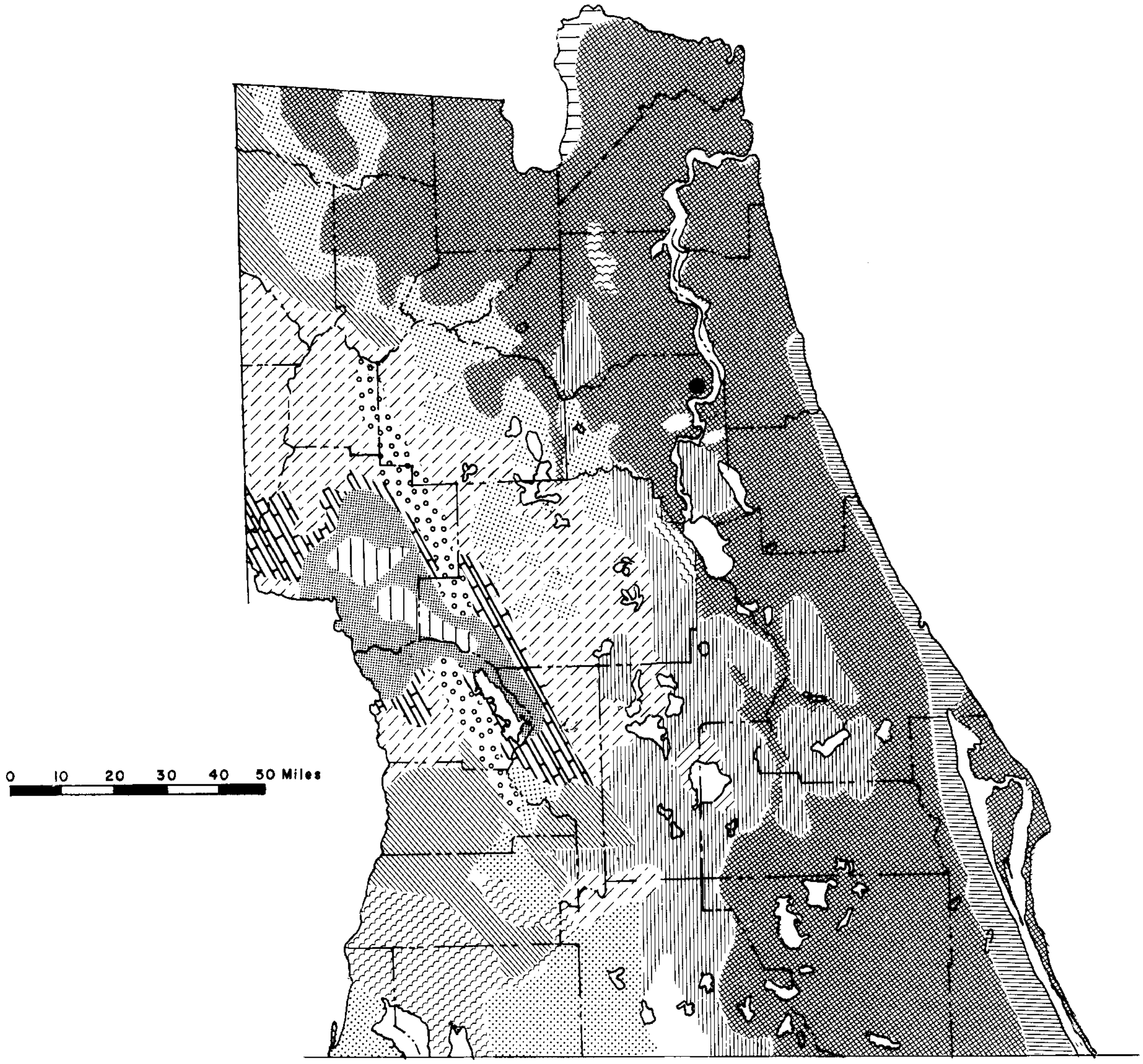


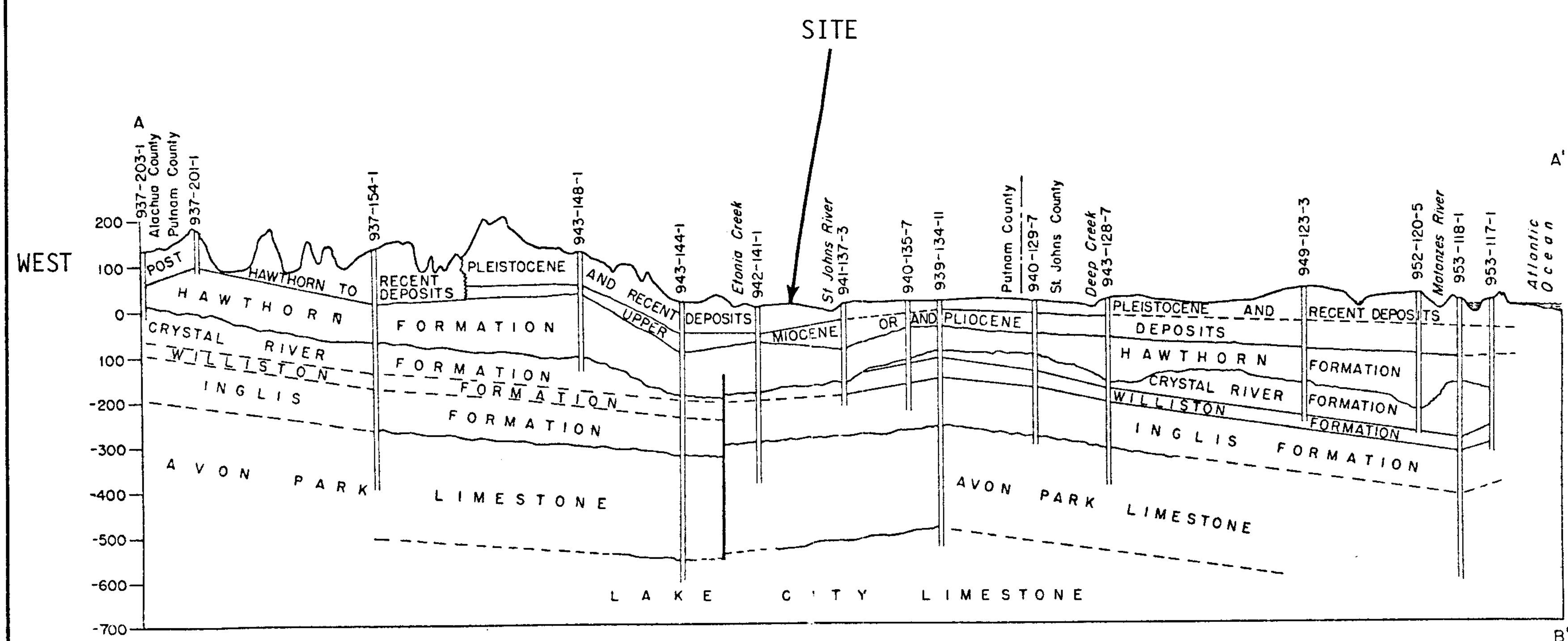
Figure 2.2-3. Regional Delineation of Marine Terraces.



SERIES	STAGE	FORMATION & MEMBER
RECENT AND PLEISTOCENE		SEVERAL LOWER MARINE AND ESTUARINE TERRACE DEPOSITS
		LAKE FLIRT MARL
PLEISTOCENE		ANASTASIA FORMATION
		FORT THOMPSON FORMATION
MIOCENE	CHOCTA-WHATCHEE	"CHARLTON" FORMATION
		JACKSON BLUFF FORMATION
		ALACHUA FORMATION
		FORT PRESTON FORMATION
		HAWTHORN FORMATION
	TAMPA	ST. MARKS FORMATION
OLIGOCENE		SUWANNEE LIMESTONE
EOCENE	JACKSON	CRYSTAL RIVER FORMATION
		WILLISTON FORMATION
		INGLIS FORMATION
	CLAIBORNE	AVON PARK LIMESTONE

AFTER: VERNON and PURI, 1964

Figure 2.2-4. Geologic Map of Northeast Florida.



MODIFIED AFTER: B. J. BERMES, G. W. LEVE, AND G. R. TARVER 1963

Figure 2.2-5. Regional Cross Section Showing Generalized Geologic Conditions.

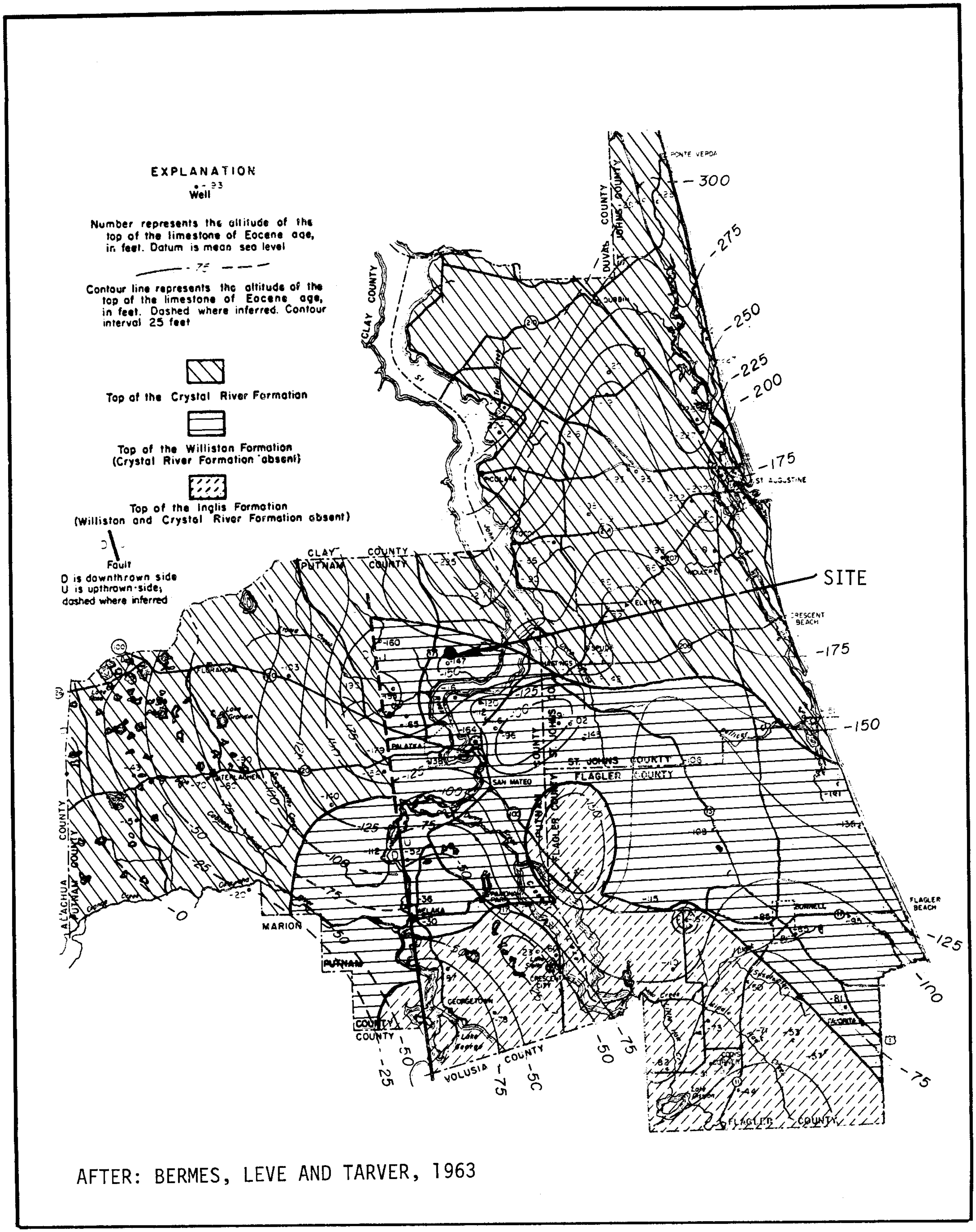
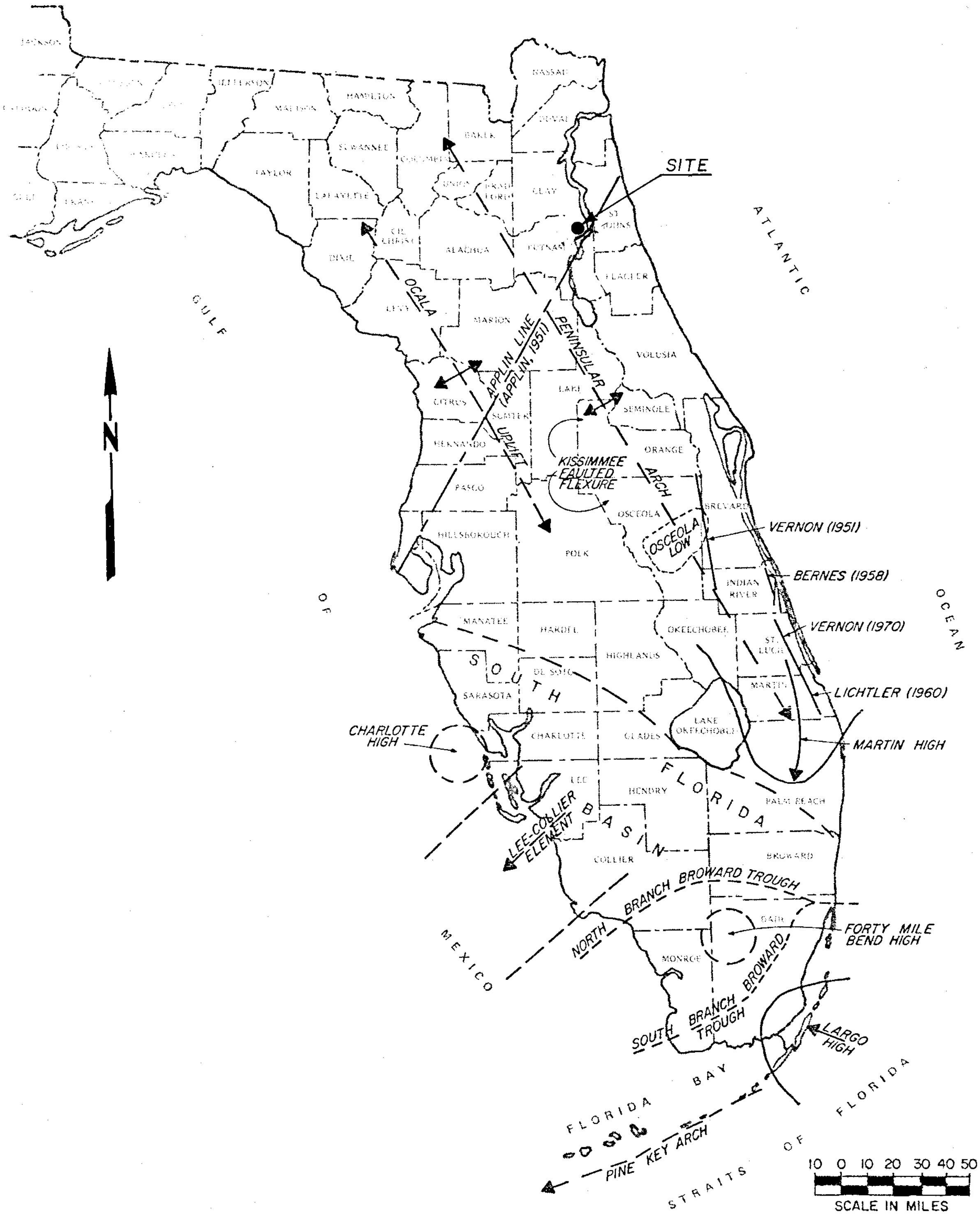
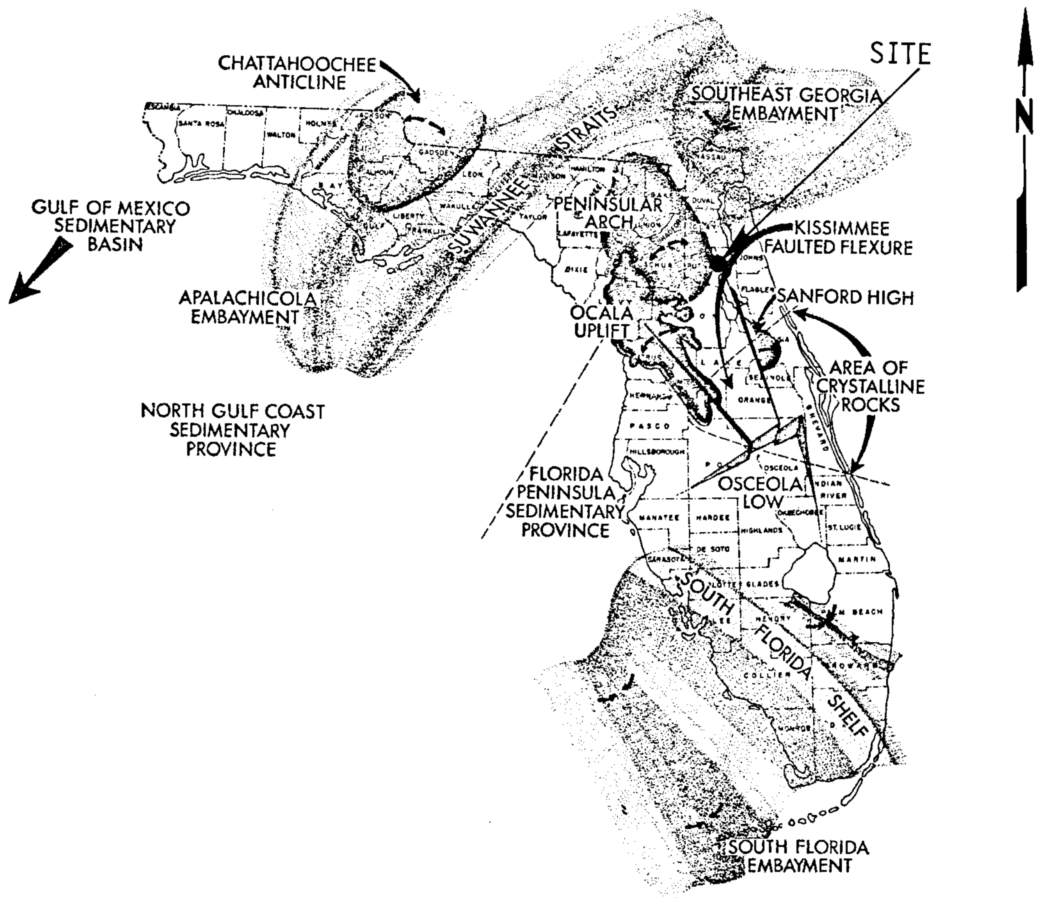


Figure 2.2-6. Contours to Top of Eocene.



AFTER CHEN,1965;VERNON,1951;BERMES,1958;
VERNON,1970;LICHTLER,1960;APPLIN,1951;
WINSTON,1971.

Figure 2.2-7. Regional Geologic Structure.



AFTER: PURI AND VERNON, 1964

Figure 2.2-8. Regional Geologic Structure.

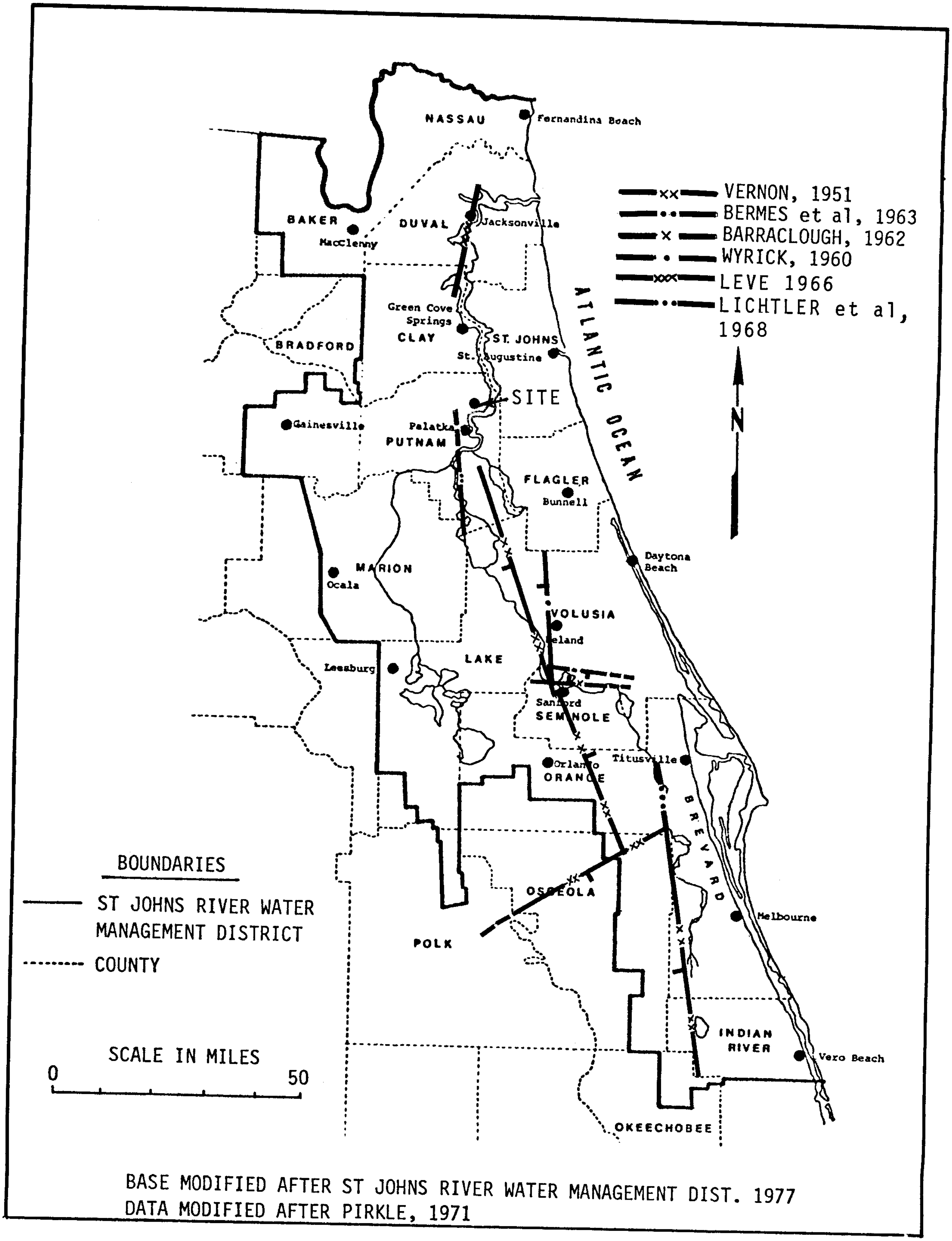


Figure 2.2-9. Some Reported Faults Along the St. Johns River

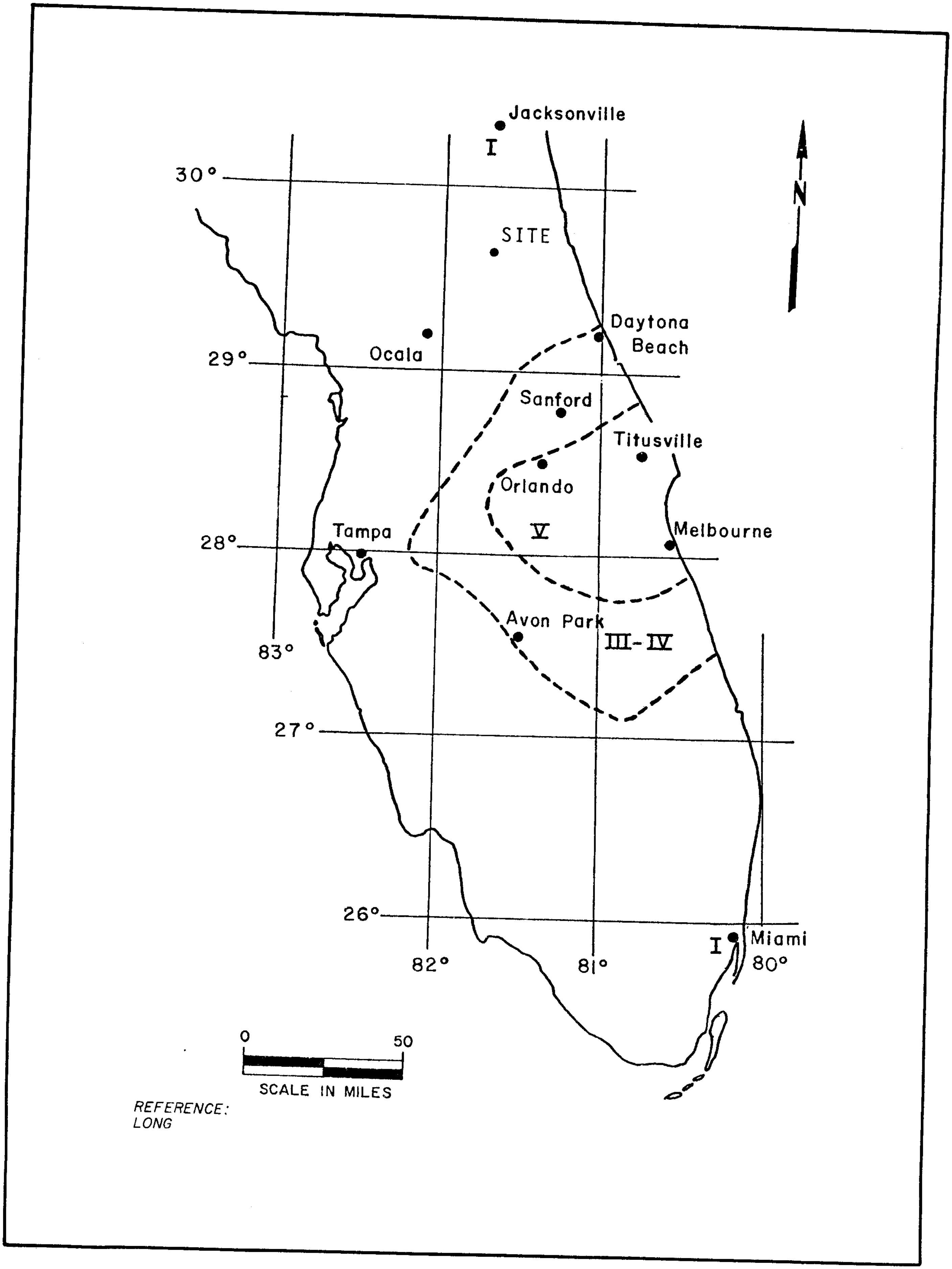


Figure 2.2-11. Modified Mercalli Isoseismal Map of the Florida Earthquake, October 27, 1973.

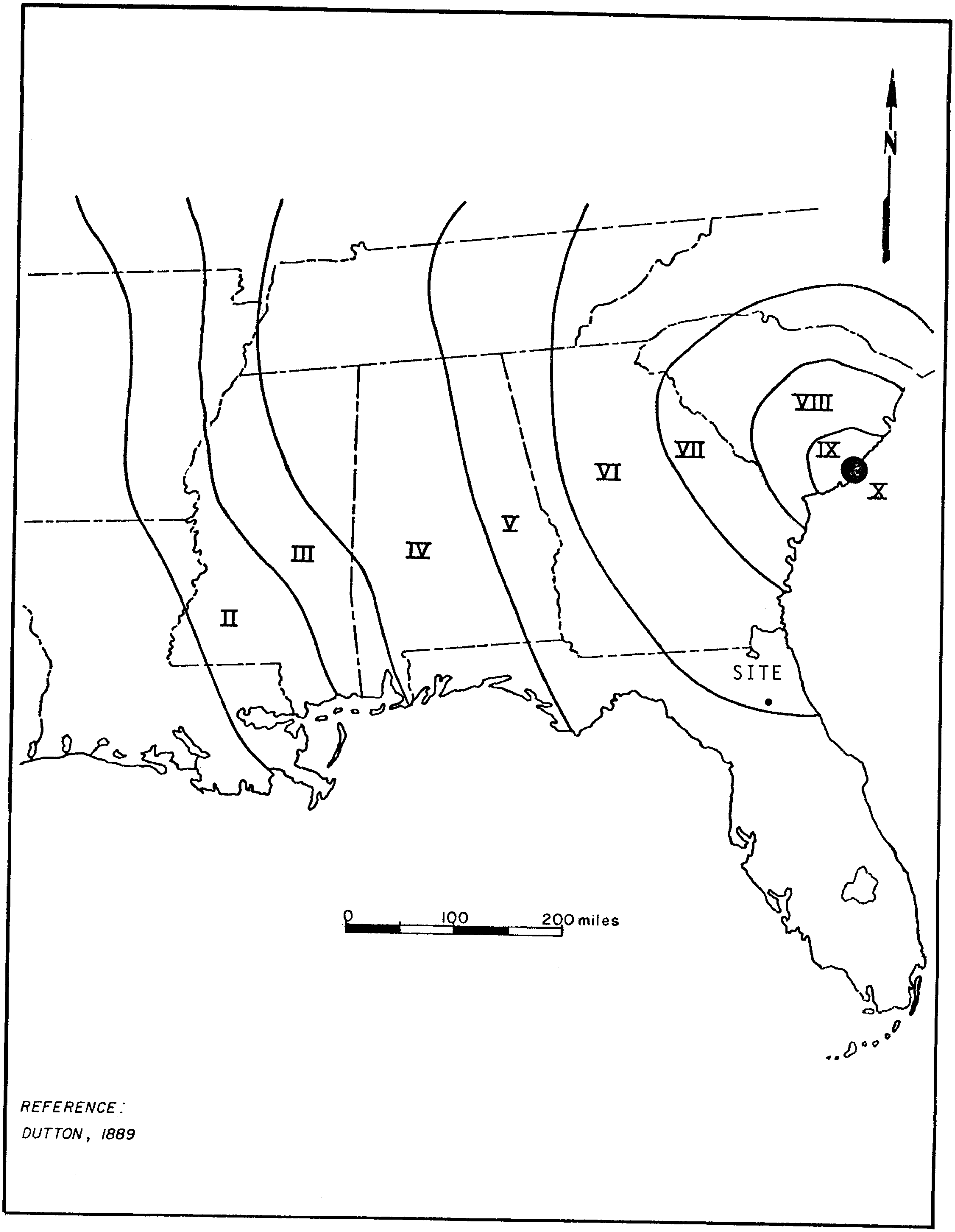


Figure 2.2-12. Modified Mercalli Isoseismal Map of the Charleston S.C. Earthquake August 31, 1886

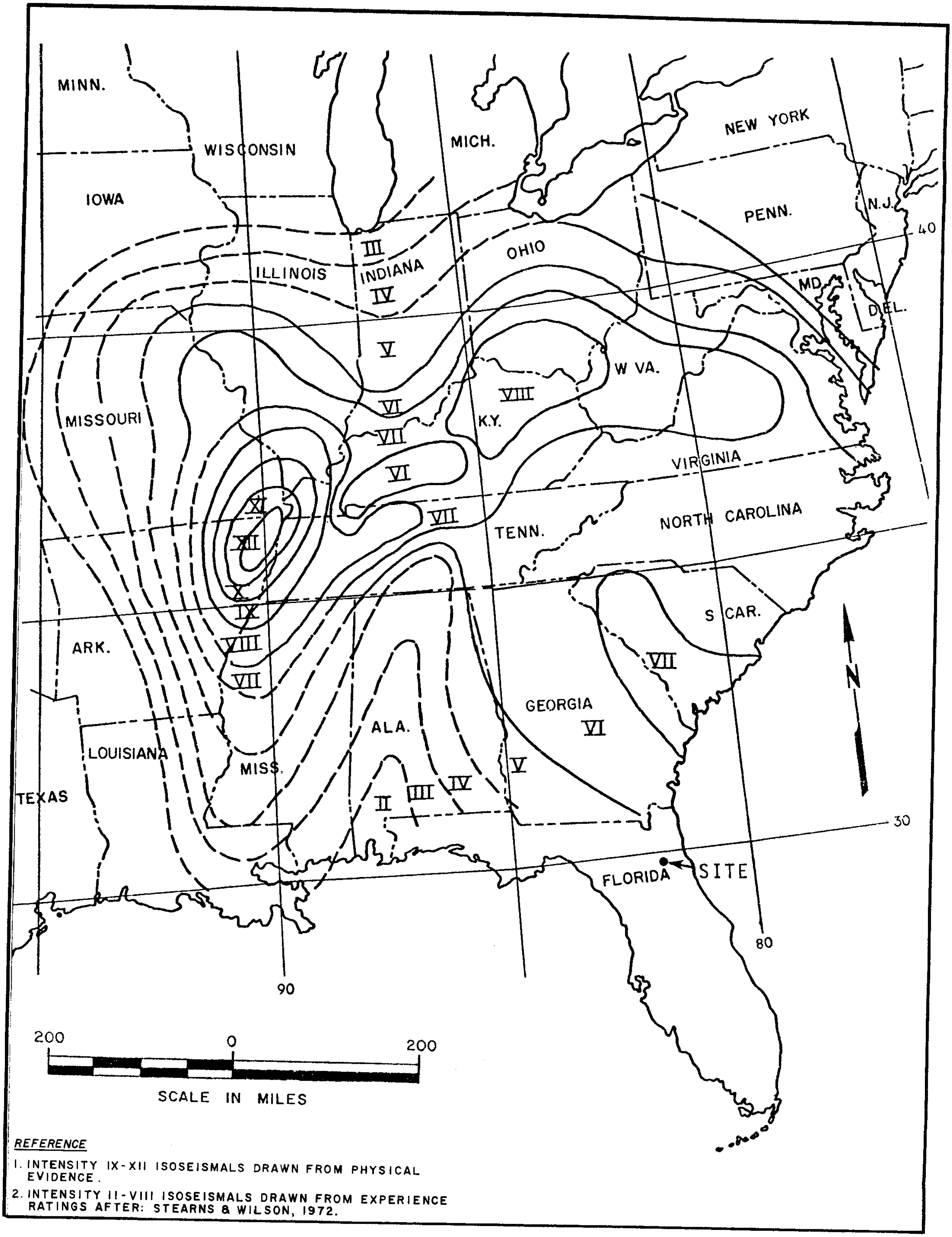


Figure 2.2-13. Modified Mercalli Isoseismal Map of New Madrid Earthquakes of 1811-1812.

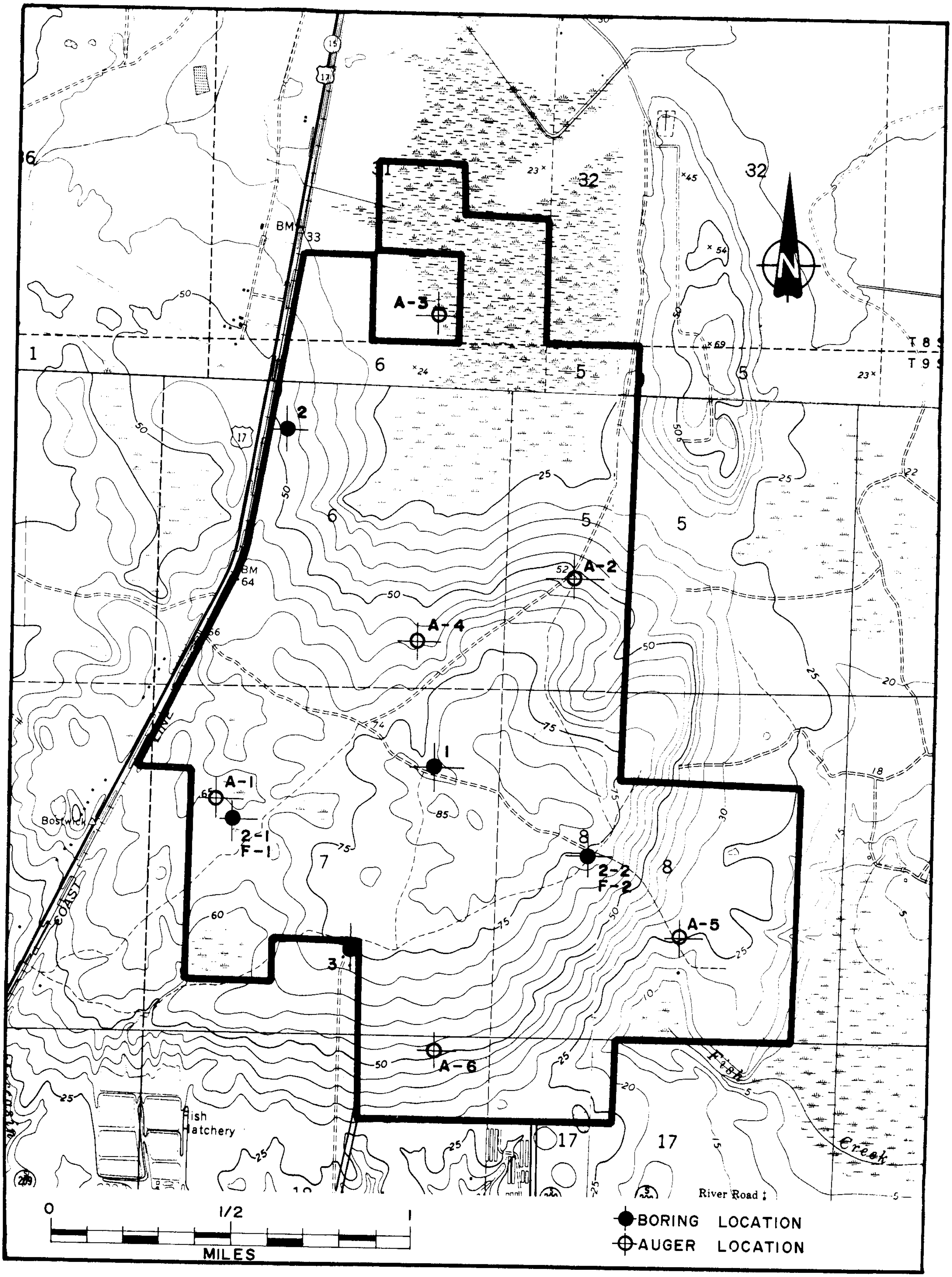


Figure 2.2-14. Soil Boring Location Map.

REVISED 3/15/79

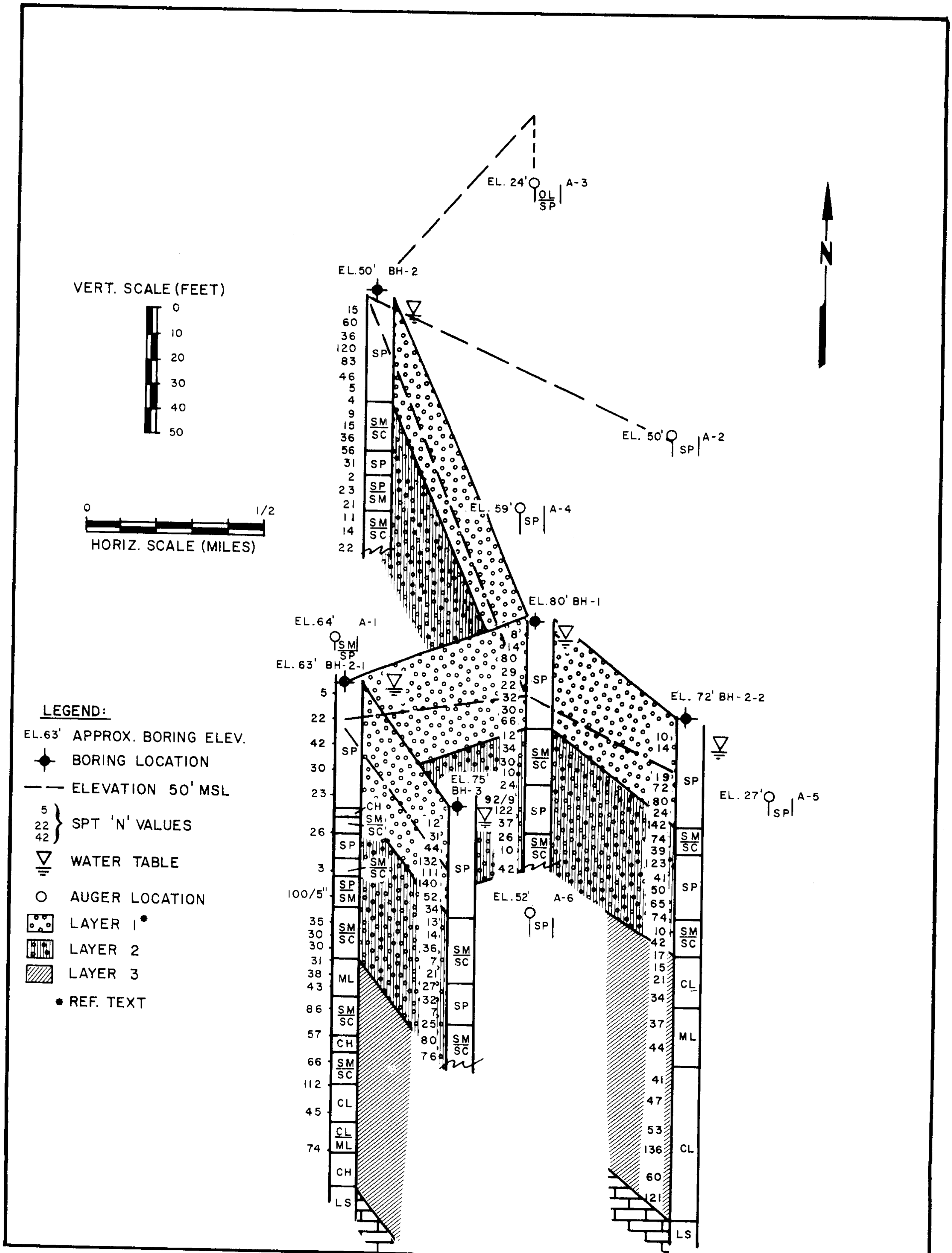


Figure 2.2-15. Panel Diagram - Generalized Subsurface Layers on Site.

2.3 HYDROLOGY

2.3.1 Surface Water

2.3.1.1 St. Johns River

Regional Environment

The St. Johns River, with its 300-mile length and 9,430 square mile basin, is the largest watershed entirely within the State of Florida (Figure 2.3-1). The river rises in a poorly drained swamp in northwestern St. Lucie County, and becomes a discernible channel in southern Brevard County. Downstream of Brevard County, channel widenings give rise to eight lakes: Sawgrass, Washington, Winder, Poinsett, Puzzle, Hardey, Monroe, and George. At Palatka, the river widens to form a virtually continuous estuary with minor tributary bays. It is characterized generally by many extremely deep and wide segments, low stream velocities and flow reversals. The low velocities and flow reversals are products of an average hydraulic gradient of only 0.15 feet per mile and a backwater effect from tidal and wind action (Reynolds, 1974). Combined wind and tidal effects influence river levels and flow a maximum of 161 miles upstream from the mouth. Although there are normal seasonal flow variations, the large drainage basin and average annual rainfall in excess of 50 inches, coupled with artesian flow and springs produces an estimated average freshwater discharge of 6,000 cubic feet per second (cfs) into the Atlantic Ocean at Jacksonville (United States Geological Survey [USGS], 1977).

Normal tidal ranges affect river flow up to Deland, Florida; thus this 140-mile river reach may be considered an estuary. However, as indicated by the water quality data base, a salinity wedge has not been observed at Palatka. Therefore, in the Palatka area, the river can be considered to be a freshwater estuary. The water surface area of the estuary reach of the river and its adjoining lakes is 246 square miles. Mean tidal ranges vary from 1.2 feet at Jacksonville and Palatka to 0.5 feet at Welakea to less than 0.5 feet from Lake George to Deland (USGS, 1977).

Local Environment

The proposed steam-electric generating station will be located near the northwest bank of the St. Johns River, approximately 73 miles from the mouth of the river and five miles downstream of Palatka, Florida. The river reach on which the site is located is commonly known as the Lower St. Johns River reach, which extends 100 miles from the Oklawaha River to the Atlantic Ocean. In the vicinity of the site the St. Johns River is approximately 6,000 feet wide; its depth varies from a few feet to a maximum of about 15 feet with an average depth on the order of 10 feet.

Flow records have been collected for the Lower St. Johns River by the USGS at Palatka and Jacksonville. Strong tidal action at both stations limits the accuracy of mean daily flow computations. The total flow volume for each day must be computed from recorded river stage and velocity measurements. Upstream flow is subtracted from downstream flow to determine net daily freshwater discharge to the ocean. Freshwater discharge is only a small part of the daily water movement (USGS, 1977).

The gaging station located near Palatka was installed in January 1968 and discontinued in February 1976. The published discharge records are computed using continuous stage and velocity records obtained from a recording deflection meter and represent the net of much larger upstream and downstream discharges. The maximum downstream and upstream flows of record are, respectively, 31,311 cubic feet per second (cfs) on November 5, 1970, and 20,400 cfs on March 24, 1968. Average freshwater discharge at Palatka has been computed as 7,613 cfs with a mean tidal range of 1.2 feet based upon eight years of published records (USGS, 1977). Average velocities are on the order of 0.2 foot per second (fps), with a maximum on the order of 1.0 fps.

Although the long-term average daily flow at Palatka (1.07 cfs per square mile) compares closely with flows at other stations on the St. Johns River (Appendix C, Table C-1), the tremendous storage capacity of the estuary prohibits meaningful substantiation of the daily Palatka station records through comparison of daily records from more reliable upstream stations. In addition, as shown in Appendix C, Table C-2, little correlation is evident between the gaging station in Jacksonville and the Palatka station.

The only additional source of streamflow data on the St. Johns River in the project vicinity is the USGS Rice Creek gaging station at U.S. Route 17, with stage records from 1959 to 1972. At this station, located approximately 4,000 feet from the St. Johns River, Rice Creek is a St. Johns backwater, experiencing rapid response to stage fluctuations in the river. The stage records from this station may be used to approximate stages on the St. Johns, thereby increasing the available data for river stages to seventeen consecutive years. The data from these two stations are discussed in Appendix C, Section C.1.1.

Low Flows

In order to quantify the water supply potential and waste assimilation capacity of a stream, a design flow regime must be selected. Usually, a statistical frequency analysis may be performed to derive low flows and return periods having various probabilities of occurrence. In addition to the low flow frequency (or return period), the duration of the low flow must also be specified.

The St. Johns River in the site vicinity normally experiences tide-induced flow reversals twice daily. Consequently, there are instantaneous zero discharges at moments of flow reversal and periods of negative (upstream) flow. The river functions similar to a reservoir with inflow from both the ocean and the drainage basin being stored through variations in stage. Therefore, even during periods of near zero flow or negative flow, there may be an increase in the volume of water in the estuary if the stage is increasing. Conversely, during periods of high downstream flow there may be a decrease in the volume of water in the estuary if the stage is decreasing. As a result, flow rates in the St. Johns at Palatka do not reflect its water supply potential, and the usual statistical low flow analysis is meaningless.

Additionally, the water supply potential in the St. Johns estuary is directly related to the volume of freshwater in storage which is controlled by the combined effects of freshwater runoff and stages in the Atlantic Ocean. Mean daily freshwater runoff into the estuary is 7,613 cfs. During periods of low freshwater runoff, large volumes of freshwater are maintained by stages on the Atlantic Ocean. Withdrawal of water from the St. Johns, therefore, would be compensated by this ability to maintain a large reservoir of freshwater during periods of low freshwater runoff.

Waste Assimilative Capacity

The waste assimilation capacity of the estuary is dependent on its dilution and dispersion characteristics during a design flow regime. In Florida, the usual design flow regime for waste assimilation on streams not subject to tide-induced flow reversals is normally taken as the seven-consecutive-day, one-in-ten year (7-day Q_{10}) minimum discharge (Oven, 1978). Since the St. Johns River is subject to tidal effects, this flow condition may not be computed for reasons previously stated. As discussed in Appendix C, the worst flow condition at the site in terms of effluent dispersion and dilution occurs when a minimum volume of water is discharged pass the site in either the upstream or downstream direction. As a seven-day duration is normally utilized for river design flow conditions, the available USGS flow records at Palatka were examined for the seven-consecutive-day period with the minimum cumulative upstream or downstream flow. This flow condition, hereinafter referred to as the seven-consecutive-day average daily minimum absolute flow (7-day MAF) represents the 7-day period of record in which there was the least amount of flushing action in the estuary from either upstream or downstream flows.

As stated above, the design flow is usually taken as the once-in-ten-year minimum discharge. The short streamflow record of only eight years at Palatka prohibits a meaningful frequency analysis for a 10-year design flow. However, during the 7-day MAF of record from September 2, to September 8, 1971, there was volumetric flux upstream of only 2522 acre-feet. This represents an average flow rate of 180 cfs or a net rate of movement of the water body of less than 0.004 fps. Because this closely approximates oscillatory movement in the estuary, and a completely oscillatory tidal cycle represents the minimum amount of flushing possible, the 7-day MAF was utilized in the analysis as a suitable design flow.

High Stages

As discussed earlier, stage records are available from the St. Johns Palatka station and Rice Creek station for a total of 17 years. The highest stage of record was 5.5 feet mean sea level (MSL) which occurred in September 1964 as a result of Hurricane Dora. This is the only hurricane to move inland from the east over extreme northeastern Florida in over 90 years of record (National Oceanic and Atmospheric Administration [NOAA], 1976). The strong, long duration onshore winds produced unusually high tides on the Atlantic coast from 5 to 8 feet or more above normal. The storm surge up the St. Johns River was further aggravated by increased freshwater flow caused by the storm's total rainfall, in excess of 10 inches over the northern portion of the St. Johns Basin.

Apart from Hurricane Dora, most tropical storms reaching this latitude have tended either to move parallel to the coastline well out to sea, or to lose much of their force by moving overland before reaching this area. As a result, most of the extreme stage events are the result of late summer and fall storms along the northeast Florida coast (NOAA, 1976), and are marked by winds of 20 to 30 miles per hour and steady drizzle. The greatest stage at Palatka resulting from such a storm was 3.8 feet MSL, on September 30, 1968. A summary of the annual flood stages near the site is provided in Appendix C, Table C-3.

As Hurricane Dora was the most severe hurricane in over 90 years of record in the general region of the site and produced the highest stages in the seventeen years of state records near Palatka, it was assumed to be a suitable design hurricane for use in determining hurricane surge elevations in the site vicinity.

The Department of Housing and Urban Development (HUD) has developed a Flood Hazard Boundary Map (Flood Insurance Administration, 1978) for Putnam County. The areal extent of the Flood Hazard Areas and 1964 hurricane flood stages are shown in Figure 2.3-2.

2.3.1.2 Local Tributaries and Site Hydrologic Characteristics

Tributaries

Tributaries draining the general site area are shown in Figure 2.3-3 and Figure C-6. Their drainage areas are summarized in Appendix C, Table C-6. The major tributaries in the general site vicinity are Rice Creek, draining 353 square miles southwest of the site, and Cedar Creek draining 18 square miles northeast of the site. Of tributaries in the site vicinity, discharge records are only available for Rice Creek. Two USGS stations are presently in operation in this basin, one on Rice Creek near Springside and one on a tributary, Etonia Creek, at Bardin, Florida. A third station, discussed in Section 2.3.1.1, operated at the

U.S. Route 17 Rice Creek bridge from 1959 until 1972. The discharge records from this station are quite poor as the flow is affected by St. Johns River stages and effluent discharges from the Hudson Pulp and Paper Company (USGS, 1974).

Although records on Rice Creek at the U.S. Route 17 bridge indicate periods of zero discharge, such flows are the result of creek discharges being forced into storage by high stages on the St. Johns River. This is evident by the fact that the minimum discharge of record at the upstream Etonia Creek station is 54 cfs. The net average discharge from the basin is 345 cfs with a maximum net daily discharge of almost 6,500 cfs.

By assuming an average discharge per square mile comparable to measured discharges on Rice Creek and Etonia Creek, the discharges from the remaining tributaries in the site vicinity areas were determined as shown in Table C-5 and C-6. Average discharges range from 18.0 cfs for Cedar Creek to 0.5 cfs for a small unnamed tributary draining the southwest corner of the site.

2.3.1.3 Onsite Drainage

Site Drainage Characteristics

Site elevations vary from 5 feet MSL in the southeastern corner to 85 feet MSL in the central portion to 25 feet MSL in the north (Figure 2.3-2). Figure E-11 (Appendix E) is based on a site specific U. S. Soil Conservation Service soil survey (SCS, 1978). The soils in the central or upland portion of the site are predominately of the Tavares, Immokalee and Cassia soil series. The Tavares series is a nearly level, moderately wet, acidic, rapidly permeable deep fine sand. The Immokalee series is also a nearly level to gently sloping, rapidly permeable fine sand, but is poorly drained. The Cassia series is a permeable fine sand that is moderately well drained. The upland portion of the site is surrounded by nearly level poorly drained fine sands of the St. Johns-Cassia-Adamsville soil series association.

The high rate of infiltration associated with the soils in the upland portion of the site, and the lack of elevation relief with the poorly drained soils surrounding the upland, results in an absence of well defined surface watercourses on the site. Rainfall percolates into the ground in the upland, migrates downslope, and eventually discharges into the lowlands.

Site Erosion

The capability of a soil surface to resist erosion is a function of the soil's physical and chemical properties, the average rainfall intensity, length and degree of slope, and the vegetative cover. As the site has no defined surface watercourses, soil loss will be principally the result of sheet and rill erosion. Such soil losses may be estimated by the Universal Soil Loss Equation (USLE) developed by the SCS (1975). The parameters listed above are quantified in Appendix C, Section C.1.2.

Site erosion is limited primarily to the upland portion of the site discussed in the previous section. Soils eroded from the upland slopes will be deposited in the surrounding lowlands. The quantity of eroded soils actually reaching the lowlands is dependent on a sediment delivery ratio. The ratio may be determined with SCS (1965) nomographs relating the sediment delivery to drainage basin area.

The site area contributing to the sediment production was estimated to be on the order of 1550 acres. This area consists of the Tavares-Immokalee-Cassia soil series association with a vegetative cover of long leaf pine, turkey oak, grasses, and saw palmetto. As detailed in Appendix C, Section C.1.2, soil loss under the above parameters is calculated to be on the order of from 0.2 to 0.4 tons per acre per year This is a relatively low rate of soil loss. By comparison, the average rate of erosion in the United States is 1.7 tons per acre per year (EPA, 1974); for agricultural areas, the average is 7 tons per acre per year (Georgia State Soil and Water Conservation Committee, 1973); and unprotected highly erodible soils can yield as much as 350 tons per acre per year (Diseker and Richardson, 1968). The sediment delivery ratio may be as high as 0.5 resulting in the depositions of from 150 to 300 tons of sediment per year in the lowlands on and surrounding the site.

2.3.1.4 Water Quality

Florida Water Quality Standards

Water quality standards are statements of the physical, chemical and biological characteristics of any water body which must be maintained if that water is to be acceptable under specific usage classifications. These standards are defined for the State of Florida by the Florida Department of Environmental Regulation (DER) under Chapter 17-3, 17-4, and 17-6, Florida Administrative Code, effective March 1, 1979.

The DER has established a designation system by which waters of the State are classified according to their usage. Except for a portion of the headwaters, the entire length of the St. Johns River has been designated as a Class III water body. These waters are used for recreational purposes, including such body contact activities as swimming and water skiing, and for the maintenance of a well-balanced fish and wildlife population.

The DER also has set specific standards for discharges of heated effluent into waters of the State of Florida. As part of these standards, the State has designated its waters as being fresh, coastal, or open and in either Peninsular or Northern Florida Climatic Zone. The St. Johns River in the vicinity of the proposed site is classified as freshwater and is in the Northern Climatic Zone.

The DER allows a "zone of mixing" within which certain standards are not applicable. The "zone of mixing" is defined in Chapter 17-3.021 as "... a volume of surface water containing the point or area of discharge and within which an opportunity for the mixture of water with receiving surface waters has been afforded." The DER has classified the St. Johns in the vicinity of the proposed discharge as estuary (Florida DER, 1978). For such classification the maximum allowable mixing zone shall be 125,600 square meters.

The water quality standards which apply to surface waters beyond the zone of mixing include 17-3.061 setting forth the criteria that apply to all waters of the state, 17-3.121 setting forth the criteria that apply to Class III waters, and 17-3.05 setting forth thermal criteria for surface waters.

Federal Effluent Quality Standards

In addition to the in-stream regulations of the State of Florida, limitations on effluent quality have been promulgated by the U. S. Environmental Protection Agency (EPA) pursuant to the Federal Water Pollution Control Act (PL 92-500). Effluent quality criteria have been defined for the electric power industry under 40 CFR 423, Effluent Guidelines and Standards for Steam Electric Power Generating Point Source. These regulations require application, not later than July 1, 1983, of the "best available technology economically achievable which will result in reasonable progress toward the national goal of eliminating the discharge of all pollutants." The effluent limitations pertinent to achieving the above goal are shown in Appendix C, Table C-11.

Ambient Water Quality

The St. Johns River water quality sampling station nearest to the site is located at the U.S. Route 17 bridge at Palatka approximately four miles upstream of the site. Sampling is conducted by the USGS and published in "Water Resources Data for Florida", under sampling station number 02244450 (USGS, 1977). Measurement of chemical quality parameters began in 1962 and were performed weekly from June to October of 1962 and from November 1966 to July 1973. From January 1974 to present the measurements have been monthly. Water temperature measurements began in October 1970 and were performed on a weekly basis until 1973. From January 1974 through February 1976 temperature measurements were conducted once-daily. Appendix C, Table C-8 contains the USGS water quality data base at the Palatka station. Table 2.3-1 summarizes measurements from the St. Johns River compared with applicable Florida Water Quality standards.

The St. Johns River in the vicinity of the site is classified as Effluent Limited (DER, 1975) meaning that additional wastewater discharges will be permitted so long as the wastewater meets secondary treatment standards (secondary waste treatment removes no less than 90 percent of BOD-5 and suspended solids). Effluent limited segments, in general, are not greatly affected by additional wastewater discharges provided that existing and new discharges meet specified effluent standards (Jacksonville Area Planning Board, 1977).

In the site vicinity, the St. Johns has relatively high nitrogen concentrations and, as a result, has some dissolved oxygen (DO) problems (DER, 1975). Ten samples out of the available 64 had DO concentrations less than the DER standard of 5.0 mg/liter, and a minimum concentration of 2.7 mg/liter has been recorded.

Specific conductance and concentrations of total dissolved solids (TDS) and chlorides are relatively high in the Lower St. Johns, even though the river is classified as freshwater. Four heavy metals--cadmium, lead, mercury, and zine--have been recorded at concentrations in excess of state standards at the Palatka sampling station. Historical water quality records (STORET Data System) indicated that these elements are exceeded at nearly every St. Johns River station.

In addition to USGS water quality data, Dames & Moore collected baseline water quality data in September 1977 and January, February, and March 1978 in conjunction with the aquatic ecological monitoring program. Sediment samples were collected in April, 1978. Sampling stations are depicted in Figure 2.3-3. Results of field and laboratory water quality analyses are shown in Appendix C, Table C-10 and C-11 while the data from the sediment samples are shown in Table C-12. In general, concentrations of various parameters measured were similar to those recorded by the USGS.

Water quality in Rice Creek is not as good as that in the St. Johns River. The creek has been classified as Water Quality Limited, meaning that unusually stringent effluent limitations are required in order to meet water quality standards. Although water quality data is limited for Rice Creek, available samples summarized in Appendix C, Table C-9 indicate problems with nitrogen, phosphate and DO.

TABLE 2.3-1

WATER QUALITY OF THE ST. JOHNS RIVER
AT PALATKA
COMPARED WITH STATE STANDARDS

Parameter[a]	Number of Measurements	State Limitation[b]	Number of Measurements Not Meeting Standards
Alkalinity	48	20[c]	0
Ammonia[d]	54	20[e]	0
Cadmium	23	1.2[e]	3
Copper (total)	12	30[e]	0
Dissolved Oxygen	64	5[c]	10
Iron (total)	16	1	0
Lead (total)	23	30[e]	2
Mercury (total)	25	0.2[e]	6
Nickel (total)	3	0.1	0
pH	51	6.0-8.5[f]	0
Selenium (total)	5	25[e]	0
Zinc (total)	20	30[e]	3

Source: STORET Data File

[a]Units in milligrams/liter unless otherwise noted
[b]Chapter 17-3.121, FAC, effective 3-1-79
[c]Minimum limitation
[d]Un-ionized
[e]Micrograms/liter
[f]Units

Table 2.3-2

Deleted

Table 2.3-2

Water Quality of Rice Creek
Compared With State Standards

Parameter Measured	Units	Number of Measurements	DER Limitations[a]	Number of Measurements In Excess of Standards
Turbidity	JTU	7	50	0
DO	mg/l	15	5[b]	14
BOD (5-day)	mg/l	8	5	4
pH	unit	16	6.0-8.5	0
Chloride Cl, Dissolved	mg/l	11	250	0
Arsenic As, Totaled	mg/l	5	0.05	0
Copper Cu, Totaled	mg/l	6	0.5	0
Iron Fe, Totaled	mg/l	5	0.3	4
Lead Pb, Totaled	mg/l	4	0.5	0
Zinc Zn, Totaled	mg/l	6	1.0	0
Fluorine F, Dissolved	mg/l	11	10	0
TSS	mg/l	2	5	0
TDS Residue @180°	mg/l	11	500 (1000)[c]	2 above 500
Phenols	mg/l	1	0.001	-
KJELDAHL Nitrogen Totaled	mg/l	-	3	-

[a]Maximum limitations except as noted.

[b]Minimum limitations

[c]500 mg/l TSD - maximum monthly average
1000 mg/l TDS - maximum instantaneous measurement.

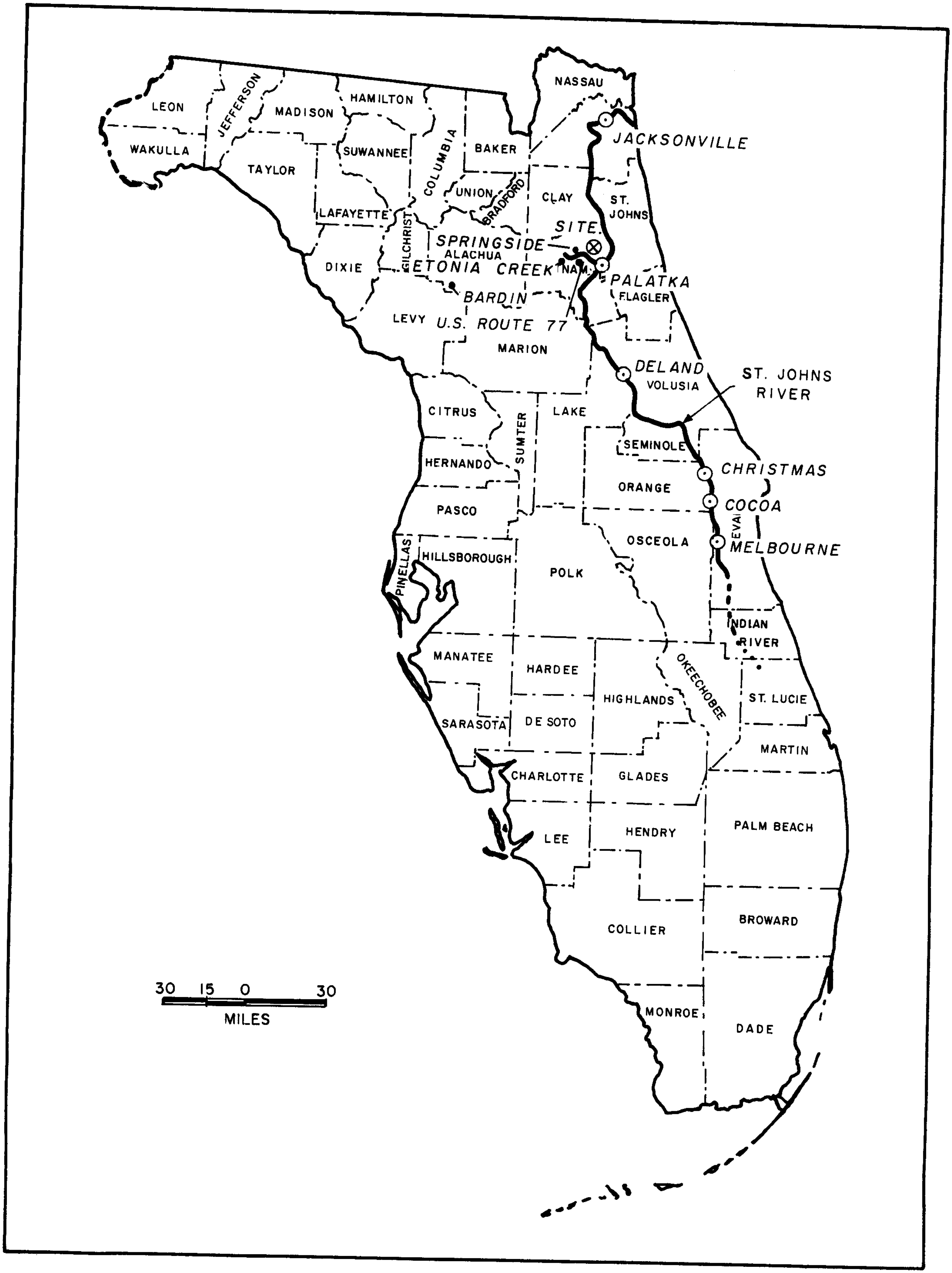


Figure 2.3-1. St. Johns River Basin.

