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OPEN-FILE REPORT 106

Text to accompany geologic map of the USGS Saint Petersburg 30 x 60 minute quadrangle, west central Florida

By

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ABSTRACT

The accompanying 1:100,000 scale geologic map (Open-File Map Series 109, Plate 1) depicts the areal distribution of bedrock and surficial geologic units for the U.S. Geological Survey (USGS) Saint Petersburg 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), core and cuttings analyses and descriptions, and analyses of various Geographic Information System (GIS) data sources. The resulting data were compiled in ESRI® ArcGIS® ArcMap™ 10.3.1 software for publication as part of the Florida Geological Survey Open-File Map Series. Mapped units range in age from late Oligocene to late Holocene. Important resources in the mapped area include potable groundwater, springs, sand, clay, phosphate, shells, and limestone. Numerous springs and karst features are present in the study area.

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, springs, 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, energy production facilities, waste management and storage facilities, locating sources of mineable resources, and protection of springs, surface and groundwater quality.

Keywords: Florida, geologic map, Avon Park Formation, Ocala Limestone, Suwannee Limestone, Hawthorn Group, Arcadia Formation, Tampa Member, Nocatee Member, Peace River Formation, Bone Valley Member, geomorphology, hydrogeology, springs, swallets, karst, sinkholes, Floridan aquifer system, Tampa Bay, Hillsborough Bay, Hardee County, Hillsborough County, Manatee County, Pinellas County, and Polk County.

INTRODUCTION

Florida Geological Survey (FGS) Open-File Report (OFR) 106 accompanies Open-File Map Series (OFMS) 109, which is comprised of three plates. Plate 1 depicts the near-surface geology of the USGS Saint Petersburg 30 x 60 minute quadrangle (U.S. Geological Survey, 1981) on a digital elevation model (DEM). This DEM is a composite derived from light detection and ranging (LiDAR) where it was available and elevations from USGS topographic quadrangles covering the mapped area where LiDAR was not available. Plate 2 depicts six geologic cross-sections, along with a correlation chart of the stratigraphic units in the study area. Plate 3 is a geomorphology map on a DEM, showing locations of known springs and subsidence incident reports (SIRs), along with a detailed LiDAR image of a portion of Tampa Bay.

The study area lies south of Tarpon Springs and north of Sarasota. It includes the communities of Clearwater, Largo, Pinellas Park, St. Petersburg, Sun City, and Tampa. It also includes portions of Hardee, Hillsborough, Manatee, Pinellas, and Polk counties (Figure 1). It is bounded to the north by the USGS Tarpon Springs 30 x 60 minute quadrangle, previously mapped

under the STATEMAP program (Green et al., 2012a; Green et al., 2012b), to the south by the USGS Sarasota 30 x 60 minute quadrangle, mapped under the STATEMAP Program (Green, et al., 1997; Green, et al., 1998), and to the east by the USGS Bartow 30 x 60 minute quadrangle (Figure 1). The study area encompasses most of Old Tampa, Tampa, and Hillsborough bays, along with the Alafia, Little Manatee, and Manatee rivers, numerous creeks, and springs. Recharge to the Floridan aquifer system (FAS) occurs throughout the study area. The FAS is the primary source of water for springs and drinking water in the region.

One objective for this report is to provide basic geologic information for the accompanying OFMS 109. Information provided by this report and the plates in OFMS 109 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 potential aquifer recharge and confinement, 3) aiding water-management decisions on groundwater usage, 4) providing information on aquifer vulnerability to pollution, 5) ecosystem, wetlands, and environmental characterization, and 6) recreation.

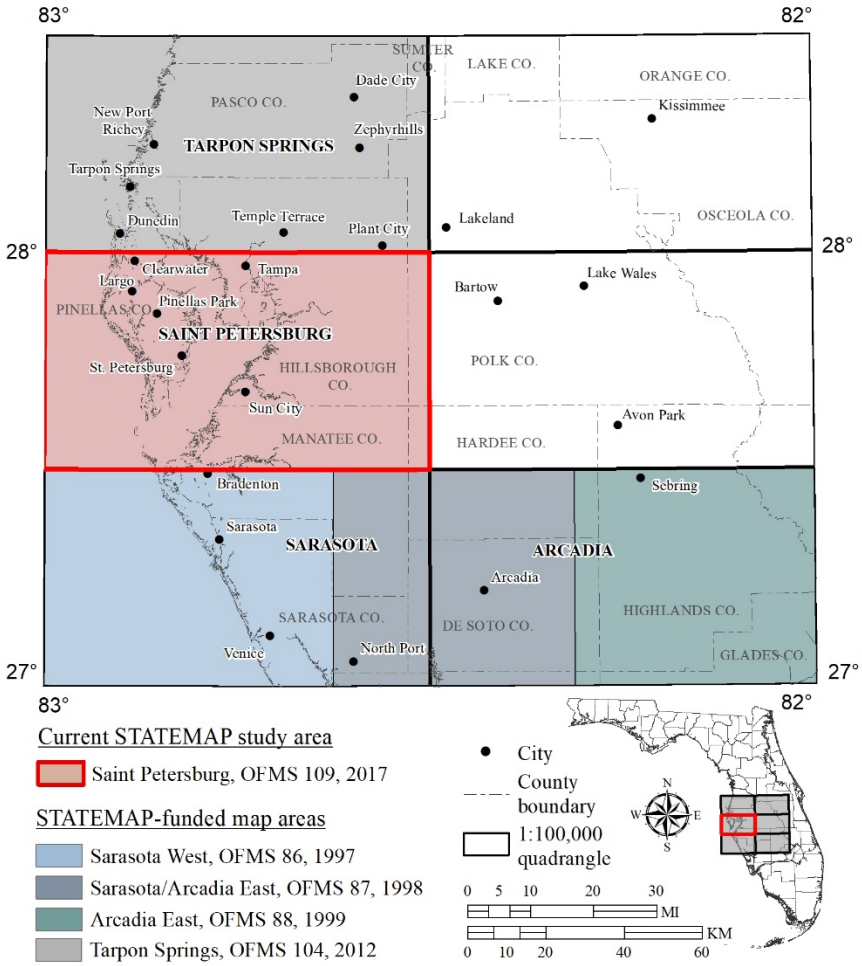


Figure 1. Nearby areas mapped under the FGS STATEMAP Program.

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) analyses of existing core and cuttings samples from the FGS sample repository, 4) new core drilling, 5) collecting and describing outcrop samples, and 6) preparing a geologic map, geological cross-sections and geomorphic map of the area. Field work, performed during the fall of 2016 through the summer of 2017, consisted of sampling and describing numerous outcrops, as well as samples from river and quarry exposures.

Thirty-nine new geologic samples were added to the FGS surface-sample archives (M-Series) and two cores (670 feet or 204.2 meters total) were drilled. Approximately 100 outcrops and exposures were also examined during this project. In addition to the new M-series samples collected, 50 historical M-series samples were examined. All data, including over 400 wells from the study area and surrounding quadrangles, were compiled and analyzed by the authors. Figure 2 shows the locations of FGS cores, cuttings, and M-series samples within the study area. The map and accompanying plates were developed in ESRI® ArcGIS® ArcMap™ 10.3.1 software for publication as part of OFMS 109.

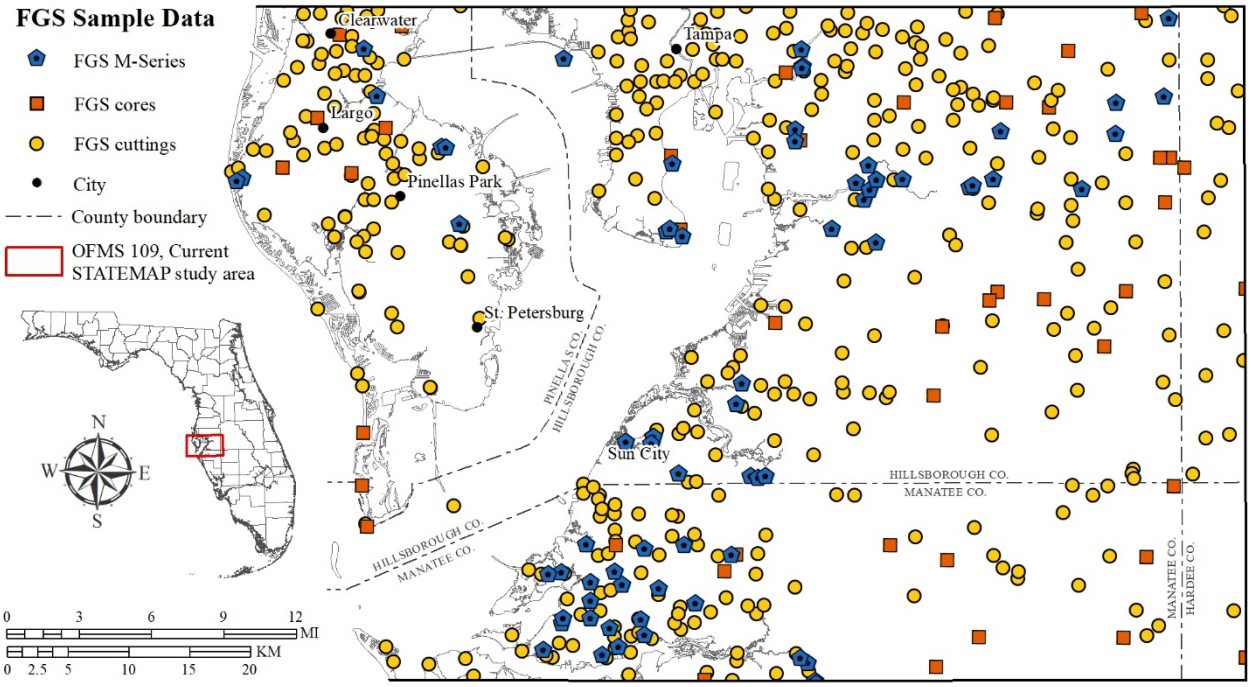


Figure 2. FGS cores, cuttings, and M-series samples used for models.

Top of unit models were created for several geologic units within the study area, using the borehole descriptions produced during the course of this study. In order to produce these interpolated surfaces, the tops of each unit were converted from depths below land surface to 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 value. In cases where boreholes fell within the borders of the mined areas, where the original land surface has been disturbed (and elevation may have changed), the original documented elevation of the well at the time that it was drilled was used.

Modeling was performed using ArcMap's Geostatistical Analyst extension. All surface models were created using the Simple Kriging method or the Empirical Baysian Kriging methods. Regardless of the kriging method used, substantial attention was devoted to manually tuning each model to ensure a good fit to the empirical semivariogram of each dataset. All of the units exhibited non-normal distributions and significant trends within the study area, and in order to correct for this, the data were adjusted using the normal score method and detrended using the first, second, or third polynomial detrend functions prior to modeling. Model parameters – primarily the kernel type, lag distance, and number of lags were manually adjusted for each unit to ensure goodness of fit of the model to the data and to produce models with a suitably low average standard error and an average error approaching zero.

After examining the borehole data for each unit, it was evident that the high amount of predictive error in these models was attributable to either low data density, a handful of 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 always exists in locating contacts, 2) many of the borehole samples are based on cuttings taken at intervals of 10 feet, which introduces uncertainty in the elevation of the contacts even when the contact is clearly evident, and 3) the presence of karst in limestone units can produce significantly different unit elevations in boreholes a short distance apart. In cases where the resultant surfaces indicated large errors, an iterative modelling process was used to reduce the average standard error of the interpolated surface, whereby the boreholes were cross validated with the first model in order to find boreholes that were the worst performing in terms of predictive accuracy. These boreholes – generally 5 or less for each unit - were then removed from the data and a new model was built out of the subset of boreholes.

After the top of unit models were completed, they were exported to floating point rasters whose cell size and borders were snapped to a hybrid digital elevation model. These interpolated surfaces were then subtracted from the 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 is a boxplot of the ranges in elevations of mapped units, relative to mean sea level (MSL), based on core and cuttings data. The elevations were calculated by subtracting the unit's depth below ground level from the elevation of the land surface. Each unit's depth was retrieved from both core and cutting samples, while the land surface elevation was extracted from the DEM. The resulting values are the units' elevations relative to MSL. 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. These plots were then used to determine which points should be considered for removal from the analyses and the models were re-run without the selected outliers.

Upon completion of the box plots and removal of problematic data points, an ordinary kriging method was used to generate a top of unit surface using the "stable" algorithm. Lag size was empirically calculated based on the total spatial extent of the combined datasets, and adjusted slightly to improve model performance. The error values for all data were examined after each

iteration of the model, and any points with a standardized error greater than five or less than negative five were discarded in order to improve the final model performance.

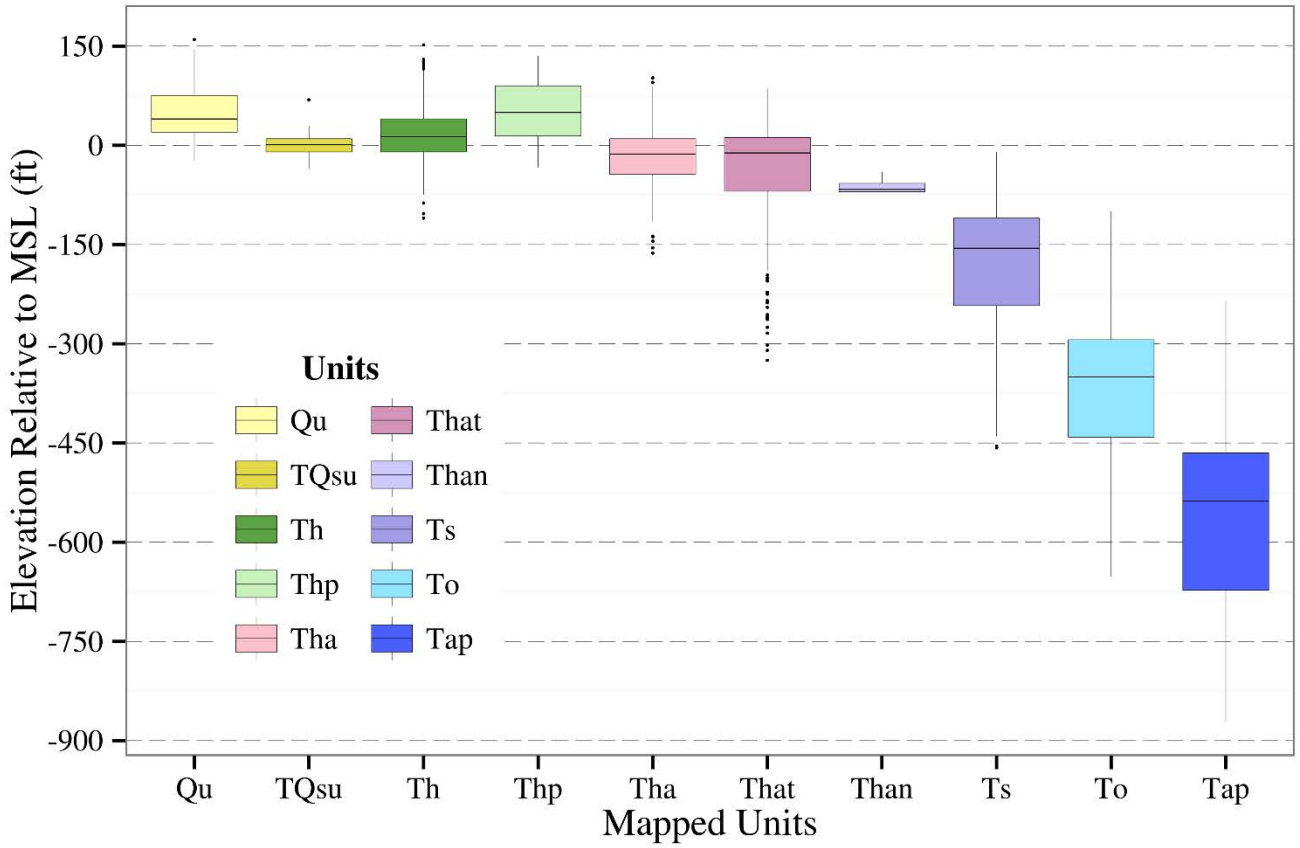


Figure 3. Boxplot of top of lithostratigraphic unit elevation ranges.

