STATE OF FLORIDA

FLORIDA GEOLOGICAL SURVEY
Guy H. Means, *State Geologist and Director*

OPEN-FILE REPORT 110

Text to accompany geologic map of the USGS Fort Pierce 30 x 60 minute quadrangle, south Florida

By

Richard C. Green, (P.G. # 1776), Christopher P. Williams, Crystal L. Hebets, Jade W. Greene,
Nickolaus P. Hall, Garrett S. Evans, and Brittany M. Duffey

2022
ISSN (1058-1391)

This project was funded in part by the USGS National Cooperative Geologic Mapping Program under assistance award number G20AC00368 in Federal fiscal year 2020 (Project completion was delayed due to COVID-19)

TABLE OF CONTENTS

LIST OF FIGURES

Text to accompany geologic map of the USGS Fort Pierce 30 x 60 minute quadrangle, south Florida

Richard C. Green, (P.G. # 1776), Christopher P. Williams, Crystal L. Hebets, Jade W. Greene, Nickolaus P. Hall, Garrett S. Evans, and Brittany M. Duffey

ABSTRACT

The accompanying 1:100,000 scale geologic map (Open-File Map Series 113, Plate 1) depicts the areal distribution of bedrock and surficial geologic units for the U.S. Geological Survey (USGS) Fort Pierce 30 x 60 minute quadrangle. The map was constructed using a combination of field mapping (at 1:24,000 scale), compilation of data from existing maps (various scales), borehole core and cuttings analyses and descriptions, and analyses of various Geographic Information System (GIS) data sources. The resulting data were compiled in ESRI® ArcGIS® ArcPro™ 2.9.1 software for publication as part of the Florida Geological Survey Open-File Map Series. Mapped geologic units range in age from Pliocene to Holocene. Important resources in the mapped area include potable groundwater, sand, fossil shells, and limestone.

The geologic map and accompanying plates produced for this area not only provide a greater understanding of the interaction between the geologic units, associated karst, and ecosystems, but have utility as a land management tool for economic development, mineral and energy production, and environmental protection for Florida. Examples include designing new construction projects, siting new water supply wells, wastewater treatment plants, energy production facilities, waste management and storage facilities, locating sources of mineable resources, and protecting surface and groundwater quality.

Keywords: Florida, geologic map, Ocala Limestone, Hawthorn Group, Arcadia Formation, Peace River Formation, undifferentiated Tertiary/Quaternary shelly sediments, Anastasia Formation, geomorphology, hydrogeology, Floridan aquifer system, Glades County, Highlands County, Martin County, Okeechobee County, St. Lucie County, Fort Pierce, St. Lucie

INTRODUCTION

Florida Geological Survey (FGS) Open-File Report (OFR) 110 accompanies Open-File Map Series (OFMS) 113, which is comprised of three plates. Plate 1 depicts the near-surface geology of the USGS Fort Pierce 30 x 60 minute quadrangle overlain on a digital elevation model (DEM). Plate 2 depicts six geologic cross-sections, a stratigraphic correlation chart, and an index geologic map with cross-section lines for the study area. Plate 3 depicts a geomorphology map, along with a DEM.

The study area is in southeastern Florida (Figure 1) and covers portions of Glades, Highlands, Martin, Okeechobee, and St. Lucie counties. It includes the communities of Fort Pierce, Hobe Sound, Jupiter Island, Okeechobee, Port St. Lucie, St. Lucie, and Stuart. The quadrangle is bounded to the north by the USGS Vero Beach 30 x 60 minute quadrangle (Green, et al., 2021a; Green, et al., 2021b), to the northwest by the USGS Bartow 30 x 60 minute quadrangle, (Green et al., 2019a; Green et al., 2019b), and to the west by the USGS Arcadia 30 x 60 minute quadrangle (Green et al., 1998; Green et al., 1999), all previously mapped under the STATEMAP program. It is bounded to the south by the USGS West Palm Beach 30 x 60 minute quadrangle (mapping in progress 2021-2023), and to the southwest by the USGS Fort Myers 30 x 60 minute quadrangle (funded for 2022-2024 STATEMAP Program mapping).

One objective of this report is to provide basic geologic information for the accompanying OFMS 113. Information provided in this report and on the plates from OFMS 113 is intended for a diverse audience of professionals in geology, hydrology, engineering, environmental and urban planning, and laypersons, all of whom have varying levels of geologic knowledge. The maps can help users identify and interpret geologic features which impact activities related to groundwater quality and quantity, as well as aid in locating mineral resources, land-use planning, and construction project design. Applied uses of the maps and data in this report include: 1) identifying potential new mineral resources, 2) characterizing zones of geologic hazards, 3) characterizing potential aquifer recharge, discharge, and confinement, 4) surface water, groundwater, and fate and transport modeling, 5) aiding water-management decisions on groundwater usage, 6) providing information on aquifer vulnerability to potential pollution, 7) characterizing ecosystems and 8) recreational activities.

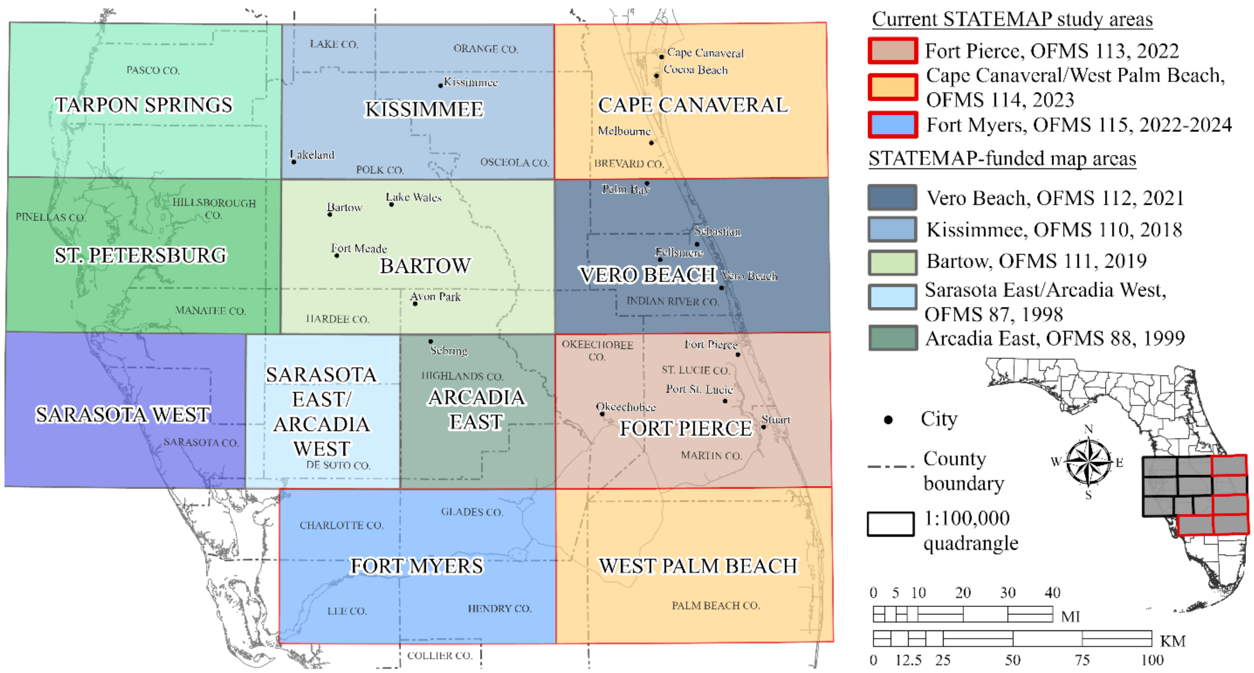

Figure 1. Nearby areas mapped under the FGS STATEMAP Program.

Methods

Mapping efforts consisted of: 1) reviewing and compiling existing geologic literature and data, 2) mapping geologic units in the field at 1:24,000 scale using standard techniques, 3) analyzing existing borehole core and cuttings samples from the FGS sample collections facility, 4) drilling new cores, 5) collecting and describing outcrop samples, and 6) preparing a geologic map, geological cross-sections, and a geomorphic map of the area. Field work, performed during the fall of 2019 through the spring of 2022, consisted of sampling and describing outcrops, as well as samples from river and pit exposures.

Two new geologic samples were added to the FGS surface-sample archives (M-Series) and four cores (491 feet [149.7 meters] total) were drilled. More than a dozen outcrops were also examined during this project. In addition to the new M-series samples collected, 34 historical M-series samples were examined. All data, including formation picks from over 250 wells from the study area and a five-mile (8.0 kilometer) buffer from surrounding quadrangles, were compiled and analyzed. Figure 2 shows the locations of FGS cores, cuttings, outcrops, and M-series samples within the study area. The map and accompanying plates were developed in ESRI® ArcGIS® ArcPro™ 2.9.1 software for publication as part of OFMS 113.

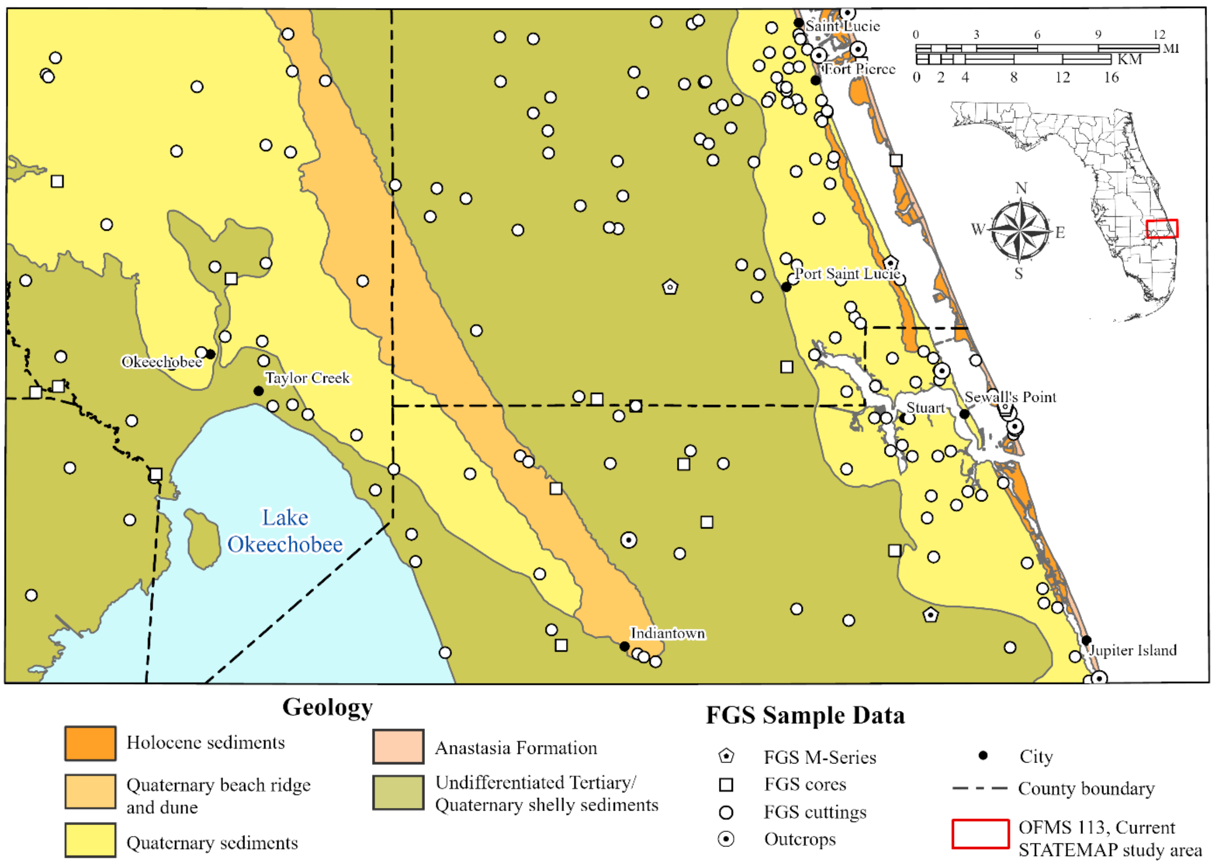

Figure 2. FGS cores, cuttings, outcrops, and M-series samples used for models.

Due to incomplete light detection and ranging (LiDAR) data, a custom elevation model was created for this study area. Eight datasets were used to create this digital elevation model: standard LiDAR elevation models comprised of six different collection years and quality levels, with horizontal resolutions ranging from one foot (0.3 meters) to 10 feet (3 meters), and two digital elevation models based on topographic contours with a horizontal resolution of 15 feet (4.5 meters) to 50 feet (15.24 meters). Vertical resolution was between one foot (0.3 meters) and five feet (1.5 meters). LiDAR data was obtained for the entirety of Martin and Glades counties. It was available for a majority of Okeechobee and St. Lucie counties; the missing areas were filled in using the contour-based DEM.

The hybrid digital elevation model was created by first combining all the existing LiDAR elevation models into a single raster (a matrix of cells [pixels] organized into a grid where each cell [pixel] contains a value representing an elevation). The lower-resolution, contour-based DEM was re-sampled and aligned to match the higher-resolution LiDAR elevation models. A conditional statement was then used in ESRI® ArcGIS® ArcPro™ 2.9.1 to create a new hybrid raster by selecting an elevation value from the LiDAR grid, if available. Where LiDAR was not available, elevation values were drawn from the lower-resolution, contour-based DEM.

Top-of-unit rasters were created for several geologic units within the study area using the borehole descriptions completed during this study. In order to produce interpolated top-of-unit rasters, the borehole depth for the top of each unit was first converted from depths below land surface into elevations referenced to mean sea-level. This conversion was performed by taking the elevation value of the well point from the digital elevation model raster and subtracting the depth below land surface value, resulting in the mean sea-level elevation for the top-of-unit raster.

The mean sea-level elevation data for each geologic unit was used to create a Natural Neighbor (NN) interpolation of the top-of-unit surface, overburden, and isopach for the unit. The NN method of interpolation is a simple and exact interpolation method that relies on Voronoi tessellation (a partitioning of a plane into regions based on distances to points) to select a local subset of points and determine a weighted influence at every raster grid cell. This method produces a surface that passes through every data point in the input data set and thus does not attempt to account for errors or outliers. The NN method is particularly useful for visualizing the 'raw' data for problematic areas and extreme outliers prior to building and optimizing the final model.

