

APPENDIX 10.7

MONITORING PROGRAMS

APPENDIX 10.7.1

CULTURAL RESOURCES ASSESSMENT SURVEY

Cultural Resource Assessment Survey of the Duke Energy 2018 CC Parcel Citrus County, Florida



July 2014



Cultural Resource Assessment Survey of the Duke Energy 2018 CC Parcel, Citrus County, Florida

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EXECUTIVE SUMMARY

SEARCH conducted a Cultural Resource Assessment Survey (CRAS) in May 2014 of the approximately 643-acre Duke Energy 2018 CC Parcel in northwest Citrus County, Florida. The tract is owned by Duke Energy Florida (DEF), which requested the CRAS in anticipation of permitting requirements associated with proposed construction activities in the Crystal River Energy Complex (CREC). This study was conducted to comply with Chapters 267 of Florida Statutes and Rule Chapter 1A-46, Florida Administrative Code. All work was performed in accordance with the Florida Division of Historical Resources (FDHR) recommendations for such projects as stipulated in *Cultural Resource Management Standards & Operations Manual, Module Three: Guidelines for Use by Historic Preservation Professionals* (FDHR 2012). The Principal Investigator for the project meets the Secretary of the Interior's *Standards and Guidelines for Archaeology and Historic Preservation* (48 FR 44716-42). This study also complies with Section 106 of the National Historic Preservation Act (as amended) and its implementing regulation 36 CFR Part 800 (Protection of Historic Properties).

The project objectives were to identify and define any cultural resources within the 643-acre project area and assess their eligibility for listing in the National Register of Historic Places (NRHP). Prior to fieldwork, the Florida Master Site File (FMSF) database was consulted for previously identified resources in the project tract and surrounding area. The archaeological survey consisted of a pedestrian walk-over and shovel testing. Shovel tests were excavated at 100-m intervals across 94 percent (603 acres) of the parcel, which was considered to have low archaeological potential. The remaining 6 percent (40 acres) of the property consists of portions of the CREC with extensive paving, underground utilities, and disturbance; this area was untestable and has no potential to contain intact archaeological deposits. Shovel tests measured 50 x 50 cm and were excavated to depths exceeding 100 centimeters below surface (cmbs), subsurface conditions permitting. Soils were screened through ¼-inch mesh hardware cloth. A total of 230 shovel tests were excavated during the course of the project. The architectural survey consisted of a review of historic maps and aerial photographs to identify structures older than 50 years on the project tract, followed by a pedestrian survey. Two cultural resources were identified during the study, 8CI01455 and 8CI01456. Linear resource 8CI01455 is a segment of the twentieth-century Seaboard Coast Line Railroad, and archaeological site 8CI01456 is small, low-density lithic scatter. Assessment indicates that neither resource meets the criteria for inclusion on the NRHP, as established in 36 CFR, Part 60.4 (NHPA).

Based on the results of this survey, it is the opinion of the Principal Investigator that the project will have no effect on cultural resources eligible for listing on the NRHP. SEARCH recommends that plans for the Duke Energy 2018 CC Parcel proceed without further consideration for cultural resources. If unanticipated discoveries are found during development of the project area subsequent to this report, including in the 40 acres of untestable area, they should be treated in accordance with the Unanticipated Discoveries Statement provided in **Appendix A**.

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CHAPTER 1

INTRODUCTION

This report presents the findings of a cultural resource assessment survey (CRAS) of the approximately 643-acre Duke Energy Florida (DEF) 2018 CC Parcel in northwest Citrus County, Florida (**Figure 1.1**). The CRAS was completed by SEARCH at the request of DEF as Due Diligence in anticipation of permitting requirements associated with proposed construction activities in the Crystal River Energy Complex (CREC).

SEARCH conducted the field survey from May 20 through May 29, 2014. The survey was supervised by a professional archaeologist who meets the Secretary of the Interior's Standards and Guidelines (48 FR 44716-42). Michael Arbuthnot, MS, RPA, served as Principal Investigator, and fieldwork was conducted by Blue Nelson, Kyle Lent, and Jacob Woosley. This study was conducted to comply with Chapters 267 of Florida Statutes and Rule Chapter 1A-46, Florida Administrative Code. All work was performed in accordance with the Florida Division of Historical Resources (FDHR) recommendations for such projects as stipulated in *Cultural Resource Management Standards & Operations Manual, Module Three: Guidelines for Use by Historic Preservation Professionals* (FDHR 2012). This study also complies with Section 106 of the National Historic Preservation Act (as amended) and its implementing regulation 36 CFR Part 800 (Protection of Historic Properties).

The goals of the CRAS were to locate and define any archaeological sites or historic resources within the project area and to assess their eligibility for listing in the National Register of Historic Places (NRHP). The architectural survey consisted of a review of historic maps and aerial photographs to identify structures older than 50 years on the subject parcel, followed by a pedestrian survey. One newly recorded historic linear resource, the Seaboard Coast Line Railroad (8CI01455), was identified and evaluated. The archaeological investigation excavated a total of 230 shovel tests during the course of the project. One prehistoric archaeological site (8CI01456) was identified in the project tract. Neither resource meets the criteria for inclusion in the NRHP, as established in 36 CFR, Part 60.4 (NHPA).

It is the opinion of SEARCH that no further work is required on the 643-acre tract examined herein. Any unanticipated discoveries found subsequent to this report should be treated in accordance with the Unanticipated Discoveries Statement provided in **Appendix A**.