Much of the study area is blanketed by a veneer of undifferentiated Tertiary and Quaternary sediments and soils. For this reason, and in keeping with geologic mapping practices developed by Scott et al. (2001), the authors have adopted the policy of mapping the first named geologic unit within 20 feet (6.1 meters) of the surface. If undifferentiated Quaternary (Qu), or Holocene (Qh) sediments attain a thickness greater than 20 feet (6.1 meters), then they appear as the mapped unit. If these undifferentiated sediments are less than 20 feet (6.1 meters) thick, then the underlying lithostratigraphic unit appears on the map.

Parts of the region are heavily vegetated, and public access in parts of the mapped area is hindered by the presence of numerous wetlands, phosphate mines, farms, ranches and privately-owned land. Additionally, much of the coastal area is heavily developed with subdivisions, many of which are gated communities. Fieldwork access was typically limited to public roads, State-owned, and County-owned lands. Furthermore, much of the study area is impacted by current and historic mining of phosphate. As such, large sections of the mapped area were inaccessible. In these areas, the authors had to rely on historic data, cores, and cuttings.

Previous Work

The current study builds on many previous geologic investigations in and around the present map area which were useful in preparing this report. Preliminary county geologic maps for Hardee (Scott and Campbell, 1993), Hillsborough (Campbell and Arthur, 1993), Manatee (Campbell, 1993a), Pinellas (Arthur and Campbell, 1993), and Polk (Campbell, 1993b) 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 time-frame of two weeks utilizing selected in-house geologic data with little-to-no extra field work. Although these maps provided a starting point for the detailed geologic mapping undertaken for this project, significant refinement of prior geologic maps was possible as a result. A statewide geologic map (Scott et al., 2001) was published by the FGS in digital format and provided a framework for the current, more detailed mapping.

Scott (1988) published detailed descriptions, structure contour maps, and isopach maps for units of the Hawthorn Group. Arthur et al. (2008) provided unit descriptions, structure contour and isopach maps of all of the major lithostratigraphic units investigated in this study.

This study benefited from the work performed during geologic mapping of the USGS Tarpon Springs 30 x 60 minute quadrangle (Green et al., 2012a; Green et al., 2012b) and the USGS Sarasota and Arcadia quadrangles (Green et al., 1997, and Green et al., 1998). Some of the field relationships and stratigraphic problems were worked out during those projects. Data gathered during work on the Tarpon Springs, Sarasota, and Arcadia quadrangles proved invaluable to the completion of this project.

GEOLOGIC SUMMARY

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

Tampa Bay displays aspects of drowned river valley morphology, particularly with the Hillsborough River and Hillsborough Bay. Yet, the present rivers flowing into the bay are underfit to the size of Tampa Bay. Work by Hine et al. (2009) indicates that karst basin complexes, each on the order of tens of kilometers in diameter with depths of 40-60 meters, exist as interpreted from regional seismic data. Deep-seated dissolution during the middle to late Miocene, suggested by deformation of the underlying late Oligocene to middle Miocene carbonates, caused stratigraphic collapse of the subbasins. Infill from the Miocene onward includes carbonates, followed by siliciclastic fluvio-deltaic sediments, in the Miocene and Pliocene, and mostly coastal sedimentary processes from Pleistocene to Recent (Duncan et al., 2003). Regionally, the infill has been from north to south, as apparent on cross-sections (OFMS 109, Plate 2, cross sections D-D', E-E', and F-F'). Missimer and Maliva (2017) provide detailed discussion regarding the southern Appalachian Mountains sediment source for the siliciclastics deposited in South Florida during the Miocene and Pliocene.

The oldest unit to crop out in the Saint Petersburg quadrangle is the late Oligocene to middle Miocene Arcadia Formation (Hawthorn Group). It crops out at various locations in the southern portion of the map area (OFMS 109, Plate 1). The Tampa Member of the Arcadia Formation crops out in northwestern Hillsborough County along the shores of Old Tampa Bay, Tampa Bay, Hillsborough Bay, and portions of the Alafia River (OFMS 109, Plate 1). The middle

Miocene to lower Pliocene Peace River Formation (Hawthorn Group), which unconformably overlies the Arcadia Formation and the Tampa Member (Arcadia Formation), crops out in much of the eastern portion of the study area. Sediments of undifferentiated Oligocene to Pliocene Hawthorn Group and undifferentiated Tertiary/Quaternary shelly sediments, and undifferentiated Quaternary sediments overlie various units of the Hawthorn Group in the western portion of the map area (OFMS 109, Plates 1 and 2).

The first significant carbonate unit encountered in boreholes in the mapped area is the top of the Arcadia Formation (which includes the Tampa Member of the Arcadia Formation in some areas). This unit is unconformably underlain by the lower Oligocene Suwannee Limestone, which is unconformably underlain by the Eocene Ocala Limestone, throughout the study area. These latter two formations can both vary from wackestone to grainstone. Current authors and others (Brewster-Wingard et al., 1997) have noted that, lithologically, the contact between the Suwannee Limestone and the Ocala Limestone can be difficult to differentiate in cores and cuttings. At times there is a distinct contact between the two formations; however, this is not always the case.

Detailed description of the lithology of all units found in the study area start on page 15 of this publication. Along with lithologic criteria, several diagnostic foraminifera and echinoids aid in distinguishing the Suwannee Limestone from the Ocala Limestone. Furthermore, there are some similarities between benthic foraminifera assemblages of the Suwannee Limestone, and the Avon Park Formation (which unconformably underlies the Ocala Limestone) that help to distinguish these units from the Ocala Limestone. Both of the former units contain *Fallotella* spp. which is found infrequently at the base of the Ocala Limestone (personal communication, Jonathan Bryan), as well as *Discorinopsis gunteri*, which is not found in the Ocala Limestone. The occurrence of *Nummulites* spp. and *Lepidocyclina* spp. in the Ocala Limestone helps to distinguish it from the Suwannee Limestone and the Avon Park Formation in the study area.

The Saint Petersburg quadrangle encompasses portions of the Crystal River to St. Petersburg, Hillsborough, Tampa Bay, Alafia, Little Manatee, Manatee, and Peace River basins (Figure 4). Small portions of the Myakka River and Sarasota Bay basins occur along the southern edge of the study area (Hydrologic Unit Codes: Basins, 1993). There are numerous springs in these basins within the study area, including 26 springs in Hillsborough County and two springs in Pinellas County.

Many of these springs, which developed as karst features under lower water table conditions, have shown significant increases in pollutants in the last few decades, particularly nitrate (Phelps, 1994; Phelps, 2004; Jones et al., 1996; Scott et al., 2002; Upchurch et al., 2004; Copeland et al., 2009). Detailed geologic mapping of lithostratigraphic units in this area provides critical data needed for future assessments of the vulnerability of the aquifer systems and springs to contamination. Understanding the surficial geology of the map area is a key factor in developing management and protection plans, not only for the springs, but for the unconfined portions of the Floridan aquifer system.

Karst processes have extensively modified the topography of the region, and continue to actively shape it today. Karst topography is characterized by solutional features, subterranean drainage, and caves, all of which occur within the study area (Poucher and Copeland, 2006). Downward infiltration of slightly acidic rain and surface water through preferential pathways, such as joints, fractures, and bedding planes, combined with groundwater fluctuations, cause dissolution of the carbonate rocks (Waltham et al., 2005).

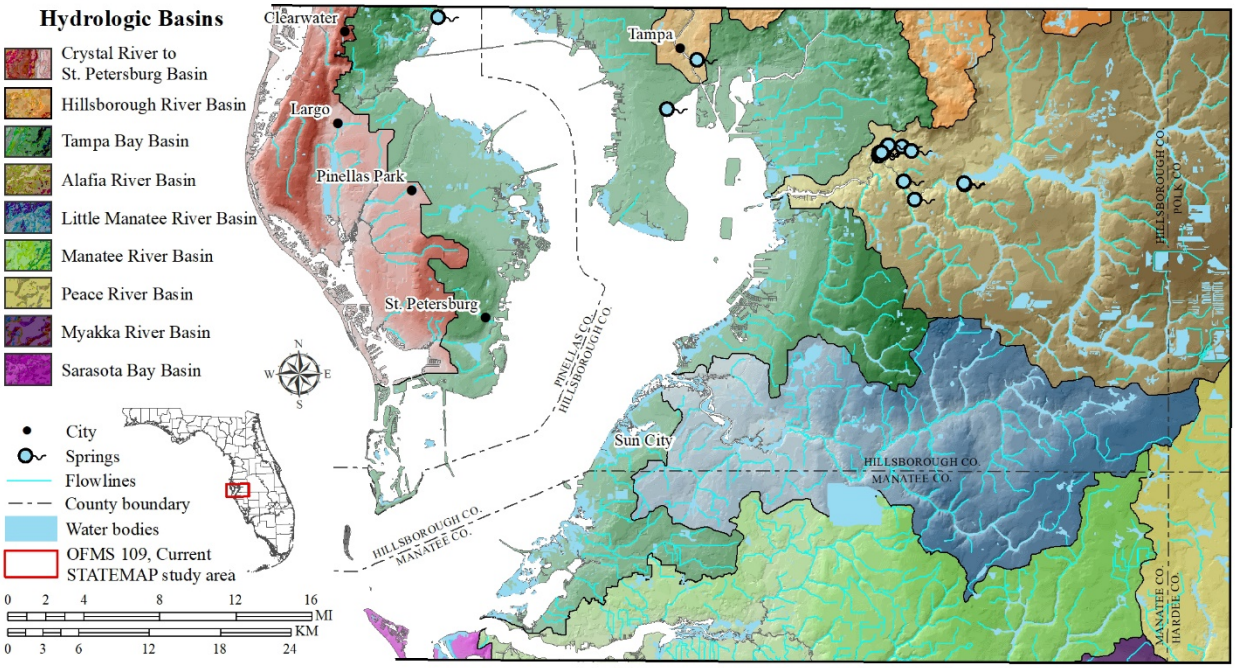


Figure 4. Location of selected river basins, springs, and other water bodies.

The most common karst landforms observed in the study area are sinkholes. Three types of sinkholes dominate the region: 1) solution-subsidence, 2) cover-subsidence, and 3) cover-collapse. Solution-subsidence sinkholes occur where overburden is relatively thin. Downward percolating rain and surface water infiltrates into joints, fractures, and bedding planes slowly dissolving the carbonate rocks below generally forming a large, broad, shallow low-angle surface depression (Tihansky, 1999). Cover-subsidence sinkholes occur where overburden is relatively thick. The overburden sediments, which consist primarily of low cohesion sediments, ravel into joints, fractures, and cavities below via infiltrating rain and surface water, resulting in a relatively small, gently sloped surface depression (Waltham et al., 2005). Cover-collapse sinkholes occur where the overburden contains some amount of cohesive sediments, such as clay, that acts mechanically as a bridge overlying a cavity within the carbonate rocks below (Waltham et al., 2005). The overburden sediments abruptly collapse into the cavity when either the weight of the overburden sediments exceeds the bridging sediment's load-bearing capacity, or when the potentiometric surface of groundwater within the carbonate rocks drops below bridging sediments, no longer providing the necessary buoyancy to help support those bridging sediments (Waltham et al., 2005; Beck and Sinclair, 1986).

The variability of the karst observed within the study area is closely related to the thickness of overburden and the presence/absence of Hawthorn Group clays within the overburden mantling the region's carbonate rocks. Those clays are often the sediments that create a bridge over any cavities which have formed within the carbonates. Karst is more common at the surface in the northern part of the study area, particularly in northern Hillsborough County. In northwestern Hillsborough County, the Peace River Formation and undifferentiated Quaternary sediments overlie the limestones of the Tampa Member of the Arcadia Formation. Cover-subsidence sinkholes are more common in this region as are springs. This area is within the Land O' Lakes

Karst Plain province (discussion of geomorphology begins on page 10). In northeastern Hillsborough County, thin undifferentiated sediments, along with Peace River Formation sediments, overlie the Tampa Member of the Arcadia Formation. This region is within the Hardee Upland province. Karst occurs in the northern extent of the Hardee Upland where carbonates are closer to the surface. Due to clays in the Peace River Formation, cover-collapse sinkholes occur more frequently. Most of the Hardee Upland has thick siliciclastic deposits overlying the carbonates which limit the surface expression of karst features. Both cover-subsidence and cover-collapse sinkholes are possible throughout the northern part of the study area (Sinclair and Stewart, 1985).

Anthropogenic activities, combined with extreme weather and climatic conditions, can lead to accelerated sinkhole development. The Saint Petersburg quadrangle and surrounding area have experienced two such events in the last decade. In January 2010, freezing or near freezing conditions were experienced for record 11 consecutive days within the Plant City/Dover area, which has and abundance of strawberry farms. In order to protect their crops, farmers sprayed them with groundwater to create a protective rind of ice which insulated the crop from freezing temperatures (SWFWMD, 2010). During freezing conditions, farmers were allowed to pump additional amounts of groundwater beyond their normal permitted daily rate of consumption. During average seasonal weather conditions, farmers in the Plant City/Dover area were permitted to pump approximately 38 million gallons per day (MGD; SWFWMD, 2010). During freezing conditions, farmers in the Plant City/Dover area were permitted to pump up to approximately 942 MGD, a 2,479% increase in pumping above normal rates (SWFWMD, 2010). Pumping at that increased rate caused water levels in the FAS to drop as much as 60 feet in and around the Plant City/Dover area (SWFWMD, 2010). As a result of that extreme drop, over 750 local wells went dry, and more than 150 sinkholes formed within the vicinity (SWFWMD, 2010).

In June 2012, Tropical Storm Debby dropped record amounts of rain on portions of the state of Florida and caused significant flooding (National Oceanic and Atmospheric Administration, 2012). In 2011, leading up to that storm event, Florida was experiencing drought conditions during which regional groundwater levels had been lowered due to the lack of rainfall and groundwater pumping. With such lowered regional groundwater levels, much of the region's overburden sediments no longer had the necessary buoyancy support from below. As such, when the rains associated with Tropical Storm Debby fell on the area, the additional weight from the rain water in the overburden sediments, and lubrication of sediments, caused the formation of numerous sinkholes around the state including this area.

Structure

Several structural features have affected the geology of the region (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 lies to the north and east 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 north of the study area. The arch was a topographic high during most of the Cretaceous Period and had Upper Cretaceous sediments deposited upon it (Applin, 1951). It formed a relatively stable base for early Cenozoic carbonate deposition

(Williams et al., 1977). The arch did not affect mid-Tertiary to Holocene sediment deposition (Williams et al., 1977; Scott, 1997).