After examining the initial models created for geologic units, it was evident that some of the predictive errors in the first model were directly attributable to either low data density, local outliers in the borehole data, or both. Outliers are a common occurrence in Florida geologic data for a variety of reasons, both human and natural, including: 1) Hawthorn Group units can be difficult to distinguish even for a trained professional geologist, and therefore some degree of uncertainty may exist in locating contacts, 2) many of the borehole samples are based on cuttings taken at intervals of 10 feet (3.1 meters), which introduces uncertainty in the elevation of the contacts even when the contact is clearly evident and 3) dissolution in carbonate units can produce significantly different unit elevations in boreholes that are a short distance apart.

In cases where the accuracy metrics of the modeled surfaces indicated large amounts of error due to outliers, an iterative modeling process was used to reduce the average standard error of the interpolated surface and the least-accurate boreholes were removed from the dataset via cross-validation to improve predictive accuracy. After the removal of outlier data points (generally fewer than ten boreholes per unit), a new interpolated surface was generated.

Figure 3 is a boxplot used to illustrate the distribution and range of elevation values, relative to mean sea level (MSL), for each geologic unit investigated within the study area. The crossbar within the box represents the median elevation value for each geologic unit. The upper and lower borders of each box correspond to the 25^{th} and 75^{th} percentiles, or the first and third quartiles, respectively; this area is also called the interquartile range and represents the middle 50% of the values in each group. The whiskers that extend from each boxplot reach no further than 150% of the interquartile range. Data that fall beyond the whiskers are considered outlier points and are represented by a dot.

Once the top-of-unit models were completed, they were exported to floating-point rasters where cell size and borders were snapped to the hybrid digital elevation model. These top-of-unit interpolated surfaces were then subtracted from the hybrid digital elevation model to produce a raster showing overburden depth between each unit and land surface. The overburden rasters were then used to assist in drawing the final surficial geologic map for the study area.

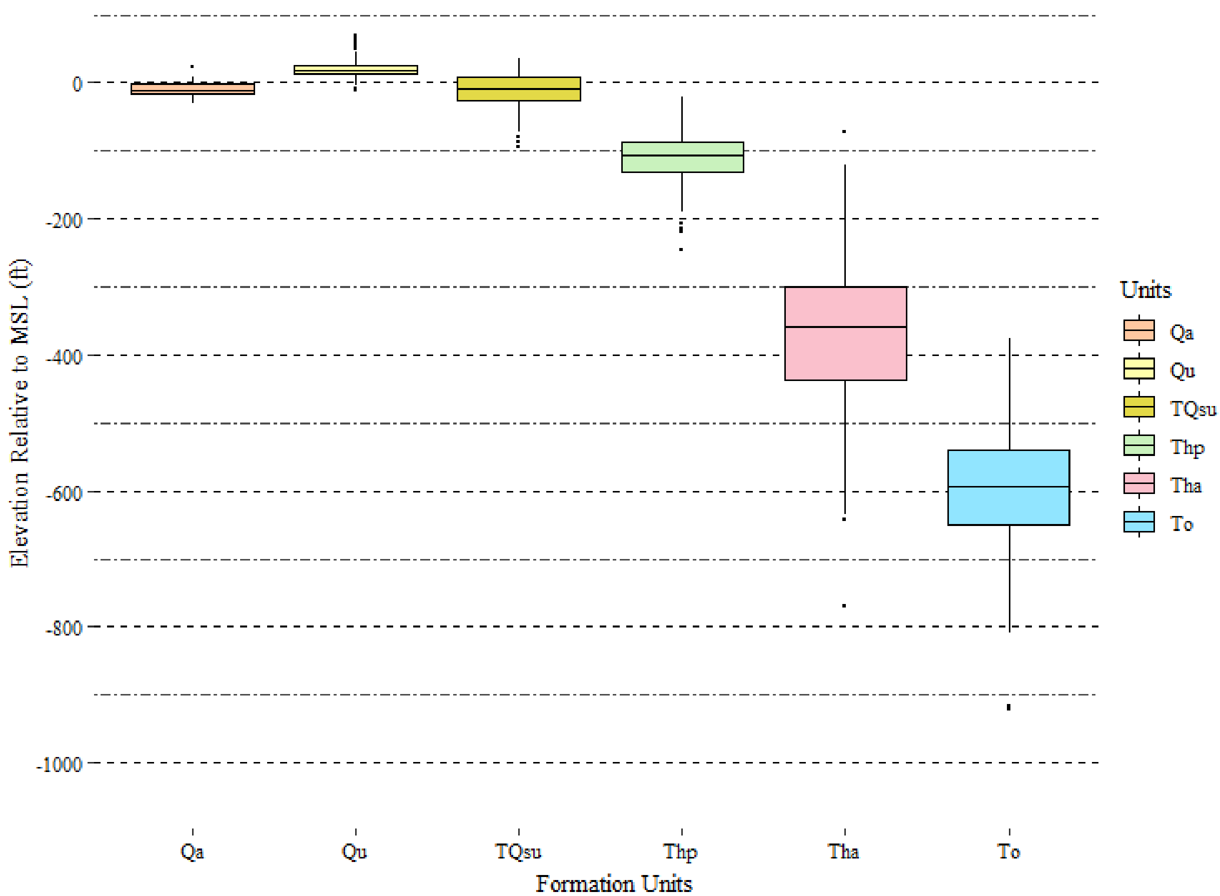

Figure 3. Boxplot of top of lithostratigraphic unit elevation ranges.

Much of the study area is blanketed by a veneer of undifferentiated Quaternary sediments. For this reason, and in keeping with geologic mapping practices developed by Scott et al. (2001), the authors have adopted the procedure of mapping the first named geologic unit within 20 feet (6.1 meters) of the surface. If undifferentiated Quaternary (Qu) sediments have a thickness greater than 20 feet (6.1 meters), they appear as the mapped unit. If these undifferentiated sediments are less than 20 feet (6.1 meters) thick, the underlying lithostratigraphic unit appears on the map. The geologic map (OFMS 113, Plate 1) and the geologic cross-sections (OFMS 113, Plate 2) may appear to disagree slightly when depicting the upper unit due to this convention. This is because geologic cross-section contacts are based on straight-line projection between boreholes, which may lead to apparent unit thicknesses between boreholes not supported by field evidence or other nearby boreholes.

Parts of the study area are heavily vegetated, and public access in portions of the mapped area was hindered by the presence of numerous wetlands, mines, farms, ranches, and privately-owned land. Fieldwork access was typically limited to public roads, State-owned lands, and County-owned lands. As such, large sections of the mapped area were inaccessible. In these areas, the authors had to rely on existing core, cuttings, outcrop, and M-Series sample data.

Previous Work

The current study builds on the many previous geologic investigations in and around the present map area. Preliminary county geologic maps for Glades (Campbell, 1993), Highlands (Arthur, 1993), Martin (Duncan and Scott, 1993), Okeechobee (Scott, 1993b), and St. Lucie (Scott, 1993a) counties were previously published at a 1:126,720 scale by the FGS. However, each of these OFMS geologic maps were constructed in an average timeframe of two weeks utilizing selected in-house geologic data with little-to-no extra field work. A statewide geologic map (Scott et al., 2001), published by the FGS, provided a framework for the current, more detailed mapping. Although these maps provided a starting point for the detailed geologic mapping undertaken for this project, significant refinement of prior geologic maps was possible because of this additional field work and data.

Scott (1988) published detailed descriptions, structure contour maps, and isopach maps for units of the Hawthorn Group. This study also benefited from the work performed during geologic mapping of the USGS Bartow (Green et al., 2019a; Green et al., 2019b), Kissimmee (Green et al., 2018a; Green et al., 2018b), Sarasota and Arcadia (Green et al., 1997; Green et al., 1998; Green et al., 1999), and Vero Beach (Green et al., 2021a; Green et al., 2021b) 30 x 60 minute quadrangles. Some of the field relationships and stratigraphic problems were worked out during those projects.

GEOLOGIC SUMMARY

The near-surface geology of the USGS 30 x 60 minute Fort Pierce quadrangle is composed of a complex mixture of Tertiary to Quaternary carbonate and siliciclastic sediments. A combination of factors, including fluvio-deltaic deposition, marine deposition and erosion of sediments as a result of eustatic changes in sea level, dissolution of underlying carbonates (karstification), and structural features have influenced the geology of the study area.

The oldest unit to crop out in the Fort Pierce quadrangle is the undifferentiated Tertiary/Quaternary shelly sediments. The unit can be seen in numerous pits and quarries throughout the map area (OFMS 113, Plate 1). The undifferentiated Tertiary/Quaternary shelly sediments overlie the Peace River Formation throughout the mapped area (OFMS 113, Plate 2). The oldest unit investigated for geologic cross-sections is the Eocene Ocala Limestone (OFMS 113, Plate 2). Detailed descriptions of the lithology of all units found in the study area begin on page 16 of this publication.

The Fort Pierce quadrangle encompasses portions of the Kissimmee, South Indian, and Upper St. Johns river basins, the Fisheating Creek, Taylor Creek, Lake Okeechobee basins, and the Florida Southeast Coast basin (Figure 4). There are no known springs within the study area.

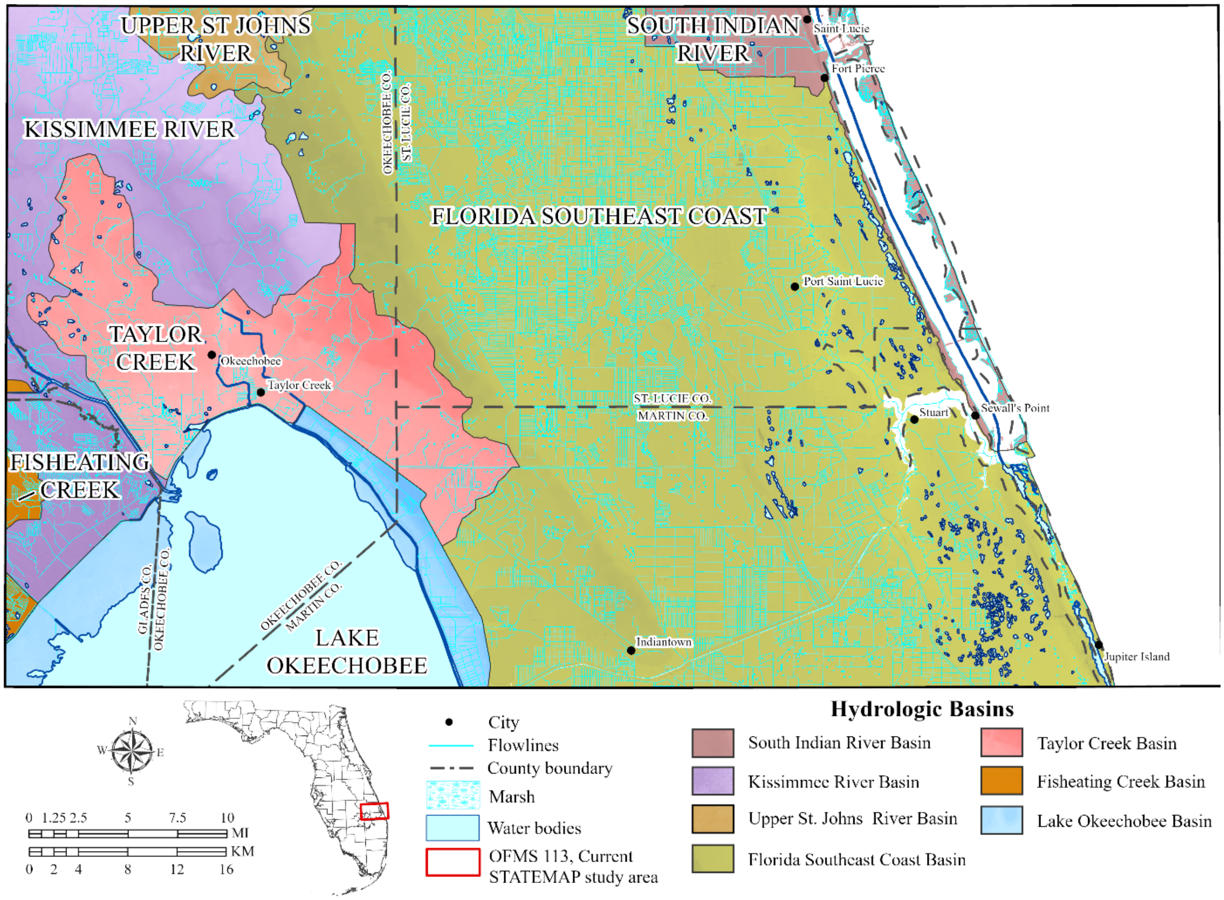

Figure 4. Location of selected river basins and other water bodies (modified from Hydrologic Unit Codes: Basins, 1993).

Structure

Several structural features have affected the geology of Peninsular Florida (Figure 5). The Peninsular Arch, a structurally high area which affected deposition from the Cretaceous to the early Cenozoic, is the dominant subsurface feature of the Florida peninsula (Applin and Applin, 1944; Applin, 1951; Puri and Vernon, 1964; Williams et al., 1977; Schmidt, 1984; Miller, 1986; Scott, 1997). The axis of the Peninsular Arch, which ends north of the study area, extends from southeastern Georgia to the vicinity of Lake Okeechobee in southern Florida in a general northwest to southeast trend. The crest of the arch passes beneath Alachua County and is highest in Union and Baker counties northwest of the study area. The arch was a topographic high during most of the Cretaceous Period and has Upper Cretaceous sediments deposited upon it (Applin, 1951). It formed a relatively stable base for Eocene carbonate deposition (Williams et al., 1977; Hine, 2013). The arch did not affect mid-Tertiary to Holocene sediment deposition (Williams et al., 1977; Scott, 1997; Hine, 2013).