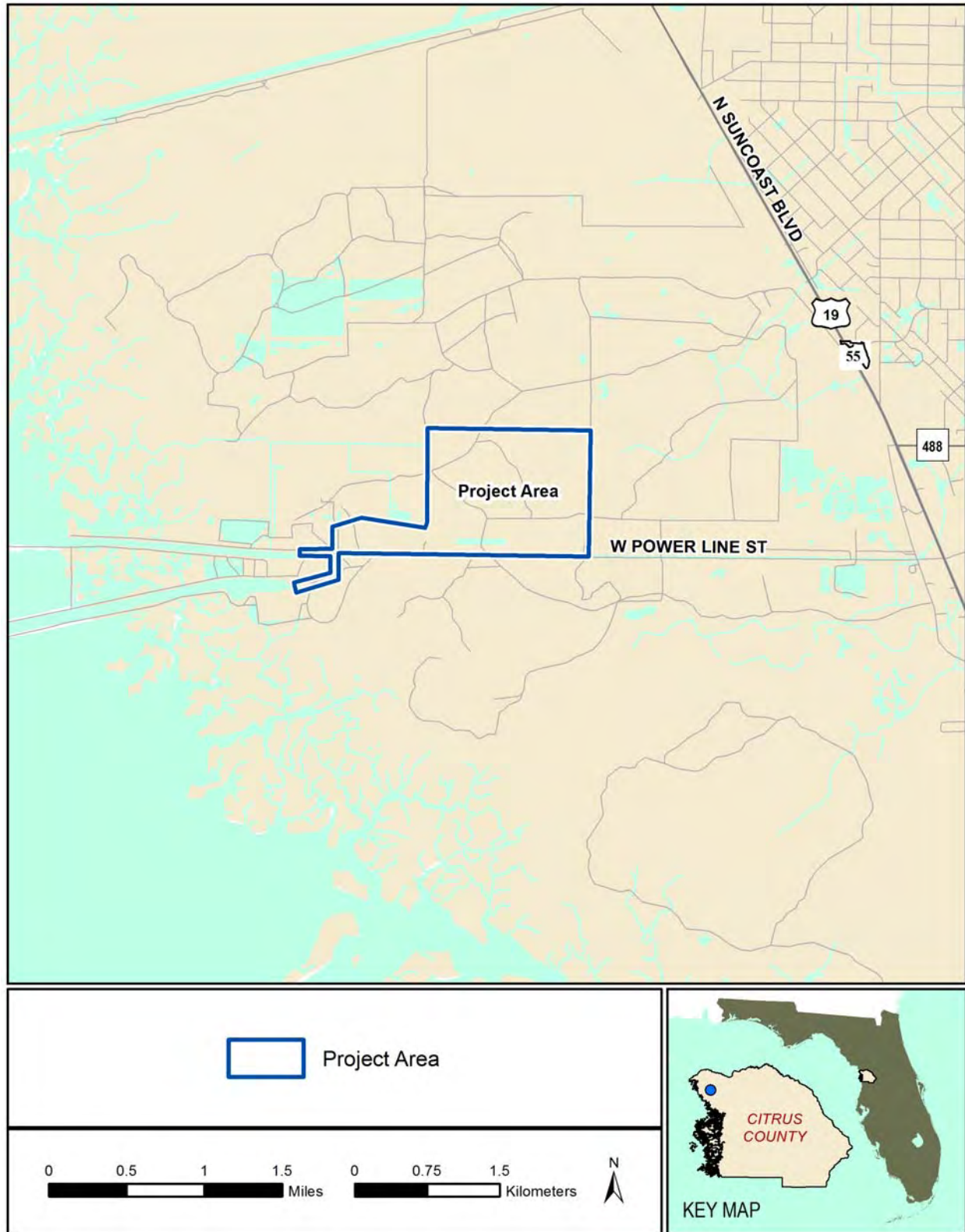


Figure 1.1. Location map showing the DEF 2018 CC project area in Citrus County, Florida.

CHAPTER 2

PROJECT LOCATION AND ENVIRONMENT

The Duke Energy 2018 CC survey area is approximately 643 acres in size and is located in Sections 27, 28, 33, and 34 of Township 17 South, Range 16 East in northwestern Citrus County (**Figure 2.1**). The project area comprises lands within the CREC (249 acres, south side) and the Holcim (394 acres, north side) properties. It is located approximately 6 miles east of the Gulf of Mexico, 2.5 miles south of the Cross Florida Barge Canal, 2 miles west of US 19, and about 5 miles north of the City of Crystal River. West Powerline Street forms the property's southern boundary.

MODERN ENVIRONMENT

The environment associated with the tract is flatwoods, coastal swamps, and industrial. Land use in proximity to the project area consists of mining, silviculture, agriculture, and conservation. Residential settlement in the surrounding region consists of very low-density and dispersed single-family homes and farmsteads. The only residential development in the immediate vicinity is Crystal Manor, which is located on the east side of US 19. The majority of the project area is within the Holcim mine property, and an active mine is located immediately to the northwest; however, the east-west roadway and transmission lines in the south, as well as the developed portions of the CREC in the southwest, are owned by DEF.

The project area is located in the Swamps and Flats province of the Ocala Uplift District physiographic region (Brooks 1981). Soils within the Holcim and CREC properties are consistent with coastal settings in this region. The topography is generally flat and ranges from 6 ft above mean sea level (amsl) to 10 ft amsl. The majority of the land consists of poorly drained soils comprising Boca, Boca-Pineda, and Hallandale rock outcrop complex (**Table 2.1**). These soils are nearly level and underlain by a limestone substratum (**Figure 2.2**).

Table 2.1 Soil Types Occurring within the Project Area.

Soil type	Drainage	Total Acres	% of Project Area
Boca-Pineda, limestone substratum complex	Poorly drained	155.81	24.2
Boca fine sand	Poorly drained	351.50	54.7
Boca fine sand, depressional	Very poorly drained	23.87	3.7
Broward fine sand	Somewhat poorly drained	0.94	0.1
Hallandale-Rock outcrop complex, rarely flooded	Poorly drained	74.65	11.6
Quartzipsaments, 0 to 5 percent slopes	Well drained	35.06	0.5
Water	Water	0.32	0.1
Waters of the Gulf of Mexico	Water	0.86	0.1
Total:		643.01	100.00