The Ocala Platform is the most prominent feature affecting the near surface units within the map area. 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 continuing 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.

The current study area is on the southwestern flank of the Ocala Platform, which influenced late Tertiary sediment deposition. Miocene sediments of the Hawthorn Group are thought to have been deposited across the platform (Scott, 1981a; Scott, 1988; Scott, 1991a). Post-Miocene erosion has removed sediments of the Hawthorn Group from much of the crest of the Ocala Platform, exposing Eocene and Oligocene carbonates (Cooke, 1945; Espenshade and Spencer, 1963; Scott, 1981b). This is evident throughout the central portion of the map area where the Tampa Member of the Arcadia Formation (Hawthorn Group) is mapped (OFMS 109; Plate 1).

The South Florida Basin (Applin and Applin, 1965; Winston, 1971) is a stratigraphic basin which contributed to the southward thickening of Mesozoic and early Cenozoic lithostratigraphic units in the southern Florida peninsula. The reader is referred to Arthur, et al., (2008) for a more complete discussion of structural features in the area.

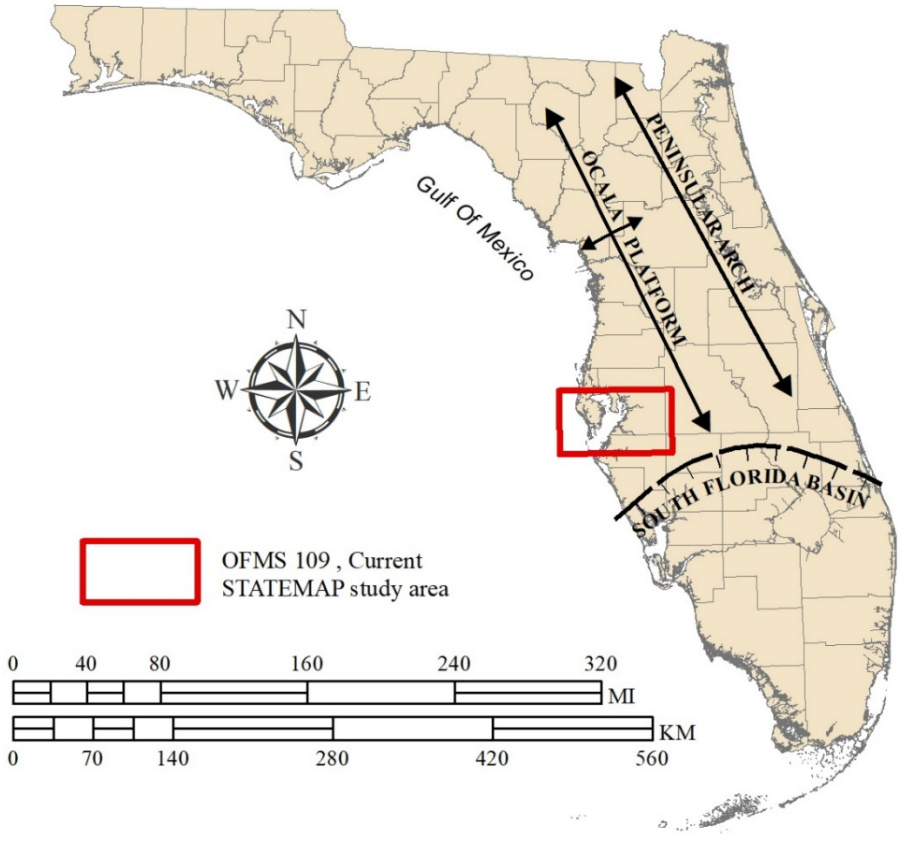


Figure 5. Principal subsurface structures of the Florida peninsula (modified from Arthur et al., 2008).

Geomorphology

The Florida Geological Survey is in the process of producing a new statewide geomorphic map of Florida (Williams et al., in preparation). The new map 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 significant work by retired FGS colleague, Thomas Scott, are central to the new statewide map. More recent data and technology, particularly the addition of significant coverage of LiDAR and new possibilities for digital geomorphological mapping that employ spatio-temporal and geocomputational approaches to data analysis, are allowing the FGS to revise nomenclature and refine boundaries for some units in Florida. In the section which follows, all geomorphology unit names and discussions are from Williams et al. (in preparation).

The new map will divide the geomorphology by regional units (districts) and sub-regional to local units (provinces; Figure 6). 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. Definition of the more localized provinces and their morphologies are important for the characterization of the districts.

Based on the work of Williams et al. (in preparation), the study area falls within two geomorphic districts: the Ocala Karst District and the Peace River District (OFMS 109; Plate 3, Figure 3). The Ocala Karst District has one province (The Land O'Lakes) present in the mapped area (OFMS 109; Plate 3, Figure 4). In the study area, the Peace River District is further subdivided into three provinces: the Hardee Upland, the Peninsula Coastal Lowlands, and the Pinellas Ridge.

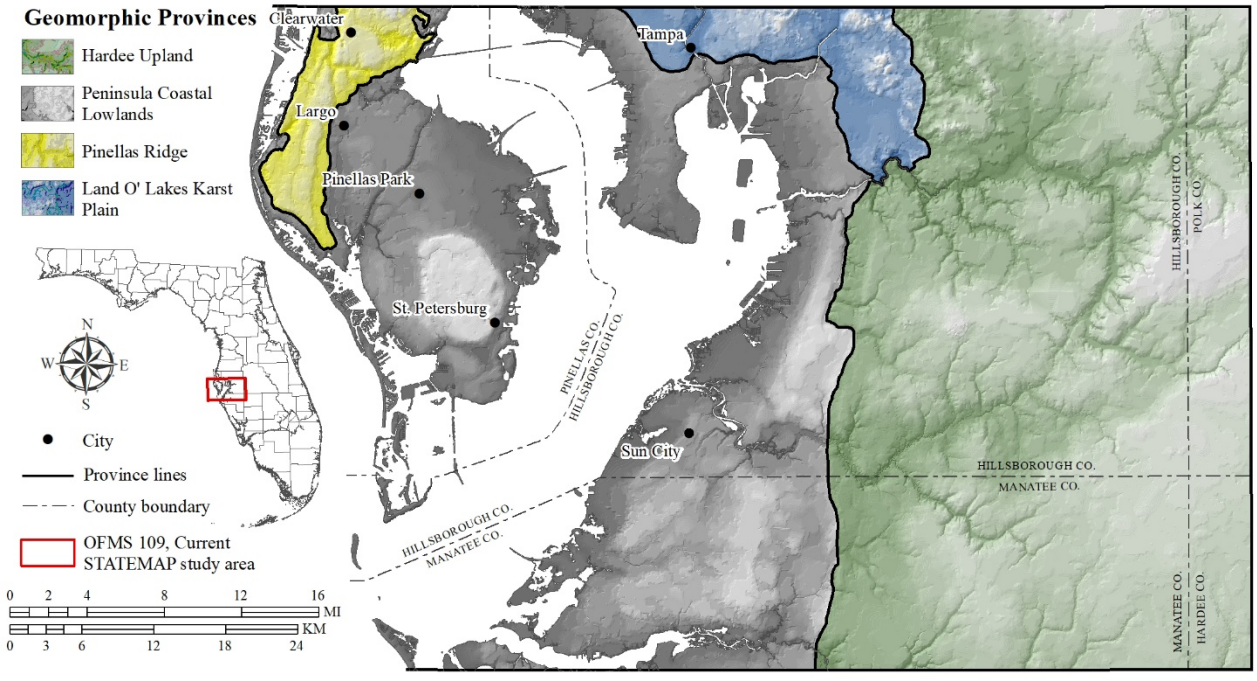


Figure 6. Geomorphic provinces.

Ocala Karst District

The Ocala Karst District encompasses a broad area of White's (1970) Gulf Coastal Lowlands and Coastal Swamps from Franklin County in the panhandle to Hillsborough and Pinellas counties in west-central peninsular Florida (OFMS 109; Plate 3, Figure 3). Carbonate sediments ranging in in age from middle Eocene through early Miocene lie at or near the land surface (Scott et al., 2001; Evans et al., 2004; Green et al., 2005; Green et al., 2006; Green et al., 2007a; Green et al., 2007b; Green et al., 2008a; Green et al., 2008b; Green et al., 2009a; Green et al., 2009b; Green et al., 2010; Williams et al., 2010; Green et al., 2011; Williams et al., 2011; Williams et al., 2012; Green et al., 2012a; Green et al., 2012b; Green et al., 2013a; Green et al., 2013b; Green et al., 2015a; Green et al., 2015b). Along the Gulf of Mexico coastline there are the karst dominated terrains of the Woodville Karst Plain, Perry Karst, Chiefland Karst Plain, Gulf Hammock, Crystal River Karst Plain, and Land O' Lakes Karst Plain. Elevations within the district range from sea level along the Gulf of Mexico to just over 300 feet (91 meters) above MSL on Brooksville Ridge. The topography over much of the district is gently rolling with only minor relief. However, on the Brooksville Ridge, the terrain looks more like that of the Lakes District and relief may exceed 200 feet (61 meters). Dissolution of carbonates has created distinct landforms that characterize the Ocala Karst District, including caves, caverns, numerous springs, sinkholes, siphons, swallets (sinking streams), and resurgences. The southern terminus of the district occurs where the impermeable Hawthorn Group sediments retard the development of karst features in the Peace River District and streams and rivers become more common. The entire district has siliciclastic cover of varying thickness ranging from a few feet (1 meter) of sand and clay, to as much as 200 feet (61 meters) of sediment overlying carbonate rocks.

The Ocala Karst District is dominated by solution sinkholes, and shallow, broad, bowl-shaped depressions, producing a gently rolling topography. This type of dissolution occurs in areas where there is a thin, permeable, siliciclastic cover allowing downward percolating groundwater to dissolve the limestone surface. These sinkholes develop slowly. Areas of the Ocala Karst District where there is a thicker cover of permeable siliciclastic sediments are characterized by cover-subsidence sinks. These areas have few shallow sinks formed by the downward movement of the siliciclastic cover to fill voids created by the dissolution of carbonate sediments. Cover-subsidence sinkholes develop slowly in response to the dissolution. Cover-collapse sinkholes form in those areas where the siliciclastic sediments overlying the limestone are cohesive. Dissolution of the carbonate sediments forms voids into which the overlying sediments collapse. This type of sinkhole forms abruptly. The thickness of sediments covering the carbonates increases to the north, south, and east in the province. As the sediment thickness increases, the type of sinkholes and their abundance changes, grading from solution sinks to cover-collapse sinks. Rock collapse sinks occur, but are uncommon. The maturity of the karst varies across the district, and regional geomorphic terrains are recognized within the Ocala Karst District based upon elevation, abundance, and type of karst features, drainage, geology, and topographic relief. In general, toward the Gulf of Mexico coast, the karst is more mature and has less relief due to more extensive dissolution and erosion of the overlying siliciclastics. Planation by transgressing seas also influenced the geomorphology near the Gulf Coast. The Ocala Karst District developed on the crest of the Ocala Platform.

Land O' Lakes Karst Plain

The Land O' Lakes Karst Plain occurs from southwestern Hernando County southward into northern Pinellas and Hillsborough counties. It lies west of the southern end of Brooksville Ridge and Green Swamp, and north of the Pinellas Ridge, Peninsula Coastal Lowlands, and Hardee Upland provinces. Elevations in the Land O' Lakes Karst Plain range from sea level to 140 feet (42.7 meters) above MSL, with most less than 80 feet (24.4 meters) above MSL. Highest elevations are in dunes at the northern end of the plain and in the regions adjacent to Brooksville Ridge. The occurrence of karst features varies from abundant and closely spaced to scattered. Sand dunes are present in several areas of the karst plain, particularly in the northern part of the Land O' Lakes Karst Plain in southwestern Hernando County and northwestern Pasco County. The terrain, which varies from poorly drained to well-drained, includes several coastal rivers, such as the Pithlachascotee, Anclote, and Hillsborough rivers. Much of the Hillsborough River valley is in the southeastern extent of the Land O' Lakes Karst Plain. The province also contains many springs.

The northern half of the Land O' Lakes Karst Plain is underlain by the lower Oligocene Suwannee Limestone or by the upper Eocene Ocala Limestone, where the Suwannee Limestone is missing through marine and karst erosion west of the Brooksville Ridge. The upper Oligocene to lower Miocene Tampa Member of the Arcadia Formation (Hawthorn Group) underlies the southern portion of the karst plain. Clays and sands of Miocene undifferentiated Hawthorn Group overlie the carbonate sediments in much of the area. Quaternary siliciclastic sediments, both undifferentiated (Qu) and Beach Ridge and Dune (Qbd), cover much of the karst plain (Scott et al., 2001; Green et al., 2011; Williams et al., 2011; Williams et al., 2012; Green et al., 2012a; Green et al., 2012b).

Peace River District

The Peace River District, referred to as the Sarasota River District in earlier FGS publications, covers much of west-central peninsular Florida extending from Hillsborough and Pinellas counties, southward to the Caloosahatchee Valley in Lee and Glades counties. The district is characterized by the occurrence of numerous rivers and streams which are more common than in any other geomorphic district in the state, except possibly the Southern Pine Hills in the westernmost panhandle of Florida (OFMS 109; Plate 3, Figure 3). The rivers in the Peace River District include the Alafia, Little Manatee, Manatee, Myakka, Peace, and their tributaries. The Peace River District lies south of the Ocala Karst District, west of the Lakes District and northwest of the Everglades District (OFMS 109; Plate 3, Figure 3). Low permeability siliciclastic sediments of the Hawthorn Group underlie the Peace River District allowing the development of numerous rivers and streams (Scott et al., 2001; Green et al., 2012a; Green et al., 2012b; Green et al., 2105a; Green et al., 2015b).

The Ocala Karst District merges with the Peace River District where the Hawthorn Group sediments retard the development of karst features, which are common in the Ocala Karst District. The transition from the Peace River District to the Lakes District occurs where the low permeability sediments of the Hawthorn Group either become more permeable due to facies changes, or where Hawthorn Group sediments are eroded and no longer retard the development of karst features. The separation of the Peace River District from the Everglades District is defined where the surface-water flow pattern becomes westerly in the Caloosahatchee Valley. The landscape of the Peace River District is relatively flat, with limited relief outside of areas incised by local rivers and hills in the eastern part of the district in the Hardee Upland. Elevations range

from sea level along the coastline, to more than 190 feet (57.9 meters) above MSL in the hills among the headwaters of the Alafia River. The Peace River District includes the Hardee Upland, Peninsula Coastal Lowlands, and Pinellas Ridge provinces (OFMS 109; Plate 3, Figure 4).

Hardee Upland

The Hardee Upland is a new province name that merges the areas of White (1970) which included his Polk Upland and DeSoto Plain. The Hardee Upland is a broad, sloped plain, but hydrologically an upland, with elevations from about 10 feet (3 meters) in the incised river valleys to over 190 feet (57.9 meters) above MSL. Elevations adjacent to the incised river valleys are approximately 60 feet (18.3 meters) above MSL. Elevations in the province rise moderately from west to east away from the Gulf of Mexico as opposed to the relatively slow rise from south to north. The Hardee Upland includes the headwaters and most of the tributaries of the Alafia, Little Manatee, Manatee, and Myakka rivers in the Peace River District. The central portion of the province is relatively flat. Much of the northern part of the Hardee Upland has been terraformed due to phosphate mining throughout the 20th and into the 21st century. Greatest relief occurs along numerous stream and river valleys that are incised into the underlying upper Oligocene-lower Pliocene Hawthorn Group and undifferentiated Quaternary siliciclastic sediments (Scott et al., 2001; Green et al., 2012; Green et al., 2015a; Green et al., 2015b). Very few karst features are recognized on the Hardee Upland.