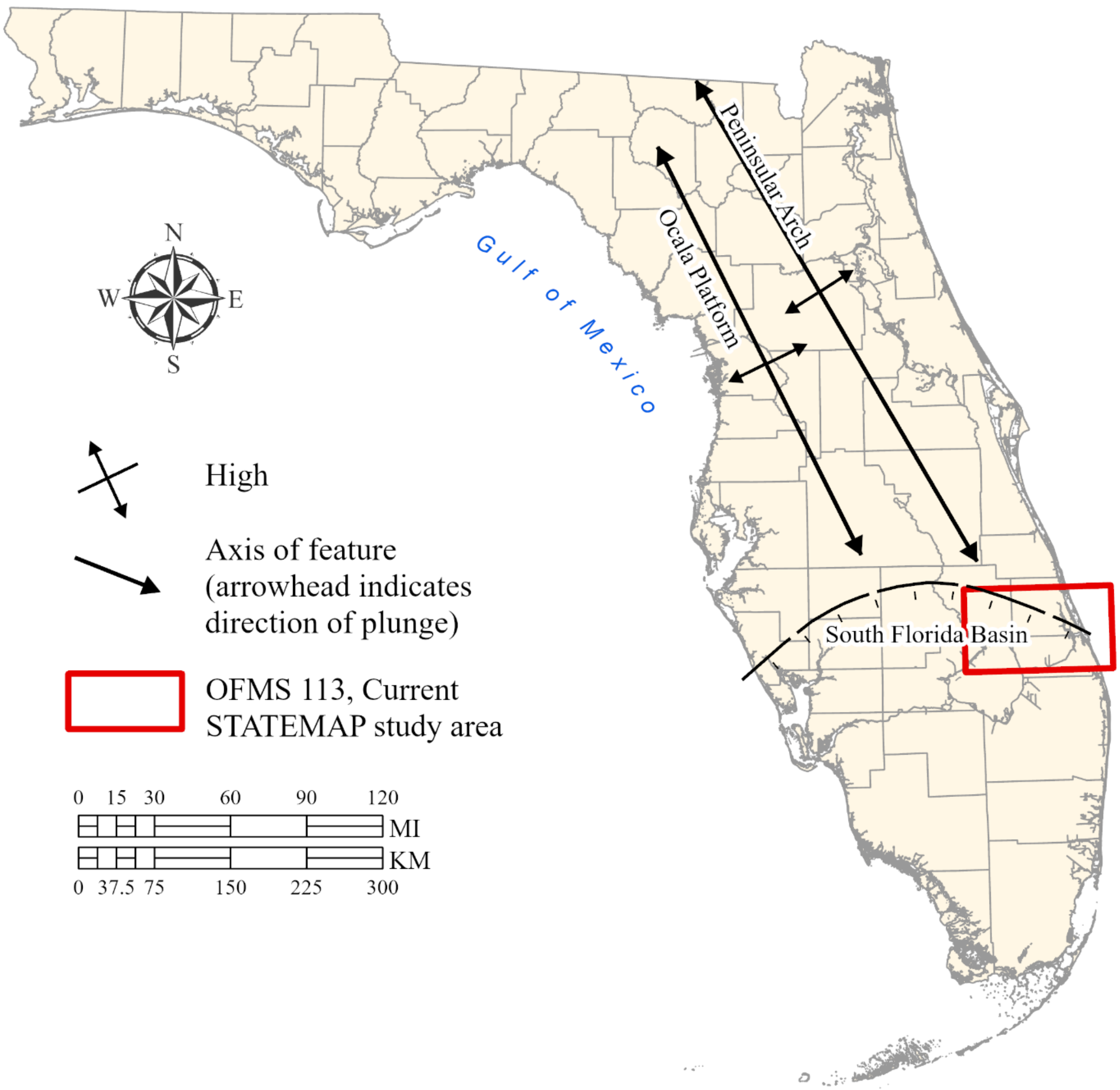

Figure 5. Principal subsurface structures of the Florida peninsula (modified from Scott, 1988).

The Ocala Platform is another prominent feature affecting the near-surface units within peninsular Florida. Hopkins (1920) originally named this feature the Ocala Uplift. Vernon (1951) described the Ocala Uplift as a gentle flexure developed in Tertiary sediments with a northwest-southeast trending crest. Because there is uncertainty about the origin of this feature, Scott (1988) used the term Ocala Platform, rather than Ocala Uplift, or Ocala Arch, since it does not have a structural connotation. Although the Ocala Platform does not come into the mapped area, discussion of it is included because of its effects on the regional geology of several map units.

The South Florida Basin (Applin and Applin, 1965; Winston, 1971) is a stratigraphic basin which contributed to the southward thickening and deepening of Mesozoic and early Cenozoic lithostratigraphic units in the southern Florida peninsula. This is evident in several of the cross-sections (OFMS 113, Plate 2).

Geomorphology

The Florida Geological Survey is producing a new statewide geomorphic atlas of Florida (Williams et al., 2022). The atlas will synthesize over a century of geomorphic writings and maps about Florida, along with the addition of new data and new interpretations of the geomorphology. *The Geomorphology of the Florida Peninsula* (White, 1970), in addition to work by former FGS colleague, Thomas M. Scott, is central to the new statewide map. Recent data and technology, including the addition of significant LiDAR coverages and new possibilities for digital geomorphological mapping that employ GIS and spatial data analysis, allowed the FGS to revise nomenclature and refine geomorphic district and province boundaries. In the following section, all geomorphic unit names and most discussions are from Williams et al. (2022).

The new atlas shows the geomorphology by regional units (districts; Figure 6) and sub-regional to local units (provinces; Figure 7). Districts are defined by regional groupings in which the geomorphology and near-surface geology are combined to form map polygons that are distinct from adjacent districts. Defining the more localized provinces and their landforms is important for the characterization of the districts.

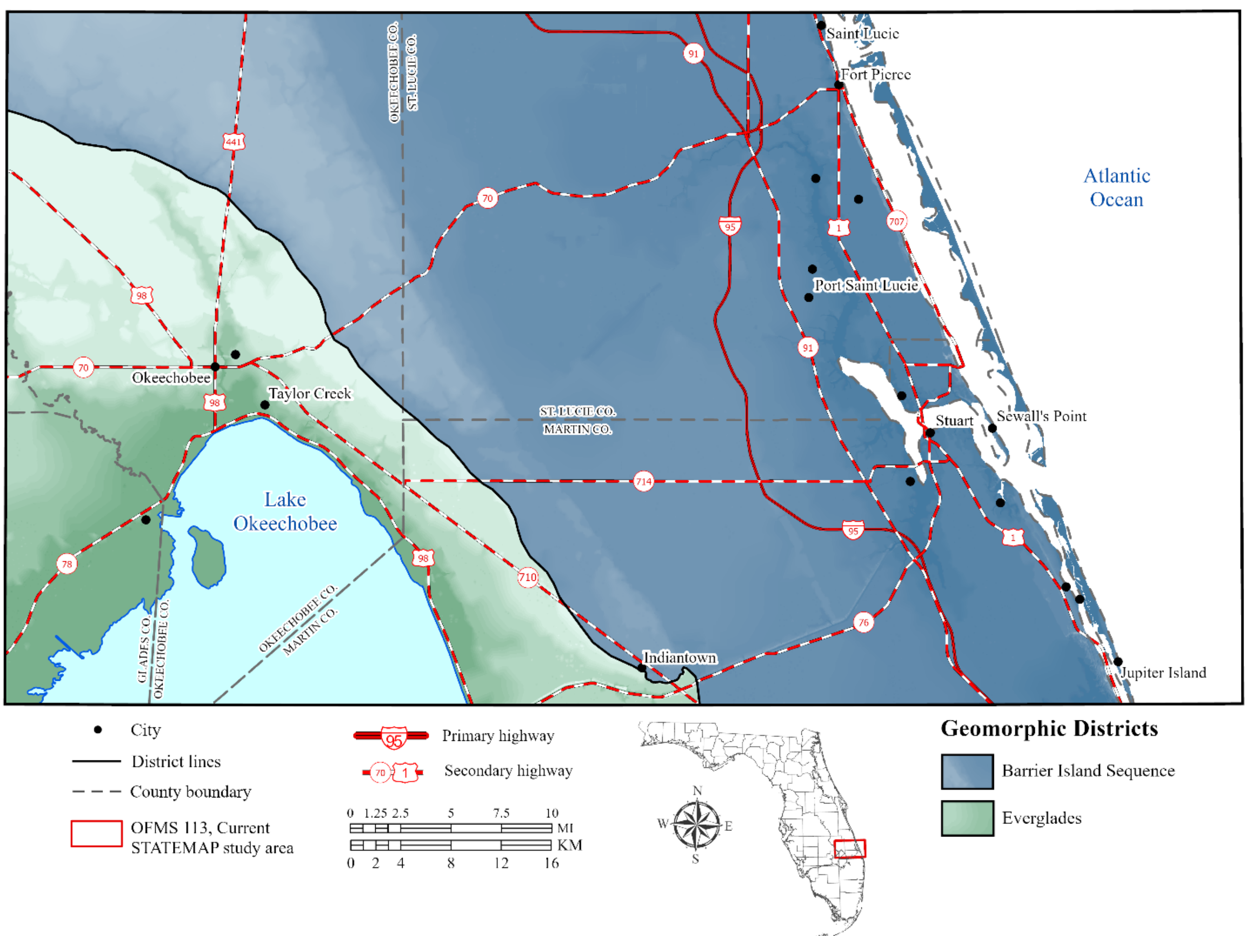

Figure 6. Geomorphic districts within the Fort Pierce quadrangle.

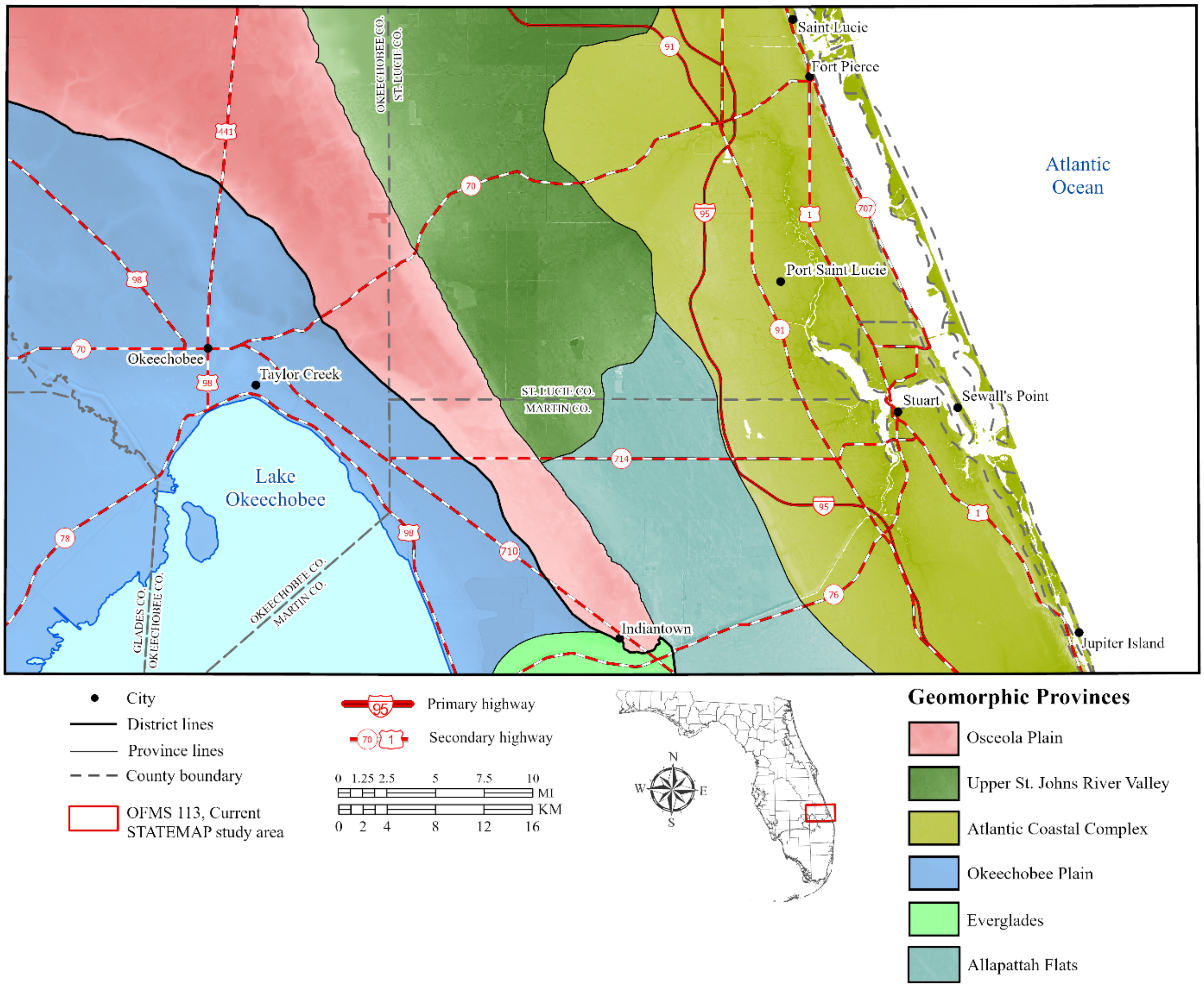

Figure 7. Geomorphic provinces within the Fort Pierce quadrangle.

Given the significance of karst and marine erosion and deposition in Florida, landforms derived via these processes are important to the identification of both province and districts. The study area falls partially within the Barrier Island Sequence District and partially within the Everglades District (Figure 6; OFMS 113, Plate 3, Figure 3). These districts are subdivided into provinces (Figure 7; OFMS 113, Plate 3, Figure 4).

Barrier Island Sequence District

The Barrier Island Sequence District occurs along the Atlantic Coast. It extends from Georgia (Clark and Zisa, 1976) into Florida, and south to the vicinity of Lake Okeechobee (OFMS 113, Plate 3, Figure 3). Pleistocene and Holocene coastal processes formed extensive barrier islands, beaches, lagoons, embayments, and shallow-water marine terraces in the district. Within the mapped area, the Barrier Island Sequence District is subdivided into four provinces: Allapattah Flats, Osceola Plain, Upper St. Johns River Valley, and Atlantic Coastal Complex (OFMS 113, Plate 3, Figure 4). Elevations of the district within Florida range from sea level to about 235 feet (71.6 meters) above MSL. Within the study area, elevations in the district range from sea level along the Atlantic Coast in the Atlantic Coastal Complex Province, to approximately 90 feet (27.4

meters) above MSL in the Osceola Plain Province (OFMS 113, Plate 3, Figure 1). The Barrier Island Sequence District in the mapped area is bounded to the south by the Everglades District and to the west by the Lakes District (OFMS 113, Plate 3, Figure 3).