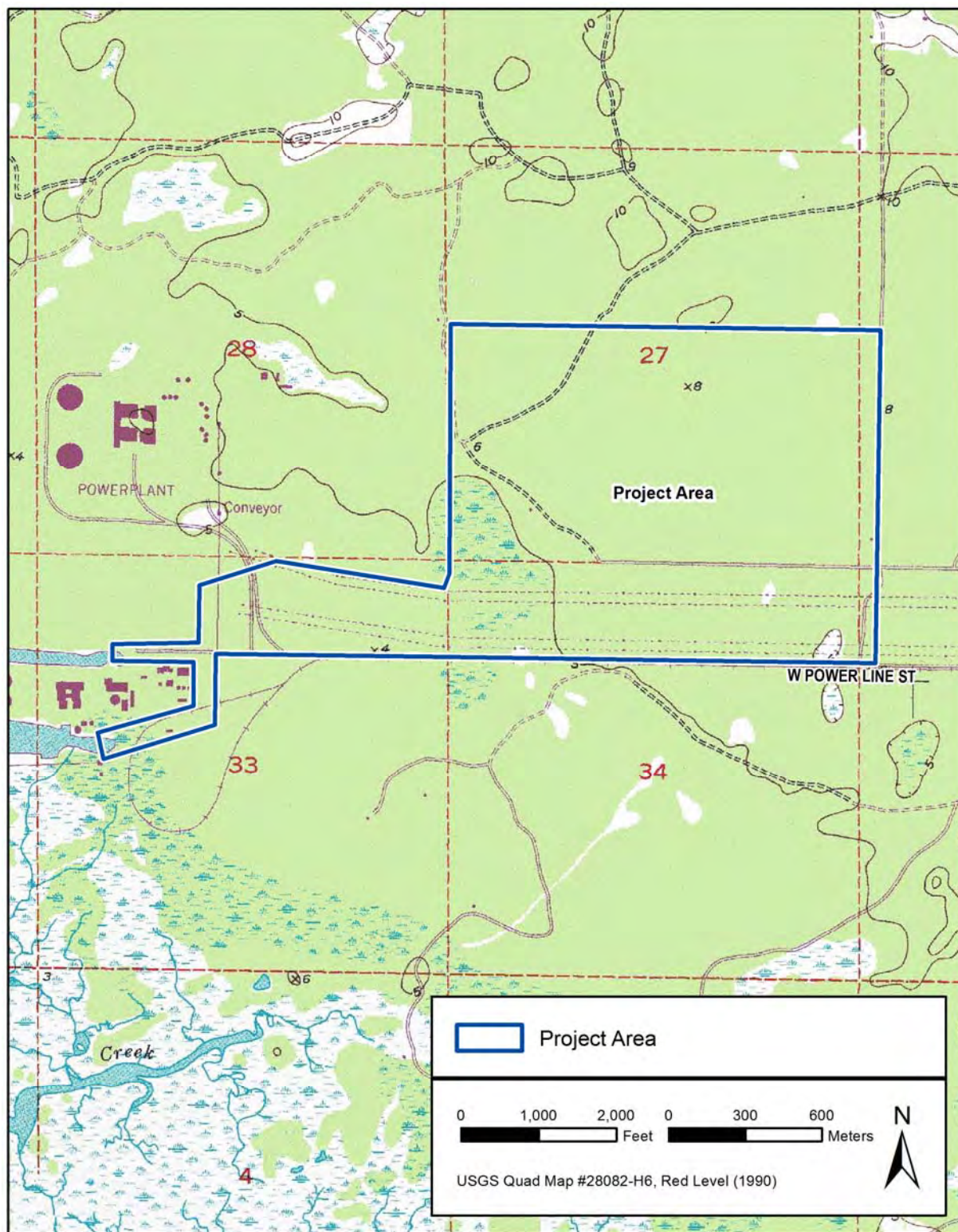


Figure 2.1. Topographic map showing the DEF 2018 CC project area.