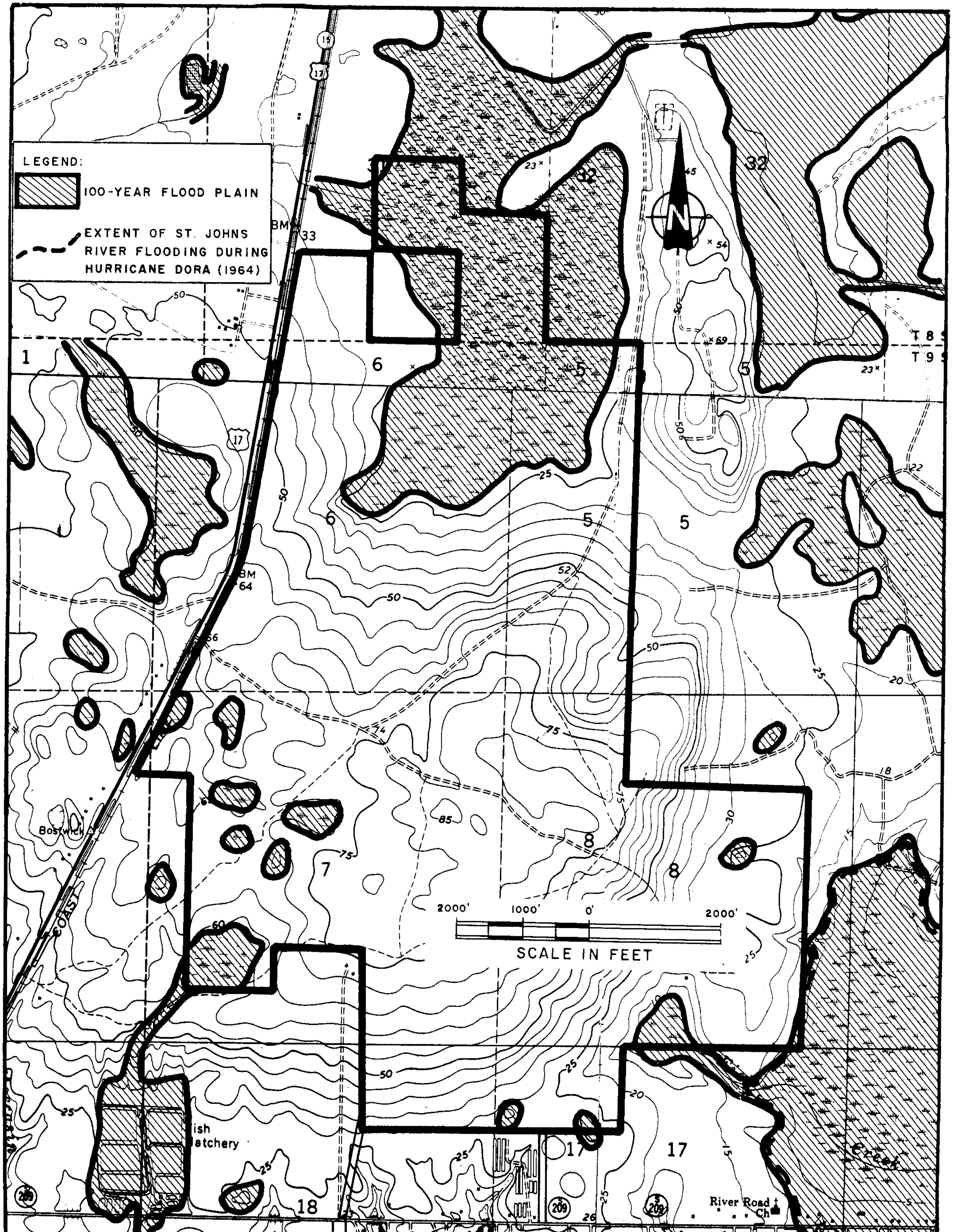


Figure 2.3-2. 100 Year Flood Plain and Extent of Hurricane Flooding.

REVISED 3/15/79

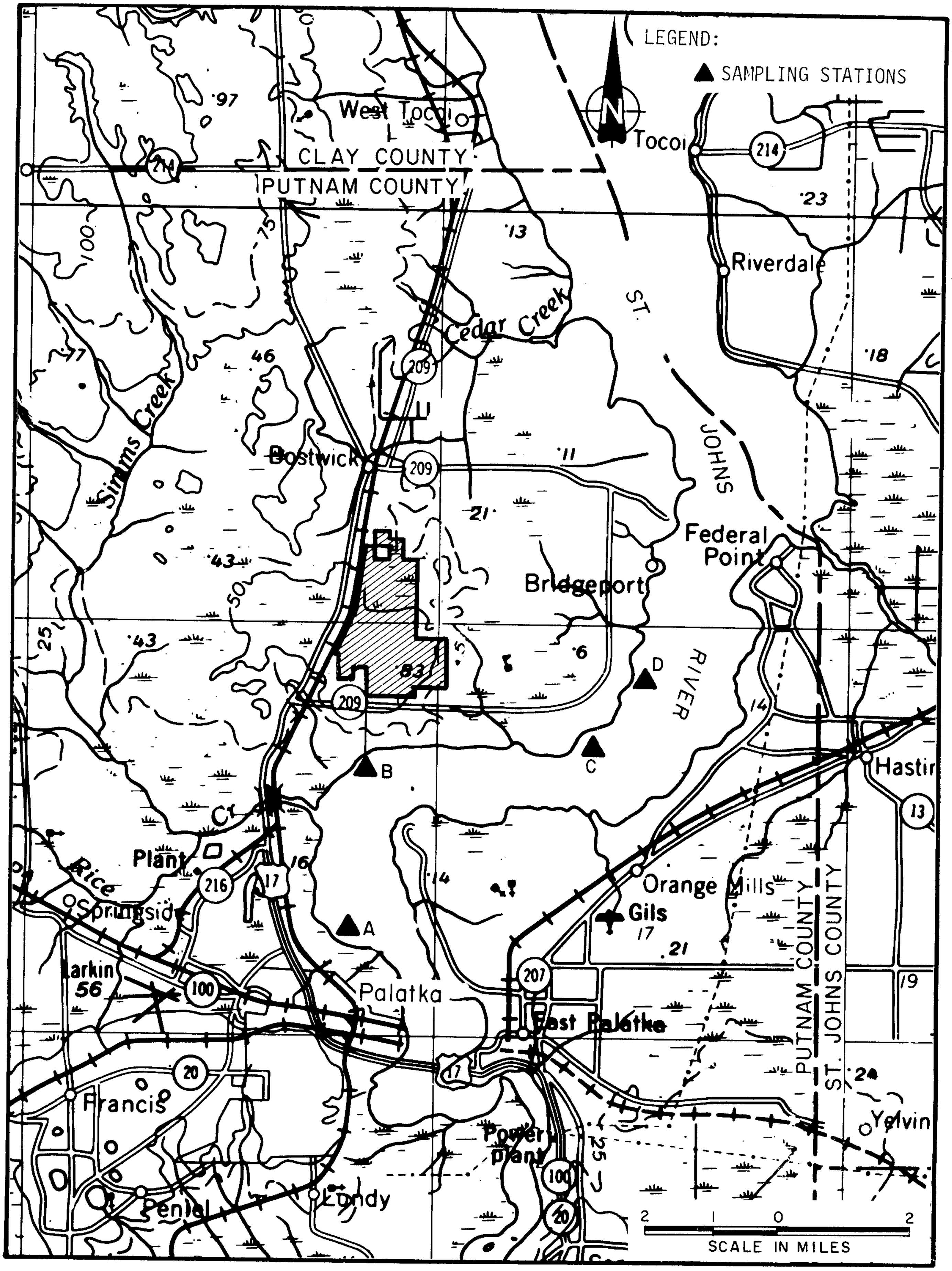


Figure 2.3-3. Local Tributaries and Dames & Moore Sampling Stations.

APPENDIX C

SURFACE WATER HYDROLOGY

C.1 BASELINE CONDITIONS

C.1.1 St. Johns River

General

As discussed in Section 2.3.1.1 the Seminole steam-electric generating station is located northwest of the St. Johns River, approximately 73 miles from its mouth and five miles downstream from Palatka, Florida. Although USGS (1977) flow records at Palatka and Jacksonville are available, the strong tidal action at both stations makes mean daily flow computations difficult. Due to the uncertainty of the data and the limited period of record, substantiation of the Palatka records was sought through analysis and comparison with other stations in the St. Johns watershed. Average discharges in cubic feet per second (cfs) per square mile are given in Table C-1 for the selected stations shown in Figure C-1. As seen in the table, the average fresh water discharge at Palatka of 1.07 cubic feet per second per square mile (cfsm) is comparable to the discharge from upstream stations that are not tidally influenced.

However, due to the tremendous storage capacity in the estuary from Palatka to Jacksonville, daily flow records from upstream stations cannot be used to extend the daily records at Palatka. In addition, as shown in Table C-2, the Jacksonville station with its 20 years of records shows no flow correlation with flows at Palatka.

The only source of meaningful data on the flow regime of the St. Johns River near the site other than the Palatka station is the USGS station on Rice Creek (Figure C-1). Because Rice Creek is a backwater to the St. Johns River at the station and experiences rapid response to stage fluctuations in the river, it may be used to extend the state record available on the St. Johns station. The peak stage records from the two stations are shown in Table C-3.

Low Flows

In order to assess the impact of the plant surface water discharges, a design low flow condition was selected for the St. Johns River which approximated minimum flushing from the estuary during a seven day period with a return interval of once in ten years. This flow, termed the minimum absolute flow, is hereinafter referred to as the 7-day MAF. The flow regime at Palatka during the 7-day MAF is summarized in Table C-4.

The flow regime at Palatka was extrapolated to the site vicinity using a Dames & Moore hydrodynamic model, TIDAL2, described in Section C.4. The speed of wave propagation or wave celerity through the estuary in the vicinity of the site utilized in the model was approximated by comparing continuous stage records from Rice Creek Station and the St. Johns Palatka station. The results of the comparison are shown in Figure C-2. From this comparison the average wave celerity was found to be approximately 16.0 fps. According to shallow water theory (Stoker, 1957) the speed of propagation of a wave is given by:

$$C = \sqrt{gh}$$

where, C = the wave celerity,
g = the gravitational constant, and
h = the water depth for an average depth of 10 feet.

The theoretical wave celerity is 18 fps which compares closely to the measured value of 16 fps. The computed velocity vectors for three different periods of the tidal cycle relating to a slack tide, flood tide and ebb tide during the 7-day MAF are shown in Figures C-3 through C-5.

High Flows

In order to obtain a quantitative estimate of the potential flood elevations in the vicinity of the site, the available data base was examined for peak stage events during each year of record. As described earlier, the eight years of record at Palatka were increased by utilizing stage data from the Rice Creek station. The results of the comparison is shown on Table C-3. As seen in the table, for the five years of overlapping record between the stations, the Rice Creek stages were from 0.05 feet to 0.16 feet higher than the St. Johns stages. An average value of 0.08 feet was used to convert the Rice Creek stages from 1959 to 1967 to St. Johns River stages.

C.1.2 Local Tributaries and Site Hydrologic Characteristics

Local Tributaries

The tributaries draining the general site area are shown in Figure C-6. Average discharge data is available from only two stations in the Rice Creek drainage basin. In order to obtain average discharge values for the ungaged tributaries, the discharges in cfsm from the two gaged stations were assessed. As seen in Table C-5, the cfsm of 0.76 at the Rice Creek station was significantly different from the Etonia Creek station discharges of 0.23 cfsm. The 0.76 cfsm was utilized in obtaining the average discharges shown in Table C-6 because it represented a drainage area that better approximated the small areas drained by the subject tributaries.

From Figure C-6 and Table C-6, each of the watercourses draining the site area has an average discharge of less than five cfs. As defined by 33 CFR 323, an average discharge of five cfs is utilized by the U.S.Corps of Engineers (COE) to define those watercourses for which they exercise jurisdiction.

Site Erosion

The quantity of soil eroded per year may be estimated with the Universal Soil Loss Equation (USLE) developed by the Soil Conservation Service (SCS, 1975). The complete USLE is A = RKLSCP, where:

A = computed soil loss (sheet and rill erosion) in tons per acre per year;

R = rainfall factor; number of erosion-index units in a normal year's rain;

K = soil-erodibility factor; erosion rate per unit of erosion index for a specific soil in cultivated continuous fallow, on a 9-percent slope 72.6 feet long;

L = slope-length factor; ratio of the soil loss from the field slope length to that from a 72.6 feet length on the same soil type and gradient;

S = slope-gradient factor; ratio of soil loss from the field gradient to that from a 9-percent slope;

C = cropping management factor; ratio of soil loss from area with specific vegetative conditions to that from the fallow condition on which the factor K is evaluated;

P = erosion-control practice factor; ratio of soil loss with contouring, stripcropping, or contour irrigated furrows to that with straightrow farming, up-down slope.

The parameter values are shown in Table C-7. The soil loss should average from 0.18 to 0.36 tons per acre per year or 300 to 600 tons/year over the 1550-acre area experiencing erosion.

Only a portion of the soil lost will actually leave the upland area. This portion, which is determined by a sediment delivery ratio, is deposited in the lowlands surrounding the upland area. Based on SCS (1965) data, the delivery ratio to the lowlands may be related to the drainage areas contributing sediment. The upland area drains into five distinct lowland areas of which four are partially within site boundaries. The respective drainage areas range from approximately 0.1 to 0.5 square miles. With such areas, the delivery ratio should be between 0.4 and 0.5. Using a conservative value of 0.5, the sediment deposition would be between 150 and 300 tons/year.

C.1.3 Water Quality Standards

Florida Water Quality Standards

The use classifications for the surface waters in the State of Florida as defined by the Florida Department of Pollution Control (Florida Department of Environmental Regulation, 1977) are presented below:

Class I Waters - public water

Any waters from which water is withdrawn for treatment and distribution as a potable supply.

Class II Waters - shellfish harvesting

Waters in areas which either actually or potentially have the capability of supporting recreational or commercial shellfish progation and harvesting.

Class III Waters - recreation and propagation and management of fish and wildlife.

Waters to be used for recreational purposes, including such body contact activities as swimming and water skiing; and for the maintenance of a well-balanced fish and wildlife population. All surface waters within the coastal waters contiguous to these basins, including off-shore waters, not otherwise classified shall be classified as Class III.

Class IV Waters - agricultural and industrial water supply

Waters to be used for agricultural or stock watering or industrial water supply. Additionally, all secondary and tertiary canals wholly within agricultural areas are Class IV waters.

Class V Waters - navigation, utility and industrial

Waters which will be suitable for navigation and any other uses except for waters previously classified.

In addition to the above classifications, waters in the State of Florida are either freshwater, coastal waters, or open water as defined below:

Freshwater - all waters of the State which are contained in lakes, and ponds, or are in flowing streams above the zone in which tidal actions influence the salinity of the water and where the concentration of chloride ions is normally less than 1500 mg/l.

Coastal waters - all waters in the State which are not classified as freshwaters or as open waters.

Open waters - all waters in the State extending seaward from the most seaward 18-foot depth contour line (three-fathom bottom depth contour) which is off shore from any island; exposed or submerged bar or reef; or mouth of any embayment or estuary which is narrowed by headlands. Contour lines shall be determined from Coast and Geodetic Survey Charts.

The St. Johns is classified in the site vicinity as a Class III freshwater stream.

C.1.4 Water Discharges

Downstream of the site, there are twelve waste water treatment facilities discharging into the St. Johns River in water quality segment 20.3 FA shown in Figure C-7. These twelve facilities, detailed in Table C-17, have a total design capacity of 5.55 mgd (DER, 1975).

Upstream of the site there are seven facilities which discharge into either Rice Creek or the St. Johns in water quality segments 20-3 GA and 20-3 HA shown in Figure C-7. These facilities are detailed in Table C-18. Hudson Pulp and Paper Company is the major discharger with 50 mgd of industrial waste discharged into Rice Creek. The next major contributor is a Florida Power & Light electric generating plant whose major contribution is 2.1 mgd of heated cooling water.

TABLE C-12

WATER QUALITY DATA - ST. JOHNS RIVER*

Parameter Measured	Units	Measure-ments	Data Average	Maximum Value	Minimum Value	Beginning Date	Ending Date
Water Temp.	°C	68	23.9	30.5	8.5		
Turb. JKSN	JTU	56	4.875	21	1	62-08-16	77-05-20
Specific Conductivity at 25°C						68-09-24	77-05-20
	mhos	66	974	1400	510		
DO	mg/l	64	6.6	11.6	2.7	62-06-08	77-05-20
DO saturated	%	57	76	107	35	68-04-26	77-05-20
BOD (5-day)	mg/l	35	.6	8.2	.6	68-04-26	77-05-20
pH	units	51	6.1	9.4	5.4	68-09-24	77-05-20
Bicarbonate HCO_3	mg/l	48	102	150	48	62-06-08	77-05-20
Carbonate CO_3	mg/l	1	3	3	3	62-08-16	77-02-25
Phosphate PO_4 Tot	mg/l	5	.15	.24	.05	66-11-22	76-07-18
Ortho PO_4 Diss.	mg/l	7	.09	.16	.01	68-04-26	70-09-21
TOT Hard $CaCO_3$	mg/l	58	196.1	310	94	66-11-22	71-00-14
Ammonia Nitrogen Tot	mg/l	54	.05	.28	.01	62-06-08	77-05-20
Calcium Ca, Diss.	mg/l	52	47.7	78	30	68-09-24	77-05-20
Magnesium Mg, Diss.	mg/l	52	17.8	28	10	62-06-08	77-05-20
Sodium Na, Diss.	mg/l	48	121.6	180	70	62-06-08	77-05-20
Potassium K, Diss.	mg/l	48	4.5	8.8	1.2	62-06-08	77-02-25
Chloride Cl, Diss.	mg/l	57	220	400	120	62-06-08	77-02-25
Sulfate SO_4, Diss.	mg/l	48	64.7	114	37	62-06-08	77-05-20
						62-06-08	77-02-25

*Source: USGS, STORET data file.

TABLE C-12 (Continued)

Parameter Measured	Units	Measure-ments	Data Average	Maximum Value	Minimum Value	Beginning Date	Ending Date
Arsenic As, Tot	µg/l	13	5.4	20	1	72-05-22	77-02-25
Cadmium Cd, Tot	µg/l	6	2.1	6	1	72-05-22	77-02-25
Chromium Cr, Tot	µg/l	11	<12.7	20	<9	70-05-18	77-02-25
Copper Cu, Tot	µg/l	12	3.25	10	1	72-05-22	77-02-25
Iron Fe, Tot	µg/l	16	218	360	40	72-05-22	77-02-25
Lead Pb, Tot	µg/l	16	14.6	74	1	72-05-22	77-02-25
Mercury Hg, Tot	µg/l	10	.19	.5	.1	71-05-12	77-02-25
Manganese Mn, Tot	µg/l	14	15.7	30	6	72-05-22	76-05-18
Zinc Zn, Tot	µg/l	11	26.4	70	4	72-05-22	77-02-25
CO_2	mg/l	36	4.5	14	.1	62-08-16	77-02-25
Fec.Col.	/100ml	31	74.2	1200	5	74-01-16	76-11-10
Fecstrep	/100ml	2	27.5	50	5	76-12-21	77-05-20
Aldrin Whl Smpl	µg/l	0	0	0	0	68-09-24	68-09-24
DDD Whl Smpl	µg/l	0	0	0	0	68-09-24	68-09-24
DDT Whl Smpl	µg/l	0	0	0	0	68-09-24	68-09-24
DDE Whl Smpl	µg/l	0	0	0	0	68-09-24	68-09-24
Endrin Whl Smpl	µg/l	0	0	0	0	68-09-24	68-09-24
HCHLR Whl Smpl	µg/l	0	0	0	0	68-09-24	68-09-24
Lindane Whl Smpl	µg/l	0	0	0	0	68-09-24	68-09-24
Alkalinity ($CaCo_3$)	mg/l	48	73	123	39	62-06-08	77-02-25
Total Carbon (C)	mg/l	30	32.8	72	24	71-05-12	77-05-20

TABLE C-12 (Continued)

Parameter Measured	Units	Measurements	Data Average	Maximum Value	Minimum Value	Beginning Date	Ending Date
Silica SiO_2, Diss.	mg/l	48	4.4	14	.1	62-06-08	77-02-25
Flouride f, Diss.	mg/l	48	.3	.8	.1	62-06-08	77-02-25
Cobalt Co, Tot	µg/l	5	2	5	1	72-05-22	77-02-05
Nickel Ni, Tot	µg/l	3	2	3	1	73-05-25	76-05-18
Strontium Sr, Diss	µg/l	42	1086	8600	80	66-11-22	77-02-25
Aluminum Al, Tot	µg/l	3	83	150	40	70-05-18	76-05-18
Selenium Se, Tot	µg/l	5	5	10	1	74-01-16	77-02-25
Silvex	ug/l	0	0	0	0	75-07-22	75-07-22
Eldrin Whl Smpl	µg/l	0	0	0	0	68-09-24	68-09-24
Total 24-D	µg/l	2	23	28	18	75-07-22	76-01-27
Total 245-T	µg/l	1	.04	.04	.04	75-07-22	76-01-27
TSS	mg/l	2	8	8	8	73-05-25	73-09-21
TDS Residue @180°	mg/l	48	578	935	378	62-06-08	77-02-25
Phenols	µg/l	1	1	1	1	68-09-24	70-05-18
Nitrite Tot	mg/l	41	.013	.10	.01	68-09-24	77-05-20
Nitrate Tot	mg/l	39	.098	.54	.01	62-06-08	77-05-20
KJELDAHL Nitrogen Tot	mg/l	50	1.0	2.5	.10	73-05-25	77-05-20

TABLE C-13

WATER QUALITY FIELD ANALYSIS - ST. JOHNS RIVER

Transect[a]	Date	Time	Water Depth (m)	Sample Depth (m)	Water Temp. (c)	Air Temp. (c)	D.O. (mg/l)	Conductivity (μmhos)	pH	Secchi (m) Down[b]	Secchi (m) Up[c]
A	9-13-77	0925	1.22	0.10	29.8	--	4.9	1200	7.2	.60	.60
			--	1.00	29.5	--	3.9	1210	7.2	--	--
A-1	1-30-78	0940	2.00	0.10	8.5	--	12.0	780	8.3	.62	.62
			--	1.00	8.5	--	11.4	780	--	--	--
			--	2.00	8.5	--	11.4	780	--	--	--
	3-28-78	0800	2.00	--	18.5	11.0	7.8	850	7.2	.55	--
A-2	1-30-78	0840	1.00	.10	6.0	--	12.1	620	8.2	.59	.60
			--	1.00	6.0	--	12.0	620	--	--	--
	3-28-78	0730	1.52	--	18.5	--	7.5	850	7.2	.55	--
		2400	1.52	--	20.00	13.0	9.1	920	7.2	--	--
	4-13-78	1100	1.5	--	24.5	25.0	8.1	975	7.4	.55	--
B	9-13-77	0910	1.22	0.10	29.3	--	4.2	1175	7.3	.85	.59
			--	1.00	29.0	--	3.9	1180	7.3	--	--
B-1	1-30-78	1125	3.00	0.10	9.0	--	8.1	550	8.4	.46	.45
			--	1.00	9.0	--	8.3	575	--	--	--
			--	2.00	9.0	--	8.9	625	--	--	--
			--	3.00	9.0	--	8.8	625	--	--	--
	3-28-78	0850	3.00	--	19.5	17.8	6.2	815	7.2	.45	--

TABLE C-13 (Continued)

Transect[a]	Date	Time	Water Depth (m)	Sample Depth (m)	Water Temp. (c)	Air Temp. (c)	D.O. (mg/l)	Conductivity (μmhos)	pH	Secchi (m) Down[b]	Secchi (m) Up[c]
B-2	1-30-78	1040	1.00	.10	9.0	--	6.4	550	8.4	.48	.47
			---	1.00	9.0	--	6.2	550	--	--	--
	3-28-78	0920	1.00	--	19.0	--	5.4	800	7.0	.55	--
		1945	1.00	--	21.5	15.0	9.7	960	7.1	--	--
	4-13-78	1230	1.5	--	26.0	25.0	6.8	1000	7.3	.50	--
C	9-13-77	0850	.90	.10	29.0	--	5.9	1120	7.3	.51	.51
			--	.73	29.0	--	5.4	1120	7.3	--	--
C-1	1-30-78	1310	3.00	.10	10.0	--	11.0	750	8.1	.67	.66
			--	1.00	10.0	--	10.9	750	--	--	--
			--	2.00	10.0	--	10.8	750	--	--	--
			--	3.00	10.0	--	10.7	750	--	--	--
	3-28-78	1100	3.00	--	20.0	18.0	7.6	860	7.2	.60	--
C-2	1-30-78	1220	1.00	.10	9.5	--	11.4	700	8.5	.55	.54
			---	1.00	9.5	--	10.3	700	--	--	--
	3-28-78	1030	1.00	--	20.0	--	7.7	850	7.2	.60	--
		2125	1.00	--	19.5	14.0	9.0	930	7.1	--	--
	4-13-78	1330	1.5	--	26.5	25.0	7.6	1010	7.5	.35	--
D	9-13-77	0810	.90	.10	28.8	--	5.5	1120	7.5	.60	.59
			--	.73	28.5	-	4.7	1120	7.5	--	--

TABLE C-13 (Continued)

Transect[a]	Date	Time	Water Depth (m)	Sample Depth (m)	Water Temp. (c)	Air Temp. (c)	D.O. (mg/l)	Conductivity (μmhos)	pH	Secchi (m) Down[b]	Secchi (m) Up[c]
D-1	1-30-78	1450	3.00	.10	10.0	--	11.6	700	8.6	.55	.55
			--	1.00	10.0	--	11.5	700	--	--	--
			--	2.00	10.0	--	11.5	700	--	--	--
			--	3.00	10.0	--	11.5	700	--	--	--
	3-28-78	1215	3.00		21.0	19.0	8.9	850	7.4	.60	--
D-2	1-30-78	1405	1.00	.10	10.0	--	11.8	700	8.7	--	--
			--	1.00	10.0	--	11.8	700	--	.47	.47
	3-28-78	1230	1.00	--	20.5	--	8.1	900	7.4	.60	--
		2230	1.00	--	19.5	14.0	9.6	890	7.1	--	--
	4-13-78	1430	.8	--	26.5	24.5	7.6	975	7.4	.60	--

[a]For transect locations see Figure C-6.

[b]Reading taken as secchi disk is being lowered.

[c]Reading taken as secchi disk is being raised.

TABLE C-14

ST. JOHNS RIVER - WATER QUALITY LABORATORY ANALYSIS
(Samples Collected by Dames & Moore)

Parameter[b]	February 1, 1978 TRANSECTS[a] A	B	C	D	March 29, 1978 TRANSECTS[a] A	B	C	D
Total Alkalinity $CaCO_3$	76	68	64	68	55	70	55	60
Total Hardness $CaCO_3$	224	184	196	200	195	190	190	190
Total Dissolved Solids	815	680	715	730	608	596	606	606
Total Suspended Solids	<1	1	1	1	28	4	6	46
Ortho-Phosphate, P	0.01	0.01	0.07	0.03	0.02	<0.01	<0.01	<0.01
Total Phosphate, P	0.06	0.07	0.14	0.05	0.10	0.10	0.10	0.25
Nitrate Nitrogen, N	1.00	1.60	1.10	2.60	0.01	0.02	0.02	0.01
Nitrite Nitrogen, N	0.010	0.002	0.002	0.004	0.001	0.002	0.004	0.006
Amonia Nitrogen, N	0.05	0.12	0.09	0.10	0.38	0.14	0.12	0.16
Kjeldahl Nitrogen, N	0.06	0.14	0.11	0.11	1.58	1.36	1.11	2.09
Sulfate, SO_4	80	80	68	65	67	1.79	73	65
Silica, $SiSO_2$	2.6	3.8	4.0	4.0	1.1	11	1.0	1.0
BOD (5-day)	0.2	1.2	0.6	0.4	3.0	1.0	2.0	3.0
Detergents, MBAS[c]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fecal Coliform/100 ml (MFT)[d]	2	8	4	2	300	40	12	12
Magnesium Hardness, $CaCO_3$	80	60	72	68	65	70	70	70
Calcium Hardness, $CaCO_3$	144	124	124	132	130	120	120	120
Chemical Oxygen Demand, COD	46	56	60	58	88	64	64	106

TABLE C-14 (Continued)

Parameter[b]	February 1, 1978 TRANSECTS[a] A	B	C	D	March 29, 1978 TRANSECTS[a] A	B	C	D
Oil & Grease, Infrared	10	4.0	20	22	13	10	10	12
Phenols (μg/l)	<1	<1	<1	<1	<1	<1	<1	<1
Turbidity, JTU	<25	<25	<25	<25	<25	<25	<25	<25
Turbidity, NTU	2.5	3.5	<3.2	2.9	6.2	4.5	4.4	9.5
Color (units)	80	120	80	75	100	140	110	80
Chloride, Cl	290	230	225	245	210	230	240	204
Flouride, F	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Carbonate, CO_3	0	0	0	0	0	0	0	0
Bicarbonate, HCO_3	93	83	78	83	67	85	67	73
Chromium, Total (μg/l)	<10	<10	<10	<10	<10	<10	<10	<10
Mercury, Hg (μg/l)	<1	<1	<1	<1	<1	<1	<1	<1
Arsenic, As (μg/l)	2.9	1.9	1.9	1.9	20	5	2	4
Lead, Pb (μg/l)	1.89	<0.01	1.86	<0.01	13	12	9	10
Copper, Cu (μg/l)	<100	<100	<100	<100	<100	<100	<100	<100
Iron, Fe (μg/l)	80	120	80	60	100	90	50	20
Zinc, Zn (μg/l)	140	160	180	120	14	22	20	56
Cadmium	--	--	--	--	1	2	<1	<1

[a]For transect locations see Figure C-6.

[b]Values in mg/liter unless otherwise noted.

[c]Methyl blue active substance.

[d]Membrane filter technique.

TABLE C-15

SEDIMENT SAMPLES - ST. JOHNS RIVER
(in mg/kg dry weight)

Parameter	Analysis A	Analysis B	Analysis C	Analysis D
Chromium, Cr	2.98	5.29	42.58	0.998
Mercury, Hg	5.3	1.4	6.0	<0.1
Arsenic, As	1.99	3.17	1.77	0.998
Lead, Pb	2.49	2.11	17.74	0.998
Copper, Ca	2.53	4.23	10.64	0.998
Iron, Fe	1,491	1,480	14,192	289
Zinc, Zn	30.8	54.9	97.6	469
Cadmium, Cd	0.10	0.21	0.43	0.37
Phenols	27.0	<0.2	19.7	<0.02
BHC	<0.001	<0.001	<0.001	<0.001
Lindane	0.023	0.011	0.004	0.002
Heptachlor	<0.001	<0.001	<0.001	<0.001
Aldrin	0.280	0.024	0.009	0.006
Heptachlor Epoxide	0.026	0.029	0.004	0.002
Dieldrin	<0.001	0.022	<0.001	<0.001
Endrin	<0.001	<0.001	<0.001	<0.001
Captan	<0.001	<0.001	<0.001	<0.001
DDE	<0.001	<0.001	<0.001	<0.001
DDD	<0.001	<0.001	<0.001	<0.001
DDT	<0.001	<0.001	<0.001	<0.001
Methoxyghchlor	<0.001	<0.001	<0.001	<0.001
Endosulfan	<0.001	<0.001	<0.001	<0.001
Dichloran	<0.001	<0.001	<0.001	0.001
Mirex	<0.001	<0.001	<0.001	<0.001
Pentachloronitrohenzene	<0.001	<0.001	<0.001	<0.001
Trifluralin	<0.001	<0.001	<0.001	<0.001
Strobane	<0.001	<0.001	<0.001	<0.001
Toxaphene	<0.001	<0.001	<0.001	0.001
Chlordane	<0.001	<0.001	<0.001	<0.001
Polychlorinated Biphenyls	<0.001	<0.001	<0.001	<0.001

Notes: 1) Date of collection: April 13, 1978.

2) Collecting device: K-B Cora Sampler; sample contained a plastic tube liner.

3) Samples placed in containers supplied by Orlando Laboratories Inc. (no preservative added).

4) Analysis for: Heavy metals (similar to the water column) PCB's; Pesticides.

TABLE C-16

WATER QUALITY DATA - RICE CREEK*

Parameter Measured	Units	Measure-Ments	Data Average	Maximum Value	Minimum Value	Beginning Date	Ending Date
Water Temp.	°C	17	28.9	30.0	25.0	67-05-12	73-09-26
Turb. JTU	JTU	7	15.3	20	2	70-09-28	73-09-26
Specific Conductivity at 25°C	mhos	14	564	1120	220	67-05-12	73-09-26
DO	mg/l	15	1.82	6.0	.1	67-05-12	73-09-26
DO saturated	%	10	17.8	77	1	67-05-12	72-09-27
BOD 5-day	mg/l	8	4.91	11	.5	70-04-29	73-09-26
pH	units	16	6.11	7.9	6.3	67-05-12	73-09-26
Bicarbonate HCO_3	mg/l	10	121.1	192	52	67-05-12	73-06-27
Carbonate CO_3	mg/l	0	0	0	0	67-05-12	73-06-27
Phosphate PO_4 T	mg/l	2	.99	1.1	.88	70-04-29	70-09-28
Ortho PO_4 Diss.	mg/l	2	.56	.85	.27	67-05-12	68-04-26
TOT Hard $CaCO_3$	mg/l	12	99.7	183	47	67-05-12	73-09-26
Ammonia Nitrogen Tot	mg/l	5	.05	.09	.03	71-09-14	73-06-27
Calcium Ca, Diss.	mg/l	12	28.2	50	13	67-05-12	73-09-26
Magnesium Mg, Diss.	mg/l	12	6.9	14	3.4	67-05-12	73-09-26
Sodium Na, Diss.	mg/l	11	91.8	172	32	67-05-12	73-09-26
CO_2	mg/l	1	6.6	6.6	6.6	73-06-27	73-06-27
Alkalinity (CaCO3)	mg/l	10	99.3	157	43	67-05-12	73-06-27
Carbon (C)	mg/l	5	48	57	42	72-05-10	73-06-26
Potassium K, Diss.	mg/l	11	2.6	3.8	1.3	67-05-12	73-06-26
Chloride Cl, Diss.	mg/l	11	102	242	10	67-05-12	73-06-26

*Source: USGS, STORET data file

TABLE C-16 (Continued)

Parameter Measured	Units	Measure-ments	Data Average	Maximum Value	Minimum Value	Beginning Date	Ending Date
Sulfate SO_4, Diss.	mg/l	11	43.4	78	16	67-05-12	73-09-26
Silica Sio_2, Diss	mg/l	11	6.8	9.0	5.8	67-05-12	73-09-26
Flouride F, Diss.	mg/l	11	.4	.6	.3	67-05-12	73-09-26
Arsenic As, Tot	ug/l	5	14	20	5	72-02-10	73-09-26
Cadmium Cd, Tot	ug/l	4	1	1	1	72-05-10	73-09-26
Cobalt Co, Diss.	ug/l	2	1	1	1	70-09-28	72-09-27
Copper Cu, Tot	ug/l	6	15.3	30	3	70-09-28	72-09-27
Iron Fe, Tot	ug/l	5	637	750	460	72-05-10	73-09-26
Lead Pb, Tot	ug/l	4	4.2	7	2	72-05-10	73-09-26
Manganese Mn, Tot	ug/l	5	45	70	20	72-05-10	73-09-26
Nickel Ni, Tot	ug/l	1	17	17	17	73-06-27	73-09-26
Strontium Sr, Diss.	ug/l	9	280	460	120	67-05-12	73-09-26
Zinc Zn, Tot	ug/l	6	141	400	30	70-04-29	72-09-27
Alumimum Al, Tot	ug/l	3	790	840	740	70-04-29	73-09-26
TSS	mg/l	2	8	8	8	73-06-27	73-09-26
TDS Residue @180°	mg/l	11	407	685	192	67-05-12	73-09-26
TDS sum of const.	mg/l	10	352	664	135	67-05-12	73-09-26
Nitrite Tot	mg/l	5	.01	.02	.01	72-05-10	73-09-26
Nitrate Tot	mg/l	3	.01	.02	.01	72-05-10	73-09-26
Mercury Hg, Tot	ug/l	5	1.19	3.5	.3	70-09-28	73-09-26

2.3.2 Ground Water

2.3.2.1 Principal Aquifers

General

Two principal aquifers underlie the site: the water table aquifer and the artesian Floridan aquifer. The Floridan Aquifer is of much greater local importance.

The water table Aquifer consists of unconsolidated sand with some shell beds and some silty sands. Secondary aquifer zones, some of which are under pressure, are associated with this sand aquifer in some areas. However, the secondary artesian aquifers are not always present, and the water table aquifer can in general be thought of as being a single hydrologic unit. The water table aquifer extends from the surface to a depth of about 100 feet.

The Hawthorn Formation separates the water table and Floridan aquifers and is about 100 feet thick. These strata are confining but can locally include some permeable beds which act as secondary artesian zones; however, their primary function in the hydrologic system is that of a confining layer.

Under the confining strata is the Floridan Aquifer, the principal and most important aquifer. This hydrologic unit consists of porous limestones with some solution cavities. A generalized stratigraphic column, indicating the principal hydrologic units and their water bearing characteristics, is given in Figure 2.3-4.

Approach To Present Study

The published literature provided the general geologic and hydrologic background for the present study. A field program for constructing test wells and monitoring wells was devised for site-specific information.

The field program provided information on the hydraulic characteristics of the water table and Floridan aquifers, and identified sites at which water samples could be obtained for baseline water quality data. Figure 2.3-5 gives the locations of the borings and permeability tests. Appendices D.1 and D.2 provide logs and technical information on the borings.

Some borings served three purposes: soil sampling (reported in Section 2.2, Geology and Soils), ground water quality sampling, and monitoring of water surface elevations and potentiometric elevations.

Industrial and domestic wells within a five-mile area also provided useful information. Most wells tap the Floridan Aquifer, only a few domestic wells tap the water table aquifer. The well inventory from this program and selected data from an earlier published inventory (Bermes and others, 1963b) appear in Appendix D.6.

Water Table Aquifer

The unconsolidated sand at the surface of the site, together with somewhat indurated beds below that unit to a depth of approximately 100 feet, constitute a single aquifer. Some discontinuous beds of finer materials below about 45 feet in depth cause localized artesian conditions, but these are the exception . Most of the water in this aquifer exists under unconfined (water table) conditions (Figure 2.3-4).

The loose uncemented sand forming the top 40- to 50-ft layer is fine-grained and is Recent and Pleistocene in age (Section 2.2). The lack of cement within the sand permits interstitial openings allowing moderate to high vertical and horizontal permeabilities. Recharge is from local precipitation.

The top or first layer overlies a second layer of silty sands, silts, clays, and sands of upper Miocene age which are about 50 to 60 feet thick. Shell beds within the second layer provide water supplies locally. The less permeable beds may act as confining beds for the Floridan Aquifer. Recharge can be from the water table aquifer, underlying artesian aquifer, or rainfall.

The water table aquifer is used as a source of water for some sixteen families in the town of Bostwick northwest of the site, and at a few scattered dwellings elsewhere within the five-mile radius of study. Most wells within five-miles, however, tap Floridan Aquifer.

The water table aquifer provides adequate water supplies for general domestic uses. During this study, a production well was pumped at 48 gallons per minute (gpm) for 24 hours. A relatively shallow cone of depression was created with a 5.5-foot drawdown at its center. The specific capacity of the well was 9 gpm/foot of drawdown. Hydraulic characteristics of the aquifer and well design are given in Appendix D.2; water level fluctuations are discussed in Appendix D.4.

Confining Strata

The Hawthorne Formation is the confining unit, about 100 feet thick, between the water table aquifer and the underlying Floridan Aquifer. It is early- to mid-Miocene in age and consists of clay, marl, and sandy clays, together with some interbedded sands and limestones. These sands and limestones can sometimes act as secondary artesian aquifers of low yield, especially along the St. Johns River. Recharge to these secondary aquifers may come from the overlying water table aquifer, and from the Floridan Aquifer (Bermes and others, 1963a).

Floridan Aquifer

The Floridan Aquifer is the primary aquifer at the site and is under artesian pressure. Since it is limestone, its waters are generally higher in dissolved calcium carbonate than the waters of the overlying water table aquifer. It is composed of several stratigraphic formations: the Lake City Limestone (oldest), Avon Park Limestone, and the Ocala Group (Inglis Formation, Williston Formation and the Crystal River Formation) (St. Johns River Water Management District, 1977). In addition, about 10 feet of the lower beds of the Hawthorne Formation may be hydraulically connected to the underlying limestone formations, and, in effect, would be part of the Floridan Aquifer. A test well drilled during the study penetrated a total of 220 feet of the aquifer (Appendix L).

The thickness of the principal water-bearing zone in the Putnam-St. Johns-Flagler County area is about 450 feet (Bentley, 1977). Within that range, the upper 50 to 200 feet of the Floridan Aquifer are more permeable than the lower 200 to 300 feet. An estimate of the average porosity of the upper 400 feet of the Floridan Aquifer is 62 percent (Bermes and others, 1963a). Hydraulic characteristics are given in Appendix D.3; water level fluctuations are in Appendix D.4.

At the site, the height to which water in a tightly-cased well will rise from the Floridan Aquifer when penetrated by a drill (called the potentiometric head) is about 30 to 28 feet above mean sea level (MSL), and 37 to 44 feet below land surface in wells F-1 and F-2, respectively (November 1977 to February 1978). These wells, therefore, are non-flowing artesian wells.

Recharge to the Floridan Aquifer is from areas remote from the site. Direct recharge is also through sinkholes in the vicinity of western and southeastern Putnam County (Bermes and others, 1963a).

It is unlikely that percolating water from the onsite land surface could reach the Floridan aquifer. Movement would be severely, if not completely, retarded by 100 feet of confining materials (Hawthorne Formation) of very low permeability. Further, under present conditions, the percolating water could not reach the Floridan aquifer due to the hydraulic gradient from upward artesian pressure of the Floridan Aquifer waters.

The potential for sinkhole development in the site vicinity has also been reviewed. Solutioning of the aquifer at depth, transport of subsurface material, and sink development is unlikely under existing gradients. This is reflected in the lack of topographic expression of recent sink activity in the site area.

2.3.2.2 Ground Water Flow

The topography of the site causes water within the water table aquifer to flow radially from the topographic high. In the northern part of the site, the flow direction is generally toward the lowland area, which is in turn drained by a ditch flowing northeast away from the site. In the southern part of the site, the water table aquifer flow is directly toward the St. Johns River. On the eastern and western areas of the site the flow is away from the site, toward lowlands.

Water table contours for the fall of 1977 are shown in Figure 2.3-6. Flow occurs at right angles to the contour lines, from higher toward lower elevations.

The flow of the Floridan Aquifer is best evaluated with a regional perspective. The potentiometric contours of the Floridan Aquifer in Putnam and adjacent counties are shown in Figure 2.3-7 (Healy, 1975; St. Johns River Water Management District, 1977). Direction of flow is perpendicular to the contours and from higher to lower pressures.

2.3.2.3 Ground Water Quality

A monitoring program was established to develop a ground water quality baseline for both the water table aquifer and the Floridan Aquifer. Site sampling began in two wells in each aquifer in November 1977. An offsite domestic well (S-1) was added to the program in December 1977 to monitor the water table aquifer offsite. All were monitored, as field conditions permitted, through April 1978. Particulars of the monitoring program appear in Appendix D.5.

Water Table Aquifer

The quality of the water in the water table aquifer was generally good compared to U. S. Environmental Protection Agency (EPA) and Florida Department of Environmental Regulation (DER) existing and proposed drinking water standards. Total dissolved solids (TDS) averages were not over 164 milligrams per liter (mg/liter) on the site, and 310 mg/liter at the offsite well. Individual inorganic chemical constituents are also below the prescribed limits. However, turbidity in Well Number 1 and color in Well Number 3 were above the limits. In Well S-1, average turbidity was also above acceptable levels. Iron content was high enough to be noticed by users, but no EPA or DER standards prescribed iron.

Floridan Aquifer

The quality of water from the Floridan Aquifer is considered to be good. An objectionable odor, mainly due to hydrogen sulfide gas, was above EPA/DER limits in both wells (F-1 and F-2). Well F-1 was above the limits in odor, color and turbidity averages. The average total dissolved solids of Well F-2 is 617 mg/liter, which was above the 500 mg/liter recommended limit. No measured inorganic chemical constituents were above the limits set by EPA/DER. Only minor treatment of this water would be necessary to make it a good potable water supply.

Chloride content was measured in the Floridan Aquifer wells. Average chloride for Well F-1 was 12 mg/liter, whereas it was 189 mg/liter for Well F-2 about one mile east of Well F-1. Both wells produce from the upper 20 to 25 feet of the Floridan Aquifer. The difference was probably caused by the proximity of the brackish water near the bottom of Well F-2. That well is not only nearer the coast, but is also nearer an area across the St. Johns River in which artesian pressures have been lowered by pumping for irrigation. This area apparently has non-potable water located at a higher elevation (Figure 2.3-9).

The interface between brackish and fresh water slopes inland from the coast (fresh water across the entire Florida peninsula can, in general, be thought of as floating on denser sea water, with higher water table elevations corresponding to a deeper salt water-fresh water interface). The continuous lowering of artesian pressures in the agricultural area since 1900 (Kellum, Patterson & Bell, Inc., 1977) has caused increased salt water intrusion. Lowering of the artesian pressures allows both an upward movement of more saline water as well as horizontal movement from the coast.

Regional water quality data (Figure 2.3-8) indicate that the reported higher chloride content of Well F-2 is to be expected. The depth to the base of potable water is shown to be about 250 feet below the land surface at the site (St. Johns River Water Management District, 1977) (Figure 2.3-8). Chloride content at this elevation is, in part, a result of irrigation pumping and the area's proximity to the coast. Klein (1971), furthermore, attributes the presence of nonpotable water at higher elevations to faulting along the St. Johns River. Fractures may allow water of poorer quality to rise closer to the surface.

2.3.3 References

Bentley, C. B., 1977, Aquifer test analyses for the Floridan aquifer in Flagler, Putnam, and St. Johns counties, Florida. U. S. Geological Survey Water Resources Invest. 77-36.

Bermes, B. J., Leve, G. W., and Tarver, G. R., 1963a, Geology and ground-water resources of Flagler, Putnam, and St. Johns Counties, Florida. Fla. Geological Survey Rpt. Invest. 32.

Brown, Judith, 1978, St. Johns Water Management District. Personal Communication.

Diseker, E. G., and Richardson, E. C., 1968, Transaction of the American Society of Agricultural Engineers, St. Joseph, Michigan, vol. 1, p. 62-64.

Environmental Protection Agency, 1974, Proceedings workshop on agricultural non-point source water pollution control. EPA, Washington.

Flood Insurance Administration, 1978, Flood Hazard Boundary Map, Putnam County.

Florida Power & Light Company, 1975, Application for modification of conditions of certification no. PPS-74-01. Department of Environmental Regulations.

Florida Department of Environmental Regulations, 1975-76. St. Johns basin, water quality management plan. Florida Department of Environmental Regulations.

__________, 1978, Hamilton S. Oven, Jr., Administrator, Power Plant Siting. Personal Communication, December 7.

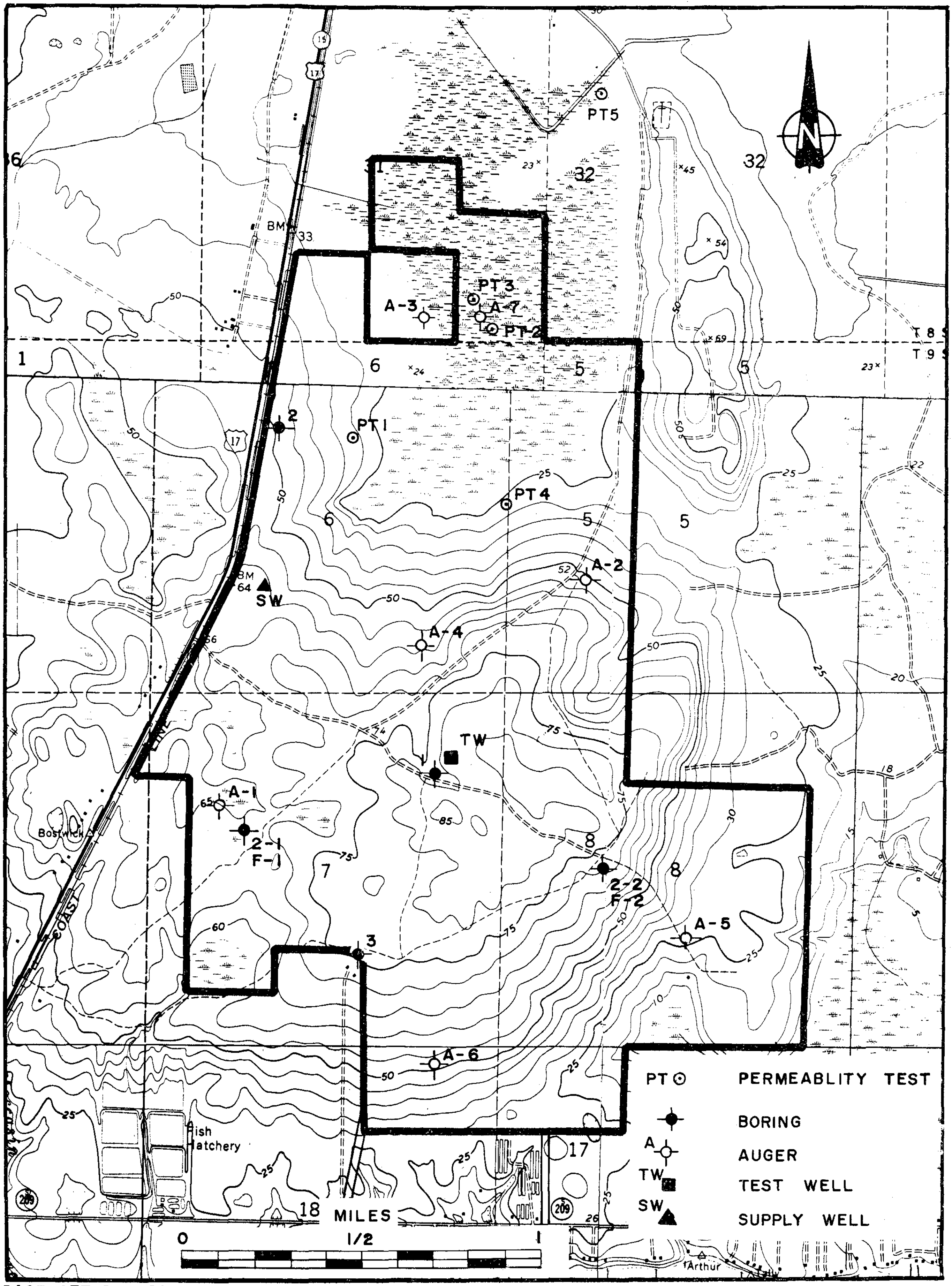
Georgia State Soil and Water Conservation Committee, 1973, Georgia governor's conference on sediment control, University of Georgia, Center for Continuing Education, Athens, Georgia.

Healy, H. G., 1975, Potentiometric surface and areas of artesian flow of the Floridan Aquifer of Florida. Fla. Bur. Geol. Map Series 73.

Jacksonville Area Planning Board, 1977, Regional land use element. Jacksonville Area Planning Board, HUD, CPA-FL-04-00-1005.

Kellum, Patterson and Bell, Inc., 1977, Comprehensive plan, Putnam County, Florida, vol. 1, Planning data inventory and analysis. Kellum, Patterson and Bell, Inc., Planning Consultants, Tampa.

Klein, H., 1971, Depth to base of potable water in the Floridan Aquifer. Fla. Bur. Geol. Map Series 42.



BASE AFTER USGS

Figure 2.3-5. Location of Auger Holes, Test and Supply Wells, Borings, and Permeability Tests.

REVISED 3/15/79

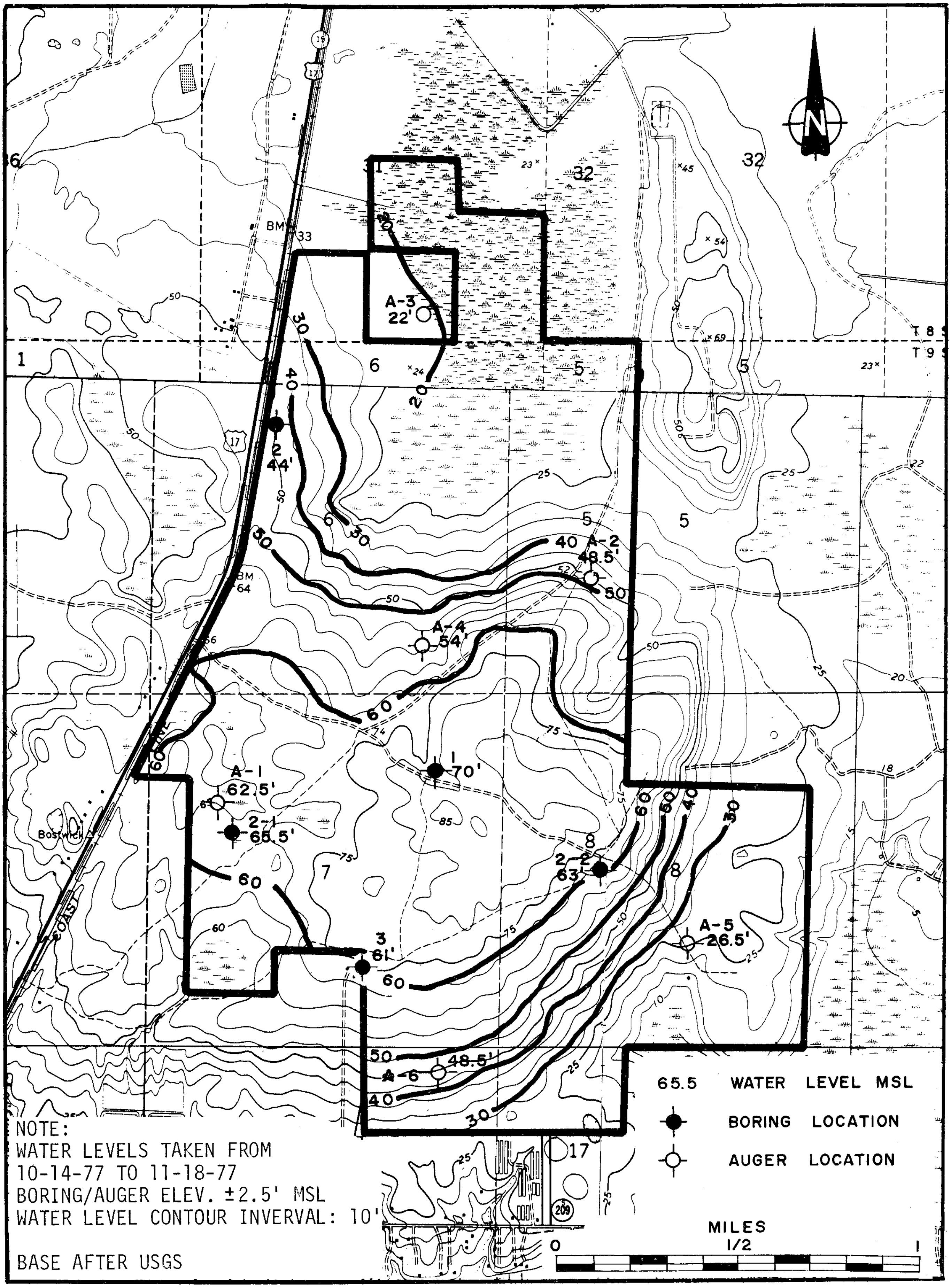


Figure 2.3-6. Site Water Level Contour Map of Water Table Aquifer.

REVISED 3/15/79

APPENDIX D

GROUND WATER HYDROLOGY

D.1 MONITOR WELLS

Borings 1 and 3 from the drilling program of June 1977 were used as monitor wells for the water table aquifer. Figure D-1 shows their locations; Figures D-2 and D-3 show their geologic characteristics and details of construction.

A private domestic well outside the site boundary near Bostwick was chosen for additional sampling of water from the water table aquifer. Mr. S. R. Harrison, Sr. is the owner and has given permission to sample. He reports the well to be completed at 80 feet total depth in the water table aquifer. It is cased with 1-1/2 inch diameter steel casing.

Water from the Floridan Aquifer was sampled in two wells (F-1 and F-2) drilled for that purpose. The wells are adjacent to Borings 2-1 and 2-2 drilled for soil samples and reported under Section 2.2, Geology and Soils. Details of construction and geologic characteristics of Wells F-1 and F-2, and shallow water supply wells drilled during drilling, are given in Figures D-4, D-5, and D-6.

D.2 HYDRAULIC CHARACTERISTICS OF THE WATER TABLE AQUIFER

A hydraulic test of the water table aquifer was made in November 1977. A test well 100 feet deep with casing slotted from 10 to 95 feet (Figure D-6) was pumped for 24 hours at 48 gpm. Drawdown observed in Boring No. 1, 74 feet west of the test well, was 5.5 feet at the end of the test period.

The specific capacity was computed to be about 9 gallons per minute per foot of drawdown. The transmissivity of the aquifer was computed to be about 16,500 gallons per day per foot (gpd/ft) of aquifer and the storage coefficient was computed to be about 0.30.

Storage coefficients, as calculated, were highly variable. Most were inapplicable because values pertaining to artesian conditions were obtained because of incomplete aquifer drainage. However, the average of the values obtained by using the Boulton curves that are applicable to unconfined conditions is comparable to reported results from similar well-sorted, fine-grained sands. Table D-1 gives details of the aquifer test.

The upper 40 to 50 feet of the water table aquifer is of primary concern with reference to water movements (this unit is referred to as Layer 1 in Section 2.2). In calculating horizontal permeabilities, the total transmissivity of the unconfined aquifer (16,500 gpd/ft) is considered to be 80 percent attributable to Layer 1. The saturated thickness of Layer 1 was 34 feet at the time of the aquifer test. Results appear in Table D-2.

D.3 HYDRAULIC CHARACTERISTICS OF THE FLORIDAN AQUIFER

Studies by the U. S. Geological Survey (USGS) and the Florida Geological Survey (FGS) provide information on the hydraulic and other characteristics of the Floridan Aquifer. A transmissivity of about 275,000 gpd/ft of aquifer is representative of the Floridan Aquifer in the Putnam County vicinity. This figure is based on results of pumping tests performed by the USGS (Bermes and others, 1963) and by a more recent pumping test near Bostwick in which a transmissivity of about 127,000 gpd/ft was calculated (Bentley, 1977) based on a well that does not completely penetrate the aquifer. The full transmissivity is considered to be possibly about 500,000 gpd/ft (Craig Bentley, personal communication, October 1977). For the entire Putnam, St. Johns, and Flagler County area, Bentley (1977) considers about 450,000 gpd/ft as representative.

The storage coefficient of the Floridan Aquifer ranges from less than 1.0×10^{-4} to more than 9.0×10^{-4} with the high end of the range measured near Palatka at the Hudson Pulp and Paper Company (Bermes and others, 1963). The small values of the coefficients are indicative of artesian conditions. The well tested was pumped at 5,000 gpm for two days. Bentley (1977) considers 8×10^{-4} to be the best estimate for the three-county area.

However, the transmissivities and storage coefficients of the Floridan Aquifer may vary throughout the State of Florida and locally by <u>several</u> orders of magnitude. This variance is especially common in limestone karst topographic regions as solutioning of the aquifer in many localized areas magnifies this variance.

As detailed in Appendix L, analysis of the Floridan Aquifer pumping test on the Putnam Site indicates a transmissivity of 46,000 gpd/ft and a storage coefficient of 1×10^{4}.

D.4 WATER LEVEL FLUCTUATIONS

Water level measurements of both the water table and Floridan Aquifer taken during the monitoring program are shown in Table D-3 and D-4. Because of the short monitoring period, the data may not necessarily be indicative of long-term fluctuations.

The longest-term available record of water level fluctuations in the water table aquifer consists of measurements in three borings drilled during June 1977. In order to compare the three wells, Table D-3 shows water levels in the three wells over a six-month period from June to November 1977. (Sometime after the November readings, Boring No. 2 was disturbed and, therefore, was eliminated from the monitoring program.) Table D-3 also contains the maximum measured fluctuations in the three wells. The largest recorded fluctuation was seven feet amplitude and occurred between June 1977 and February 1978.

Water level data for the two wells in the Floridan Aquifer are based on a six month period of record from November 1977 to April 1978 (Table D-4). The largest recorded fluctuation was 4 feet in amplitude between March and April 1978. This figure agrees with short term reported fluctuations (Bermes and others, 1963).

D.5 GROUND WATER QUALITY MONITORING DATA

Results of the six-month monitoring program (November 1977 through April 1978) are presented in Table D-5, Ground Water Quality Parameters. Well locations are shown in Figure D-1.

D.6 WATER WELL INVENTORY

Introduction

Wells within a five-mile radius of the site were inventoried for physical characteristics and use. The wells are numbered according to quadrants, based on townships (see Figures D-7 and D-9), and designated with prefixes of A through D.

The inventory was performed from October 17 to 28, 1977, with a special inventory near Bostwick on November 16, 1977 (Figure D-8). Well information, such as casing depth and total depths, were based on interviews with the well owners. Efforts were made to obtain drillers logs for the wells to verify well construction. However, very limited well data were available. Table D-6 presents the inventory data. Figure D-7 locates the wells in the October inventory, and Figure D-8 shows the well locations in the special inventory.