Strand plains and shore-parallel dunes represent the preserved depositional features of former shorelines. The swales between beach ridges are often swampy and contain lakes, wetlands, linear swamps, and tributary streams in addition to the coast-parallel mangrove swamps landward of the barrier islands within the study area. The swales control the development of lakes in parts of the Osceola Plain Province and the extensive linear wetlands of the Atlantic Coastal Complex Province. Much of the river and stream drainage in the Barrier Island Sequence District is controlled by the relict ridges forming distinct, swale-induced, drainage patterns. The district includes two important coastal drainage systems within the study area, the North and South forks of the St. Lucie River, flowing toward the Atlantic Coast. The Indian River and Hobe Sound are estuarine lagoons that receive water from the St. Lucie River, numerous small streams, canals, and ditches that drain east toward the Atlantic Ocean. The St. Johns River Marsh, the headwater region of the St. Johns River, is in the Barrier Island Sequence District in the study area.

Tertiary/Quaternary undifferentiated shelly sediments underlie the Barrier Island Sequence District within the mapped area. The Pleistocene Anastasia Formation, Quaternary beach ridge and dune deposits, Quaternary undifferentiated sediments, and Holocene sediments overlie the Tertiary/Quaternary undifferentiated shelly sediments. The Anastasia Formation occurs at and near the coast, where it is sporadically exposed along the barrier island coastlines within the mapped area. Holocene sediments exist along the Atlantic Coast (OFMS 113, Plate 1). Karst features in the district are mostly related to dissolution of shell and carbonate beds within the Tertiary/Quaternary undifferentiated shelly sediments and the Anastasia Formation. Shallow karst depressions, including cover-subsidence sinkholes and solutions pits, were formed by dissolution of shell and coquina (Schmidt and Scott, 1984). Cover-subsidence sinkholes often form wetlands. In areas where the Anastasia Formation crops out along the Atlantic Coast, microkarst surfaces have developed (Upchurch et al., 2019).

Osceola Plain Province

The Osceola Plain Province extends from Seminole County to Martin County. It includes most of the Kissimmee River valley in the western two-thirds of the province and a strand plain in the eastern third. The flat, undulating surface of the Osceola Plain Province has the topography of a marine terrace (White, 1970) or a shallow marine platform. There are significant accumulations of dune and beach sand on the western boundary of the province, continuing onto the eastern flank of the Lake Wales Ridge Complex Province. Some of the dune fields are well developed and have significant relief. Elevations of the Osceola Plain Province in the study area range from approximately 25 feet (7.6 meters) MSL along the boundary with the Upper St. Johns River Valley Province (OFMS 113, Plate 3, Figure 1), to about 90 feet (27.4 meters) above MSL. The eastern boundary between the Osceola Plain Province and the Upper St. Johns River Valley Province is at the toe of a slope break marking a marine escarpment. The Osceola Plain Province is higher, has greater relief, and is better drained than the Allapattah Flats Province to the southeast (OFMS 113, Plate 3, Figure 1). The boundary between these two provinces is placed at the base of the marine escarpment along the eastern boundary of the Osceola Plain Province. The Osceola Plain Province shares a short boundary with the Everglades Province (Everglades District) to the south (OFMS 113, Plate 3, Figures 1 and 4). The boundary is placed at the transition from slightly higher elevations and relief of the Osceola Plain Province to the slightly lower elevations and relief of the

Everglades Province. The southern boundary with the Okeechobee Plain Province (Everglades District) separates the lower end of the Kissimmee River valley and the lowlands surrounding the northern half of Lake Okeechobee. The strand plain in the eastern third of the Osceola Plain Province is well developed from southeastern Seminole and eastern Orange counties into eastern Osceola County, narrowing to a ridge ending in westernmost Indian River County and northeastern Okeechobee County (Figures 1 and 2). Drainage in the province includes swale-controlled streams and wetlands associated with the many streams that parallel the Atlantic Coast. Several creeks cut across the ridges and flow toward the St. Johns River. The Kissimmee River once meandered through a shallow, flood plain south to Lake Okeechobee. In the 1960s, the Kissimmee River was channelized for flood control, and the landscape was significantly altered. In the late 1990s, efforts began to restore the natural flow of the river system.

Surficial geologic units exposed on the Osceola Plain include Tertiary/Quaternary undifferentiated shelly sediments, Quaternary undifferentiated sediments, and Quaternary beach ridge and dune sediments (OFMS 113, Plate 1). Tertiary/Quaternary undifferentiated shelly sediments underlie the surficial quartz sands in the province throughout the mapped area (OFMS 113, Plate 2). Large karst landforms are not common in the Osceola Plain Province. The shallow depressions and cover-subsidence sinkholes which are present are most likely due to dissolution of shell material in the shallow subsurface.

Upper St. Johns River Valley Province

The Upper St. Johns River Valley Province includes the fluvial/paludal valley from the headwaters of the St. Johns River, near the St. Lucie-Martin County boundary, northward to the outfall of Lake Monroe between Seminole and Volusia counties. The province follows a low-elevation drainage system that was an ancient embayment or lagoon between the Atlantic Coastal Complex Province to the east and the strand plain of the eastern Osceola Plain Province to the west (OFMS 113, Plate 3, Figure 4). Most of the Upper St. Johns River Valley Province is very flat with a riverine floodplain, wetlands, and lakes. The southern part of the province is slightly higher in elevation and lacks the distinct river channel and fluvial landforms that are present in the northern part of the province. Sediment transport in the system is negligible, but wetland development and the lacustrine/paludal sediments influence the presence of distributaries, lakes, and other landforms. Elevations in the Upper St. Johns River Valley Province in the mapped area range from five feet (1.5 meters) MSL to about 45 feet (13.7 meters) above MSL. Elevations above 35 feet (10.7 meters) MSL are generally restricted to the border regions with the Atlantic Coastal Complex Province and the Osceola Plain Province. The eastern boundary with the Atlantic Coastal Complex Province follows the change from coastal ridges to the east, and the wetland and river complex to the west (OFMS 113, Plate 3, Figure 1). The southern boundary between the Upper St. Johns River Valley Province and the Allapattah Flats Province is placed where the St. Johns River Marsh drains north into the St. Johns River (OFMS 113, Plate 3, Figure 1). The boundary of the Upper St. Johns River Valley Province with the Osceola Plain Province is placed at the toe of a marine escarpment where elevations increase on to the Osceola Plain Province to the west (OFMS 113, Plate 3, Figure 1). The concept that the province was once an embayment or lagoon is supported by the presence of coastal landforms on the margins of the Atlantic Coastal Ridge Complex Province to the east and the Osceola Plain Province to the west. Lakes are present along the course of the river in the northern part of the province, and there are many distributaries and oxbows, as is typical of a sediment-choked, low-gradient stream system. Anthropogenic alteration of the southern portion of the Upper St. Johns River Valley Province is extensive.

The Upper St. Johns River Valley Province is a broad area where Tertiary/Quaternary undifferentiated shelly sediments and Quaternary undifferentiated sediments occur at or near the land surface. Holocene sediments overlie these deposits in many of the low-lying river and wetland areas. Regions that are relatively unaffected by ditching and drainage systems have common, but not abundant, shallow depressions that are cover-subsidence sinkholes. These formed as a result of dissolution of shell material in the underlying Tertiary/Quaternary shelly sediments.

Atlantic Coastal Complex Province

The Atlantic Coastal Complex Province extends along the Atlantic Coast from the St. Johns River in Duval County to central Palm Beach County. The province consists of Quaternary barrier islands and related features on, and inland from, the Atlantic Coast. Water bodies and wetlands landward of the barrier islands include lagoons and small embayments. Within the study area, tidal estuarine coastlines are dominated by mangrove swamps. Most of the Atlantic Coastal Complex Province is a Pleistocene strand plain. Many of the beach ridges and dunes in this province are coast parallel. Elevations of the province in the study area range from sea level along the Atlantic Coast to about 50 feet (15.2 meters) above MSL along the western boundary of the province. The ridge and dune topography of the Atlantic Coastal Complex Province transitions to slightly lower elevation and flatter topography along most of its western boundary with the Upper St. Johns River Valley Province within the mapped area (OFMS 113, Plate 3, Figure 1).

Open lagoons and small embayments, located landward of the barrier islands, are locally termed “rivers” because of their historic uses for navigation. Drainage patterns in the Atlantic Coastal Complex Province are swale-dominated and coast-parallel in nature, with streams and wetlands occupying the swales between ridges. Some streams flow toward the Atlantic Ocean through breaks in the beach ridges, such as the North and South forks of the St. Lucie River.

The surficial lithostratigraphic units that affect the landforms in the Atlantic Coastal Complex Province include Tertiary/Quaternary undifferentiated shelly sediments, the Pleistocene Anastasia Formation, Quaternary undifferentiated sediments, and Quaternary beach ridge and dune sediments (Scott et al., 2001). Holocene sediments occur on many of the barrier islands and in the tidal mangrove estuaries. Sporadic exposures of the Anastasia Formation from St. Johns County to Palm Beach County create unique rocky coastlines. Cover-subsidence sinkholes occur in the province where the Tertiary/Quaternary undifferentiated shelly sediments and the Pleistocene Anastasia Formation are at or near the land surface. Dissolution features can be seen where the Anastasia Formation is exposed along the modern coast and in the Tertiary/Quaternary undifferentiated shelly sediments exposed in mines and borrow pits.

Allapattah Flats Province

The Allapattah Flats Province extends from southern St. Lucie County to northeastern Palm Beach County (OFMS 113, Plate 3, Figure 4). The province includes the indistinct, low-elevation, drainage divide between the headwater wetlands of the St. Johns River and the northeastern Everglades. It is characterized by very little change in elevation, highly variable directions of surface water flow, and numerous shallow circular wetlands in undeveloped areas of the landscape. The Allapattah Flats Province north of the St. Lucie Canal has elevations between 25 feet and 30 feet (7.6 meters and 9.1 meters) MSL. The southern part of the province ranges from 15 feet to 25 feet (4.6 meters to 7.6 meters) MSL, with most elevations below 20 feet (6.1 meters) MSL in the headwaters of the local drainage systems to the south and east (OFMS 113, Plate 3, Figure 4). The boundaries of the Allapattah Flats Province are largely based on drainage patterns. The boundary between the Allapattah Flats Province and the Upper St. Johns River Valley Province is placed where the St. Johns River Marsh drains north to the St. Johns River (OFMS 113, Plate 3, Figure 1). The northern Allapattah Flats Province is separated from the Atlantic Coastal Complex Province by Green Ridge (White, 1970), a narrow, coastal ridge which largely isolates the coastal rivers of St. Lucie and Martin counties from the Allapattah Flats Province (OFMS 113, Plate 3, Figure 1). The Allapattah Flats Province is slightly higher in elevation than the Everglades Province (Everglades District), but there is no definitive elevation break upon which a province boundary can be drawn. Therefore, the boundary approximates where the pre-development Everglades drainage system began. The boundary with the Osceola Plain Province to the west is at a distinct break in elevation on to the southern end of the strand plain that covers the eastern part of the Osceola Plain Province (OFMS 113, Plate 3, Figure 1).

Regions in the northern Allapattah Flats Province that have not been ditched and drained have wetlands that run north-northwest to south-southeast, parallel to the ancient coastal landforms. These landforms indicate that the northern Allapattah Flats Province was once a shallow marine shelf. The low ridges and swales within this area are likely either coast-parallel bedforms developed on this shelf, or poorly developed strand plains created as the sea retreated from the shelf. The southern portion of Allapattah Flats Province does not have obvious landforms indicative of coastal or shallow marine processes. The Allapattah Flats Province includes wetlands that historically drained north to the St. Johns River, west and south to the Everglades, or east to the Atlantic Ocean prior to construction of the St. Lucie Canal. Drainage is complex because surface-water drainage directions can change with water stage. Well-defined streams are rare, but strand-plain swales and interconnected, coalesced, cover-subsidence sinkholes exist. The depressions created by strand-plain formation control locally dominant paths of surface water flow. By the end of the 20th century, the St. Lucie Canal had been constructed and large areas of the province had been partly drained by shallow ditches, altering the historical drainage system. Undeveloped lands remain swampy.

The Allapattah Flats Province is underlain by Tertiary/Quaternary undifferentiated shelly sediments. Karst landforms are limited to numerous, nearly circular, shallow, closed depressions. These depressions are cover-subsidence sinkholes formed on shell beds that occur near land surface in the Tertiary/Quaternary shelly sediments. Toward the edges of the province, these depressions become oriented in the general direction of surface water flow.

Everglades District

The Everglades District includes the southern part of peninsular Florida (OFMS 113, Plate 3, Figure 3). Many areas are characterized by wetlands, but others include Pleistocene to Holocene carbonate islands and coastal ridges. The district has little topographic relief. The Everglades District is subdivided within the mapped area into two provinces: The Okeechobee Plain and Everglades provinces (OFMS 113, Plate 3, Figures 1 and 4). Elevations within the Everglades District gradually decrease from north to south. Lowest elevations in the district are at sea-level along the coastlines. Highest elevations approach 50 feet MSL. Elevations of the district within the mapped area range from approximately five to 45 feet (1.5 to 13.7 meters) MSL.

Nearshore marine and coastal processes have had limited impact on the dominant landforms in the northern part of the district. All the provinces within the Everglades District are related to a vast and complex drainage system that begins with the Kissimmee River and its tributaries in the Barrier Island Sequence District to the north. Lake Okeechobee has human-modified outlets to the west and east, but much of its natural flow is south toward Florida Bay. Drainage in much of the district is by way of sloughs, sheet flow in wetlands, and poorly defined stream systems predominantly flowing from north to south. Much of the district is covered by extensive wetlands. All the provinces within the district have relatively flat landscapes, and elevation changes of inches or a few feet often mark the differences between provinces. With few exceptions, pre-development drainage was as sheet flow and through sloughs (wetlands). The dominant flow of water through the central and eastern Everglades District has historically been north to south. Flow beginning in the Kissimmee River valley would discharge to Lake Okeechobee, then over the low, natural sills on the south side of the lake, and finally as sheet flow through the Everglades Province. During the 20th century, the St. Lucie Canal was constructed for navigation and as an eastern outlet for Lake Okeechobee.