The underlying geology and the observed landforms of the Hardee Upland are all similar. The former break by White (1970) between Polk Upland and DeSoto Plain was an ill-defined scarp that has been incised by the Peace River and its tributaries. It is generally at about 90 feet (27.4 meters) above MSL. While there is a change in elevation between northeastern and southern Hardee Upland, it is not distinct when travelling across the terrain due to the extended slope of the topography. Most of what White (1970) defined as DeSoto Plain is less than 100 feet (30.5 meters) above MSL, which includes the southern part of the Hardee Upland. The western portion of Hardee Upland has been more deeply incised by rivers due to the more rapid change in elevation from Tampa Bay in the Peninsula Coastal Lowlands to the west. Elevations in this region are similar to southern Hardee Upland. Elevations in northeastern Hardee Upland (former eastern Polk Upland) are greater than 100 feet (30.5 meters) above MSL. The lower Oligocene Suwannee Limestone underlies the extent of the Hardee Upland (Arthur et al., 2008). The upper Oligocene-lower Pliocene Hawthorn Group, consisting of phosphatic sand, clay, and carbonate, overlies the Suwannee Limestone. Sand and clayey sand of the weathered Hawthorn Group and undifferentiated Quaternary siliciclastic sediments overlie the Hawthorn Group (Scott et al., 2001; Green et al., 2012; Green et al., 2015a; Green et al., 2015b).

Peninsula Coastal Lowlands

The Peninsula Coastal Lowlands province forms the western portion of the Peace River District, adjacent to the Gulf of Mexico, from the Anclote Keys in the north to Sanibel Island in the south. It nearly surrounds the Pinellas Ridge in Pinellas County. It occurs in the region west and south of the Hardee Upland. Elevations in the Peninsula Coastal Lowlands vary from sea level to around 60 feet (18.3 meters) above MSL near the border of the Hardee Upland. The coastal areas are more impacted by erosion from recent Pleistocene sea level fluctuations than the relative highland areas to the east in the Hardee Upland. The boundary between the Peninsula Coastal Lowlands and the Hardee Upland, particularly in Manatee and Hillsborough counties, is at times

arbitrary due to the fact that no single paleo-shoreline feature can be used for the entire boundary. The upland has been incised by the regional rivers, and much of the terrain from the Alafia River south to the Myakka River has higher elevation than the regions on the north and west sides of Tampa Bay. Even the area from the Myakka River to the boundary with Caloosahatchee Valley gently slopes away from the Gulf of Mexico, with lowlands more like western Tampa Bay being limited to areas adjacent to and west of Charlotte Harbor. The greatest variability in elevations in the Peninsula Coastal Lowlands is in the river valleys, which drain to the west and south in the Peace River District. Most of the province is underlain by upper Oligocene-lower Pliocene Hawthorn Group units and Pliocene-Pleistocene shelly sediments.

The uppermost sediments are the undifferentiated Quaternary deposits and Holocene sands and finer materials in estuaries and on the barrier islands of the Gulf of Mexico coastline (Scott et al., 2001; Green et al., 2012a; Green et al., 2012b). One feature of note is the hill in southern Pinellas County on which the city of St. Petersburg is located. Regarding elevation, and possible dissection, it would at first appear that it might be a detached portion of the Pinellas Ridge. Further examination of the regional geology reveals that this area is underlain by undifferentiated Tertiary/Quaternary shelly units which are more like the geology underlying the Peninsula Coastal Lowlands to the east of Tampa Bay in Hillsborough County. Therefore, this hill in southern Pinellas County is retained in the Peninsula Coastal Lowlands.

Pinellas Ridge

The Pinellas Ridge occurs in Pinellas County. It is bound on the north by the Land O' Lakes Karst Plain, and on the west, south, and east by the Peninsula Coastal Lowlands which broaden toward the south and east. The Pinellas Ridge consists of Miocene undifferentiated Hawthorn Group and undifferentiated Quaternary sediments that remain as a relative highland in Pinellas County (Scott et al., 2001; Green et al., 2012a; Green et al., 2012b). Elevations within the province range from sea level to over 105 feet (32 meters) above MSL. The ridge is well drained. The northern portion of the Pinellas Ridge, adjacent to the Land O' Lakes Karst Plain and just southwest of Lake Tarpon, contains a few small karst depressions. There are numerous sinkholes apparent on the topographic maps, LiDAR elevation models, and aerial photographs, but the karst is not as extensive and the geology is dissimilar enough that is not merged with the Land O' Lakes Karst Plain.

LITHOSTRATIGRAPHIC UNITS

Tertiary System

Eocene Series

Avon Park Formation

The middle Eocene Avon Park Formation (Tap), first named by Applin and Applin (1944), is entirely a subsurface unit within the USGS Saint Petersburg 30 x 60 minute quadrangle. It was encountered in many of the wells utilized for this study and efforts were made to include it in the geologic cross sections where suitable well coverages existed (see OFMS 109, Plate 2). In some instances, geologic cross-sections do not depict the Avon Park Formation due to graphical constraints (OFMS 109, Plate 2).

The lithology of the Avon Park Formation can vary between limestone and dolostone. The limestones are cream to light brown to tan, poorly to well-indurated, variably fossiliferous grainstone and wackestone, with rare mudstone. They are often interbedded with tan to brown, very poorly to well-indurated, very fine to medium crystalline, fossiliferous (molds and casts), vuggy dolostones. Minor clay beds and organic-rich laminations may occur, especially at or near the top of the unit. Although not common, sedimentary structures include cross-beds and burrows. The burrows generally occur in the uppermost thinly bedded up-dip part of the formation (e.g., where the unit crops out in Citrus and Levy counties; Green et al., 2010; Williams et al., 2012). Accessory minerals include chert, pyrite, celestine, gypsum, and quartz (some as doubly-terminated euhedral crystals "floating" in vugs).

Fossils present in the unit include mollusks, foraminifera (*Spirolina* sp., *Lituonella floridana*, and *Cushmania* [*Dictyoconus*] *americana*), echinoids (*Neolaganum* [*Peronella*] *dalli*), algae, and carbonized plant remains. Porosity in the Avon Park Formation is generally intergranular in the limestone section. Fracture porosity occurs in the more densely recrystallized dolostone, and intercrystalline porosity is characteristic of sucrosic textures. Pinpoint vugs and fossil molds are present to a lesser extent.

Distinction between the middle Eocene Avon Park Formation and the unconformably overlying unit, the upper Eocene Ocala Limestone, can at times be difficult in the study area. Dolomitization of the Avon Park Formation and common recrystallization of the lowermost Ocala Limestone has significantly altered the original rock lithology and fabric. Fossil indicators are only somewhat helpful because the latest deposits of the Avon Park Formation and the earliest deposits of the Ocala Limestone are both bank assemblages, consistent with deposition in a shallow-water limestone bank or plateau, not unlike the present-day Bahama Banks (Bryan, 2004). This is especially true in the southwestern portion of the study area, where the Avon Park Formation is deepest. In this area, the transition from the Ocala Limestone to the Avon Park Formation is typically, though not always, marked by a transition from a yellowish-gray grainstone, often containing *Lepidocyclina ocalana* and *Nummulites ocalanus*, to an orangish-brown, sucrosic dolostone. Approaching the northeast portion of the study area, the transition is characterized by a subtle textural change in the limestone and a change in fossil fauna where common Ocala Limestone benthic foraminifera give way to *Fallotella* sp. and *Cushmania* [*Dictyoconus*] *americana*.

The top of the Avon Park Formation ranges from approximately 390 feet (118.9 meters) below MSL in W-10577 (OFMS 109; Plate 2, cross-section A-A') to approximately 688 feet (209.7 meters) below MSL in W-16181 (OFMS 109; Plate 2, cross-section A-A'). Due to limited coverage of deeper wells, the total thickness of the Avon Park Formation was not investigated in this study. The Avon Park Formation forms part of the Floridan aquifer system (FAS; Southeastern Geological Society Ad Hoc Committee on Florida Hydrostratigraphic Unit Definition, 1986).

Ocala Limestone

The upper Eocene Ocala Limestone (To), 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 can be informally subdivided into an upper and lower unit (Scott, 1991b). 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). Fossils commonly 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.

The Ocala Limestone occurs throughout the study area (OFMS 109, Plate 2). The top of the Ocala Limestone ranges from 230 feet (70.1 meters) below MSL in W-10577, (OFMS 109; Plate 2, cross-section A-A' and F-F') to 635 feet (193.5 meters) below MSL in W-19338 (OFMS 109; Plate 2, cross-section E-E'). Very few of the wells utilized for geologic cross-sections penetrate the entire thickness of the Ocala Limestone. In these wells, the thickness of the Ocala Limestone ranges from 280 feet (85.3 meters) in W-9241 (OFMS 109; Plate 2, cross-section B-B' and F-F') to 95 feet (29.0 meters) in W-15379 (OFMS 109; Plate 2, cross-section A-A').

The Ocala Limestone is generally thickest in the southern portion of the study area off the nose of the Ocala Platform. It exceeds 250 feet (76.2 meters) in these areas (Arthur et al., 2008). The Ocala Limestone forms part of the FAS (Southeastern Geological Society Ad Hoc Committee on Florida Hydrostratigraphic Unit Definition, 1986).

Oligocene Series

Suwannee Limestone

The lower Oligocene Suwannee Limestone (Ts), named by Cooke and Mansfield (1936), consists of limestone (grainstone and packstone) in the study area. The unit is typically gray, tan, and yellowish gray, moderately to very well-indurated, finely to coarsely crystalline, with limited occurrences of fossiliferous beds. Chert is occasionally present in the unit in minor amounts. Porosity types include intergranular and moldic. Sedimentary features include bioturbation and cross-bedding (Budd, 2002). Fossils present in the unit include mollusks, corals, echinoids (including the index fossil *Rhyncholampas gouldii),* as well as abundant miliolids, and other benthic foraminifera such as *Discorinopsis gunteri, Fallotella* [*Dictyoconus*] *cookei,* and *Fallotella* [*Coskinolina*] *floridana.*

The Suwannee Limestone unconformably overlies the Ocala Limestone throughout the study area. The Suwannee Limestone may be conformably overlain by the Tampa Member of the Arcadia Formation (Hawthorn Group) in parts of Hillsborough and Pinellas counties and the Nocatee Member of the Arcadia Formation in the eastern part of the mapped area (Arthur et al., 2008). In these areas, the Suwannee Limestone and Tampa Member of the Arcadia Formation may be difficult to differentiate due to the presence of trace amounts (typically less than three percent) of fine quartz sand in the upper Suwannee Limestone and lower Tampa Member of the Arcadia Formation, leading geologists familiar with the region into using the term “SuwaTampaHaw” (Tom Scott, personal communication, 2004). In these instances, the formation break is based on the presence of phosphate, general increase in quartz sand size in the Tampa Member of the Arcadia Formation, and a commonly occurring subtle shift from a wackestone to a packstone in the Suwannee Limestone.

In the subsurface, the Suwannee Limestone and Ocala Limestone can be difficult to distinguish in the study area because both units may be dominated by packstones and often contain

no diagnostic fossils. Brewster-Wingard et al. (1997) studied these units further south in the Florida peninsula and state: "…the delineation of the formational boundary [between the Ocala Limestone and the Suwannee Limestone] is often difficult, and foraminifera frequently provide the most reliable means for identifying the units." The present authors agree with this statement for the current map area.

The Suwannee Limestone is entirely a subsurface unit in the mapped area (OFMS 109, Plate 2). The top of the Suwannee Limestone ranges from approximately 75 feet (22.9 meters) below MSL in W-11541 (OFMS 109; Plate 2, cross-section A-A' and E-E') to 385 feet (117.3 meters) below MSL in W-16740 (OFMS 109; Plate 2, cross-sections C-C'). The thickness of the Suwannee Limestone ranges from 310 feet (94.5 meters) in W-1699 (OFMS 109; Plate 2, cross-section A-A') and W-802 (OFMS 109; Plate 2, cross-section E-E') to 130 feet (39.6 meters) in W-10577 (OFMS 109; Plate 2, cross-section A-A' and F-F') and W-9241 (OFMS 109; Plate 2, cross-section B-B' and F-F'). The Suwannee Limestone makes up part of the FAS (Southeastern Geological Society Ad Hoc Committee on Florida Hydrostratigraphic Unit Definition, 1986).

Oligocene-Pliocene Series

Hawthorn Group

Sediments of the upper Oligocene to Pliocene Hawthorn Group are thought to have been deposited over the Ocala Platform throughout the study area, but post-Pliocene erosion and karstification have removed sediments from the crest of the Ocala Platform, exposing Oligocene carbonates in portions of the map area (Cooke, 1945; Espenshade and Spencer, 1963; Scott, 1981b). Hawthorn Group sediments within the study area consist of phosphatic siliciclastics (sands, silts and clay) and carbonates. Fossils in the Hawthorn Group are sparse but may include vertebrate remains, corals, and mollusks. Benthic foraminifera characteristic of the Hawthorn Group include *Archaias* spp. and *Sorites* sp. Williams et al. (1977) report that the most commonly found fossils are oysters and coral heads.

Within the mapped area, the Hawthorn Group is composed of sediments from the Arcadia Formation (including the Tampa and Nocatee members), the Peace River Formation (including the Bone Valley Member), and undifferentiated Hawthorn Group (Th). The sediments of the Arcadia Formation lie unconformably over the Suwannee Limestone. The various Hawthorn Group sediments are, at times, unconformably overlain by the undifferentiated Tertiary-Quaternary shelly sediments and/or undifferentiated Quaternary sediments.

Arcadia Formation

The upper Oligocene to middle Miocene (Brewster-Wingard et al., 1997) Arcadia Formation (Tha) is a yellowish gray to white, variably sandy (quartz and phosphorite) carbonate, intercalated with beds of siliciclastic-dominant sediments. Although limestone is present, dolostones are most common, ranging in grain size from microcrystalline to medium, with the coarser material being sucrosic. Minor clay and chert beds (some composed of silicified clay) also occur (Upchurch et al., 1982; Scott, 1988). Porosity types include intergranular and moldic. In places, the Arcadia Formation can be further subdivided into the Tampa Member and Nocatee Member. See below for further discussion of these units.

Undifferentiated Arcadia Formation sediments range from approximately 80 feet (24.4 meters) above MSL (OFMS 109; Plate 2, cross-section F-F', W-9235) to more than 250 feet (76.2

meters) below MSL (OFMS 109; Plate 2, cross section F-F', W-19652). The unit is thickest in the southeastern portion of the study area and ranges from 265 feet (80.8 meters) thick (OFMS 109; Plate 2, cross-section F-F', W-11570) to approximately 30 feet thick (9.1 meters; OFMS 109; Plate 2, cross-section A-A', W-15380). The Arcadia Formation grades into undifferentiated Hawthorn Group sediments in southern Pinellas County (OFMS 109; Plate 2, cross-section D-D'). See section on undifferentiated Hawthorn Group below for more discussion.