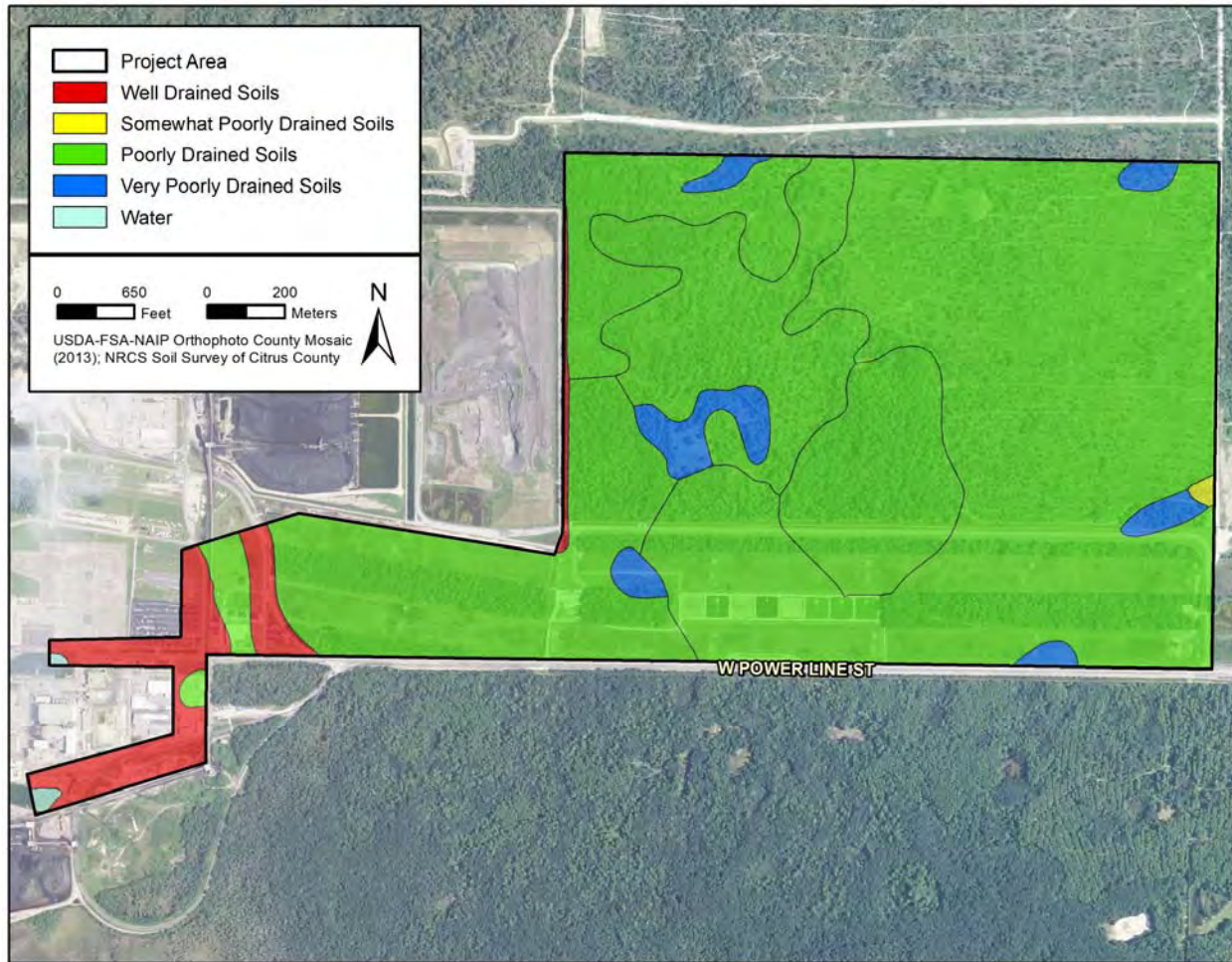


Figure 2.2 Soil drainage characteristics within the DEF 2018 CC project area.

Much of the property has been modified by land-clearing activities. Undisturbed land within the project tract includes discrete areas comprised of native flatwoods (pine, palmetto) vegetation. The tract also includes multiple wetlands containing cypress, bay, and sweet gum, which appear to be largely unmodified. The understory varies and is characterized by scrub palmetto in the dryer portions of the project area and gallberry in the wetter zones. Limestone formations are visible on the surface in several areas. **Figures 2.3 through 2.6** depict representative views of current vegetation and activities within the project area.



Figure 2.3 North view of field and live oaks in the central portion of the DEF 2018 CC project area from ST 33.



Figure 2.4. East view of the vegetation in southwest portion of the DEF 2018 CC project area from ST 22.



Figure 2.5. Rock outcrop in the central portion of the DEF 2018 CC project area at ST 108.



Figure 2.6. Activities within the transmission line on the DEF 2018 CC project area.

PALEOENVIRONMENT

Between 16,000 and 10,000 BC, Florida was a much cooler and drier place than it is today. Melting of the continental ice sheets led to a major global rise in sea level (summarized for long time scales by Rohling et al. 1998) that started from a low stand of -120 m at 16,000 BC. The rise was slow while glacial conditions prevailed at high latitudes but became very rapid in the latest Pleistocene and earliest Holocene. It became warmer and wetter rather rapidly during the next three millennia. By about 7000 BC, a warmer and drier climate began to prevail. These changes were more drastic in northern Florida and southern Georgia than in southern Florida, where the “peninsular effect” and a more tropically influenced climate tempered the effects of the continental glaciers that were melting far to the north (Watts 1969, 1971, 1975, 1980). Sea levels, though higher, were still much lower than at present; surface water was limited, and extensive grasslands probably existed, which may have attracted mammoth, bison, and other large grazing mammals. By 4000–3000 BC, the climate had changed to one of increased precipitation and surface water flow. By the late Holocene, ca. 2000 BC, the climate, water levels, and plant communities of Florida attained essentially modern conditions. These have been relatively stable with only minor fluctuations over the past 4,000 years.

CHAPTER 3 HISTORIC OVERVIEW

This historical overview presents a summary of the peopling of Florida from 12,000 BP until the present, with special emphasis on the native cultures and historic activities along the North Peninsular Gulf Coast of Florida.

NATIVE AMERICAN CULTURE HISTORY

The following overview of the Native American culture history of the North Peninsular Gulf Coast region of Florida consists of a three-part chronology, with each period based on distinct cultural and technological characteristics recognized by archaeologists. From oldest to most recent, the three major temporal periods include Paleoindian, Archaic, and Ceramic. These periods, along with their regional subperiods, are presented in **Table 3.1**.

Paleoindian (10,000–8000 BC)

The most widely accepted model for the peopling of the New World argues that Asian populations migrated to North America over the Bering land bridge that formerly linked Siberia and Alaska, some 12,000 years ago. However, data are mounting in support of migrations that date to before 12,000 years ago. Regardless of the precise timing of the first occupation of the New World, it does not appear that Florida was inhabited by humans prior to about 12,000 years ago. The earliest radiocarbon dates that are firmly associated with human artifacts come from the Sloth Hole site in Jefferson County (Hemmings 2004) and indicate that Paleoindian people were in Florida by at least 11,000 BP, while at the Page-Ladson site modified bones of extinct mammals have been dated to about 12,000 years ago Paleoindian (Webb and Dunbar 2006).

Table 3.1. Native American Cultural Chronology for the North Peninsular Gulf Coast Region.

Period	Calendrical Dates
Paleoindian	10,000–8000 BC
Archaic	
Early Archaic	8000–6000 BC
Middle Archaic	6000–2000 BC
Late Archaic (Orange)	2000–500 BC
Ceramic	
Deptford	500 BC–AD 400
Weeden Island	AD 400–750
Suwannee Valley	AD 750–1565

The conventional view of Paleoindian existence in Florida is that they were nomadic hunters and gatherers who wandered an environment quite different than that of the present. Excavations at the Harney Flats site in Hillsborough County (Daniel and Wisenbaker 1987) have altered this view, and many archaeologists now believe that Paleoindian people lived part of the year in habitation sites that were located near critical resources. Because the climate during the Paleoindian period was cooler and drier than at present, with coastal sea levels and

the inland water table much lower than at present (Carbone 1983; Watts and Hansen 1988; Watts et al. 1996), many archaeologists believe that the scarcity of potable water sources played a crucial role in the distribution of Paleoindian bands across the landscape. They hypothesize that human groups frequented sinkholes and springs to collect water and exploit the flora and fauna that were also attracted to these locations (Dunbar 1991; Milanich 1994; Webb et al. 1984). Many of these freshwater sources were located in areas of exposed Tertiary-age limestone that had become silicified, providing Paleoindians with a raw material source (chert) for tool manufacture. Thus, it is thought that permanent freshwater sources (sinkholes, springs), along with outcrops of high-quality chert, were primary factors influencing Paleoindian settlement patterns in Florida. North-central Florida is rich in freshwater sources and chert outcrops, and evidence of Paleoindian occupations in this region is extensive. Dunbar and Waller (1983) identify several areas within north Florida as having an abundance of Paleoindian projectile point finds, including the Withlacoochee River basin. In addition, many sites are probably now submerged in the Gulf due to rising sea levels since the late Pleistocene (Faught 2004).