Near-surface sediments of the northern Everglades District include Tertiary/Quaternary undifferentiated shelly sediments (Scott et al., 2001). Karst landforms are geologically young, thus small, forming during the Pliocene to Holocene. They are subtle, and more common in the southern than northern part of the district. Karren on rock surfaces and sinkholes can be found throughout the Everglades District. Duricrusts, microkarst, and breccias are also common wherever limestone is exposed. Cover-subsidence sinkholes (Upchurch et al., 2019) are common in many of the regions where the Tertiary/Quaternary shelly sediments and Tamiami Formation (west of mapped area) are at or near the land surface. Cover collapse sinkholes are rare in the district.

Okeechobee Plain Province

The Okeechobee Plain Province is the northernmost province of the Everglades District encompassing parts of Highlands, Okeechobee, Glades, and Martin counties and small areas of St. Lucie and Hendry counties (OFMS 113, Plate 3, Figure 4). The northern part of the province includes the lower Kissimmee River valley. This province includes Lake Okeechobee and the low-elevation plains and wetlands surrounding the northern half of the lake. The land surface of the Okeechobee Plain Province has low relief, with elevations as low as 5 feet (1.5 meters) MSL, increasing to 45 feet (13.7 meters) MSL within the study area. In the Kissimmee River valley, the boundary between the Okeechobee Plain Province and the Osceola Plain Province to the north is placed where the river valley begins to narrow relative to the southern part of the valley (OFMS 113, Plate 3, Figure 4). The boundary is more distinct to the northeast as elevation rises to the ridge at the southern end of the Osceola Plain Province. On the east, the boundary with the Everglades Province diverges from Lake Okeechobee where historic southward overland flow of water to the Everglades occurred. The boundary with the Everglades Province is along the southern shore of Lake Okeechobee, the former location of a low sill that controlled flow to the Everglades (OFMS 113, Plate 3, Figure 4). The sill has been replaced by the Herbert Hoover Dike.

Coastal landforms are muted and indistinct in the Okeechobee Plain Province. The province is a broad, relatively flat marine terrace that has been modified by fluvial processes and wetland development. The dominant fluvial feature is the lower Kissimmee River valley. The natural river channel meanders, and the floodplain includes abandoned meanders and other fluvial landforms. In the 1960s, the Kissimmee River was channelized for flood control. In the late 1990s, restoration to the natural drainage began and can be observed in the northern part of the province. Elsewhere in the province wetlands are common in low areas.

The Okeechobee Plain Province is underlain by Tertiary/Quaternary undifferentiated shelly sediments and Quaternary undifferentiated sediments (Scott et al., 2001). Surficial sediments include peat, muck, and marl associated with Holocene wetlands. Karst features are uncommon. Cover-subsidence sinkholes appear to be related to dissolution of the shell material, but they are less frequent than in the southern provinces of the Everglades District.

Everglades Province

The Everglades Province extends from the southern shore of Lake Okeechobee through Palm Beach, Broward, and Miami-Dade counties and parts of Glades, Martin, Hendry, Monroe, and Collier counties (OFMS 113, Plate 3, Figure 4). The province constitutes the largest subtropical wetland in the United States. The Everglades Province is a broad plain, sloping gently from north to south in southern peninsular Florida. For the most part, the province was covered by sawgrass marsh with scattered tree islands that transition to mangroves to the south and pine flatwoods to the east and west. Today, parts of this drainage system have been interrupted by canals, agricultural areas, and other land uses, including the Everglades Agricultural Area in the north. Land-surface elevations in the Everglades Province range from sea level to 40 feet (12.2 meters) MSL. Within the study area, elevations in the Everglades Province range from about 10 to 40 feet (3.0 to 12.2 meters) MSL. The northern boundary of the Everglades Province with the Okeechobee Plain Province follows the southern shore of Lake Okeechobee where drainage is southward to the Everglades Province (OFMS 113, Plate 3, Figure 4). The boundary of the Everglades Province with the Okeechobee Plain Province on the east side of Lake Okeechobee is near the St. Lucie Canal, the approximate location where historic overflow from Lake Okeechobee to the south began. The narrow boundary with the Osceola Plain Province follows a distinct increase in elevation at a low ridge at the southeastern end of the Osceola Plain Province, near Indiantown. The boundary of the province with the Allapattah Flats Province is based upon slightly higher elevations in the Allapattah Flats Province. The Everglades Province includes the historical drainage system from Lake Okeechobee toward the south and southwest. Historically, the Everglades Province was a sawgrass marsh dominated by sheet flow of water with scattered, tear-drop shaped tree islands, mostly south of Lake Okeechobee.

The Pliocene Tamiami Formation underlies most of the Everglades Province outside of the mapped area. The northern part of the Everglades Province is underlain by Tertiary/Quaternary undifferentiated shelly sediments. Holocene peat and calcitic marl form a thin cover over the shelly sediments (Scott et al., 2001). Peat deposits were thickest to the north, in the Everglades Agricultural Area. Karst in the northern Everglades Province develops in response to dissolution of carbonate shell material within the Tertiary/Quaternary shelly sediments that are near the land surface. Where thick muck soils and peats bury the limestone and shelly sediments, karst landforms are not evident; although, they do occur beneath the organic sediments. Where the upper surface of limestone in the peatlands is exposed, small karren and microkarst are often evident. Duricrusts and breccias are also found on the surface of the limestone. Larger depressions (solution sinkholes; Upchurch et al., 2019) are also found on the limestone surface in the Everglades Province. These features are common under hammocks, ponds, and sloughs, and seem to be associated with regions of peat accumulation. The organic acids in the peats are thought to have dissolved the limestone surface.

LITHOSTRATIGRAPHIC UNITS

Tertiary System

Eocene Series

Ocala Limestone

The oldest unit investigated for this study was the upper Eocene Ocala Limestone (To). The Ocala Limestone, first described by Dall and Harris (1892), is a biogenic marine limestone comprised largely of foraminifera, mollusks, echinoids, and bryozoans. The Ocala Limestone, which sits unconformably on the Avon Park Formation, is recrystallized to varying degrees within the study area.

Based on lithologic differences, the Ocala Limestone, in some areas, can be informally subdivided into an upper and lower unit (Scott, 1991). This subdivision, while often apparent in cores and quarries, is not readily apparent in cuttings. As a consequence of this, the geologic cross-sections do not depict the upper and lower Ocala Limestone. The upper unit is typically a white to cream, fine- to coarse-grained, poorly- to well-indurated, moderately- to well-sorted, very fossiliferous limestone (wackestone, packstone, and grainstone). Common fossils include foraminifera (*Lepidocyclina ocalana* and *Sphaerogypsina globulus*), bryozoans, mollusks, and a rich diversity of echinoids. The lower unit is typically a white to cream, fine- to medium-grained, poorly- to moderately- indurated, moderately- to well-sorted limestone (grainstone to packstone). Fossils include foraminifera (*Amphistegina pinarensis*, *Nummulites* [*Camerina*] *vanderstoki*, and *Nummulites* [*Operculinoides*] *ocalanus*), bryozoans, algae, mollusks, echinoids, and crustaceans. Porosity types in the unit range from intergranular to moldic depending on the lithology.

The Ocala Limestone occurs throughout the study area (OFMS 113, Plate 2). The top of the Ocala Limestone ranges from approximately 375 feet (114.3 meters) below MSL in W-17096, to approximately 920 feet (280.4 meters) below MSL in W-12556 (Appendix A). The thickness of the unit was only determined for 37 wells in the study area. In those wells, thickness ranged from 70 feet (21.3 meters; W-14666) to 350 feet (106.7 meters; W-1022).

The Ocala Limestone is generally thickest in the eastern part of the study area toward the coast. The Ocala Limestone forms part of the Floridan aquifer system (FAS; Southeastern Geological Society Ad Hoc Committee on Florida Hydrostratigraphic Unit Definition, 1986).

Oligocene-Pliocene Series

Hawthorn Group

Sediments of the lower Oligocene to Pliocene Hawthorn Group (Th) are thought to have been deposited over the Ocala Platform throughout peninsular Florida, but post-Pliocene erosion and karstification have removed them from the crest of the Ocala Platform (Cooke, 1945; Espenshade and Spencer, 1963; Scott, 1981). Within the mapped area, the Hawthorn Group is composed of sediments from the Arcadia and Peace River formations. Arcadia Formation sediments lie unconformably over the Ocala Limestone throughout the mapped area (OFMS 113, Plate 2, cross-sections). The Peace River Formation lies unconformably over the Arcadia Formation throughout the mapped area. The Hawthorn Group sediments are unconformably overlain by the Tertiary/Quaternary undifferentiated shelly sediments. The top of the Hawthorn

Group ranges from approximately 20 feet (6.1 meters) below MSL in W-17096 (Appendix A) to 245 feet (74.7 meters) below MSL in W-13967 (Appendix A). The thickness of the Hawthorn Group ranges from approximately 290 feet (88.4 meters) in W-14701 (Appendix A) to 750 feet (228.6 meters) in thickness in W-12556 (Appendix A) along the eastern edge of the mapped area in the vicinity of Stuart. The Hawthorn Group forms part of the intermediate aquifer system/intermediate confining unit (IAS/ICU) in the study area (Southeastern Geological Society Ad Hoc Committee on Florida Hydrostratigraphic Unit Definition, 1986).

Arcadia Formation

The lower Oligocene to middle Miocene (Covington, 1993; Brewster-Wingard et al., 1997) Arcadia Formation (Tha) is a poorly to moderately indurated, yellowish-gray to white carbonate with variable amounts of quartz sand and phosphate, interbedded with siliciclastic-dominant sediments. Phosphate content can be highly variable, ranging up to 25 percent, but is more commonly in the 10 percent range (Scott, 1988). Although limestone is present, dolostone is most common, ranging in grain size from microcrystalline to medium, with the coarser material often having a sucrosic texture. Minor clay and chert beds (some composed of silicified clay) also occur (Scott, 1988). Porosity types include intergranular and moldic. Brewster-Wingard et al. (1997) have indicated that an unconformity, spanning the latter half of the early Oligocene into the earliest Miocene, exists in the region. The Arcadia Formation was identified in wells within the study area based on the presence of sandy, phosphatic carbonate beds, with occasional presence of bored phosphatic hardgrounds.

The Arcadia Formation ranges from approximately 70 feet (21.3 meters) below MSL (Appendix A; W-12141) to approximately 770 feet (234.7 meters) below MSL (Appendix A; W-14754). The unit is thickest in the southern portion of the study area and ranges from 40 feet (12.2 meters) thick in W-12141 (Appendix A) to approximately 380 feet (115.8 meters) thick in W-14754 (Appendix A). The Arcadia Formation forms part of the intermediate aquifer system/intermediate confining unit (IAS/ICU) in the study area (Southeastern Geological Society Ad Hoc Committee on Florida Hydrostratigraphic Unit Definition, 1986).

Peace River Formation

The middle Miocene to lower Pliocene (Scott, 1988; Covington, 1993) Peace River Formation (Thp) is comprised of unconsolidated to poorly indurated yellowish-gray to olive-gray, interbedded quartz sands, clays, and carbonates. Siliciclastics are the predominant component of the unit (Scott, 1988). Phosphatic sand and gravel are most common in the uppermost beds, although they are generally interspersed throughout the unit. The Peace River Formation contains a diverse fossil assemblage of marine and terrestrial fauna. Porosity types in the formation are generally intergranular.

The Peace River Formation unconformably overlies the Arcadia Formation throughout the mapped area (OFMS 113, Plate 2). In areas where the carbonate component of the Peace River Formation is high, or the siliciclastic component of the Arcadia Formation is high, identifying the contact between these formations can be difficult. In such cases, the contact of the Peace River Formation with the Arcadia Formation is best estimated based on the occurrence of sedimentary structures, and where the overall lithologic sequence becomes more carbonate-dominant (Scott, 1988). In most of the study area, the contact is readily recognized at the first occurrence of a light-colored, phosphatic and quartz-sandy dolosilt.

The Peace River Formation ranges from approximately 20 feet (6.1 meters) below MSL in W-17096, to 245 feet (74.7 meters) below MSL in W-13967. Thicknesses range from approximately 20 feet (6.1 meters) in W-12141, to 470 feet (143.3 meters) in W-12556 (Appendix A).

The Peace River Formation sediments comprise a low-permeability confining- to semi-confining facies within the IAS/ICU within the study area (Southeastern Geological Society Ad Hoc Committee on Florida Hydrostratigraphic Unit Definition, 1986).

Tertiary/Quaternary Systems

Pliocene/Pleistocene Series

Tertiary/Quaternary undifferentiated shelly sediments

A sequence of Tertiary/Quaternary undifferentiated shelly sediments (TQsu) lies east of the Lake Wales Ridge Complex in peninsular Florida. Huddlestun (1988) named this unit the Nashua Formation. Much of the evidence listed by Huddlestun (1988) was based on biostratigraphic correlation and not lithology. Sediments located along the Econlockhatchee River were investigated during fieldwork for mapping in the Orlando quadrangle (Green et al., 2015a; Green et al., 2015b) and were determined to be very young (late Pleistocene-Holocene, Roger Portell, personal communication, 2015). Given the age uncertainty of these units, lack of adequate core control and lack of access to the type section, the authors decided to use the convention of Scott et al. (2001) and map these sediments as Tertiary/Quaternary undifferentiated shelly sediments. Huddlestun (1988) indicated the unit grades laterally into the Cypresshead Formation in the vicinity of Trail Ridge (north of the mapped area). Evidence from mapping in the Orlando quadrangle (Green et al., 2015a; Green et al., 2015b) indicates that the unit is, at least in part, older than the Cypresshead Formation. This may be a result of prograding of Cypresshead Formation sediments over Tertiary/Quaternary shelly sediments during changes in sea level. Some of these fossiliferous sands north of the study area (e.g., in the Daytona Beach quadrangle) are Pliocene (Roger Portell, personal communication, 2015).

There are problems in mapping these sediments as separate units because their historical definition is based on biostratigraphic, not lithostratigraphic, criteria (Scott and Allmon, 1990; Scott and Wingard, 1995). Scott and Campbell (1993) informally applied the name “Okeechobee formation” to these sediments in an effort to provide a lithostratigraphic framework, but the unit was never formalized. Therefore, the Florida Geological Survey continues to classify them as Tertiary/Quaternary undifferentiated shelly sediments.