Tampa Member

The upper Oligocene to lower Miocene (Brewster-Wingard et al., 1997) Tampa Member of the Arcadia Formation (That) varies from white to yellowish gray in color and ranges from a wackestone to packstone with varying amounts of quartz sand, silt, and clay (Scott, 1988). Phosphate is often absent in the Tampa Member, making this one of the characteristics that aid in distinguishing it from undifferentiated Arcadia Formation sediments. Phosphate can be present, though in amounts less than three percent. Dolomite, silt, and clay are occasionally present though rare. Dolomite is mostly observed near contacts with overlying and/or underlying units such as the Arcadia Formation or dolomitized sections of the Suwannee Limestone. Occasional thin clay beds were observed in core, and less notably in cuttings, throughout the area. Quartz sand content in the carbonate sections varies from two percent to thirty percent. Sand beds can be found intermittently within the unit. Chert, silicified limestone, and silicified corals are not uncommon in the Tampa Member. Silicified (agatized) coral is commonly found at Ballast Point along the western shore of Hillsborough Bay. Silicified corals are formed when calcium carbonate undergoes dissolution and is replaced with cryptocrystalline quartz through precipitation. According to Weisbord (1973), often the “original calcareous structure has been partially or wholly dissolved and the replacing siliceous deposit is so obscurative as to render identification of the taxon difficult or impossible.” Fossil molds of foraminifera, mollusks, and gastropods are all common within the Tampa Member. Porosity of the unit is generally intergranular and moldic.

In the study area, the Tampa Member overlies the Suwannee Limestone and the contact appears to be locally conformable. At times, however, this contact can be difficult to identify (see above reference to “SuwaTampaHaw”). In these cases, the unit is differentiated by a transition from quartz sand in minor amounts to the absence of quartz sand, indicating the top of the Suwannee Limestone. In many wells, the transition between the Tampa Member and the overlying undifferentiated Arcadia Formation is marked by a transition from phosphatic dolostone (Arcadia Formation) to a limestone with little to no phosphate content (Tampa Member, Arcadia Formation). In parts of Pinellas and Hillsborough counties, the unit is unconformably overlain by undifferentiated clays, dolosilts, and dolostones of the undifferentiated Hawthorn Group (Th), and undifferentiated Quaternary sands and clays (Qu). In the eastern portion of the study area, the Tampa Member is unconformably overlain by the Peace River Formation. Along the updip erosional pinchout of the Tampa Member, where it forms an irregular subcrop contact with the Suwannee Limestone, the top of the FAS generally coincides with the uppermost carbonate unit occurrence (Arthur et al., 2008).

In the study area, the top of the Tampa Member ranges from approximately 30 feet (9.1 meters) above MSL (OFMS 109; Plate 2, cross-section E-E', W-802) to approximately 275 feet (83.8 meters) below MSL (OFMS 109; Plate 2, cross-sections E-E’, W-19338). The maximum observed thickness of the Tampa Member is 160 feet (48.8 meters) in W-13515 (OFMS 109; Plate 2, cross-sections B-B' and E-E'). The Tampa Member is thinnest at 30 feet (9.1 meters) in W-10577 (OFMS 109; Plate 2, cross-sections A-A' and F-F') where the Nocatee Member is present.

Nocatee Member

The upper Oligocene (Brewster-Wingard et al., 1997) Nocatee Member of the Arcadia Formation (Than) is predominantly a siliciclastic unit consisting primarily of quartz sand and clay beds with occasional phosphate, silt, clay, limestone, and dolomite (Scott, 1988). The Nocatee Member is entirely a subsurface unit in Florida. Where present, it forms the base of the Arcadia Formation. The Nocatee Member was only recognized in five wells along the easternmost part of the study area (OFMS 109; Plate 2, cross-section A-A' and F-F'). Arthur et al., (2008) show the extents of the unit just barely coming into the mapped area. The Nocatee Member is differentiated from the overlying Tampa Member and underlying Suwannee Limestone by a significant increase in quartz sand content and lower percentage of calcareous matrix. This unit is also marked by an increase in light olive gray to light greenish gray clay beds. In the mapped area, the top of the unit ranges from 40 feet (12.2 meters) below MSL (OFMS 109; Plate 2, cross-section A-A' and F-F', W-10577) to 64 feet (19.5 meters) below MSL (OFMS 109; Plate 2, cross-section F-F'; W-18816). The unit ranges in thickness from 60 feet (18.3 meters) to 25 feet (7.6 meters; OFMS 109; Plate 2, cross-section F-F'; W-10577 and W-18816). The Nocatee Member of the Arcadia Formation, where present, forms part of the FAS (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 yellowish gray to olive gray, interbedded sands, clays and carbonates with the siliciclastic component being dominant (Scott, 1988). Phosphate 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 (e.g., shark teeth, ray spines, horse teeth, dugong, and whale ribs), particularly within the Bone Valley Member. Porosity types in the formation are generally intergranular.

The Peace River Formation unconformably overlies the Tampa Member of the Arcadia Formation in the central portion of the mapped area, and the Arcadia Formation in the eastern portion of the mapped area (OFMS 109, Plate 2). The contact between the Peace River Formation and Arcadia Formation can be problematic in the southwestern portion of the study area. In this area, the two units may appear to be conformable, with phosphate-rich siliciclastics grading with depth into more siliciclastic-interbedded carbonates containing generally finer-grained and less abundant phosphate (Arthur et al., 2008). In such cases, the lower contact of the Peace River Formation is estimated based on sedimentary structures as well as a best approximation of where the overall lithologic sequence becomes more carbonate dominant (Scott, 1988). In the northeastern portion of the study area, the contact is readily recognized at the first occurrence of a light colored, phosphatic and quartz sandy dolostone.

The Peace River Formation ranges from 132 feet (40.2 meters) above MSL in W-9235 (OFMS 109; Plate 2, Cross Section F-F') to 39 feet (11.9 meters) below MSL in W-13515 (OFMS 109; Plate 2, Cross-section B-B' and E-E'). Thicknesses range from 136 feet (41.5 meters) in W-16740 (OFMS 109; Plate 2, Cross-section C-C') to six feet (1.8 meters) in W-17113 (OFMS 109; Plate 2, Cross-section A-A').

The Peace River Formation is within the upper portion of the Intermediate Aquifer System/Confining Unit (IAS/ICU) and regionally is a confining to semi-confining lithostratigraphic unit. The Peace River Formation and undifferentiated Hawthorn Group

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).

Bone Valley Member

The middle Miocene to lower Pliocene (Webb and Crissinger, 1983) Bone Valley Member of the Peace River Formation (Thpb) is lithologically very similar to the Peace River Formation. The lithology of the Bone Valley Member differs in that it contains higher concentrations of coarse-grained phosphate (more than 30 percent by volume), ranging up to gravel-size nodules. Some pebble sized grains show evidence of reworking, boring structures and multiple stages of phosphatization. Phosphate coloration ranges from black and brown to cream and white. The non-phosphorite component of the Bone Valley Member is comprised of quartz sand and clay (e.g. palygorskite and sepiolite; Scott, 1988), occasionally with minor amounts of dolomite. Carbonate beds are not present; however, limestone and dolostone cobbles may be present (Tom Scott, personal communication, 2005). According to Scott (1988, p. 87), "the occurrence of phosphate gravels in the Bone Valley Member is the most lithologically important factor in the separation of the member from the remainder of the Peace River Formation." Scott (1988) also notes that the contact between the Bone Valley Member and the Peace River Formation is gradational, both laterally and vertically. While the Bone Valley Member can often be separated from the remainder of the Peace River Formation in cores and in mines, it is rarely possible to differentiate the unit in cuttings.

After looking at hundreds of sets of cuttings and dozens of cores throughout the study area the authors determined that the Bone Valley Member, as defined by Scott (1988), could not reliably be mapped at this scale in the study area. This is due to a combination of several factors including the gradational nature of the contacts, lithological similarities between the Bone Valley Member and the Peace River Formation, poor core control, and significant amounts of phosphate mining activities during the last century.

Of the 230 boreholes located in the area historically mapped as the Bone Valley Member, only a small fraction of the wells had sediment matching the lithostratigraphic definition of the Bone Valley Member of Scott (1988). Arthur et al. (2008) only had eleven wells within the current map area which identified the Bone Valley Member as being present. It should be noted that the areas mapped as Bone Valley Member in Arthur et al. (2008) and Scott (1988) were based on a very limited number of wells, and the boundaries of the unit were heavily influenced by the presence of phosphate mines. Mining in the phosphate district is largely driven by economics and thus they historically mined phosphate-rich zones, not necessarily the Bone Valley Member lithostratigraphic unit as defined by Scott (1988).

The eastern part of the mapped area has been extensively mined for phosphate (Figure 7) going as far back as 1890 (Sellards, 1915). As a result, much of the area formerly mapped as Bone Valley Member by Scott (1988) and Arthur et al. (2008) has been removed and/or reclaimed, and the surficial sediments no longer truly represent the original lithology. This also proved to be an issue when working with core and cutting samples that have been collected over the span of the past 100 years. These samples often had incomplete location and elevation information, making the determination of the top of the Bone Valley Member problematic at best. Without reliable information on boreholes located in mined areas and specific locations and elevations, the authors were unable to determine if the various samples examined were collected pre- or post-mining in many instances. After much discussion with various staff geologists (including Tom Scott), it was

determined that it was best to map the area as Peace River Formation and forego attempts to delineate the Bone Valley Member at this scale. The reader is referred to Scott (1988) and Arthur et al. (2008) for the former extents and additional discussion of the Bone Valley Member.

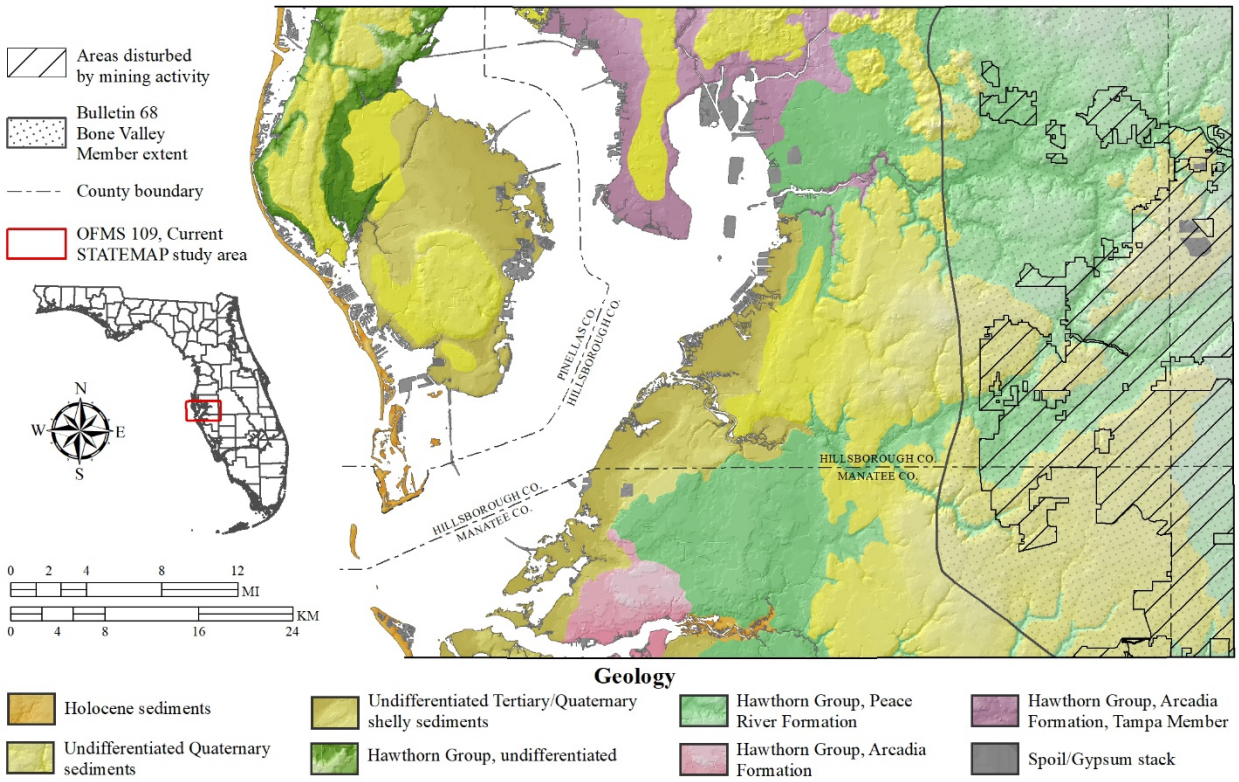


Figure 7. Mined areas with extents of Bone Valley Member from Arthur et al. (2008)

Hawthorn Group (undifferentiated)

The Hawthorn Group (undifferentiated) is mapped throughout Pinellas County following the convention of Scott et al. (2001). Similar lithologies of the lower Peace River Formation and upper Arcadia Formation, combined with post-depositional reworking of Hawthorn Group sediments, makes consistently differentiating the Peace River and Arcadia formations difficult in cores and impossible in cuttings. Based solely upon lithology, due to overall siliciclastic content, many of these sediments could be considered as Peace River Formation. However; the chert, agatized corals, and intervals dominated by dolosilt and dolostone are more typical of an Arcadia Formation lithology. Additionally, the Tampa Member of the Arcadia Formation underlies these undifferentiated Hawthorn Group sediments in Pinellas County.

Undifferentiated Hawthorn Group (Th) sediments lie unconformably above upper Oligocene to lower Miocene (Brewster-Wingard et al., 1997; Scott, et al., 2001) Tampa Member of the Arcadia Formation (That; OFMS 109; Plate 2, Cross Section A-A', B-B', and D-D'). They are light olive gray and blue gray in unweathered sections and brownish gray to grayish orange and reddish brown to reddish gray in weathered sections. They consist of poorly- to moderately-consolidated, clayey sands to silty clays, and relatively pure clays with minor phosphate due to leaching and transport (Scott, 2001). In addition to these clays, the present study noted that the unit also contains dolosilts, dolostones, and variable (but typically low) concentrations of

phosphatic sand with occasional phosphatic gravel. The clays are often expansive, but are, at times, silicified. Agatized corals and chert are also present.

Where present, undifferentiated Hawthorn Group sediments unconformably overlie the Tampa Member of the Arcadia Formation (Scott et al., 2001). They are at times unconformably overlain by undifferentiated Quaternary sediments or undifferentiated Tertiary/Quaternary shelly sediments (OFMS 109, Plates 1 and 2). The undifferentiated Hawthorn Group sediments transitionally grade into undifferentiated Arcadia Formation towards the south in Pinellas County (OFMS 109; Plate 2, W-17600/W-252).

Within the study area, the top of the unit ranges from 25 feet (7.6 meters) above MSL to 110 feet (33.5 meters) below MSL (OFMS 109; Plate 2, cross-section D-D', W-3413). The undifferentiated Hawthorn Group ranges from 100 feet thick (30.5 meters; OFMS 109; Plate 2, cross-section D-D', W-14778) to 20 feet thick (6.1 meters; OFMS 109; Plate 2, cross-section B-B', W-3118).

The undifferentiated Hawthorn Group sediments generally have low permeability and form part of the IAS/ICU (Southeastern Geological Society Ad Hoc Committee on Florida Hydrostratigraphic Unit Definition, 1986).