Published data from an earlier inventory by the U. S. Geological Survey (USGS) provided information on additional wells within the five-mile radial area. Results are in Table D-7. Only a few of the wells inventoried by the USGS were located and restudied during the field inventories.

An average of one well per square mile was inventoried as a representative number. In areas of low well density, all wells were inventoried. In areas in which similar wells were clustered, one or more were selected. All wells known to have higher than average yields were given particular attention. Wells producing from the Floridan Aquifer and those tapping the water table aquifer were identified. Near Bostwick, the special inventory identified water table wells at a greater density than the other inventory. The results of the inventories are summarized in the following sections.

Quadrant A

Quadrant A covers the area north and northeast of the site and includes the Community of Bostwick (approximately 150 families). Bostwick is in an area of moderate artesian flow. The well and water use inventory located a total of 16 water table aquifer wells ranging from 56 to 120 feet in depth with 14 wells in the range of 80-100 feet (Figure D-8). The remainder of the wells serving Bostwick produce from the Floridan Aquifer with depths ranging from 180 to 300 feet. Those were not inventoried, but one Floridan well (S-17) downstream from the site was inventoried. Most wells serve one family only; a trailer park is served by a single well tapping the water table aquifer. One well located during the special inventory (S-1) was monitored monthly to assist in establishing baseline water quality.

The area directly to the east of Bostwick along State Route 209 is lightly populated, with approximately one family per quarter mile. The wells serving this area are flowing Floridan Aquifer wells ranging from 150 to 500 feet in depth. These wells serve one family each, with the exceptions of Well A-16 which is a 6-inch Floridan well that serves the St. Johns Harbor Trailer Park (approximately 75 families), and Well A-23, a 6-inch Floridan well serving the Community of Bridgeport (approximately 12 families). The wells in the Flint Point, Pine Bluff, Deadman Point, Nine Mile Point, and Palmetto Bluff areas are flowing Floridan wells serving one family each.

Quadrant B

Quadrant B located to the northwest of the site is a sparsely populated area, in which the Floridan Aquifer is tapped by single-family wells ranging in depth from 180 to 500 feet. Only one water table aquifer well could be found in this area.

Quadrant C

Quadrant C covers the area to the west and southwest of the site and includes the Community of Bardin (approximately 50 families), Hudson Pulp and Paper Company, and the St. Johns River Barge Port.

No flowing wells were found in the area directly west of the site between State Route S209 and Bostwick along U. S. Route 17. However, well depths suggest that at least some wells reach the Floridan Aquifer. The wells range in depth from 135 to 200 feet and serve individual families.

The inventory in the Bardin area showed Floridan Aquifer wells ranging in depths from 114 to 300 feet and serving one family each. Also two wells owned by Hudson Pulp and Paper Company, Well C-6 (12 inches; 600 feet) and Well C-7 (20 inches; 1203 feet), were uncapped and flowing into Etonia Creek. These wells were also included in the 1963 USGS inventory.

Quadrant D

This quadrant includes the area directly south and east of the site. The wells in this area are flowing Floridan Aquifer wells ranging in depth from 150 to 310 feet. Each serves one family. These wells were, for the most part, located between State Route S209 and the St. Johns River.

Also included in this quadrant is an area on the east bank of the St. Johns River just north of East Palatka. This is mainly an agricultural area (potatoes, cabbage); however, the wells inventoried were mostly residential and each served a single family. These wells were found to be flowing Floridan wells ranging in depth from 150 to 350 feet. Each owner reported that his well was affected by irrigation pumping in the fields directly to the east in the Patersonville-Orange Mills area. Data on agricultural wells were unavailable at the time of inventory.

General Findings

In all areas covered, the Floridan Aquifer wells observed were equipped with aeration and filtration systems to eliminate hydrogen sulfide odor in the water. About 40 percent of the owners of water table aquifer wells surveyed reported a high iron content in their water.

Well yields from the Floridan Aquifer are usually dependent on the size of pipe chosen for water delivery, hence not likely to be representative of the capacity of the well. Well yields from the water table aquifer were unavailable, but presumed to be modest, inasmuch as most are two inches in diameter. No springs were found during the inventory.

Table D-1

Hydraulic Parameters of the Water Table Aquifer

Well	Plot	Method	Transmissivity (gpd/ft.)			Storage
			No. of Calc.	Range	Ave. For Method	Coefficient
Test well (pumped)	time vs. recovery	non-leaky artesian aquifer curve (Theis, 1935).	3	16,120-16,670	16,400	inapplicable
D&M #1 (observ.)	time vs. drawdown	leaky artesian/unconfined aquifer curve (Bolton, 1963)	2	16,450-17,030	16,700	0.22 - 0.37
Selected representative value					16,500	0.30

Table D-2

Permeability of Upper Part of Water Table Aquifer
(Layer 1)

Vertical[a]		Horizontal[b]	
(ft/sec.)	(gpd/ft^2)	(ft/sec.)	(gpd/ft^2)
4.4×10^{-5}	28.4	6.03×10^{-4}	389

[a]Average of results of 3 field tests using falling-head parameters.

[b]Computed from pumping test.

Table D-3

Water Level Fluctuations in Water Table Aquifer

Boring No.	Land Surface[a] Elevation (ft MSL)	Water Level[b] (ft. LSD)	Water Level[b] (ft. MSL)	Six Month Amplitude of Fluctuation (ft)	Date Recorded	Maximum Measured Fluctuation	Period of Record
1	79	7 10	72 69	3	6-27-77 11-4-77	4	6/77-4/78
2	49	5 5	44 44	0	6-29-77 11-4-77	0	6/77-11/77
3	75	8 14	67 61	6	6-30-77 11-4-77	7	6/77-4/78

[a]Elevations estimated from 1/24,000 scale topographic map; Above mean sea level (MSL).
[b]Below land surface datum (LSD); above mean sea level (MSL).

Table D-4

Water Level Fluctuations in Floridan Aquifer

Well	Land Surface[a] Elevation (ft. MSL)	Water Level[b] (ft. LSD)	Water Level[b] (ft. MSL)	Six Month Amplitude of Fluctuation (ft.)	Dates Recorded
F-1	67	35	32	4	3-21-78
		39	28		4-26-78
F-2	72	43	29	3	2-20-78
		46	26		4-26-78

[a]Elevations estimated from 1/24,000 scale topographic map; above mean sea level (MSL)
[b]Below land surface datum (LSD); Above mean sea level (MSL)

TABLE D-5

GROUND WATER QUALITY PARAMETERS

NOTE: All values are expressed in milligrams per liter (mg/l) unless otherwise noted. Analyses by Orlando Laboratories, Inc., Orlando, Florida, except for December 9, 1977 duplicate analysis.

WELL NO. 1 AQUIFER Water Table

PARAMETER	DATE SAMPLED 11-4-77	12-9-77	1-4-78	2-14-78	3-21-78	4-26-78	AVERAGE
Water level (ft. below LSD)	9.6	10.2	9.6	9.0	6.2	7.7	--
Color (PCU)	30	5	25	5	5	5	13
Odor Threshold	15	0	1	1	0	0	3
Turbidity (field) (NTU)	--	28	32	--	65	20	30
Turbidity (lab) (NTU)	40	--	--	41	120	380	180
Temperature (°C)	23	--	23.1	22	21	--	22.3
Specific conductance (μmhos/cm @ 25°C)	115	63	61	58	67	62	69
Total Dissolved Solids	95	50	40	44	56	36	54
pH field (units)	--	6.1	6.7	--	--	5.7	6.2
pH lab (units)	6.0	--	--	6.1	5.6	6.1	5.9
Alkalinity, total as $CaCO_3$	24	20	21	16	25	20	21
Hardness, total as $CaCO_3$	56	26	20	22	24	30	30
Hardness, Non carbonate as $CaCO_3$	32	6	2	6	1	10	10
Alkyl Benzene Sulfonate	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic	<0.01	<0.01	<0.01	0.012	0.01	0.016	<0.013
Barium	<0.5	<0.5	<0.5	<0.1	<0.5	<0.1	<0.37
Bicarbonate as HCO_3	29	24	26	20	31	24	26
Boron	--	--	0.06	0.05	0.07	0.05	0.058
Cadmium	<0.01	<0.01	<0.01	0.001	<0.005	0.004	<0.005
Calcium	13	6.4	4.8	5.6	6.4	8	7.4
Carbon Dioxide as CO_2	50.0	35	9.0	18.0	130	32	46
Carbonate as $CaCO_3$	0	0	0	0	0	0	0
Chloride	6.6	5.9	4.0	4.6	5.1	5.9	5.35
Chromium Hexavalent	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Copper	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Cyanide	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Flouride	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1
Hydrogen Sulfide as S[a]	1.4	<0.1	0.25	0.06	<0.01	<0.01	<0.31
Hydroxide as OH	0	0	0	0	0	0	0
Iron[b]	28.0	24.0	5.90	4.95	18	15	10.9
Lead	<0.01	<0.01	<0.01	0.007	<0.01	0.019	<0.011
Magnesium	5.8	2.4	1.9	1.9	1.9	2.4	2.7
Manganese	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Mercury	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nitrate	5.67	0.80	1.28	3.32	4.43	0.89	2.73
Phenols	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Phosphate as PO_4	0.62	0.34	0.34	0.37	1.43	<0.16	0.54
Potassium	1.0	0.1	0.1	0.32	0.74	0.75	0.50
Selenium	<0.01	<0.01	<0.01	<0.01	<0.01	0.003	0.009
Silica	6.0	3.0	3.0	2.9	2.8	6.4	3.9
Silver	<0.01	<0.01	<0.01	0.041	<0.01	<0.01	<0.015
Sodium	8.1	3.5	3.4	3.6	4.7	3.6	4.5
Sulfate	50	4	5.0	3.0	<1	10	12.2
Zinc	0.08	0.02	0.06	0.03	0.04	0.10	0.06
Stability Index	12.2	12.9	12.5	13.1	13.2	12.0	12.7
Saturation Index	-3.1	-3.4	-2.9	-3.5	-3.8	-2.9	-3.3

[a] Hydrogen sulfide titrated in field, except November, 1978 and duplicate of December 9, 1977.

[b] Values for iron invalid in November, 1977, and not included in average. Sample not filtered in the field.

TABLE D-5 (cont'd)

GROUND WATER QUALITY PARAMETERS

NOTE: All values are expressed in milligrams per liter (mg/l) unless otherwise noted. Analyses by Orlando Laboratories, Inc., Orlando, Florida, except for December 9, 1977 duplicate analysis.

WELL NO. 3 AQUIFER Water Table

PARAMETER	DATE SAMPLED 11-4-77	12-9-77	1-4-78	2-14-78	3-21-78	4-26-78	AVERAGE
Water level (ft. below LSD)	14.0	14.7	14.4	15.1	13.2	14.7	--
Color (PCU)	35	30	25	30	30	30	30
Odor Threshold	5	5	0	40	0	0	9
Turbidity (field) (NTU)	--	3.8	2.4	--	4.1	3.4	3.4
Turbidity (lab) (NTU)	2.8	--	--	5.2	4.3	4.6	4.7
Temperature (°C)	23	--	22.8	22	--	--	22.6
Specific conductance (μmhos/cm @ 25°C)	450	240	194	119	139	123	210
Total Dissolved Solids	350	210	135	64	112	112	164
pH field (units)	--	7.0	6.6	--	--	6.4	6.7
pH lab (units)	6.8	--	6.6	6.4	6.9	6.7	6.7
Alkalinity, total as $CaCO_3$	208	120	88	60	60	52	98
Hardness, total as $CaCO_3$	196	112	88	55	60	56	94
Hardness, Non carbonate as $CaCO_3$	12	8	0	5	<1	4	5
Alkyl Benzene Sulfonate	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic	<0.01	<0.01	<0.01	0.012	<0.01	0.014	<0.011
Barium	<0.5	<0.5	<0.5	<0.1	<0.5	<0.1	<0.367
Bicarbonate as HCO_3	254	146	107	73	73	63	119
Boron	--	--	0.04	0.02	0.05	0.01	0.030
Cadmium	<0.01	<0.01	<0.01	<0.001	<0.005	0.003	0.007
Calcium	74	42	27	6.3	19	19	31.2
Carbon Dioxide as CO_2	69	25	46	48	16	21	37.5
Carbonate as $CaCO_3$	0	0	0	0	0	0	0
Chloride	15	6.8	6.1	6.3	8.4	8	8.4
Chromium Hexavalent	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Copper	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Cyanide	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Flouride	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Hydrogen Sulfide as S	0.5	0.4	0.34	<0.1	0.03	0.03	0.23
Hydroxide as OH	0	0	0	0	0	0	0
Iron	1.9	0.93	0.38	0.88	0.88	0.68	0.75
Lead	<0.01	<0.01	<0.01	0.013	0.02	0.018	0.014
Magnesium	2.9	1.9	4.9	<0.2	2.9	1.9	2.45
Manganese	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Mercury	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nitrate	.71	3.99	0.27	0.66	0.93	1.99	1.43
Phenols	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Phosphate as PO_4	0.16	0.43	0.43	1.40	0.37	<0.03	<0.470
Potassium	2.6	0.6	0.39	0.51	0.84	0.35	0.89
Selenium	<0.01	<0.01	<0.01	<0.01	<0.01	0.002	<0.01
Silica	6.5	7.0	9.0	8.1	6.8	7.5	7.5
Silver	<0.01	<0.01	<0.01	0.045	<0.01	<0.01	<0.01
Sodium	28	9.0	5.0	5.3	11	5.5	10.6
Sulfate	25	2.0	<1.0	<1.0	15	8	8.6
Zinc	0.13	0.02	0.29	<0.01	0.02	0.02	0.08
Stability Index	8.0	8.8	9.0	10.6	10.1	9.9	9.4
Saturation Index	-0.6	-0.9	-1.2	-2.1	-1.6	-1.6	-1.3

TABLE D-5 (cont'd)

GROUND WATER QUALITY PARAMETERS

NOTE: All values are expressed in milligrams per liter (mg/l) unless otherwise noted. Analyses by Orlando Laboratories, Inc., Orlando, Florida, except for December 9, 1977 duplicate analysis.

WELL NO. S-1 AQUIFER Water Table

PARAMETER	DATE SAMPLED 12-9-77	2-14-78	3-21-78	4-26-78	AVERAGE
Water level (ft. below LSD)	--	--	--	--	
Color (PCU)	10	5	0	10	8.3
Odor Threshold	0	0	0	0	0
Turbidity (field)(NTU)	13	15	5.0	5.4	9.6
Turbidity (lab)(NTU)	--	--	4.5	7.2	5.9
Temperature (°C)	--	--	20	--	2.0
Specific conductance (µmhos/cm @ 25°C)	455	400	460	460	444
Total Dissolved Solids	380	268	288	304	310
pH field (units)	--	7.1	--	7.3	7.2
pH lab (units)	7.3	7.3	7.5	7.0	7.3
Alkalinity, total as $CaCO_3$	270	240	240	240	247
Hardness, total as $CaCO_3$	220	224	236	232	228
Hardness, Non carbonate as $CaCO_3$	20	16	4	8	12
Alkyl Benzene Sulfonate	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic	<0.01	0.006	<0.01	0.014	0.01
Barium	<0.5	0.7	<0.5	<0.1	<0.5
Bicarbonate as HCO_3	293	293	293	293	293
Boron	--	<0.01	0.03	0.05	0.03
Cadmium	<0.01	0.002	<0.005	0.002	0.005
Calcium	80	80	82	80	80
Carbon Dioxide as CO_2	24	26	16	49	29
Carbonate as $CaCO_3$	0	0	0	0	0
Chloride	13	12	12	13	13
Chromium Hexavalent	<0.01	<0.01	<0.01	<0.01	0.01
Copper	<0.1	<0.1	<0.1	0.35	<0.16
Cyanide	<0.01	<0.01	<0.01	<0.01	<0.01
Flouride	0.3	0.3	0.3	0.3	0.3
Hydrogen Sulfide as S[a]	<0.1	0.04	0.02	0.01	0.04
Hydroxide as OH	0	0	0	0	0
Iron[b]	1.80	1.00	0.44	0.82	0.75
Lead	<0.01	0.006	<0.01	<0.01	<0.01
Magnesium	4.9	5.8	7.8	7.8	6.6
Manganese	<0.05	<0.05	<0.05	<0.05	<0.05
Mercury	<0.001	<0.001	0.0006	<0.001	<0.001
Nitrate	2.92	3.81	0.22	6.65	3.4
Phenols	<0.001	<0.001	<0.001	<0.001	<0.001
Phosphate as PO_4	0.59	0.78	0.47	0.03	0.47
Potassium	2.2	2.74	2.53	1.4	2.22
Selenium	<0.01	<0.01	<0.01	0.004	<0.01
Silica	25	30	29	28	28
Silver	<0.01	0.045	<0.01	<0.01	0.019
Sodium	17	14	13	12	14
Sulfate	3	1.5	5	2	2.9
Zinc	0.74	0.32	0.14	0.13	0.33
Stability Index	7.3	7.3	7.1	7.2	7.2
Saturation Index	0.0	0.0	0.2	-0.1	--

a Hydrogen sulfide titrated in field, except November, 1978 and duplicate of December 9, 1977.

b Values for iron invalid in November, 1977, and not included in average. Sample not filtered in the field.

TABLE D-5 (cont'd)

GROUND WATER QUALITY PARAMETERS

NOTE: All values are expressed in milligrams per liter (mg/l) unless otherwise noted. Analyses by Orlando Laboratories, Inc., Orlando, Florida, except for December 9, 1977 duplicate analysis.

WELL NO. F-1 AQUIFER Floridan

PARAMETER	DATE SAMPLED						AVERAGE[d]
	11-18-77	12-9-77	12-9-77[c]	1-4-78	2-21-78	4-26-78	
Water level (ft. below LDS)	37.6	--	36.3	35.8	35.1	38.6	
Color (PCU)	5	160	300	0	30	30	87.5
Odor Threshold	1	15	--	5	10	0	8
Turbidity (field) (NTU)	--	28	--	1.6	1.1	3.3	12.2
Turbidity (lab) (NTU)	144	--	27	--	1.2	3.3	2.3[c]
Temperature (°C)	--	--	--	23	--	--	23
Specific conductance (μmhos/cm @ 25°C)	285	295	272	290	275	300	286
Total Dissolved Solids	240	250	229	170	220	212	220
pH field (units)	--	--	--	7.7	--	6.9	7.3
pH lab (units)	9.0	7.7	8.2	7.7	7.6	7.7	7.8[c]
Alkalinity, total as $CaCO_3$	160	164	159	128	132	136	146
Hardness, total as $CaCO_3$	190	155	176	140	140	140	157
Hardness, Non carbonate as $CaCO_3$	30	9	17	12	8	4	13
Alkyl Benzene Sulfonate	<0.01	<0.01		<0.01	<0.01	<0.01	<0.01
Arsenic	<0.01	<0.01	0.028	<0.01	<0.01	<0.01	<0.01
Barium	<0.5	<0.5	0.24	<0.5	<0.5	<0.1	<0.39
Bicarbonate as HCO_3	156	200	159	156	161	166	166
Boron	--	--	0.11	0.05	0.04	0.04	0.06
Cadmium	<0.01	<0.01	<0.001	<0.01	<0.005	0.004	0.007
Calcium	52	44	43.8	35	38	34	41
Carbon Dioxide as CO_2	<1.0	7.0	--	5.1	6.5	5.6	5.0
Carbonate as $CaCO_3$	20	0	0	0	0	0	0[c]
Chloride	11	17	10.0	12	10	10	12
Chromium Hexavalent	<0.01	<0.01	<0.001	<0.01	<0.01	<0.01	<0.009
Copper	<0.1	<0.1	0.007	<0.1	<0.1	<0.1	< .09
Cyanide	<0.01	<0.01	<0.002	<0.01	<0.01	<0.01	<0.01
Flouride	0.8	0.7	0.57	0.5	0.4	0.4	0.6
Hydrogen Sulfide as S[a]	0.14	1.5	0.1	1.22	1.00	0.04	0.67
Hydroxide as OH	0	0	0	0	0	0	0
Iron[b]	7.30	0.48	0.33	0.07	0.13	0.17	0.26
Lead	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01
Magnesium	12	11	16.17	13	11	14	13
Manganese	<0.05	<0.05	0.02	<0.05	<0.05	<0.05	<0.05
Mercury	<0.001	<0.001	0.0024	<0.001	<0.001	<0.001	0.001
Nitrate	0.93	0.22	--	0.49	0.40	1.86	0.78
Phenols	<0.001	<0.001	--	<0.001	<0.001	<0.001	<0.001
Phosphate as PO_4	0.56	0.78	0.80	0.22	0.62	<0.03	<0.495
Potassium	3.7	2.6	3.05	1.40	2.05	1.25	2.34
Selenium	<0.01	<0.01	<0.005	<0.01	<0.01	0.002	<0.01
Silica	17	9.5	10.0	15	12	13	13
Silver	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sodium	6.8	9.0	7.76	5.4	7.7	7.9	7.4
Sulfate	11	3	11.6	10	21	9	11
Zinc	0.17	0.06	0.021	0.02	<0.01	0.04	0.05
Stability Index	6.4	7.7	7.18	8.1	8.2	7.7	7.55
Saturation Index	1.3	0.0	0.51	-0.2	-0.3	<0.1	--

[a] Hydrogen sulfide titrated in field, except November, 1978 and duplicate of December 9, 1977.

[b] Values for iron invalid in November, 1977, and not included in average. Sample not filtered in the field.

[c] By Southern Analytical Laboratories, Jacksonville, Florida
Turbidity is measured in Jackson Turbidity Units and hydroxide is expressed as $CaCO_3$.

[d] Averages exclude suspect values when water stagnation caused non-representative values in Floridan aquifer wells (November 18, and some December 9 values).

TABLE D-5 (cont'd)

GROUND WATER QUALITY PARAMETERS

NOTE: All values are expressed in milligrams per liter (mg/l) unless otherwise noted. Analyses by Orlando Laboratories, Inc., Orlando, Florida, except for December 9, 1977 duplicate analysis.

WELL NO. F-2 AQUIFER Floridan

PARAMETER	DATE SAMPLED								AVERAGE[e]
	11-19-77	12-9-77	12-9-77[c]	12-28-77	1-4-78	2-14-78	3-21-78	4-26-78	
Water level (ft. below LSD)	45.2	44.7	--	44.3	43.4	43.1	43.3	46.4	
Color (PCU)	5	10	30	0	0	0	0	0	0
Odor Threshold	10	15	--	33	0	3	35	20	18
Turbidity (field) (NTU)	--	8.4	--	--	2.3	1.54	0.4	1.2	1.4
Turbidity (lab) (NTU)	100	17	17	4.8	--	--	0.76	6.5	2.78
Temperature (°C)	--	--	--	--	24	23	25	--	24
Specific conductance (μmhos/cm @ 25°C)	800	2660	2320	910	920	950	940	910	930
Total Dissolved Solids	500	1862	979	640	615	586	628	542	617
pH field (units)	--	11.7	--	--	7.8	7.3	7.3	8.0	7.5
pH lab (units)	9.4	--	12.1	7.4	--	--	7.6	7.7	7.5
Alkalinity, total as $CaCO_3$	40	490	538	106	80	100	102	58	97
Hardness, total as $CaCO_3$	260	460	448	268	248	276	276	250	267
Hardness, Non carbonate as $CaCO_3$	220	56	0	140	168	56	174	192	134
Alkyl Benzene Sulfonate	<0.01	<0.01	--	0	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic	<0.01	<0.01	0.018	<0.01	<0.01	0.012	<0.01	0.011	<0.01
Barium	<0.5	<0.5	1.79	<0.05	<0.5	<0.1	<0.5	<0.1	<0.29
Bicarbonate as HCO_3	20	0	0	129	98	122	124	71	118
Boron	--	--	0.11	--	0.01	0.07	0.07	0.05	0.05
Cadmium	<0.01	<0.01	<0.001	<0.01	<0.01	0.002	<0.005	<0.001	0.007
Calcium	72	176	135.43	56	82	62	67	62	67
Carbon Dioxide as CO_2	<1.0	<1.0	--	9.0	2.9	10	5.5	2.4	6.8
Carbonate as $CaCO_3$	15	34	76	0	0	0	0	0	0
Chloride	180	240	142	180	175	188	211	195	189
Chromium Hexavalent	<0.01	<0.01	<0.001	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Copper	<0.1	<0.1	0.020	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Cyanide	<0.01	<0.01	0.002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Flouride	0.4	0.3	0.27	0.3	0.1	0.3	0.3	0.3	0.25
Hydrogen Sulfide as S[a]	1.20	1.50	0.8	3.3	1.72	0.8	3.28	2.0	2.27
Hydroxide as OH	0	434	462	0	0	0	0	0	0
Iron[b]	2.15	0.20	0.05	0.09	0.03	0.02	0.01	0.05	0.04
Lead	<0.01	<0.01	0.02	<0.01	<0.01	0.015	<0.01	<0.01	<0.01
Magnesium	19	4.9	2.81	31	11	29	26	23	24
Manganese	<0.05	<0.05	0.01	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Mercury	<0.001	<0.001	0.0020	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nitrate	0.49	<0.01	0.04	<0.01	<0.04	2.46	<0.04	2.35	0.64
Phenols	<0.001	<0.001	--	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Phosphate as PO_4	0.77	0.16	0.15	0.12	0.12	0.03	0.28	0.03	<0.14
Potassium	0.9	79	5.74	3.0	5.0	7.0	3.95	6.0	4.7
Selenium	<0.01	<0.01	<0.005	<0.01	<0.01	<0.01	<0.01	<0.001	<0.01
Silica	14	9.0	8.0	16	14	14.0	13.0	12.0	14.3
Silver	<0.01	<0.01	<0.01	<0.01	<0.01	0.035	<0.01	<0.01	<0.02
Sodium	64	128	106.29	94	80	78	88	82	85
Sulfate	94	100	82	110	100	78	90	95	94.5
Zinc	0.29	0.02	0.034	<0.01	<0.04	0.235	<0.01	0.03	<0.07
Stability Index	6.8	1.7	1.36	8.2	7.8	8.3	8.0	8.0	8.1
Saturation Index	1.3	5.0	5.37	-0.4	0.0	-0.5	-0.2	-0.1	--

[a] Hydrogen sulfide titrated in field, except November, 1978 and duplicate of December 9, 1977.

[b] Values for iron invalid in November, 1977, and not included in average. Sample not filtered in the field.

[c] By Southern Analytical Laboratories, Jacksonville, Florida
Turbidity is measured in Jackson Turbidity Units and hydroxide is expressed as $CaCO_3$.

[d] Averages exclude suspect values when water stagnation caused non-representative values in Floridan aquifer wells (November 18, and some December 9 values).

[e] Only analyses for December 28 through March 21 averaged for F-2. Air compressor not available in April 1978.

TABLE D-6

WELL INVENTORY AND WATER USE WITHIN 5-MILE RADIUS OF SITE (ALL WELL SPECIFICATIONS BASED ON INTERVIEW WITH OWNER)

Well	Location	Well[a] Depth (ft.)	Casing Dia. (in)	Casing Depth (ft)	Ground Surface[b] Elevation (ft above MSL)	Static Water Level (ft MSL)	+(Above) or -(Below) Ground Surface	Date Measured	Use	Remarks
A-1[c]	T8S, R27E SW¼, SE¼, NE¼, Section 19	350*	4	40*	10	17.5	+7.5*	10-27-77	Residential	Flowing
A-8	NE¼, SE¼, NE¼ Section 26	218*	2.5	126*	2	-	-	10-19-77	Residential	Flowing
A-9	NW¼, NE¼, NE¼ Section 35	220*	2	-	5	-	-	10-19-77	Residential	Flowing
A-10	NE¼, SE¼, NE¼ Section 35	229*	2	138*	2	-	-	10-19-77	Residential	Flowing
A-11	SE¼, SW¼, SE¼ Section 27	257*	2.5	125*	19	-	-	10-19-77	Residential Cattle (30)	Flowing
A-12	SW¼, NE¼, SE¼ Section 28	250*	4	-	15	9.37	-5.63	10-19-77	Livestock	-
A-13	NW¼, NE¼, SW¼ Section 13	210*	2	63*	20	-	-	10-19-77	Commercial Residential	Flowing
A-14	NE¼, NE¼, SW¼ Section 30	95*	2	95*	25	-	-	10-19-77	Residential 8 Families	-
A-15	SE¼, SE¼, SE¼ Section 27	252*	4	100*	12	-	-	10-26-77	Livestock	Flowing
A-16	Section 35 Irregular	-	6	-	12	-	-	10-26-77	Trailer Park 75 Units	-
A-17	SW¼, NW¼, NW¼ Section 23	195*	2	-	2	-	-	10-27-77	Residential	Flowing
A-18	SE¼, SW¼, NW¼ Section 23	500*	2	-	3	-	-	10-27-77	Residential	Flowing
A-19	SW¼, SE¼, SE¼ Section 23	450*	3	-	2	-	-	10-27-77	Residential	-
A-20	NW¼, NE¼, SW¼ Section 28	310*	3	-	15	-	-	10-27-77	Residential	Flowing
A-21	SW¼, SE¼, NW¼ Section 31	250*	4	-	52	22.69	-29.31	10-27-77	Livestock	-
A-22	SE¼, SW¼, SE¼ Section 35	250*	3	-	2	-	-	10-26-77	Residential	Flowing
A-23	SW¼, SW¼, SE¼ Section 35	300*	6	-	3	-	-	10-26-77	Residential 4 Homes	-
B-2	T8S, R26E NE¼, NW¼, SW¼ Section 12	180*	2	-	52	53.3	+1.3	10-24-77	Residential	-
B-3	SE¼, NW¼, SW¼ Section 12	474*	2	200*	51	51.85	+0.85	10-24-77	Livestock	Flowing
B-4	NE¼, NE¼, SE¼ Section 24	88*	3	88*	42	-	-	10-24-77	Residential	-
C-6[c]	T9S, R26E SW¼, SW¼, NW¼ Section 9	600*	12	178*	10	-	-	10-25-77	To Create Surface Water	Flowing
C-7[c]	NE¼, SW¼, NW¼ Section 7	1203*	20	183*	10	-	-	10-25-77	To Create Surface Water	Flowing

NOTES:
- a Well and casing depths are below ground surface
- b Ground surface elevations estimated from 1:24,000 topographic maps
- c Well was also inventoried prior to study (1963) (Fla. Geological Survey Info. Circular 37)
- * Data is reported; not measured

TABLE D-6 (cont'd)

WELL INVENTORY AND WATER USE WITHIN 5-MILE RADIUS OF SITE
(ALL WELL SPECIFICATIONS BASED ON INTERVIEW WITH OWNER)

Well	Location	Well[a] Depth (ft.)	Casing Dia. (in)	Casing Depth (ft)	Ground Surface[b] Elevation (ft above MSL)	Static Water Level (ft MSL)	+(Above) or -(Below) Ground Surface	Date Measured	Use	Remarks
C-10	NE¼, SE¼, NE¼ Section 13	-	10	-	26	29.25	+0.25	10-20-77	Commercial Fish Hatchery	Flowing
C-11	SW¼, NE¼, NW¼ Section 13	190*	2	80*	27	-	-	10-24-77	Residential	-
C-12	NW¼, NE¼, NE¼ Section 17	180*	2	180*	15	-	-	10-25-77	Irrigation Fern Farm	Flowing
C-13	NW¼, NE¼, NE¼ Section 17	270*	5	-	20	-	-	10-25-77	Livestock	(3200 gpm Reported Pump cap)
C-14	SW¼, SE¼, SE¼ Section 8	37*	1¼	37*	17	-	-	10-25-77	Residential	-
C-15	SE¼, SW¼, NE¼ Section 8	312*	2	135*	21	-	-	10-25-77	Residential	Flowing
C-16	SE¼, SW¼, NE¼ Section 8	114*	1¼	85*	23	-	-	10-25-77	Abandoned	Flowing
C-17	NW¼, SE¼, NE¼ Section 8	106*	2	85*	17.5	19.5	+2.0*	10-25-77	Residential	Flowing. Affected by pumping at Hudson Paper Co.*
C-18	SE¼, SE¼, NE¼ Section 8	300*	2	-	17	-	-	10-25-77	Abandoned	-
C-19	SE¼, SE¼, SE¼ Section 5	250*	3	-	22	29.5	+7.5	10-25-77	Residential	Flowing
C-20	SW¼, SE¼, SW¼ Section 12	210*	4	96*	37	26.42	-10.58	10-27-77	Residential	-
C-21	SW¼, SW¼, SW¼ Section 13	179*	3	-	14	-	-	10-27-77	Residential	Flowing Approx. 16 gpm thru 1.5" Pipe
C-22	NW¼, SE¼, NE¼ Section 23	237*	2	90*	10	-	-	10-27-77	Residential	Flowing
C-23	NW¼, SE¼, NE¼ Section 12	130*	2	-	65	-	-	10-27-77	Residential	-
C-24	Section 37 Irregular	280*	2	-	9	-	-	10-27-77	Residential	Flowing
C-25	Section 37 Irregular	300*	2	-	7	-	-	10-27-77	Residential	Flowing
C-26	Section 37 Irregular	-	12	-	5	17.55	+11.55	10-27-77	Fire Control	5 psi head Flowing
C-27	SW¼, SW¼, SW¼ Section 6	68*	2	-	62	-	-	10-24-77	Residential	-
C-28	Irregular Section 1 mi. N. of Palatka	200*	2	-	15	-	-	10-27-77	Residential	Flowing
C-29	NE¼, NE¼, SE¼ Section 23	200*	4	-	5	-	-	11-8-77	Residential	-
D-1[c]	T9S, R27E NW¼, SW¼, SE¼ Section 7	279*	4	-	77	29.85	-47.15	10-20-77	Residential	-
D-34[c]	Section 40 Irregular	190*	4	110	7	11.0	+4.0	10-21-77	Residential	Flowing

NOTES:
- a Well and casing depths are below ground surface
- b Ground surface elevations estimated from 1:24,000 topographic maps
- c Well was also inventoried prior to study (1963) (Fla. Geological Survey Info. Circular 37)
- * Data is reported; not measured

TABLE D-6 (cont'd)

WELL INVENTORY AND WATER USE WITHIN 5-MILE RADIUS OF SITE
(ALL WELL SPECIFICATIONS BASED ON INTERVIEW WITH OWNER)

Well	Location	Well[a] Depth (ft.)	Casing Dia. (in)	Casing Depth (ft)	Ground Surface[b] Elevation (ft above MSL)	Static Water Level (ft MSL)	+(Above) or -(Below) Ground Surface	Date Measured	Use	Remarks
D-39	NE¼, NW¼, SE¼ Section 18	50*	2	50*	20	-	-	10-20-77	Residential	-
D-40	NW¼, NW¼, SW¼ Section 16	220*	2	-	5	14.23	+9.23	10-20-77	Residential	4 psi head Flowing
D-41	NW¼, NW¼, SW¼ Section 16	186*	2	186*	5	14.23	+9.23	10-20-77	Residential	4 psi head Flowing
D-42	SW¼, SW¼, NW¼ Section 16	220*	2	-	5	16* (1966)	+11	10-20-77	Residential	Flowing
D-43	SW¼, SW¼, NW¼ Section 18	280*	2	100*	22	31.24	+9.24	10-20-77	Residential	4 psi head Flowing
D-44	SW¼, SW¼, NW¼ Section 18	85*	2	85*	21	15.0	-6*	10-20-77	Residential	-
D-45	SW¼, SW¼, NW¼ Section 18	275*	4	100*	20	-	-	10-20-77	Commercial Fish Hatchery	Flowing (No Flow when Hudson Paper is Pumping*)
D-46	SW¼, NW¼, NW¼ Section 18	310*	4	100*	30	-	-	10-20-77	Commercial Fish Hatchery	Same as D-45
D-47	NW¼, SW¼, SW¼ Section 18	310*	4	100*	6	-	-	10-20-77	Abandoned	-
D-48	NW¼, NE¼, SW¼ Section 17	300*	2	-	17	-	-	10-20-77	Residential	* Flows except during potato season
D-49	NW¼, NE¼, SE¼ Section 16	250*	2	-	6	-	-	10-26-77	Residential	Flowing
D-50	NW¼, NE¼, SE¼ Section 16	173*	2	105*	5	21.17	+16.17	10-26-77	Residential	7 psi head Flowing
D-51	Section 51 Irregular	160*	2	100*	10	-	-	10-26-77	Residential	Flowing
D-52	Section 51 Irregular	300*	2	-	10	-	-	10-26-77	Residential	Flowing
D-53	Section 3 Irregular	5.5	3	-	15	9.93	-5.07	10-26-77	Residential	Well is wood plank installed approx. 1900*
D-54	Section 3 Irregular	-	6	-	12	-	-	10-26-77	Abandoned	Flowing
D-55	Section 10 Irregular	300*	2	-	7	-	-	10-26-77	Residential	Flowing
D-56	NE¼, NE¼, NE¼ Section 3	285*	4	-	10	-	-	10-26-77	Residential	Flowing
D-57	Section 45 Irregular	360*	4	-	10	20	+10	10-21-77	Residential Livestock Quail Farm	Flowing; affected by irrigation pumping to East *
D-58	Section 45 Irregular	300*	3	-	7	-	-	10-21-77	Residential	Same as D-57 *
D-59	Section 40 Irregular	-	3	-	10	-	-	10-21-77	Residential Commercial (Nursery)	-
D-60	Section 40 Irregular	330*	4	-	4	-	-	10-21-77	Residential	Flowing

NOTES:
- a Well and casing depths are below ground surface
- b Ground surface elevations estimated from 1:24,000 topographic maps
- c Well was also inventoried prior to study (1963) (Fla. Geological Survey Info. Circular 37)
- * Data is reported; not measured

TABLE D-6 (cont'd)

WELL INVENTORY AND WATER USE WITHIN 5-MILE RADIUS OF SITE
(ALL WELL SPECIFICATIONS BASED ON INTERVIEW WITH OWNER)

Well	Location	Well[a] Depth (ft.)	Casing Dia. (in)	Casing Depth (ft)	Ground Surface[b] Elevation (ft above MSL)	Static Water Level (ft MSL)	+(Above) or -(Below) Ground Surface	Date Measured	Use	Remarks
D-61	Section 45 Irregular	125*	1¼	100*	10	-	-	10-21-77	Residential	-
D-62	NW¼, NE¼, NE¼ Section 40	150*	3	-	5	17	+12	10-21-77	Residential	Flowing
D-63	NW¼, NW¼, NE¼ Section 40	180*	3	-	10	11.33	+1.33	10-21-77	Decorative Pond	Flowing 80 gpm *
D-64	NW¼, NW¼, SW¼ Section 17	178*	2	-	10	-	-	10-20-77	-	Flowing
D-65	NW¼, NW¼, SW¼ Section 16	-	6	-	5	-	-	10-20-77	Residential	Flowing; approx. 35 gpm
D-66	SW¼, NE¼, SE¼ Section 16	-	6	-	7	-	-	10-26-77	Residential	Flowing
D-67 (D&M #3)	NW¼, SW¼, SE¼ Section 7	100*	2	100*	75	61.25	-13.75	10-20-77	-	-
S-1	NW¼, SE¼, NW¼ Section 32 T8S, R27E	80*	1¼	80*	30	-	-	11-16-77	Residential	-
S-2	SE¼, NW¼, NW¼ Section 32	95*	1¼	95*	21	8.42	-12.58	11-16-77	Abandoned	-
S-3	NE¼, NW¼, NW¼ Section 32 T8S, R27E	95*	1¼	95*	25	-	-	11-16-77	Residential	-
S-4	Bostwick	100*	1¼	100*	23	-	-	11-16-77	Residential	-
S-5	Bostwick	85*	1¼	85*	21	-	-	11-16-77	Residential	-
S-6	Bostwick	120*	1¼	120*	20	-	-	11-16-77	Residential	-
S-7	Bostwick	80*	2	80*	20	-	-	11-16-77	Residential	-
S-8	Bostwick	85*	2	85*	20	-	-	11-16-77	Residential	-
S-9	Bostwick	80*	2	80*	20	-	-	11-16-77	Residential	-
S-10	Bostwick	85*	1¼	85*	20	-	-	11-16-77	Residential	-
S-11	Bostwick	67*	2	67*	20	-	-	11-16-77	Residential	-
S-12	Bostwick	56*	1¼	56*	20	-	-	11-16-77	Residential	-
S-13	Bostwick	80*	2	80*	20	-	-	11-16-77	Residential	-
S-14	Bostwick	85*	2	85*	20	-	-	11-16-77	Residential	-
S-15	Bostwick	80*	2	80*	20	-	-	11-16-77	Residential	-
S-16	Bostwick	85*	2	85*	20	-	-	11-16-77	Residential	-
S-17	NE¼, SE¼, NE¼ Section 29 T8S, R27E	-	6	-	9	-	-	2-21-78	Residential	Flowing (Floridan aquifer)

NOTES:
[a] Well and casing depths are below ground surface
[b] Ground surface elevations estimated from 1:24,000 topographic maps
[c] Well was also inventoried prior to study (1963) (Fla. Geological Survey Info. Circular 37)
* Data is reported; not measured

TABLE D-7

GROUND WATER LEVELS AND YIELD PRIOR TO STUDY[a]
(within 5 mile radius of site)

Well Number	Location	Well[b] Depth (ft)	Casing Dia. (in.)	Casing Depth (ft)	Ground Surface[c] Elevation (ft MSL)	Static Water Level High (ft above MSL)	Static Water Level Low (ft above MSL)	Date Measured	Amplitude (ft)	Yield (gal./min.)	Remarks
	T 8 S, R 27 E										
A-1[d]	SW¼, SE¼, NE¼ Section 19	350	4	40	20	37	 25	6-1-34 2-18-57	12	-	-
A-2	SW¼, SE¼, NE¼ Section 29	-	-	-	9.5	24	-	1-28-57	-	-	-
A-3	SW¼, SE¼, NW¼ Section 28	300	4	-	12	27	-	1-28-57	-	-	-
A-4	NE¼, SW¼, SW¼ Section 28	350	6	-	19	33	 31	12-4-57 6-2-58	2	440	-
A-5	SW¼, NE¼, NW¼ Section 31	260	6	90	31.67	31.67	 31.45	3-20-56 9-17-58	.22	5	-
A-6	SW¼, SE¼, NW¼ Section 31	267	6	110	30	31.2	 29.5	7-5-56 4-3-56	1.70	30	-
A-7	SE¼, NE¼, SE¼ Section 32	278	4	126	20	30.5	-	-	-	80	-
	T 8 S, R 26 E										
B-1	SE¼, SW¼, SW¼ Section 33	700	12	174	25	51	-	4-28-56	-	1,200	Floridan Aquifer, Hudson Well 1-12 (abandoned)
	T 9 S, R 26 E										
C-1	SE¼, NE¼, NE¼ Section 23	480	4	-	17.73	40.7	 27.7	5-31-34 2-18-57	13.0	-	-
C-2	NW¼, SW¼, NW¼ Section 22	415	6 4	180½ 405 1/3	2	29	-	10-30-55	-	703	Hudson Well 1-6; sp. cap. 16 gpm/ft (1973)
C-3	SW¼, NE¼, SE¼ Section 27	218	6	170	10	-	-	-	-	195	-
C-4[d]	South Half Section 37	260	4	9	15	31	-	7-13-56	-	-	-
C-5	SW¼, NW¼, NW¼ Section 9	700	12	174	15	-	-	-	-	490	Hudson Well 4-12; sp. cap. 27 gpm/ft (1973)
C-6[d]	SW¼, SW¼, NW¼ Section 9	600	12	178	13	-	-	-	-	440	Hudson Well 3-12; sp. cap. 20 gpm/ft (1973)
C-7[d]	NE¼, SW¼, NW¼ Section 17	1203	20	183	17	-	-	-	-	1590	Hudson Well 2-20; sp. cap. 61 gpm/ft (1973)
C-8	SE¼, SE¼, NW¼ Section 16	975	20	177	3	-	-	-	-	2260	Hudson Well 3-20; sp. cap. 62 gpm/ft (1973)
C-9	NE¼, SE¼, NE¼ Section 17	600	12	179	15	-	-	-	-	680	Hudson Well 2-12; sp. cap. 43 gpm/ft (1973)
	T 9 S, R 27 E										
D-1[d]	Section 7	279	4	103	77	35	-	5-27-57	-	-	-
D-2	Section 7	188	2	73	13.77	32.3	 27.8	3-15-56 9-17-58	4.5	210	-
D-3	Section 40	227	4	108	10.04	30.0	 27.5	6-7-57 9-29-58	2.5	-	Floridan Aquifer
D-4	Section 40	209	4	108	11	35	-	5-8-34	-	-	-
D-5	Section 48	450	6	80	15	24	-	6-3-57	-	440	-
D-6	Section 48	450	6	80	19	29	-	6-3-57	-	650	-
D-7	Section 48	408	6	76	17	25	-	7-8-57	-	325	-
D-8	Section 38	300	3	60	5	14	-	4-11-57	-	-	-
D-9	Section 38	280	4	-	3	19	-	4-17-57	-	-	-
D-10	Section 48	-	6	-	10	25	-	9-21-56	-	-	-
D-11	Section 48	155	6	115	15	26	-	4-16-57	-	528	-
D-12	Section 48	245	4	185	5	19	-	9-21-56	-	-	-
D-13	Section 49	370	6	120	8	18	-	6-3-57	-	-	-

NOTES:

a Measurements by U.S. Geological Survey published in 1963 by Florida Geological Survey Information Circular 37; and from Hudson Paper Company as noted.

b Well and casing depths are below ground surface

c Elevation estimated from 1:24,000 topographic maps when not given in publication

d Irregular sections; see location map.

TABLE D-7 (cont'd)

GROUND WATER LEVELS AND YIELD PRIOR TO STUDY[a]
(within 5 mile radius of site)

Well Number	Location	Well[b] Depth (ft)	Casing Dia. (in.)	Casing Depth (ft)	Ground Surface[c] Elevation (ft MSL)	Static Water Level High (ft above MSL)	Static Water Level Low (ft above MSL)	Date Measured	Amplitude (ft)	Yield (gal./min.)	Remarks
D-14	Section 49	410	8	-	12	25	-	2-1-56	-	225	-
D-15	Section 48	356	6	120	15	29	23	9-23-57 3-19-56	6	95	-
D-16	Section 48	350	6	120	15.99	28.5	18.7	9-23-57 2-20-57	9.8	170	-
D-17	Section 48	411	6	115	14.64	27.4	19.1	3-4-58 4-3-56	8.7	100	-
D-18	Section 48	-	1	-	15	18	-	3-21-56	-	-	-
D-19	Section 48	337	4	60	11	19	-	9-5-56	-	-	-
D-20	Section 48	450	4	84	12	25	-	4-11-57	-	140	-
D-21	Section 49	144	4	-	17	20	-	3-20-56	-	50	-
D-22	Section 49	250	4	-	17	24	18	6-12-57 4-3-56	6.0	22	-
D-23	Section 49	258	4	-	18	20	18	3-20-56	-	19	-
D-24	Section 49	222	4	-	18	21	-	3-21-56	-	50	-
D-25	Section 49	245	4	63	19	24	-	8-13-56	-	-	Floridan Aquifer
D-26	Section 48	185	4	-	18	21	-	3-21-56	-	60	-
D-27	Section 48	272	4	63	19	27	21	4-14-58 2-20-57	6.0	115	-
D-28	Section 49	-	4	-	20	24	-	7-8-57	-	150	-
D-29	Section 49	13	1¼	10	18	14	-	11-15-57	-	-	-
D-30	Section 49	-	4	-	18	23	-	7-8-57	-	-	-
D-31	Section 49	-	4	-	20	24	-	7-8-57	-	40	-
D-32	Section 10	275	4	-	15.45	29.0	24.8	9-17-58 4-3-56	4.2	80	-
D-33	Section 48	300	3	60	15	24	-	4-11-57	-	-	-
D-34	Section 40	190	4	110	7	20	-	8-13-56	-	-	-
D-35	Section 48	450	6	-	12	20	-	4-16-57	-	-	-
D-36	Section 48	100	4	-	13	21	-	6-3-57	-	-	-
D-38	Section 49	-	6	-	16.91	23.66	-	7-18-57	-	75	-

NOTES:

a Measurements by U.S. Geological Survey published in 1963 by Florida Geological Survey Information Circular 37; and from Hudson Paper Company as noted.

b Well and casing depths are below ground surface

c Elevation estimated from 1:24,000 topographic maps when not given in publication

d Irregular sections; see location map.

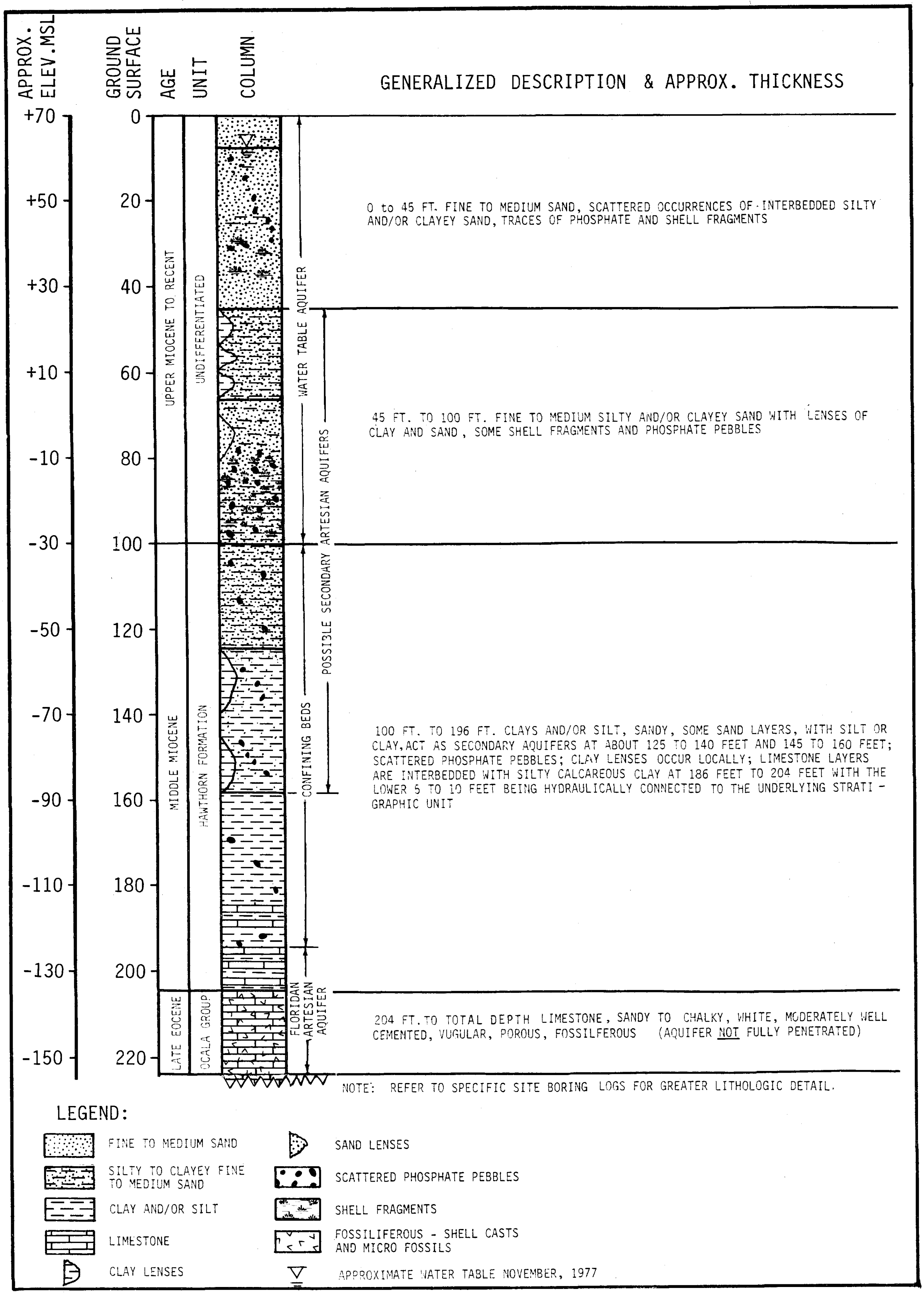
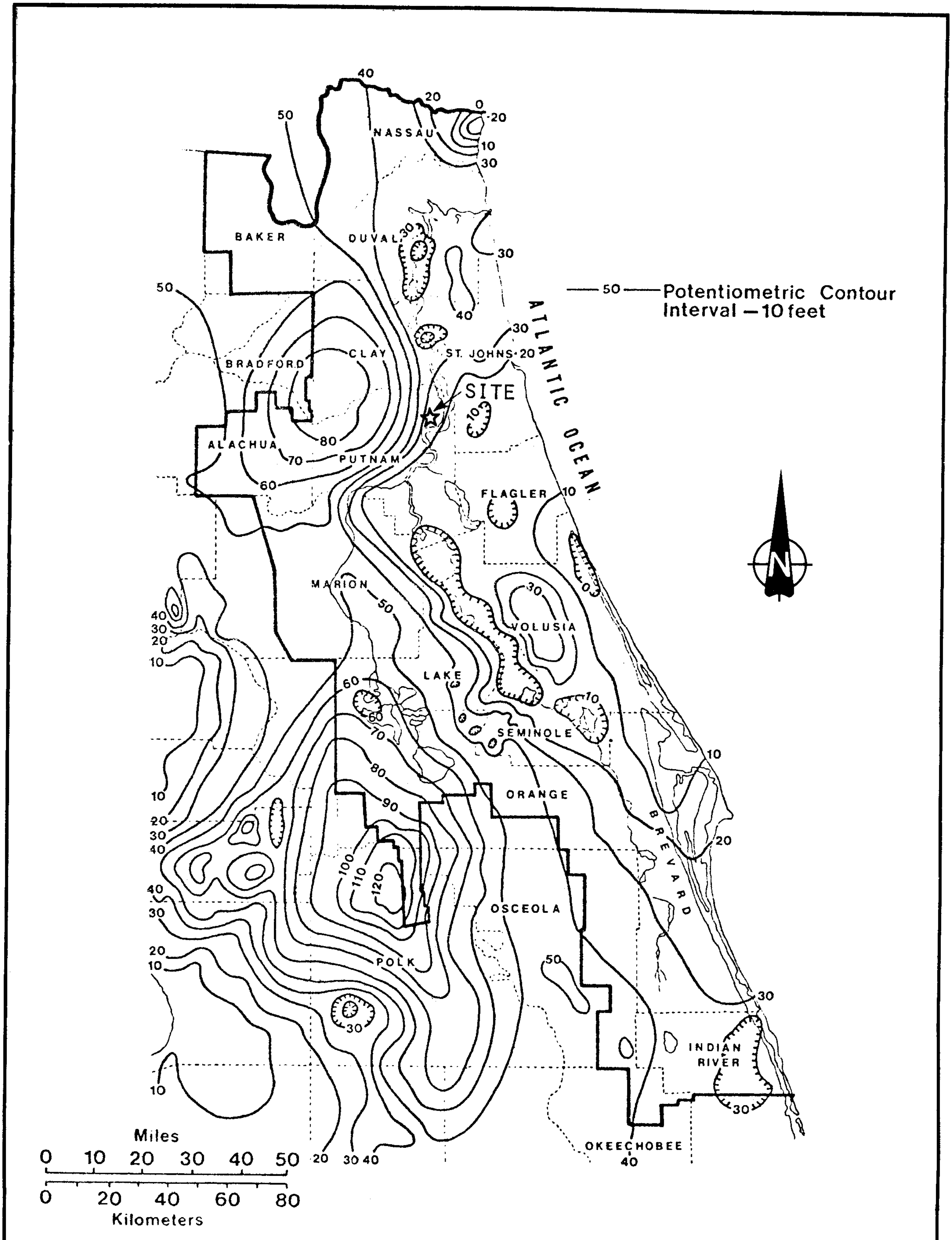
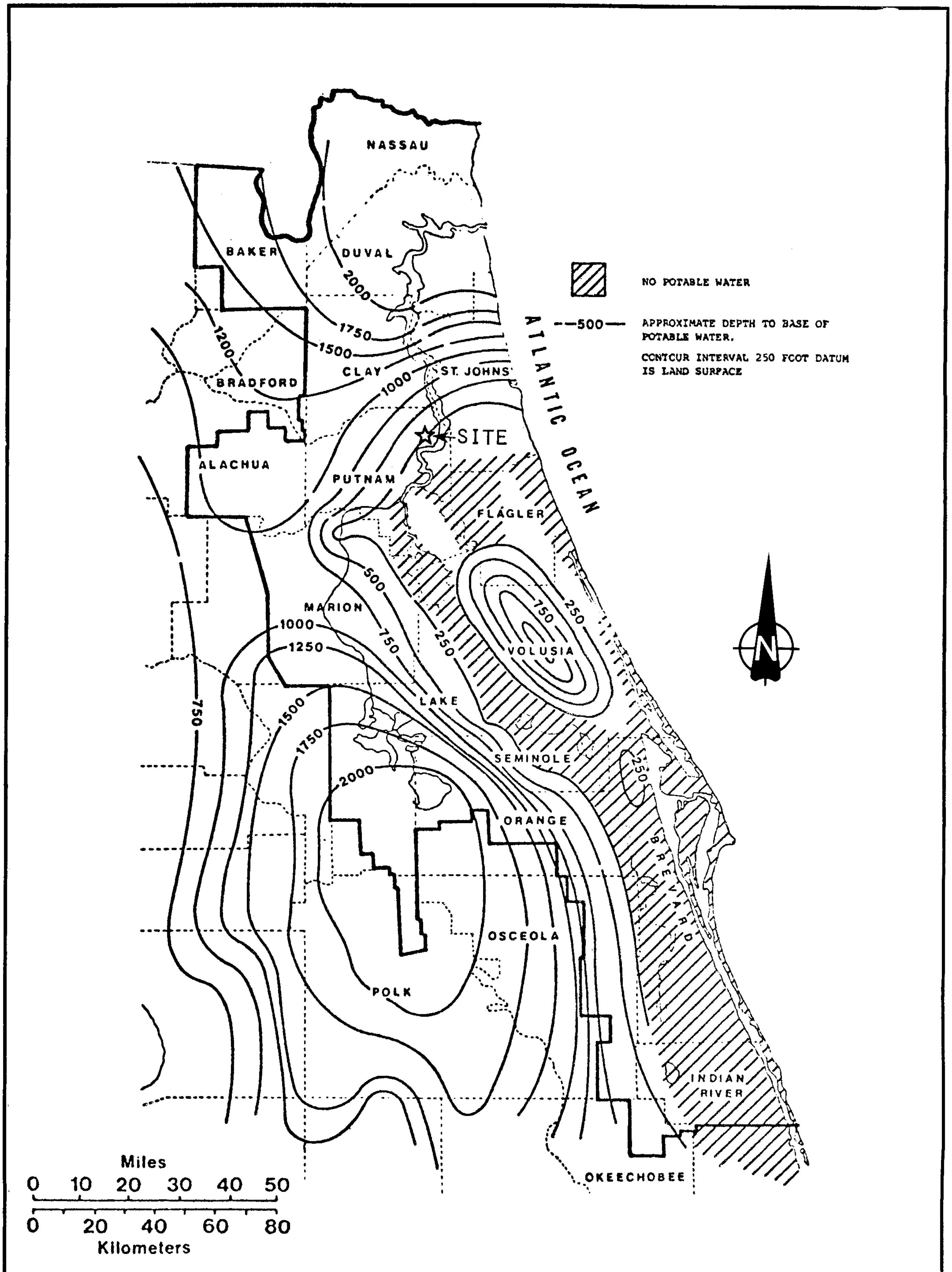


Figure 2.3-4. Generalized Stratigraphic Column and Water Bearing Characteristics.



(AFTER HEALY, 1975; FROM ST. JOHNS RIVER WATER MANAGEMENT DISTRICT, 1977)

Figure 2.3-7. Regional Potentiometric Surface of Floridan Aquifer.



(AFTER KLEIN, 1971; FROM ST. JOHNS RIVER WATER MANAGEMENT DISTRICT, 1977)

Figure 2.3-8. Depth to Base of Potable Water.

2.4 METEOROLOGY

2.4.1 General Climate

The prevailing sub-tropical marine climate of the northeastern Florida region results from the influence of the Atlantic Ocean and the Bermuda high pressure system. Long, warm, humid summers and short, mild winters prevail. Because of its southerly location and marine influences, this area has a notably equable climate, evidenced by small annual and diurnal temperature variations. Rainfall is moderate to heavy during the summer and light during the winter. Well developed extra-tropical migratory high and low pressure centers usually travel to the north of the region.

Winds are of moderate speed, and blow from the southeast to southwest during the warmer half of the year. During the cooler months the predominant direction is northwesterly. Along the coastal areas of northeastern Florida, local land-sea breeze circulations modify regional wind patterns by superimposing an easterly wind component during the daytime hours and a westerly component at night.

The average annual rainfall in this region is over 50 inches. Summer precipitation (May-October) exceeds winter precipitation (November-April) by a ratio of approximately 2 to 1. Winter precipitation results from frontal systems, pre-frontal squall lines, and wave disturbances along fronts stalled over the Florida peninsula. Summer precipitation is mostly of the convective type, resulting in frequent summertime afternoon thundershowers in this region. Tropical disturbances periodically cause significant precipitation during the summer and fall seasons.

Extremely hot weather is rare because of the ocean influence; maximum temperatures over a summer usually do not exceed the middle 90's. Winter temperatures are mild, interrupted only a few times per season by northerly or northwesterly advections of polar air. Inland locations generally display a greater range of temperatures due to the rapid heating and cooling of ground surfaces as compared with water bodies.

Due to sea breeze circulations, good ventilation, and flat terrain, the dispersion characteristics of the region are generally good. This is especially true for coastal areas due to higher wind speeds and infrequent ground level inversions.

2.4.2 Site Climatology

In describing site climatology, frequent reference is made to weather measurements collected at Jacksonville. Many types of observations are made only at major stations operated by the National Weather Service. The nearest and probably the most representative of these stations is located at the Jacksonville Airport. Weather patterns for locations not directly on the coastline are generally similar throughout northeastern Florida.

2.4.2.1 Temperature and Water Vapor

Monthly and annual values of average daily mean, maximum, and minimum temperatures recorded at Jacksonvlle are presented in Table 2.4-1 (USDC, 1974). Temperature extremes are also included.

Because the Putnam Site is both further inland and south of Jacksonville Airport, slightly higher temperatures would be expected there than at Jacksonville. This is confirmed by observations during the period 1941-1970 during whch the mean annual temperature at Palatka was 71.3°F, compared to a mean annual temperature at Jacksonville of 68.4°F (USDC, 1973).

The atmosphere in northeastern Florida is moist, with an average relative humidity of about 75 percent. Table 2.4-2 (USDC, 1974) presents monthly and annual averages of relative humidity observed at Jacksonville for the hours 0100, 0700, 1300, and 1900 local time. Relative humidities are generally highest during the early morning hours, typically ranging between 80 and 90 percent, compared to about 50 to 60 percent during the afternoon. Mean relative humidities tend to be lowest in the spring months and highest in the summer months; however, the seasonal differences are small.