Tertiary/Quaternary undifferentiated shelly sediments typically consist of fine-to-medium quartz sands and marine mollusk shell beds with variable amounts of micrite, silt, clay, and calcite cement. The unit occasionally contains lenses and thin beds of fresh-water mollusks. Colors range from light gray to light-olive gray. Fossil mollusk shells, which may vary from whole to fragments, are often highly weathered and abraded and regularly become the dominant lithology. Porosity is generally intergranular. Other accessory minerals may include calcite, aragonite, mica, heavy minerals, pyrite, and minor phosphate sand and gravel. A basal phosphate lag is occasionally present. In the study area, these Tertiary/Quaternary undifferentiated shelly sediments occur in the form of both unconsolidated sand with varying percentages of shell fragments and calcite-cemented sand and shell fragments, with occasional lithified carbonate beds.

The Tertiary/Quaternary undifferentiated shelly sediments present in the study area are generally less than 30 feet (9.1 meters) above MSL, with most of the unit being less than ten feet (3.0 meters) above MSL (OFMS 113, Plate 2, cross-sections). The elevation of the Tertiary/Quaternary shelly sediments is highest in the northwest portion of the mapped area in Okeechobee County and lowest along the Atlantic Coast (OFMS 113, Plate 2). It is postulated that these occurrences of higher elevation Tertiary/Quaternary undifferentiated shelly sediments are indicative of paleo-shorelines that have been "stranded" due to sea-level fluctuation. Additional studies, with much better core control than available in this study, are needed to determine the exact nature and relationships of the unit in the region.

The Tertiary/Quaternary undifferentiated shelly sediments are overlain by Quaternary undifferentiated sediments or Quaternary beach ridge and dune sediments in the central and western portions of the mapped area (OFMS 113, Plate 2). In the eastern portion of the mapped area, along the Atlantic Coast, the unit is overlain by the Anastasia Formation. The Tertiary/Quaternary undifferentiated shelly sediments are exposed in several quarries within the study area. Tertiary/Quaternary undifferentiated shelly sediments disconformably overlie the Peace River Formation throughout the Fort Pierce quadrangle.

The top of the Tertiary/Quaternary undifferentiated shelly sediments ranges from approximately 35 feet (10.7 meters) above MSL in the northwest corner of the quadrangle (W-16948), to 95 feet (29.0 meters) below MSL in W-12662. The thickness of the Tertiary/Quaternary undifferentiated shelly sediments in the mapped area varies from approximately 10 feet (3.1 meters) in W-16670 to 210 feet (64.0 meters) in W-18897 (Appendix A).

Permeable strata within the Tertiary/Quaternary undifferentiated shelly sediments form part of the surficial aquifer system (SAS; Southeastern Geological Society Ad Hoc Committee on Florida Hydrostratigraphic Unit Definition, 1986).

Pleistocene/Holocene Series

Anastasia Formation

The late Pleistocene Anastasia Formation (Qa) is present within a narrow band along the eastern edge of the study area. The formation, named by Sellards (1912), is composed of interbedded coquinoid limestone and quartz sand. It typically occurs as an orangish-brown, poorly- to well-indurated coquinoid limestone consisting of whole and broken mollusk shells in a quartz sand matrix. The coquina is commonly cemented by sparry calcite. The sand occurs in beds that are light-gray-to-tan and orangish-brown, unconsolidated to moderately indurated, and variably fossiliferous. Porosity is intergranular to intercrystalline but may be vuggy and even karstic in more cemented zones. In the study area, the Anastasia Formation occurs predominantly as a light-gray-to-tan and orangish-brown, unconsolidated to moderately indurated quartz sand and shells, with coquinoid limestone being less common. Exposures of the Anastasia Formation can be seen in numerous places along the Atlantic Coast, with particularly good examples near the House of Refuge Museum in Stuart, Florida.

The Anastasia Formation can be difficult to distinguish from the Tertiary/Quaternary undifferentiated shelly sediments in some areas due to similarity in lithologic components. Typically, the Anastasia Formation is distinguished based on its fairly uniform fossil content, tendency to contain rounded sand and shell fragments (typical of beach material), orangish-brown color, and lack of clay and silt matrix. In localities where the Anastasia Formation-Tertiary/Quaternary shelly sediments cannot be easily distinguished, Tertiary/Quaternary undifferentiated shelly sediments were picked where the shell fragments become more leached and weathered, and more diverse in taxonomy and texture.

The unit sits on Tertiary/Quaternary undifferentiated shelly sediments (OFMS 113, Plate 2). The top of the Anastasia Formation ranges from approximately ten feet (3.0 meters) above MSL in W-17726, to 20 feet (6.1 meters) below MSL in W-13968. The thickness of the Anastasia Formation varies from less than five feet (1.5 meters) in W-17727, to 85 feet (25.9 meters) in W-13967 (Appendix A). This formation is considered part of the SAS (Southeastern Geological Society Ad Hoc Committee on Florida Hydrostratigraphic Unit Definition, 1986).

Quaternary undifferentiated sediments

While not a formally recognized lithostratigraphic unit, Quaternary undifferentiated sediments (Qu) are mapped following the convention of Scott et al. (2001) in order to facilitate a better understanding of Florida's geology. The Quaternary undifferentiated sediments in the mapped area may be highly variable in thickness. Quaternary undifferentiated sediments in the study area lie unconformably on Anastasia Formation or Tertiary/Quaternary undifferentiated shelly sediments (OFMS 113, Plate 2).

Quaternary undifferentiated sediments generally consist of white-to-gray to orange-to-brown, fine- to coarse-grained, clean-to-clayey (usually) unfossiliferous quartz sand, sandy clays and clays, with variable admixtures of organics. Minor shell fragments are sometimes present in Quaternary undifferentiated sediments near the coast. This makes distinction between Quaternary undifferentiated sediments and Anastasia Formation difficult at times. The Quaternary undifferentiated sediments form part of the SAS (Southeastern Geological Society Ad Hoc Committee on Florida Hydrostratigraphic Unit Definition, 1986).

Quaternary beach ridge and dune

Quaternary beach ridge and dune sediments (Qbd) are mapped on the basis of having a surficial expression of relict beach ridges and dunes. While not a formally recognized lithostratigraphic unit, the unit is mapped following the convention of Scott et al. (2001) in order to facilitate a better understanding of Florida's geology. The unit unconformably overlies Tertiary/Quaternary undifferentiated shelly sediments in the central part of the study area (OFMS 113, Plate 2).

Beach ridge and dune sediments are comprised of quartz sands with occasional shells and are unconsolidated to poorly consolidated. Organics typically occur as a disseminated organic matrix, roots and plant debris, carbonized remains, or charcoal. The unit is considered part of the SAS (Southeastern Geological Society Ad Hoc Committee on Florida Hydrostratigraphic Unit Definition, 1986).

Holocene Sediments

Sediments mapped as Holocene (Qh) may include quartz sands, marls, organics, and minor carbonate sands and mud. They occur along the eastern portion of the mapped area and are associated with mangroves and marshes along the coast, in some coastal lowlands, and in modern barrier islands. These sediments are considered part of the SAS (Southeastern Geological Society Ad Hoc Committee on Florida Hydrostratigraphic Unit Definition, 1986).

HYDROGEOLOGY

Hydrostratigraphic units within the map area, in ascending order, consist of the FAS, the IAS/ICU, and the SAS (Southeastern Geological Society Ad Hoc Committee on Florida Hydrostratigraphic Unit Definition, 1986). A correlation chart of the hydrostratigraphic units, and their relationship to lithostratigraphic units, can be seen on OFMS 113, Plate 2, Figure 2. The FAS, the primary source for drinking water in the region, is generally comprised of carbonate units of the Avon Park Formation and the Ocala Limestone. The sands, silts, clays, and carbonates of the Hawthorn Group comprise the IAS/ICU. The SAS is comprised of Quaternary undifferentiated sediments, Quaternary beach ridge and dune sediments, Holocene sediments, Anastasia Formation, and Tertiary/Quaternary undifferentiated shelly sediments.

DERIVATIVE PRODUCTS

Several derivative products were developed in the process of completing this project. During the mapping efforts, data from 184 wells with samples were analyzed and used (Appendix A). Formation picks made on these cores and cutting samples will allow creation of structure contour and isopach maps for the top of several units in the area, as well as future 3-D models. Additional derivative products anticipated to come from this mapping effort include aquifer vulnerability assessment maps, karst susceptibility and risk maps, and aquifer and confining unit maps. Data derived from prior STATEMAP products have often been used to augment other Florida Geological Survey and Florida Aquifer Vulnerability Assessment (FAVA) projects in the state (Arthur et al., 2007; Baker et al., 2007; Kromhout et al., 2017). These geologic maps will also be compiled and published as part of the Statewide Surficial Geologic Map in the next decade.

REFERENCES

Applin, P., 1951, Possible future petroleum provinces of North America - Florida: American Association of Petroleum Geologists Bulletin, v. 35, p. 405-407.

Applin, P.L., and Applin, E.R., 1944, Regional subsurface stratigraphy and structure of Florida and southern Georgia: American Association of Petroleum Geologists Bulletin, v. 28, p. 1673-1753.

Applin, P.L., and Applin, E.R., 1965, The Comanche Series and associated rocks in the subsurface in central and south Florida: U.S. Geological Survey Professional Paper 447, 84 p, https://doi.org/10.3133/pp447.

Arthur, J.D., 1993, Geologic map of Highlands County, Florida: Florida Geological Survey Open-File Map Series 52, scale 1:126,720, https://doi.org/10.35256/OFMS52.

Arthur, J.D., Wood, H.A.R., Baker, A.E., Cichon, J.R., and Raines, G.L., 2007, Development and implementation of a Bayesian-based aquifer vulnerability assessment in Florida: Natural Resources Research, v. 16, p. 93-107, https://doi.org/10.1007/s11053-007-9038-5.

Baker, A.E., Wood, H.A.R., and Cichon, J.R., 2007, The Marion County Aquifer Vulnerability Assessment: unpublished report submitted to Marion County Board of County Commissioners in fulfillment of Marion County Project No. SS06-01, March 2007, 42 p.

Brewster-Wingard, G.L., Scott, T.M., Edwards, L.E., Weedman, S.D., and Simmons, K.R., 1997, Reinterpretation of the peninsular Florida Oligocene: an integrated stratigraphic approach: Sedimentary Geology, v. 108, p. 207-228, https://doi.org/10.1016/S0037-0738(96)00055-3.

Campbell, K.M., 1993, Geologic map of Glades County, Florida: Florida Geological Survey Open-File Map Series 60, Scale 1:126,720, https://doi.org/10.35256/OFMS60.

Clark, W.Z., Jr. and Zisa, A.C., 1976, Physiographic map of Georgia: The Geologic and Water Resources Division, Georgia Department of Natural Resources, scale 1:2,000,000, 1 sheet.

Cooke, C.W., 1945, Geology of Florida: Florida Geological Survey Bulletin 29, 342 p, https://doi.org/10.35256/B29.

Covington, J.M., 1993, Neogene nannofossils of Florida, *in* Zullo, V.A., Harris, W.B., Scott, T.M., and Portell, R.W., eds., The Neogene of Florida and adjacent regions: Florida Geological Survey Special Publication 37, 112 p, https://doi.org/10.35256/SP37.

Dall, W.H., and Harris, G.D., 1892, Correlation papers, Neocene: U.S. Geological Survey Bulletin 84, 349 p, https://doi.org/10.3133/b84.

Duncan, J.G., and Scott, T.M., 1993, Geologic map of Martin County, Florida: Florida Geological Survey Open-File Map Series 56, Scale 1:126,760, https://doi.org/10.35256/OFMS56.

Espenshade, G.H., and Spencer, C.W., 1963, Geology of phosphate deposits of northern peninsular Florida: United States Geological Survey Bulletin 1118, 115 p, https://doi.org/10.3133/b1118.

Green, R.C., Scott, T.M., Campbell, K.M., Arthur, J.D., and Means, G.H., 1997, Surficial and Bedrock Geology of the western portion of the USGS 1:100,000 scale Sarasota quadrangle, Florida: Florida Geological Survey Open-File Map Series 86, 2 maps, 6 cross-sections, https://doi.org/10.35256/OFMS86.

Green, R.C., Scott, T.M., Campbell, K.M., and Means, G.H., 1998, Surficial and Bedrock Geology of the eastern portion of the USGS 1:100,000 scale Sarasota quadrangle and the western portion of the USGS 1:100,000 scale Arcadia quadrangle, Florida: Florida Geological Survey Open-File Map Series 87, 2 maps, 6 cross-sections, https://doi.org/10.35256/OFMS87.

Green, R.C., Means, G.H., Scott, T.M., Arthur, J.D., and Campbell, K.M., 1999, Surficial and Bedrock Geology of the eastern portion of the USGS 1:100,000 scale Arcadia quadrangle, Florida: Florida Geological Survey Open-File Report 88, 2 maps, 6 cross-sections, https://doi.org/10.35256/OFR88.

Green, R.C., Williams, C.P., Bambach, P.W., Hannon, L.M., Apolinar, B., Campbell, K.M., and Dyer, S.B., 2015a, Geologic map of the USGS 30 x 60 minute Orlando quadrangle, central Florida: Florida Geological Survey Open-File Map Series 107, scale 1:100,000, 3 plates, https://doi.org/10.35256/OFMS107.

Green, R.C., Williams, C.P., Bambach, P.W., Hannon, L.M., Apolinar, B., Campbell, K.M., and Dyer, S.B., 2015b, Text to accompany geologic map of the USGS 30 x 60 minute Orlando quadrangle, central Florida: Florida Geological Survey Open-File Report 105, 31 p, https://doi.org/10.35256/OFR105.

Green, R.C., Williams, C.P., Lamarche, A.G., Albritton, C.K., White, K.M., and Bassett, S.W., 2018a, Geologic map of the USGS Kissimmee 30 x 60 minute quadrangle, central Florida: Florida Geological Survey Open-File Map Series 110, scale 1:100,000, 3 plates, https://doi.org/10.35256/OFMS110.

Green, R.C., Williams, C.P., Lamarche, A.G., Albritton, C.K., White, K.M., and Bassett, S.W., 2018b, Text to accompany geologic map of the USGS Kissimmee 30 x 60 minute quadrangle, central Florida: Florida Geological Survey Open-File Report 107, 42 p, https://doi.org/10.35256/OFR107.

Green, R.C., Williams, C.P., Lamarche, A.G., Hebets, C.L., Albritton, C.K., and Evans, G.S., 2019a, Geologic map of the USGS Bartow 30 x 60 minute quadrangle, central Florida: Florida Geological Survey Open-File Map Series 111, scale 1:100,000, 3 plates, https://doi.org/10.35256/OFMS111.