Archaic Period (8000–500 BC)

Around 8000 BC, the environment and landscape of Florida underwent pronounced changes due to climatic amelioration. These changes were interconnected and included a gradual warming trend, a rise in sea level, a reduction in the width of peninsular Florida, and the spread of oak-dominated forests and hammocks throughout much of Florida (Milanich 1994; Smith 1986). Concomitant with these environmental changes was the extinction of the Pleistocene fauna and therefore alterations in native subsistence strategies. These became more diverse due to the emergence of new plant, animal, and aquatic species. Also occurring at this time was a significant increase in population numbers and density, with native groups developing regional habitat-specific adaptations and material assemblages (Milanich 1994; Smith 1986:10). As conditions became wetter, coastal, riparian, and lacustrine adaptations became increasingly more common. This Archaic period is typically divided into Early, Middle, and Late subperiods by archaeologists.

Within north-central Florida, evidence of the earliest Archaic occupations usually consists of lithic scatters containing chert debitage and occasionally projectile points. Early Archaic Arredondo, Hamilton, and Kirk (Bullen 1975) projectile points have been recovered at sites in north Florida. However, much of the data on the Early Archaic period come from surface-collected materials. Habitations from this period were placed next to water sources, including Paynes Prairie in Alachua County and Orange Lake in Marion County.

During the Middle Archaic period, an array of site types evolved that included residential bases, short-term settlements, specialized procurement camps, quarries, and cemeteries (Milanich 1994:75–85). Middle Archaic occupations are most common in the inland river valleys of Florida. One of the largest known Middle Archaic sites is situated on the high ground between Newnans Lake and Paynes Prairie (8AL00356) in Alachua County (Clausen 1964). This site was a

central base settlement, but many Middle Archaic sites are small, seasonally occupied hunting and fishing camps (Hemmings and Kohler 1974). The distinctive, stemmed Middle Archaic projectile points, such as Marion, Putnam, Alachua, Hillsborough, and Newnan, are very common in nearby Alachua and Marion County (Bullen 1975). Large chopping tools and heat-treated lithics also appeared at this time (Bullen 1958; Ste. Claire 1987).

Occupation of coastal estuaries became more common after 3000 BC, possibly due to a decrease in the rate of sea level rise. The trend toward increased sedentism and more circumscribed territories continued into the Late Archaic period, as environmental and climatic conditions approached those of today (Watts and Hansen 1988). Coastal and riverine locales were sought out by Late Archaic groups, perhaps because they were able to provide a greater quantity of dependable aquatic foods to the growing populations of this time (Milanich 1994:87). Late Archaic sites are most common on the northeast coast and the inland waterways, the coast of southwest Florida, and along the St. Johns River (Milanich 1994:85).

A major technological innovation of the Late Archaic was the development of fired-clay pottery around 2000 BC. Referred to as Orange pottery by archaeologists, this early ceramic ware was tempered with vegetal fibers, either thin strands of palmetto or Spanish moss (Sassaman 1993). During a span of approximately 1,500 years, a variety of plain, incised, and punctated types were produced. With regard to vessel form, early pots were hand-molded and tended to be thick-walled, whereas some of the later vessels were thinner and formed by coiling. Fiber-tempered pottery may have been introduced into north-central Florida from the people of the St. Johns region (Clausen 1964).

Ceramic Period (500 BC–AD 1565)

Deptford Culture

Milanich and Fairbanks (1980:66) describe the Deptford people as primarily a “coastal dwelling culture” that relied heavily on maritime subsistence strategies. Deptford culture flourished between ca. 500 BC and AD 500. Many Deptford sites include large linear shell middens that contain plain pottery or ceramics with checked patterns stamped on the exterior of the pot (Milanich and Fairbanks 1980). These exterior patterns were produced by impressing or stamping the vessel with carved wooden paddles before firing. These paddled designs have been incorporated into the names of the wares by archaeologists; Deptford Checked Stamped is an example. The Deptford period is also marked by the gradual change from fiber tempering to sand and grit tempering. Besides check-stamped, surface treatments can be plain, cord-wrapped, brushed, punctated, or malleated. Lithic tools are extremely rare in Deptford sites, with only small triangular points occurring in small numbers.

Deptford sites are found from near Savannah, Georgia to as far south as Levy County on the west coast of Florida and near Jacksonville on the east coast. Although the majority of Deptford sites are located on the coast, inland sites have been recorded in the interior forests and along rivers. Deptford sites are poorly represented in north-central Florida, but these coastal people

apparently were coming inland to procure seasonal resources and a supply of chert. The sites are primarily short-term occupations by small groups, probably traveling the inland waterways in search of nuts, berries, and other terrestrial resources (wood, game, stone to make tools, etc.). These sites are often found along lakes and streams where hickory and oak are present.

Weeden Island Cultures

The emergence of Weeden Island cultural attributes in north-central Florida and the panhandle of Florida began at about AD 400. Early Weeden Island is characterized by the appearance of complicated-stamped pottery along with pottery decorated with incised and punctated lines. Weeden Island and related ceramics appear up until about AD 1200, particularly in burial mounds. It is not clear exactly what ceramic traditions followed Weeden Island in this area, but possibly some extension of them does exist. Much of the cultural change that occurred from the earlier Orange period through the Deptford to later more elaborate Weeden Island cultures was due to their location between the Woodland cultures of the north and the south Florida populations. Their geographic position allowed them to act as “middle men,” as described by Milanich, and reap the benefits of being involved in trade between these two groups (Milanich and Fairbanks 1980). The large Crystal River mound complex was in use as a possible aggregation and ceremonial center during the Weeden Island period (Pluckhahn et al. 2010; Weisman 1995).