2.4.2.2 Wind, Stability, and Limited Dispersion Characteristics

Wind

Figure 2.4-1 is an annual surface-level wind rose for the period 1970 to 1974 at Jacksonville (USDC, 1974). These data indicate that winds from the southwest and northwest quadrants are most common, but all directions occur fairly often. Table 2.4-3 presents monthly average wind speeds and directions recorded at Jacksonville during the period 1941-1974. The annual average wind speed for this period was 8.6 mile per hour (mph), with northwesterly winds being most common. The most common direction varies from southwesterly in the spring and summer to northwesterly in the fall. The monthly mean wind speed varies from 9.7 mph in February to 7.7 mph in July.

Stability

Atmospheric stability in conjunction with general wind patterns indicates the potential of the atmosphere to disperse airborne pollutants. Atmospheric conditions are typically categorized as unstable, neutral, or stable. An unstable atmosphere is one in which rapid diffusion takes place in both the horizontal and vertical direction. Viewed in terms of changes in temperature with height, an unstable atmosphere is characterized by a sharp decrease in temperature with height. Neutral conditions are common in the atmosphere and are associated with moderate diffusion rates. Temperatures also decrease with height in a neutral atmosphere but not as rapidly as under unstable conditions. A stable atmosphere is characterized by slight decreases, or even increases of temperature with height, and greatly reduced diffusion rates in comparison with unstable or neutral atmospheres.

The stability classifications presented in this section are based on the well-known Turner (1964) or STAR method, which assigns a stability on the basis of surface wind speed, cloud cover, and solar angle. The mean annual frequency distribution of stability classes for a 5-year period from 1970 to 1974 at Jacksonville (USDC, 1974) is summarized in Table 2.4-4.

Seasonal stability distribution indicates that during the summer months there is a high incidence of unstable conditions (39%), while winter has the lowest incidence of unstable conditions (13%) and the highest percentage of neutral conditions (48%). The largest relative percentage of stable conditions (57%) occurs during the fall. There are also distinct diurnal trends displayed by atmospheric stability. The daytime hours are characterized by very unstable conditions (A,B); moderately stable conditions prevail at night. Atmospheric instablity during mid-day is caused by strong incoming solar radiation.

Appendix F includes Tables F-1 through F-5, which present annual average joint frequency distributions of wind speed, wind direction, and stability.

Limited Dispersion Characteristics

One indication of dispersion capability is mixing height, defined as the vertical extent of the surface layer within which relatively vigorous mixing takes place. Holzworth (1972) has compiled statistical summaries for mixing height at various locations throughout the United States based on twice-daily balloon soundings. Average mixing heights and associated average wind speeds through the mixing layer for Jacksonville during the period 1960 to 1964 are shown in Table 2.4-5. This table also shows the number of episodes characterized by two or more consecutive days with mixing heights and mixing layer wind speeds lower than selected values. Holzworth's comparison of 62 locations throughout the United States indicates that conditions in northeastern Florida are more favorable to dispersion than are most other areas of the country.

2.4.2.3 Precipitation

Rainfall in the area surrounding the Putnam Site reaches maximum occurrence during summer months and diminishes during the late fall and winter months. Summer rainfall tends to be in the form of convective showers with large differences in amounts from one location to another on any given day. Winter precipitation is generally associated with frontal activity from migrating low pressure systems.

The average annual rainfall at Palatka during the period 1941 to 1970 was 54.84 inches (USDC, 1973). Monthly average rainfall amounts are listed in Table 2.4-6. The month with the highest average rainfall was July (7.74 inches). Lowest average rainfall occurred during November (1.85 inches).

2.4.2.4 Severe Weather

Thunderstorms and Hail

Based on a 33-year period of observation at Jacksonville, thunderstorms can be expected to occur on about 62 days a year in the vicinity of the site. Ninety percent of this thunderstorm activity occurs in the warmest 6 months of the year, and is usually associated with summertime land mass heating and low level convergence of moist air by sea-breeze effects. Thunderstorms can also be spawned by tropical storms as they approach the Florida coast. Northeastern Florida's thunderstorm season peaks in July, when such storms can be expected to occur about once every two days.

Hail is not considered a significant hazard. According to Pautz (1969) there were only 4 reports of hail 3/4 inches or greater in diameter in the 1-degree longitude-latitude square containing the Putnam Site during the period 1955 through 1967.

Windstorms

Winds in excess of 40 mph have been recorded in every month of the year at Jacksonville (Table 2.4-3). Strong, gusty, surface winds often occur in association with severe thunderstorm activity, well-developed cold fronts, and tropical cyclones. The fastest mile of wind on record at Jacksonville is 82 mph; it was associated with Hurricane Dora in September 1964.

Tornadoes

During the period 1955 through 1967, a total of 16 tornadoes were recorded in the one degree latitude-longitude square containing the

Putnam Site (Pautz, 1969). According to Thom (1963), the probability of a tornado hitting a point is:

$$P = (2.8209)\ t/A$$

where A is the area in square miles of a 1°F square centered on the point, and t is the mean annual frequency of tornadoes in the area. The probability of a tornado hitting the Putnam Site in any given year is 0.00054 with a return frequency of once every 1,839 years. By comparison, the maximum probability in the United States, based on 1955-1967 tornado occurrences, was 0.00588 (return period of 170 years) occurring near Oklahoma City.

Tropical Cyclones

The northeast Florida coast lies near the path of tropical cyclones that develop over ocean areas. The hurricane season extends from June through November, but the majority of hurricanes occur from August through October.

A study of all tropical cyclone events from 1886-1970 was performed based on the frequency and intensity of storms crossing the United States coastline within 50-mile sections along the Gulf and Atlantic coasts (Simpson, 1971). This study included all cyclones with maximum sustained winds of 39 mph or higher.

For the coastal sections near the Putnam Site, six tropical cyclones crossed the coastline during the 85-year period of record. Two were of hurricane strength (winds 74 mph or greater). The average number of years between tropical cyclones was 14, and the average number between hurricanes was 42. These statistics are, however, somewhat misleading since cyclones that remain offshore are not counted and since tropical cyclones crossing other sections of the Florida coast can exert significant effects on the area of the Putnam Site.

2.4.3 References

Holzworth, G. C., 1972, Mixing heights, wind speeds, and potential for urban air pollution throughout the contiguous United States. U. S. Environmental Protection Agency, Office of Air Programs, Publication No. AP-101.

Pautz, R., 1969, Severe local storm occurrences, 1955-1967. ESSA Tech. Memo No. WBTM FEST-12, Silver Springs, Maryland.

Simpson, R. H., 1971, Atlantic hurricane frequencies along the United States coastline. U. S. Dept. of Commerce, Tech. Memo No. NWS SR-58, Forth Worth, Texas.

Thom, H. C. S., 1963, Tornado probabilities. Monthly Weather Review Boston.

Turner, D. B., 1964, A diffusion model for an urban area, Journal of Applied Meteorology, Vol. 3, p 83-91.

U. S. Department of Commerce, 1973, Monthly normals of temperature precipitation, and heating and cooling degree days, 1941-1970. No. 81, Florida, Asheville, North Carolina.

U. S. Department of Commerce, Natural Oceanic and Atmospheric Adm., 1974a, Local climatological data, Jacksonville International Airport. Asheville, North Carolina.

__________, 1974b, STAR data, Jacksonville International Airport. Asheville, North Carolina.

Table 2.4-1

Atmospheric Temperature (°F) at Jacksonville, Florida
1940 - 1974

	Averages			Extremes	
Month	Daily Max	Daily Min	Mean	Highest	Lowest
Jan	64.6	44.5	54.6	85	19
Feb	66.9	45.7	56.3	88	19
Mar	72.2	50.1	61.2	91	25
Apr	79.0	57.1	68.1	95	35
May	84.6	63.9	74.3	100	45
June	88.3	70.0	79.2	103	56
Jul	90.0	72.0	81.0	105	61
Aug	89.7	72.3	81.0	102	64
Sep	86.0	70.4	78.2	100	50
Oct	79.2	61.7	70.5	96	38
Nov	71.4	51.0	61.2	88	21
Dec	65.6	45.1	55.4	84	12
Annual	78.1	58.7	68.4	105	12

Source: USDC, 1974.

Table 2.4-2

Mean Monthly and Annual Relative Humidity at Jacksonville, Florida 1936 - 1974

Month	Hour of the Day 0100	0700	1300	1900
Jan	85	87	57	74
Feb	82	85	52	68
Mar	81	85	49	65
Apr	83	85	47	64
May	84	84	49	66
Jun	87	86	56	72
Jul	88	87	58	75
Aug	90	90	60	78
Sep	89	91	62	79
Oct	88	90	58	78
Nov	86	89	55	77
Dec	86	88	58	77
Annual	86	87	55	73

Source: USDC, 1974

Table 2.4-3

Wind Conditions at Jacksonville, Florida
1941 - 1974

Month	Average Speed (mph)	Most Common Direction	Fastest Mile
Jan	8.5	NW	41
Feb	9.7	WSW	52
Mar	9.6	NW	44
Apr	9.3	SE	48
May	8.9	WSW	52
Jun	8.6	SW	76
Jul	7.7	SW	49
Aug	7.4	SW	52
Sep	8.5	NE	82
Oct	8.8	NE	72
Nov	8.4	NW	62
Dec	8.3	NW	62
Annual	8.6	NW	82

Source: USDC, 1974

Table 2.4-4

Average Frequency Distribution of
Stability Classes at Jacksonville, Florida
1970 - 1974

Pasquill Stability Class	Description	Percent Frequency by Season				
		Dec-Feb	Mar-May	Jun-Aug	Sep-Nov	Annual
A	Extremely Unstable	0	1	2	1	1
B	Unstable	4	6	15	5	7
C	Slightly Unstable	9	14	22	11	14
D	Neutral	48	40	20	33	35
E	Stable	39	39	41	50	43

Source: USDC, 1974

Table 2.4-5

Average Mixing Height and Episodes of Limited Dispersion at Jacksonville, Florida
1960 - 1964

	Morning		Afternoon	
	Average Mixing Height (m)	Average Mixing Layer Wind Speed (m/s)	Average Mixing Height (m)	Average Mixing Layer Wind Speed (m/s)
Winter	345	5.2	1058	6.7
Spring	447	5.3	1639	7.1
Summer	567	4.3	1681	5.6
Autumn	418	4.7	1321	6.5
Annual	444	4.9	1424	6.5

Number of Episodes Lasting Two or More Days

Mixing Height (m)	Mixing Layer Wind Speed (m/s)		
	≤2	≤4	≤6
≤ 500	0	0	1
≤1000	0	2	12
≤1500	0	12	43

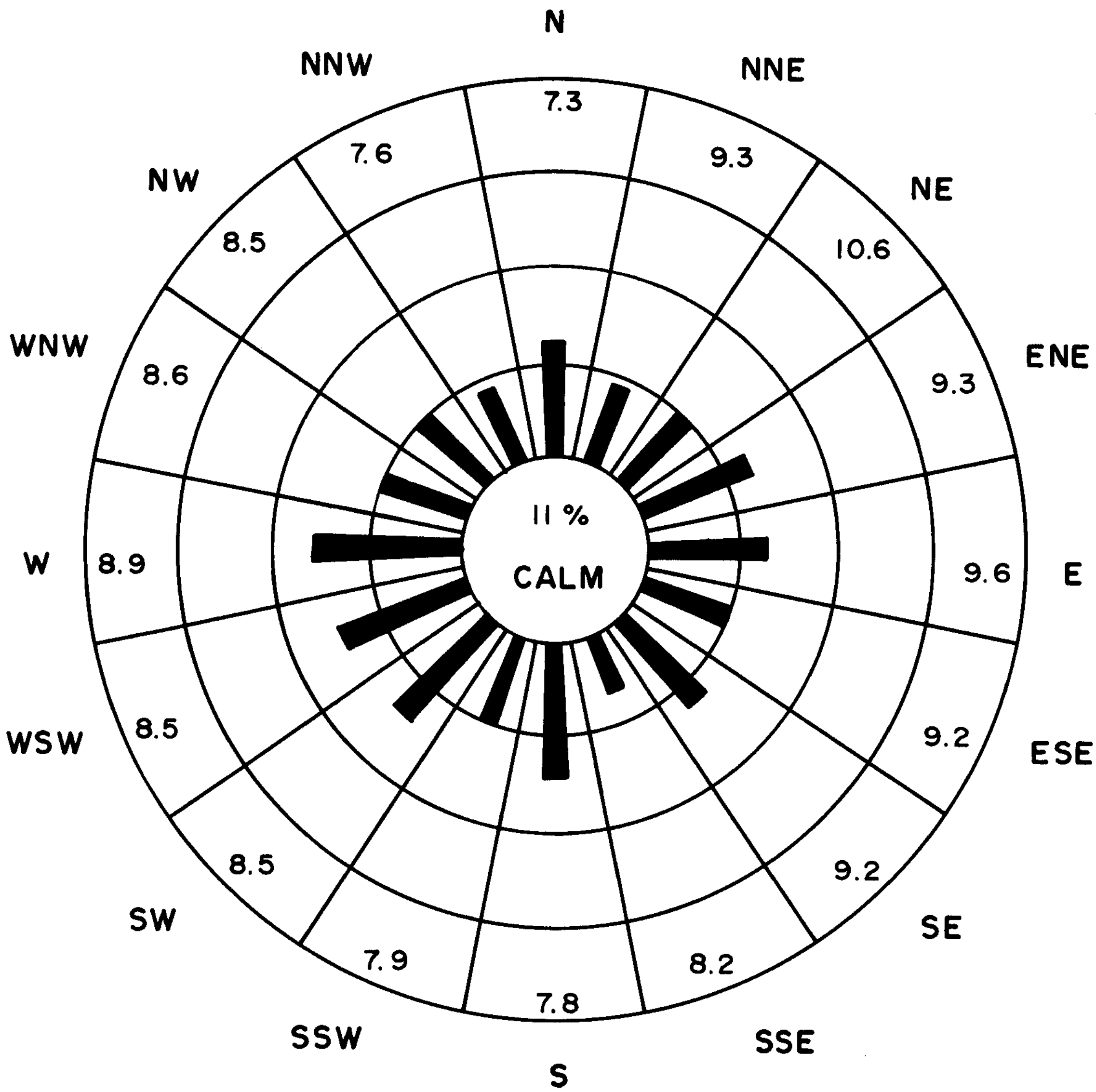
Source: Holzworth, 1972

Table 2.4-6

Average Rainfall at Palatka, Florida,
1941 - 1970

Month	Average Amount (Inches)
Jan	2.54
Feb	3.42
Mar	4.05
Apr	3.00
May	3.32
Jun	6.49
Jul	7.74
Aug	7.56
Sep	7.58
Oct	4.88
Nov	1.85
Dec	2.41
Annual	54.84

Source: USDC, 1973



Note: Concentric circles represent 5 percent frequency intervals. Average wind speed (mph) shown along outer circumference for each direction.
Period of record: 1970-1974

Source: U.S. Department of Commerce, October 1975.

Figure 2.4-1. Annual Wind Rose for Jacksonville (North Climatic Division).

2.5 AMBIENT AIR QUALITY

2.5.1 Air Quality Standards and Classifications

Ambient Air Quality Standards

Ambient air quality standards define levels of air quality which have been imposed to protect public health and welfare with an adequate margin of safety. Standards applicable to the proposed station have been set by both State and Federal regulatory agencies. These National Ambient Air Quality Standards (NAAQS) and Florida Ambient Air Quality Standards (FAAQS) are listed in Table 2.5-1. Only those standards are listed which apply directly to the major substances emitted by a coal-fired, steam-electric generating station -- sulfur dioxide (SO_2), total suspended particulate matter (TSP), and nitrogen oxides (expressed as nitrogen dioxide, NO_2).

Prevention of Significant Deterioration Requirements

Procedures have been established, in the Clean Air Act Amendments of 1977 and in related regulations, to protect areas where air quality is better than that allowed by NAAQS. A major portion of these Prevention of Significant Deterioration (PSD) requirements is the adoption of restrictions in the increase of ambient concentrations of SO_2 and TSP which can be caused by new emission sources. These restrictions are referred to as PSD increments. It should be remembered that these increments do not constitute new ambient standards. They do not regulate total ambient concentrations as ambient standards, but rather limit increases in concentration above some baseline level which is unique to each location.

Increments have been established for three different types of areas: Class I areas, in which virtually no new emission sources are permitted; Class II areas, in which a moderate amount of growth is permissable; and Class III areas, in which greater increases in ambient concentrations are possible. There are currently no PSD Class III areas in existence anywhere in the United States. Most areas, including the general area around the Putnam Site, are designated as Class II areas. In reference to the Putnam Site, the nearest existing PSD Class I area is the Okefenokee National Wilderness Area located in Georgia approximately 105 kilometers (km) (65 miles) to the north-northwest. Because of the remoteness of this area from the site, impacts attributable to the proposed station will be minor, as discussed in a later section. Therefore, the effect of emissions from the station will be evaluated by regulatory agencies primarily in terms of the PSD Class II increments. These increments are listed along with the NAAQS and FAAQS in Table 2.5-1.

Before concluding the subject of PSD area classifications, it should be noted that several areas are under consideration for redesignation to Class I status. Congress, through the Clean Air Act (as amended in 1977), has directed Federal land managers to review all national monuments, primitive areas, and national preserves, and recommend appropriate areas for redesignation by 8 August 1978. The Department of Interior (DOI) has published a list in the Federal Register (10 April 1978, 43 FR 10514) of the 82 national monuments and 2 national preserves in the National Park Service and the 11 primitive areas administered by the Bureau of Land Management, and has stated the intention of reviewing these areas to determine whether Class I redesignation should be recommended. Four major criteria will be used by DOI in making this determination, and consultations with appropriate States will also be held to assist in arriving at recommendations.

Two of the areas in the DOI review list are located about 30 km (20 mi) from the Putnam Site. One of these is the Castillo de San Marcos National Monument located in Saint Augustine, and the other is the Fort Matanzas National Monument located about 20 km (12 mi) south of St. Augustine. Both of these monument areas are quite small, the first occupying about 20 acres and the second about 300 acres. This size factor is important because one of the criteria to be applied by DOI consists of deciding whether an area is of such small size, and characterized by resources interdependent with those of the surrounding region, that redesignation is impractical. Considering that all existing Class I areas are at least 5000 acres in size and typically not located in or adjacent to urban areas, it is unlikely that either of the National Monuments near the Putnam Site will be nominated for Class I status.

Nonattainment Status

A nonattainment area is an area in which one or more of the NAAQS are being violated. According to a list published in the Federal Register on 3 March 1978 (43 FR 8961), there are no nonattainment areas within approximately 50 km (30 mi) of the Putnam Site. The nearest nonattainment area is Duval County which is considered nonattainment for TSP and photochemical oxidants. The oxidants nonattainment problem is not considered relevant to an emission source (Seminole Plant Units No. 1 and No. 2) which emits very small quantities of hydrocarbons. Therefore the following remarks are directed toward TSP nonattainment.

It should first be noted that the nonattainment designation relates to current conditions, whereas Seminole Unit No. 1 is not scheduled to begin operation until June 1983. It is quite possible that by 1983 the TSP problem in Duval County will be under control. However, no credit has been allowed for this possibility in preparing this assessment.

The next point to note is that the southern edge of Duval County is approximately 50 km (30 mi) from the Putnam Site. The point of maximum existing TSP levels in central Jacksonville is even further removed from the site. As will be shown, the TSP concentrations at a distance of 50 km (30 mi) attributable to the proposed station have been calculated and assessed in terms of being significant or insignficant. Guidelines suggested by EPA (EPA, 1977) to determine significant TSP impacts in nonattainment areas are as follows:

Annual Average - 1 $\mu g/m^3$ (micrograms per cubic meter)
24-Hour Average - 5 $\mu g/m^3$

If concentrations associated with the emissions of a single source are below these levels, these emissions can be considered negligible in relation to the nonattainment area.

Emission Standards

Emission or performance standards set a minimum level of emissions control which must be achieved by a particular source category. The current State and proposed Federal emission standards applicable to the Seminole Station are listed in Table 2.5-2. The proposed Federal regulations require application of continuous emission controls which, in addition to achieving compliance with an emission rate standard, also result in a percentage reduction in the emissions resulting from fuel combustion.

2.5.2 Background Ambient Air Quality

2.5.2.1 Description of Available Measurements

Three ambient air quality monitoring stations are being operated in the vicinity of the Putnam Site. One of these is a TSP monitoring station operated at the Kay Larkin Airport by the Florida Department of Environmental Regulation (DER). The other two are stations operated by Florida Power & Light Company (FP&L) at which SO_2, NO_2, and TSP are measured. These stations are referred to as the Yelvington Road and Cracker Swamp Road sites. The locations of all three stations are shown in Figure 2.5-1.

Although not located in the immediate vicinity of the Putnam Site, these monitoring points provide a reasonable indication of existing air quality conditions in the general area. This statement is based on the fact that there are few significant emission sources within 50 km (30 mi) of the Putnam Site (as will be discussed below), and therefore ambient concentrations are likely to be basically uniform outside the immediate impact area of the sources which do exist. In this regard, it should be noted that the FP&L monitoring sites were established to monitor the effects of FP&L's emissions and to determine that ambient standards are not being exceeded as a result of these emissions. Because of the proximity of these sites to FP&L's emission sources, the concentrations measured may be somewhat more influenced by the FP&L plant than are other locations in the general area as a whole.

Both the DER and FP&L TSP measurements are obtained from Hi-Vol samplers. At the DER monitoring site, a 24-hour sample is collected once every 6 days. The sampling frequency of the FP&L stations was once every 6 days in 1975 and 1976 and once every 3 days in 1977. The FP&L measurements also represent a 24-hour average.

The method used to obtain SO_2 measurements at the two FP&L sites is the West-Gaeke pararosaniline bubbler method. Samples are taken over a 24-hour period. The sampling frequency was once every 6 days in 1975 and 1976 and once every 3 days in 1977. Prior to 1977, the SO_2 bubblers were not contained within a cool, temperature-controlled housing, and therefore measured concentrations during this period may be lower than actual concentrations. Since 1976, however, temperature control has been maintained.

The measurement of NO_2 at the FP&L monitoring sites is made with 24-hour bubblers using the Jacobs-Hochheiser technique. Samples were collected once every 6 days in 1975 and 1976 and once every 3 days in 1977.

2.5.2.2 Measurement Results

Total Suspended Particulates

A summary of TSP measurements at all three sampling locations is provided in Table 2.5-3. These values are based on data supplied by DER. The lower number of samples reported for 1976 at the two FP&L sites represents all of the information currently on file at the DER's St. Johns River Subdistrict Office.

Patterns of annual geometric means at all stations are similar. Based on the information shown, a reasonable value for a current background annual geometric mean TSP concentration in the vicinity of the Putnam Site is in the range of 30 to 40 $\mu g/m^3$. There have been three instances of 24-hour concentrations at the Cracker Swamp Road station above the FAAQS and secondary NAAQS of 150 $\mu g/m^3$, but in comparison with the annual mean it can be seen that these are anomalous events. The FP&L plant was not even in operation on the day on which the highest 24-hour concentration was measured (information concerning the status of the FP&L plant during the other two exceedance events is not available); so it is likely that this concentration can be attributed to some local activity causing fugitive dust emissions. With the exception of a few measurements at the Cracker Swamp Road station, the annual second-high 24-hour concentration in the general area of the Putnam Site has been less than 80 $\mu g/m^3$.

Sulfur Dioxide

A summary of SO_2 measurements at both FP&L sites is shown in Table 2.5-4. These values are based on data supplied by DER. The lower number of samples reported for 1976 represents all of the information currently on file at the DER St. Johns River Subdistrict Office.

Measured concentrations of SO_2 have been extremely low. In fact, all of the concentrations are probably below the accurate detectability limit of the West-Gaeke method. Low concentrations in 1975 and 1976 can be attributed in part to a lack of temperature control during sample collection, but 1977 measurements continue to show low concentrations. These results are not surprising in light of the relatively non-industrialized nature of the general area. Based on these measurements and the nature of existing emission sources (see Section 2.5.3), average background concentrations in the vicinity of the Putnam Site can be considered negligible.

Nitrogen Dioxide

A summary of NO_2 measurements at both FP&L sites is shown in Table 2.5-5. Highest and second highest 24-hour concentrations are listed in addition to annual average concentrations, even though ambient standards for NO_2 are presently expressed in terms of an annual average only. The values presented are based on data supplied by DER. The lower number of samples reported for 1976 represents all of the information currently on file at the DER's St. Johns River Subdistrict Office.

The annual mean concentrations at both sites have been very low. In the absence of heavy traffic flow and concentrated industrial point emission sources, such low concentrations would be expected. Based on these measurements and the nature of existing emission sources, the annual average background NO_2 concentrations in the vicinity of the Putnam Site can be considered negligible.

2.5.2.3 Other Regulated Pollutants

Pollutants regulated by NAAQS are commonly referred to as criteria pollutants. The three criteria pollutants of greatest concern in an evaluation of the effects of a coal-fired stream-electric station are SO_2, TSP, and NO_2. The other criteria pollutants are carbon monoxide (CO), hydrocarbons (HC), and photochemical oxidants. HC are usually not considered separately from oxidants. The ambient standard for HC is really not a true standard but a guide to be used in controlling oxidant concentrations.

Measurements of these other criteria pollutants have not been made in the vicinity of the Putnam Site, either by regulatory agencies or industry, primarily because there is no reason to expect that local emission sources would contribute significantly to ambient concentrations. The presence of CO is primarily related to automobile emissions, and CO concentrations are generally not a problem outside major metropolitan areas. High concentrations of oxidants (ozone being the primary species) have been measured in practically every area of the country, urbanized and rural, but the major problem areas are also considered to be major metropolitan areas. Consequently, documenting prevailing concentrations of these pollutants in a non-urbanized area such as that in which the Putnam Site is located is not a typical practice. In any case, as has been stated, the proposed station emissions would not greatly affect these concentrations.

2.5.3 Existing Emission Sources

To evaluate potential interactions among the proposed station and other emission sources and to develop a better understanding of present air quality conditions, an inventory was obtained from DER (St. Johns River Subdistrict Office). The inventory contains a listing with stack characteristics of all significant point emission sources within the Putnam Site area of interest, an area extending to a distance of at least 50 km (30 mi) in all directions and taking in all or portions of Clay, Flagler, Putnam, and St. Johns Counties. The only sources excluded from this listing were two hospital incinerators in Clay County; a hospital incinerator and a small concrete batching plant (estimated annual TSP emissions of 1 ton) in Flagler County; a hospital incinerator, an x-ray film incinerator, and a humane society incinerator in St. Johns County; and a hospital incinerator and a small sand dryer (estimated annual TSP emissions of 4 tons) in Putnam County. All of these are very minor intermittent sources that have a negligible effect on local air quality conditions.

The final PSD regulation published in the Federal Register on 19 June 1978 (43 FR 26388) somewhat revised the definition of emission sources which count against the PSD increments. Without going into all the details of this involved definition, the regulations basically state that emissions from all new "major sources" (as defined in the regulations) commencing construction after 6 January 1975 count against the increments, as do increases in emissions from any source which takes place after 7 August 1977. In addition, major modifications of an existing source which takes place after 6 January 1975 must also be considered unless the modificatin involves no increase in the net amount of emissions and no "adverse air quality impact" such as might occur if emissions were slightly reduced but stack heights were greatly reduced, thereby causing higher ground-level concentrations.

In order to perform an evaluation of compliance with PSD increments as well as an evaluation of compliance with ambient air quality standards, it was requested that DER supply two inventories - one showing emissions as of the end of 1974 and the other showing current conditions. Information on the difference in emissions and emission sources between 1974 and the present could be used in conjunction with the proposed Seminole emissions to assess PSD increment compliance. (As it turned out, it was not necessary to distinguish between emission increases before and after 7 August 1977, as further explained below.) Current emissions in conjunction with the proposed Seminole emissions and information on general background conditions could be used to assess the probability of compliance with ambient standards.

The DER inventory indicates that there have been no new companies with emission sources added since 1974, that is no new locations, but that there have been changes in emissions at two of the companies in existence as of 6 January 1975. The location of emission sources within about 50 km (30 mi) of the Putnam Site is shown in Figure 2.5-2. A listing of specific sources indicating whether or not emission characteristics have changed since 1974 is provided in Table 2.5-6. As can be seen, the only two sources which have changes are Solite and Hudson Pulp and Paper Company. Of these two, only Hudson is within the immediate vicinity of the Putnam Site. (Hudson is about 8 km (5 mi) from the Site, while Solite is about 38 km (25 mi) away).

Pertinent emission characteristics for each of the sources (listed in Table 2.5-6) are presented in Table 2.5-7. These characteristics include stack height, exit temperature, volumetric flow rate, and total annual emissions of SO_2, TSP, and NO_2. Values applicable to both 1974 and current conditions are shown.

A careful review of Table 2.5-7 shows that, for the two sources which have changed emissions (Solite and Hudson Pulp and Paper Company), the change has resulted in a net decrease in SO_2 and TSP emissions. At Solite, SO_2 emissions have decreased from an estimated 7,148 tons per year to 2,137 tons per year; TSP emissions have been reduced from 1,250 to 107 tons per year. Annual SO_2 emissions at Hudson Pulp and Paper Company have decreased from 7,650 to 6,982 tons, and annual TSP emissions have dropped from 13,301 to 849 tons. At Hudson, there are three sources (Recovery Boiler #4, Lime Kiln #4, Smelt Dissolve Tank #4) which are new since 1974, but the units replaced by these new sources had greater emission rates and lower plume rise characteristics, and therefore greater ground-level ambient impact. In addition, two of the sources existing in 1974 (Power Boiler #5 and Combination Boiler #4) have been modified so that now total SO_2 emission rates are greater for both sources by about 5 percent, but stack heights have been increased by 92 feet, thereby offsetting any effect on ground-level SO_2 concentrations. Finally, there has been an increase in annual TSP emissions from Combination Boiler #4 since 1974 of about 172 tons, but the increase in stack height of 92 feet for this source, plus the great decrease in TSP emissions from other sources, means that no increase in ambient TSP concentrations has resulted from this change. The modifications which have take place at Hudson have therefore not resulted in a net emissions increase or an adverse change in air quality impact.

One conclusion to be drawn from this discussion of other SO_2 and TSP emission sources located within the Putnam Site area of interest is that there are no other sources (where source refers to one or more emission points at the same location) which count against the PSD increments available for use by the proposed station. This conclusion is in accord with the discussion of emission source changes affecting increment consumption presented above. Therefore, modeling Seminole's emissions alone is sufficient to demonstrate compliance with PSD increments.

2.5.4 Reference

U. S. Environmental Protection Agency, 1977, Interim guideline on air quality models. Office of Air Quality Planning and Standards, OAQPS No. 1.2-080, p. A-1.

Table 2.5-1

APPLICABLE AMBIENT AIR QUALITY REQUIREMENTS
FOR PRIMARY POLLUTANTS OF CONCERN

Category and Averaging Period	Sulfur Dioxide, $\mu g/m^3$ (ppm)	Particulate Matter, $\mu g/m^3$	Nitrogen Dioxide, $\mu g/m^3$ (ppm)
Florida Ambient Air Quality Standards			
3-Hour	1300 (0.5)[a]	---	---
24-Hour	260 (0.1)[a]	150[a]	---
Annual Arithmetic	60 (0.02)	---	100 (0.05)
Annual Geometric	---	60	---
National Ambient Air Quality Standards			
3-Hour, Secondary	1300 (0.5)[a]	---	---
24-Hour, Primary	365 (0.14)[a]	260[a]	---
24-Hour, Secondary	---	150[a]	---
Annual Arithmetic, Primary	80 (0.03)	---	100 (0.05)
Annual Arithmetic, Secondary	---	---	100 (0.05)
Annual Geometric, Primary	---	75	---
Annual Geometric, Secondary	---	60[b]	---
National Prevention of Significant Deterioration Increments			
Class II 3-Hour Maximum	512[a]	---	---
Class II 24-Hour Maximum	91[a]	37[a]	---
Class II Annual Arithmetic	20	---	---
Class II Annual Geometric	---	19	---

[a] Not to be exceeded more than once a year.

[b] As a guide to be used in assessing implementation plans to achieve the 24-hour standard.

Table 2.5-2

EMISSION STANDARDS APPLICABLE TO COAL-FIRED STEAM GENERATORS

	Proposed Federal New Source Performance Standards [a]	Florida Emission Limiting Standards [b]
Sulfur Dioxide	1.2 $lb/10^6$ Btu	1.2 $lb/10^6$ Btu
Particulate Matter	0.03 $lb/10^6$ Btu	0.1 $lb/10^6$ Btu
Nitrogen Oxides (as NO_2)	0.6 $lb/10^6$ Btu	0.7 $lb/10^6$ Btu

Note: Standards applicable to fossil fuel-fired steam generators with greater than 250 x 10^6 Btu/h heat input.

[a]Federal NPS proposed on 9/19/78 also require the following reductions of defined potential emissions when combusting solid fuel:

Sulfur Dioxide reduction = 85 percent, except may be as low as 75 percent up to three 24-hour periods during any calendar month. Percent reduction can include credit for fuel pretreatment (washing).

Particulate Matter reduction = 99 percent.

Nitrogen Oxides reduction = 65 percent.

[b]Florida standards refer to maximum 2-hour average.

Table 2.5-3

PARTICULATE MATTER AMBIENT AIR QUALITY DATA
(All concentrations in $\mu g/m^3$)

Station	Year	Highest 24-Hour	2d High 24-Hour	Annual Geometric Mean	Number of Samples
Kay Larkin Airport (DER)	1973	123	75	40	62
	1974	72	67	34	59
	1975	85	64	34	60
	1976	77	77	28	59
	1977	61	60	30	55
Yelvington Road (FP&L)	1975	87	76	34	48
	1976	68	59	30	31
	1977	92[a]	72	27[a]	121
Cracker Swamp Road (FP&L)	1975	119	113	42	48
	1976	166	75	31	31
	1977	183[a]	154	37[a]	120

[a] Does not include a concentration of 331 $\mu g/m^3$ at Yelvington Road and a concentration of 387 $\mu g/m^3$ at Cracker Swamp Road measured during a major dust storm in February which caused high TSP concentrations throughout much of the U.S. DER has decided that concentrations measured during this episode are not to be included in determining compliance with ambient standards.

Source: Florida DER

Table 2.5-4

SULFUR DIOXIDE AMBIENT AIR QUALITY DATA
(All concentrations in $\mu g/m^3$)

Station	Year	Highest 24-Hour	2d High 24-Hour	Annual Arithmetic Mean	Number of Samples
Yelvington Road (FP&L)	1975	10	8	3	53
	1976	10	5	1	31
	1977	18	10	1	119
Cracker Swamp Road (FP&L)	1975	15	11	3	54
	1976	10	8	1	33
	1977	17	6	1	121

Note: Temperature control not maintained prior to 1977.

Source: Florida DER

Table 2.5-5

NITROGEN DIOXIDE AMBIENT AIR QUALITY DATA
(All concentrations in $\mu g/m^3$)

Station	Year	Highest 24-Hour	2d High 24-Hour	Annual Arithmetic Mean	Number of Samples
Yelvington Road (FP&L)	1975	31	17	5	47
	1976	8	5	1	36
	1977	60	20	4	120
Cracker Swamp Road (FP&L)	1975	27	18	5	49
	1976	17	10	3	37
	1977	27	17	3	121

Source: Florida DER

Table 2.5-6

EMISSION SOURCES WITHIN PUTNAM SITE AREA OF INTEREST

Source	1974	1978	Distance From Putnam Site (km)
CLAY COUNTY			
E.I duPont De Nemours			
Ilmenite Dryer	B	S	43
Zircore Dryer	B	S	43
Zipcon Dryer	B	S	43
Gilman Paper Company			
Kiln Boiler	B	S	61
Johns-Manville Products			
Boiler	B	S	55
Finish End-Transite	B	S	55
Making Machine	B	S	55
PVC Blk Tr #15	B	S	55
Bag Fill	B	S	55
New Florida, Inc.			
Boiler	B	S	42
Solite			
Kiln #1	B	D	38
Kiln #2	B	NO	38
Kiln #3	B	NO	38
Kiln #4	B	NO	38
Kiln #5	B	D	38
Titanium Enterprises			
Rock Dryer #1	B	S	17
Rock Dryer #2	B	S	17
Rock Dryer #3	B	S	17
Rock Dryer #4	B	S	17
FLAGLER COUNTY			
ITT Rayonier			
Boiler	B	S	45
PUTNAM COUNTY			
Edgar Plastic Kaolin Co.			
Sand Dryer	B	S	34
Clay Mill	B	S	34
Sand Glass Dryer	B	S	34
Florida Furniture Co.			
Dryer	B	S	10

Table 2.5-6 (continued)

Source	1974	1978	Distance From Putnam Site (km)
Florida Power & Light Co.			
Combined Cycle 1A-1B	B	S	12
Combined Cycle 2A-2B	B	S	12
Unit #1	B	S	12
Unit #2	B	S	12
Hudson Pulp & Paper Co.			
Recovery Boiler #1	B	R	8
Recovery Boiler #2	B	R	8
Recovery Boiler #3	B	R	8
Recovery Boiler #4	NE	N	8
Power Boiler #1	B	R	8
Power Boiler #2	B	R	8
Power Boiler #3	B	R	8
Power Boiler #4	B	S	8
Power Boiler #5	B	D	8
Combination Boiler #1	B	R	8
Combination Boiler #4	B	D	8
Lime Kiln #1	B	R	8
Lime Kiln #2	B	R	8
Lime Kiln #3	B	R	8
Lime Kiln #4	NE	N	8
Smelt Dissol. Tk #1	B	R	8
Smelt Dissol. Tk #2	B	R	8
Smelt Dissol. Tk #3	B	R	8
Smelt Dissol. Tk #4	NE	N	8

Legend:

B = In 1974 Baseline
D = Different from 1974 Baseline
N = New since 1974
NE = Not in Existence in 1974
NO = Not Now in Operation
R = Retired since 1974
S = Same as 1974 Baseline

Source: Florida DER

Table 2.5-7

EMISSION CHARACTERISTICS OF SOURCES WITHIN PUTNAM SITE AREA OF INTEREST

Source[a]	UTM Coordinates East	UTM Coordinates North	SO_2 Emission Rate (ton/yr)	TSP Emission Rate (ton/yr)	NO_2 Emission Rate (ton/yr)	Stack Height (ft)	Exit Temperature (°F)	Volumetric Flow Rate (ft^3/min)
CLAY COUNTY								
E.I. duPont								
Ilm. Dryer	400.2	3308.6	175	28	9	33	240	13,000
Zir. Dryer	"	"	2	2	87	30	311	6,870
Zip. Dryer	"	"	20	2	4	40	300	13,774
Gilman Paper								
Boiler	403.4	3333.6	279	19	50[b]	30	365	9,450
Johns-Manville								
Boiler	434.9	3316.6	213	28	18	34	350	15,098
Fin. End	"	"	-	15	-	32	72	16,000
Mak. Mach.	"	"	-	13	-	33	72	10,000
PVC Blk	"	"	-	1	-	25	72	8,300
Bag Fill	"	"	-	1	-	25	72	8,300
New Florida								
Boiler	426.0	3329.6	71	5	18	30	1,000	11,170
Solite								
Kiln #1 (1974)	428.3	3326.2	1,314	218	c	65	455	22,443
(1978)	"	"	876	48	11[b]	110	145	8,969
Kiln #2 (1974)	"	"	1,314	218	c	65	455	22,443
Kiln #3 (1974)	"	"	1,314	218	c	65	455	22,443
Kiln #4 (1974)	"	"	1,314	218	c	65	455	22,443
Kiln #5 (1974)	"	"	1,892	378	c	75	455	54,286
(1978)	"	"	1,261	59	17[b]	80	150	22,652

Table 2.5-7 (continued)

Source[a]	UTM Coordinates East	UTM Coordinates North	SO_2 Emission Rate (ton/yr)	TSP Emission Rate (ton/yr)	NO_2 Emission Rate (ton/yr)	Stack Height (ft)	Exit Temperature (°F)	Volumetric Flow Rate (ft^3/min)
Titanium Ent								
Dryer #1	431.9	3304.2	146	128	73	46	320	6,197
Dryer #2	"	"	34	6	20	46	330	2,280
Dryer #3	"	"	21	2	15	46	235	6,044
Dryer #4	"	"	2	1	1	46	300	2,094
FLAGLER COUNTY								
ITT Rayonier								
Boiler	474.0	3261.5	20	196	66	45	500	8,046
PUTNAM COUNTY								
Edgar Plastic Kaolin								
Sand Dryer	407.8	3274.2	175	28	9	33	240	13,000
Clay Mill	"	"	2	2	87	30	311	6,870
Sand Glass Dryer	"	"	20	2	4	40	300	13,774
Florida Furniture								
Dryer	438.2	3278.9	3	26	59	50	491	7,298
Florida Power & Light								
Comb. Cycle 1A-1B	443.4	3277.6	4,380	603	3,869	53	350	414,348
Comb. Cycle 2A-2B	"	"	4,380	603	3,869	53	350	414,348
Unit #1	442.8	3277.6	277	27	607	150	275	248,414
Unit #2	"	"	163	102	2,000[b]	150	275	248,475

Table 2.5-7 (continued)

Source[a]	UTM Coordinates East	UTM Coordinates North	SO_2 Emission Rate (ton/yr)	TSP Emission Rate (ton/yr)	NO_2 Emission Rate (ton/yr)	Stack Height (ft)	Exit Temperature (°F)	Volumetric Flow Rate (ft^3/min)
Hudson Pulp & Paper								
Rec. Boil. #1 (1974)	434.0	3283.4	156	3,389	c	250	190	76,038
Rec. Boil. #2 (1974)	"	"	297	3,352	c	250	210	120,364
Rec. Boil. #3 (1974)	"	"	311	3,316	c	133	210	112,614
Rec. Boil. #4 (1978)	"	°	107	215	4[b]	230	400	406,000
Pow. Boil. #1 (1974)	"	"	58	4	14	105	425	21,340
Pow. Boil. #2 (1974)	"	"	56	4	14	105	425	21,340
Pow. Boil. #3 (1974)	"	"	82	6	20	105	425	30,450
Pow. Boil. #4	"	"	909	34	185	122	400	36,000
Pow. Boil. #5 (1974)	"	"	4,125	312	1,086	158	450	189,000
(1978)	"	"	4,342	158	963[b]	230	450	189,000
Comb. Boil. #1 (1974)	"	"	86	6	15	250	400	31,283
Comb. Boil. #4 (1974)	"	"	1,570	228	c	158	450	187,151
(1978)	"	"	1,624	400	165	230	420	190,000
Lime Kiln #1 (1974)	"	"	-	788	-	50	263	10,177
Lime Kiln #2 (1974)	"	"	-	416	-	50	154	20,679
Lime Kiln #3 (1974)	"	"	-	445	-	52	157	29,234
Lime Kiln #4 (1978)	"	"	-	59	-	149	171	37,312
SDT #1 (1974)	"	"	-	352	-	100	200	7,285
SDT #2 (1974)	"	"	-	619	-	100	215	13,220
SDT #3 (1974)	"	"	-	30	-	109	205	3,450
SDT #4 (1978)	"	"	-	17	-	222	160	19,000

[a] Characteristics shown are for both 1974 and 1978 unless otherwise indicated by date in parentheses, in which case characteristics apply to either the 1974 baseline only or to current conditions only.

[b] Calculated from information supplied by DER.

[c] Not supplied by DER but not needed since NO_2 concentrations do not have to be known for 1974 baseline.

Source: Florida DER

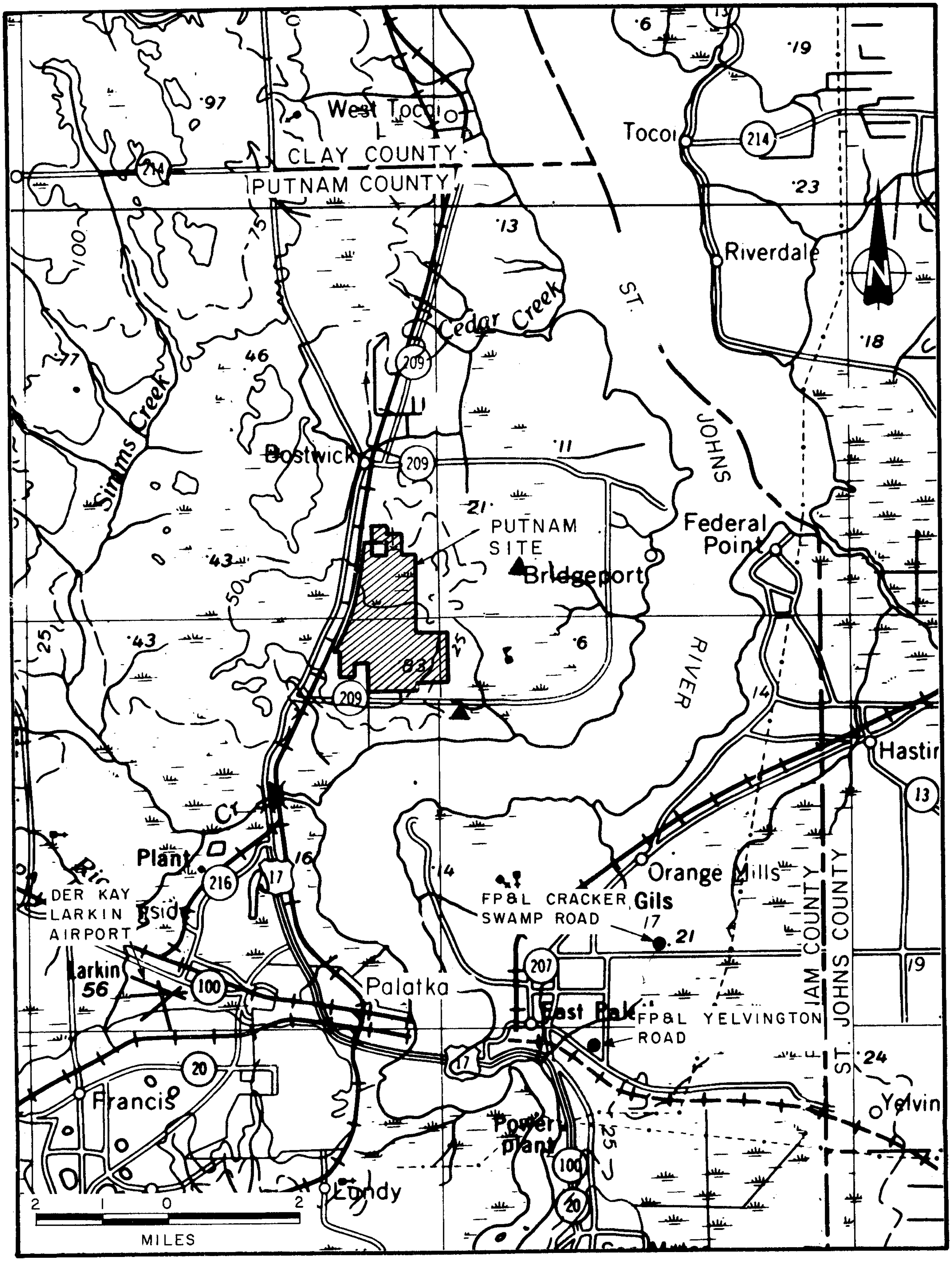


Figure 2.5-1. Location of Ambient Air Quality Monitoring Stations. ▲

REVISED 3/15/79

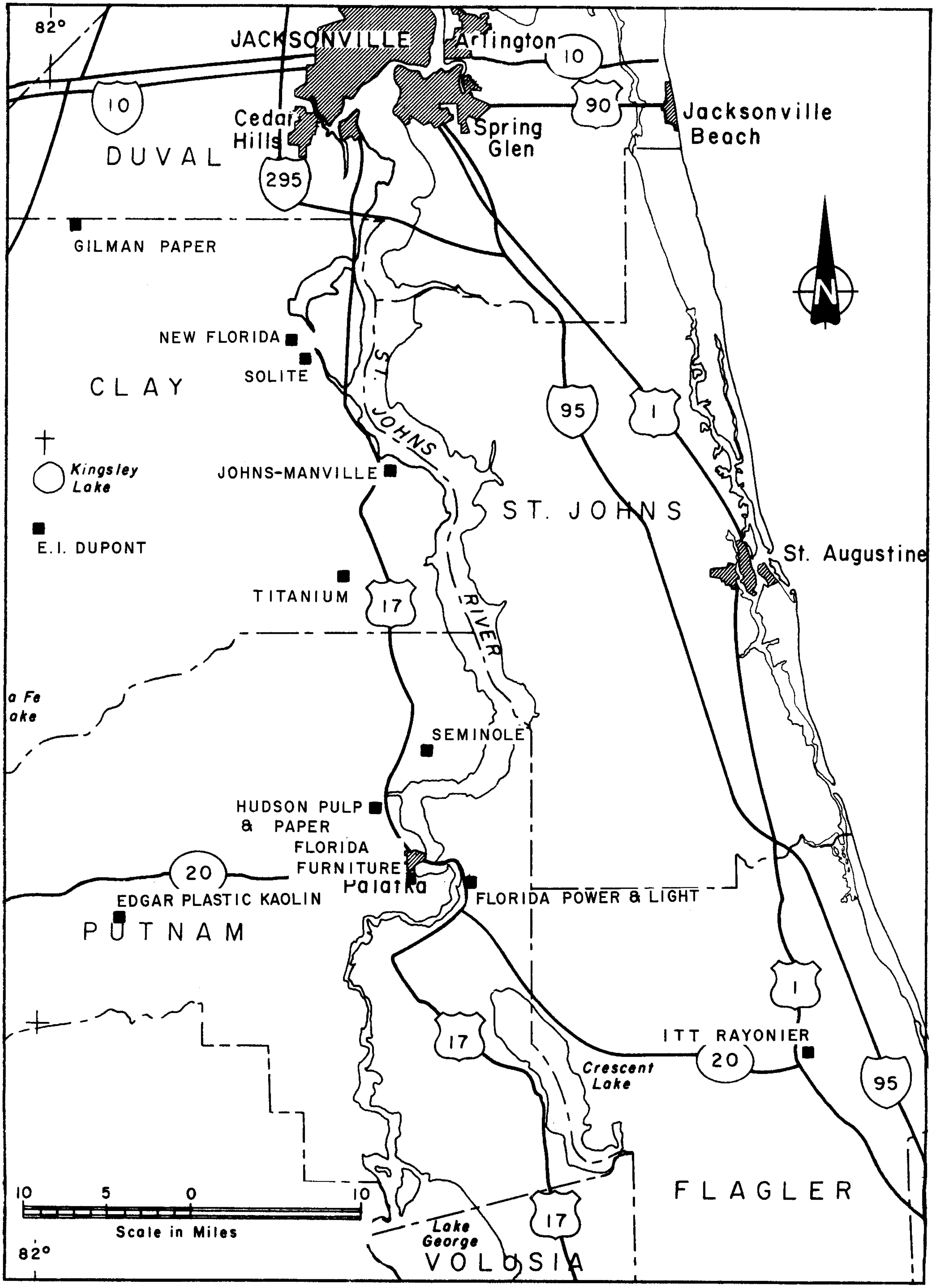


Figure 2.5-2. Location of Existing Emission Sources in Vicinity of the Seminole Site.

2.6 ACOUSTICS

2.6.1 Introduction

This section contains a description and results of the program conducted to obtain baseline ambient sound quality data at and near the proposed station. To describe sound quality, an ambient sound survey was conducted at six locations, discussed below and shown in Figure 2.6-1. These locations were selected to reflect the present sound climates at the site boundary and nearby noise-sensitive areas.

> Location 1 is near residences at the end of East River Road, at Warner Point on the east bank of St. Johns River, approximately one and a half miles south of the Putnam site.
>
> Location 2 is at trailer courts adjacent to the DeGeyter Motel on U.S. Route 17 near the northern end of Palatka, approximately five miles south southwest of the site.
>
> Location 3 is at the Wide Waters Trailer Park near State Route S209 (West River Road), along the west bank of the St. Johns River, south of the site.
>
> Location 4 is on the site, approximately one-quarter mile east of U. S. Route 17.
>
> Location 5 is near residences, Bostwick Baptist Church and the Bostwick Elementary School at the corner of Mulberry and Tillman Streets, Community of Bostwick, approximately one mile north of the site.
>
> Location 6 is near residences at U.S. Route 17, adjacent to the Seaboard Coast Line Railroad and the western site boundary, approximately one-quarter mile south of the site entrance.

The ambient sound survey was conducted during the period November 17 to November 19, 1977. Sound level recordings were made on typical weekdays and weekend during daytime (0700-1800), evening (1800-2200) and nighttime (2200-0700) periods. The daytime periods from 0700-2200 hours and nighttime periods from 2200-0700 hours are used by the federal U. S. Environmental Protection Agency (EPA) in its definition of day/night average sound level, L_{dn}.

Sound and noise nomenclature and a description of the instrumentation and techniques used for acquisition and analysis of the ambient sound data are presented in Appendix G.

2.6.2 Summary of Sound Levels

Summaries of weekday and weekend ambient sound survey results for the data collected at the six monitoring locations described above are presented in Tables 2.6-1 and 2.6-2, respectively. These tables contain the statistical A-weighted sound levels, L_{95}, L_{90}, L_{50}, L_{10}, and L_5 and average sound level, L_{eq}, for each measurement period, and L_d, L_n and L_{dn} at each measurement location. These data represent the background ambient sound levels of the existing environment at and near the proposed site. They were acquired during periods when there were no uncharacteristic activities at the site, and thus do not contain any intrusive sounds. A composite of the weekday and weekend ambient sound levels is presented in Table 2.6-3. Detailed results of the ambient sound survey are presented in Appendix G.3.

2.6.3 Description of Ambient Sound Environment

The proposed site is located in a sparsely populated area immediately northwest of the St. Johns River. Noise sensitive land use areas adjacent to the site boundaries are scattered along U.S. Routes 17 and State Route S209 (West River Road), near survey locations 3, 5, and 6. The dominant noise sources there are traffic along major routes, local traffic, resident activities, train noise along the Seaboard Coast Line Railroad and occasional aircraft overflights. During weekends, traffic along U.S. Route 17, State Route S209 and local roads increases. Resident activity also increases during the same periods. There was no noticeable increase in the number of trains passing along the Seaboard Coast Line Railroad. The largest nearby population concentration is the City of Palatka, approximately five miles south-southwest of the site.

Location 2 is representative of the sound climate at the north end of town, where Route 17 enters Palatka and intersects with Highway 19. Traffic is the dominant noise source at this location. Activities at the nearby paper and saw mill also contribute to sound levels at this location.

Measurements at Location 4 are representative of the existing sound climate on the site. Sound levels at this location are contributed by traffic on U.S. Route 17, train noise, and occasional aircraft overflights.

Present sound levels at Location 1 are predominantly due to local traffic, resident activities, train noise and occasional aircraft overflights. There was no noticeable variation in local traffic and resident activities between weekday and weekend measurement periods.

Table 2.6-1

Summary of Ambient Sound Levels -dB

Location	Weekdays Daytime (0700-1800)		Evening (1800-2200)		Nighttime (2200-0700)	
1	11/18/77	1125	11/17/77	1800	11/17/77	2227
L_{95}	35		41		38	
L_{90}	36		42		38	
L_{50}	37		45		39	
L_{10}	43		46		42	
L_5	47		46		46	
L_{eq}	40.8		44.7		40.5	
L_d						42.2
L_n						40.5
L_{dn}						47.1
2	11/18/77	1215	11/17/77	1855	11/17/77	2311
L_{95}	40		42		42	
L_{90}	41		43		43	
L_{50}	47		46		51	
L_{10}	56		53		54	
L_5	58		54		56	
L_{eq}	52.1		49.1		51.8	
L_d						51.4
L_n						51.8
L_{dn}						58.1
3	11/18/77	1255	11/17/77	1931	11/17/77	2347
L_{95}	36		35		28	
L_{90}	37		35		28	
L_{50}	44		41		31	
L_{10}	52		49		41	
L_5	54		52		45	
L_{eq}	48.3		44.9		39.0	
L_d						47.6
L_n						39.0
L_{dn}						48.1

Table 2.6-1 (Continued)

	Weekdays					
Location	Daytime (0700-1800)		Evening (1800-2200)		Nighttime (2200-0700)	
4	11/18/77	1338	11/17/77	2009	11/18/77	0024
L_{95}	36		29		24	
L_{90}	36		29		24	
L_{50}	39		35		26	
L_{10}	44		44		36	
L_{5}	46		50		41	
L_{eq}	43.7		42.9		35.7	
L_{d}						43.5
L_{n}						35.7
L_{dn}						44.4
5	11/18/77	1430	11/17/77	2054	11/18/77	0104
L_{95}	35		31		27	
L_{90}	36		32		27	
L_{50}	39		39		29	
L_{10}	44		48		38	
L_{5}	46		50		40	
L_{eq}	41.0		43.4		33.6	
L_{d}						41.7
L_{n}						33.6
L_{dn}						42.5
6	11/18/77	1511	11/17/77	2133	11/18/77	0139
L_{95}	40		30		30	
L_{90}	42		32		31	
L_{50}	49		45		36	
L_{10}	62		57		39	
L_{5}	64		61		40	
L_{eq}	58.5		55.1		38.8	
L_{d}						57.8
L_{n}						38.8
L_{dn}						56.0

Table 2.6-2

Summary of Ambient Sound Levels -dB

Weekend

Location	Daytime (0700-1800)	Evening (1800-2200)	Nighttime (2200-0700)	
1	11/19/77 1050	11/18/77 1800	11/18/77 2238	
L_{95}	36	36	33	
L_{90}	36	36	33	
L_{50}	39	37	35	
L_{10}	48	43	40	
L_{5}	51	45	41	
L_{eq}	44.1	42.3	37.1	
L_{d}				443.6
L_{n}				37.1
L_{dn}				45.2
2	11/19/77 1142	11/18/77 1845	11/18/77 2326	
L_{95}	43	40	35	
L_{90}	44	41	36	
L_{50}	49	48	40	
L_{10}	56	56	51	
L_{5}	59	58	53	
L_{eq}	43.7	52.2	46.3	
L_{dn}				53.3
L_{n}				46.3
L_{dn}				54.6
3	11/19/77 1216	11/18/77 1925	11/19/77 0002	
L_{95}	36	32	25	
L_{90}	37	32	26	
L_{50}	42	40	32	
L_{10}	50	42	43	
L_{5}	53	52	45	
L_{eq}	47.3	45.6	39.6	
L_{d}				46.9
L_{n}				39.6
L_{dn}				48.1

Table 2.6-2 (Continued)

Location	Weekend Daytime (0700-1800)	Weekend Evening (1800-2200)	Weekend Nighttime (2200-0700)	
4	11/19/77 1403			
L_{95}	39	*	*	
L_{90}	40			
L_{50}	41			
L_{10}	44			
L_{5}	45			
L_{eq}	42.1			
L_{d}				
L_{n}				
L_{dn}				
5	11/19/77 1329	11/18/77 2105	11/19/77 0150	
L_{95}	39	36	25	
L_{90}	40	38	25	
L_{50}	44	43	30	
L_{10}	50	50	41	
L_{5}	52	52	44	
L_{eq}	52.2	47.2	37.8	
L_{d}				51.3
L_{n}				37.8
L_{dn}				50.2
6	11/19/77 1249	11/18/77 2000	11/19/77 0037	
L_{95}	46	28	26	
L_{90}	47	33	27	
L_{50}	52	46	46	
L_{10}	59	60	58	
L_{5}	61	62	60	
L_{eq}	55.7	56.0	53.8	
L_{d}				55.7
L_{n}				53.8
L_{dn}				60.6

*Measurements were not made due to restricted access to the site. Observation indicates that ambient sound levels at this location are similar between weekday and weekend periods.

Table 2.6-3

Composite Ambient Sound Levels

Location	Daytime (0700-2200) L_d	Nighttime (2200-0700) L_n	Day/night L_{dn}
1	42.6	39.8	46.7
2	52.0	50.8	57.4
3	47.4	39.2	48.2
4	43.2	35.7	44.3
5	46.9	35.3	46.4
6	57.3	48.7	57.9

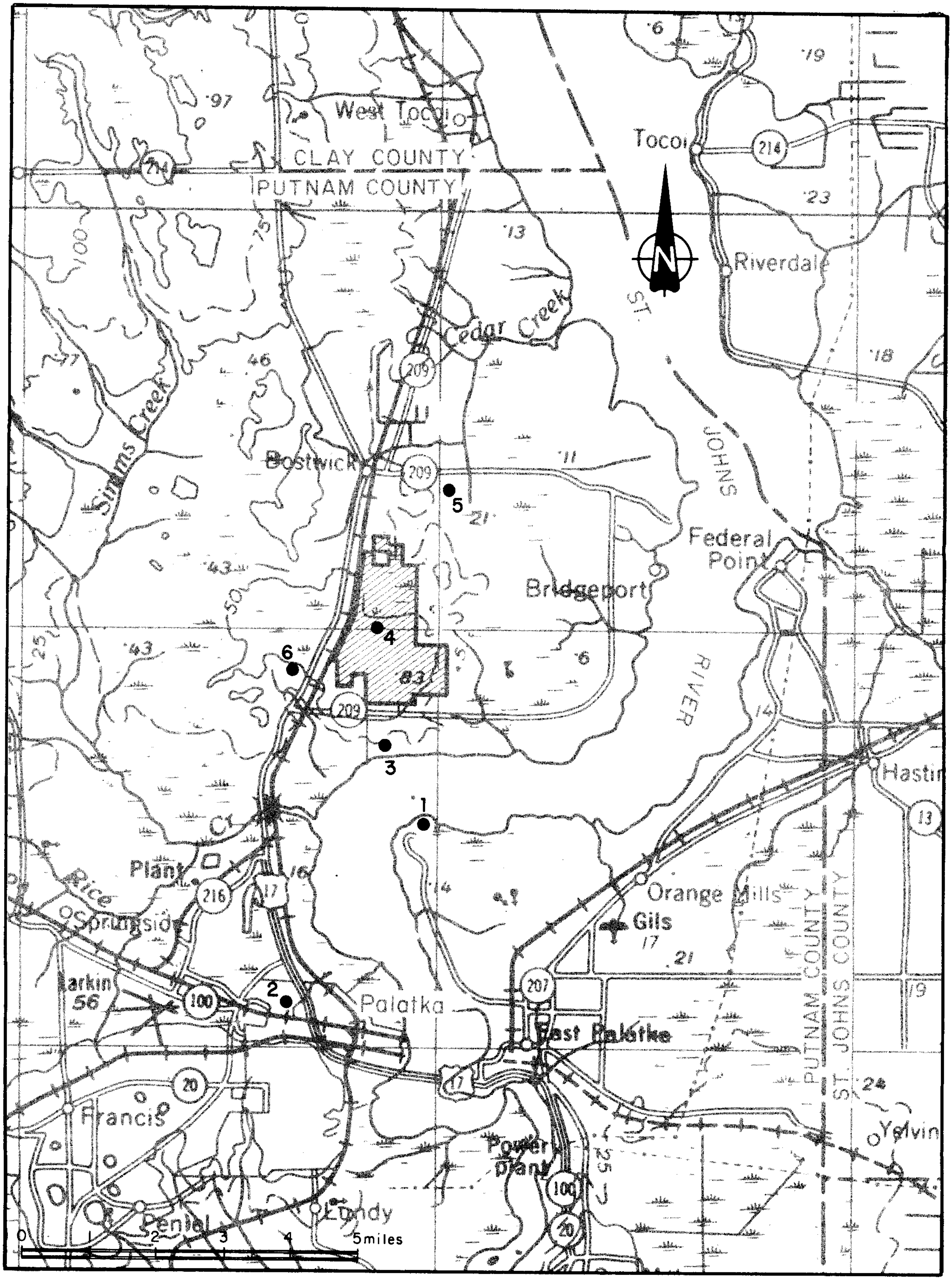


Figure 2.6-1. Ambient Sound Survey Measurement Locations.