Green, R.C., Williams, C.P., Lamarche, A.G., Hebets, C.L., Albritton, C.K., and Evans, G.S., 2019b, Text to accompany geologic map of the USGS Bartow 30 x 60 minute quadrangle, central Florida: Florida Geological Survey Open-File Report 108, 38 p, https://doi.org/10.35256/OFR108.

Green, R.C., Lamarche, A.G., Williams, C.P., Hebets, C.L., Evans, G.S., and Albritton, C.K., 2021a, Geologic map of the USGS Vero Beach 30 x 60 minute quadrangle, central Florida: Florida Geological Survey Open-File Map Series 112, scale 1:100,000, 3 plates, https://doi.org/10.35256/OFMS112.

Green, R.C., Lamarche, A.G., Williams, C.P., Hebets, C.L., Evans, G.S., and Albritton, C.K., 2021b, Text to accompany geologic map of the USGS Vero Beach 30 x 60 minute quadrangle, central Florida: Florida Geological Survey Open-File Report 109, 38 p, https://doi.org/10.35256/OFR109.

Hine, A.C., 2013, Geologic history of Florida: major events that formed the Sunshine State: Gainesville, University Press of Florida, 230 p.

Hopkins, O.B., 1920, Drilling for oil in Florida: U.S. Geological Survey Press Bulletin, April, 1920.

Huddlestun, P.F., 1988, A revision of the lithostratigraphic units of the Coastal Plain of Georgia, the Miocene through Holocene: Georgia Geologic Survey Bulletin 104, 262 p.

Hydrologic Unit Codes: Basins, 1993: Tallahassee: Florida Department of Environmental Protection, https://geodata.dep.state.fl.us/datasets/florida-hydrologic-unit-code-huc-basins-areas/explore?location=28.016653%2C-83.755400%2C7.48 [accessed October, 2022]

Kromhout, C., Baker, A.E., Albritton, C.K., Scott, T.M., Cichon, J.R., and Miller, S.R., 2017, The Favorability of Florida's Geology to Sinkhole Formation: A report prepared for the Florida Division of Emergency Management, Mitigation Section, 76 p., http://publicfiles.dep.state.fl.us/FGS/FGS_Publications/FGS%20Library%20Documents/GreyLit/Misc/DEMSinkholeReport.pdf

Miller, J.A., 1986, Hydrogeologic framework of the Floridan aquifer system in Florida and in parts of Georgia, Alabama, and South Carolina: Regional Aquifer-System Analysis: U.S. Geological Survey Professional Paper 1403-B, 91 p., 33 plates, https://doi.org/10.3133/pp1403B.

Puri, H.S., and Vernon, R.O., 1964, Summary of the geology of Florida and a guidebook to the classic exposures: Florida Geological Survey Special Publication 5 (Revised), 312 p, https://doi.org/10.35256/SP05R.

Schmidt, W., 1984, Neogene stratigraphy and geologic history of the Apalachicola Embayment: Florida Geological Survey Bulletin 58, 146 p, https://doi.org/10.35256/B58.

Scott, T.M., 1981, The Hawthorn Formation of North Florida: Southeastern Geological Society, Field Conference Guidebook, v. 23, p. 15-23.

__________, 1988, The lithostratigraphy of the Hawthorn Group (Miocene) of Florida: Florida Geological Survey Bulletin 59, 148 p, https://doi.org/10.35256/B59.

__________, 1991, A geological overview, *in* Scott, T.M., Lloyd, J.M., and Maddox, G.L., eds., Florida's ground-water quality monitoring program, hydrogeologic framework: Florida Geological Survey Special Publication 32, 97 p, https://doi.org/10.35256/SP32.

__________, 1993a, Geologic map of St. Lucie County, Florida: Florida Geological Survey Open-File Map Series 53, Scale 1:126,760, https://doi.org/10.35256/OFMS53.

__________, 1993b, Geologic map of Okeechobee County, Florida: Florida Geological Survey Open-File Map Series 54, Scale 1:126,760, https://doi.org/10.35256/OFMS54.

__________, 1997, Miocene to Holocene history of Florida, *in* Randazzo, A.F., and Jones, D.S., eds., The Geology of Florida: Gainesville, University Press of Florida, p. 57-67.

Scott, T.M., and Campbell, K.M., 1993, Geologic map of Hardee County, Florida: Florida Geological Survey Open-File Map Series 51, Scale 1:126,760, https://doi.org/10.35256/OFMS51.

Scott, T.M., Campbell, K.M., Rupert, F.R., Arthur, J.A., Green, R.C., Means, G.H., Missimer, T.M., Lloyd, J.M., and Duncan, J.G., 2001, Geologic map of Florida: Florida Geological Survey Map Series 146, scale 1:750,000, https://doi.org/10.35256/MS146.

Scott, T.M., and Allmon, W., eds., 1990, Plio-Pleistocene stratigraphy and paleontology of south Florida: Southeastern Geological Society Field Trip Guidebook 31, unpaginated.

Scott, T.M., and Wingard, G.L., 1995, Facies, fossils, and time – A discussion of the litho- and biostratigraphic problems in the Plio-Pleistocene sediments in southern Florida, *in* Scott, T.M., 1995, compiler, Stratigraphy and paleontology of the Plio-Pleistocene shell beds, southwest Florida: Southeastern Geological Society Guidebook no. 35, unpaginated.

Sellards, E.H., 1912, The soils and other surface residual material of Florida: Florida Geological Survey Fourth Annual Report, p. 1-79, https://doi.org/10.35256/AR04.

Southeastern Geological Society Ad Hoc Committee on Florida Hydrostratigraphic Unit Definition, 1986, Hydrogeological units of Florida: Florida Geological Survey Special Publication 28, 8 p, https://doi.org/10.35256/SP28.

Upchurch, S.B., Scott, T.M., Alfieri, M.C., Fratesi, B., and Dobecki, T.L., 2019. The karst systems of Florida: understanding karst in a geologically young terrain: New York, Springer Nature, 450 p, https://doi.org/10.1007/978-3-319-69635-5.

U.S. Geological Survey, 1986, 1:100,000-scale metric topographic map of Fort Pierce, Florida: U.S. Geological Survey, 1 sheet.

Vernon, R.O., 1951, Geology of Citrus and Levy Counties, Florida: Florida Geological Survey Bulletin 33, 256 p, https://doi.org/10.35256/B33.

White, W.A., 1970, The geomorphology of the Florida peninsula: Florida Geological Survey Bulletin 51, 164 p, https://doi.org/10.35256/B51.

Williams, C.P., Scott, T.M., and Upchurch, S.B., 2022, Florida Geomorphology Atlas: Florida Geological Survey Special Publication 59, 238 p.

Williams, K.E., Nicol, D., and Randazzo, A.F., 1977, The geology of the western part of Alachua County, Florida: Florida Geological Survey Report of Investigation 85, 97 p, https://doi.org/10.35256/RI85.

Winston, G.O., 1971, Regional structure, stratigraphy and oil possibilities of the South Florida basin: Gulf Coast Association of Geological Societies Transactions, v. 21, p. 15-29.

ACKNOWLEDGEMENTS

The authors wish to extend thanks to the personnel that assisted with permitting and land access for drill sites. Manohardeep Josan, Wayne Lewis, David Colangelo, and Joe Martin, from South Florida Water Management District, devoted time assisting with site selection and access for Allapattah Flats Management Area. Steve Krupa and Emily Richardson, from the Hydrogeology unit at South Florida Water Management District, assisted the STATEMAP team with access to additional borehole data in the area. Robin Jackson and Timothy Parsons with the Division of Historical Resources aided in reviewing the proposed drill sites for clearance of historical significance.

Special thanks to Guy Richardson, Nicholas Bloodworth, and Jesse Hurd for operating the drill rig. Alan Baker, Gary Fowler, and Clint Kromhout reviewed, discussed, and edited the product. Kathryn Etheridge, Archivist at the Florida Geological Survey, devoted considerable time compiling literature pertinent to the project. Roger Portell, Director of Invertebrate Paleontology and Micropaleontology Collections at the Florida Museum of Natural History, provided stratigraphic field data from select localities in the region.

This geologic map was funded in part by the Florida Geological Survey (a Division of the Florida Department of Environmental Protection) and by the United States Geological Survey National Cooperative Geologic Mapping Program under assistance award number G20AC00368 in Federal fiscal year 2020.

APPENDIX A: FLORIDA GEOLOGICAL SURVEY WELLS UTILIZED FOR STUDY

This table lists FGS wells within the boundaries of the USGS Fort Pierce 30 x 60 minute quadrangle utilized for the project. Due to graphical constraints, not all wells will appear on Plate 1 of OFMS 113. The first 24 wells in the table were utilized for geologic cross-sections and appear on Plates 1 and 2 of OFMS 113.

Map ID	Well Label	Data Source	Sample Type	Latitude	Longitude	24K QUAD	Elevation (ft.)	Total Depth (ft.)
1	W-4399	FGS	Cuttings	27.16820	-80.24588	SAINT LUCIE INLET	12	1057
2	W-4480	FGS	Cuttings	27.30865	-80.82617	TAYLOR CREEK SE	28	825
3	W-5405	FGS	Cuttings	27.14345	-80.69233	MARCY	18	1008
4	W-5439	FGS	Cuttings	27.12107	-80.89653	OKEECHOBEE SW	12	1018
5	W-7677	FGS	Cuttings	27.44556	-80.41861	FORT PIERCE NW	19	576
6	W-8361	FGS	Cuttings	27.33611	-80.57389	NORTH OF BLUEFIELD	21	1340
7	W-14062	FGS	Cuttings	27.44198	-80.84145	TAYLOR CREEK NE	63	1040
8	W-14666	FGS	Cuttings	27.15561	-80.61367	BLUEFIELD	30	1200
9	W-16066	FGS	Cuttings	27.24090	-80.26223	PALM CITY	16	2214
10	W-16540	FGS	Cuttings	27.25699	-80.81756	TAYLOR CREEK SE	21	840
11	W-16543	FGS	Cuttings	27.33711	-80.49053	FORT PIERCE SW	21	1540
12	W-16949	FGS	Cuttings	27.46309	-80.95950	TAYLOR CREEK NW	65	238
13	W-16969	FGS	Cuttings	27.45365	-80.76200	TAYLOR CREEK NE	56	238
14	W-17023	FGS	Cuttings	27.47921	-80.58894	SAINT JOHNS MARSH SLOUGH	21	1260
15	W-17024	FGS	Cuttings	27.44615	-80.58839	SAINT JOHNS MARSH SLOUGH	23	1220
16	W-17145	FGS	Cuttings	27.26167	-80.60840	NORTH OF BLUEFIELD	26	997
17	W-17423	FGS	Cuttings	27.31144	-80.78367	TAYLOR CREEK SE	30	990
18	W-17805	FGS	Cuttings	27.44197	-80.35361	FORT PIERCE	19	880
19	W-18624	FGS	Continuous Core	27.09840	-80.26045	INDIANTOWN SE	12	3200
20	W-18774	FGS	Cuttings	27.31027	-80.38751	FORT PIERCE SW	24	3300
21	W-18776	FGS	Cuttings	27.15459	-80.87533	OKEECHOBEE NW	19	880
22	W-18994	FGS	Cuttings	27.38640	-80.37720	FORT PIERCE NW	22	3206
23	W-19253	FGS	Cuttings	27.31010	-80.34164	ANKONA	14	2000
24	W-19800	FGS	Continuous Core	27.11986	-80.41675	INDIANTOWN	28	258
25	W-51	FGS	Cuttings	27.24512	-80.83739	OKEECHOBEE	29	810
26	W-396	FGS	Cuttings	27.41920	-80.32191	FORT PIERCE	15	154
27	W-398	FGS	Cuttings	27.42306	-80.31611	FORT PIERCE	27	174
28	W-399	FGS	Cuttings	27.42417	-80.31611	FORT PIERCE	29	162
29	W-627	FGS	Cuttings	27.01949	-80.11106	HOBE SOUND	44	81
30	W-630	FGS	Cuttings	27.00144	-80.09964	HOBE SOUND	25	90
31	W-1022	FGS	Cuttings	27.40354	-80.42196	FORT PIERCE NW	19	930
32	W-1052	FGS	Cuttings	27.40006	-80.41493	FORT PIERCE NW	13	867
33	W-1368	FGS	Cuttings	27.37936	-80.34208	FORT PIERCE	1	154
34	W-1392	FGS	Cuttings	27.38786	-80.41136	FORT PIERCE NW	20	860
35	W-2396	FGS	Cuttings	27.15949	-80.94645	OKEECHOBEE NW	19	1215
36	W-2621	FGS	Cuttings	27.42583	-80.40972	FORT PIERCE NW	18	88
37	W-3070	FGS	Cuttings	27.17199	-80.21394	SAINT LUCIE INLET	10	84
38	W-3609	FGS	Cuttings	27.30318	-80.37276	ANKONA	25	63