Suwannee Valley Culture

The Suwannee Valley culture developed out of the prior Weeden Island culture and is contemporaneous with the Wakulla culture in northwest Florida and the Alachua culture in north-central Florida (Milanich 1994). The change is noticeable in the archaeological record at about AD 750 and may have been related to increased agricultural production and possibly the inclusion of maize in the diet, although there is no hard evidence for maize until later in prehistory. Ken Johnson and Bruce Nelson conducted several surveys in north Florida in which several hundred sites dating after AD 750 were identified (Johnson 1986, 1987; Johnson and Nelson 1990). Most of the sites were found during surface survey, as little subsurface testing was conducted; thus, the full range of earlier occupations of the sites is not well understood. Johnson and Nelson found that the settlement patterns had shifted from the clustered village pattern of the Weeden Island period to more numerous smaller sites located in previously unsettled locations. Suwannee Valley villages appear to be less nucleated and actually more like hamlets and special-use sites (Johnson 1991; Johnson and Nelson 1990).

John Worth has studied the pottery associated with the Suwannee Valley culture, which he defined during a revision of the aboriginal ceramic typology for north Florida (Worth 1992). The Suwannee Valley series is distinguished from other pottery that occurs in north Florida (Lamar, Jefferson, Goggin, St. Johns, Pasco, and Fort Walton series pottery types) based on the temper and surface decoration (Worth 1992). Suwannee Valley ceramics are unique in their simple design and utilitarian nature, which is quite a contrast to the pottery of the earlier Weeden Island and contemporaneous Mississippian groups. Suwannee Valley ceramics are sand and grit tempered and decorated over the entire surface of the vessel. Most vessels are in the form of jars and bowls

with varying types of rims. The pottery types associated with the Suwannee Valley culture are Fig Springs Roughened (varieties Ichetucknee and Santa Fe), Fig Springs Incised, Trestle Point Shell Impressed, Grassy Hole Pinched, Alachua Cob Marked, Prairie Cord Marked, Lochloosa Punctated, and Alachua Plain (Milanich 1994; Worth 1992).

The types of stone tools made by the people of the Suwannee Valley cultures have not been adequately defined. However, the bow and arrow was in use by this time, and small Pinellas, Ichetucknee, and Tampa arrow points are common in late prehistoric-period sites (Bullen 1975). The ceramics of the Suwannee Valley culture changed little between AD 750 and 1500. The Suwannee Valley culture seems to have developed without influence or interference from the Mississippian cultures to the north. The descendants of the Suwannee Valley culture still inhabited north Florida when European explorers arrived in the sixteenth century.

POST-CONTACT HISTORY

Early European Exploration, the First Spanish Period, and the British Period (1521–1784)

The European exploration of Florida began in the early sixteenth century. The first documented visit occurred in 1513 when Juan Ponce de León traveled up the east coast of the peninsula (Tebeau 1971:21). Ponce de León sailed as far north as the mouth of the St. Johns River before turning south, rounding the tip of the peninsula, and sailing up Florida's west coast to an area near Charlotte Harbor. Ponce de León returned in 1521 to the San Carlos Bay region where he intended to settle but changed his plans after he found the natives in the area too hostile (Gannon 1996).

Following Ponce de León's visit to the west coast of Florida was Pánfilo de Narváez's expedition through the area in 1528. Narváez landed in Tampa Bay and made an overland journey to St. Marks, just south of Tallahassee, passing through the vicinity of present-day Dunnellon near the Withlacoochee River (Dunn 1977:13).

In 1539, Hernando de Soto landed on the west coast of Florida in Tampa Bay near the mouth of the Little Manatee River. De Soto and some of his men left the Tampa Bay camp and headed northeast, crossing the Alafia River (River of Mocosó). De Soto trekked north through Florida and into the southeastern United States. Many archaeologists plot his course through Florida as passing through Citrus County (Milanich and Hudson 1993). The present-day community of Hernando is located where de Soto is believed to have forded the Withlacoochee River (Morris 1995:117).

Over the next two centuries, European settlements developed along the east coast of Florida, while the west coast remained relatively unsettled. The only pockets of nonnative populations in western Florida were coastal areas to the south of Citrus County, in the vicinity of present-

day Tampa and St. Petersburg, where Cuban fisherman had established camps (Fernald and Purdum 1992).

At the beginning of the eighteenth century, Native Americans in Florida found their population greatly reduced due to diseases, slave raids, intertribal warfare, and attacks from the Creeks, a new group of Indians from Alabama and Georgia who had moved into Florida during the early eighteenth century to escape the political and population pressures of the British colonies to the north.

By 1763, the British had extended their influence into Florida and gained control of the peninsula. After Spain ceded Florida to Great Britain, the British divided the territory at the Apalachicola River into East and West Florida. Present-day Citrus County was part of the East Florida territory (Fabel 1996). Like the Spanish who preceded them, the British had little or no presence in modern-day Citrus County.

During the British period, Creek Indians continued to migrate into Florida, seeking refuge from British pressure and intertribal fissioning. By 1765, the Creek refugees were being referred to as *cimarrones*, the Spanish term for runaways (Fernald and Purdum 1992). The *cimarrones* were later known as the Seminoles and eventually became the dominant Native American group in Florida by the end of the eighteenth century.

Second Spanish Period (1784–1821)

At the Revolutionary War's end, the British defeat at the hands of the American colonists saw a new Treaty of Paris (1783), which returned sovereignty of Florida to Spain. The influx of foreign nationals into north Florida and the growing sentiment that the United States should control the territory, however, contributed to the continued deterioration of Spanish dominance in the area (Franklin and Morris 1996). Spanish authority in Florida slowly waned until 1819, when the United States purchased the territory for \$5 million dollars. The United States officially took over Florida in 1821, with Andrew Jackson serving as the territorial governor (Dunn 1977:15).