REVISED 3/15/79

2.7 ECOLOGY

2.7.1 Terrestrial Ecology

2.7.1.1 Introduction/Regional Description

The dominant natural feature in this region is the St. Johns River. The St. Johns River together with its tributary, the Oklawaha River, flows from the Central Highlands of Florida northward to the Atlantic Ocean. The Oklawaha River swamp is one of the most distinctive features of the predominately rural central regions of Florida (Carter, 1974). This region is noted for its abundant citrus production and numerous lakes. The St. Johns River is the main water course through the flat coastal plain region paralleling the coastline in the northeastern section of Florida.

The coastal plain east of the Putnam Site is extremely flat, with an elevation less than 25 feet above sea level. The dominant vegetation type (wildlife habitat) is Pine Flatwoods. Pine Flatwoods are characterized by a rather open overstory of one of several pine species with a thick understory of gallberry and palmetto. Areas of slightly higher elevation are found in southern Putnam County and south. These areas exhibit rolling topography and deep sand soils. Vegetation is pine and xeric scrub oaks. Low areas along the St. Johns River and its tributaries are bottomland hardwood and cypress swamps. Non-forested wetlands are vegetated with various aquatic grasses, sedges, and rushes and are known as freshwater marshes. Swamps and marshes are very important recharge areas and highly productive wildlife habitats. The entire St. Johns River and its floodplain are classified as having little or no tolerance for development because of the delicate riverine environment (Carter, 1974). Areas not in close proximity to river have slight tolerance to development if it is well planned.

2.7.1.2 Vegetation

The floristic survey of the Putnam Site consisted of traversing the majority of the site and recording plant species observed (see Appendix A.1 for survey methods). On the Putnam Site, 35 tree species, 31 shrub

2.7 ECOLOGY

2.7.1 Terrestrial Ecology

2.7.1.1 Introduction/Regional Description

The dominant natural feature in this region is the St. Johns River. The St. Johns River together with its tributary, the Oklawaha River, flows from the Central Highlands of Florida northward to the Atlantic Ocean. The Oklawaha River swamp is one of the most distinctive features of the predominately rural central regions of Florida (Carter, 1974). This region is noted for its abundant citrus production and numerous lakes. The St. Johns River is the main water course through the flat coastal plain region paralleling the coastline in the northeastern section of Florida.

The coastal plain east of the Putnam Site is extremely flat, with an elevation less than 25 feet above sea level. The dominant vegetation type (wildlife habitat) is Pine Flatwoods. Pine Flatwoods are characterized by a rather open overstory of one of several pine species with a thick understory of gallberry and palmetto. Areas of slightly higher elevation are found in southern Putnam County and south. These areas exhibit rolling topography and deep sand soils. Vegetation is pine and xeric scrub oaks. Low areas along the St. Johns River and its tributaries are bottomland hardwood and cypress swamps. Non-forested wetlands are vegetated with various aquatic grasses, sedges, and rushes and are known as freshwater marshes. Swamps and marshes are very important recharge areas and highly productive wildlife habitats. The entire St. Johns River and its floodplain are classified as having little or no tolerance for development because of the delicate riverine environment (Carter, 1974). Areas not in cloes proximity to river have slight tolerance to development if it is well planned.

2.7.1.2 Vegetation

The floristic survey of the Putnam Site consisted of traversing the majority of the site and recording plant species observed (see Appendix A.1 for survey methods). On the Putnam Site, 35 tree species, 31 shrub species, 118 herbaceous species, 11 vine species, and 2 epiphyte species were recorded (see Appendix A.2, Vegetational Species List for the Putnam Site). The total number of plant species recorded was 207 indicating a diverse vegetation cover. Four major habitats were represented on the Putnam Site: the Sandhill Community, Pine Flatwoods, Bayhead Forest, and Hardwood and Cypress Swamp (Figure 2.7-1). Pine Plantations, Cypress Heads, and scattered Oak Hammocks were present on site to a lesser degree.

Sandhill Community

The Sandhill Community, as discussed by Monk (1960), may occur in three different forms or phases: 1) turkey oak phase (*Quercus laevis*); 2) southern red oak phase (*Q. falcata*); and 3) sand post oak phase (*Q. margaretta*). All three phases are found in combination with longleaf pine (*Pinus palustris*). In addition, all three phases occur in limited extent on the Putnam Site, but the turkey oak phase characterized the majority of the upland portion of the site which comprises 25 percent of the site. Due to extensive onsite lumbering activities which have removed the marketable pines, turkey oak dominates the overstory (Table 2.7-1). Turkey oak had an importance value three times greater than that of the longleaf pines. Longleaf pine was still present but had a sparse distribution. The pines were actively reproducing, evidenced by a number of individuals of these species observed growing in the "grass" stage. Grazing of the terminal buds of small longleaf pines by pigs has probably been deleterious to further growth of many of these plants. Large sandy areas devoid of any litter accumulation were often found where turkey oak dominated. Two types of foliose lichens were observed colonizing these areas, where they aid in consolidating surface soils and retarding soil erosion.

The Sandhill Community did not contain a well developed shrub layer or understory except for the presence of saw palmetto (*Serenoa repens*). Palmetto is commonly found in many of the drier Florida habitats, and in this study was sampled with the ground cover stratum (Table 2.7-2). Three-awn grass (*Aristida* sp.) was the dominant ground cover species with lichen also abundant. Spanish moss (Tillandsia usneoides) was found growing on the majority of the turkey oaks in this community. Spanish moss, an epiphyte, belongs to the bromeliad family and it was found in all habitats on the Putnam Site. It is the most common bromeliad in Florida.

Considering its relatively large area, the Sandhill Community exhibited a very low diversity (number of species). This is due to a number of environmental factors including the rather sterile soils, the xeric edaphic conditions, and the inhibitory effects of the longleaf pine (i.e. shading and presence of tannins in needle litter).

Pine Flatwoods Community

Pine Flatwoods are found on the southeast and northeast portions of the Putnam Site (Figure 2.7-1) and comprise approximately 46 percent of the site. This habitat is an open subclimax forest of slash pine (Pinus elliottii), saw palmetto, and scattered hardwood shrubs. Three awn grass is generally the dominant ground cover. Slash pine is replaced by pond pine (P. serotina) on those flatwoods areas located on slightly lower elevations as is found on the slopes southeast of the Sandhill Community.

The Pine Flatwoods is an intermediate stage in succession from open field to hardwood forest. The Bayhead Forest is an onsite example of what much of the Flatwoods would become if not inhibited by factors such as fire and grazing which keep hardwoods from reaching a dominant status.

Pine Plantation

Portions of the site have been extensively managed for pine production. Approximately 8 percent of the site is Pine Plantation. These areas have been cleared of all vegetation and planted in slash pine. The southwest portion of the site has recently been clearcut and planted with pine seedlings while the northwestern side of the site is dominated by 10 to 15 year old planted pine. Grasses, forbs, and shrubs have vegetated the clearcut area, but no ground cover or understory is present in the older pine plantations (for the same reasons mentioned in the Sandhill Community).

Oak Hammock Community

A few Oak Hammocks occur along the southwestern corner of the site on areas that are fairly well drained. A hammock is defined as a fertile area that is usually higher than its surroundings and that is characterized by hardwood vegetation and deep humus-rich soil. The major overstory species in these areas is live oak (Quercus virginiana) which is strongly dominant. The only other noteworthy overstory components are southern magnolia (Magnolia grandiflora) and an occasional cabbage palm (Sabal palmetto). A very heavy accumulation of leaf litter in this area has possibly proven detrimental to the development of an appreciable herbaceous stratum.

Bayhead Forest Community

There is an extensive Bayhead Forest in the northwestern portion of the site. This community covers approximately 7 percent of the site. Based on PCQ data (Table 2.7-3) and field observations, this area was, in the not-too-distant past, a low Pine Flatwood. The suppression of fire as an influencing factor enhanced the development of the successional trend from pond pine (Pinus serotina) to Bayhead Forest. This is further substantiated by the combination of rather large, widely spaced pond pines now occurring in a matrix of very small broadleaved evergreen trees.

The understory stratum is dominated by a dense growth of palmetto (Sabal minor), but a complex mixture of young trees such as maple (Acer saccharum), red bay (Persea borbonia), Basswood (Tilia caroliniana) sweet bay (Magnolia virginiana), swamp red bay (Persea palustris), blackgum tupelo (Nyssa sylvatica) and dahoon holly (Ilex cassine) and a number of shrubs such as custard apple (Asimina parviflora), black haw (Viburnum obovatum), strawberry bush (Euonymus americanus), shiny blueberry (Vaccinium myrsinites), blueberry (V. fuscatum), and tangleberry (Gaylussacia frondosa) also occur. Dense growth of holly (Ilex glabra), lyonia (Lyonia coriacea), and kalmia (Kalmia hirsuta) occur on the gradual slopes that lead to the Bayhead Forest.

The herbaceous stratum was strongly dominated by bracken fern (Pteridium aquilinum), although cinnamon fern (Osmunda cinnamonia) and southern clubmoss (Lycopodium adpressum) commonly occurred.

Hardwood and Cypress Swamp Community

A mixed hardwood and cypress swamp occurs in the northern portion of the property and covers 7 percent of the site. The soil in this low-lying area was either inundated or (partly to completely) saturated with water. Many large bald cypress (Taxodium distichum) stumps were observed indicating that this species was at one time dominant or at least codominant with the hardwood species prior to the extensive logging that occurred in this area. Dominant hardwood species found growing in the swamp were sweetgum (Liquidambar styraciflua), ash (Fraxinus caroliniana), water tupelo (Nyssa aquatica), and red maple (Acer rubrum) (Table 2.7-4). Presently sweetgum is strongly dominant as indicated by its much higher importance value.

The understory stratum is comprised mainly of young ash and maple, and some shrubby growth of chinquapin (Castanea alnifolia) and box elderberry (Sambucus canadensis) (Table 2.7-5).

The very wet soil was covered by a low layer of herbaceous growth. Occasional grasses or sedges were present although most of the ground cover consisted of water pennywort (Hydrocotyle sp.), ferns, and lizard's tail (Saururus cernuus). Areas of shallow standing water were usually occupied by pickerelweed (Pontederia cordata) and lizard's tail, while along the edges tangled mats of buttonweed (Diodia virginiana) and vegetative growth of pennywort predominated. The herbaceous species found in this wetland area, their percent cover and relative frequency are listed in Table 2.7-6. A common epiphyte in this habitat was wild pine (Tillandsia fasciculata). Wild pine is usually found attached to cypress trees and except for spanish moss is the most common bromeliad in Florida.

Cypress Head Community

A number of Cypress Heads occur throughout the Putnam County site. These cypress "domes," as they are sometimes called, are very small, seldom more than two or three acres in size. They comprise less than two percent of the site area. Pond cypress (Taxodium ascendens) is virtually monodominant in these stands. Peat moss (Sphagnum sp.) is also very common, as are a number of other species such as pitcher plant (Sarracenia minor) which are characteristically found in acid soil.

2.7.1.3 Amphibians and Reptiles

Twelve species of herpetiles were collected or observed on the site (Table 2.7-7). These included two species of salamanders, three species of frogs, two species of toads, three species of lizards, one species of tortoise, and one species of snake. These species were found in either the upland habitats or bottomland habitats on site. The upland habitats collectively include the Sandhill Community, Pine Flatwoods, Pine Plantation and Oak Hammocks. The bottomland habitats include the Bayhead Forest, Cypress Heads, and Hardwood and Cyrpess Swamp.

Upland Habitats

The upland habitats were occupied by the American toad (Bufo ameri canus), southern toad (Bufo terrestris), southern fence lizard (Sceloporus undulatus undulatus), ground skink (Leiolopisma laterale), green anole (Anolis carolinensis), gopher tortoise (Gopherus polyphemus), and southern black racer (Coluber constrictor priapus). The American toad occurs in a variety of habitats. They tend to prefer habitats which contain shallow bodies of water which are used as breeding sites in the early spring. This large toad is commonly observed on warm, rainy nights in the spring and fall but is encountered only occasionally during the hot summer months. This may be due to the toad's practice of estivating during much of the summer (Mount, 1975). The southern toad was active on the site throughout most of the summer, especially at night. However, during the hotter months, it confined its activities to the wetter portions of the Putnam Site.

The southern fence lizard is an abundant reptile in the dry, open habitats of northern and central Florida. This lizard was commonly seen scurrying along the ground in the Sandhill and Flatwoods. When approached, it rapidly seeks shelter in a nearby tree. Food items include insects, especially ants.

The green anole is a smooth skinned lizard commonly called the "chameleon" because of its ability to change color. The anole may be green, brown, or gray, depending on its "mood" or its environment. This lizard is chiefly arboreal, and is found in any habitat with abundant vegetation and shade. It was abundant in all the habitats on the Putnam Site.

The ground skink is seldom found in trees. It prefers to hunt among leaves and forest debris on the woodland floor for its insect food. The Pine Flatwoods and Sandhill Community are preferred over the more mesic bottomland areas by this skink. This secretive and elusive reptile was found in these dryer habitats under leaf litter and rotten logs.

The black racer was the only snake species found on the site. This alert and active snake is found in most terrestrial habitats and is most common in open woods and forest edges. It was found in the Pine Flatwoods on site. All of the toads and lizards already discussed are food items for the racer. It may also eat rodents, small birds, and other snakes when the opportunity arises.

The gopher tortoise is one of the better known residents of the Sandhill Community where they build their conspicuous gopher burrows. This species is becoming increasingly scarce due to overhunting and loss of habitat. The tortoise is discussed further in Section 2.7.1.6.

Bottomland Habitats

Five herpetile species found in the bottomland habitats on site included the southern leopard frog (*Rana utricularia*), squirrel treefrog (*Hyla squirella*), little grass frog (*Limnaoedus ocularis*), slimy salamander (*Plethodon glutinosus*), and dwarf salamander (*Eurycea quadridigitata*). The southern leopard frog is found in all aquatic habitats.

This alert, active frog is frequently found well away from water during the summer months when lush vegetation offers shade and protection. Leopard frogs were most common on site in the bottomland hardwoods area where there was an abundance of ground vegetation and pools of water in depressions, ditches, and tire tracks.

The squirrel treefrog is a small variable colored frog common to all habitat areas with lush vegetation. It is more likely to be heard than seen due to its loud distinctive call and secretive habits. These treefrogs are especially active after a rain shower when their voices can be heard in all mesic habitats. Specimens were frequently seen during the nightlighting surveys on site roads after showers.

The little grass frog is the smallest frog in North America (Conant, 1975). Adults are generally 1 to 1.5 centimeters in length. This tiny frog prefers the low grassy vegetation in Pine Flatwoods and Bayhead Forest but was most abundant in the cypress domes on site. This area afforded a wet habitat with grass and marsh plants available for cover.

The slimy salamander is abundant in moist terrestrial habitats in northern and central Florida. This rather large, dark salamander prefers to live in well rotted logs and stumps in areas in which the soil is frequently flooded. This salamander was found in the bottomland hardwood habitat on site. The smaller slender dwarf salamander was also found in this habitat. This salamander lives under logs, boards, and other debris in low Bayhead Forests and swampy areas. The ground skink, which is found in higher Pine Flatwoods, resembles this salamander in general shape and coloration.

2.7.1.4 Birds

Forty-four species of birds were observed on the Putnam Site (Table 2.7-8). As in the case of many wildlife groups, some birds are associated with specific habitats while others are found in a variety of habitats. The habitats on the Putnam Site can be divided into upland and bottomland habitats. The upland habitats are the Sandhill Community, Pine Flatwoods, Pine Plantations, and Oak Hammocks, while the bottomland habitats are the Bayhead Forest, Cypress Heads, and Hardwood and Cypress Swamp. A description is presented of several of the major bird species observed in each of these habitats as well as those which occur in several or all habitats.

Upland Habitats

The Sandhill Community and Pine Flatwoods are attractive to those species that require open canopied, forested habitats. Birds likely to occur in these upland areas include the bobwhite (*Colinus virginianus*), pine warbler (*Dendroica pinus*), ground dove (*Columbigallina passerina*), kingbird (*Tyrannus tyrannus*), white-throated sparrow (*Zonotrichia albicollis*), savannah sparrow (*Passerculus sandwichensis*), field sparrow (*Spizella pusilla*), and loggerhead shrike (*Lanius ludovicianus*). The bobwhite is an especially important game species in the southeast. Preferred habitat is old field habitat, which is any open relatively clear area in an early successional stage where grasses, sedges and other seed producing ground cover are abundant. This habitat was available in the clearcut area on the southwest portion of the site. Bobwhite were also present in the Pine Flatwoods areas, including those areas with relatively thick understory growth.

The pine warbler is one of the more common birds in any pine habitat. They occur in the upper portions of pines where they search for insects in and on the pine bark. Also found in these upper levels of the pine habitats is the kingbird. This bird is a flycatcher and uses trees and overhead wires for perches from which to launch itself at passing flying insects.

The loggerhead shrike is another species which uses trees and overhead wires as perches. This interesting bird operates much like a tiny hawk and it can locate prey at an astonishing distance. Prey items include grasshoppers and other insects, lizards, frogs, small birds, and mice. Its peculiar habit of impaling prey on thorns or barbed wire, to be devoured later, has given rise to the shrike's nickname of "butcherbird." Shrikes were present at scattered locations throughout the Flatwoods habitat on site.

The sparrows found on site are generally seed eaters and are found either on the ground or in low, thick vegetation. The white-throated sparrow is found in any habitat that contains thick hedgerows and field edges. It travels in groups and was especially abundant during the winter season in the clearcut portion of the site. The savannah sparrow and field sparrow are birds of fields, pastures, and brushy hedgerows. These species are mostly found feeding on or near the ground on grass seeds and occasionally on insects. These sparrows were most commonly observed in the open pinelands onsite.

The ground dove is a diminutive resident of sandy habitats throughout the deep south. It is generally observed on the ground feeding on grass and weed seeds. This dove was common in the Flatwoods and Sandhill Community on the Putnam Site.

Bottomland Habitats

These habitats contained bird species which require moist, lushly vegetated areas for food and cover. Some of the bottomland species observed on the Putnam Site include the yellow-rumped warbler (*Dendroica coronata*), black-and-white warbler (*Mniotilta varia*), brown thrasher (*Toxostoma rufum*), cardinal (*Cardinalis cardinalis*), white-eyed vireo (*Vireo griseus*), rufous-sided towhee (*Pipilo erythrophthalmus*), chuck-wills-widow (*Caprimulgus carolinensis*), and pileated woodpecker (*Dryocopus pileatus*). The warblers are abundant migrant visitors to Florida. The myrtle warbler is a low-ranging bird preferring bushes, hedgerows, and thickets rather than taller trees. It is fond of wax myrtle and redcedar, both of which are common in the Bayhead Forest in which it was seen on the Putnam Site. The black-and-white warbler prefers swampy areas, where it may be seen creeping along tree trunks and under limbs. Its diet consists almost entirely of insects.

The brown thrasher is a bird familiar to most residents of the South. It frequents thick, bushy places where it searches on or near the ground for seeds and insects. Small acorns make up a good portion of its vegetable diet (Sprunt, 1954). Another bird commonly found scratching around the forest floor is the rufous-sided towhee. The towhee is essentially a ground bird and likes to search for fruits, seeds, and insects in heavy thickets of myrtle, honeysuckle, and holly.

The cardinal is possibly the best-known bird in the state (Sprunt, 1954). Its brilliant coloration and frequent co-existence with man make it an easily recognized species. Thickets and bushes are essential to its well-being; therefore, it is common in hedgerows, bottomland habitats, and swamps. It does not occur in pure pine stands or open prairies.

The white-eyed vireo is a common but seldom seen resident of dense, moist deciduous woods. This small bird frequents the tops of trees whose height and foliage make observation from the ground difficult. Its song usually identifies its presence. Like all warblers its food is largely insects.

One common summer resident in this area is the chuck-wills-widow. This large, nocturnal bird is rarely seen except on dark, rainy days or when swooping through car lights. Its distinctive call, which says its name, is commonly recognized. It feeds on flying insects at night, catching them in its over-sized mouth. This bird spends the day perched on the ground in decidous woods where its mottled, dark brown coloration blends with the forest litter.

The largest and most spectacular of the several woodpeckers found in bottomland areas is the pileated woodpecker. This species is second only to the extremely rare ivory-billed woodpecker in size. The pileated, unlike the ivory-billed, has been able to adapt to changing environment and has actually extended its range into localities which were without it twenty years ago (Sprunt, 1954). It is found in any habitat having large dead or dying trees from which it extracts wood-boring insects which, together with various fruits and berries, make up its diet.

Non-Specific Habitat Preference

There are several birds which may be expected to occur in almost any habitat in Florida. Those observed onsite include the mockingbird (Mimus polyglottos), common crow (Corvus brachyrhynchos), blue jay (Cyanocitta cristata), and turkey vulture (Cathartes aura). The mockingbird is the State bird of Florida and no portion of the State is without it. Its food consists of fruits, berries, and insects. It is partial to shrubby areas but is common in any habitat from orange groves and residential areas to hedgerows and deep woods.

The common crow is a species readily identified either by its harsh call or its coal black color. It is a wide-ranging bird which has adapted well to man's taming of the land. Flocks of crows may be expected in any habitat. It is considered a pest by farmers for its depredations in almost all cultivated crops. Wild foods include fruit, acorns, berries, beetles, grasshoppers and other insects, crayfish, fish, amphibians, reptiles, young birds, small mammals, and dead skunks.

Another common bird found on the Putnam Site and throughout Florida is the blue jay. Like the crow, its call is quite distinctive, and its habit of scolding any intruder is well known to any hunter or woodsman. Its diet is quite varied, but acorns, nuts and wild fruit compose most of its food.

The turkey vulture is a common sight on a clear day in any region of the south. These large scavengers are constantly soaring, searching for carrion. They are quite important in the elimination of decomposing animal matter and garbage.

Several raptors were observed on the site. These include the red-tailed hawk (Buteo jamaicensis), screech owl (Otus asio), and the barred owl (Strix varis). The red-tailed hawk is the largest of the Florida hawks and is frequently seen soaring over any habitat which might harbor small mammals, its main prey. These hawks were seen flying over the site but were not observed feeding. The paucity of rodents on the site probably precludes this area as good feeding habitat (Section 2.7.1.5); however, rabbits may contribute to its diet here.

The screech owl is a tiny bird more widely known by its call than by sight. Open pinelands, palmetto scrub, and hammocks are its preferred habitat. It was heard calling from the bottomland habitats on site where it was probably able to locate small rodents during its nocturnal hunting.

The barred owl is a common resident of southern swamps and river bottoms. Its deep hoots are one of the characteristic sounds of the Florida night (Sprunt, 1954). The barred owl's diet is quite varied and includes mice, birds, frogs, lizards, crayfish, fish, and insects. One owl was heard calling in the hardwood and cypress swamp on the northern portion of the site.

Three important game bird species which occurred on the Putnam Site were the bobwhite (Colinus virginianus), mourning dove (Zenaidura macroura), and wild turkey (Meleagris galapavo). The bobwhite is considered by many to be the prince of game birds; this is certainly true in Georgia and Florida where it attracts thousands of hunters each year. As has aleady been discussed, its preferred habitat is sandy, open pineland and old fields.

The mourning dove is a common resident that is joined by an influx of migrants each winter. It is a bird of the open country, preferring pastures, cultivated fields, and sandy areas. It is primarily a seed eater and feeds on some of the smaller cultivated grains. It nests in bottomland forests and was frequently heard "cooing" in these areas on the site.

The wild turkey is a large, colorful resident of dense hammocks and the drier swamps. It may also be found in Pine Flatwoods and palmetto prairie where the thick scrub offers cover. This cautious, wily bird is seldom seen but is generally recognized by its tracks. Turkey tracks were quite numerous in the Hardwood and Cypress Swamp on the north portion of the site and were also common on roads through the Sandhill and Flatwoods. Turkeys have been hunted here in the past with moderate success (Hansford, personal communication).

No evidence of rare or endangered bird species was found on the Putnam Site. Much of the habitat in and around the site may be suitable to certain species and is further discussed in Section 2.7.1.6.

2.7.1.5 Mammals

Fourteen species of mammals were observed on the Putnam Site (Table 2.7-9). Of these species, the most abundant and obvious mammal on the site was the feral hog (*Sus scrofa*). Hogs are common in many areas of Florida as they are frequently released on a landowner's property, where they seek their own food and are available for recapture when the owner desires a hog for food. Hogs are found in all habitats, but because of their abundance in the Pine Flatwoods, they are commonly called "piney woods rooters." Here they forage for acorns, palmetto berries, and other mast and root for underground tubers and roots. Hogs will also eat the terminal buds of longleaf pine trees when they are in the "grass stage." Longleaf pine grows very little above ground for the first three to six years while it is establishing its deep taproot. At this time its terminal bud is only a foot or two off the ground, and if the bud is destroyed, the tree will not grow out of the grass stage. Evidence of hogs eating these buds was common in much of the Sandhill Community on site.

Hogs frequent bottomland habitats where they can easily dig roots in the moist soil and where mast from oaks, gums, ash, maple, and other bottomland species is abundant. Hogs are opportunistic feeders and will eat anything they can catch including frogs, lizards, snakes, birds, small mammals, and carrion. Tracks and evidence of rooting were abundant in all site habitats. No hogs were actually seen except in traps that the landowner had set to remove them from the site.

The whitetail deer (*Odocoileus virginianus*) is the only other large mammal found on the site. This familiar herbivore is found in any habitat forested enough to offer cover and food in the form of browse and mast. Bottomland areas are productive habitats for deer due to abundant food. The Pine Flatwoods is the most common habitat in Florida and supports a substantial deer population on acorns, palmetto berries, woody plants and twigs, forbs, and mushrooms (Harlow and Jones, 1965). Deer were most common in the bottomland areas of the Putnam Site, but tracks were present in the upland areas as well. Deer were not seen during the nightlighting surveys but were flushed infrequently when working in the bottomland areas during the day. Local residents hunt deer extensively in this area (Hansford, personal communication). Hunting pressure and disruption on the site probably have caused the deer to move elsewhere for suitable habitat.

The primary carnivore found on the site is the bobcat (Lynx rufus). This cat is primarily nocturnal and solitary. It was identified by tracks and droppings in the bottomland habitats.

The gray fox (Urocyon cinereoargenteus) is another predator whose presence on site was common. This secretive animal feeds on small mammals, birds, fruit, acorns, eggs, and insects. It is an opportunistic feeder with an obviously omnivorous choice in food items. Tracks and droppings were found on all the roads through the site.

Two additional omnivorous species found on the Putnam Site are the raccoon (Procyon lotor) and opossum (Didelphis marsupialis). These animals prefer the wetter habitats where they can feed on frogs, salamanders, lizards, insects, birds, fruit, mast, and occasionally carrion. The raccoon and opossum are chiefly noctural but are occasionally abroad during the day. Signs of activity were especially abundant around any depressions and pools where amphibians might be found.

The armadillo (Dasypus novemcinctus) is a mammal which is now common to most of Florida. This species has extended its range into Florida from Texas and central America (Hall and Kelson, 1959). It is found in all but the wettest habitats where it digs in the leaf litter and soil for invertebrates. Armadillos dig underground burrows, usually located in palmetto thickets, for protection. Signs of digging were common in the Sandhill, Flatwoods, and Bayhead Forest habitats on site.

The only rabbit species observed on this site was the eastern cottontail (Sylvilagus floridanus). The cottontail is abundant in habitats containing heavy brush intermixed with open areas. One such area was the recently clearcut pine habitat in the southwest portion of the site. Here, brush piles and windrows offered good cover from predators such as hawks, owls, foxes, and bobcats; and the recently cleared land contained abundant newgrowth vegetation upon which the cottontail feeds.

The eastern gray squirrel (Sciurus carolinensis) is a resident of the bottomland areas. This squirrel is chiefly arboreal and prefers hardwood habitats where it feeds on a variety of nuts, seeds, fruit, and fungi. Gray squirrels generally jump from tree to tree and do not venture far from the protection of trees. The eastern fox squirrel (Sciurus niger) is found in open pine habitats such as the Flatwoods and Sandhill. The fox squirrel is roughly twice the size of the gray squirrel and is frequently seen running on the ground or along a road before taking refuge in the top of a nearby pine tree.

The only small rodent captured in 276 trapnights in various habitats during three seasons was the cotton mouse (Peromyscus gossypinus). Two mice were captured in the Bayhead Forest habitat; one young mouse was captured in the drift fence in the same habitat. Cotton mice prefer wooded habitats bordering fields or swampy areas. They feed on seeds and insects and frequently climb trees where they nest (Burt and Grossenheider, 1976).

Evidence of a subterranean mammal, the eastern mole (Scalopus aquaticus), was found in all habitats except those with standing water. This species is rarely seen as it spends most of its life tunneling just below the surface of the soil hunting for worms and insects. The Bayhead Forest contained the highest number of tunnels, but tunnels were also present in the more moist portions of the Pine Flatwoods habitat.

Two other mammals seen on site which deserve mention are the domestic dog (Canis familiaris) and cat (Felis domesticus). Hunting dogs were observed on the site from time to time. These dogs are usually used to tree raccoons or run foxes and bobcats. They may also be used to catch hogs. Dogs are generally ineffective predators and do little more than harass wild species. However, they may become more proficient at capturing small mammals if they are forced to live entirely on food available in the wild. Cats, on the other hand, are very efficient predators and will frequently capture birds, small mammals, and reptiles. Kittens were found abandoned on the site on one occasion and probably occur here on an infrequent basis.

No rare or endangered mammals were encountered on the Putnam Site. This site has been exposed to frequent disruption by logging, burning, and clearing as well as competition and general habitat destruction from the introduction of feral hogs. These factors have probably caused a noticeable lack of ground dwelling animals and make the area generally unattractive to species considered endangered or rare.

2.7.1.6 Endangered Species and Biologically Sensitive Areas

A historic lack of management practices and recent disturbances to the plant communities on the site have greatly reduced the possibility that a population of a threatened or endangered plant species may occur. No species presently on the Federal list of threatened and endangered plants are found in Florida. There are, however, several taxa listed on the Florida state list that potentially could occur in the Sandhill Community. However, none of these species were observed on the Putnam Site.

Florida has several vegetative communities which are endemic to the state and provide specific habitats to varied wildlife species. Many of these wildlife species are becoming more scarce as their habitats are lost to residential, industrial, or agricultural development, or as an effect of changes brought about in topography or surface and groundwater flow. One such habitat, the Sandhill Community, is disappearing due to development because it is generally a well drained area of slightly higher elevation. Several wildlife species associated with the Sandhill are also disappearing due to this loss of habitat. These species include the Florida gopher frog, gopher tortoise, eastern indigo snake, short-tailed snake, Florida scrub lizard, Florida scrub jay, red-cockaded woodpecker, and Florida mouse. All but the scrub jay and red-cockaded woodpecker are directly associated with the gopher tortoise. This terrestrial turtle is an accomplished burrower and prefers to excavate its burrow in the deep sandy soil of the Sandhill. These burrows may be thirty feet or more in length and are usually as wide as the tortoise is long, enabling the tortoise to turn around in any portion of the burrow. The burrows provide shelter for a multitude of Sandhill inhabitants such as the ground dwelling species previously mentioned as well as pine snakes, coachwhips, diamondback rattlesnakes, burrowing owls, and numerous arthropods.

Currently, the eastern indigo snake is listed as a threatened species by the State of Florida and the U. S. Fish and Wildlife Service. The gopher tortoise, gopher frog, and Florida mouse are listed as threatened by the State (Suzanne Cooper, personal communication). The tortoise has had the distinction of being listed as a threatened species at the same time it is considered an official game species. Local residents consider the tortoise to be fine food, and frequently they will drive miles to hunt "gophers." The common means of capturing the tortoise is to push a garden hose into the burrow, pour a small amount of gasoline into the hose and blow the gas vapor into the burrow. This usually drives out most of the inhabitants.

This same technique is used to gas rattlesnakes out of burrows during the rattlesnake "round-ups" common in many of the southern states during the winter. The practice of "gassing" has recently been prohibited in Florida because gassing may kill indigo snakes (a threatened species). The gopher tortoise itself is undergoing a status determination by the U. S. Fish and Wildlife Service. The fact that gopher tortoise burrows are relatively easy to locate due to their association with the Sandhill vegetation type has led to a problem of overhunting.

The Florida scrub jay does not depend on the Sandhill as its primary habitat. It utilizes many other so called "scrub" areas in which the more xeric oaks and sand pine, saw palmetto, myrtle, and gallberry are found.

The red-cockaded woodpecker is unique in that it nests almost exclusively in living pines infected with the fungus called "red-heart." This fungus weakens the tree's heartwood and enables the bird to excavate its cavity. The longleaf pine, when available, is prefered as a nesting site, and since longleaf pine is the dominant species in the longleaf pine-turkey oak community on the Sandhill, this woodpecker is commonly found in that habitat.

Investigations on the Putnam Site, however, revealed that of the listed endangered or threatened species only the gopher tortoise was present in the Sandhill Community. No other associated species mentioned previously were found. The site has been heavily impacted in the past. The larger longleaf pine has been removed years ago, thus making the site unattractive to the red-cockaded woodpecker. Smaller trees which were left, and have been cut in the past year, were too small to offer nesting opportunities to this species. No scrub jays were found during the survey onsite. Evidence of "gassing" (either for tortoises or rattlesnakes) was found at several tortoise burrows, so it is quite likely that many burrow inhabitants have been removed or perhaps destroyed by this technique. Also the presence of feral hogs on the site has probably adversely affected the residents due to habitat disruption, competition for food, and predation by the hogs.

Three tortoises of different sizes were found on the site. One tortoise was only 5.2 centimeters long (carapace); the other two were adults. The majority of the tortoise burrows observed were in use, but since tortoises may use more than one burrow, it is not possible to determine the number of tortoises present by the number of active burrows.

Other species of special concern have been noted on or near the Putnam Site. The southern bald eagle (Haligeetus l. leucocephalus) the state and endangered by the U. S. Fish and Wildlife Service. Eagle populations in Florida have declined dramaticaly in the past 30 years (U. S. Forest Service, 1976).

However, Florida has been and still is a stronghold for the eagle. It is probably more abundant in Florida than anywhere else in the United States (Sprunt, 1954). The recent Cross Florida Barge Canal Restudy Report (U. S. Forest Service, 1976) surveyed eagle populations throughout the state and most specifically along the canal route, beginning in Palatka (5 miles south of the Putnam Site) and continuing south and west for 100 miles. Several active eagle nests were recorded in southern Putnam County.

Habitat requirements for the eagle include living slash pine and cypress for nest sites. Some scattered slash pines large enough to support an eagle's nest were present on the northern portion of the site and cypress was present along the St. Johns River directly south of the site. The site and adjacent areas were flown at low altitude in a single-engine airplane during September, 1977 and February and April, 1978 for the purpose of searching for large raptor nests. None were observed on the site or along the St. Johns River from Palatka to Federal Point.

A forester working on the site reported seeing an eagle nest on the northern portion of the site in a tall slash pine during the winter of 1976-77. No eagle was actually seen, but the forester did hear it call from the nest as he approached the tree. This area was logged during the Fall of 1977 and Spring of 1978, and all large pines and cypress were removed. This area was thoroughly searched for evidence of either a nest tree or the remains of a nest in cut pine tops. No evidence of such a nest was found. An eagle nest is possible on the site, although the site does not represent prime nesting habitat. The Rodman Reservoir, fifteen miles southwest of the site, is much more attractive due to the abundance of old pines and cypresses and its proximity to a large body of water. Active eagle nests were observed there during the Cross Florida Barge Canal Restudy.

The osprey (Pandion haliaetus) is listed as a threatened species by Florida. It was observed feeding in the St. Johns River near the Putnam Site. The aerial survey previously mentioned, and an additional ground survey, failed to locate any osprey nests in cypress trees along the St. Johns River at any of the areas under consideration for sites for water intake/discharge structures. The osprey prefers to nest in the tops of dead trees; few of the trees in these areas were dead, as most were located on residential property from which any dead tree would have been removed. More suitable nesting habitat was probably located in the Rice Creek swamp area south of the site, although no nests were actually observed there either. The Cross Florida Barge Canal Restudy located numerous osprey nests south of Palatka.

2.7.1.7 References

Burt, W. H., and Grassenheider, R. P., 1964, A field guide to the mammals. Haughton-Mifflin co., Boston.

Carter, L. J., 1974, The Florida experience. The John Hopkins Univ. Press, Baltimore.

Conant, R., 1975, A field guide to reptiles and amphibians. Houghton-Mifflin Co., Boston.

Cooper, Suzanne, 1978, Biologist, Florida Game and Fresh Water Fish Commission, personal communication.

Hall, E. R., and Kelson, K. R., 1959, The mammals of North America. The Ronald Press Company, New York.

Hansford, J. R., 1978, Hansford Realty, Palatka, Florida, personal communication.

Harlow, R. F., and Jones, F. K. Jr., 1965, The white-tailed deer in Florida. Florida Game and Fresh Water Fish Commission, Tech. Bull. No. 9.

Monk, C. D., 1960, A preliminary study on the relationship between the vegetation of a mesic hammock and a sandhill community. Quarterly Journal Florida Academy Science, vol. 23, p. 1-2.

Mount, R. H., 1975, The reptiles and amphibians of Alabama. Agricultural Experiment Station, Auburn, Alabama.

Robbins, C. S., Bruun B., and Zim, H. S., 1966, Birds of North America. Golden Press, New York.

Sprunt, A. Jr., 1954, Florida bird life. Coward-McCann, Inc., New York.

U. S. Forest Service, 1976, Cross Florida barge canal-restudy report, eagle-osprey survey. U. S. Department of Agriculture.

2.7.2 Aquatic Ecology

2.7.2.1 Introduction

This section discusses the aquatic ecology of the St. Johns River adjacent to the proposed Putnam Site and its alternative intake/discharge locations. The material addresses the various biotic communities of the St. Johns River both regionally and specific to the site alternatives.

This material was developed to comply with, among others, requirements of the National Environmental Policy Act, especially Section 102(2) (C); Section 316(B), PL 92-500; the Endangered Species Act; Section 10 River and Harbor Act; Section 404, PL 92-500; Florida Electrical Power Plant siting Act; and Chapter 17-3, Pollution of Waters, Florida Administrative Codes.

The plan of study had been structured to:

1. Document existing conditions of the aquatic environment in the vicinity of the proposed plant utilizing the literature to determine the amount and relevancy of site-specific information available and to fill any gaps in such information by site-specific sampling.

2. Then, utilizing the information obtained from site-specific sampling and other sources, to direct the design and location of intake and discharge facilities.

3. Develop an information base upon which reasonable predictions can be made of the impact that may occur as a result of construction and operation of an intake/discharge facility.

This section principally addresses items 1 and 3 and provides the background for analyses on which intake siting and impact analyses are based.

The St. Johns River emerges from marshes in east central Florida and flows northward for some 300 miles before reaching the Atlantic Ocean at Jacksonville. The northern two-thirds of the river is tidally affected and has dissolved solids content due to ground water input from the Floridan Aquifer (Bayley and Odum, 1973). The southern one-third of the river contains generally high quality fresh water. Agricultural runoff, ground water discharge, and natural organic impurities progressively lower the water quality downstream. There are many intermittent ponds, swamps, and marshes and a few permanent lakes in the level plains of the upper St. Johns River Basin. Most of these wet areas are connected by sluggish streams or by wide shallow sloughs which drain into the tributaries of the St. Johns River. Several lakes occur along the river to the south; these lakes affect both the water quality and quantity in the St. Johns River in the vicinity of the site.

Site Characteristics

The site is considered to be in the lower basin of the St. Johns River; at this point the river is approximately 1800 meters wide and the average depth slightly more than 3 meters. Net velocity is on the order of 0.2 foot per second (fps) with a maximum on the order of one fps. The river in the vicinity of the site is influenced by tidal changes. The normal tidal range affects river flow to Deland, Florida; this is approximately 140 miles upstream from the mouth at Jacksonville. The entire 140 mile reach may be considered an estuary (Reynolds, Smith, and Hills, 1974). A detailed discussion of hydrological characteristics is presented in Section 2.3.1 and in Appendix C.

Man's influence is noticeable due to the effluent coming from Rice Creek which is located immediately upstream of the site (Figure 2.3-3). During the September 1977 collecting period, when taking bottom samples, a strong odor of hydrogen sulfide, indicative of anaerobic decomposition, was evident along the area. In addition, bottom characteristics include the presence of wood filings. The combination of these characteristics and the lack of aquatic vegetation does not make this a very desirable habitat for aquatic species. Farther downstream along the west bank of the river there are several homes. Most of these have boat docks and watercraft which are used primarily for sport fishing and/or pleasure boating. Approximately 750-900 meters offshore of the west bank, in the site vicinity, commercial fishing is much in evidence by the presence of gill and pound nets and crab traps. The most sought after species include several species of catfish, eels during certain times of the year, and blue crabs. The commercial fish catch from the St. Johns River, Putnam County, amounts to approximately 1 to 2 million pounds per year (Florida Game and Fresh Water Fish Commission [FG&FWFC], 1977).

Although transparency limits the euphotic zone, primary production, temperatures, and nutrient supplies are generally high enough to support a fairly high standing crop of biota year-round.

Several biological studies have been conducted on the St. Johns River. At least one of these is ongoing at the present time. The FG&FWFC has 31 collection points on the St. Johns River, including station number 30 which is located at the confluence of Rice Creek and the St. Johns River (Figure 9.3-2). The study monitors physiochemical characteristics, phytoplankton, zooplankton, macroinvertebrates, and fish. Tagatz (1968) studied the distribution of fishes on the St. Johns River as a follow-up of McLane's work discussed below. A recent biological study of the St. Johns River was conducted approximately seven miles upstream of the site (Applied Biology, 1976) in conjunction with 316 demonstrations for a Florida Power and Light Company (FP&L) fossil-fired plant.

Aquatic biota of the upper St. Johns River Basin are typical of the fresh water habitats of Florida and as characterized by Goolsby and McPherson (1970) include: green and blue-green algae, generally in low concentrations that dominate the phytoplankton; zooplankton, most commonly represented by rotifers and copepods; vascular hydrophytes including the water hyacinth and various sedges; and benthic macroinvertebrates including mussels, various crustaceans, dipteran larvae, and oligochaetes.

The fish fauna of the St. Johns River consista of 174 species which include 57 fresh water forms and 117 marine invaders (McLane, 1955). Considerable commercial fishing is conducted on much of the St. Johns River. Some of the more important species harvested include American eel, mullet, several species of catfish, and American shad. Angling is a popular sport on the St. Johns River with some of the important sought-after species being the largemouth bass, and other species of centrarchids.

Sampling Station Locations

Sampling transects and stations were chosen to systematically allow sampling of the alternate intake and discharge sites and to assess various components of the aquatic ecosystem in the St. Johns River in the site vicinity (Figure 9.3-2).

Each of the sampling transects was chosen on the basis of three alternative locations for the intake/discharge facilities in addition to one control transect. These locations of the intake/discharge facilities on the river were considered in relation to (1) the use of pipeline corridors between the plant and the river placed to have the least adverse impact on residential developments and wetland habitat in the area, and (2) competing uses of the navigational channel of the river to cause least apparent interference with river traffic.

Transects B, C, and D coincide with the proposed intake/discharge facilities location alternatives. Transect A is designated a "control transect" and was not an alternative intake/discharge site. It was located upstream from Rice Creek. Two collection points were utilized along each transect, located nearshore and offshore to allow comparison of habitats for intake/discharge placement and to establish overall baseline conditions at each location.

The location of transects and individual collection points were selected to allow the collection of information pertinent to compliance with Section 316(b), PL 92-500 through directing the engineering decisions required for the siting and operation of discharge and to optimize intake type and configuration to minimize entrainment and impingement of fish, fish eggs, larvae, and other biota.

Transect A

Transect A was the control transect. During the September 1977 collection period, this transect was located approximately 610 meters upstream of the confluence of Rice Creek and the St. Johns River (Figure 9.3-2).

Station 1 was located approximately 150 - 175 meters offshore. Bottom composition was primarily detritus and organic matter. Water depth was approximately 2.0 - 2.5 meters.

Station 2 was located approximately 20 meters offshore. Bottom composition was primarily detritus, organic matter, and a few wood chips or fillings. Water depth was approximately 1.0 - 1.5 meters.

During the January 1978 collection period, and for all subsequent collections Transect A was relocated approximately 1525 meters downstream of Hog Eye Point and approximately 25 meters downstream of the overhead transmission line crossing the St. Johns River. The transect was relocated so that it would not be influenced by the spoil area that was approximately 275 meters from the west bank of the river and 100 meters upstream of the confluence of Rice Creek and the St. Johns River. Spoil area dimensions were approximately 640 x 110 meters (Figure 4.4-2).

Station 1 at the new location, was approximately 150 meters offshore. Bottom composition was primarily silt and detritus. Water depth was approximately 2 meters.

Station 2 at the new location was approximately 15 - 20 meters offshore. Bottom composition was primarily silt and detritus. Depth was approximately 1.0 - 1.5 meters.

Transect B

Transect B was located approximately 2000 meters downstream of Rice Creek in Section 18, Township 9S 26E. This corresponded to pipeline Corridor A.

Station 1 was located approximately 150 meters offshore. The bottom conditions consisted primarily of detritus and organic matter. Water depth was approximately 2.0 - 2.5 meters.

Station 2 was located approximately 20 meters offshore. Bottom composition was primarily detritus, organic matter, and some wood chips. During September 1977, bottom substrate smelled of hydrogen sulfide; this odor was also noted during the benthic macroinvertebrate sampling. Water depth was approximately 1.0 - 1.5 meters.

Transect C

Transect C was located immediately north of Verdiere Point. This corresponded to pipeline Corridor B.

Station 1 was located approximately 100 - 125 meters offshore. Bottom composition was predominately sand and some detritus. Water depth was approximately 3.0 - 3.5 meters.

Station 2 was located approximately 50 meters offshore. Bottom composition was primarily organic matter with some sand. Water depth was approximately 1.0 - 1.5 meters. The adjacent shoreline was a sandy beach.

Transect D

Transect D was located at Bodine Point. This corresponded to pipeline Corridor C.

Station 1 was located about 125 meters offshore. Bottom composition was primarily sand and some detritus. Water depth was about 3.0 - 3.5 meters.

Station 2 was located 50 meters offshore. Bottom composition was silt, detritus, and some sand. Water depth was approximately 2.0 meters.

2.7.2.2 Aquatic Flora

2.7.2.2.1 Phytoplankton

Phytoplankton consist of small, photoautotrophic algae of open waters, having limited powers of locomotion and, therefore, more or less dependent upon water currents for their distribution. Their occurrence in a stream or river is often a result of breaking loose from algal communities attached to a substratum or entering a steam from the outflow of a lake, although slow moving rivers may support an actively growing community. They usually have relatively short life spans measured in days (Wetzel, 1975; Odum, 1971).

Temporal and spatial distribution of these organisms is dependent on several environmental factors. In addition to the basic roles of light and temperature, they require a means of remaining in the euphotic zone for sufficient lengths of time to permit photosynthetic activity to promote growth and reproduction. A number of nutrients are also required, particularly compounds of inorganic nitrogen and phosphorous and often members of the major classes of organic molecules including certain vitamins. Biological limitations may also be imposed on the growth of phytoplankton populations. For example, growth inhibiting secretions may be produced by some species or selective predation or grazing may reduce one or more populations from the community.

The community of phytoplankters provides the major mechanism for energy transfer from sunlight to non-photosynthetic members of the aquatic ecosystem. The position of these algae, therefore, is at the base of the food web. Phytoplankton are consumed by zooplankton and other primary consumers which in turn provide food for large animals. Thus, phytoplankton abundance, in part, determines the quality and quantity of larger organisms which depend upon them for food. Within the physical and biological limitations of the environment these autotrophs may provide the highest gross productivity in the community. Although seasonal fluctuations in density and diversity of algal communities often appear, the number of species generally remains constant from year to year excepting the occurrence of outside perturbations (Wetzel, 1975).

Visible, sometimes extensive, accumulations of algae at or near the surface are designated as "blooms." The changes in water quality that induce excessive growths of certain species of algae are often the result of organic or inorganic pollutants added to the ecosystem (Wetzel, 1975). Many algal species die from the addition of these pollutants but some algae are tolerant of these changes and, lacking competition from less tolerant forms, rapidly grow and reproduce. Algae that show this response to pollutants are known as indicators of these conditions. If these algae occur in sufficient numbers, their respiratory activity, or that of bacteria involved in their decomposition, may reduce the oxygen in the water to levels low enough to produce large fish kills (Palmer, 1968; Zawnecki, 1968).

Those phytoplankton most commonly occurring as tolerant organisms and considered characteristic of eutrophic conditions are representatives of the Cyanophyta or blue-green algae (Palmer, 1968). The blue-greens most commonly identified as typical of eutrophic conditions are Anabaena, Anacystis, Aphanizomenon, and Oscillatoria (Cole, 1975; McNaughton and Wolf, 1973; Colinvaux, 1973; Kormondy, 1976). In addition to forming large, mucous secreting mats, some of the blue-greens release toxins into the water (Odum,1971; Zawnecki, 1968; Cole, 1975) and very few are of significant nutritional value (Cole, 1975). Being selectively avoided by grazing herbivores, such as the zooplankton, may also account for their ability to reach very high densities. The blue-greens are also very responsive to thermal effects in aquatic ecosystems, readily out-producing other algal groups (Colinvaux, 1973).

Algae, other than blue-greens, that form significant populations in the phytoplankton are the Chlorophyta, or green algae; the Chrysophyta, or golden-brown algae; the Bacillariophyta, or diatoms; and several flagellates, mostly unicellular forms, such as the euglenoids, dinoflagellates, and cryptomonads. The most important members of the phytoplankton are usually the diatoms, although many diatoms are sessile and appear as plankton only when broken loose from the periphyton. All diatoms have siliceous cell walls and many form colonies or filaments. The euglenoids are not always planktonic but do occur in very great numbers under proper conditions, particularly in shallow water with high ammonia and/or organic materials in solution (Wetzel, 1975). Many of the dinoflagellates have very specific requirements with narrow tolerances for calcium, pH, dissolved organic nutrients, and temperature.

The phytoplankton of the St. Johns River have been sampled extensively since the 1960's (FG&FWFC, 1970; Applied Biology, Inc., 1976). Other studies conducted by the FG&FWFC (1977) included phytoplankton surveys near Rice Creek; and a recent study by Applied Biology, Inc. (1976) included stations near Palatka, upstream from Rice Creek. These studies have documented a decrease in species diversity along the river, particularly around the outflow of major lakes. It is commonly recognized that high rigor or stress in an ecosystem is accompanied by low community diversity, that is, dominance by few species (Odum, 1971). In developed areas this reduced diversity is often indicative of excessive pollution (Wilhm and Doris, 1968). In the St. Johns River studies, low diversity was commonly associated with high numbers of organisms with tolerance to organic pollution, particularly populations of euglenoids and blue-green algae. Some seasonal variation was observed, with low population densities and dominance by diatoms or blue-greens, especially Anacystis, in the winter; euglenoids, lesser populations of diatoms, and green algae in the spring; and high populations dominated by blue-greens in the summer and fall (FG&FWGC, 1970; 1977; Applied Biology, 1976). The dominance of blue-green algae in this riverine/lake/estuarine system may indicate a trend towards eutrophication resulting from increased organic pollutants, such as detritus, sewage wastewater, and runoff from agricultural areas. Also, greater light availability, due to removal of water hyacinths and higher temperatures, promoting growth of thermophilic algae may contribute to this trend.

Surveys conducted by Dames & Moore in September 1977 and January 1978 documented species composition, density, diversity, and spatial distribution of the phytoplankton community.

The phytoplankton collections of the lower St. Johns River, based on previous studies (FG&FWFC, 1970) and the current investigations were represented by 193 species (Appendix B, Table B-1), including 55 diatom species, 39 species of blue-green algae, and 99 species of other algae (green, gold, and miscellaneous other groups). The findings of the present report were consistent with the other studies in this region of the St. Johns River.

Table B-2 illustrates the number of taxa identified at each station and Table B-3 compares the numbers of taxa found at offshore and nearshore sampling sites. Although no substantive differences seem apparent between offshore and nearshore stations, there is an obvious decrease in the number of taxa present in September from those found in January, especially at Transect D where the mean number of taxa decreased from 81.5 in January to 26 in September (Table B-2). Generally, the change in number of taxa seems to occur less among the blue-green than among other algae.

All algal groups were represented by higher populations at the various transects in September (mean of 25.2 x 10^6 cells/liter) than in January (mean of 9.2 x 10^6 cells/liter) with blue-green algae dominating all sampling stations during both seasons sampled (Tables B-4, B-5, B-7 through B-12). Diatoms were next highest in density although their concentration was always less than half that of the blue-greens. The greatest seasonal changes were noted at Transect B, with an increase in blue-greens from 3.1 x 10^6 to 19.5 x 10^6 cells per liter, and Transect

A where the blue-greens increased from 6.8 x 10^6 to 19.1 x 10^6 cells per liter between the January and September samplings. Overall, the blue-greens comprised 62 percent of the January collection and 64 percent of the phytoplankton obtained in September, while diatoms made up only 23 percent and 20 percent in January and September, respectively. The green, gold, and other algae comprised only about 15 percent of the phytoplankton during both surveys. Table B-5 compares the offshore and nearshore collecting sites for all transects for both seasons surveyed. The algal densities at offshore sampling stations were generally similar to those collected at onshore stations for January. However, onshore stations demonstrated consistently higher densities than offshore sites during the September sampling period, a time when overall population densities were at their highest. These differences in September were most obvious at Transect A where 83 percent of the blue-green algae and 84 percent of the diatoms were obtained from the nearshore sample. The other phytoplankton exhibited no apparent pattern of difference between offshore and onshore samplings (Table B-5).

An organism comprising 15 percent or more of the total cells of a major group (i.e., blue-greens, diatoms, or other algae) was considered a dominant species. Those species of algae indentifed for this investigation that met this criterion of dominance are noted in Table B-6.

The dominant blue-green algae at all transects in January were *Oscillatoria acutissima* (49-57 percent of all blue-greens) and *Spirulina laxissima* (16-19 percent of all blue-greens). In September, however, this species of *Oscillatoria* (*O. acutissima*) was replaced by two others; an unidentified species (16 percent of blue-greens at Transect A and 52 percent of the blue-greens at Transect D) and *O. limmetica* (29 percent at Transect C). It is of importance to note that *Oscillatoria* is listed by Palmer as the second most pollution tolerant genus of algae (Palmer, 1969). Additionally, *Anacystis*, another blue-green of importance because of its association with fish kills, was found to be dominant at Transect C in September.

The diatoms with dominant populations in January were an unidentified species of Navicula (20-27 percent) and Nitzschia gracilis (23-41 percent) found at all transects. An unidentified species of Nitzschia was also reported as a dominant from all transects except Transect B (Table B-6). Shifts in dominance among the diatoms were evident in September when two species of centric diatoms, Cyclotella meneghiniana and Melosira italica, were dominant species, along with unidentified species of Nitzschia and Cocconeis. Melosira is a filamentous diatom and its prevalence in a population, like that of many filamentous blue-greens, may be a result of being selectively avoided by herbivorous zooplankton which find filaments difficult to ingest (Wetzel, 1975). Representatives of Nitzschia, Navicula, and Cyclotella are listed among the top 15 most pollution tolerant algae (Palmer, 1969).

Of the other algae identified in this survey, the dominant species in January was Selenestrum minutum recognized as dominant at all transects except B, although it composed 14 percent of the population at this transect. In September, S. minutum was replaced as dominant by four other algal species (Table B-6) including Senedesmus quadricauda and Ankistrodesmus falcatus, representative of genera listed by Palmer as among the top 10 of pollution tolerant algae (Palmer, 1969).

The species diversity indices obtained in this study (Table B-13) are consistent with similar values obtained in this same region of the St. Johns River (Demort, 1978).

Summary

The eutrophic state of the St. Johns River observed in earlier surveys (FG&FWFC, 1970; Applied Biology, 1976) is supported by present findings of this report. Pollution-tolerant, blue-green algae were dominant at every transect during both sampling periods, a generally recognized characteristic of eutrophic conditions. Further, the low nutritional value of these blue-green algae, as well as their association with production of fish toxins and anoxic conditions contribute to the degradation of the river.

2.7.2.2.2 Aquatic Macrophytes

The term macrophyte applies to rooted and floating vascular plants that can be easily seen with the unaided eye. This will be considered synonymous with "higher plants" as defined by Hynes (1970). Hynes divides higher plants into three ecological categories:

1. plants attached to solid objects,
2. those with roots penetrating the substratum, and
3. the free-floating plants.

Aquatic macrophytes perform several important functions in aquatic ecosystems. First, they are primary producers in that they contribute to the supply of oxygen in the water by withdrawing carbon dioxide during photosynthesis and giving off oxygen. Secondly, by competing with phytoplankton for available nutrients, they may be potentially important in the control of algal blooms (Fitzgerald, 1969). In addition, they provide habitat, cover, and food for many species of animals including amphipods, crayfish, and larvae of many species of aquatic invertebrates, and several species of fish.

The flushing of floating plants and plant nutrients, characteristic of fast-moving streams, is absent in the St. Johns River and other Florida Streams. Hence, these streams are often eutrophic (rich in nutrients) resulting in an overabundance of aquatic weeds, particularly water hyacinth (Eichornia crassipes), hydrilla (Hydrilla verticillata), eurasian watermilfoil (Myriophyllum spicatum), and alligator weed (Alternanthera philoxeroidae) (U. S. Corps of Engineers [COE], 1973). These four aquatic plant species are included on the list of species reported in the St. Johns River Basin (Table B-14).

Factors other than nutrient availability also influence the presence or absence of aquatic macrophytes in a lotic ecosystem. Haslam (1971) pointed out that the absence of aquatic plants was usually due to a combination of factors, such as unsuitable substrate, high water velocity, or toxic substances in the water. One of the most limiting factors for submerged plants in the St. Johns River may be light penetration. Westlake (1966) indicated that water depth and turbidity were very important factors in reducing light penetration. He found that in large turbid rivers only one percent of surface irradience reached 1 meter water depth. Therefore, the relatively low Secchi Disc transparency value (0.35 - 0.66 M) found at each transect in the present study may be a major factor limiting the growth of submerged aquatic vegetation. Other physical, chemical, and biotic factors also influence the presence and abundance of vegetation on the St. Johns River. Additionally, the COE has an aquatic weed control program that includes most of this length of the St. Johns River (COE, 1977). Nevertheless, the abundance of aquatic vegetation recorded in other areas of the St. Johns River (COE, 1973) suggests that much of this river is suitable for vigorous vegetation propagation.

Previous investigations of aquatic macrophytes on the St. Johns River include the waterway control studies for the State of Florida (COE, 1973, 1977) and studies of the FG&FWFC (1976). Representative organisms identified in these studies are listed in Table B-14.

The results of present studies showed that aquatic macrophytes were only found in Transects C & D (Figure 9.3-2).* The species common to both of those transects included water celery (Vallisneria americana), common water nymph (Najas guadalupensis), and stonewort (Chara sp.) (Table B-15). At Transect D, spatterdock (Nuphar luteum) and filamentous algae were present. The vegetation was generally scarce throughout the transect and none was found at depths greater than 1 meter. These macrophytes are described as follows:

> Vallisneria americana (water celery) - This aquatic submerged plant occurs frequently in lakes and beds of flowing streams. Its range extends throughout the eastern half of the United States from north Dakota and Texas. It is ecologically important in that it provides an excellent food source for wildfowl, which eat all parts, especially winter buds and rootstocks. It attracts marsh birds, wildfowl, and shorebirds. It supports insects, harbors minute animals, provides shade and shelter, and is a valuable food for fish (Fasset, 1957).

Note: See page B-2, Appendix B.

Najas guadalupensis (common water nymph) - This submerged aquatic plant occurs abundantly in ponds, lakes, and quiet waters chiefly in the outer Coastal Plain. *N. guadalupensis* is often used by wildfowl as a source of food (Correll and Correll, 1972).

Chara sp. (muckgrass, stonewort) - This alga always occurs in hard water. This is consistent with water quality data (See Section 2.3.1) which indicate a total hardness of 196 mg/liter. This species provides habitat for minute aquatic animals which in turn provide an often important food source for wildfowl (Fasset, 1957).

Nuphar luteum (Spatterdock) - This aquatic perennial, closely related to the water lily, is commonly found in water or in mud of shallow lakes, streams, or ponds. Vegetative propagation of this aquatic plant often becomes so extensive that other plant species are crowded out. It is a source of food for animals, the stems and leaves being eaten by deer and the seeds by wildfowl. The lower surface of the leaves provide a habitat for numerous aquatic invertebrates (Fasset, 1957).

2.7.2.3 Aquatic Fauna

2.7.2.3.1 Zooplankton

The zooplankton are the assemblage of small animals of open waters that are incapable of moving against a current and, therefore, depend in large part upon water flow for their distribution. They are generally secondary (or higher) consumers in the community deriving their nutrition either as predators, feeding on other zooplankton; herbivores, feeding on organic breakdown products of plants and animals; or omnivores, feeding on more than one energy source (Wetzel, 1975).

Most zooplankton are filter feeders, removing particulate matter from the water. The feeding effectiveness of herbivorous zooplankton is dependent upon algal density. At low densities insufficient food is caught and at high densities the algae may clog the filter apparatus and inhibit ingestion rates. Some species of algae may release toxins that inactivate the feeding apparatus of the zooplankton (Wetzel, 1975). Direct cropping of the phytoplankton by the zooplankton as well as selective grazing may influence the fluctuations of phytoplankton populations (Winner, 1975). Additionally, much of algal productivity enters the detrital pathway and so transfer of food is "short circuited" through bacteria and particulate detrital organic matter which can then be utilized by filter feeders. All zooplankton populations in turn regulate and are regulated by populations of planktivorous fish and other aquatic animals. Zooplankton are the crucial link in the food web between the phytoplankton and most other consumers, such as young fish and shellfish. The common freshwater macrozooplankton that occur are Rotifera and two subgroups of Crustacea, the Cladocera and the Copepoda.

The most significant fluvial zooplankton are usually the Rotifera (rotifers), which include both omnivorous and sessile forms. The size of the majority of food consumed by rotifers is small (under 12 mm in diameter) and so large algae or other plankton may not be eaten or be of reduced value. Factors affecting seasonal fluctuations in rotifers, include both food availability and temperature with highest populations occurring during mid or late summer. It has been generally accepted that the presence of several closely related species within one genus or the occurrence of several dominant genera may be indicative of an eutrophic system (Winner, 1975).

The Cladocera (commonly known as "water-fleas") are almost all filter feeders and feed upon particles as small as bacteria. The Copepoda (copepods) are variable in their feeding. Some are selectively predatory, but most others are true filter feeders. Although most copepods are littoral benthic species, the few that are planktonic may form a major part of the zooplankton community of a lotic ecosystem with their main diet being phytoplankton (Barnes, 1974).

Both cladocera and, to a leser extent, copepods, have an ability to select food, with many small algae being ingested and gelatinous green algae or large unpalatable species being rejected. Where these algae dominate, the filtering rates of these zooplankton are usually reduced; and if blue-green algae dominate the phytoplankton, the rates of ingestion, assimilation, survivorship, and reproduction of cladocera are known to decrease (Wetzel, 1975).