Tertiary/Quaternary Systems

Pliocene/Pleistocene Series

Undifferentiated Tertiary/Quaternary shelly sediments

Undifferentiated Tertiary/Quaternary shelly sediments (TQsu) disconformably overlie the Arcadia Formation or the Peace River Formation throughout western Manatee and southwestern Hillsborough counties east of Tampa Bay. TQsu sediments disconformably overlie undifferentiated Hawthorn Group (Th) in Pinellas County. 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. McCartan and Moy (1995) mapped several units south of this area (Sarasota quadrangle) based upon inferred ages from fossils, stratigraphic position, and isotope age dates. Due to the similar lithologies of these units, difficulties encountered in attempting to differentiate them in drill cuttings, and the fact that the Okeechobee formation was never formalized, they are placed within the TQsu on this map.

The undifferentiated Tertiary/Quaternary shelly sediments include sediments from the Pinecrest Member (Tamiami Formation), Caloosahatchee Formation, Bermont formation, and Fort Thompson Formation. Lithologies of the TQsu consist of clay, silt, sand, phosphate, shells, and carbonate in varying admixtures. The unit may range from a shelly sand with carbonate and clay, to shell beds with accessory carbonate, sand and clay. Phosphate is commonly associated with the unit, having been reworked from the underlying Hawthorn Group sediments. Virtually all of the individual lithologies are fossiliferous, containing some of the most macrofossiliferous sediments in the Gulf and Atlantic Coastal Plain. For discussion of these sediments and the fossils contained in them, refer to Petuch (1982), Scott and Allmon (1990), Scott and Wingard (1995), and Hulbert et al. (1995a, 1995b). In western Manatee County, south of I-275, the TQsu becomes thinner, in most cases less than ten feet (3.1 meters), and intermittent. Field and borehole data here indicate that the area is a mix of thin, shallow TQsu, Arcadia Formation, and a mixture of residual sand,

clay, and phosphate which may in some cases be isolated remnants of Peace River Formation. The authors have decided to map this area as TQsu, but are aware that it could also be mapped as Arcadia Formation with known, intermittent, TQsu present. Additional work and data are needed to most accurately determine which unit should be mapped in this area. Permeable sediments of the undifferentiated Tertiary/Quaternary shelly sediments (TQsu) form part of the surficial aquifer system (SAS) (Southeastern Geological Society Ad Hoc Committee on Florida Hydrostratigraphic Unit Definition, 1986).

Pleistocene to Holocene Series

Undifferentiated Quaternary sediments

While not a formally recognized lithostratigraphic unit, undifferentiated Quaternary sediments (Qu), are mapped following the convention of Scott et al. (2001), in order to facilitate a better understanding of Florida's geology. The undifferentiated Quaternary sediments in the mapped area may be highly variable in thickness. Undifferentiated Quaternary sediments (Qu) in the study area lie unconformably on the Peace River Formation, the Arcadia Formation, Tampa Member of the Arcadia Formation, undifferentiated Hawthorn Group, or undifferentiated Tertiary/Quaternary shelly sediments (OFMS 109, Plate 2).

Generally, undifferentiated Quaternary sediments consist of white to gray to orange to brown, fine- to coarse-grained, clean to clayey (usually) unfossiliferous sands, sandy clays and clays with variable admixtures of organics. The undifferentiated Quaternary sediments form part of the SAS (Southeastern Geological Society Ad Hoc Committee on Florida Hydrostratigraphic Unit Definition, 1986). Where these sediments lack clay and overlie the Tampa Member of the Arcadia Formation, they are hydraulically connected to the Floridan aquifer system.

Holocene sediments

Sediments mapped as Holocene (Qh) may include quartz sands, marls, organics, and minor carbonate sands and mud. They may also include fresh-water gastropods and modern shells. Within the study area, these occur near the Manatee River and along the present coastline in barrier islands on the Gulf of Mexico. Studies by Davis et al. (1992) suggest Holocene age for these barrier islands. The Holocene sediments (Qh) form part of the SAS (Southeastern Geological Society Ad Hoc Committee on Florida Hydrostratigraphic Unit Definition, 1986).

SPOIL

Areas mapped as spoil include a variety of materials. Extensive human modification of the shorelines throughout the study area have occurred during the past century. Historical late 1930s and early 1940s aerial photographs from the George A. Smathers Library at the University of Florida were accessed for Pinellas (1942 and 1943), Hillsborough (1938), and Manatee (1940) counties. Numerous areas of canal cut and fill construction and development are present, but regions mapped as spoil were limited to those directly impacting change to the historical shorelines and fringing salt marsh and mangroves. Additionally, mining activities in the central Florida phosphate district have created numerous "gypstacks" which are mounds of phosphogypsum derived as byproduct from phosphate processing. These "gypstacks" represent recent, manmade

materials. Therefore, it was decided to delineate them as spoil on the current maps (OFMS 109, Plates 1 and 2) using a spoil pattern and the letters “GYP” as a label in the mapped polygon.

MINING EFFECTS

Figure 7 depicts areas subjected to phosphate mining in the mapped quadrangle. The geologic map and cross-sections associated with this product (OFMS 109, plates 1 and 2) are based on field work and borehole data from the FGS Geological Sample Repository. Areas shown as Peace River Formation (Thp) and undifferentiated Quaternary (Qu) in the phosphate mining zones on OFMS 109 (plates 1 and 2) reflect data which are primarily derived from boreholes and historic data. As such, the reader should note that there are differences between the geology as mapped and the surficial geology inside of these mined areas. In some of the mined areas, the undifferentiated Quaternary sediments (dominated by quartz sand) and Peace River Formation have been removed during mining, in some cases multiple times, in the last century. Mining processes in these areas have mixed the undifferentiated Quaternary sediments and quartz sand, unmined phosphate grains, clays, and carbonate materials from the Peace River Formation.

Determination of original ground surface versus mined and reclaimed surfaces is practically impossible and is further complicated by the lack of LiDAR in the region. The DEM in this portion of the map is based on topography derived from USGS 7.5 minute quadrangles from the 1950’s through the 1980’s, thus the elevations depicted on the cross-sections and maps may not reflect current topography in these mined or reclaimed areas. One example of this is the area around W-9235 (OFMS 109, Plate 2, cross-section F-F'). This borehole, which was likely drilled in the 1960’s by Humble Oil Refining Company (the precise date is unknown) and was given to the FGS for archiving in 1969, predated mining in this area. The “gypstacks” shown on the map now exceed 360 feet (109.7 meters) in elevation, but the DEM data for the area only shows a surface elevation of 160 feet (48.8 meters). This area has been mined since the 1970’s for phosphate and phosphogypsum has been stored here since the mid-1970’s. As such, the authors have decided to map the geology based on borehole data and historic data, showing the areas that are likely disturbed in Figure 7.

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 graphic representation of the hydrostratigraphic units, and their relationship to lithostratigraphic units, can be seen on OFMS 109, Plate 2, Figure 2. The FAS, the primary source for springs and drinking water in the region, is generally comprised of carbonate units of the Avon Park Formation, the Ocala Limestone, the Suwannee Limestone, and the Arcadia Formation (Hawthorn Group). Arthur et al. (2008) provide a more detailed discussion of the FAS in the region. The sands, silts, clays and carbonates of the remainder of the Hawthorn Group comprise the IAS/ICU. The IAS/ICU is highly localized and laterally discontinuous in the study area. The SAS is comprised of TQsu, Qu, and Qh sediments.

Where clayey siliciclastic sediments of the Hawthorn Group and younger units are thick and continuous, they provide confinement for the FAS, but where the clayey siliciclastic sediments of the Hawthorn Group and younger units are thin, missing or lack significant clay component, karst features often occur.

DERIVATIVE PRODUCTS

Several derivative products were developed in the process of completing this project. During the mapping efforts, data from 430 wells with samples were analyzed and used (Appendix A). Formation picks made on these cores and cutting samples, allow creation of structure contour and isopach maps for the top of several units in the area. Additional derivative products anticipated to come from this mapping effort include aquifer vulnerability assessment 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).

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APPENDIX A: FLORIDA GEOLOGICAL SURVEY WELLS UTILIZED FOR STUDY

This table lists FGS wells within the boundaries of the USGS Saint Petersburg 30 x 60 minute quadrangle utilized for the project. Due to graphical constraints, not all wells will appear on Plate 1 of OFMS 109. The first 34 wells in the table were utilized for geologic cross-sections and appear on Plates 1 and 2 of OFMS 109.

Map ID	Well Label	Sample Type	Latitude	Longitude	24K Quad	Elevation (ft.)	Total Depth (ft.)
1	W-802	Cuttings	27.98921	-82.51695	GANDY BRIDGE	30	500
2	W-1669	Cuttings	27.88091	-82.63834	SAFETY HARBOR	3	11507
3	W-1744	Cuttings	27.93447	-82.77095	CLEARWATER	45	137
4	W-2677	Cuttings	27.90675	-82.30370	BRANDON	37	443
5	W-3118	Cuttings	27.76833	-82.64073	SAINT PETERSBURG	32	315
6	W-3310	Cuttings	27.78765	-82.74174	SAINT PETERSBURG	21	395
7	W-3413	Cuttings	27.71796	-82.73893	PASS-A-GRILLE BEACH	5	175
8	W-6092	Cuttings	27.93297	-82.50736	GANDY BRIDGE	18	600
9	W-7006	Cuttings	27.60367	-82.52686	PALMETTO	35	380
10	W-7337	Cuttings	27.59276	-82.44158	PARRISH	34	900
11	W-9211	Cuttings	27.67945	-82.03389	DUETTE NE	137	570
12	W-9235	Cuttings	27.83206	-82.03466	KEYSVILLE	140	740
13	W-9241	Cuttings	27.75881	-82.01840	KEYSVILLE	120	704
14	W-10577	Cuttings	27.95944	-82.06333	NICHOLS	110	650
15	W-11541	Core	27.88872	-82.48091	TAMPA	5	400
16	W-11570	Core	27.64361	-82.06084	DUETTE NE	137	462
17	W-13515	Cuttings	27.73958	-82.46389	RUSKIN	1	285
18	W-14386	Cuttings	27.74083	-82.14256	FORT LONESOME	102	925
19	W-14778	Cuttings	27.84346	-82.75375	SEMINOLE	10	260
20	W-15379	Cuttings	27.92653	-82.22380	DOVER	93	820
21	W-15380	Cuttings	27.93722	-82.15667	DOVER	61	900
22	W-15389	Cuttings	27.99015	-82.75681	CLEARWATER	60	200
23	W-16181	Core	27.91628	-82.77753	CLEARWATER	10	801.5
24	W-16430	Cuttings	27.89871	-82.70792	SAFETY HARBOR	7	25
25	W-16456	Core	27.76200	-82.25413	RIVERVIEW	144	1575
26	W-16618	Core	27.76500	-82.39389	GIBSONTON	13	1270
27	W-16740	Core	27.58948	-82.25037	RYE	129	1013
28	W-17113	Core	27.90055	-82.37305	BRANDON	13	470
29	W-17600	Core	27.61389	-82.73473	ANNA MARIA	7	69
30	W-18795	Core	27.83389	-82.47305	GIBSONTON	5	136.5
31	W-18816	Core	27.87975	-82.05155	NICHOLS	101	320
32	W-19338	Core	27.58112	-82.43644	PARRISH	39	1600
33	W-19652	Core	27.53150	-82.10333	DUETTE	110	350
34	KT-1	Core	27.59139	-82.08389	DUETTE	130	67
35	W-60	Cuttings	27.98806	-82.73167	SAFETY HARBOR	65	846
36	W-252	Cuttings	27.61589	-82.73566	ANNA MARIA	5	991
37	W-267	Cuttings	27.90225	-82.14620	DOVER	80	805
38	W-624	Cuttings	27.64583	-82.55417	COCKROACH BAY	0	270
39	W-632	Cuttings	27.99940	-82.01778	NICHOLS	135	683
40	W-688	Cuttings	27.97699	-82.52533	GANDY BRIDGE	23	221
41	W-690	Cuttings	27.98092	-82.51660	GANDY BRIDGE	30	508
42	W-766	Cuttings	27.97555	-82.51507	GANDY BRIDGE	30	512
43	W-953	Cuttings	27.95371	-82.79393	CLEARWATER	50	296
44	W-957	Cuttings	27.94373	-82.46117	TAMPA	9	350
45	W-1005	Cuttings	27.80472	-82.14028	LITHIA	98	10129
46	W-1448	Cuttings	27.86856	-82.11970	KEYSVILLE	61	820
47	W-1523	Cuttings	27.87468	-82.84267	SEMINOLE	29	258
48	W-1604	Cuttings	27.92141	-82.44370	TAMPA	3	720
49	W-1615	Cuttings	27.89394	-82.77077	CLEARWATER	15	160
50	W-1621	Cuttings	27.89946	-82.79723	CLEARWATER	67	303
51	W-1622	Cuttings	27.92460	-82.76279	CLEARWATER	16	127
52	W-1623	Cuttings	27.88902	-82.78879	CLEARWATER	35	142
53	W-1668	Cuttings	27.99368	-82.77527	CLEARWATER	20	995
54	W-1740	Cuttings	27.84444	-82.82127	SEMINOLE	27	195
55	W-1745	Cuttings	27.95654	-82.77573	CLEARWATER	62	188