Territorial Period (1821–1860)

Present-day Citrus County was originally part of Duval County, which was formed on August 12, 1822. In December 1824, Duval County was divided into smaller units, one of which was Alachua County—which included the area now known as Citrus County. One of the early communities established in Citrus County was Red Level. This settlement was founded near an Indian trail (now US 19), just north of Crystal River. The early settlers cleared the forest in the area and reshaped the land for cattle ranching, citrus cultivation, and turpentine production. One of the first settlers in the Red Level area was William Turner, who came to the area from Pennsylvania. Turner established a homestead in a nearby cedar grove by 1820 and eventually started a turpentine operation. Other early settlers included Daniel Edwards, who started a

ranch on the fertile land just south of Crystal River, and Jim Bertine, who raised cattle on the open range around Red Level (Dunn 1977:15–16).

As increasing numbers of American settlers moved into Florida, conflicts over arable land arose with the Seminole Indians. The federal government responded by drawing up the Treaty of Moultrie Creek in 1823, which restricted the Seminoles to approximately four million acres of land in the middle of the peninsula from Micanopy to just north of the Peace River (Mahon 1967: rear foldout map). Subsequent treaties included the Payne's Landing Treaty in 1832 and the 1833 Fort Gibson Treaty, which called for the emigration of Seminoles to the western territories (Mahon 1967:75–76, 82–83). These three treaties were not popular with the Seminoles and only increased their hostility toward white settlers, culminating ultimately in 1835 in the Second Seminole War. The war was initially centered near the Withlacoochee River in northern Citrus County, where Seminole chief Osceola maintained his headquarters. In 1838, the conflict moved into the Lake Okeechobee and Everglades areas, as US troops moved south to pursue the retreating Seminoles. The Second Seminole War lasted nearly 10 years and was one of the most prolonged of American wars, resulting in over 1,500 deaths.

Following the suppression of the Seminole uprising, Congress encouraged settlement in Florida by establishing the Armed Occupation Act of 1842. This act granted 160 acres to any man who maintained arms, built a house, farmed at least five acres of land, and lived on the granted land for at least five years. The purpose of the act was to ensure, through a civilian presence, that the Seminole Indians did not rise up again. A year after the establishment of the Armed Occupation Act, Hernando County was established in western Florida. The county was named in honor of Hernando de Soto, and its boundaries included the present-day counties of Hernando, Citrus, and Pasco (State of Florida 1945:5). To facilitate settlement of the area, much of the land in Citrus County was surveyed in 1844 (Dunn 1977:15–16). Further inducement for settlement came on March 3, 1845, when Florida became the 27th state of the United States of America.

Civil War and Postbellum Period (1860–1899)

On January 10, 1861, Florida seceded from the United States as a slave state, becoming the third state to join the Confederacy. During the war, the area around the Homosassa River contributed to supplying Confederate troops with sugar from the Yulee Sugar Mill and oranges from the numerous groves in the area.

After the war, agricultural production increased, and new citrus operations reshaped the landscape as a result of the expansion of railroads and canals through the county. One of the earliest railroads through the area was the Dunnellon Short Railroad, which ran from Ocala via Dunnellon to Homosassa. By the late 1880s, the corridor was taken over by the Silver Springs, Ocala, and Gulf Railroad (SSO&G) (**Figure 3.1**). The SSO&G ran southeast from Ocala through Dunnellon to Grand Junction in northern Citrus County. At Grand Junction, the railroad split into two branch lines. The western branch passed through the trackside town of Citronelle, 8 miles east of the current project area, before terminating in Homosassa. The eastern branch passed

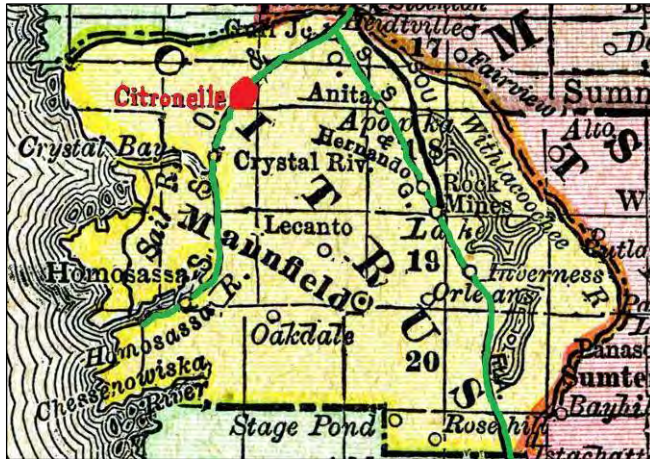


Figure 3.1. 1888 Rand McNally map of Citrus County showing the SSO&G Railroad (green lines). The western branch passed through Citronelle (red dot), eight miles east of the current project area. Source: Florida Center for Instructional Technology, University of South Florida.



Figure 3.2. 1897 Century Atlas map showing the former SSO&G Railroad corridor taken over by the Plant System (red lines) in Citrus County. Source: Florida Center for Instructional Technology, University of South Florida.

through the county seat of Inverness before reaching the junction point of Pemberton in Hernando County. The SSO&G provided freight, passenger, and mail service to several Citrus County communities along the railroad corridor (Dunn 1977:30, 71). By the late 1890s, the SSO&G had been consolidated into Henry B. Plant's sprawling transportation network of railroads and steamboats known as the Plant System (**Figure 3.2**). In 1902, the Atlantic Coast Line acquired the Plant System and operated its railroads through Citrus County.

The area was also reshaped politically when Governor E. A. Perry signed a bill in June 1887 that divided Hernando County into three counties—Hernando, Citrus, and Pasco (State of Florida 1945:5). Mansfield served as the temporary county seat for Citrus County. In 1891, voters elected to move the county seat to Inverness (Dunn 1977:101).