Zooplankton in the lower St. Johns River have been surveyed near Palatka by Applied Biology, (1976) and near Rice Creek by the FG&FWFC (1977). The Applied Biology 1975 survey was conducted during February, May, August, and November, 1975 and recorded a cyclic fluctuation in zooplankton with a dominance of rotifers in August (206 per liter), cladocera in May (216 per liter) and copepods and copepod larvae in February (44 adults and 314 nauplii per liter). The lowest zooplankton density was in November (Table B-17).

The 1976-1977 investigation of the FG & FWFC identified 10 species of zooplankton at the Rice Creek station during June 1977, which was the highest number among all samples collected. Additionally, this station produced the highest frequency of occurrence of rotifers and the lowest frequency of cladocera. The dominant zooplankton at the Rice Creek station were cladocera, making up 71 percent of the zooplankton collected (Table B-17), whereas copepods were dominant at all other upstream stations. Although the stations near Rice Creek and Green Cove Springs, downstream from Rice Creek, produced 11 to 12 percent of the total zooplankton collected along the St. Johns River, the population densities were higher at the upstream collections.

Surveys conducted by Dames & Moore in September 1977 and January 1978 provided site specific information on the composition of the zooplankton community near Rice Creek. The analysis of these collections emphasized the distribution, density, and diversity of planktonic animals among stations and among transects.

Collections made by Dames & Moore at the four transects near Rice Creek produced 30 species of zooplankton (Table B-16), more than twice that found by the FG & FWFC for June of 1977.

As a whole, January and September collections produced almost the same mean number of taxa per station and per transect. Differences were noted, however, between these sampling periods for a specific station or transect (Tables B-18 through B-20). No pattern was apparent for these differences. Diversity indices showed little difference among stations for each sampling period but measurable difference between periods; the mean index for January was 1.74 while that for September was 2.57. A low diversity index usually denotes a stressed system. This stressed, probably eutrophic, state was further substantiated by the finds, especially during September, of: (1) several dominant genera (Brachionus, Keratella, and Trichocerca) as well as, (2) the presence of several species of the same genus (Brachionus), either condition considered to be indicative of a eutrophic ecosystem (Wetzel, 1975; Winner, 1975).

A substantive difference was noted in the number of organisms sampled during the two seasons investigated. January sampling produced a mean of 570 organisms/liter while September sampling showed an average of 2087 zooplankters per liter. The general variation in zooplankton densities between offshore and onshore sampling stations is illustrated in Tables B-21 and B-22. Although little difference in population densities during January was observed between offshore and nearshore stations (Table B-21), the offshore samples in September produced almost 2500 organisms per liter more than nearshore collections. When compared by transect (Table B-22), the offshore samples were higher at Transect B in January and lower at Transect C than the onshore stations, but all transects had higher offshore densities during September. There was little nearshore vegetation and this was located only at Transects C and D (see Section 2.7.2.2.1), resulting in little protection or suitable substrate for zooplankton.

There were several zooplankton taxa identified in this study with interdependent roles in the aquatic ecosystem. The dominant rotifer in the January sample was a species of Asplanchna. This organism is a first level carnivore that preys especially on rotifers of the genus Brachionus (Wetzel, 1975). The population dynamics of these two genera, therefore, are probably mediated by a predator-prey interaction. Ths may account, in part, for the low populations of Brachionus spp. when Asplanchna was present in January (Table B-19) and the high populations of Brachionus when Asplanchna was absent in September (Table B-18). Keratella was another rotifer that dominated the zooplankton in September. Keratella sp., along with the rotifer Filinia, are warm water organisms with reproductive rates closely related to temperature (Wetzel, 1975; Winner, 1975). Thus, the warmer waters of the September sampling period (29.1°C mean) correlate with high densities for these two organisms, in contrast to the reduced population of Keratella and the absence of Filinia during the cooler January collections (8.6°C mean).

Seasonal fluctuations of zooplankton densities suggested a positive correlation with densities of the phytoplankton. Population increases of Polyarthra, for example, are reported to show a positive correlation with population increases of the euglenoid, Cryptomonas. In the current study, the highest concentrations of Polyarthra were found in September at Station 1, Transects A, C, and D (Table B-18), the same sampling sites where Cryptomonas was obtained (Table B-11).

Summary

In summary, characteristics of high densities of rotifers in the zooplankton were reported in earlier studies along the lower portion of the St. Johns River. These reports were substantiated by data collected by Dames and Moore. The identification of 6 rotifer genera in this survey from 9 rotifer genera proposed as indicative of eutrophic conditions (Winner, 1975) suggests an aquatic system under considerable environmental stress.

Effects of season on zooplankton distribution were apparently more important than effects due to variation in station location or proximity to shore. Fall zooplankton increases, however, were greater in offshore populations. This implied possible influences nearshore from increased planktivore activity, increased blue-green algae populations, or absence of suitable substrates.

The site specific information developed in this study illustrated the influence of season and location on the zooplankton community. Thus, the total number of organisms collected was highest in September, at Station 1, Transect D while the lowest number were obtained in January at Station 2, Transect A. The greatest number of taxa were found at Station 2, Transect D (15) in January while the lowest number (8) were at Station 2, Transect B in January and C in September.

The highest indices of diversity and equitability were at Station 2, Transect A in September. The lowest values for these two indices were at Station 2, Transect B in January.

2.7.2.3.2 Benthic Macroinvertebrates

Benthic macroinvertebrates are bottom dwelling organisms which live all or part of their life cycles in and upon various underwater substrates. These organisms are large enough to be retained by a U. S. Standard Number 30 seive and may be recognized by the unaided eye (EPA, 1973).

Benthic macroinvertebrates are important in the aquatic ecosystem because of the very diverse nature of their trophic relationships. Macroinvertebrates occupy virtually all levels of the trophic web. They include carnivores, herbivores, and omnivores as well as deposit and detritus feeders, scavengers, parasites, grazers, and predators.

Macroinvertebrates play an important role in the recycling of nutrients in the aquatic system and in supplying a food source for other organisms in the food web. Macroinvertebrates represent an important food source for fish and often included among these invertebrates are both commercial and recreational species (EPA, 1973).

The makeup of the macroinvertebrate community varies in response to both the biotic and abiotic factors of its enviroment. Variations in this community occur both spatially and temporally. Factors such as water temperature, velocity, substrate type, presence of chemical substances, presence of other biota (especially habitat forming macrophyte plants), and water quality all affect macroinvertebrate distribution. Examination of the macroinvertebrate community requires analysis of species presence, density, and community structure. Species presence is simply the examination of a community to determine if a species is present or absent. The presence of a species may be controlled by any of the factors mentioned above or, in addition, by tolerance to chemical conditions, competitive interactions with other organisms, or simply by the lack of opportunity to invade a particular habitat.

The density or abundance of a particular species is indicative of the relative fitness of an organism for a particular environment and a measure of its success in utilizing community resources.

In addition to the examination of individual species populations, the structure of an aquatic community, in this case the benthic macroinvertebrates, may also be examined. The community is important since it represents a metabolically interrelated level of organization (Odum, 1971). The community level of an ecosystem has both diversity and structure which may be examined in part through the use of diversity indices. These indices take into account two prime components of community structure: richness of species and the distribution of individuals among species.

The literature (EPA, 1973) has generally associated high diversities with unpolluted, unstressed communities. Low diversities have been associated with stressed or polluted communities.

Macroinvertebrates in the St. Johns River have been studied FG&FWFC (1976) which also reviewed earlier work by the USGS. In the vicinity of the plant site, other studies were by Applied Biology (1978) made for FP&L near Palatka, upstream of the proposed site; and by the Florida Department of Environmental Regulation (DER, 1974) near the confluence of Rice Creek with the St. Johns River. Many of the species of macroinvertebrates collected during these studies were also sampled by Dames & Moore (Table B-23). Since it is well documented that the presence and abundance of macroinvertebrates reflects their sensitivity to edaphic factors, especially the substrate type (Scott, 1958) and presence of aquatic vegetation (Pettee and Gifford, 1964; FG&FWFC, 1976) these factors were to be addressed in site-specific sampling of the Putnam Site.

Forty-three taxa of macroinvertebrates were collected during September 1977 and January 1978, representing 21 insect taxa and 22 non-insect taxa. During both of the collecting periods, the major taxa collected were dipterans, crustaceans, and oligochaetes. Of these, the dipterans (the chironomids, in particular) were dominant (Tables B-25 and B-26). Data collected by personnel from DER (1974) in the vicinity of Rice Creek and the confluence of the St. Johns River also indicated that chironomids were the dominant benthic forms.

As pointed out in an earlier study (Applied Biology, 1976),many of the benthic macroinvertebrates in the St. Johns River are estuarine species and these include a number of those species found at the site, among them _Corphium_ sp., _Cyanthura polita_, and _Mysidopsis bigelow_.

Only one aquatic organism, _Procladius_ sp., occurred at all stations and transects (January 1978). The next most widely distributed macroinvertebrates a Bythiniid snail and _Limnodrius_ spp., occurred at 7 of the 8 stations and at all transects (September 1977). _Gammarus_ sp., _Limnodrilus hoffmeisteri_, and immature tubificid worms (no hair setae) were well distributed at 6 of the 8 stations (January 1978). Organisms showing limited distribution, occurring at 4 to 5 stations, were _Hyalella azteca_, _Cyanthura polita_, _Coelotanypus condinnus_, a Bythiniid snail and _Limnodrilus_ spp. during January 1978.

As classified for tolerance to organic wastes (EPA, 1973), these major taxa were all either tolerant or facultative in response to decomposable organic wastes. The presence and wide distribution of pollution tolerant macroinvertebrates at the site generally agrees with results of other studies.

The spatial distribution of taxa were also investigated. The greatest abundance of taxa was found along the control transect (Transect A, both Stations 1 and 2 combined). Fewest taxa were found at Transect B (Corridor A) in September 1977 and Transect D (Corridor C) during January 1978 (Tables B-25 and B-26). More taxa were collected at inshore than at offshore stations. Also, there were greater numbers of organisms collected nearshore than offshore (Tables B-25 and B-26). The difference between nearshore and offshore locations was statistically significant during the September study but not during the January survey. The higher numbers of taxa and organisms found inshore may be related to the shallowness of that area; greater penetration of light; less water movement nearshore, and at some locations, the presence of macrophytes providing a more suitable habitat.

Seasonal trends in the numbers of benthic macroinvertebrates were observed during the January survey period, there was a total of 37 species collected, compared to 28 species during the September period. This may be due, in part, to the typically cyclical emergence patterns most benthic macroinvertebrates. Seasonal changes in the benthos are also shown by data collected near the FP&L Plant upstream of the study area. In constrast to the overall stability of oligochaetes and crustacean populations annually, insect species were least abundant during warmer months, but increased during the colder months (FP&L, 1975).

Numbers of macroinvertebrtes varied with each transect as well as seasonally. Statistical examination of total numbers of macroinvertebrates at each transect showed no significant differences. Due to the highly variable and seasonal nature of many of the macroinvertebrates, and the large numbers of replicates required for precision, detailed analysis of each individual taxon was not justified. Macroinvertebrates were also collected at the site incidentally with gear primarily used in the collection of nekton, particularly fish (Table B-24). Collections consisted of grass shrimp, blue crab, and one unidentified species of crab. The overall distribution of blue crab was fairly uniform but not the distribution of grass shrimp. The greatest numbers of grass shrimp were found at Transects C and D (Corridors B and C), where 116 and 189 total individuals were collected, respectively. Only one grass shrimp was collected at Corridor A (Transect B) and none at the control (Transect A).

Two indices of community structure, species diversity, and equitability (Tables B-25 and B-26), were used describe combined components of species richness and define community patterns within the study area.

Values for species diversity ($\bar{d}$) fell between those values reported for unpolluted waters and those reported for pollution stressed waters (EPA, 1973). During the September sampling, values were higher nearshore than offshore. In January, the distinction was much less clear with each transect displaying differences. Since water quality conditions were not severe, and a fairly large number of taxa tolerant to moderate and high levels of pollution were found, it was not unexpected that diversities might be high.

Equitability (e) was also fairly high, generally greater than expected under conditions of moderate pollution (EPA, 1973). This may be more related to the lack of overwhelming dominance by any particular species than any other factor. Both species diversity and equitability were within values found at the Palatka Plant (Applied Biology, 1976).

In summary, the macroinvertebrate community in the St. Johns River at the site area is similar to communities in other sections of the river in terms of species present, levels of abundance, species diversity, and equitability. Organisms were identified as tolerant to moderate or high levels of pollutants. No statistically significant differences were found among any of the potential intake/discharge transects with the exception of grass shrimp distribution. Grass shrimp were far lower in abundance at Corridor A. No unique species, habitats, or associations were noted among the macroinvertebrates.

2.7.2.3.3 Fish and Ichthyoplankton

Introduction

Fish are among the most important organisms in the aquatic ecosystem, both to man and to the aquatic system itself. Fish species occupy a wide variety of trophic levels as consumers and predators as well as detrital feeders and herbivores. Fish also have the longest reproductive cycle of any of the major aquatic organisms and are also generally the most fragile.

The St. Johns River system supports an important fishery resource, well documented by many authors including the FG&FWFC (1970 and 1976), McLane (1955), Moody (1961 and 1963) and Tagatz (1968). This review is intended to summarize existing data for the river system and correlate it with recent field surveys conducted in the vicinity of the Putnam Site.

The distribution of fish species along coastal rivers is largely determined by salinity. Because of the unusual pattern of salinity in the St. Johns River, both marine and freshwater species occur for more than 103 miles upstream. Tributary creeks and coves along the lower 25 miles provide areas of intermediate salinity where fish can undergo gradual transition from salt to fresh water (Tagatz, 1968). The range of marine species is further extended upriver by mineral springs that increase dissolved solids along the river from Palatka to Lake George (Beck, 1965).

McLane (1955) characterized the fish species of the St. Johns River by salt tolerance and used the following categories:

1. Primary Freshwater Species - those species that spend their entire life history in freshwater. The most important family in this category is the sunfish. Shad and gar are also included, but they are also found in brackish water.

2. Marine Invaders - forms that enter both fresh and saltwater during part of their life history.

   a. Anadromous - marine forms that return to freshwater to spawn. The most important group is the shad (American shad, hickory shad).

   b. Catadromous - those fish that live generally in freshwater but migrate to coasts or open sea to spawn. The American eel is the most notable species in this group, while striped mullet could be placed between catadromous and the following amphidromous category.

c. Amphidromous - species that migrate but not for breeding purposes. Species included in this category are ladyfish, bay anchovy, and sturgeons.

d. Non-migrating - euryhaline species. Striped bass and stingrays are included in this category.

The St. Johns River system supports a diverse fish fauna of at least 174 species (Table B-27); 57 freshwater and 117 marine invaders. The sport and commercial fisheries of the system were valued at $20 million in 1970 (FG&FWFC, 1970). Recently (1973-1976) the commercial fishery alone, in the vicinity of Palatka (Putnam County), was conservatively estimated to have an annual value of more than $1.2 million from the landing of 1 to 2 million pounds of fish (FG&FWFC, 1977).

A 1970 (FG&FWFC) study, however, indicates that game and food fish production in the river could be much greater, citing a period of 20 years of declining landings. The depressed game and food fish resources of the river system are characterized by FG&FWFC (1970) data which show the percentage decline by weight for landings of the following fish: largemouth bass, 40; black crappie, 46; bluegill, 68; redear sunfish (shellcracker) 42; redbreast sunfish, 98; channel catfish, 48; and white catfish, 27 percent. However, the FG&FWFC (1970) data also show that total fishery productivity increased by a factor of more than two. The increase was attributed primarily to non-game fish which had the following percent weight increase in landings: longnose gar, 2640; gizzard shad, 477; Florida gar, 100; and various estuarine and marine fish, 109.

The commercial fishery of the river is dominated by catfish (White and Channel catfish) landings; however, the American eel, white mullet, striped mullet, red drum, and American shad are also important components of the landings. In 1974, nearly 90 percent of the commercial American shad and 98 percent of the American eel landings in Florida were from the St. Johns River. Blue crabs are also an important commercial fishery resource in the St. Johns River and are sought as far upstream as Lake George.

The causes of changes in the fish community structure of the St. Johns River are complex. Major factors which may contribute to these changes include municipal and industrial waste, watershed development and decay of water hyacinths, which contribute to eutrophic conditions. Other factors include run-off of pesticides, dredging, waterfront development, and restricted commercial fisheries operations.

Some of the more important game and/or sport fish include American shad and white and channel catfish, which are also major commercial species. Other important sport fish include largemouth bass, black crappie, striped bass, bluegill, redear sunfish, and several other species of sunfish (bream).

Recent field surveys revealed 59 species of fish from the St. Johns River in the vicinity of Palatka (Table B-28). During September 1977 and January 1978, two field surveys were conducted to gather site specific fisheries data. During these surveys, 37 species of fish were collected (Table B-28), 33 in September and 23 in January (many were common to both collections). Nearly half of the fish species collected may be classified as marine invaders. A total of 181 pounds and 142 pounds of fish (including shrimp and blue crabs), respectively were collected during the two surveys.

Game and food fish (including freshwater catfish, bass, crappie, bream, American shad, mullet, and flounder) accounted for 18 percent by number and 42 percent by weight of fish collected during the survey (Tables B-29 through B-36). By weight, the game and food fish were most abundant at downstream Transects C and D where they made up 45 and 56 percent of the catch, respectively. The abundance of game and food fish at Transects C and D may be due in part to the abundance of submerged aquatic vegetation. Transects near Rice Creek had a somewhat reduced game and food fish population of 32 and 37 percent by weight at Transect A and B, respectively. The reduced game and food fish at these transects may be due in part to the poor water quality (including high nitrogen, specific-conductance and low D.O.) of Rice Creek (Section 2.3.1.4) and lack of submerged aquatic vegetation.

Blue crabs, bluegill, redear sunfish, largemouth bass, and striped mullet were collected at all transects. White catfish and black crappie were common but not taken in collections at Transect D. Non-game fish such as the gizzard shad and Florida gar were also collected from all transects. Largemouth bass of more than 3 pounds were collected at all transects and an 8 pound specimen was collected at Transect C.

Larval fish net surveys were conducted in February, March, and April 1978 to identify spawning and/or nursery areas and to determine their relative spatial and seasonal variation in the vicinity of the site. A total of 11 species of fish was collected during the three month larval fish survey (Table B-37). Approximately 99 percent of the fish were collected at night. The large night catches may be due in part to diurnal activity patterns of the small fish and net avoidance behavior during the day. No night collection was made during february.

Densities of fish from larval net collections were generally higher nearshoze than offshore except for one case at Transect C and one at Transect D. Studies by Applied Biology Inc. (1976) indicated that larval fish densities in the St. Johns River near Palatka were very low from October through March; significantly higher in April and May and at their highest densities between June and September. During recent Dames & Moore studies, fish collected in larval net tows were least abundant at Transect B in March while the second smallest collection was made at the same transect in April (Table B-37). Similar trends were noted during the March seine surveys (Table B-38) at Transects A and B where the smallest collections were made. No statistically significant differences in abundance were found comparing total nearshore versus offshore collections.

The larval fish net collections were characterized by marine invaders with the exception of the gizzard shad (Table B-37). The bay anchovy was the most abundant fish collected, dominating at all stations except Station A-2 during the April survey. The blueback herring was the second most abundant fish in March and the Atlantic croaker, although not quite as abundant, was collected at most of the stations. The only valuable game and food fishes collected during the survey were the American eel, striped bass, and striped mullet which were never reported in large densities (Table B-37). Simiarly the March seine collections were dominated by non-game fish, primarily the blueback herring, bay anchovy and an unidentified shiner (Table B-38). The species composition of the fish during the survey was significantly different from that found in studies by Applied Biology Inc. (1976), upstream. The threadfin shad, gizzard shad, naked goby, and hogchoker (all non-game fish) comprised more than 82 percent of all the fish collected during their survey. This difference may be attributed to several factors including water quality, seasonal variation, and significant differences in habitat between the two survey areas.

In summary, the submerged beds of aquatic vegetation at Transects C and D seem to contribute the most desirable habitat of the transects sampled for food and game fish. The most abundant game and food fish collected during the survey included the catfish, bass, bream, and mullet; while the non-game fish were generally dominated by shad and gar. Data from the larval fish net survey indicated that the most suitable habitat and highest densities of fish were nearshore in the vicinity of Transects C and D. However, there were no indications of either significant spawning grounds or nursery areas at any transect. Few food and game fish were collected during the larval net survey. The species found did not include threatened or endangered species (USDI, 1973, 1977) and were fairly typical of the species found in the St. Johns River.

2.7.2.4 Endangered Species

2.7.2.4.1 Fish

The only fish species listed as endangered which has been reported from the St. Johns River system is the shortnose sturgeon (Tech. Adv. Comm. on Endangered Species, 1977). This fish is very rare and only two specimens have been reported since 1949; the most recent collections being south of Palatka in 1977 (McLane, 1955, FG&FWFC, 1977). The decline in abundance of this fish has been attributed to pollution, overfishing (U. S. Department of Interior, 1973) and loss of spawning habitat due to navigation and flood control projects. The life history of the fish is not well known, but, it is believed that they reach sexual maturity in about five years and spawns in late April (Whitworth and others, 1968). McLane (1955) reported that it was not likely that this fish breeds in the St. Johns River system. Typical spawning habitats of turbulent waters in deep pools and over hard rocky bottoms are not found in the St. Johns River near Palatka.

Two species of fish reported from the St. Johns River system have been given a "threatened status" by the State of Florida (Tech. Adv. Comm. on Endangered Species, 1977) and the Florida Committee on Rare and Endangered Plants and Animals (1975). The threatened fish are the Atlantic sturgeon and the Lake Eustis minnow. The Lake Eustis minnow is the only fish endemic to the St. Johns River system; however, it is not known on the main stem of the river. The Atlantic sturgeon is as rare as the shortnose sturgeon in the St. Johns River system. The most recent collection of this fish in the St. Johns River system was in 1949 during a shad seining operation in Crescent Lake, Flagler County (McLane, 1955). The reasons for the decline in abundance of this fish are similar to those for the shortnose sturgeon. Its life history is now well known, although it is believed to reach sexual maturity after 10-12 years and spawn in early spring (Whitworth and others, 1968). McLane (1955) reported that it was also unlikely that this fish breeds in the St. Johns River system. Typical spawning habitats of turbulent waters in deep pools and over hard rocky bottoms as, noted above, are not located in the St. Johns River near Palatka.

Several species of fish reported from the St. Johns River system have been designated as rare or "of special concern" by the Florida Committee on Rare and Endangered Plants and Animals (1975). The species designated as rare include the sea lamprey, shortnose sturgeon, eastern mudminnow, snail bullhead, opposum pipefish, mud sunfish, blackbanded sunfish, mountain mullet, and the river goby. The dusky shiner and bluenose shiner are designated as "species of special concern". The shortnose sturgeon is the only fish on this list which is also listed by Federal or State Agencies (Florida threatened and endangered species list, 1977; U. S. Department of Interior, 1977). All of these fish are considered to be rare in the St. Johns River system with the exception of the snail bullhead (Table B-27) and none of these fish have been reported recently from the St. Johns River near Palatka (Table B-28) nor have they been collected in sampling conducted at the site.

2.7.2.4.2 Aquatic Mammals

The West Indian (Florida) manatee (Trichechus manatus latirostris) is a large aquatic mammal that is currently listed as a threatened species by the state and an endangered species by the U. S. Fish and Wildlife Service. The manatee once ranged extensively throughout the southeastern coastal areas of the United States (Husar, 1974). The current population is around 1000 individuals, most of which are in Florida. Population decline was primarily due to overhunting by man for meat; more recently they have been totally protected, and poaching is a minor problem (Peterson, 1974). Current mortalities are due to collisions with boats and barges (Campbell, 1976).

U. S. Fish and Wildlife Service laboratory manatee records for 1974-75 show scattered manatee sightings from Rice Creek south to Palatka (Campbell, 1976). Concentrations of ten or more individuals were found at Palatka. The mammals feed on aquatic macrophytes which are generally scarce in the areas nearest the Putnam Site. Therefore, the manatee may be expected to travel in the St. Johns River near the Putnam Site but probably does not stay in this area for long periods of time due to a general lack of forage food.

2.7.2.5 References

Applied Biology Inc., 1976, Ecological parameter monitoring at the Palatka plant (St. Johns River), for Florida Power & Light Company.

Barnes, Robert D., 1974, Invertebrate zoology. W. B. Saunders Co., Philadelphia.

Beck, W. M., Jr., 1965, The streams of Florida. Bull. Florida State Mus., 10 (3): 91-120.

Correll, D. S., and Correll, H. B., 1972, Aquatic and wetland plants of the southwestern United States. Environmental Protection Agency, Government Printing Office, Washington.

Demort, Carole, 1978, Personal communication.

Fasset, Norman C., 1957, A manual of aquatic plants. The University of Wisconsin Press, Madison.

Fitzgerald, George P., 1969, Some factors in the competition or antagonism among bacteria, algae, and aquatic weeds. Journal of Phycology 5:351-359.

Florida Committee on Rare and Endangered Plants and Animals, 1975, Fishes.

Florida Game and Fresh Water Fish Commission, 1970, Statement St. Johns River Hearing, Palatka, Florida, unpublished.

__________, 1976, Upper St. Johns River study, 1976. Dingell-Johnson Project F-25, St. Johns Fishery Laboratory, West Melbourne, Florida.

__________, 1977, 1976-1977 Annual progress report for research project (Ecological aspects of the fishery of the St. Johns River). Dingell-Johnson Project F-33-1., St. Johns Fishery Laboratory, West Melbourne, Florida.

Haslam, S. M., 1971, Physical factors and some river weeds. Proc. Eur. Weed Res. Council 3rd int. Symp. Aquatic Weeds, p 29-39.

Hynes, H. B. N., 1970, The ecology of running waters. Liverpool University Press, Liverpool, England.

McLane, W. M., 1955, The fishes of the St. Johns River System. Unpublished Ph.D. Disertation, University of Florida.

Moody, H., 1963, St. Johns River. Dingell-Johnson Project F-6-R, Florida Wildlife Magazine.

Moody, W., 1961. Exploited fish populations of the St. Johns River, Florida. Quart. Jour., Florida Acad. Sci., 24(i):1-18.11.

Odum, Eugene P., 1971, Fundamentals of ecology, 3rd ed., W. B. Saunders Co., Philadelphia.

Palmer, C. M., 1968, Algae, in Parrish, Fred K.(ed), Keys to water quality indicative organisms. Prepared for U. S. Department of the Interior, Federal Water Pollution Control Administration.

__________, 1969, A composite rating of algae tolerating organic pollution. J. Phycol, 5:78-82.

Patten, B. C., 1971, Species diversity in net phytoplankton of Raritan Bay, in Nybahkan (ed), Readings in marine ecology. Harper & Row Publications, Inc., New York.

Tagatz, M.E., 1968, Fishes of the St. Johns River, Florida. Quart. Jour. Florida Acad. Science. 30 (1): 25-50.

Technical Advisory Committee on Endangered Species, 1977, Florida threatened and endangered species list.

U. S. Army Corps of Engineers, 1973, Final environmental statement, aquatic plant control program, State of Florida, U. S. Army Engineer District, Jacksonville.

__________, 1977, Corps report and final supplement, Environmental Impact Statement: Aquatic plant control. State of Florida.

U. S. Department of Interior, 1977, Endangered and threatened wildlife and plants. Fish and Wildlife Service, Federal Register 42 (135), Part V., Washington.

U. S. Environmental Protection Agency, 1973, Biological field and laboratory methods for measuring the quality of surface waters and effluents. Office of Research and Development, EPA-670/4-73-001, Cincinnati.

Westlake, D. F., 1966, the light climate for plants in rivers. Symp. Br. Ecol. Soc. 6:99-119.

Wetzel, Robert G., 1975, Limnology. W. D. Saunders Co., Philadelphia.

Whitton, B. A., 1975, Algae, in Whitton, B. A. (ed) River ecology, University of California Press, Los Angeles.

Whitworth, W. R., Berrien, P.L., and Keller, W. T., 1968, Fresh water fishes of Connecticut. State Geological and Natural History Survey of Connecticut, Bulletin 101. Connecticut Department of Agriculture and Natural Resources, Hartford.

Winner, J. M., 1975, Zooplankton in Whitton, B. A. (ed) river ecology. University of California Press, Los Angeles.

Zawnecki, S., 1968, Algae and fish relationships, in Jackson, D. F. (ed). Algae, man and the environment. Syracuse University Press, Syracuse.

Table 2.7-1

Mean Basal Area, Relative Frequency, Relative Density, and Relative Dominance for Trees Comprising the Overstory of the Sandhill Community (Turkey Oak Phase)

Scientific Name	Common Name	Mean Basal Area Per Tree	Relative Frequency	Relative Density	Relative Dominance	Importance Value
Quercus laevis	Turkey oak	59.4	66.7	82.5	86.9	236.1
Pinus palustris	Longleaf pine	42.1	33.3	17.5	13.1	63.9

Table 2.7-2

Herbaceous Ground Cover
(Sandhill Community)

Scientific Name	Common Name	Percent Cover	Absolute Frequency
Aristida sp.	Three awn grass	18	90
Agrostis perennans	Bent grass	>1	20
Aster sp.	Aster	>1	10
Lichen	Lichen	14	40
Serenoa repens	Saw palmetto	17	50
Cassia sp.	Partridge pea	>1	20
Andropogon sp.	Brown sedge	>1	10

Table 2.7-3

Relative Frequency, Relative Density, and Relative Dominance for Trees Comprising the Overstory of the Bayhead Forest Community

Scientific Name	Common Name	Relative Frequency	Relative Density	Relative Dominance	Importance Value
Pinus serotina	Pond pine	50	70.0	63.3	183.3
Pinus elliottii	Slash pine	10	10.0	23.2	43.2
Persea borbonia	Red bay	25	12.5	11.3	48.8
Ilex coriacea	Gallbery	10	5.0	1.5	16.5
Magnolia virginiana	Sweetbay	5	2.5	0.7	8.2

Table 2.7-4

Mean Basal, Relative Frequency, Relative Density, Relative Dominance, and Importance Values for Trees Comprising the Overstory of the Hardwood and Cypress Swamp Community

Scientific Name	Common Name	Mean Basal Area Per Tree	Relative Frequency	Relative Density	Relative Dominance	Importance Value
Liquidumbar styraciflua	Sweetgum	92.4	26.5	35.7	40.2	162.0
Fraxinus caroliniana	Pop ash	92.3	13.3	14.3	16.0	73.2
Nyssa aquatica	Water tupelo	150.78	13.3	10.7	19.7	73.3
Persea borbonia	Redbay	13	4.4	3.6	0.6	18.7
Acer rubrum	Red maple	64.7	13.3	10.7	8.4	62.0
Taxodium distichum	Bald-cypress	56	8.8	7.1	4.9	40.6
Quercus nigra	Water oak	77	4.4	3.6	3.3	21.2
Magnolia virginiana	Sweetbay	32	7.3	7.1	2.8	38.5
Ulmus americana	American elm	64	4.4	3.6	2.8	20.7
Quercus phellos	Willow oak	31	4.4	3.6	1.3	19.2

Table 2.7-5

Understory
(Hardwood and Cypress Swamp)

Scientific Name	Common Name	Density (plants/acre)	Relative Frequency
Fraxinus caroliniana	Pop ash	121	22.5
Castanea alnifolia	Chinquapin	2,308	22.5
Acer rubrum	Red maple	688	22.5
Sambucus canadensis	Elderberry	1,943	10.9
Taxodium distichum	Bald cypress	81	10.9
Liquidambar styraciflua	Sweetgum	81	10.9

Table 2.7-6

Herbaceous Ground Cover
(Hardwood and Cypress Swamp)

Scientific Name	Common Name	Percent Cover	Relative Frequency
Carex sp.	Carex	2.2	3.5
Rhus radicans	Poison ivy	0.06	14.4
Centella asiatica	Centella	0.01	3.5
Osmunda regalis	Royal fern	0.37	7.1
Hydrocotyle sp.	Pennywort	22.09	14.4
Gratiola neglecta	Hedge hyssop	2.2	3.5
Diodia virginiana	Buttonweed	2.2	3.5
Carex stricta	Carex	0.01	3.5
Polypodium sp.	Fern	4.45	14.4
Saururus cernuus	Lizard's tail	5.8	10.6
Panicum sp.	Panic grass	0.01	3.5
Parthenocissus quinquefolia	Virginia creeper	0.03	7.1
Pontederia cordata	Pickerelweed	2.26	3.5
Rubus sp.	Brier-berry	0.36	3.5
Sphagnum sp.	Peat moss	0.36	3.5

Table 2.7-7

Amphibians and Reptiles Observed on the Putnam Site

FAMILY	SCIENTIFIC NAME	COMMON NAME	UPLAND HABITAT	BOTTOMLAND HABITAT
Testudinidae	*Gopherus polyphemus*	Gopher Tortoise	C	-
Iguanidae	*Anolis carolinensis*	Green Anole	C	U
	Sceloporus undulatus	Fence Lizard	C	-
Scinidae	*Leiolopisma laterale*	Ground Skink	U	-
Colubridae	*Coluber constrictor priapus*	Southern Black Racer	U	-
Plethodontidae	*Plethodon glutinosus*	Slimy Salamander	-	U
	Eurycea quadridigitata	Dwarf Salamander	-	U
Bufonidae	*Bufo americanus*	American Toad	C	U
	Bufo terrestris	Southern Toad	C	U
Hylidae	*Hyla squirella*	Squirrel Treefrog	-	C
	Limnaoedus ocularis	Little Grass Frog	-	U
Ranidae	*Rana utricularis*	Southern Leopard Frog	-	C

Notes: Upland Habitats: Sandhill Community, Pine Flatwoods, Pine Plantations, Oak Hammocks.
Bottomland Habitats: Bayhead Forest, Cypress Heads, Hardwood and Cypress Swamp.
A = Abundant, C = Common, U = Uncommon

Taxonomic Source: Conant, 1975.

Table 2.7-8

Birds Observed on the Putnam Site

FAMILY	SCIENTIFIC NAME	COMMON NAME	UPLAND HABITAT	BOTTOMLAND HABITAT
Cathartidae	Cathartes aura	Turkey Vulture	A	A
	Coragyps atratus	Black Vulture	C	C
Accipitridae	Buteo jamaicensis	Red-tailed Hawk	C	C
Meleagrididae	Meleagris gallopavo	Turkey	-	C
Phasianidae	Colinus virginianus	Bobwhite	C	-
Columbidae	Zenaidura macroura	Mourning Dove	C	-
	Columbigallina passerina	Ground Dove	C	-
Cuculidae	Coccyzus americanus	Yellow-billed Cuckoo	-	C
Strigidae	Otus asio	Screech Owl	-	U
	Strix varis	Barred Owl	-	U
Caprimulgidae	Caprimulgus carolinensis	Chuck-will's-widow	-	C
Apodidae	Chaetura pelagica	Chimney Swift	C	-
Picidae	Colaptes auratus	Common Flicker	C	-
	Dryocopus poleatus	Pileated Woodpecker	U	C
	Centurus carolinus	Red-bellied Woodpecker	C	C
	Dendrocopos villosus	Hairy Woodpecker	U	U
	Dendrocopos pubescens	Downy Woodpecker	U	U
Tyrannidae	Tyrannus tyrannus	Eastern Kingbird	U	C
	Sayornis phoebe	Eastern Phoebe	U	-

Table 2.7-8 (Continued)

FAMILY	SCIENTIFIC NAME	COMMON NAME	UPLAND HABITAT	BOTTOMLAND HABITAT
Corvidae	Cyanocitta cristata	Blue Jay	A	A
	Corvus brachyrhynchos	Common Crow	A	A
	Corvus osifragus	Fish Crow	U	U
Paridae	Parus bicolor	Tufted Titmouse	U	A
Troglodytidae	Thryothorus ludovicianus	Carolina Wren	U	U
Mimidae	Mimus polyglottos	Mockingbird	A	A
	Dumetella carolinensis	Gray Catbird	C	C
	Toxostoma rufum	Brown Thrasher	C	C
Turdidae	Turdus migratorius	American Robin	U	U
	Catharus guttatus	Hermit Thrush	-	U
Sylviidae	Polioptila caerulea	Blue-gray Gnatcatcher	U	C
Bombycillidae	Bombycilla cedrorum	Cedar Waxwing	U	-
Laniidae	Lanius ludovicianus	Loggerhead Shrike	A	-
Vireonidae	Vireo griseus	White-eyed Vireo	-	C
Parulidae	Mniotilta varia	Black-and-white Warbler	U	U
	Dendroica coronata	Yellow-rumped Warbler	U	U
	Dendroica dominica	Yellow-throated Warbler	U	U
	Dendroica pinus	Pine Warbler	C	-
	Setophaga ruticilla	American Redstart	-	U
Thrapidae	Piranga rubra	Summer Tanager	U	-

Table 2.7-8 (Continued)

FAMILY	SCIENTIFIC NAME	COMMON NAME	UPLAND HABITAT	BOTTOMLAND HABITAT
Fringillidae	Cardinalis cardinalis	Cardinal	C	C
	Pipilo erythrophthalmus	Rufous-sided Towhee	C	C
	Passerculus sandwichensis	Savannah Sparrow	U	-
	Spizella pusilla	Field Sparrow	U	-
	Zonotrichia albicollis	White-throated Sparrow	U	-

Notes: Upland Habitats: Sandhill Community, Pine Flatwoods, Pine Plantations, Oak Hammocks.
Bottomland Habitats: Bayhead Forest, Cypress Heads, Hardwood and Cypress Swamp.
A = Abundant, C = Common, U = Uncommon

Taxonomic Source: Robbins et. al., 1966

Table 2.7-9

Mammals Occurring on the Putnam Site

FAMILY	SCIENTIFIC NAME	COMMON NAME	UPLAND HABITAT	BOTTOMLAND HABITAT
Didelphiidae	Didelphis marsupialis	Oppossum	C	C
Talpidae	Scalopus aquaticus	Eastern Mole	C	-
Procyonidae	Procyon lotor	Raccoon	A	A
Canidae	Urocyon cinereoargenteus	Gray Fox	U	C
	Canis familiaris	Domestic Dog	C	C
Felidae	Lynx rufus	Bobcat	-	U
	Felis domesticus	Domestic Cat	U	U
Sciuridae	Sciurus carolinensis	Gray Squirrel	-	C
	Sciurus niger	Fox Squirrel	U	-
Cricetidae	Peromyscus gossypinus	Cotton Mouse	-	U
Leporidae	Sylvilagus floridanus	Cottontail	C	-
Suidae	Sus scrofa	Hog	A	A
Cervidae	Odocoileus virginianus	Whitetail Deer	C	C
Dasypodidae	Dasypus novemcinctus	Armadillo	A	A

Notes: Upland Habitats: Sandhill Community, Pine Flatwoods, Pine Plantations, Oak Hammocks.
Bottomland Habitats: Bayhead Forest, Cypress Heads, Hardwood and Cypress Swamp.
A = Abundant, C = Common, U = Uncommon

Taxonomic Source: Burt and Grossenheider, 1976.

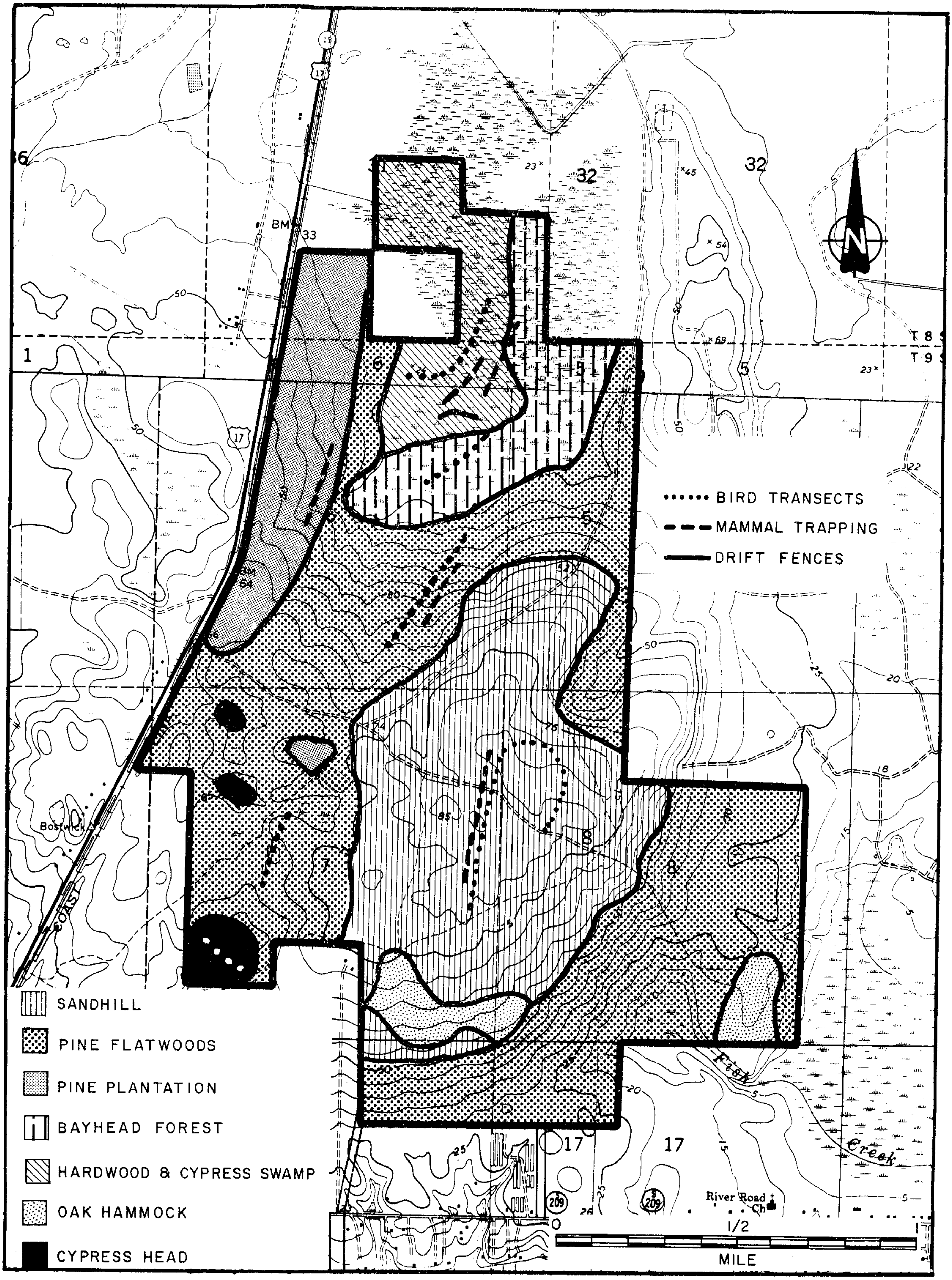


Figure 2.7-1. Vegetation and Habitat Map

2.8 LAND USE

2.8.1 Regional Overview

The Putnam Site lies within the Southern Florida Flatwoods land resource region, an area of approximately 17,900 square miles. The eastern portion of this area extends along the coast of Florida (north to south) from Jacksonville to Miami and extends inland (east to west) from 10 to 50 miles. The nearly level sandy coastal plain of the area varies in elevation from sea level along the coast to 100 feet inland. Prominent landscape features of swamps, marshes, lakes, and streams occur extensively throughout the area (Austin, 1967).

Approximately 90 percent of the southern Florida Flatwoods region is in private ownership with the remainder in State and National forests, game refuges and military facilities. Many of the land holdings are large with minor areas organized into operating farm units. More than 25 percent of the area is in forests which are used extensively for grazing purposes. Approximately 50 percent of the area is used for pasture although only about 25 percent of this pasture has a high carrying capacity for livestock. The remaining area consists of mixed managed and native rangeland vegetation. About 5 percent of the total area is cropped, with citrus fruits and winter vegetables important cash crops (Austin, 1967).

2.8.1.1 Putnam County Land Use

Land use in Putnam County in 1972 was dominated by forest and wetland area classifications (Table 2.8-1). Upland forests covered approximately 40 percent of Putnam County and 25 percent of the county was classified as forested wetlands; thus almost 65 percent of the county is in forest cover. Agricultural and water areas were next most widespread in the county, comprising approximately 13 and 10 percent of total land use, respectively. Most of the agricultural classifications were cropland and pasture acreages, with rangeland classification comprising only 2 percent of the county's land area. Urban and developed land, mainly residential, was 5 percent of the county area. Barren land, was 4 percent of the county and was composed mainly of areas in transition to other uses such as subdivisions, cropland, and planted pine plantations.

2.8.1.2 Soils

Soil characteristics are a good indicator of potential uses of land and provide an insight into current land use alternatives. In many cases urban development patterns and agricultural activities are closely related to soil types. County soil maps indicate that approximately 45 percent of Putnam County is suitable for urban and community development of a general nature. However, much of the development area is not suitable for sanitary facilities such as septic tanks and sewage lagoons normally associated with residential units, therefore limiting development potential for this use (Division of State Planning, 1973). Agricultural development potential of the soils in the county is only moderate, with 57 percent of the soils suitable for improved pasture uses and 37 percent suitable for cropland uses. The Division of State Planning's general soils atlas of the county indicates that improved pasture uses appear most suitable in the county since a larger percentage of the soils possess characteristics necessary for this use. Approximately 46 percent of the counties' soils have high to moderate potential for pine forest production (Division of State Planning, 1973).

2.8.1.3 Agriculture

Agriculture in Putnam County is diminishing in importance relative to other economic sectors (Kellum, Patterson, and Bell, Inc., 1977). The losses in the agricultural sector are manifest in changes in land use by agricultural activities, such as the total number of farms in the county and the amount of land in farms. Table 2.8-2 presents significant agricultural characteristics of the county for the years 1969 and 1974. The table reveals that land used for agricultural activities declined during the five year period with the total land in farms declining by 42 percent and the average size of farms decreasing by 40 percent. Similarly, the amount of cropland, pasture, and woodland on farms decreased as did the amount of livestock in the county.

2.8.1.4 Land Ownership

Putnam County is dominated by large single ownerships of land. A 1970 study found that 21 owners controlled approximately 60 percent of the rural land in the county (Alleger, 1970). Much of the land is owned by pulpwood and paper companies who manage the land for longterm returns on forestry products. It is likely that future expansion of these companies would entail the conversion of more land into tree farming plots.

2.8.2 Land Use Within 5 Miles of the Site

Land use within 5 miles of the site is depicted in Figure 2.8-1. Analysis of the areal extent of the land uses with the five mile radius is shown in Table 2.8-3. Over 60 percent of the land is forested in evergreens or wetland hardwood types. Cropland and pasture uses covered 6285 acres or about 12.5 percent of the area. Only about 1400 acres was in urban development and the majority of this, 1100 acres, was residential in nature. There are no military facilities of major importance within 5 miles of the site.

Land uses/cover in the immediate site vicinity (Figure 2.8-2) are generally similar to those found throughout the county. Residential areas along the St. Johns River, south of the site, and along U.S. Route 17 are the most notable concentrations of urban development. Some intensive agricultural operations occur in the site vicinity. These uses include poultry and fishing operations along the southern site boundary, improved pasture uses east and south of the site, and a planted pine forest east of the site.

2.8.2.1 Industrial Development

The county's largest industrial concern, the Hudson Pulp and Paper Company, is located approximately 3.4 miles southwest of the site. The pulp mill covers approximately 275 acres with 90 acres of associated water treatment reservoirs nearby. Rail connections to the plant include spurs to the Seaboard Coast Line Railroad (north-south) and the Southern Railway (east-west), as well as spurs to the St. Johns River Barge Port. Rice Creek also provides barge access to the plant from the St. Johns River.

Florida Power & Light's Putnam and Palatka plants, located on the St. Johns River approximately 7 miles south of the proposed site, are the nearest electric power generating facilities. Both plants are oil-fired, but only the Putnam plant is operational. The old Palatka plant has been retired.

2.8.2.2 <u>Recreation</u>

The St. Johns River is a significant recreational attraction of Palatka and Putnam County. Palatka is known as the "Bass Capitol of the World" and has been the site of many bass fishing tournaments. Fishing camps are numerous on the river, but the heaviest concentration occurs south of Palatka rather than in the Putnam Site vicinity. Only about 3 camps are located along the river in the site vicinity. The river also provides recreational opportunities for other water sports such as pleasure boating and water skiing. Residential and second-home development along the river is prominent, and the area is expected to remain an attractive locale for such development. No other significant recreational attractions are found within the site vicinity.

Discussion of dedicated lands may be found under Section 2.8.4 - Historic, Scenic, Cultural and Natural Landmarks.

2.8.2.3 <u>Onsite Land Use</u>

Historically, the site has never been used intensively for agricultural activities or urban development, but has generally served as rangeland or timberland. Existing land uses and land cover in the immediate site vicinity are shown in Figure 2.8-2. The site is presently used for foraging operations and has recently been timbered. No urban uses or intensive agricultural operations occur on the site.

Figure 2.8-3 displays rural land use potential ratings for food crop production, forage for livestock, and timber production for areas on the site. Most of the site has a good potential for forage and timber production, while potential food crop suitability appears lowest. No prime or unique agricultural land is found on the site (Florida Department of Administration, Division of State Planning, 1974).

2.8.3 Future Land Use

2.8.3.1 Zoning and Ownership Influences

Land use in the site vicinity is expected to remain much as it is at present. Putnam County is not expected to experience development pressures as intensely as other counties in the coastal zone. Much of the land in the county is owned by pulp and paper companies, assuring perpetuation of this land in a forested state. However, this land may be considered as being unavailable for development, forcing development of acreage now in private ownership. Most of the area north and southwest of the plant is held by private individuals rather than companies or corporations. Those companies owning land east of the site vicinity are mainly concerned with cattle operations, so large scale development of the property is unlikely.

Since much of the area in the site vicinity is zoned as agricultural or open rural land, rezoning would be necessary for its development. Zoning of the area, then, gives the county the opportunity to control development and to prevent conflicting uses.

Ownership density of lands in the site vicinity and along the St. Johns River is depicted in Figure 2.8-4. The figure also shows which lands have been platted and are under development for residential uses. It is likely that these areas will be the first lands in the site vicinity to be developed. In general, these areas are sufficiently distant from the site to avoid conflicts.

2.8.3.2 Land Use Planning Activities

The Coastal Zone Management effort in Florida has produced development criteria on lands within the Coastal Zone in which the site is located. Figure 2.8-5 indicates three classifications: Development, Conservation, and Preservation of land on the site.

The following nine factors are considered before any area is classified:

Present land and water use
Geological factors
Water classifications
Ecological significance and tolerance to alteration
Susceptibility to flooding
Soils suitability
Archeological and historical significance
Unique environmental factors
Legal constraints

The preservation area is 11 percent of the site while conservation and development areas comprise 43 percent and 46 percent of the site, respectively.

The area designated for preservation on the site is a resource subcategory, freshwater swamp or marsh. Priority uses of this area are designated as open space, wildlife habitats, freshwater retention, possible water recharge, and water quality functions. General state policy on these areas is to discourage development unless the development is not contrary to the public interest (Jacksonville Area Planning Board, 1975).

The lands of conservation status on the site are of resource subcategorized marginal lands, areas that, due to soil characteristics or other physical restrictions, require special treatment in order to be made suitable for urban development. The priority use of this land is recreation, wildlife habitat, open space, timber production, and agricultural or grazing activity not requiring drainage or pumping. Development is permitted when no other alternatives are available. The state's objective is to ensure that adequate precautions and corrective measures are undertaken before development is allowed to occur.

Land categorized for development on the site is undeveloped land suitable for intensive development. No restrictions are placed on the area other than that suitable environmental safeguards are realized during the development. Further descriptions of biophysical categories are contained in Figure 2.8-5.

2.8.4 Historic, Scenic, Cultural, and Natural Landmarks

2.8.4.1 Public Lands

The nearest State Park, Ravine Gardens, is south of the city of Palatka and 7 miles south of the site (Figure 2.8-6). The park is 182 acres in area and features picnic facilities and nature trails in ornamental gardens. Park attendance for the year 1976-1977 totalled 148,296 visitors (Department of Natural Resources, 1976).

The Hudson Wildlife Management Area and the Rice Creek Sanctuary comprise 13,000 acres approximately 4.7 miles southwest of the site. The 2,000-acre Rice Creek Sanctuary contains a section of the Florida Trail, a hiking path running from Gold Head State Park to the Ocala National Forest, and the remaining of a Revolutionary-period rice and indigo plantation. The Sanctuary is surrounded by the 11,000-acre Hudson Wildlife Management Area. This is a cooperative public hunting (deer and small game) area managed jointly by the Hudson Pulp and Paper Company and the Florida Game and Fresh Water Fish Commission (Florida Game and Fresh Water Fish Commission, 1965).

2.8.4.2 Archeological and Historical Resources on Site

Between November 1977 and May 1978 a survey was conducted to identify, locate, and assess cultural resources on the Putnam Site in accordance with 36 CFR 800, "Procedures for the Protection of Historic and Cultural Properties." The survey area comprised some 2,380 acres and included the Putnam Site proper as well as three potential outfall corridors to the St. Johns River (Figure 9.3-2).

Archeological field work involved surface survey and subsurface testing for cultural resources based upon existing knowledge of prehistoric and historic site distribution in terms of natural landscape features. Data derived from study of previously known site locations recorded in the literature and the Florida Master Site File at the Division of Archives, History, and Records Management were compared with information about the tract taken from contour, soil, and vegetation maps, as well as recent large-scale aerial photographs to suggest likely site locations. The resulting locations were examined by surface survey and posthole testing.

Concurrently, a historic documents study was conducted to reveal information about human habitation or utilization of the tract in the past 500 years. Published historical studies, travellers' accounts, federal and state land records, Spanish land grants, county property and tax records, and historical maps and plats were examined in Tallahassee and Palatka. Little activity of historical significance has been recorded for the study area, and no sites of National Register importance were indicated by the documents. During the field survey, several areas on the tract showed evidence of late historic period habitation, consisting of two or three farmstead sites dating to the late nineteenth and early twentieth century. Probable dates of occupation and names of owners of these sites were established.

Two prehistoric shell middens were found on the bank of the St. Johns River in outfall Corridor B (Figure 9.3-2). These middens were small, partially eroded, but otherwise undisturbed. These sites contain intact stratigraphy and, being likely to yield information important in prehistory, must be considered eligible for inclusion in the National Register of Historic Places.

The Putnam Site and outfall Corridors A or C could be used for the proposed purpose without adverse impact upon existing or potential National Register or otherwise significant sites.

Appendix J contains the complete archeological and historical resources survey report.

There are several public boat ramps on the St. Johns River in the vicinity of the site. The locations of these ramps are depicted in Figure 2.8-7. In addition, the Riverdale County Park and Recreation area on the eastern shore of the St. Johns River in St. Johns County is approximately 7 miles northwest of the site.

2.8.4.3 National Register Sites

The nearest National Register sites are located in Palatka, approximately 5 miles south of the Putnam Site. The two sites, the Bronson-Mulholland House and the St. Marks Episcopal Church, located on 2nd Street in Palatka, were nominated to the Register in 1972 and 1973, respectively.

2.8.5 References

Alleger, H. F., 1970, Florida's land ownership. University of Florida, Gainesville.

Austin, M. E., 1972, Land resource regions and major land resource areas of the United States. Soil Conservation Service, Washington.

Florida Department of Administration, Division of State Planning, 1974, Land use potential maps, Daytona SW., Gainesville.

Florida Department of Natural Resources, 1976, Park attendance figures. Tallahassee.

Florida Game and Fresh Water Fish Commission, 1965, Hudson Game Management Area. Department of Natural Resources, Tallahassee.

Jacksonville Area Planning Board, 1975, Coastal zone management atlas. Jacksonville.

Kellem, Patterson and Bell Inc., 1977, Putnam County comprehensive plan. Putnam County, Florida.

Table 2.8-1

Putnam County Land Use, 1972

Level I Classification	Percent of County	Predominant Level II Classification
Urban or Builtup Land	5.3	Residential
Agriculture	13.1	Cropland/Pasture
Rangeland	2.2	Herbaceous
Forest Land	39.9	Evergreen
Water	10.4	Streams/Lakes
Wetland	25.1	Forested
Barren Land	4.0	Transitional Area

Source: Analysis of 1972 Florida Land Use Development Analysis Maps (LUDA) State of Florida Division of State Planning.

Table 2.8-2

Agricultural Characteristics of Farms With Sales over $2500,
Putnam County, Florida

	1974	1969	Percent Change 1969-1974
Number of Farms	212	220	-4
Land in Farms (A)	148,380	256,640	-42
Average Size of Farm (A)	700	1,167	-40
Total Cropland	21,635	24,579	-12
Harvested Cropland	11,362	13,514	-16
Cropland Use for Pasture	8,854	7,970	+11
All Other Cropland	1,419	3,095	-54
Woodland and Woodland Pasture	107,185	176,080	-39
Irrigated Land	4,239	9,116	-54
Number of: Cattle and Calves	14,782	20,261	-27
Hogs and Pigs	415	1,909	-78

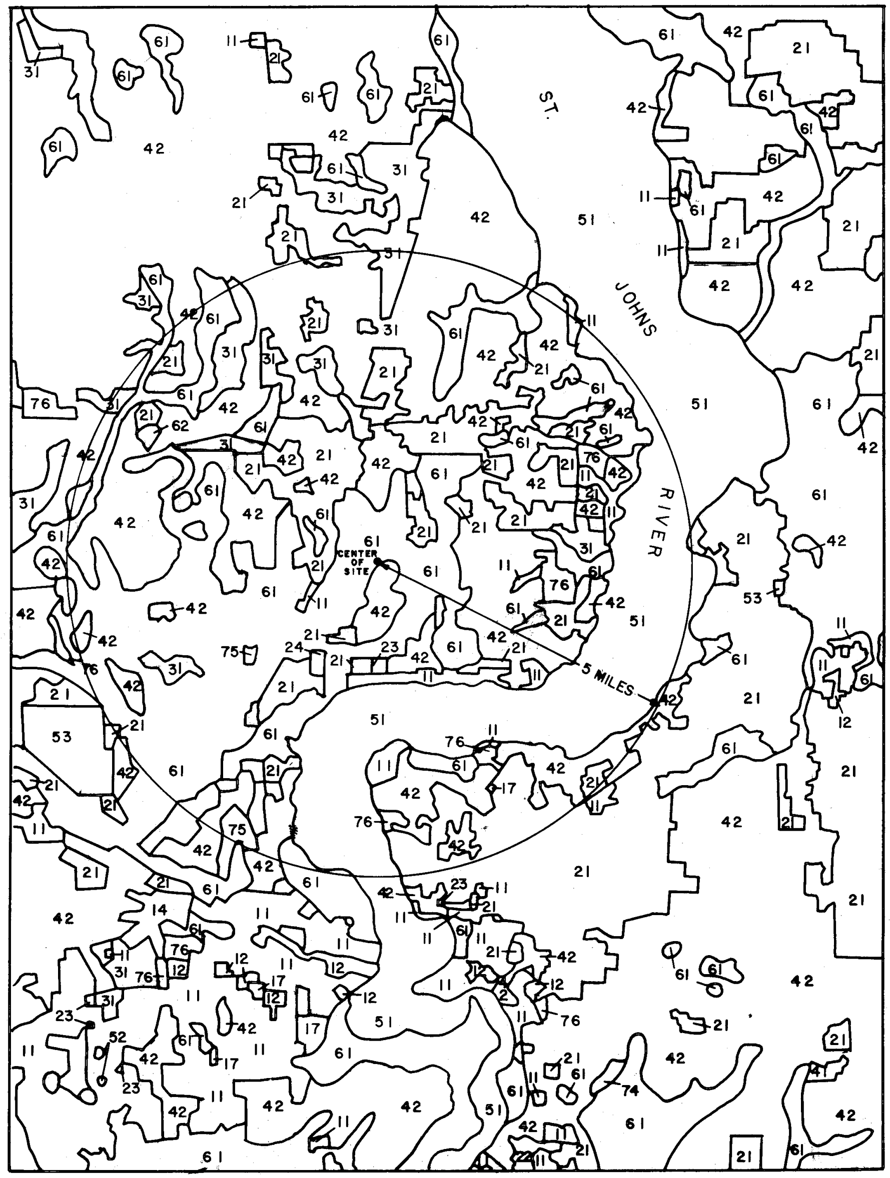
Source: U. S. Department of Commerce, Bureau of the Census. 1974 Census of Agriculture, Florida.

Table 2.8-3

Land Use Within 5 Miles of the Site

Mapping Unit	Classification: Level I	Classification: Level II	Percent of 5 Mile Area	Acreage
11	Urban & Builtup	Residential	2	1,100
12	Urban & Builtup	Commercial Services	1>	130
13	Urban & Builtup	Industrial	1>	140
17	Urban & Builtup	Other	1>	55
21	Agricultural	Cropland/Pasture	13	6,285
23	Agricultural	Confined Feeding Operations	1>	40
24	Agricultural	Other	1>	65
31	Rangeland	Herbaceous	4>	1,880
42	Forest	Evergreen Forest	32	15,785
51	Water	Streams & Canals	17	8,755
61	Wetland	Forest Wetland	31	15,415
75	Barren Land	Quarries/Gravel Pits	1>	140
76	Barren Land	Transitional Areas	1>	445

Source: Analysis of 1972 Florida Land Use Development Analysis Maps (LUDA). State of Florida Division of State Planning.