Map ID	Well Label	Sample Type	Latitude	Longitude	24K Quad	Elevation (ft.)	Total Depth (ft.)
56	W-1765	Cuttings	27.83014	-82.24795	LITHIA	70	140
57	W-1823	Cuttings	27.52629	-82.56276	PALMETTO	12	551
58	W-1857	Cuttings	27.93013	-82.21138	DOVER	80	190
59	W-2007	Cuttings	27.99964	-82.65759	SAFETY HARBOR	1	1805
60	W-2152	Cuttings	27.76669	-82.21203	LITHIA	130	816
61	W-2178	Cuttings	27.73233	-82.22191	FORT LONESOME	105	405
62	W-2179	Cuttings	27.76099	-82.12687	LITHIA	120	790
63	W-2242	Cuttings	27.95332	-82.28473	BRANDON	60	101
64	W-2283	Cuttings	27.97985	-82.32054	BRANDON	35	90
65	W-2302	Cuttings	27.97696	-82.28696	BRANDON	61	116
66	W-2317	Cuttings	27.50670	-82.45055	PARRISH	10	620
67	W-2324	Cuttings	27.68309	-82.47426	RUSKIN	25	640
68	W-2352	Cuttings	27.96601	-82.30962	BRANDON	53	122
69	W-2381	Cuttings	27.89208	-82.39929	TAMPA	5	150
70	W-2416	Cuttings	27.84078	-82.14433	LITHIA	110	495
71	W-2437	Cuttings	27.97271	-82.27599	BRANDON	62	120
72	W-2473	Cuttings	27.95918	-82.48426	TAMPA	35	93
73	W-2489	Cuttings	27.87654	-82.84891	CLEARWATER	0	100
74	W-2492	Cuttings	27.91947	-82.52704	GANDY BRIDGE	1	114
75	W-2511	Cuttings	27.73219	-82.42901	RUSKIN	5	504
76	W-2545	Cuttings	27.72173	-82.45044	RUSKIN	5	110
77	W-2553	Cuttings	27.52809	-82.57371	PALMETTO	12	423
78	W-2566	Cuttings	27.81750	-82.73640	SAINT PETERSBURG	15	125
79	W-2568	Cuttings	27.98415	-82.27457	BRANDON	66	182
80	W-2574	Cuttings	27.92826	-82.49322	TAMPA	20	67
81	W-2575	Cuttings	27.85452	-82.71461	SAINT PETERSBURG	11	85.5
82	W-2586	Cuttings	27.94842	-82.47308	TAMPA	20	155
83	W-2587	Cuttings	27.96583	-82.54170	GANDY BRIDGE	7	100.5
84	W-2588	Cuttings	27.98258	-82.45914	TAMPA	38	146
85	W-2592	Cuttings	27.97143	-82.44597	TAMPA	45	107
86	W-2605	Cuttings	27.79906	-82.65056	SAINT PETERSBURG	50	245
87	W-2609	Cuttings	27.94378	-82.49292	TAMPA	22	59
88	W-2659	Cuttings	27.89023	-82.71951	SAFETY HARBOR	15	82
89	W-2663	Cuttings	27.90055	-82.72103	SAFETY HARBOR	15	115
90	W-2664	Cuttings	27.90395	-82.50932	GANDY BRIDGE	10	163
91	W-2668	Cuttings	27.77733	-82.38528	GIBSONTON	10	275
92	W-2681	Cuttings	27.96578	-82.76127	CLEARWATER	65	289
93	W-2689	Cuttings	27.88937	-82.52696	GANDY BRIDGE	5	70
94	W-2698	Cuttings	27.96370	-82.77399	CLEARWATER	75	182
95	W-2703	Cuttings	27.87503	-82.70808	SAFETY HARBOR	10	134
96	W-2704	Cuttings	27.99970	-82.41821	TAMPA	47	503
97	W-2705	Cuttings	27.82491	-82.66627	SAINT PETERSBURG	31	180
98	W-2710	Cuttings	27.90549	-82.49348	TAMPA	15	50
99	W-2752	Cuttings	27.77528	-82.77639	SEMINOLE	5	150
100	W-2760	Cuttings	27.96055	-82.44305	TAMPA	25	170
101	W-2762	Cuttings	27.72711	-82.74312	PASS-A-GRILLE BEACH	5	130
102	W-2766	Cuttings	27.90500	-82.73194	SAFETY HARBOR	15	134
103	W-2796	Cuttings	27.70320	-82.42189	RUSKIN	20	550
104	W-2932	Cuttings	27.99358	-82.78885	CLEARWATER	25	184
105	W-2942	Cuttings	27.94818	-82.74516	SAFETY HARBOR	34	284
106	W-2949	Cuttings	27.90777	-82.72954	SAFETY HARBOR	15	123
107	W-2954	Cuttings	27.99201	-82.01161	NICHOLS	138	78
108	W-2971	Cuttings	27.94813	-82.73750	SAFETY HARBOR	20	293
109	W-2975	Cuttings	27.69814	-82.41073	RUSKIN	21	605
110	W-3008	Cuttings	27.95167	-82.75500	CLEARWATER	37	205
111	W-3009	Cuttings	27.94415	-82.80556	CLEARWATER	23	280
112	W-3029	Cuttings	27.98967	-82.45634	TAMPA	43	183
113	W-3067	Cuttings	27.82267	-82.65720	SAINT PETERSBURG	19	435
114	W-3086	Cuttings	27.82240	-82.65662	SAINT PETERSBURG	20	280
115	W-3090	Cuttings	27.97336	-82.78584	CLEARWATER	20	325
116	W-3091	Cuttings	27.82267	-82.65720	SAINT PETERSBURG	19	330
117	W-3113	Cuttings	27.85687	-82.39400	GIBSONTON	4	793
118	W-3114	Cuttings	27.93611	-82.73251	SAFETY HARBOR	6	110
119	W-3117	Cuttings	27.76184	-82.71007	SAINT PETERSBURG	23	460

Map ID	Well Label	Sample Type	Latitude	Longitude	24K Quad	Elevation (ft.)	Total Depth (ft.)
120	W-3134	Cuttings	27.94950	-82.76237	CLEARWATER	44	265
121	W-3138	Cuttings	27.99172	-82.73582	SAFETY HARBOR	74	337
122	W-3175	Cuttings	27.94071	-82.51820	GANDY BRIDGE	9	73
123	W-3181	Cuttings	27.94141	-82.27592	BRANDON	55	335
124	W-3209	Cuttings	27.57906	-82.58926	PALMETTO	1	289
125	W-3240	Cuttings	27.50456	-82.51604	PALMETTO	3	75
126	W-3275	Cuttings	27.92000	-82.73000	SAFETY HARBOR	15	98
127	W-3323	Cuttings	27.78842	-82.74215	SAINT PETERSBURG	21	488
128	W-3338	Cuttings	27.94444	-82.48750	TAMPA	22	225
129	W-3369	Cuttings	27.90551	-82.79958	CLEARWATER	61	120
130	W-3370	Cuttings	27.96044	-82.43815	TAMPA	24	184
131	W-3372	Cuttings	27.97363	-82.78932	CLEARWATER	22	200
132	W-3394	Cuttings	27.52444	-82.52747	PALMETTO	10	325
133	W-3469	Cuttings	27.85611	-82.73695	SAINT PETERSBURG	17	215
134	W-3511	Cuttings	27.90139	-82.73763	SAFETY HARBOR	15	110
135	W-3572	Cuttings	27.83822	-82.76778	SEMINOLE	10	0
136	W-3615	Cuttings	27.62949	-82.66228	PASS-A-GRILLE BEACH	0	215
137	W-3625	Cuttings	27.87165	-82.51069	PORT TAMPA	10	145
138	W-3668	Cuttings	27.98811	-82.49979	TAMPA	31	205
139	W-3682	Cuttings	27.95598	-82.50534	GANDY BRIDGE	26	143
140	W-3759	Cuttings	27.81713	-82.70971	SAINT PETERSBURG	23	251
141	W-3823	Cuttings	27.72807	-82.43298	RUSKIN	5	175
142	W-3854	Cuttings	27.95743	-82.72694	SAFETY HARBOR	37	120
143	W-3860	Cuttings	27.82114	-82.31759	RIVERVIEW	83	323
144	W-3953	Cuttings	27.90280	-82.73138	SAFETY HARBOR	15	38
145	W-3966	Cuttings	27.94382	-82.50671	GANDY BRIDGE	22	427
146	W-3969	Cuttings	27.94498	-82.35540	BRANDON	28	80
147	W-3971	Cuttings	27.89287	-82.83057	CLEARWATER	20	130
148	W-3972	Cuttings	27.91763	-82.78682	CLEARWATER	50	190
149	W-3973	Cuttings	27.87377	-82.74854	SAINT PETERSBURG	19	202
150	W-3988	Cuttings	27.99576	-82.44216	TAMPA	55	324
151	W-3989	Cuttings	27.83444	-82.72972	SAINT PETERSBURG	15	77.5
152	W-3996	Cuttings	27.99585	-82.38120	TAMPA	34	338
153	W-4016	Cuttings	27.85610	-82.73000	SAINT PETERSBURG	15	112
154	W-4084	Cuttings	27.93186	-82.21055	DOVER	77	450
155	W-4159	Cuttings	27.95881	-82.52640	GANDY BRIDGE	14	175
156	W-4282	Cuttings	27.96661	-82.37830	TAMPA	30	556
157	W-4411	Cuttings	27.97816	-82.44273	TAMPA	50	140
158	W-4508	Cuttings	27.94400	-82.47756	TAMPA	20	114
159	W-4648	Cuttings	27.83644	-82.65504	SAINT PETERSBURG	5	187
160	W-4687	Cuttings	27.96796	-82.46311	TAMPA	40	228
161	W-4702	Cuttings	27.90195	-82.52694	GANDY BRIDGE	4	265
162	W-4731	Cuttings	27.92996	-82.31049	BRANDON	30	269
163	W-4802	Cuttings	27.85667	-82.32694	RIVERVIEW	40	337
164	W-4831	Cuttings	27.98156	-82.33488	BRANDON	50	305
165	W-5067	Cuttings	27.88656	-82.69172	SAFETY HARBOR	11	144
166	W-5078	Cuttings	27.83013	-82.24795	LITHIA	70	346
167	W-5209	Cuttings	27.94442	-82.39361	TAMPA	6	80
168	W-5254	Cuttings	27.96498	-82.23840	DOVER	84	330
169	W-5396	Cuttings	27.94926	-82.45469	TAMPA	20	225
170	W-5414	Cuttings	27.86270	-82.54149	PORT TAMPA	5	581
171	W-5457	Cuttings	27.90962	-82.38445	TAMPA	10	94
172	W-5498	Cuttings	27.67833	-82.39421	RUSKIN	13	493
173	W-5522	Cuttings	27.92372	-82.50153	GANDY BRIDGE	20	76
174	W-5524	Cuttings	27.89899	-82.51659	GANDY BRIDGE	10	140
175	W-5577	Cuttings	27.89389	-82.69210	SAFETY HARBOR	10	160
176	W-5596	Cuttings	27.54611	-82.50756	PALMETTO	30	180
177	W-5662	Cuttings	27.84918	-82.37315	RIVERVIEW	12	150
178	W-5678	Cuttings	27.72595	-82.03335	DUETTE NE	113	500
179	W-5683	Cuttings	27.97916	-82.45156	TAMPA	50	150
180	W-5718	Cuttings	27.95115	-82.33521	BRANDON	40	182
181	W-5751	Cuttings	27.87181	-82.71281	SAINT PETERSBURG	15	104
182	W-5800	Cuttings	27.98259	-82.30354	BRANDON	65	615
183	W-5945	Cuttings	27.70894	-82.36467	WIMAUMA	30	257

Map ID	Well Label	Sample Type	Latitude	Longitude	24K Quad	Elevation (ft.)	Total Depth (ft.)
184	W-5957	Cuttings	27.77225	-82.14925	LITHIA	116	926
185	W-6140	Cuttings	27.98840	-82.08298	NICHOLS	135	721
186	W-6255	Cuttings	27.87143	-82.29424	RIVERVIEW	24	176
187	W-6324	Cuttings	27.89153	-82.32890	BRANDON	37	84
188	W-6330	Cuttings	27.53333	-82.51389	PALMETTO	15	255
189	W-6438	Cuttings	27.63750	-82.54028	COCKROACH BAY	10	115
190	W-6439	Cuttings	27.58226	-82.59943	PALMETTO	4	150
191	W-6584	Cuttings	27.59278	-82.21111	KEENTOWN	118	1162
192	W-6623	Cuttings	27.60092	-82.45837	PARRISH	29	928
193	W-6688	Cuttings	27.61195	-82.52730	PALMETTO	28	205
194	W-6698	Cuttings	27.51917	-82.53744	PALMETTO	5	50
195	W-6708	Cuttings	27.57917	-82.40977	PARRISH	32	31
196	W-6813	Cuttings	27.56528	-82.53944	PALMETTO	19	90
197	W-6816	Cuttings	27.51739	-82.57943	PALMETTO	10	100
198	W-6828	Cuttings	27.54917	-82.55611	PALMETTO	20	130
199	W-6896	Cuttings	27.51912	-82.58501	PALMETTO	8	80
200	W-6898	Cuttings	27.53137	-82.49698	PARRISH	5	350
201	W-6953	Cuttings	27.62222	-82.47500	PARRISH	24	600
202	W-6972	Cuttings	27.63889	-82.55417	COCKROACH BAY	5	585
203	W-6973	Cuttings	27.60750	-82.48000	PARRISH	30	1057
204	W-6978	Cuttings	27.99596	-82.23414	DOVER	98	465
205	W-6982	Cuttings	27.90215	-82.41185	TAMPA	0	150
206	W-6983	Cuttings	27.95917	-82.34390	BRANDON	30	165
207	W-6988	Cuttings	27.53820	-82.47224	PARRISH	20	44
208	W-6992	Cuttings	27.51725	-82.53470	PALMETTO	5	100
209	W-7001	Cuttings	27.60318	-82.51010	PALMETTO	30	400
210	W-7035	Cuttings	27.97729	-82.42301	TAMPA	54	250
211	W-7052	Cuttings	27.55106	-82.44754	PARRISH	34	628
212	W-7189	Cuttings	27.51404	-82.71228	ANNA MARIA	0	360
213	W-7191	Cuttings	27.50064	-82.42957	PARRISH	15	87
214	W-7261	Cuttings	27.52222	-82.60500	PALMETTO	4	127
215	W-7282	Cuttings	27.54011	-82.52807	PALMETTO	20	230
216	W-7330	Cuttings	27.51472	-82.42583	PARRISH	0	50
217	W-7385	Cuttings	27.70982	-82.30104	WIMAUMA	100	300
218	W-7494	Cuttings	27.52498	-82.71862	ANNA MARIA	0	375
219	W-7495	Cuttings	27.57086	-82.14012	KEENTOWN	108	500
220	W-7497	Cuttings	27.59444	-82.40833	PARRISH	26	600
221	W-7501	Cuttings	27.56389	-82.49111	PARRISH	30	900
222	W-7572	Cuttings	27.86421	-82.39930	GIBSONTON	4	1075
223	W-7672	Cuttings	27.85750	-82.49445	GIBSONTON	8	1000
224	W-7690	Cuttings	27.93472	-82.35455	BRANDON	21	350
225	W-7815	Cuttings	27.59361	-82.49084	PARRISH	25	612
226	W-7816	Cuttings	27.55195	-82.53989	PALMETTO	20	340
227	W-7979	Cuttings	27.51639	-82.65222	ANNA MARIA	16	120
228	W-7982	Cuttings	27.50556	-82.39278	PARRISH	20	515
229	W-7986	Cuttings	27.96828	-82.33017	BRANDON	35	140
230	W-8029	Cuttings	27.56196	-82.43440	PARRISH	45	412
231	W-8030	Cuttings	27.63463	-82.54131	COCKROACH BAY	10	588
232	W-8039	Cuttings	27.91521	-82.31045	BRANDON	35	190
233	W-8144	Cuttings	27.54971	-82.40922	PARRISH	25	126
234	W-8145	Cuttings	27.52083	-82.42528	PARRISH	0	90
235	W-8147	Cuttings	27.55207	-82.09203	DUETTE	110	237
236	W-8148	Cuttings	27.62278	-82.47972	PARRISH	25	185
237	W-8157	Cuttings	27.60889	-82.46101	PARRISH	25	940
238	W-8226	Cuttings	27.58000	-82.50555	PALMETTO	15	365
239	W-8311	Cuttings	27.55503	-82.47295	PARRISH	30	605
240	W-8313	Cuttings	27.56083	-82.56722	PALMETTO	5	360
241	W-8438	Cuttings	27.56738	-82.53101	PALMETTO	28	185
242	W-8440	Cuttings	27.53583	-82.50756	PALMETTO	20	110
243	W-8573	Cuttings	27.95913	-82.42662	TAMPA	12	503
244	W-8707	Cuttings	27.82087	-82.32963	RIVERVIEW	60	600
245	W-8712	Cuttings	27.71250	-82.37833	RUSKIN	35	600
246	W-8714	Cuttings	27.71276	-82.39413	RUSKIN	36	600
247	W-8719	Cuttings	27.60833	-82.40139	PARRISH	27	785