Map ID	Well Label	Data Source	Sample Type	Latitude	Longitude	24K QUAD	Elevation (ft.)	Total Depth (ft.)
39	W-4851	FGS	Cuttings	27.02225	-80.47437	INDIANTOWN	34	115
40	W-4853	FGS	Cuttings	27.01986	-80.46928	INDIANTOWN	36	115
41	W-4896	FGS	Cuttings	27.19449	-80.89507	OKEECHOBEE NW	18	1313
42	W-5143	FGS	Cuttings	27.24360	-80.32702	PALM CITY	11	71
43	W-5219	FGS	Cuttings	27.22028	-80.27639	PALM CITY	6	126
44	W-5228	FGS	Cuttings	27.15889	-80.30056	PALM CITY	15	70
45	W-6062	FGS	Cuttings	27.37028	-80.31389	ANKONA	17	106
46	W-6067	FGS	Cuttings	27.45583	-80.34806	FORT PIERCE	19	130
47	W-6068	FGS	Cuttings	27.46722	-80.34750	FORT PIERCE	19	138
48	W-6069	FGS	Cuttings	27.46750	-80.36417	FORT PIERCE	21	130
49	W-6070	FGS	Cuttings	27.45694	-80.33944	FORT PIERCE	16	130
50	W-6071	FGS	Cuttings	27.46750	-80.34750	FORT PIERCE	17	131
51	W-6072	FGS	Cuttings	27.45778	-80.37278	FORT PIERCE	17	120
52	W-6120	FGS	Cuttings	27.41648	-80.32031	FORT PIERCE	16	60
53	W-6121	FGS	Cuttings	27.38507	-80.31174	FORT PIERCE	16	52
54	W-6403	FGS	Cuttings	27.43893	-80.35005	FORT PIERCE	19	106
55	W-6407	FGS	Cuttings	27.44171	-80.35005	FORT PIERCE	20	112
56	W-6968	FGS	Cuttings	27.08898	-80.15062	GOMEZ	15	70
57	W-7565	FGS	Cuttings	27.45300	-80.47709	FORT PIERCE NW	21	100
58	W-7667	FGS	Cuttings	27.44609	-80.41739	FORT PIERCE NW	18	120
59	W-7880	FGS	Cuttings	27.05922	-80.13683	GOMEZ	22	138
60	W-8176	FGS	Cuttings	27.41167	-80.39639	FORT PIERCE NW	17	161
61	W-8481	FGS	Cuttings	27.19663	-80.26742	PALM CITY	1	57
62	W-8749	FGS	Cuttings	27.22471	-80.22315	SAINT LUCIE INLET	11	88
63	W-8755	FGS	Cuttings	27.27156	-80.29357	ANKONA	13	78
64	W-8756	FGS	Cuttings	27.17651	-80.25421	PALM CITY	8	115
65	W-10476	FGS	Cuttings	27.25625	-80.30974	ANKONA	10	106
66	W-10716	FGS	Cuttings	27.42861	-80.40361	FORT PIERCE NW	17	127
67	W-11094	FGS	Cuttings	27.43238	-80.34166	FORT PIERCE	20	110
68	W-11379	FGS	Cuttings	27.16889	-80.57194	BLUEFIELD	37	96
69	W-12085	FGS	Cuttings	27.43259	-80.39105	FORT PIERCE NW	18	85
70	W-12141	FGS	Cuttings	27.09648	-80.43934	INDIANTOWN	27	290
71	W-12160	FGS	Cuttings	27.38708	-80.49100	FORT PIERCE NW	20	94
72	W-12162	FGS	Cuttings	27.29967	-80.34458	ANKONA	15	105
73	W-12333	FGS	Cuttings	27.26681	-80.28881	ANKONA	14	87
74	W-12396	FGS	Cuttings	27.31485	-80.35050	ANKONA	14	115
75	W-12556	FGS	Cuttings	27.19632	-80.24847	SAINT LUCIE INLET	8	3001
76	W-12658	FGS	Cuttings	27.29893	-80.25588	ANKONA	38	202
77	W-12659	FGS	Cuttings	27.19671	-80.27727	PALM CITY	7	182
78	W-12660	FGS	Cuttings	27.17244	-80.26394	PALM CITY	2	162
79	W-12661	FGS	Cuttings	27.05589	-80.12560	GOMEZ	9	200
80	W-12662	FGS	Cuttings	27.14838	-80.17032	SAINT LUCIE INLET	6	200
81	W-12663	FGS	Cuttings	27.13922	-80.18838	SAINT LUCIE INLET	6	160
82	W-12665	FGS	Cuttings	27.14199	-80.19977	SAINT LUCIE INLET	8	140
83	W-12666	FGS	Cuttings	27.22310	-80.24283	SAINT LUCIE INLET	12	180
84	W-12667	FGS	Cuttings	27.29893	-80.30505	ANKONA	12	162
85	W-12668	FGS	Cuttings	27.05533	-80.34227	INDIANTOWN SE	34	240

Map ID	Well Label	Data Source	Sample Type	Latitude	Longitude	24K QUAD	Elevation (ft.)	Total Depth (ft.)
86	W-12669	FGS	Cuttings	27.01644	-80.45950	INDIANTOWN	29	200
87	W-12670	FGS	Cuttings	27.16313	-80.40305	INDIANTOWN NW	27	240
88	W-12676	FGS	Cuttings	27.08142	-80.55572	BARLEY BARBER SWAMP	31	180
89	W-12677	FGS	Cuttings	27.15894	-80.67700	MARCY	24	220
90	W-12678	FGS	Cuttings	27.16449	-80.56505	BLUEFIELD	34	180
91	W-12679	FGS	Cuttings	27.23189	-80.22348	SAINT LUCIE INLET	24	220
92	W-12680	FGS	Cuttings	27.16328	-80.49709	INDIANTOWN NW	29	180
93	W-12683	FGS	Cuttings	27.13200	-80.20920	SAINT LUCIE INLET	19	220
94	W-12869	FGS	Cuttings	27.36138	-80.48648	FORT PIERCE SW	20	42
95	W-12892	FGS	Cuttings	27.48083	-80.33972	FORT PIERCE	30	117
96	W-13044	FGS	Cuttings	27.06995	-80.13784	GOMEZ	23	120
97	W-13423	FGS	Cuttings	27.44660	-80.73438	JERNIGANS POND	40	86
98	W-13677	FGS	Cuttings	27.46972	-80.33250	FORT PIERCE	19	73
99	W-13679	FGS	Cuttings	27.38853	-80.32594	FORT PIERCE	13	73
100	W-13850	FGS	Cuttings	27.49023	-80.45852	FORT PIERCE NW	22	1223
101	W-13903	FGS	Cuttings	27.47750	-80.33833	FORT PIERCE	36	84
102	W-13905	FGS	Cuttings	27.34452	-80.32310	ANKONA	11	101
103	W-13907	FGS	Cuttings	27.16833	-80.22459	SAINT LUCIE INLET	16	80
104	W-13937	FGS	Cuttings	27.27885	-80.29684	ANKONA	10	75
105	W-13955	FGS	Cuttings	27.42591	-80.33833	FORT PIERCE	19	140
106	W-13956	FGS	Cuttings	27.43033	-80.34921	FORT PIERCE	18	120
107	W-13967	FGS	Cuttings	27.18420	-80.16165	SAINT LUCIE INLET	5	1525
108	W-13968	FGS	Cuttings	27.21394	-80.17866	SAINT LUCIE INLET	2	1025
109	W-14270	FGS	Cuttings	27.43391	-80.36388	FORT PIERCE	18	95
110	W-14686	FGS	Cuttings	27.24093	-80.22818	SAINT LUCIE INLET	25	100
111	W-14700	FGS	Cuttings	27.23917	-80.19274	SAINT LUCIE INLET	1	1705
112	W-14701	FGS	Cuttings	27.39004	-80.31060	FORT PIERCE	14	958
113	W-14754	FGS	Cuttings	27.04005	-80.54589	BARLEY BARBER SWAMP	26	1220
114	W-15288	FGS	Continuous Core	27.02871	-80.53792	BARLEY BARBER SWAMP	25	75
115	W-15361	FGS	Cuttings	27.19944	-80.74861	BARLEY BARBER SWAMP	17	83
116	W-15392	FGS	Cuttings	27.44893	-80.35811	FORT PIERCE	20	120
117	W-15458	FGS	Cuttings	27.21626	-80.30034	PALM CITY	9	121
118	W-15476	FGS	Cuttings	27.19843	-80.48989	INDIANTOWN NW	30	40
119	W-15696	FGS	Cuttings	27.13891	-80.23019	SAINT LUCIE INLET	16	140
120	W-15701	FGS	Cuttings	27.20667	-80.76139	OKEECHOBEE	19	80
121	W-15702	FGS	Cuttings	27.20556	-80.77778	OKEECHOBEE	16	80
122	W-15813	FGS	Continuous Core	27.37171	-80.95764	TAYLOR CREEK SW	40	10836
123	W-15816	FGS	Cuttings	27.11083	-80.66222	CHANEY BAY	16	1019
124	W-15817	FGS	Cuttings	27.09056	-80.65889	CHANEY BAY	16	1007
125	W-15818	FGS	Cuttings	27.02311	-80.63422	CHANEY BAY	36	1012
126	W-16225	FGS	Cuttings	27.23908	-80.78542	OKEECHOBEE	32	1800
127	W-16283	FGS	Cuttings	27.24588	-80.23616	SAINT LUCIE INLET	16	182
128	W-16287	FGS	Cuttings	27.12255	-80.23366	GOMEZ	18	157
129	W-16371	FGS	Cuttings	27.43448	-80.54672	SAINT JOHNS MARSH SLOUGH	25	110

Map ID	Well Label	Data Source	Sample Type	Latitude	Longitude	24K QUAD	Elevation (ft.)	Total Depth (ft.)
130	W-16372	FGS	Cuttings	27.47774	-80.56107	SAINT JOHNS MARSH SLOUGH	21	115
131	W-16373	FGS	Cuttings	27.36699	-80.64144	JONES HAMMOCK	29	115
132	W-16374	FGS	Cuttings	27.34607	-80.64693	JONES HAMMOCK	29	120
133	W-16375	FGS	Cuttings	27.43195	-80.32079	FORT PIERCE	29	153
134	W-16376	FGS	Cuttings	27.43791	-80.46982	FORT PIERCE NW	21	115
135	W-16377	FGS	Cuttings	27.36942	-80.67607	JONES HAMMOCK	31	119
136	W-16383	FGS	Cuttings	27.35412	-80.52193	NORTH OF BLUEFIELD	23	142
137	W-16384	FGS	Cuttings	27.39315	-80.54835	SAINT JOHNS MARSH SLOUGH	21	122
138	W-16385	FGS	Cuttings	27.40968	-80.54894	SAINT JOHNS MARSH SLOUGH	23	112
139	W-16386	FGS	Cuttings	27.48587	-80.36227	FORT PIERCE	20	120
140	W-16389	FGS	Cuttings	27.35946	-80.61718	NORTH OF BLUEFIELD	26	122
141	W-16397	FGS	Cuttings	27.02644	-80.16504	GOMEZ	11	174
142	W-16398	FGS	Cuttings	27.04677	-80.29898	INDIANTOWN SE	23	132
143	W-16400	FGS	Cuttings	27.17255	-80.43033	INDIANTOWN NW	28	155
144	W-16460	FGS	Cuttings	27.09366	-80.22838	GOMEZ	10	182
145	W-16542	FGS	Cuttings	27.44421	-80.43505	FORT PIERCE NW	20	128
146	W-16602	FGS	Cuttings	27.06505	-80.97809	OKEECHOBEE SW	13	39
147	W-16603	FGS	Continuous Core	27.21528	-80.97500	OKEECHOBEE NW	38	42
148	W-16605	FGS	Cuttings	27.25361	-80.78667	TAYLOR CREEK SE	28	38
149	W-16606	FGS	Cuttings	27.15238	-80.87640	OKEECHOBEE NW	14	38
150	W-16670	FGS	Cuttings	27.23639	-80.86194	OKEECHOBEE	32	38
151	W-16897	FGS	Cuttings	27.45597	-80.31515	FORT PIERCE	6	3300
152	W-16935	FGS	Continuous Core	27.21089	-80.50817	BLUEFIELD	25	125
153	W-16945	FGS	Cuttings	27.48115	-80.76568	TAYLOR CREEK NE	57	180
154	W-16946	FGS	Cuttings	27.29838	-80.70311	JONES HAMMOCK	54	178
155	W-16948	FGS	Cuttings	27.45087	-80.96729	TAYLOR CREEK NW	64	97
156	W-16950	FGS	Cuttings	27.29810	-80.98367	TAYLOR CREEK SW	33	138
157	W-16965	FGS	Cuttings	27.33977	-80.91645	TAYLOR CREEK SW	39	185
158	W-16966	FGS	Cuttings	27.24199	-80.95423	OKEECHOBEE NW	30	140
159	W-16967	FGS	Cuttings	27.18421	-80.70811	MARCY	25	140
160	W-16968	FGS	Cuttings	27.39365	-80.76339	TAYLOR CREEK NE	66	240
161	W-16970	FGS	Cuttings	27.39421	-80.85839	TAYLOR CREEK NE	49	200
162	W-16971	FGS	Cuttings	27.24171	-80.95423	OKEECHOBEE NW	30	140
163	W-17096	FGS	Cuttings	27.44886	-80.96542	TAYLOR CREEK NW	74	750
164	W-17136	FGS	Cuttings	27.33810	-80.49783	FORT PIERCE SW	19	1000
165	W-17138	FGS	Cuttings	27.21283	-80.52311	BLUEFIELD	26	1200
166	W-17144	FGS	Cuttings	27.43109	-80.36600	FORT PIERCE	18	900
167	W-17434	FGS	Cuttings	27.48869	-80.42855	FORT PIERCE NW	19	120
168	W-17435	FGS	Cuttings	27.49140	-80.42327	FORT PIERCE NW	21	100
169	W-17436	FGS	Cuttings	27.42278	-80.56111	SAINT JOHNS MARSH SLOUGH	20	402
170	W-17437	FGS	Cuttings	27.28634	-80.37486	ANKONA	23	105
171	W-17726	FGS	Continuous Core	27.45970	-80.28737	FORT PIERCE	9	6
172	W-17727	FGS	Continuous Core	27.38747	-80.25862	FORT PIERCE	5	7
173	W-17944	FGS	Cuttings	27.39889	-80.78389	TAYLOR CREEK NE	68	820

Map ID	Well Label	Data Source	Sample Type	Latitude	Longitude	24K QUAD	Elevation (ft.)	Total Depth (ft.)
174	W-18466	FGS	Cuttings	27.15472	-80.87533	OKEECHOBEE NW	19	950
175	W-18613	FGS	Continuous Core	27.15512	-80.87471	OKEECHOBEE	20	387
176	W-18625	FGS	Continuous Core	27.09844	-80.26072	INDIANTOWN SE	12	3200
177	W-18726	FGS	Continuous Core	27.20594	-80.47569	INDIANTOWN NW	32	1260
178	W-18727	FGS	Cuttings	27.20590	-80.47568	INDIANTOWN NW	32	360
179	W-18812	FGS	Continuous Core	27.21977	-80.95614	OKEECHOBEE NW	25	1802
180	W-18876	FGS	Continuous Core	27.29981	-80.81255	TAYLOR CREEK SE	34	3205
181	W-18897	FGS	Continuous Core	27.23455	-80.35012	PALM CITY	19	3350
182	W-19844	FGS	Continuous Core	27.16270	-80.43587	INDIANTOWN NW	28	32
183	W-19845	FGS	Continuous Core	27.14471	-80.54226	BLUEFIELD	40	12
184	W-19850	FGS	Continuous Core	27.01231	-80.45489	INDIANTOWN	20	100