CLASSIFICATION CATEGORIES

1 URBAN OR BUILT-UP LAND

11 Residential
12 Commercial and Services
13 Industrial
14 Transportation, Communications and Utilities
15 Industrial and Commercial Complexes
16 Mixed Urban or Built-up Land
17 Other Urban or Built-up Land

2 AGRICULTURAL LAND

21 Cropland and Pasture
22 Orchards, Groves, Vineyards, Nuseries, and Ornamental
23 Confined Feeding Operations
24 Other Agricultural Land

3 RANGELAND

31 Herbaceous Rangeland
32 Shrub and Brush Rangeland
33 Mixed Rangeland

4 FOREST LAND

41 Deciduous Forest Land
42 Evergreen Forest Land
43 Mixed Forest Land

5 WATER

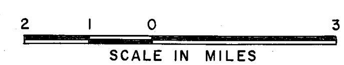
51 Streams and Canals
52 Lakes
53 Reservoirs
54 Bays and Estuaries

6 WETLAND

61 Forested Wetland
62 Nonforested Wetland

7 BARREN LAND

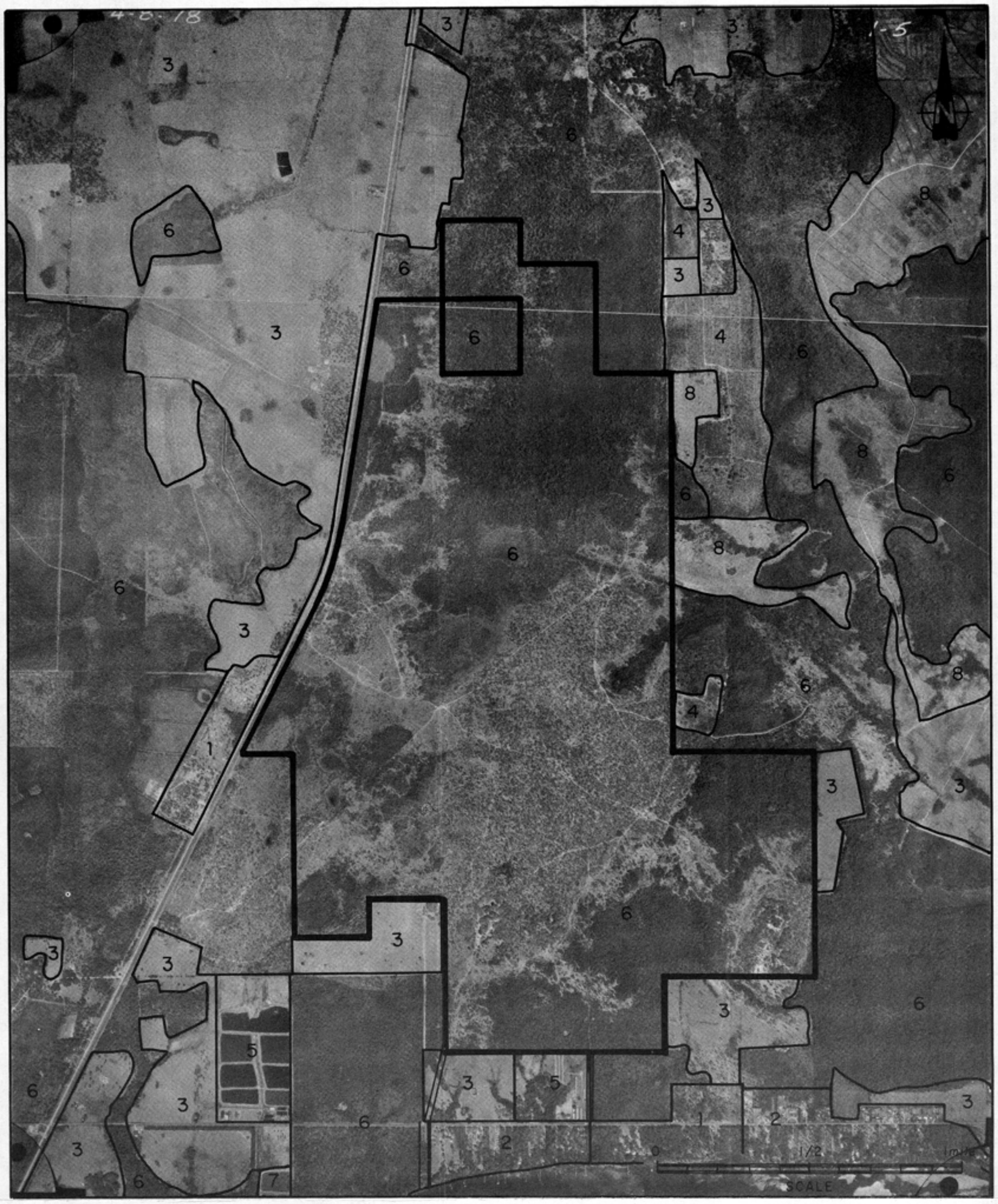
71 Dry Salt Flats
72 Beaches
73 Sandy Areas Other than Beaches
74 Bare Exposed Rock
75 Strip Mines, Quarries, and Gravel Pitts
76 Transitional Areas
77 Mixed Barren Land



SOURCE: U.S.G.S. LAND USE AND LAND COVER, 1972.
DAYTONA BEACH, FLORIDA IN CONJUNCTION
WITH FLORIDA DIVISION OF STATE PLANNING.

Figure 2.8-1. Land Use within 5 Miles of the Site.

REVISED 3/15/79



SOURCE: LAND USE/COVER ANALYSIS, JACKSONVILLE AREA PLANNING BOARD

LEGEND:

1-Low Density Residential
2-Med. Density Residential
3-Improved Pasture
4-Planted Pine
5-Confined Feeding Operation
6-Forest
7-Borrow Pit
8-Transitional Area

Figure 2.8-2. Selected Land-Use and Land Cover Designations.

REVISED 3/15/79

SOURCE: LAND USE / COVER ANALYSIS, JACKSONVILLE AREA PLANNING BOARD

LEGEND

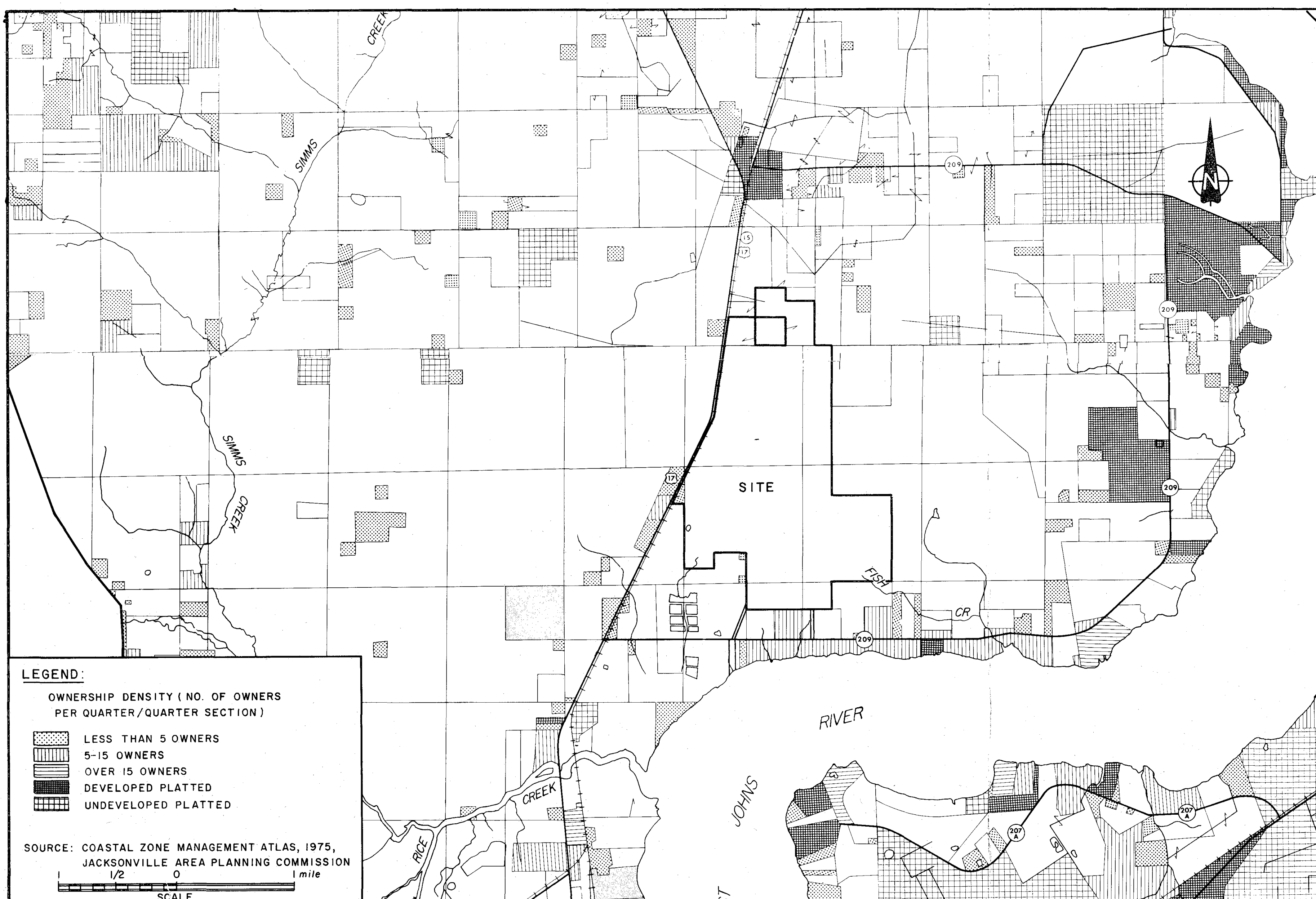
SUITABILITY

1-Good
2-Fair
3-Poor

CATEGORY

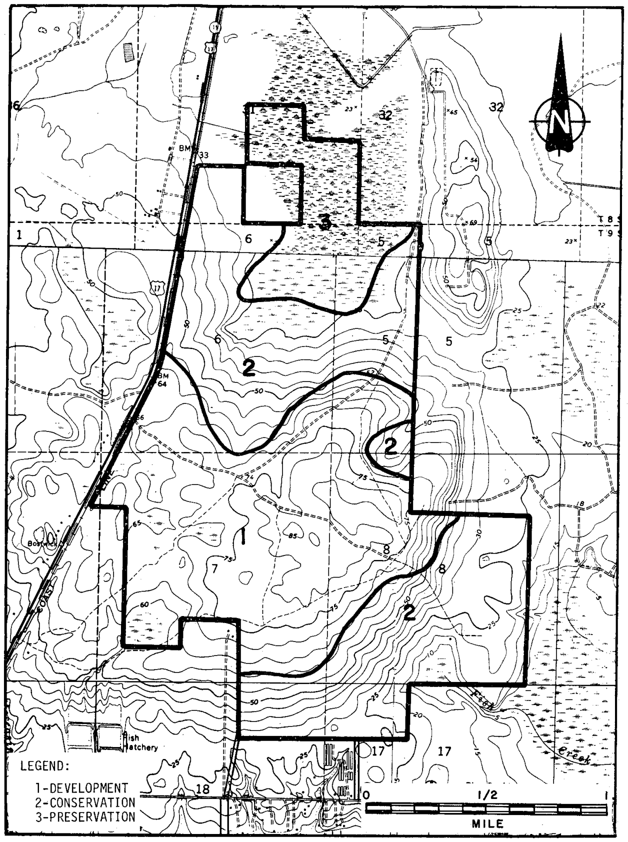
Foodcrops Woodland
3 2 2
Pasture

Figure 2.8-3. Rural Land Use Potentials.



REVISED 3/15/79

Figure 2.8-4. Ownership Density - Site Vicinity.



1 Development Category

Undeveloped Lands Suitable for Intensive Development

Priority Use:	Development, according to local desires and needs, utilizing environmental safeguards.
Description:	Land which, if they are required for development, needs little or no modification prior to such development. These areas have elevations, soils, topography and other physical conditions favorable for development (with the addition of proper sanitary facilities).
State's Objectives:	To assist local planning and zoning officials, developers and landowners in determining those areas best suited to development and assure that development occurs in a fashion that is compatible with the physical environment.
Regulatory Agencies:	County and Local Governments.

2 Conservation Category

Marginal Lands

Priority Use:	Recreation, greenbelts/open space, timber production; extensive agriculture/grazing, if these activities do not require draining or pumping; wildlife habitat, development when no other alternative areas exist.
Description:	Land, which due to soil characteristics, drainage problems, or other physical restrictions, require special treatment in order to be made suitable for urban development.
State's Objectives:	To assure that development in these areas adequately considers the physical limitations involved and does not result in direct or indirect consequences harmful to the public health, safety, and welfare.
General State Policy:	State policy shall be to encourage local government to adopt adequate policies regulating development in these areas, to require the use of central sewage systems where feasible, and to assure that appropriate precautions are taken during landscape modifications.
Regulatory Agencies:	Florida Department of Community Affairs (Federal Flood Insurance Program)

3 Preservation Category

Selected Freshwater Marshes & Selected Freshwater Swamps

Priority Use:	Open Space, wildlife habitat, freshwater retention, possible water recharge, water quality functions.
Description:	Low, poorly-drained areas characterized by water tolerant vegetation. Included are swamps and marshes adjoining rivers as well as those having predominantly internal drainage.
State's Objectives:	To protect the basic natural functions served by freshwater swamps and marshes.
General State Policy:	State policy shall be to discourage development in these areas except in cases shown to be not contrary to the public interest.
Regulatory Agencies:	Florida Department of Environmental Regulation St. Johns' Water Management District.
Note:	See Figure 3.1-16 for delineation of site categories.
Source:	Florida Department of Natural Resources, 1975. Coastal Zone Management Atlas, Region 4, Northeast Florida.

REVISED 3/15/79

Figure 2.8-5. Coastal Zone Management Biophysical Analysis.

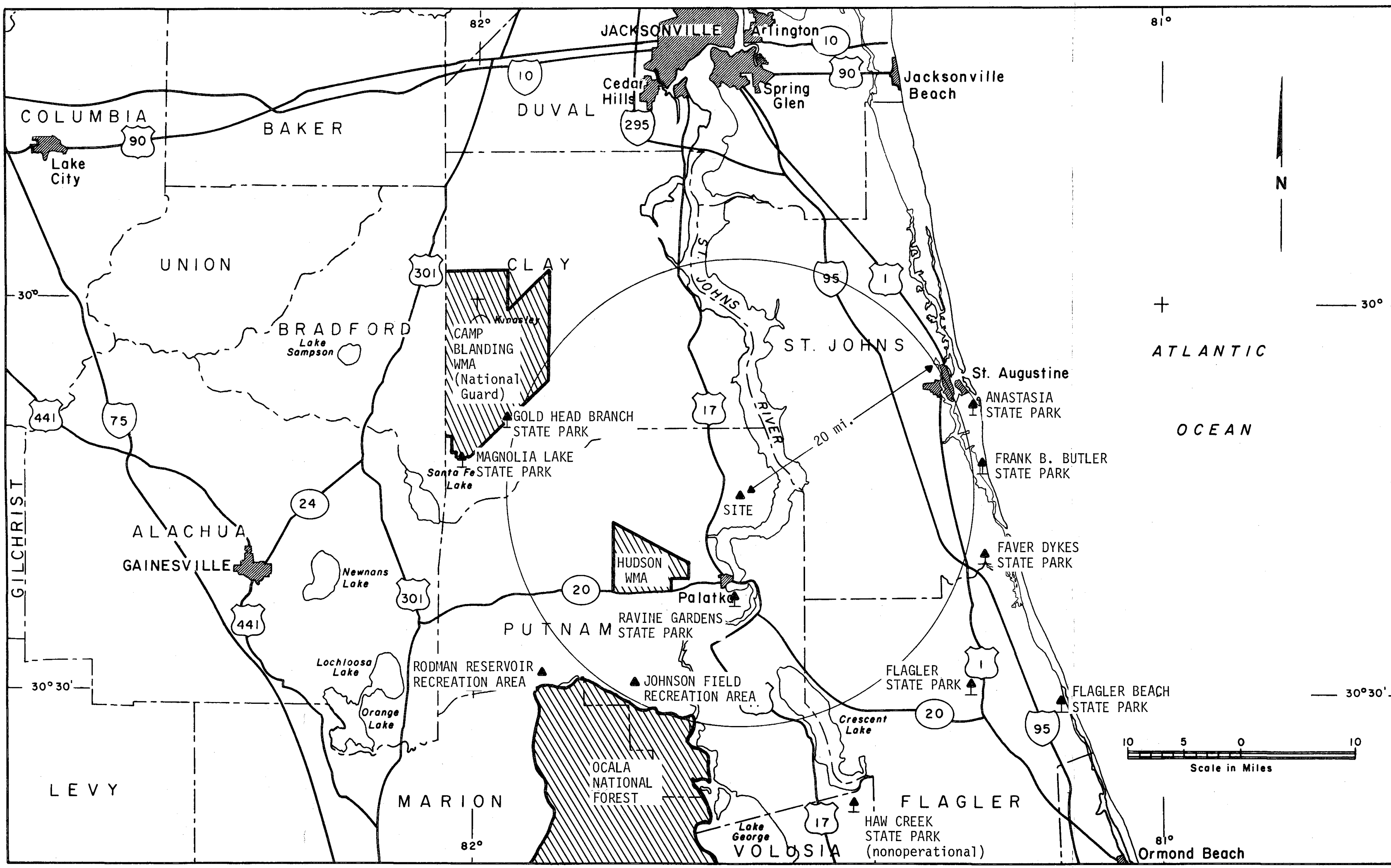


Figure 2.8-6. Public Lands.

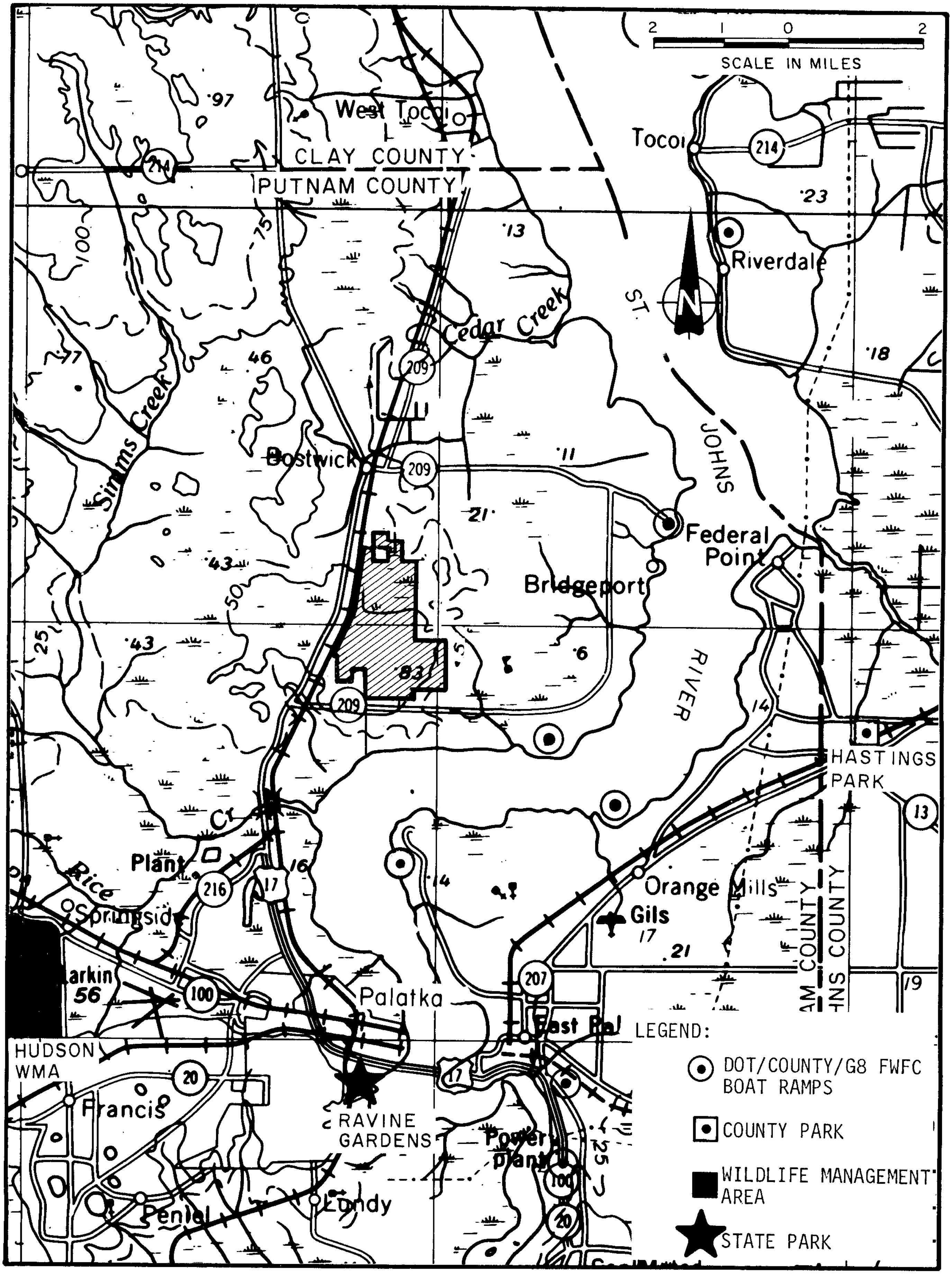


Figure 2.8-7. Public Lands in the Immediate Site Vicinity.

REVISED 3/15/79

2.9 DEMOGRAPHIC CHARACTERISTICS

Since World War II, Florida has been one of the fastest growing states in the nation. The growth of Florida has not been confined to the beaches of the south. Much population growth has also occurred in the urban areas of the northern portions of the state.

2.9.1 General Population Characteristics

In 1970, the nine counties within 50 miles of the Putnam Site varied in size from Duval County's population of 528,865 to Flagler County's population of 4,454 (Table 2.9-1). Duval County, which consists of the City of Jacksonville, has developed into one of the southeast's most diversified urban centers. With a population density of 690 persons per square mile (the statewide average is 126), Duval County is by far the most densely populated county in the study area. At the other end of the spectrum, Flagler County has a population density of only 9 persons per square mile and no major urban area. Putnam County, with a density of 47 persons per square mile, is the second least densely populated county in the study area.

From 1960 to 1970, Clay County experienced the most rapid population growth with an average annual 6.4 percent (Table 2.9-1). Over this same time period, Putnam County experienced an average annual population growth rate of 1.3 percent, substantially below the statewide average of 3.7 percent. The only county to experience a decline in population was Flagler County, which saw a 0.3 percent average annual decline in its population.

Migration into Florida has traditionally played a large role in the growth rate. Out of a 3.7 percent average annual growth rate for the state as a whole from 1960 to 1970, over 72 percent of this change was due to a positive net migration (Table 2.9-1). Many of these new residents have been older citizens in search of retirement housing. In the study area, with the exception of Clay and Volusia Counties, net migration has been below the state average. Clay County has experienced high rates of positive migration apparently due to its proximity to Jacksonville, while Volusia County's growth rate appears to be due, in part, to the attractiveness of the Daytona Beach area.

For the State of Florida as a whole, 80.5 percent of the population was classified as urban in 1970 (Table 2.9-1). Only Duval County (Jacksonville) exceeded the state average with 97.9 percent of its population classified as urban. Putnam County, the primary impact area, had only 25.7 percent of its population classed as urban.

2.9.2 Age Distribution of the Population

For the census year 1970, Florida's population had a median age of 32.5 years (Table 2.9-2). Of the study area counties, only Flagler and Volusia Counties had a median age exceeding the state average. Clay County, with a median age of 25.5 years, had the youngest population in 1970, which reflects the large numbers of young families living in the southern surburbs of Jacksonville. Alachua County had the highest percentage of population in the 18 to 64 year age group with 62.2 percent as compared to a state average of 54.2 percent. This high percentage reflects the large number of students (28,000) who attend the University of Florida in Gainesville (University of Florida, 1978).

Putnam County had a relatively young population in 1970. With 28.8 percent of its population in the 5- to 17-year age group, Putnam County exceeded the state average of 23.7 percent and trailed only Clay County, which had 30.2 percent of its population in this age group (Table 2.9-2). In general, it can be said that the population of Putnam County area is younger than that of the State of Florida as a whole.

2.9.3 Educational Characteristics of the Population

In 1970, for persons 25 years or older in Florida, the median number of school years completed was 12.1 (Table 2.9-3). Within the Seminole impact area, the range for the median number of school years completed varied from lows of 10.3 years in Bradford County, and 10.7 years in Putnam County, to a high of 12.4 years in Alachua County, where the University of Florida is located. For the state as a whole, the percent of population 25 years or older with four years of college or more was 10.3 percent. But within the Seminole impact area, only Alachua County (23.1 percent) and Volusia County (10.7 percent) exceeded the state average in this category. In general, the educational attainment level in Putnam County is below that of the State of Florida as a whole.

2.9.4 Population Trends and Baseline Projections

Population projections for the State of Florida and the Seminole impact area counties for the period 1976 through 2020 are presented in Table 2.9-4. For the State of Florida and for each county, three projections are presented for each year - a high projection, a medium projection, and a low projection. The basic assumption behind these three projections is that feasible variations in fertility do not have a major impact on Florida's population growth. Since migration has accounted for more than 90 percent of Florida's population growth between 1970 and 1976, the University of Florida, Bureau of Economic and Business Research, has assumed that net migration will continue to be the prime mover behind population growth (University of Florida, 1977). Therefore, while only one set of fertility and mortality assumptions were used, three sets of migration assumptions were used, which in turn gave rise to the high, medium and low population growth projections.

Over the period 1976 to 2020, the annual rate of population growth in Florida for the medium projection is expected to be about 1.6 percent per year (Table 2.9-4). Of the Seminole impact area counties, only Clay, Flagler and Marion Counties are expected to grow at a faster annual rate than the state as a whole. Flagler County, with a projected annual growth rate of 2.2 percent in the medium case, leads all counties in the study area. This relatively high projected growth rate is due in part to the expected impact of ITT's Palm Coast community development project in Flagler County (Florida Department of Natural Resources, 1976a).

Currently, Flagler County is a rural county with an economy based on agricultural and timber products. Although Flagler County has vast sandy ocean beaches, the tourist and retirement industry has not been a key growth factor in the past due to the ability of Daytona Beach to absorb much of the tourist and retirement trade. This is expected to change, however, as the ITT Palm Coast community development project progresses. The target of the Palm Coast development is the group of upper middle class retirees who have, in the past, settled in the St. Augustine and Daytona Beach area of St. Johns and Volusia Counties. When completed in the 1990's, the Palm Coast development, according to some estimates, is expected to add over 600,000 people to Flagler County (Florida Department of Natural Resources, 1976a), which in 1970 had a population of 4,454. Recent building activity in Flagler County has been extensive, with apartments, condominiums and mobile homes parks springing up throughout the county. This development is also expected to have a significant impact on the rate of population growth in southern St. Johns County, which currently relies on tourism in St. Augustine as its primary impetus to growth.

Clay County, with a medium projected annual growth rate of 2.1 percent, currently supplies over 5,000 commuting employees to various businesses in Duval County (Florida Department of Natural Resources, 1976a). Clay County's rate of population increase is expected to remain relatively high.

Only Alachua, Duval, Putnam, and Volusia Counties have medium projected population growth rates lower than the state average.

2.9.5 Population Within 5 Miles of the Site

Population distributions and densities within 5 miles of the site are depicted in Figure 2.9-1. The highest density levels in the vicinity of the site occur in Palatka and East Palatka. Density levels along the St. Johns River tend to be greater than those inland except for urban areas. Densities outside Palatka and East Palatka range up to 568 persons per square mile. Since approximately 2,585 persons live within 5 miles of the site, average density for the area surrounding the site is calculated to be approximately 33 persons per square mile.

The ownership maps shown in Figure 9.3-2 indicate areas plotted and subdivided for residential development. Much of the area on the east bank of the St. Johns River and in the Orange Mills vicinity has been subdivided for residential development. The most significant future residential area near the site is a platted and partially developed subdivision along State Route S209 about 2.5 miles east of the site boundary.

Much of the growth in Putnam County since 1970 has occurred around the City of Palatka and the general East Palatka area. It is likely that much of the projected population increase will occur in these areas. Some residential development can be expected along State Route S209. Certain areas of planned community facilities are also expected to concentrate populations.

2.9.6 References

Florida Department of Natural Resources, June 1976a, Florida regional coastal zone economic analysis, Region 4, northeast Florida. Division of Resources Management, Bureau of Coastal Zone Planning, Tallahassee.

University of Florida, 1977, 1978-2020 projections of Florida population by county. Bureau of Economic and Business Research, Gainesville.

Table 2.9-1

General Population Characteristics - 1970

State or County	Total Population	Population Per Square Mile	Average Annual Percent Population Change (1960-1970)[a]	Average Annual Percent Migration (1960-1970)	Percent Urban Population[b]
United States	203,212,877	57	1.3%	1.7%	73.5%
Florida	6,789,412	126	3.7%	2.7%	80.5%
Alachua	104,764	114	4.1%	2.2%	69.0%
Bradford	14,625	50	1.8%	0.8%	33.3%
Clay	32,059	54	6.4%	4.6%	50.2%
Duval	528,865	690	1.6%	0.1%	97.9%
Flagler	4,454	9	-0.3%	1.2%	0.0%
Marion	69,030	43	3.4%	2.0%	40.4%
Putnam	36,290	47	1.3%	0.0%	25.7%
St. Johns	30,727	51	0.3%	-0.4%	40.2%
Volusia	169,487	160	3.5%	3.4%	70.4%

[a] Computed by dividing the percent decade growth rate by 10.

[b] Urban population includes all persons living in communities of 2500 or greater.

Source: U. S. Department of Commerce, 1972.

Table 2.9-2

Age Distribution of Population - 1970

State or County	Total Population	Percent 0-4 Years Old	Percent 5-17 Years Old	Percent 18-64 Years Old	Percent 65 Years Old or Over	Median Age
United States	203,212,877	8.4	16.1	65.6	9.9	28.3
Florida	6,789,412	7.5	23.7	54.2	14.6	32.5
Alachua	104,764	8.5	23.0	62.2	6.3	23.2
Bradford	14,625	7.9	26.7	56.8	8.6	27.5
Clay	32,059	9.9	30.2	51.3	8.6	25.5
Duval	528,865	8.6	26.6	57.3	7.5	26.1
Flagler	4,454	8.0	25.7	50.5	15.8	33.7
Marion	69,030	8.1	26.1	52.6	13.2	30.9
Putnam	36,290	8.3	28.8	50.6	12.3	28.7
St. Johns	30,727	7.3	27.1	51.3	14.3	32.1
Volusia	169,487	6.0	21.0	50.7	22.3	40.2

Sources: U. S. Department of Commerce, 1972; County and City Data Book, and Dames & Moore, 1977.

Table 2.9-3

Educational Characteristics of Those Persons
25 Years Old and Over - 1970

State or County	Median School Years Completed	Percent with Less than 5 Years of School Completed (%)	Percent with 4 Years of High School or More (%)	Percent with 4 Years of College or More (%)	Total Population 25 Years old and Over
United States	12.1	5.5	52.3	10.7	109,899,359
Florida	12.1	5.9	52.6	10.3	3,967,881
Alachua	12.4	8.1	59.8	23.1	46,861
Bradford	10.3	10.5	36.5	4.5	7,837
Clay	12.1	5.7	53.5	9.8	16,226
Duval	12.0	6.3	51.6	8.9	271,623
Flagler	11.2	10.6	44.6	4.7	2,594
Marion	11.6	7.6	47.2	7.4	39,099
Putnam	10.7	10.0	40.0	6.2	19,559
St. Johns	11.7	6.9	48.0	8.5	17,375
Volusia	12.2	4.1	56.9	10.7	107,898

Source: U. S. Bureau of the Census, 1972, County and City Data Book.

Table 2.9-4

Baseline Population Projections
(Thousands of People)

County or State		Actual 1976	1978	1980	1985	1990	1995	2000	2010	2020	Annual Growth Rate 1976-2020
Florida	Lo		8,799.	9,041.	9,741.	10,506.	11,141.	11,744.	12,600.	13,326.	1.0%
	Med	8,552.	8,908.	9,432.	10,538.	11,722.	12,634.	13,572.	15,271.	16,994.	1.6%
	Hi		9,200.	9,853.	11,340.	12,929.	14,351.	15,728.	17,986.	20,121.	1.9%
Alachua	Lo		133.5	135.5	141.8	152.9	162.1	170.9	183.4	193.9	0.9%
	Med	131.6	135.1	141.4	153.4	170.6	183.9	197.5	222.3	247.3	1.4%
	Hi		139.6	147.7	165.	188.2	208.9	228.9	261.8	292.8	1.8%
Bradford	Lo		16.8	17.4	19.1	20.6	21.8	23.0	24.7	26.1	1.1%
	Med	16.3	17.0	18.1	20.6	23.0	24.7	26.6	29.9	33.3	1.6%
	Hi		17.5	18.9	22.2	25.3	28.1	30.8	35.2	39.4	2.0%
Clay	Lo		53.7	58.2	70.5	76.0	80.6	85.0	91.2	96.4	1.5%
	Med	49.3	54.4	60.7	76.2	84.8	91.4	98.2	110.5	123.0	2.1%
	Hi		56.2	63.4	82.1	93.5	103.8	113.8	130.1	145.6	2.5%
Duval	Lo		582.8	583.7	589.3	635.6	674.0	710.5	762.2	806.2	0.7%
	Med	579.7	590.0	608.9	637.5	709.1	764.3	821.0	923.8	1,028.0	1.3%
	Hi		609.3	636.1	686.0	782.1	868.1	951.5	1,008.0	1,217.0	1.7%
Flagler	Lo		8.1	8.0	10.9	11.8	12.5	13.2	14.2	15.0	1.6%
	Med	7.4	8.2	9.2	11.8	13.2	14.2	15.3	17.2	19.1	2.2%
	Hi		8.5	9.7	12.7	14.5	16.1	17.7	20.2	22.6	2.5%
Marion	Lo		104.6	110.6	127.6	137.6	145.9	153.8	165.0	174.0	1.3%
	Med	98.4	105.9	115.4	138.0	153.5	165.4	177.7	200.0	222.5	1.9%
	Hi		109.3	120.6	148.5	169.3	187.9	206.0	235.5	263.5	2.2%
Putnam	Lo		43.9	44.1	44.9	48.4	51.3	54.1	58.0	61.4	0.8%
	Med	43.7	44.4	46.0	48.5	54.0	58.2	62.5	70.3	78.2	1.3%
	Hi		45.9	48.1	52.2	59.5	66.1	72.4	82.8	92.6	1.7%
St. Johns	Lo		41.4	42.6	46.1	49.7	52.7	55.6	59.7	63.1	1.0%
	Med	40.3	41.9	44.4	49.9	55.5	59.8	64.3	72.3	80.5	1.6%
	Hi		43.2	46.4	53.7	61.2	67.9	74.5	85.2	95.3	2.0%
Volusia	Lo		217.4	221.6	234.4	252.8	268.0	282.5	303.1	320.6	0.9%
	Med	212.9	220.0	231.2	253.5	282.0	304.0	326.5	367.4	408.9	1.6%
	Hi		227.3	241.5	272.8	311.1	345.3	378.4	432.7	484.1	1.9%

Source: University of Florida, Bureau of Economic and Business Research, July 1977, 1978-2020 PROJECTIONS OF FLORIDA POPULATION BY COUNTY, and Dames & Moore, 1977.

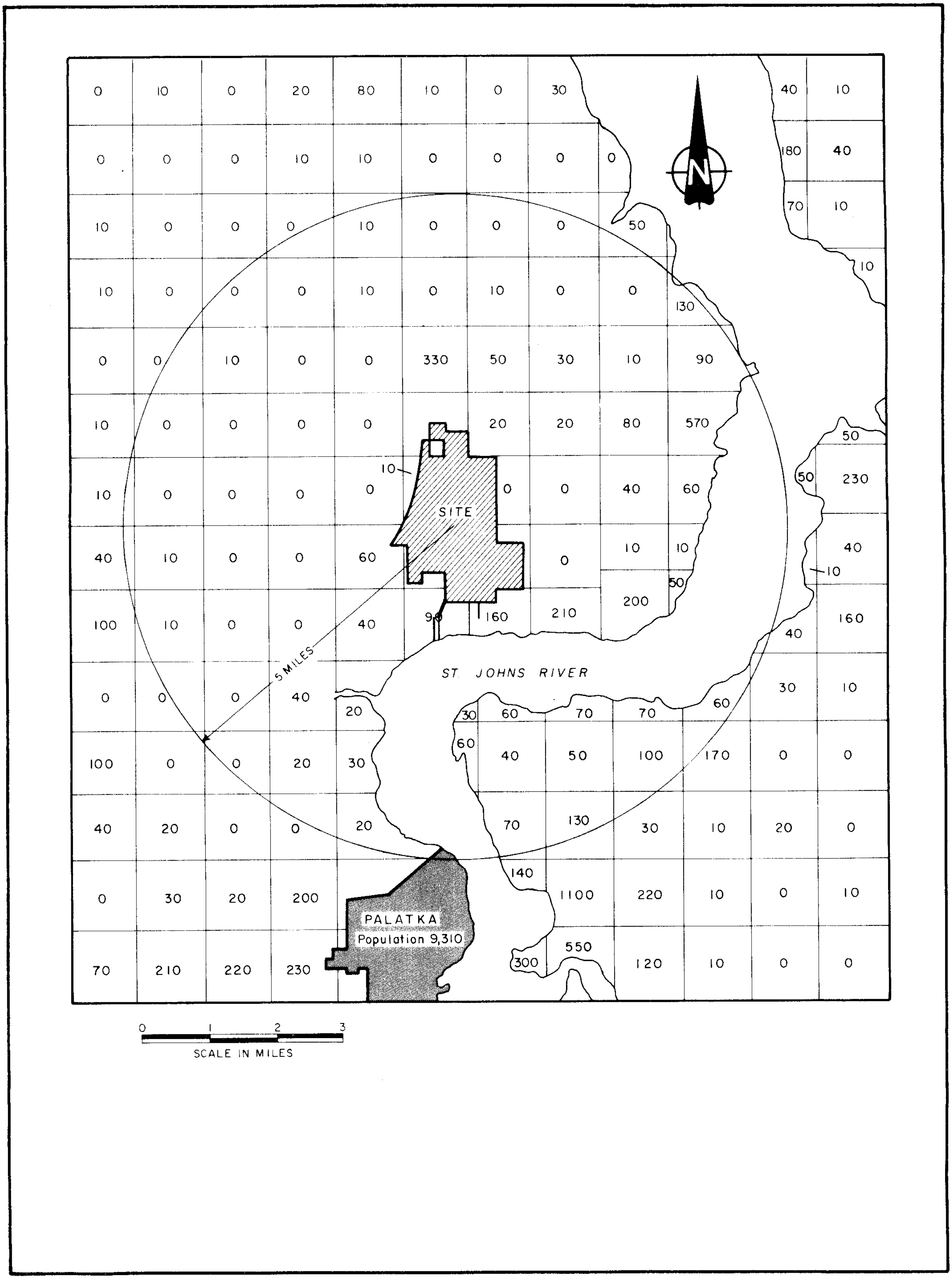


Figure 2.9-1. Estimated Population Distributions within 5 Miles of the Site.

2.10 SOCIAL AND ECONOMIC CHARACTERISTICS

Preliminary estimates by SECI indicate that the proposed plant, once all construction is completed in 1986, will require 140 permanent employees receiving an annual gross payroll of over $4,126,533 in 1986 dollars (SECI, May 2, 1978).

This socioeconomic study consists of two sections. The first section describes the existing socioeconomic environment around the proposed Putnam Site, and presents projections of socioeconomic activities in the baseline case of no construction of new electric power generating facilities. The second part of this study analyzes the socioeconomic impact that may be expected to occur as a result of the construction and operation of a new steam-electric generating station in Putnam County. The socioeconomic impact analysis is included in Section 4.0.

2.10.1 Delineation of Study Area

The site is near Bostwick in Putnam County, Florida (see Figure 2.10-1). Since most of the activities involving construction and operation of the power plant are expected to occur in Putnam County, the primary impact area for the purpose of this study is defined as Putnam County. Palatka, the Putnam County seat, is the major urban center within the primary impact area. Many other smaller communities in Putnam County, such as Interlachen, Crescent City, Pomona Park, Welaka, and Florahome are also part of the primary impact area.

The impacts of plant construction and operation will not be confined to Putnam County. Therefore, a secondary impact area, consisting of the nearby counties of Alachua, Bradford, Clay, Duval, Flagler, Marion, St. Johns and Volusia have been studied as well. The secondary impact area includes a number of major urban centers such as Gainesville in Alachua County, Jacksonville in Duval County, St. Augustine in St. Johns County, and Daytona Beach in Volusia County. Since all of these urban areas are within approximately 50 miles of the site, it is expected that much of the skilled labor required for plant construction will come from these urban areas. Table 2.10-1 briefly summarizes the population characteristics of the study area.

2.10.2 Economic Base of the Impact Area

This section of the socioeconomic baseline study examines the characteristics of the impact area with regard to employment and income. Major industrial sectors will be identified, with special emphasis placed on the primary impact area of Putnam County.

As a whole, the State of Florida has a relatively narrow economic base. In general, Florida is weak in manufacturing, but strong in tourism, trade and services, and construction. The agricultural sector is strong in certain regions of Florida, but is characterized by highly seasonal employment. Although construction has contributed much income to the State of Florida, employment within the construction industry has fluctuated widely from year to year. This may be due to the patterns of land speculation that have occurred in Florida over the years

2.10.2.1 Labor Force Characteristics

The size of the civilian labor force in the impact area counties in 1970 varied from a high of 199,101 in Duval County to a low of 1458 in Flagler County, with Putnam County falling in between with 13,049 (Table 2.10-2). In the same year, unemployment rates varied from a high of 4.4 percent in Putnam County to a low of 1.4 percent in Flagler County, as compared to the Florida average of 3.8 percent. Of the nine impact area counties, only three, (Bradford, Putnam, and Volusia) experienced unemployment rates higher than the state average.

Employment by Occupation

In 1970, 14.1 percent of the labor force in Florida was classified as being employed in manufacturing (Table 2.10-3). Within the Putnam impact area, Alachua was at the low end of the range with only 7.5 percent employed in manufacturing, while Putnam County had by far the largest percentage with 28.7 percent employed in manufacturing (Table 2.10-3). Putnam County's large percentage of employees in manufacturing occupations is a result of Putnam County's heavy reliance on pulp and paper product manufacturing for its primary source of income. For the study area as a whole, however, only two counties, Clay and Putnam, exceeded the state average of 14.1 percent (Table 2.10-3).

Wholesale and retail trade involved 23.5 percent of the labor force on the state level and ranged from a low of 17.3 percent in Putnam County to a high of 25.2 percent in Duval County (Table 2.10-4). These facts tend to support the contention that Putnam County's economic base is less diverse than many of other study area counties due to its heavy reliance on manufacturing.

The percent of the total Florida state labor force employed in service occupations was 11.5 percent in 1970. The impact area counties ranged from 6.4 percent employed in services in Bradford County to 15.0 percent in Flagler County, where services are in relatively high demand due to the high percentage of older citizens.

Educational services involved 7.4 percent of the labor force statewide, and ranged from a low of 6.5 percent in Duval County to a high of 26.6 percent in Alachua County where the University of Florida is located.

Construction employment in 1970 ranged from a low of 4.9 percent of the labor force in Putnam County to a high of 8.9 percent in Volusia County. The state average in that year was 8.5 percent.

Government jobs occupied 16.0 percent of the labor force on a statewide basis, while the study area counties varied from a low of 14.1 percent in Volusia County to a high of 42.9 percent in Alachua County.

In the professional and managerial occupations, Alachua County led the way with 33.9 percent of its labor force employed in this area, while Putnam County was the low county in the study area with 16.9 percent. The state average was 23.3 percent.

Duval County had 31.7 percent of its labor force employed in sales and clerical positions in 1970, the highest in the study area. Flagler County occupied the low end of the range with only 14.2 percent as compared to the state average of 26.6 percent.

Craftsmen and foremen involved 14.5 percent of the labor force on a statewide basis while the Seminole impact area counties ranged from a high of 17.8 percent in Clay County to a low of 10.3 percent in Alachua County.

Basic and Non-Basic Employment by Industrial Sector

In conducting economic baseline and impact studies, it is often convenient to analyze the economy of the primary impact area in terms of basic industries, which generate basic employment and basic income, and non-basic industries, which generate non-basic employment and non-basic income. Basic industries are those industries that produce output for the export (or non-local) market. Export market, in this framework, refers to those markets outside of the primary impact area. Non-basic industries, on the other hand, produce goods and services for the markets within in the primary impact area. Non-basic industries are often associated with activities of local commercial enterprises, while basic industries are associated with larger manufacturing and processing enterprises.

The first step in conducting an economic base study is to define the area of concern in geographic terms. For the Seminole Plant project, the area of concern is defined as Putnam County, the primary impact area.

Many methods exist by which the local economy could be divided into its basic and non-basic components (Tiebout, 1962). The approach utilized in this report is explained in detail in Appendix H.1. The following discussion relates the findings of the analysis.

Three sectors appear to constitute Putnam County's economic base: the agricultural sector with a basic employment of 577 (see Appendix H.1, Table H-1), the manufacturing sector with a basic employment of 440, and the state and local government sector with a basic employment of 429.

The two major crops in the Putnam County agricultural sector are potatoes and cabbage. In addition, many other types of vegetable farms exist. Flower and ornamental plant nurseries for the export market also employ a significant number of people in Putnam County. A few of the more popular Putnam products in this sector include cut flowers such as gladioli, iris, and gypsophilia, and ferns such as leather leaf fern and plumosa fern. Citrus and peach orchards and ranches with beef cattle, dairy cows, and horses are numerous in Putnam County.

The manufacturing sector in Putnam County is by far the most important single sector for generating employment. In 1974, this sector accounted for nearly 25 percent of total county employment. A more detailed breakdown of the manufacturing sector is shown in Table 2.10-4. In this table, it is evident that manufacturers of paper and allied products supply the bulk of the jobs in the manufacturing sector. The county's abundant forest and timber resources support this industry, which produces for a large market throughout the southeast. In 1974, paper and allied products accounted for 2454 jobs in Putnam County, or approximately 77 percent of all manufacturing jobs.

The largest single employer in Putnam County in 1974 was the Hudson Pulp and Paper Company with 2,400 employees. The plant accounted for nearly 19 percent of total Putnam County employment in that year (Florida Dept. of Natural Resources, 1976a).

The second largest employer in Putnam County in 1974 was Central States Diversified, Inc. a producer of paper bags and disposable hospital items, with about 300 employees. Florida Furniture Industries, Inc., a manufacturer of wooden bedroom suites, employed about 275 persons in 1974. Florida Power and Light Company (FP&L), the fourth largest employer in the county, employed approximately 220 people in 1974 (Putnam County Chamber of Commerce, no date).

The importance of the Hudson Pulp and Paper Company to the economy of Putnam County is illustrated in Table 2.10-5, "Putnam County Employment Characteristics." In 1973 the Hudson Pulp and Paper Company employed 2650 people. By the end of 1974, owing to recession conditions, Hudson had laid off 250 workers, thus reducing employment to 2400 (Florida Dept. of Natural Resources, 1976a). From Table 2.10-5, it can be seen that Putnam County's unemployment rate jumped from 3.7 percent in 1973 to 6.2 percent in 1974, an increase of 67.6 percent. During the same two-year period, unemployment for the State of Florida jumped from 4.3 percent to 6.3 percent, an increase of 46.5 percent, while unemployment for the nation as a whole increased from 4.9 percent to 5.6 percent, a change of 14.3 percent. It is thus evident that the overall economy of Putnam County is very sensitive to those factors which might affect operations at a single manufacturing plant, Hudson Pulp and Paper Company.

Baseline Employment Projections

Baseline employment projections for Putnam County, as prepared by the Jacksonville Area Planning Board, are presented in Table 2.10-6. These projections represent what is likely to happen to employment in Putnam County in the baseline case in which the Seminole Plant is not constructed. In Section 6.0 of this report, a different set of employment projections will be presented, which will represent the expected employment situation with the Seminole project.

It should be noted that the specific values of the projections represent a mid-point of a range of possible values. See Appendix H.2 for a discussion of this point.

From Table 2.10-6, it can be seen that all sectors are expected to grow in terms of employment in the baseline case except for the agriculture and mining sectors.

Manufacturing employment is expected to increase at an annual rate of about 1.5 percent over this 30 year period while total employment is expected to increase at a rate of 1.6 percent per year (Table 2.10-6). The sectors with the largest projected employment growth rates are transportation, communication, and public utilties, with a projected annual growth rate of 2.7 percent; and finance, insurance, and real estate with 3.1 percent. Looking at Appendix H.1, it can be seen that these two sectors were among the weakest in Putnam County in 1974. Therefore, it may be reasonable to assume that they will experience the most rapid growth over the next 30 years as Putnam County begins the process of diversifying its economic base.

2.10.2.2 General Income Characteristics

Table 2.10-7 presents data for total personal income and per capita personal income for the nine Putnam Site impact area counties for the years 1974 and 1975. Putnam County had the highest growth rate in both total personal and per capita personal income between 1974 and 1975 of the nine counties. This increase can be partially attributed to the income generated by construction of FP&L's new generating units in East Palatka. Despite the increases, however, Putnam County still experienced an extremely low 1975 per capita personal income of $4,018. Only Bradford County, at $3,722, trailed Putnam. These figures are far below the 1975 state average of $5640 and the impact area high of $5,646 in Duval County.

In Table 2.10-7, percentage increases in per capita personal income for project area between 1974 and 1975 is rather misleading since income is measured in nominal terms in Table 2.10-7. When inflation is taken into consideration, and real income changes are measured, the results change drastically due to the extreme inflation during 1974 (Appendix Table H-2). Wholesale prices jumped by 20.9 percent in 1974 while consumer prices jumped 12.2 percent When Putnam County income data is deflated to constant values by the implicit price deflators (Appendix Table H-3), it becomes apparent that real per capita personal income increased by only 2.4 percent from 1974 to 1975, while per capita personal income increased a nominal 12.3 percent.

Sources of Income

Personal income is often classified according to the source of the income. Table 2.10-8 presents time series data to illustrate the trends of personal income composition in Putnam County and throughout Florida. With regard to wage and salary disbursements and proprietor's income, Putnam County appears to be within a few percentage points of the state average. It is in the dividend, interest, rent, and transfer payment categories, however, that Putnam County differs significantly.

From 1970 to 1974, Putnam County's income from dividends, interest, and rent was, on the average, 38 percent below the state level. This evidence further supports the contention that Putnam County's economy shows very little diversity and points out the weakness of the finance, insurance, and real estate sectors within the county. On the other hand, over this same time period, Putnam County's income from transfer payments averaged 31 percent above the state level. Since transfer payments include welfare to unemployed persons and pensions for retired citizens, it becomes apparent that an unusually high percentage of Putnam County's income is derived from federal and state sources.

Average Wage and Salary Income, by Sector

As pointed out previously, the manufacturing sector constitutes the bulk of the economic base in Putnam County. Table 2.10-9, which provides data on average wage and salary income by industrial sector in 1974, further illustrates the importance of the manufacturing sector in the Putnam economy. In all industrial sectors, except manufacturing, Putnam County's average wage and salary income was below both the Florida and national averages. In the manufacturing sector, however, Putnam County's average wage and salary income of $10,547 exceeded both the state and national averages.

The importance of the Hudson Pulp and Paper Company to the economy of Putnam County is further illustrated in Table 2.10-10, where average wage and salary income is disaggregated within the manufacturing sector for the years 1973, 1974, and 1975. In all manufacturing sectors except paper and allied products, Putnam County's average wage and salary income is below the state average for all years. The importance of the paper and allied products sector is so great in Putnam County that Putnam County's average wage and salary income in paper and allied products not only exceeds the state averages for all years, it exceeds the average strongly enough to offset the weaknesses of the other sectors and enables the overall manufacturing wage average and salary income in Putnam

County to exceed the state average for all years shown. In fact, Putnam County's 1975 average wage and salary income of $11,790 in the manufacturing sector was a full 16.9 percent higher than the state average of $10,089.

Basic and Non-Basic Income by Industrial Sector

Location quotient analysis, as described in Appendix H.1, was used to derive the estimates of basic and non-basic income in Putnam County for 1973, as shown in Table 2.10-11. (This is in contrast to the analysis in Subsection 2.10.2.1, which characterized the basic and non-basic sectors in terms of employment rather than income.)

The importance of manufacturing in the Putnam County economic base is clearly illustrated once again in Table 2.10-11. In 1973, out of a total Putnam County income of $90.2 million, approximately $9.8 million worth of effort was devoted to producing manufactured products for the export market.

The other two major sources of basic income in Putnam County during 1973 were the agriculture and state and local government sectors. This confirms the conclusion that the economic base of Putnam County consists primarily of three sectors - manufacturing, agriculture, and state and local government.

Baseline Income Projections

Table 2.10-12 contains baseline income projections for Putnam County as prepared by the Bureau of Economic Analysis and the U.S. Corps of Engineers. As stated in Subsection 2.10.2.1 in which baseline employment projections were presented, these projections also represent only one of many possible scenarios for growth in Putnam County. Care must be taken not to attach any great relevance to the point estimates for specific years. The statements made in Appendix H.2 regarding projection assumptions, methodology, confidence intervals, and significance levels apply to this section as well.

Over the period 1980 to 2020, the finance, insurance, and real estate sector and the transportation, communication, and public utlities sector are expected to experience the most rapid real income growth with annual growth rates of 4.7 percent and 4.0 percent, respectively. One of the major factors influencing Putnam County's growth pattern will be the outward expansion of Jacksonville's urban area, which is expected to lead to more diversity in the economic base of Putnam County.

The agriculture, forestry and fisheries sector and the mining sector are expected to grow at the slowest rates over this time period, with annual growth rates of 1.7 percent and 2.7 percent, respectively. This is consistent with employment projections that indicate an absolute decrease in employment in these two sectors over time. Labor productivity gains in these two sectors are expected to be high enough to maintain real income growth despite decreases in employment.

Overall, the growth rate of real total personal income for Putnam County over the years 1980 to 2000 is projected at an annual rate of 3.7 percent. From Table 2.10-6, the total employment growth rate over the same period is projected to be 1.3 percent per year.

2.10.3 Housing

In this section of the baseline study, the existing housing situation in the Putnam impact area was investigated. This provides a basis for estimating the potential housing pressures that may develop during the proposed station construction and operation phases.

Existing Housing Stock

As of 1970, Duval County had the largest number of year-round housing units in the Seminole impact area, with 174,149 units, as shown in Table 2.10-13. In the same year, Flagler County had the smallest number of units, with only 1,841, while Putnam County had 12,900 units.

In a more recent survey of housing, conducted in November 1976 for the Putnam County Planning Commission, it was reported that there were 17,220 dwelling units in Putnam County, 15,540 of which were in unincorporated areas. Of these 17,220 units, 59 percent were classified as single family structures, 38.6 percent were classified as mobile home residences, and the remaining 2.4 percent were classified as apartment-type structures (Kellum, Patterson, and Bell, 1977c).

In this recent survey, the housing stock were divided into four classifications:

1. Standard/Sound - This category includes all structures considered to be safe and adequate shelter.

2. Standard/Minor Deterioration - This group includes all structures considered to be safe and adequate although they are in need of some minor repair work.

3. Substandard/Major Deterioration - This classification includes all structures considered to be unsafe and inadequate due to the need for major repair work.

4. Substandard/Dilapidated - This category includes all structures that should be condemned and demolished due to their extreme degree of deterioration.

Of the 17,220 dwellings in Putnam County, 93 percent of these were placed in the first two categories of standard/sound and standard/minor deterioration. All the remaining dwellings in the county were classified as substandard, 50 percent of which were considered dilapidated and suitable for demolition (Kellum, Patterson, and Bell, 1977c).

Recent years have seen a trend toward the use of permanent dwellings and mobile homes for recreational or vacation purposes in Putnam County. As a result, many dwellings in Putman County are vacant for much of the year. Approximately 3,250 units are being utilized in such a manner. Therefore, only 13,970 units out of the county total of 17,220 should be considered as being available for the use of permanent residents (Kellum, Patterson, and Bell, 1977c).

Vacancy Rates

Table 2.10-13 gives data for vacancy rates in the nine Seminole impact area counties for the year 1970. St. Johns County had the highest homeowner vacancy rate at 3.2 percent, while Flagler County had the highest rental vacancy rate at 15.3 perent. In comparison with the state averages of 1.8 percent for the homeowner vacancy rate and 10.7 percent for the rental vacancy rate, the impact area counties in the aggregate appear to have higher vacancy rates than the state for both categories. In the homeowner catagory, five of the nine impact area counties had vacancy rates higher than the 1.8 percent state average, while in the rental category, six of the nine impact area counties had vacancy rates higher than the 10.7 percent state average.

Data from the recent Putnam County Planning Commission survey of November 1976 indicates that there was an overall 12.3 percent vacancy rate for the 13,970 permanent dwelling units in Putnam County in 1976. In other words, out of 13,970 dwelling units, 12,252 were occupied and 1,718 units were vacant. Of the 12,252 occupied units, 10,108 were owner occupied and 2,144 were renter occupied. Of the 10,108 owner occupied units, 630 were classified as substandard in quality and 336 of the 630 were considered suitable for rehabilitation. Of the 2,144 renter occupied units, 355 were classified as substandard of which 189 were considered suitable for rehabilitation. Finally, 151 of the 1,718 vacant units were classified as substandard. Of the 151 substandard vacant units, 78 were considered suitable for rehabilitation (Kellum, Patterson and Bell, 1977c). Thus, in 1976 there were approximately 1567 standard dwelling units available for occupancy in Putnam County alone.

Building Activity

Table 2.10-13 indicates that Clay County experienced the largest percentage increase in housing stock of the nine Seminole impact area counties between 1960 and 1970, with a 64.2 percent increase in the number of housing units. This increase is clearly related to the rapid growth of Clay County as a suburb of the Jacksonville area. The only other two counties that experienced a change in housing stock greater than the state average of 45.4 percent were Alachua County with a 55.0 percent increase and Marion County with a 54.1 percent increase over the ten year period 1960 to 1970.

In July of 1973, Putnam County began to issue building permits for new housing in the county. Since record keeping began in July 1973, 93 single family unit building permits and 487 mobile home permits were issued through December 1973. From January to December of 1974, Putnam County issued 112 permits for single family units and 1012 permits for mobile homes. In 1975, the number of single family unit permits jumped to 285 while the number of mobile home permits jumped to 1022 (Florida Dept. of Commerce, 1976).

According to the Putnam County building codes, mobile homes can be placed in any appropriately zoned area of the county, subject to two conditions. First, a septic tank must be installed to service the mobile home (Bennett, 1977). Second, as required by the State of Florida, the lot size must be at least one-half acre in size in order to accomodate the installation of the mandatory septic tank and a well (which is optional) (Kellum, Patterson, and Bell, 1977c).

Housing Costs

Median gross rents for the nine county impact area for 1970 are indicated in Table 2.10-13. Although the data are somewhat outdated, they do indicate that rents in Bradford County, Flagler County, and Putnam County were extremely low in 1970. With the exception of Alachua County, the entire impact area experienced rents which were far below the state average of $114 per month in 1970 dollars.

June 1976 data for Putnam County from the Florida Department of Commerce indicate that the average rent for efficiencies was $100 per month. For one bedroom apartments, rents averaged $125 to $150 per month; for two bedroom apartments, $185 to $200 per month; and for 3 bedroom apartments, $210 to $225 per month (Florida Dept. of Commerce, 1976). The Florida Department of Commerce also indicates that the availability of two and three bedroom apartments in Putnam County appears to be greater than the availability of efficiencies and one bedroom apartments.

Purchase prices of existing homes in Putnam County ranges from $15,000 for a two bedroom middle income home to $35,000 for a 4 bedroom middle income home. The availability of small middle income homes and all sizes of low income homes for purchase is rated as very low (Florida Dept. of Commerce, 1976). Only three and four bedroom middle income homes appear to be in reasonable supply. Rental prices for the larger middle income homes range from $160 to $200. The smaller middle income and all low income homes rent for anywhere from $100 to $150 per month (Florida Dept. of Commerce, 1976).

Florida Department of Community Affairs data indicates that the average rent for a 4-bedroom apartment in 1974 ranged from $165 per month in Clay County to $103 per month in Flagler County (Kellum, Patterson, and Bell, 1977c). For 1976 in Putnam County, monthly rents ranged from under $50 a month to over $150 per month (Kellum, Patterson, and Bell, 1977c). During 1976 there were an estimated 106 renter occupied units in the under $50 per month price range, in 1976, 411 renter occupied units in the $50 to $99 per month range, 79 renter occupied units in the $100 to $124 per month price range, 13 units in the $125 to $149 range, and 23 units in the $150 and over range (Kellum, Patterson and Bell, 1977c).

The early years of 1970 saw high levels of residential building activity in Jacksonville and nearby urban areas. Although rents of $150 to $250 per month for one and two bedroom apartments are much higher in the Jacksonville area than the rents for comparable housing in Putnam County, the availability of these one and two bedroom apartments appears to be fairly high.

2.10.4 Public Services

Since Putnam County has been defined as the primary impact area for purposes of this socioeconomic baseline study, the discussion of existing public services in this section will focus on Putnam County. Information involving counties of the secondary impact area will be presented only in cases deserving special attention.

Education

Enrollment and capacity data for the Putnam County School District for the academic year 1977-1978 is presented in Table 2.10-14 (Putnam County School District, 1977). The Putnam County School District consists of eight elementary schools (Kindergarten through fifth grade), four middle schools (grades six to eight), and 3 high schools (grades nine to twelve). The combined student capacity of these fifteen schools is 11,952, which exceeds the 1977-1978 combined estimated enrollment of 10,448.

Table 2.10-14 indicates that five schools, Beasley Middle, Interlachen Community, Price Middle, Long Elementary, and Palatka High, are expected to experience 1977-1978 enrollments in excess of their capacity. Nevertheless, all schools in the district meet the Florida State Department of Education's recommendations that the classroom area per pupil must be at least 35 square feet for Kindergarten through second grade, 30 square feet for grades three through six, 28 square feet for grades five to eight, and 25 square feet for grades nine through twelve (Kellum, Patterson and Bell, 1977c). Additionally, from Table 2.10-14 it can be seen that all schools in the district meet the Florida State Department of Education's recommendations that the student teacher ratio not exceed 25 for elementary school students and 30 for middle and high school students (Kellum, Patterson, and Bell, 1977c).

Projected enrollments for the Putnam County School District through the academic year 1981-1982 are presented in Table 2.10-15. The general trend for the entire school system is for decreasing enrollment from 10,567 total students in 1976-1977 to an expected 10,333 total students in 1981-1982. Only the kindergarten through fifth grade category is expected to experience an increase in students, with a peak occuring in the 1979-1980 school year. The implication of increasing enrollments in the lower grades is that eventually enrollments in the higher grades will begin to increase in the years beyond 1982. There are no enrollment projections beyond 1982.

Putnam County also has a few private elementary and secondary schools, all of which are located in Palatka. As of 1975, there was the Briarwood School for grades one through twelve with 17 teachers, the Christian Independent Private School for grades one to nine with 5 teachers, and the Palatka Seventh Day Adventist Church School for grades four to eight with one teacher (Florida Dept. of Commerce, 1976).

Five libraries are available for public use in Putnam County. The major library is the Palatka Public Library with 25,000 volumes. A public library also exists in Interlachen. Three private libraries allow public access and are found in Crescent City, Welaka, and Melrose (Kellum, Patterson, and Bell, 1977c).

Many colleges and universities are located within the overall impact area. St. Johns River Junior College, located in Palatka, provides an undergraduate curriculum for approximately 1400 students (Florida Dept. of Commerce, June 1976). As one of 27 junior colleges in Florida, St. Johns River Junior College is also the site of the recently organized Florida School of the Arts (Putnam County Chamber of Commerce, 1977).

The University of Florida is located in Gainesville, while Jacksonville is the home of the University of North Florida and Jacksonville University. Finally, there is Stetson University, located in Deland, Volusia County.

Vocational technical educational opportunities are available in St. Augustine at the St. Augustine Technical Center. It is a public school with an enrollment of 2,247 (Florida Dept. of Commerce, 1976). Courses at the St. Augustine Technical Center are geared to the needs of the community.

Transportation

Roads

U.S. Route 17, the major north-south highway between Palatka and Jacksonville, will most likely be the primary access road to the Putnam Site. State Routes 20 and 100 are the major eastwest highways in Putnam County; they lead to Interstate 75 to the west. State Route 207 connects Palatka to Interstate 95 about 20 miles east of Palatka. Figure 2.10-2 indicates these and other roads in the vicinity of the Putnam Site.

The Florida Highway Patrol has indicated that the U.S. Route 17 - State Route S209 intersection at the Seaboard Coast Line Railroad crossing is very dangerous (Hodges, 1977). The intersection is heavily congested during morning and evening rush hours since State Route S209 is the only access to the homes along the riverfront, and U.S. Route 17 is busy with traffic involving the Hudson Pulp and Paper Company employees and school buses. Additionally, the Rice Creek Bridge on U.S. Route 17, just south of the above mentioned intersection, is a serious bottleneck during rush hours (Hodges, 1977).