Map ID	Well Label	Sample Type	Latitude	Longitude	24K Quad	Elevation (ft.)	Total Depth (ft.)
248	W-8787	Cuttings	27.58369	-82.20335	KEENTOWN	115	210
249	W-8797	Cuttings	27.64472	-82.14528	FORT LONESOME	130	975
250	W-8800	Cuttings	27.62192	-82.53996	PALMETTO	10	150
251	W-8802	Cuttings	27.61352	-82.22755	KEENTOWN	108	730
252	W-9019	Cuttings	27.70810	-82.05914	DUETTE NE	135	335
253	W-9020	Cuttings	27.82479	-82.09205	KEYSVILLE	96	730
254	W-9021	Cuttings	27.85393	-82.10011	KEYSVILLE	64	710
255	W-9022	Cuttings	27.84620	-82.17456	LITHIA	110	740
256	W-9025	Cuttings	27.79564	-82.06755	KEYSVILLE	148	736
257	W-9028	Core	27.85387	-82.06763	KEYSVILLE	128	490
258	W-9029	Cuttings	27.88778	-82.17268	DOVER	74	482
259	W-9030	Cuttings	27.76040	-82.16055	LITHIA	103	750
260	W-9035	Cuttings	27.68237	-82.21277	FORT LONESOME	60	470
261	W-9037	Cuttings	27.77639	-82.11293	KEYSVILLE	130	580
262	W-9038	Core	27.78833	-82.10022	KEYSVILLE	130	700
263	W-9039	Cuttings	27.88305	-82.20750	DOVER	40	480
264	W-9040	Cuttings	27.82293	-82.24257	LITHIA	80	425
265	W-9041	Cuttings	27.82457	-82.14990	LITHIA	100	610
266	W-9043	Cuttings	27.89028	-82.10031	NICHOLS	90	560
267	W-9081	Cuttings	27.55157	-82.01060	DUETTE	115	1030
268	W-9220	Cuttings	27.73699	-82.00204	DUETTE NE	132	715
269	W-9222	Cuttings	27.87045	-82.02045	KEYSVILLE	121	345
270	W-9280	Cuttings	27.59250	-82.11444	DUETTE	125	989
271	W-9282	Cuttings	27.53333	-82.08334	DUETTE	113	850
272	W-9283	Cuttings	27.64437	-82.11577	DUETTE NE	126	1027
273	W-10382	Cuttings	27.55606	-82.40297	PARRISH	31	265
274	W-10410	Core	27.97779	-82.75883	CLEARWATER	70	77
275	W-10411	Core	27.98448	-82.70673	SAFETY HARBOR	18	62
276	W-10497	Cuttings	27.69917	-82.16250	FORT LONESOME	105	222
277	W-10556	Cuttings	27.55585	-82.41666	PARRISH	35	100
278	W-10563	Cuttings	27.60695	-82.27639	RYE	110	1025
279	W-10575	Cuttings	27.98197	-82.34763	BRANDON	35	250
280	W-10628	Cuttings	27.66747	-82.36172	WIMAUMA	30	470
281	W-10684	Cuttings	27.98706	-82.31699	BRANDON	46	96
282	W-10725	Cuttings	27.89448	-82.23067	DOVER	50	150
283	W-10741	Cuttings	27.97499	-82.25068	BRANDON	54	470
284	W-10900	Cuttings	27.93473	-82.22800	DOVER	75	280
285	W-10951	Cuttings	27.95966	-82.03113	NICHOLS	117	150
286	W-10990	Cuttings	27.85750	-82.03111	KEYSVILLE	130	1208
287	W-11011	Cuttings	27.54354	-82.46109	PARRISH	35	255
288	W-11019	Cuttings	27.62365	-82.52787	PALMETTO	16	150
289	W-11026	Cuttings	27.54289	-82.47736	PARRISH	30	167
290	W-11029	Cuttings	27.52120	-82.51438	PALMETTO	5	185
291	W-11119	Cuttings	27.96141	-82.73344	SAFETY HARBOR	60	240
292	W-11196	Cuttings	27.72177	-82.38525	RUSKIN	45	210
293	W-11240	Cuttings	27.62747	-82.53824	COCKROACH BAY	10	850
294	W-11275	Cuttings	27.59276	-82.54145	PALMETTO	17	200
295	W-11278	Cuttings	27.63782	-82.44102	RUSKIN	30	75
296	W-11338	Cuttings	27.98529	-82.34953	BRANDON	31	332
297	W-11432	Cuttings	27.91836	-82.29787	BRANDON	44	351
298	W-11488	Cuttings	27.97954	-82.39521	TAMPA	49	140
299	W-11509	Cuttings	27.98326	-82.38425	TAMPA	35	180
300	W-11531	Core	27.92808	-82.28620	BRANDON	39	160
301	W-11612	Cuttings	27.90947	-82.01382	NICHOLS	100	106
302	W-11615	Cuttings	27.94582	-82.03112	NICHOLS	120	365
303	W-11706	Cuttings	27.53391	-82.61322	PALMETTO	0	50
304	W-11708	Cuttings	27.52037	-82.37611	PARRISH	10	175
305	W-11710	Cuttings	27.50761	-82.36559	RYE	11	110
306	W-11712	Cuttings	27.54989	-82.47475	PARRISH	32	445
307	W-11749	Cuttings	27.57964	-82.56913	PALMETTO	5	330
308	W-11780	Cuttings	27.75582	-82.31055	RIVERVIEW	72	500
309	W-11956	Cuttings	27.68601	-82.49287	RUSKIN	5	354
310	W-12144	Cuttings	27.50381	-82.64529	ANNA MARIA	7	115
311	W-12198	Cuttings	27.70084	-82.46122	RUSKIN	13	206

Map ID	Well Label	Sample Type	Latitude	Longitude	24K Quad	Elevation (ft.)	Total Depth (ft.)
312	W-12201	Cuttings	27.82825	-82.76238	SEMINOLE	7	170
313	W-12205	Cuttings	27.85200	-82.14581	LITHIA	107	133
314	W-12207	Cuttings	27.82890	-82.73808	SAINT PETERSBURG	13	180
315	W-12252	Cuttings	27.66765	-82.44347	RUSKIN	20	425
316	W-12285	Cuttings	27.89700	-82.76115	CLEARWATER	19	170
317	W-12288	Cuttings	27.51218	-82.68291	ANNA MARIA	0	410
318	W-12298	Cuttings	27.71388	-82.33662	WIMAUMA	65	270
319	W-12299	Cuttings	27.68752	-82.47029	RUSKIN	22	220
320	W-12327	Cuttings	27.64311	-82.14192	FORT LONESOME	130	830
321	W-12330	Cuttings	27.57615	-82.19120	KEENTOWN	112	1030
322	W-12568	Cuttings	27.86493	-82.22794	LITHIA	40	192
323	W-12627	Cuttings	27.68443	-82.45874	RUSKIN	20	400
324	W-12744	Cuttings	27.84948	-82.17409	LITHIA	106	130
325	W-12784	Cuttings	27.63798	-82.34251	WIMAUMA	50	500
326	W-12833	Cuttings	27.71356	-82.31473	WIMAUMA	95	270
327	W-13098	Cuttings	27.89391	-82.28675	BRANDON	30	380
328	W-13099	Cuttings	27.74278	-82.33778	WIMAUMA	52	500
329	W-13100	Cuttings	27.88750	-82.26722	BRANDON	55	750
330	W-13101	Cuttings	27.72110	-82.33746	WIMAUMA	66	500
331	W-13179	Cuttings	27.91545	-82.39829	TAMPA	8	152
332	W-13183	Cuttings	27.99374	-82.20766	DOVER	124	300
333	W-13191	Cuttings	27.91275	-82.02381	NICHOLS	100	480
334	W-13285	Cuttings	27.56305	-82.27749	RYE	98	825
335	W-13288	Cuttings	27.79891	-82.27688	RIVERVIEW	90	400
336	W-13331	Cuttings	27.72078	-82.06937	DUETTE NE	105	165
337	W-13333	Core	27.51667	-82.00139	DUETTE	110	198
338	W-13337	Cuttings	27.68692	-82.32835	WIMAUMA	57	300
339	W-13354	Cuttings	27.59417	-82.53333	PALMETTO	30	56
340	W-13413	Cuttings	27.56969	-82.37724	PARRISH	25	300
341	W-13442	Cuttings	27.71670	-82.68179	PASS-A-GRILLE BEACH	5	650
342	W-13443	Cuttings	27.71742	-82.68230	PASS-A-GRILLE BEACH	5	1120
343	W-13499	Cuttings	27.53272	-82.52801	PALMETTO	20	110
344	W-13510	Cuttings	27.75583	-82.06416	KEYSVILLE	100	910
345	W-13556	Cuttings	27.82684	-82.61710	PORT TAMPA	4	150
346	W-13571	Cuttings	27.96030	-82.27203	BRANDON	75	370
347	W-13580	Cuttings	27.95271	-82.11510	NICHOLS	120	247
348	W-13610	Cuttings	27.82843	-82.61959	PORT TAMPA	5	1211
349	W-13636	Core	27.78238	-82.16875	LITHIA	119	21
350	W-13637	Core	27.99422	-82.08659	NICHOLS	142	20
351	W-13644	Core	27.92461	-82.16428	DOVER	66	20
352	W-13652	Core	27.79000	-82.00000	BRADLEY JUNCTION	120	20
353	W-13662	Core	27.78805	-82.20773	LITHIA	94	21
354	W-13667	Core	27.92826	-82.20028	DOVER	57	20
355	W-13669	Core	27.78154	-82.21445	LITHIA	101	20
356	W-13838	Cuttings	27.90868	-82.16113	DOVER	70	1000
357	W-13935	Cuttings	27.71893	-82.40589	RUSKIN	24	170
358	W-13960	Cuttings	27.62374	-82.50761	PALMETTO	33	640
359	W-13969	Cuttings	27.79651	-82.33621	RIVERVIEW	55	125
360	W-14055	Cuttings	27.62465	-82.15334	KEENTOWN	125	250
361	W-14061	Cuttings	27.92661	-82.24072	DOVER	105	500
362	W-14064	Cuttings	27.91549	-82.24445	DOVER	90	430
363	W-14076	Cuttings	27.71383	-82.29812	WIMAUMA	102	195
364	W-14113	Cuttings	27.95534	-82.33335	BRANDON	39	100
365	W-14171	Cuttings	27.93957	-82.23840	DOVER	52	160
366	W-14191	Cuttings	27.94282	-82.17651	DOVER	80	194
367	W-14273	Cuttings	27.94791	-82.25644	BRANDON	55	462
368	W-14274	Cuttings	27.97002	-82.27093	BRANDON	67	355
369	W-14275	Cuttings	27.91092	-82.27341	BRANDON	68	335
370	W-14305	Cuttings	27.99501	-82.33275	BRANDON	54	105
371	W-14335	Cuttings	27.96017	-82.70485	SAFETY HARBOR	0	1332
372	W-14567	Cuttings	27.63059	-82.52763	COCKROACH BAY	20	160
373	W-14571	Cuttings	27.58078	-82.19038	KEENTOWN	108	670
374	W-14663	Cuttings	27.93658	-82.00601	NICHOLS	120	760
375	W-14668	Cuttings	27.95172	-82.36996	BRANDON	3	589

Map ID	Well Label	Sample Type	Latitude	Longitude	24K Quad	Elevation (ft.)	Total Depth (ft.)
376	W-14739	Cuttings	27.87171	-82.14568	LITHIA	36	400
377	W-14779	Cuttings	27.84331	-82.75373	SEMINOLE	10	560
378	W-14831	Cuttings	27.71538	-82.14114	FORT LONESOME	0	520
379	W-14843	Cuttings	27.65269	-82.04491	DUETTE NE	135	410
380	W-14845	Cuttings	27.84320	-82.75374	SEMINOLE	10	1090
381	W-14847	Cuttings	27.68222	-82.01417	DUETTE NE	130	180
382	W-14888	Cuttings	27.76308	-82.25370	RIVERVIEW	145	620
383	W-14896	Cuttings	27.87919	-82.84344	CLEARWATER	11	1000
384	W-14899	Cuttings	27.65650	-82.09428	DUETTE NE	132	80
385	W-14902	Cuttings	27.65345	-82.09563	DUETTE NE	140	1140
386	W-14905	Cuttings	27.64965	-82.09399	DUETTE NE	132	1240
387	W-14999	Cuttings	27.92299	-82.36301	BRANDON	20	315
388	W-15007	Cuttings	27.93773	-82.24458	DOVER	40	820
389	W-15104	Cuttings	27.89227	-82.81992	CLEARWATER	34	901
390	W-15156	Cuttings	27.93008	-82.16222	DOVER	66	865
391	W-15161	Core	27.95014	-82.38490	TAMPA	2	598.5
392	W-15280	Cuttings	27.64750	-82.46639	RUSKIN	20	1060
393	W-15283	Cuttings	27.64756	-82.45947	RUSKIN	23	205
394	W-15328	Cuttings	27.97028	-82.21472	DOVER	80	648
395	W-15381	Cuttings	27.99542	-82.75259	CLEARWATER	65	240
396	W-15384	Cuttings	27.99630	-82.72642	SAFETY HARBOR	70	275
397	W-15386	Cuttings	27.97709	-82.74825	SAFETY HARBOR	65	200
398	W-15388	Cuttings	27.96981	-82.74866	SAFETY HARBOR	70	220
399	W-15517	Core	27.51009	-82.25981	RYE	93	150
400	W-15518	Core	27.53223	-82.22362	KEENTOWN	122	193
401	W-15642	Cuttings	27.74103	-82.42284	RUSKIN	5	785
402	W-15677	Core	27.50055	-82.45277	PARRISH	15	100
403	W-15679	Core	27.50055	-82.45277	PARRISH	15	31
404	W-16004	Cuttings	27.85389	-82.21528	LITHIA	66	1200
405	W-16197	Core	27.90901	-82.72035	SAFETY HARBOR	15	677.5
406	W-16260	Core	27.60056	-82.52701	PALMETTO	35	150
407	W-16268	Core	27.71111	-82.26167	WIMAUMA	80	101.5
408	W-16271	Core	27.60028	-82.29807	RYE	72	100
409	W-16429	Cuttings	27.89076	-82.67585	SAFETY HARBOR	5	35
410	W-16431	Cuttings	27.88278	-82.71389	SAFETY HARBOR	3	25
411	W-16432	Cuttings	27.87449	-82.70383	SAINT PETERSBURG	11	25
412	W-16433	Cuttings	27.86826	-82.73455	SAINT PETERSBURG	11	0
413	W-16466	Cuttings	27.99722	-82.51500	GANDY BRIDGE	26	60
414	W-16576	Core	27.99055	-82.20944	DOVER	110	839
415	W-16577	Core	27.96639	-82.14833	DOVER	105	299
416	W-16838	Core	27.59365	-82.42639	PARRISH	40	38
417	W-17063	Cuttings	27.63778	-82.32714	WIMAUMA	33	700
418	W-17073	Cuttings	27.82500	-82.74361	SAINT PETERSBURG	3	550
419	W-17084	Cuttings	27.77194	-82.71445	SAINT PETERSBURG	17	3200
420	W-17555	Cuttings	27.76444	-82.36806	RIVERVIEW	44	885
421	W-17578	Core	27.87944	-82.80611	CLEARWATER	54	545
422	W-17579	Cuttings	27.77833	-82.40556	GIBSONTON	3	800
423	W-17599	Core	27.64417	-82.73917	PASS-A-GRILLE BEACH	3	48
424	W-17602	Core	27.68333	-82.73805	PASS-A-GRILLE BEACH	3	62
425	W-17979	Core	27.87528	-82.74861	SAFETY HARBOR	19	138
426	W-19231	Core	27.88711	-82.06303	NICHOLS	112	320
427	W-19233	Core	27.88714	-82.07130	NICHOLS	83	320
428	W-19258	Cuttings	27.54082	-82.07368	DUETTE	110	55
429	W-19327	Cuttings	27.64341	-82.54549	COCKROACH BAY	5	1600
430	W-19660	Core	27.74742	-82.12048	DUETTE NE	103	320