Table 2.10-16 presents traffic counts for the above-mentioned points as well as for other key intersections in the vicinity of the Putnam Site. U.S. Route 17 at Moccasin Creek experienced a 24-hour flow of 3,852 vehicles in 1977. U.S. Route 17 at Rice Creek, less than 2 miles south of Moccasin Creek, experienced a 24-hour flow of 5,408 vehicles in 1977. The large increase in traffic flow over this two-mile distance is largely due to traffic from State Route S09.

The State Department of Transportation's Five Year Construction Plan is designed to help alleviate the congestion problems in the Rice Creek area of U.S. Route 17 (Florida Dept. of Natural Resources, 1976e). U.S. Route 17 is scheduled to become a four lane highway from State Route S209 to South Avenue in Palatka. Additionally, the Rice Creek bridge, currently a narrow two-lane structure, is scheduled to be completely replaced by a new four-lane bridge. Although the State Attorney is currently working on property condemnation proceedings for these projects, the date of project completion is still uncertain.

Highway capacity of U.S. Route 17 in the vicinity of the Putnam Site in good weather conditions is approximately 14,000 cars per day at service level C (minimum stable flow rate retaining maneuverability). When the portion of U.S. Route 17 south of Rice Creek bridge has been widened to four lanes the basic (level C) capacity of the highway should be 22,500 cars per day with a possible capacity as high as 28,500 cars per day. For State Route S209, the best possible highway capacity at service level C is 10,500 cars per day, with a more conservative figure being 8,500 cars per day (Bilby, 1978). Existing traffic levels on these highways are well below their rated capacity.

Railroads

Putnam County is serviced by three major railroads. The Seaborad Coast Line Railroad, whose main line passes through Palatka, provides both main line passenger and freight service along the eastern seaboard. The Florida East Coast Railway provides freight service from Palatka eastward to the east coast of Florida. The Southern Railroad provides freight service from Palatka, the southern terminus of the Southern system, northward to Valdosta, Georgia and other southeastern states. Approximately 28 trains pass through Palatka every 24 hours (Hodges, 1977).

Waterways

The Putnam County Port Authority operates the St. Johns River Barge Port. With a dredged channel 12 feet deep and 100 feet wide, the barge port is able to accomodate vessels up to 250 feet in length (Figure 4.4-1). A 3800-foot long access channel from the St. Johns River waterway channel terminates in a 350 foot square turning basin at the barge port. Facilities at the barge port include cluster mooring dolphins for holding waiting barges, and a 20,000 square foot warehouse complete with sprinkler system (Florida Dept. of Commerce, 1976). Professional warehousing, materials handling, stevedoring, and container services are available at the barge port.

Airports

Putnam County has one general aviation facility, the Kay-Larkin airport, located about 3 miles from downtown Palatka. Although there is no scheduled passenger or freight service from Kay-Larkin, there are four 5000 foot runways, one of which is lighted (Florida Dept. of Commerce, 1976). Gasoline, maintenance and repair, and tie-down services are available at Kay-Larkin.

Other airports in the impact area include Gainesville, Daytona Beach, and Jacksonville. The Gainesville and Daytona Beach airports have limited scheduled airline services. Jacksonville International Airport, however, is a full facility airport served by such major airlines as Delta, United, Eastern, National, Northeast, and Southern, as well as numerous minor airlines.

Medical Facilities

The major medical facility in Putnam County is the Putnam Community Hospital in Palatka which began receiving patients on September 1, 1975 (Webb-Westbury Associates, 1975). This hospital is a general acute care medical and surgical facility that was built with private capital and is operated as a wholly-owned subsidiary of the Hospital Corporation of America. The hospital has 117 beds and an 80-percent occupancy rate (Jarnicki, 1977) and offers many services including a coronary care unit, pathology, radiology, physical therapy, electrocardiogram, nuclear medicine, isolation facilities, blood banks, outpatient services, and a 24-hour emergency room.

Other medical facilities in Putnam County include the Lakeshore Nursing Home with 92 beds for in-patient service in Crescent City, and the Putnam Memorial Nursing Home in Palatka with 60 beds for in-patient service (Florida Dept. of Commerce, 1976).

As of 1975, Putnam County had thirteen general practitioners, one gynecologist, one pediatrician, and twelve other assorted specialists including three optometrists and two chiropractors (Florida Dept. of Commerce, 1976; Putnam County Chamber of Commerce, no date). For dental care, Putnam County had eight general dentists, two orthodontists, and three dental specialists in 1975 (Florida Dept. of Commerce, 1976). Additional medical personnel can be found in Crescent City where there were three physicians and one dentist in 1975 (Putnam County Chamber of Commerce, no date).

Many other hospitals are located within the Seminole impact area. Jacksonville contains twelve hospitals, Gainesville has four hospitals, and St. Augustine has two (Jarnicki, 1977).

Fire Fighting Facilities

Putnam County is served by 21 fire companies, all of which are volunteer organizations except for the Palatka and Crescent City municipal fire departments (Florida Dept. of Commerce, 1976).

As of 1975, the Palatka fire department consisted of 1 fire station, 30 firemen, and 7 vehicles. In the same year, the Crescent City fire department included 1 station, 14 firemen, and 3 fire fighting vehicles. In all, the volunteer units consisted of 19 stations, 283 volunteers, and 41 assorted vehicles (Florida Dept. of Commerce, 1976). With an estimated population of 43,660 in 1976 and 327 firefighters, Putnam County therefore had approximately 7.5 firefighters per 1000 of population. The general minimum standard is 2.4 firefighters per 1,000 of population (Kellum, Patterson, and Bell, 1977c).

Police Protection

Putnam county is served by four different law enforcement agencies - the Putnam County Sheriff's Department, the Palatka Police Department, the Crescent City Police Department, and the Interlachen Police Department. In addition, the Florida Highway Patrol maintains a Division office at Palatka.

The Putnam County Sheriff's Department consisted of 79 employees in 1976. This group included one Sheriff, one Chief Deputy Sheriff, seven detention officers, 10 communications officers, four court officers, nine detectives, 31 patrolmen, and six secretaries (Kellum, Patterson, and Bell, 1977c). The remaining employees work as part-time communications officers, court officers, and youth officers.

The Patrol division in the Sheriff's Department has the use of 20 patrol cars, one van, one truck, and three boats. Putnam County is divided into five patrol zones, each patrolled on a 24-hour basis. Shifts consist of seven officers, six on patrol and one in the station (Kellum, Patterson, and Bell, 1977c).

The Putnam County Jail, constructed in 1963, has capacity for 95 prisoners (83 males and 12 females). The jail is too small to hold the number of prisoners projected for future years (Kellum, Patterson and Bell, 1977a).

As of 1975, the Palatka Police Department consisted of one police station, 25 policemen, and seven patrol vehicles. In the same year, the Crescent City Police Department consisted of one police station, 10 patrolmen, and three patrol vehicles, while the Interlachen Police Department comprised one station, one officer, and one vehicle (Florida Dept. of Commerce, 1976).

The Florida Highway Patrol Division in Putnam County comprises 14 officers. Including these officers with those from the other four police departments, Putnam County had approximately 129 law enforcement officers in 1975. This amounts to approximately 2.95 officers per 1000 population and compares favorably with recognized law enforcement standards which indicate that 1.75 to 2.00 officers are generally required per 1000 persons living within the area to be served (Kellum, Patterson, and Bell, 1977c).

Recreational Activities

Recreation in Putnam County includes those activities that make best use of the ample water resources and warm climate of northern Florida. As a result of the area's reputation for good fishing, Palatka is frequently referred to as the "Bass Capital of the World." In addition to the St. Johns River, the waters of Crescent Lake, Lake George, and Lake Oklawaha are famous for speckled perch, bream, catfish, blue crabs, and shrimp, as well as many species of bass. Other outdoor water sports such as sailing, swimming, boating, and water skiing are also popular in Putnam County.

Hiking and camping are popular activities in the vast forests of the Ocala National Forest which lies in Putnam County, Marion County, and Lake County. Other recreation areas in Putnam County include the Oklawaha Recreation Area, the Rodman Recreation Area, the Kenwood Recreation Area, the Orange Springs Recreation Area, and the Turtle Egg Recreation Area. These areas offer such facilities as boat ramps, canoe launching areas, hiking trails, picnic tables, shelters, and charcoal grills. Ravine Gardens State Park is located within a few blocks of downtown Palatka.

Cultural activities are also prevalent in the Putnam County area. A local concert association sponsors musical events throughout the year, and the Florida School for the Performing Arts presents various dramatic events at the St. Johns River Junior College.

The ocean beaches of Daytona Beach and St. Augustine are all within the Seminole impact area. Other recreational attractions include Walt Disney World in Orlando, the famous tourist center at Silver Springs, and the dog races at Orange Park in Clay County.

2.10.5 Public Utilities

Electricity

Putnam County receives its electric power from the Clay Electric Cooperative, a member of Seminole Electric Cooperative, Inc. (SECI), and from FP&L. The Clay Electric Cooperative, which serves western Putnam County, has no generating capacity of its own, but purchases its power from SECI, and distributes it to the rural areas of Putnam County. As of March 31, 1977, the Clay Electric Cooperative serviced 9,362 customers, 8,651 of which were residential (Putnam County Chamber of Commerce, 1977). During 1976, over 84.6 million kilowatt-hours of electricity were consumed by Clay County Electric Cooperative customers in Putnam County (Putnam County Chamber of Commerce, 1977).

Florida Power and Light Company, which serves the eastern portions of Putnam County, provided service for 11,969 residential customers, 1,834 commercial customers, and 76 industrial customers during 1976. During that same year, FP&L customers in Putnam County consumed over 226 million kilowatt-hours of electric power (Putnam County Chamber of Commerce, 1977).

Florida Power and Light Company has two existing units in operation in Palatka, and two old units were recently retired. The two recently retired units are heavy oil steam units which were constructed in 1951 and 1956 respectively. The combined generating capacity of these two units was 113 megawatts in summer and 117 megawatts in winter. The two new units are combined-cycle, heavy-oil units with a combined generating capacity of 484 megawatts in summer and 552 megawatts in winter.

Natural Gas

Natural gas is supplied to the City of Palatka by the Palatka Gas Authority. Rural areas of Putnam County do not receive natural gas, but are served by about ten companies distributing liquid propane gas and fuel oil (Florida Dept. of Commerce, 1976).

As of 1976, the Palatka Gas Authority provided service to 3,676 customers in Palatka. During that same year, the customers of the Palatka Gas Authority consumed over 270 billion cubic feet of natural gas (Putnam County Chamber of Commerce, 1977).

Water Supply Facilities

Putnam County does not presently provide water supply services within the county. Water is supplied, however, by a few of the incorporated municipalities, and by various other small-scale suppliers. As of 1973, there were approximately 34 existing water systems in Putnam County (Kellum, Patterson and Bell, 1977c). Out of an estimated 12,885 structures in the county, about 5,884, or 45.7 percent, were served by central water systems (Kellum, Patterson, and Bell, 1977c). The majority of the structures receiving water from central water systems are located in Palatka and Crescent City. Most of the water service is received on an individual basis or as part of small systems which serve single developments or subdivisions. The majority of these systems provide disinfection services, but only the City of Palatka provides fluoridation and filtration in addition to disinfection. Five of the 34 existing systems serve schools only, while 3 of the systems serve the municipalities of Palatka, Crescent City, and Interlachen (Kellum, Patterson and Bell, 1977c). Individual wells supply water in areas of the county not served by central water systems.

The water system for the City of Palatka obtains its water from four wells which enter the Floridan Aquifer (Florida Dept. of Natural Resources, 1976e). The combined capacity of these four wells is 4.6 million gallons per day, although treatment capacity is only 3.5 million gallons per day (Florida Dept. of Natural Resources, 1976e). As of 1975, the maximum daily demand was 3.5 million gallons per day while the average daily demand was 2.5 million gallons per day, for 71 percent utilization rate of the treatment capacity (Florida Dept. of Natural Resources, 1976e).

The pulp and paper industry, which is the major industrial consumer of water in Putnam County, consumes nearly 18.5 billion gallons of water per year, all of which is self-supplied (Florida Department of Natural Resources, 1976e). Approximately 59 percent of their water is drawn from artesian wells, while the other 41 percent is drawn from the surface waters of Etonia and Rice Creeks (Florida Department of Natural Resources, 1976e).

The City of Palatka maintains water storage facilities consisting of two 750,000 gallon elevated tanks and one 400,000 gallon ground storage tank (Florida Department of Natural Resource, 1976e).

Sewage Treatment Facilities

Putnam County does not presently provide sewer services or maintain a system of storm drains. As of 1973, however, there were 19 separate sewage disposal systems operating in the county. Two of these were the municipal systems for Palatka and Crescent City, and five of them served schools only. Out of an estimated 12,885 structures in the county, about 3,961 or 31 percent were served by one of these 19 sewer systems (Kellum, Patterson, and Bell, 1977c). The majority of the structures receiving central sewer service are within the incorporated municipalities of Palatka or Crescent City. Sewer services in these areas are received on an individual basis or as part of small systems serving single developments or subdivisions.

The sewer system for Palatka has a treatment plant with a capacity of 1.75 million gallons per day. The average daily flow through the treatment plant is approximately 1.5 million gallons per day. On occasion, however, the system has reached capacity (Florida Dept. of Natural Resources, 1976e).

The majority of the county residents not receiving sewer service rely on the use of septic tanks for sewage disposal. Because of poor drainage, poor percolation, and a high water table in many areas of Putnam County, however, it appears that much of the soil is poorly suited for the use of septic tanks for sewage disposal.

Solid Waste Disposal

Putnam County provides no door-to-door collection services for solid wastes. Palatka and Crescent City, however, do provide door-to-door collection services, and other areas of the county have private collection service.

The lack of an extensive collection system for the county as a whole has resulted in widespread roadside dumping despite the existence of three county operated sanitary landfill sites (Kellum, Patterson and Bell, 1977c). Due to the high water table and porous soil in much of the county, however, the use of these landfills may adversely impact ground water quality. No current plans exist to institute a county-wide solid waste collection service.

2.10.6 Public Finances (Local)

Property Taxes

As of 1975, the Putnam Site consisted of an estimated 1,942 acres of agriculturally zoned land owned by River Farms, Inc. The total assessed value of these 1,942 acres in 1975 was $291,225 and the total annual property taxes paid was $1,832.56. Since the 1975 Putnam County tax rate was 17.98 mills (Florida Dept. of Natural Resources, 1976), and only $1,832.56 was paid in taxes, it is evident that the non-exempt assessed valuation of these 1,942 acres must have been $101,922 in 1975. This implies that agriculturally zoned land was subject to an agricultural exemption amounting to 65 percent of the total assessed valuation in 1975.

The total non-exempt assesed valuation for Putnam County in 1975 was $307,377,895 as is shown in Table 2.10-17. Table 2.10-18 gives a detailed breakdown of the composition of the total and non-exempt assessed valuation. From these data, it becomes apparent that the total non-exempt assessed valuation of the Putnam Site in 1975 as a percentage of the total non-exempt assessed valuation in Putnam County was approximately 0.03 percent.

The breakdown by jurisdiction of the 17.98 mill tax rate in 1975 is illustrated in Table 2.10-19. From this table, it can be seen that the Putnam County School District levied a total of 8.38 mills upon the Putnam County taxpayers in 1975. For the 1976-1977 school year, the school district millage declined to 8.26 mills. The detailed breakdown of the 1976-1977 school district tax levy is illustated in Table 2.10-20.

The Putnam County School District receives a substantial fraction of its revenue from sources other than local property taxes. From Table 2.10-21, it can be seen that local property tax revenue constituted only 21.88 percent of the total revenues received by the Putnam County School District during the 1975-1976 school year. Table 2.10-21 also indicates, however, that the share of total school district revenue born by local property taxes is expected to increase to 26.12 percent by the 1977-1978 school year.

Various municipalities within Putnam County levy additional millages above the county millages to help finance the added costs of government services in urban areas. As can be seen from Table 2.10-22, these additional levies ranged from 3.43 mills in Pomona Park to 9.92 mills in Palatka for the year 1975.

Sales Tax

The State of Florida has a 4 percent sales tax, which does not include food, drugs, or utility sales. Data for total retail sales for 1972 to 1974 of all the impact area counties is illustrated in Table 2.10-23. The total sales tax collected by Putnam County in 1975 was $5,612,584. In 1976, Putnam County collected $5,218,069 (Putnam County Chamber of Commerce, 1977).

Gasoline Tax

In 1975, Putnam County collected $1,774,726 in state gasoline taxes. In 1976, the figure had increased to $1,938,428 (Putnam County Chamber of Commerce, 1977).

2.10.7 References

Bennett, Fay, 1977, Secretary to Codes Administrator, Putnam County Board of County Commissioners, personal communication.

Florida Department of Commerce, 1976, Economic Development Summary: Putnam County Florida, Division of Economic Development, Tallahassee, Florida.

__________, 1977, Economic Indicators of Florida's 67 Counties, Division of Economic Development, Bureau of Economic Analysis, Tallahassee, Florida.

__________, 1977a, An analysis of the Florida economy as it pertains to economic development, Bureau of Economic Analysis, Tallahassee, Florida.

__________, 1977b, Florida Facts, Division of Economic Development, Tallahassee, Florida.

__________, 1977, Putnam County Economic Data, Bureau of Economic Analysis, Tallahassee, Florida.

__________, no date, Florida Facts, Division of Economic Development Tallahassee, Florida.

Florida Department of Natural Resources, 1975, Florida regional coastal zone management atlas, Region 4, Northeast Florida Division of Resources Management, Bureau of Coastal Zone Planning, Tallahassee, Florida.

__________, 1976a, Florida regional coastal zone economic analysis, Region 4, Northeast Florida Division of Resources Management, Bureau of Coastal Zone Planning, Tallahassee, Florida.

__________, 1976b, Florida regional coastal zone land ownership inventory, Region 4, Northeast Florida, Clay County, Flagler County, Nassau County, Putnam County, Division of Resource Management, Bureau of Coastal Zone Planning, Tallahassee, Florida.

__________, 1976c, Florida regional coastal zone land use analysis, Region 4, Northeast Florida, Division of Resource Management, Bureau of Coastal Zone Planning, Tallahassee, Florida.

__________, 1976d, Florida regional coastal zone population analysis, Region 4, Northeast Florida, Division of Resource Management, Bureau of Coastal Zone Planning, Tallahassee, Florida.

__________, 1976e, Florida regional coastal zone support services analysis, Region 4, Northeast Florida, Part II, Division of Resource Management, Bureau of Coastal Zone Planning, Tallahassee, Florida.

Florida Department of Transportation, 1973, 24-hour average annual traffic, Putnam County, Florida, Tallahassee, Florida.

__________, 1974, 24-hour average annual traffic for Putnam County Florida, Tallahassee, Florida.

__________, 1975, 24-hour average annual traffic for Putnam County Florida, Tallahassee, Florida.

__________, 1976, 24-hour average annual traffic for Putnam County Florida, Tallahassee, Florida.

______, 1977, 24-hour average annual traffic flow for Putnam County Florida, Tallahassee, Florida.

Florida Power and Light Company, 1975, Response to State of Florida Power Plant Siting Act 1975-1984, Miami, Florida.

Hodges, Thomas, C., 1977, Florida Highway Patrol, Palatka, Florida, personal communication.

Jacksonville Area Planning Board, 1976a, Regional Economic Base Study, Region IV, Jacksonville, Florida.

__________, 1976b, Regional Employment Study, Region IV, Jacksonville, Florida.

Jarnicki, 1977, Putnam Community Hospital, Palatka Florida, personal communication.

Kellum, Patterson, and Bell, 1977a, Comprehensive Plan: Putnam County Florida: Summary Report, Tampa, Florida.

__________, 1977b, Comprehensive Plan, Putnam County, Volume One, Planning Data Inventory and Analysis, Tampa, Florida.

__________, 1977c, Comprehensive Plan, Putnam County, Volume Two, Comprehensive Plan Elements, Tampa, Florida.

__________, 1977d, Comprehensive Plan, Putnam County, Volume 3, Plan Implementation, Tampa, Florida.

Myhra, David, 1977, Socioeconomic impacts at energy construction sites, Power Engineering.

Putnam County Chamber of Commerce, 1977, Palatka and Putnam County Florida, Industrial Division, Palatka, Florida.

__________, 1977, Update, Palatka, Florida.

__________, no date, Palatka and Putnam County Florida Facts, Palatka, Florida.

Putnam County School District, 1976, Survey of school plants, Palatka, Florida.

__________, 1977, Office of the Superintendent, Palatka, Florida.

Sales Management, 1973, Survey of buying power, New York.

__________, 1974, Survey of buying power, New York.

__________, 1975, Survey of buying power, New York.

Seminole Electric Co-operative, 1977, Power requirements study Florida 41 Seminole, Tampa, Florida.

__________, no date, SEC-Power to the People, Tampa, Florida.

Tiebout, Charles M., 1962, The community economic base study, Supplementary Paper Number 16, Committee for Economic Development, New York.

United States Army Corps of Engineers, 1975, Projections of economic activity in Florida, Series E Populatin, South Atlantic Division.

United States Department of Commerce, 1972, County and City Data Book, Social and Economic Statistics Administration, Bureau of the Census, United States Government Printing Office, Washington.

__________, 1977, Industry-specific gross output multipliers for Bureau of Economic Analysis Economic Areas, Bureau of Economic Analysis, Regional Economic Analysis Division, United States Government Printing Office, Washington.

United Stated Water Resources Council, 1974, 1972 OBERS projections, Volume One, Concepts, methodology, and summary data, United States Government Printing Office, Washington.

University of Florida, 1977, 1978-2020 projections of Florida populations by county, Bureau of Economic and Business Research, Population Division, Gainesville, Florida.

Webb-Westbury Associates, 1975, Putnam Community Hospital, Palatka, Florida.

Table 2.10-1

Population Characteristics of the Study Area

County	1970 Population	Major City	1970 Population	Miles From Palatka
Alachua	104,764	Gainesville	64,510	44
Bradford	14,625	Starke	4848	39
Clay	32,059	Green Cove Springs	3857	26
Duval	528,865	Jacksonville	528,865	53
Flagler	4454	Bunnell	1687	30
Marion	69,030	Ocala	22,583	54
Putnam	36,424	Palatka	9444	0
St. Johns	30,727	St. Augustine	12,352	28
Volusia	169,487	Daytona Beach	45,327	53

Source: Putnam County Chamber of Commerce, (no date). Palatka and Putnam County Florida Facts.

Table 2.10-2

Labor Force Characteristics - 1970

State or County	Total Civilian Labor Force	Female Civilian Labor Force	Percent Unemployed of Total Civilian Labor Force	Percent of Labor Force Using Public Transport to Work	Percent of Labor Force Working Outside County of Residence
Florida	2,521,245	1,010,356	3.8%	4.3%	8.0%
Alachua	41,050	17,544	3.4%	1.9%	5.0%
Bradford	4985	1940	4.5%	0.6%	29.4%
Clay	9531	3694	3.1%	0.2%	53.4%
Duval	199,101	81,874	3.3%	6.7%	2.6%
Flagler	1458	530	1.4%	2.9%	23.8%
Marion	25,307	9944	3.5%	1.9%	8.6%
Putnam	13,049	5119	4.3%	2.6%	12.5%
St. Johns	10,990	4246	3.6%	3.9%	15.7%
Volusia	58,394	24,642	4.0%	2.5%	6.7%

Notes: Labor force includes those workers 16 years old and over.

Source: U. S. Department of Commerce, 1972, County and City Data Book.

Table 2.10-3

Employment Characteristics by Occupation
1970

County or State	Total Employment	Manufacturing Percent	Wholesale & Retail Trade Percent	Services Percent	Educational Services Percent	Construction Percent	Government Percent	Professional Managerial Percent	Sales & Clerical Percent	Craftsmen & Foreman Percent
Florida	2,426,268	14.1	23.5	11.5	7.4	8.5	16.0	23.3	26.6	14.5
Alachua	39,639	7.5	19.4	7.9	26.6	6.8	42.9	33.9	25.0	10.3
Bradford	4763	13.9	18.2	6.4	7.8	7.9	28.6	18.2	19.2	15.1
Clay	9232	14.9	18.4	6.5	9.0	7.2	27.4	23.5	25.3	17.8
Duval	192,517	12.3	25.2	10.4	6.5	7.3	17.2	21.9	31.7	14.7
Flagler	1437	12.1	17.7	15.0	7.9	7.2	20.6	25.2	14.2	12.0
Marion	24,428	11.9	24.7	10.5	8.1	8.6	16.4	20.3	22.4	13.3
Putnam	12,492	28.7	17.3	9.2	8.8	4.9	15.8	16.9	19.1	12.3
St. Johns	10,596	13.1	20.0	12.6	8.2	7.6	19.7	23.2	20.9	15.8
Volusia	56,054	10.7	25.0	13.7	8.3	8.9	14.1	24.8	25.1	14.1

Note: Percentages for each county do not sum up to 100% due to overlapping classification.

Source: U. S. Depatment of Commerce, 1972, County and City Data Book.

Table 2.10-4

Putnam County Manufacturing Sector Employment

MANUFACTURING SECTOR	AVERAGE MONTHLY EMPLOYMENT 1969	1974	1975
Total Manufacturing	3,498	3,194	3,137
Food and Kindred Products	193	D	50
Lumber and Wood Products	213	308	300
Furniture and Fixtures	284	D	D
Paper and Allied Products	2,754	2,454	2,397
Machinery Except Electrical	N	D	32
Other Manufacturing	54	432	358

Notes: Only workers covered by unemployment compensation are reported.
D = Non-Disclosure Item. This manufacturing group is summed in "other manufacturing."
N = Employment not reported for this manufacturing sector.

Sources: Employment Security Division, Florida Department of Commmerce, Employment and Payrolls, 1969, 1974, and 1975, as cited in Bureau of economic analysis, Division of Economic Development, Florida Department of Commerce, April 1977, Putnam County Economic Data.

Table 2.10-5

Putnam County Employment Characteristics

Year	Putnam County Civilian Labor Force	Annual Growth Rate of Labor Force (%)	Unemployment Rates (%) Putnam	Florida	USA
1970	13,400	18.6	2.5	4.3	4.9
1971	13,580	1.3	3.1	4.9	5.9
1972	13,460	-0.8	2.5	4.5	5.6
1973	14,000	4.0	3.7	4.3	4.9
1974	14,740	5.3	6.2	6.3	5.6
1975	16,280	12.5	8.6	10.7	8.5
1976	16,890	3.7	7.6	9.0	7.7
1977	17,201	1.8	6.3	8.0	7.9

Notes: All county data are March figures while Florida and United States data are annual averages.

Sources: Florida Department of Commerce, Division of Employment Security, (no date), as cited in Bureau of Economic Analysis, Division of Economic Development, Florida Department of Commerce, April 1977, Putnam County Economic Data, and Dames & Moore, 1977.

Table 2.10-6

Putnam County Baseline Employment Projections by Industrial Sector
1980 - 2000

SECTOR 1	1970 ACTUAL	1975 ESTIMATED	1980 PROJECTED	1985 PROJECTED	1990 PROJECTED	1995 PROJECTED	2000 PROJECTED	ANNUAL GROWTH RATE (%) (1970-2000)
Agriculture, forestry and fisheries	1,497	1,540	1,588	1,517	1,464	1,428	1,391	-0.24%
Mining	31	19	5	5	4	4	4	-6.8%
Construction	614	737	872	955	1,017	1,092	1,169	2.1%
Manufacturing	3,585	4,002	4,459	4,797	5,051	5,366	5,686	1.5%
Transportation, Communication, and Public Utilities	558	689	832	937	1,016	1,131	1,248	2.7%
Wholesale and Retail Trade	2,160	2,367	2,593	2,773	2,908	3,092	3,279	1.4%
Finance, Insurance and Real Estate	400	465	537	669	768	883	999	3.1%
Services	2,183	2,380	2,595	2,835	3,015	3,225	3,438	1.5%
Government	1,464	1,781	2,129	2,402	2,606	2,860	3,118	2.5%
Total Employment	12,492	13,980	15,610	16,890	17,849	19,081	20,347	1.6%
Employment-Population Ratio	.34	.36	.38	.386	.39	.395	.41	

Notes: Projections were made by Jacksonville Area Planning Board, which used the OBERS methodology and assumptions. For detailed information on OBERS methodology and assumptions, see U. S. Water Resource Council, April 1974,

1972 OBERS Projections, Volume One, Concepts, Methodology, and Summary Data. For detailed information on Jacksonville Area Planning Board Methodology for adjusting OBERS projections, see Jacksonville Area Planning Board, June 1976, Regional Employment Study.

Source: Jacksonville Area Planning Board, 1976b, Regional Employment Study, and Bureau of the Census, 1970, U. S. Census of Population, and Dames & Moore, 1977.

Table 2.10-7

Seminole Project Area Income Characteristics

County or State	Total Personal Income (million dollars) 1974	1975	Percent Change	Per Capita Personal Income 1974	1975	Percent Change
Florida	43,742	47,069	7.6	5406	5640	4.3
Alachua	568	624	9.9	4545	4813	5.9
Bradford	54	62	14.8	3415	3722	9.0
Clay	212	237	11.8	4459	4709	5.6
Duval	2983	3221	8.0	5322	5646	6.1
Flagler	28	30	7.1	4665	4631	-0.7
Marion	388	422	8.8	4112	4376	6.4
Putnam	151	174	15.2	3579	4018	12.3
St. Johns	174	190	9.2	4703	4888	3.9
Volusia	984	1072	8.9	4855	5110	5.3

Notes: All values are in current dollars.

Sources: Bureau of Economic and Business Research, University of Florida, May 1977, Florida Economic Indicators, as cited in Florida Department of Commerce, (no date), Florida Facts, and Dames & Moore, 1977.

Table 2.10-8

Sources of Personal Income

Year	Wage and Salary Disbursements (% of Total)		Proprietor's Income (% of Total)		Dividends, Interest and Rent (% of Total)		Transfer Payments (% of Total)		Other Labor Income (% of Total)	
	Putnam	Florida	Putnam	Florida	Putnam	Florida	Putnam	Florida	Putnam	Florida
1970	63.5	60.3	8.1	7.7	10.1	17.6	15.0	11.5	3.3	2.9
1971	60.6	59.4	8.7	8.0	10.3	17.2	17.1	12.4	3.3	3.0
1972	58.9	58.6	8.6	7.4	11.5	18.3	17.8	12.5	3.3	3.2
1973	56.8	57.6	8.5	7.3	12.3	19.3	19.2	12.7	3.1	3.1
1974	55.8	57.7	7.8	6.3	12.2	18.8	20.9	13.9	3.2	3.3

Sources: Bureau of Economic Analysis, U. S. Department of Commerce, (no date), unpublished data, as cited in Bureau of Econmic Analysis, Division of Economic Development, Florida Department of Commerce, April 1977, Putnam County Economic Data.

Table 2.10-9

Average Wage and Salary Income By Industrial Sector - 1974

Industrial Sector	Putnam County	Florida	United States
Total All Industries	7,956	8,420	9,295
Agriculture, Forestry, and Fisheries	5,451	7,115	6,778
Mining	D	11,841	12,671
Contract Construction	8,620	10,349	11,459
Manufacturing	10,547	9,314	10,503
Transportation, Communication, and Public Utilities	9,446	10,815	11,733
Wholesale and Retail Trade	5,509	6,968	7,342
Finance, Insurance, and Real Estate	7,588	8,900	9,277
Services	4,897	7,340	7,525
Government	7,392	9,270	10,869
Unclassified Industries	D	3,210	7,217

Notes: Only wages for workers covered by unemployment compensation are reported.
D = non-disclosure industry. These numbers are included in "Total All Industries." Data are in current 1974 dollars.

Sources: Employment Security Division, Florida Department of Commerce, Employment and Payrolls 1974, as cited in Bureau of Economic Analysis, Division of Economic Development, Florida Department of Commerce, April 1977, Putnam County Economic Data.

Table 2.10-10

Average Wage and Salary Income By Manufacturing Sector

MANUFACTURING SECTOR	1973		1974		1975	
	Putnam County	Florida	Putnam County	Florida	Putnam County	Florida
Food and Kindred Products	D	8,133	D	8,937	8,691	9,537
Lumber and Wood Products	5,129	7,185	5,391	8,214	5,791	8,092
Paper and Allied Products	10,710	10,354	11,862	11,272	13,396	12,677
Printing and Publishing	6,246	8,401	D	8,946	D	9,606
Machinery Except Electrical	D	9,611	D	10,483	6,834	11,827
Other Manufacturing	6,605	0	6,751	0	6,945	0
Total Manufacturing	9,572	8,617	10,547	9,314	11,790	10,089
All Industrial Divisions	7,390	7,841	7,956	8,420	8,772	9,050

Notes: Only wages covered by unemployment compensation are reported. D = non-disclosure item. This manufacturing sector is summed in "Other Manufacturing." Data are in current dollars.

Sources: Employment Security Division, Florida Department of Commerce, Employment and Payrolls 1973, 1974, and 1975, as cited in Bureau of Economic Analysis, Division of Economic Development, Florida Department of Commerce, April 1977, Putnam County Economic Data.

Table 2.10-11

Putnam County Basic and Non-Basic Income by Sector - 1974
(Millions of Dollars)

Sector	Total Putnam County Income	Total National Income	Basic Putnam Income	Non-Basic Putnam Income
Total Income	90.2	832,687	0	90.2
I. Agriculture	5.6	39,745	1.3	4.3
II. Non-agriculture	84.6	792,942	-1.3	85.9
A. Private Sector	68.6	647,836	-1.6	70.2
1. Mining	D	8,116	D	0.9
2. Construction	5.2	52,679	-0.5	5.7
3. Manufacturing	33.9	222,041	9.8	24.1
4. Transportation, Communication and Public Utilities	3.6	59,928	-2.8	6.4
5. Retail and Whole-sale Trade	13.0	134,377	-1.6	14.6
6. Finance, Insurance and Real Estate	2.5	42,848	-2.1	4.6
7. Services	8.6	125,301	-5.0	13.6
8. Other	D	2,546	D	0.3
B. Government Sector	16.0	145,106	0.3	15.7
1. Federal Civilian	2.0	35,134	-1.8	3.8
2. Federal Military	1.1	19,147	-1.0	2.1
3. State and Local	12.9	90,825	3.1	9.8

Note: Basic and Non-basic income is calculated via the location quotient methodology as described in Tiebout, Dec. 1962 (see Appendix I-1).

D = Non-Disclosure Industry.

Source: U. S. Department of Commerce, unpublished data, as cited in Florida Department of Commerce, Division of Economic Development, Bureau of Economic Analysis, Putnam County Economic Data, April 1977, and Dames & Moore, 1977.

Table 2.10-12

Putnam County Baseline Income Projections by Industrial Sector
1980 - 2020
(In Millions of 1967 Dollars)

Sector	1980	1990	2000	2010	2020	Annual Growth Rate (1980-2020)
Agriculture, Forestry, and Fisheries	1.8	2.1	2.5	3.0	3.5	1.7%
Mining	0.1	0.1	0.2	0.2	0.3	2.7%
Contract Construction	4.1	6.1	8.7	12.0	15.4	3.3%
Manufacturing	43.6	62.5	88.2	122.7	157.4	3.2%
Transportation, Communication, and Public Utilities	3.4	5.3	8.1	12.1	16.6	4.0%
Wholesale and Retail Trade	14.1	20.0	28.3	39.1	50.0	3.2%
Finance, Insurance and Real Estate	3.3	5.9	9.7	15.4	21.7	4.7%
Services	11.3	16.6	23.9	33.8	44.1	3.4%
Government	18.9	29.4	43.9	62.0	85.7	3.8%
Total Personal Income	142.6	209.1	300.6	419.9	546.5	3.4%

Source: U. S. Department of Commerce, Bureau of Economic Analysis, as cited in U. S. Army Corps of Engineers, South Atlantic Division, December 1975, Projections of Economic Activity in Florida, Series E Population, and Dames & Moore, 1977.

Table 2.10-13

Housing Characteristics

County or State	Total Number of Year Round Housing Units 1970	Housing Units Percent Change 1960 to 1970 (%)	Homeowner Vacancy Rate - 1970 (%)	Rental Vacancy Rate - 1970 (%)	Median Gross Rents - 1970 ($)
Florida	2,490,838	45.4	1.8	10.7	114
Alachua	33,519	55.0	2.2	8.6	115
Bradford	4591	17.2	1.0	10.5	69
Clay	10,445	64.2	2.1	9.6	112
Duval	174,149	24.3	2.3	11.5	99
Flagler	1841	23.8	1.1	15.3	69
Marion	25,830	54.1	1.6	10.9	82
Putnam	12,900	24.4	1.4	13.5	67
St. Johns	11,581	16.0	3.2	14.5	79
Volusia	70,289	40.9	2.3	14.4	91

Sources: U. S. Department of Commerce, 1972, County and City Data Book.

Table 2.10-14

Enrollment and Capacity in Putnam County School District
1977 - 1978

Name of School	Grades	Student Capacity	Estimated Enrollment	Number of Teachers	Student-Teacher Ratio	Square Footage	Square Feet Per Pupil
Beasley Middle	6-8	895	965	44	21.9	92,911	96.3
Moseley Elementary	K-5	1,501	1,092	63	17.3	122,203	111.9
Mellon Elementary	K-5	525	473	25	18.9	41,692	88.1
Smith Community	K-5	625	537	28	19.2	34,765	64.7
Interlachen Community	K-5	500	540	28	19.3	33,857	62.7
Interlachen High	9-12	955	608	31	19.6	113,695	187.0
Price Middle	6-8	365	435	19	22.9	21,184	48.7
Melrose Community	K-5	400	352	21	16.7	35,340	100.4
Long Elementary	K-5	335	356	19	18.7	25,611	71.9
Jenkins Middle	6-8	894	705	35	20.1	73,615	104.4
Browning-Pearce Community	K-5	675	637	34	18.7	48,841	76.7
Miller Middle	6-8	609	435	21	20.7	56,396	129.6
Crescent City Community	K-5	700	659	35	18.8	36,730	55.7
Crescent City High	9-12	878	527	29	18.2	95,572	181.4
Palatka High	9-12	2,095	2,127	110	19.3	206,594	97.1
Total	K-12	11,952	10,448	542	19.3	1,039,006	99.4

Note: K = Kindergarten

Source: Putnam County School District, Office of the Superintendent, 1977, and Dames & Moore, 1977.

Table 2.10-15

Putnam County School District Projected Enrollments

Year	PROJECTED ENROLLMENTS Grades K-5	Grades 6-8	Grades 9-12	Grades K-12
1976-1977	4,599	2,700	3,268	10,567
1977-1978	4,594	2,653	3,318	10,565
1978-1979	4,645	2,586	3,302	10,533
1979-1980	4,663	2,486	3,252	10,401
1980-1981	4,638	2,523	3,211	10,372
1981-1982	4,642	2,562	3,129	10,333

Note: Projection methodology is an adaptation of the "Cohort Survival Technique" as used by the United States Census Bureau.

Sources: Putnam County School District, November 1976, Survey of School Plants.

Table 2.10-16

Putnam County 24-Hour Average Annual Traffic Flows

LOCATION	Number of Vehicles Per 24-Hour Period				
	1973	1974	1975	1976	1977
US 17 at Bostwick	2,375	2,905	3,515	3,715	3,756
Route 209 at Bostwick	295	240	490	483	N
US 17 at Moccasin Creek	3,170	3,550	3,330	3,988	3,852
Route 209 at Moccasin Creek	1,135	1,560	1,285	1,651	1,678
US 17 at Rice Creek Bridge	4,655	4,780	5,305	5,528	5,408
US 17 at Pecan	5,600	5,610	6,100	6,382	5,995
Route 100 West of US 17	12,170	12,050	11,790	14,236	14,949
US 17 North of Route 100	6,785	6,850	5,935	6,393	7,542

Note: N = No data.

Source: Photogrammetric Division Traffic Planning Division, Florida State Road Department, and U. S. Department of Transportation, Federal Highway Administration, Bureau of Public Roads.

Table 2.10-17

Putnam County:
Trends in Assessed Valuation

Year	Non-Exempt Valuation ($)
1972	186,497,732
1973	245,126,908
1974	250,943,149
1975	307,377,895
1976	350,945,025

Note: Data for 1976 is subject to revision.

Source: Putnam County School District, November 1976, Survey of School Plants.

Table 2.10-18

Putnam County Assessed Valuation
1975

	Total Assessed Valuation (Dollars)	Non-Exempt Valuation (Dollars)
Real Estate	371,013,884	230,830,348
Personal Property	93,877,885	69,256,251
Utilities	7,293,321	7,291,296
Total	472,185,090	307,377,895

Source: Putnam County Chamber of Commerce, February 1977, <u>Palatka and Putnam County Florida</u>.

Table 2.10-19

Putnam County Millage and
Property Tax Revenue By Jurisdiction
1975

JURISDICTION	MILLS	REVENUE
County General Fund	6.97	$2,142,407
County Health Unit	.32	98,366
Bond Interest and Sinking Fund	.31	95,297
County School Fund	7.50	2,305,343
County School Bond Debt	.88	270,488
County Road and Bridge	2.00	614,756
Other	-	3,439
Total Taxes Levied	17.98	$5,530,096

Source: Putnam County Chamber of Commerce, February 1977, Palatka and Putnam County Florida.

Table 2.10-20

Putnam County School District Tax Levies
on Non-Exempt Property
1976 - 1977

REVENUE FUND

	DISTRICT TAX LEVIES IN MILLS		
	School Board Levy	Citizen Voted Levy	Total Levy
Operating Cost Fund	7.5	0.0	7.5
Interest and Sinking Cost Fund	0.0	0.76	0.76
Local Capital Improvement Fund	0.0	0.0	0.0
Total Millage on Non-exempt Property	7.5	.76	8.26

Note: Data applies to the 1976-1977 school year. Given the 8.26 Mill Tax Rate, and $350,945,025 of non-exempt valuation, and assuming a 95% collection rate, this levy should yield approximately $2,753,859 for the school district.

Source: Putnam County School District, November 1976, Survey of School Plants.

Table 2.10-21

Putnam County School District Revenues
1975/76 - 1977/78

REVENUE RECEIPTS	1975-1976 SCHOOL YEAR		1976-1977 SCHOOL YEAR		1977-1978 SCHOOL YEAR	
	Amount	Percent	Amount	Percent	Amount	Percent
State Revenue	$8,072,185.82	63.82	$7,942,139.02	68.88	$8,395,228.74	65.91
Federal Revenues received through the State	601,136.00	4.76	5,000.00	.04	20,000.00	.16
Local District Revenues	2,765,891.00	21.88	2,636,357.00	22.86	3,326,548.00	26.12
Other Revenues (balances)	1,200,269.32	9.50	946,985.03	8.22	995,690.52	7.81
Total Revenue	$12,639,482.14	100.00	$11,530,481.05	100.00	$12,737,467.26	100.00

Source: Putnam County School District, Office of the Superintendent, 1977.

Table 2.10-22

Millage Rates in Selected Putnam County Municipalities 1975

Municipality	Putnam County Levy	City Levy	Total Levy
Crescent City	17.98	9.42	27.40
Interlachen	17.98	6.95	24.93
Palatka	17.98	9.92	27.90
Pomona Park	17.98	3.43	21.41
Welaka	17.98	5.93	23.91

Source: Putnam County Chamber of Commerce, February 1977, Palatka and Putnam County, Florida.

Table 2.10-23

Total Retail Sales in the Study Area
1972 - 1974
(In Millions of Current Dollars)

County or State	1972	1973	1974
Florida	$17,898.6	$23,895.	$26,708.6
Alachua	252.4	340.3	415.6
Bradford	21.9	31.4	31.8
Clay	54.3	80.5	66.2
Duval	1,364.7	1,772.6	1,837.8
Flagler	6.9	8.9	15.7
Marion	219.2	306.8	346.2
Putnam	73.9	99.7	98.0
St. Johns	60.8	83.7	101.8
Volusia	451.6	560.6	719.8

Source: Sales Management Magazine, July 23,1973, July 8, 1974, and July 21, 1975, Survey of Buying Power.

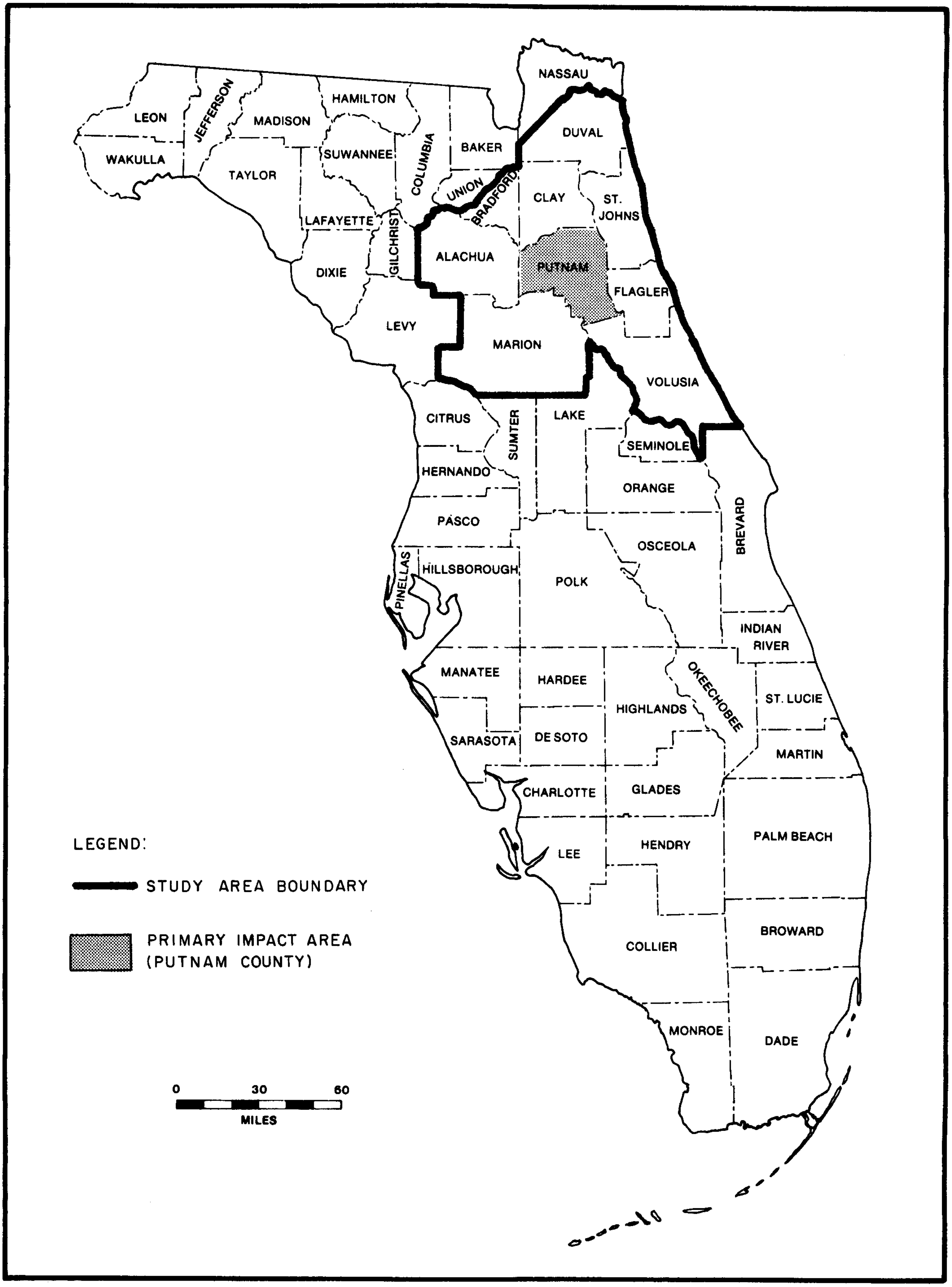


Figure 2.10-1. Putnam Site Socioeconomic Impact Study Area.

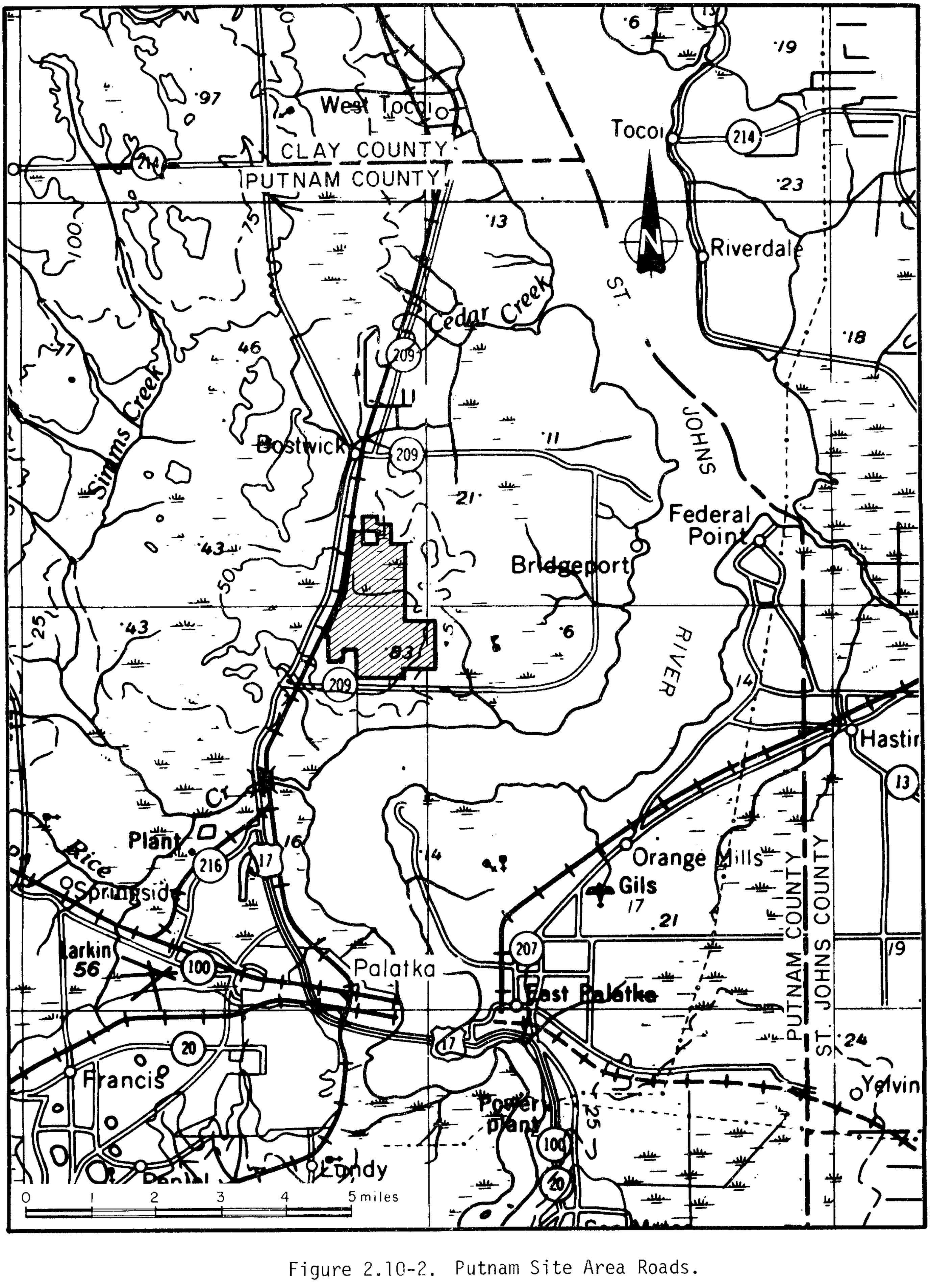


Figure 2.10-2. Putnam Site Area Roads.

REVISED 3/15/79

2.11 WATER USE

2.11.1 Surface Water Use

Withdrawal

There is relatively little withdrawal from the St. Johns River throughout its length. The principal purposes for the withdrawal are domestic, industrial, and irrigation uses. Such uses of the river are, to a degree, limited by poor water quality throughout the entire course of the river. In the upper portion of basin, total dissolved solids (TDS) concentrations are higher than normally experienced in a surface watercourse due primarily to the inflow of highly mineralized water from springs. Downstream of Palatka, the concentration of TDS is increased due to the effect of winds and tides bringing sea water upstream.

The only significant domestic withdrawal of the St. Johns River occurs from Lake Washington in its upper reaches. Increased TDS downstream precludes use of the river water for domestic water supply. Industrial uses, such as cooling water, are only a small part of the total river flow. The only significant surface water withdrawal from the St. Johns in the vicinity of the site is the Florida Power & Light (FP&L) Palatka Plant, 7.5 miles upstream. This plant withdraws a maximum of about 15.0 cubic feet per second (cfs). Approximately 11.5 cfs of this is lost due to evaporation and drift (Florida Power & Light, 1977). The old FP&L Putnam Plant located adjacent to the Palatka Plant, now inactive except for occasional peak-demand use, withdraws 124 cfs for once-through cooling purposes.

Although the potential exists for a greater use of the river for irrigation, only minimal use occurs presently because of readily available ground water of better quality.

Water Dischargers

Based on the St. Johns River Water Management Plan (DER, 1975), the plant site is located on the St. Johns River segment 20.3 FA. This segment extends from the confluence of Rice Creek and the St. Johns River, two miles upstream of the site, to Hibernia, Florida, 31 miles downstream of the site. Segment 20.3 HA extending from Rice Creek upstream through Lake George, and segment 20.3 GA, which encompasses the Rice Creek drainage basin, are the two adjacent upstream segments (Appendix C, Figure C-7).

Downstream of the site, twelve wastewater treatment facilities discharge into segment 20.3 FA (DER, 1975). Ten are domestic facilities with a total design flow of 0.845 million gallons per day (mgd) and two are industrial with a total design flow of 4.7 mgd. The nearest facility downstream of the site is a manufacturing plant eight miles away with a design capacity of 0.305 mgd. A summary of these surface water discharges is given in Appendix C, Table C-17.

Upstream of the site, seven wastewater treatment facilities discharge into segments 20.3 GA and 20.3 HA (DER, 1975). Of the seven, five discharge into the St. Johns and two into Rice Creek. The five facilities discharging into the St. Johns are all in the Palatka urban area and include three industrial facilities and two domestic facilities. The largest discharger is the FP&L Palatka Plant, the major effluent of which is cooling tower blowdown estimated at approximately 2.0 mgd. The remaining four facilities have a total design flow of 1.77 mgd.

The two facilities on Rice Creek are in the Palatka urban area and have a total design discharge of 50.01 mgd. Of this total, 50 mgd is discharged into Rice Creek four miles upstream of its mouth, and is from an industrial facility, Hudson Pulp and Paper Company. The remaining facility discharges 0.01 mgd of domestic waste into a swamp contiguous to Rice Creek approximately 3.5 miles from the mouth.

A summary of the surface water discharges upstream of the site in segments 20.3 GA and 20.3 HA are given in Appendix C, Table C-18.

TABLE C-17

WASTEWATER DISCHARGES DOWNSTREAM OF SITE
(SEG. 20.3 FA)

No.	Plant Name and Location	Discharge Point	Plant Flow (mgd)		Waste Water Effluent Charact. (lbs/day)				Estimated UOD
			Design	Aver.	BOD 5	TSS	Nitro.	Tot PO4	
	DOMESTIC								
1	Town of Green Cove Spgs.	St. Johns River	0.500	.400	55	96	108	64	528.0
2	Town of Hasings	Swamp to Cracker Cr. to St. Johns River	0.100	.075	10.4	18	20.4	12	99.0
3	Magnolia Sprgs. Apts.	Swamp to St. Johns R.	0.070	.070	12	9.0	21	12	92.4
4	Reynolds Indust. Pk.	St. Johns River	0.068	.068	2.8	6.8	18.5	10.9	89.8
5	Holiday Inn	Ditch to Six Mile Swamp to St. Johns R.	0.050	.0006	0.8	1.4	1.6	1.0	7.9
6	Econo Travel Motor Hotel	Ditch to swamp to St. Johns River	0.020	.015	2.1	3.6	4.1	2.4	19.8
7	Candyland, Inc.	Ditch to swamp to St. Johns River	0.015	.015	2.1	3.6	4.1	2.4	19.8
8	Wesley Retirement Village	St. Johns River	0.010	.010	1.4	2.4	27	1.6	13.3
9	Vines Union 76	Red House Br. to Six Mile Cr. to St. Johns R.	0.008	.008	1.1	1.9	2.2	1.3	10.6
10	Johns Manville	St. Johns River	0.005	.005	.7	1.2	1.4	8	6.6
	COMMERCIAL OR INDUSTRIAL								
11	Titanium Enterprises	Ditch to Clark Cr. to St. Johns River	4.4	2.3	-	-	-	-	-
12	Johns Manville	St. Johns River	.300	.300	-	-	130	77	-
	Total		5.546	3.2666					

TABLE C-18

WASTEWATER DISCHARGES UPSTREAM OF SITE
(SEG. 20.3 GA and 20.3 HA)

No.	Plant Name and Location	Discharge Point	Plant Flow (mgd) Design	Aver.	Waste Water Effluent Charact. (lbs/day) BOD 5	TSS	Nitro.	Tot PO4	Estimated UOD
	DOMESTIC								
13	City of Palatka, Putnam County	Canal to St. Johns River	1.750	1.700	128	142	462	272	2,244
14	Captain Joe's Restaurant	St. Johns River	.0075	UK	0.8	0.7	-	-	-
15	Paradise Park MHP Rt. #1, Palatka	Rice Creek,	.010	.006	0.8	1.4	1.6	1.0	7.9
	COMMERCIAL OR INDUSTRIAL								
16	Florida Power & Light	St. Johns River	2.0	2.0	NA	UK	-	-	-
17	East Side Launderomat	Ditch to St. Johns River	.010	.003	1.4	2.4	2.7	1.6	13.2
18	Florida Packing & Provisions, Inc.	Pipeline to St. Johns River	.009	.005	0.6	1.2	1.4	0.8	6.6
19	Hudson Pulp & Paper Co.	Rice Creek	50.0	48.0	26×10^6	-	-	-	-
	Total		53.7865	51.714					

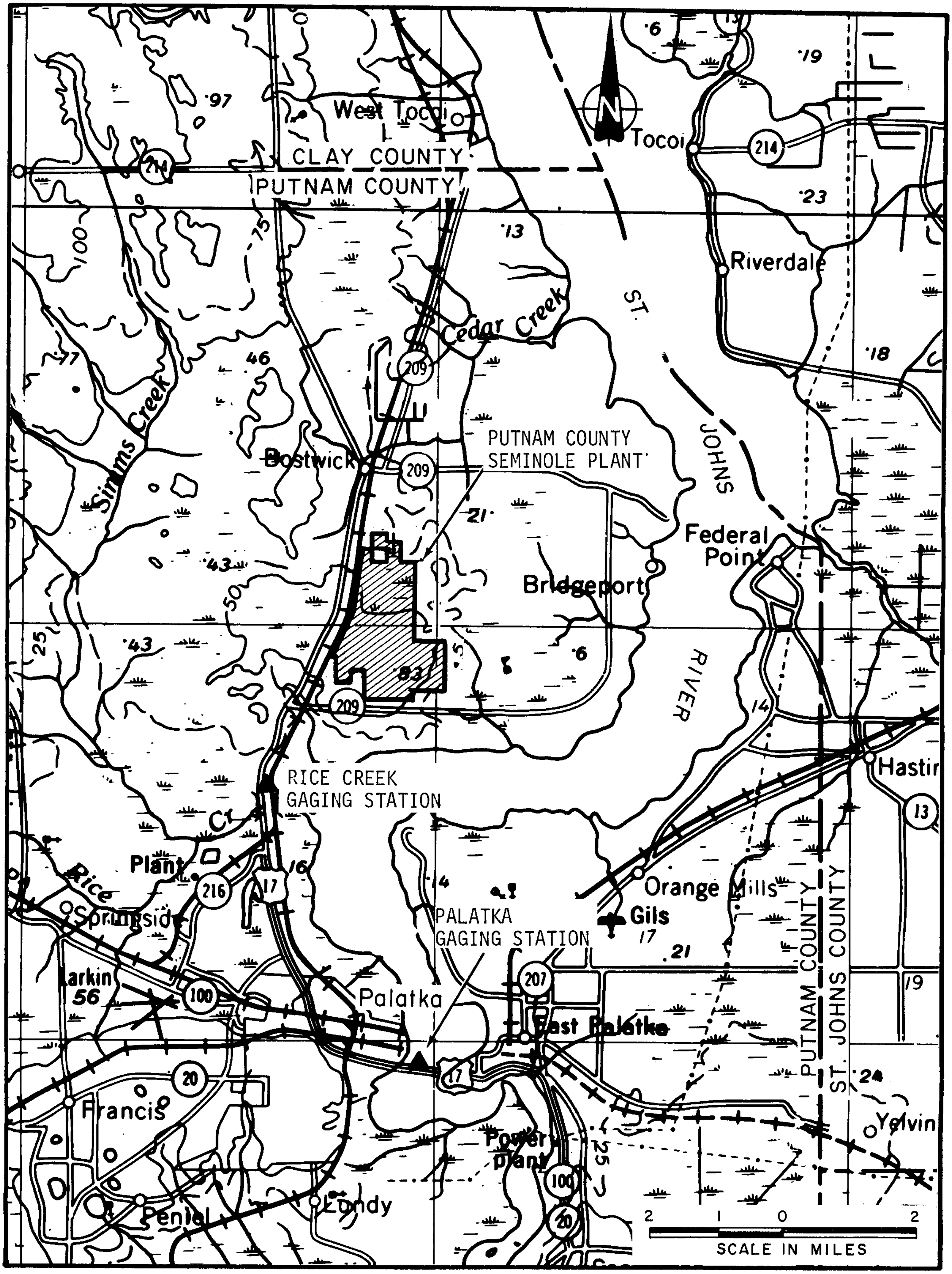


Figure C -1. Location Map.

2.11.2 Ground Water Use

Selected wells within a five-mile radius of the center of the site were inventoried for physical characteristics and water use. Appendix D.6 gives the results.

A total of 145 domestic, agricultural, and industrial wells was inventoried from the literature and/or in the field. Table 2.11-1 shows that approximately 74 percent of the wells inventoried withdrew from the Floridan Aquifer, 16 percent withdrew from the water table aquifer, and 10 percent were undetermined.

Ground water use in the Bostwick area is notable. Northward, down gradient from the site, three water table wells were identified. These wells (S-1, S-2, S-3) were located about one-half mile southeast of Bostwick (Appendix D, Figure D-8). They were near the ditch that drains from the lowlands north of the site. Other water table wells in the Bostwick area appear to be topographically independent of any movement of water-table ground water from the site. Only one other identified well (S-17) is along the ditch draining from the swamp, but it withdraws from the deeper Floridan Aquifer.

Well yields are usually a function of well construction as well as the characteristics of the aquifer. Some Floridan Aquifer wells are reported to produce at a rate greater than 2000 gpm (Well C-8, Table D-7). Yields from the water table aquifer are at significantly lesser rates but sufficient for residences and for the multiple dwellings of a trailer park in Bostwick.

Ground water withdrawn in Putnam County during 1970 by use included 2.7 mgd for public water supply (most from the Floridan Aquifer), 9.7 mgd for agriculture, and 15.5 mgd for industry (Jacksonville Area Planning Board, 1977).

Table 2.11-1

Source of Water in Wells

Quadrant*	Total	Floridan Aquifer	Water Table Aquifer	No Depths Available
A	41	22	17	2
B	4	3	1	-
C	31	27	2	-
D	69	55	4	10
Total	145	107	24	14

*Note: See Appendix D, Figures D-7 and D-9.