During the second half of the nineteenth century, Citrus County was heavily invested in the orange boom occurring throughout much of central Florida. Young entrepreneurs moved into Citrus County from outside the state to set up small-scale citrus operations (**Figures 3.3-3.5**). The orange industry remained profitable until the winter of 1894–1895, when a devastating freeze swept over most of central Florida. The freeze destroyed nearly all of the orange groves in Citrus County, forcing many growers to abandon citrus cultivation entirely in

the area (Dunn 1977:108). Since the 1894–1895 freeze, most of the citrus production has moved southward down the peninsula to areas less prone to freezing.

In addition to citrus production, phosphate mining became a profitable industry in Citrus County. Shortly before the citrus freeze, Albertus Vogt discovered phosphate near Dunnellon.



Figure 3.3. 1875 sketch of an orange grove in Citrus County by E. A. Abbey depicting workers harvesting citrus. Source: Florida Center for Instructional Technology, University of South Florida.

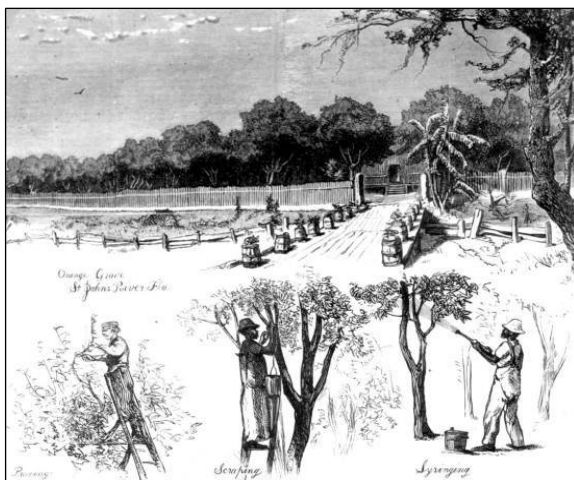


Figure 3.4. 1875 sketch of an orange grove in Citrus County by E. A. Abbey depicting workers pruning and spraying trees. Source: Florida Center for Instructional Technology, University of South Florida.



Figure 3.5. 1875 sketch of an orange grove in Citrus County by E. A. Abbey depicting workers packing citrus. Source: Florida Center for Instructional Technology, University of South Florida.

This discovery coincided with similar finds around Hawthorne in Alachua County and around the Peace River in Polk and Hardee Counties. Recognizing the value of the mineral, Vogt bought up large tracts of land in eastern Citrus County, which he later sold to the phosphate tycoon John C. Dunn (Dunn 1977:117, 131). Phosphate mining became an important industry in the county, attracting new workers and residents into the area (**Figure 3.6**). By the early 1900s, much of the phosphate was exported to Europe. With the beginning of World War I, however, European demand for phosphate dried up, leading to the demise of the industry in Citrus County and a subsequent decline in population.



Figure 3.6. Photograph depicting phosphate mining ca. 1910 in Citrus County with dredging machinery operated by Bradley Phosphate Company. Source: Florida Center for Instructional Technology, University of South Florida.

Citrus County during the Twentieth Century

In addition to phosphate mining, the economy of Citrus County during the early 1900s also included the production of turpentine, the processing of timber, cattle raising, and small-scale diversified farming. By 1916, a variety of field crops had replaced the mono-crop cultivation of cotton and citrus that characterized nineteenth-century agriculture in the area. “Citrus County does not appeal to the man who expects to get rich from a single crop,” noted a report in the *Semi-Tropic Florida Development Year Book*. Furthermore,

It appeals, rather, to the man, who, tired of wrestling with the rigors of a Northern winter, is looking for a location where general farming can be carried on throughout the whole year, a land of stock, and hogs and poultry, of varied crops which can be depended upon for moderate profits, a land of general sum and healthful conditions (Dunn 1977:230).



Figure 3.7. Grinding sugarcane on a farm in Citrus County. Photograph taken in 1947. Source: Florida Center for Instructional Technology, University of South Florida.

Among the more popular farm products were corn, oats, sweet potatoes, sugarcane (**Figure 3.7**), rice, field peas, eggplants, cucumbers, watermelons, cantaloupes, beets, beans, grapes, peaches, strawberries, and dairy products. The principal farming districts included the area around Citronelle, Crystal River, Inverness, Hartshorn, Dunnellon, and Floral City (Dunn 1977:129).

The early decades of the 1900s also brought infrastructural changes that

shaped the development of the county well into the twentieth century. One of these changes involved the construction of the Dunnellon Dam and Hydro-Electric Plant in 1907–1908 (Dunn 1977). The dam was erected 11 miles above the mouth of the Withlacoochee River near Inglis, along the border between Citrus and Levy Counties. The dam, gates, and the original power plant were built to supply power for the Camp Phosphate Company's phosphate mines and worker camps. The company also sold power to the Town of Dunnellon. The earth and concrete dam was completed in 1910, and operations began that same year. The water behind the dam formed Backwater Lake, a popular fishing and recreation area.

In 1926, the dam and property were acquired by the Florida Power Corporation. The new company upgraded the power-generating capabilities of the dam by installing three additional generating units to augment the original two (Dunn 1977:166–167). At the time, the power plant was the largest hydroelectric facility in Florida (**Figure 3.8**), providing service to Citrus, Marion, Sumter, Hernando, Pasco, and Pinellas Counties (Garnault 1925:37–45). The hydroelectric plant remained in operation until 1963, when Florida Power donated the dam and



Figure 3.8. 1955 photograph of the Dunnellon Dam and Hydro-Electric Power Plant.
Source: Florida Center for Instructional Technology, University of South Florida.

3,700 acres of land—3,000 of which constitute the bottom of the Inglis Reservoir—to the State of Florida for use as a recreational park (Dunn 1977:166–167).

At the eastern end of the county, the Inverness Power Company received a franchise to build a new electric plant on February 3, 1913. Electricity was still a new commodity and a source of great pride for those communities with access to it. When the town of Inverness, for example, finally received electricity in October 1913, community pride swelled noticeably, as observed by the *Citrus County Chronicle*:

Inverness put on metropolitan airs properly Saturday when Fletcher Morrison turned on the electric lights. Nearly every residence and business house in the town was lighted [*sic*] up, and presented a handsome appearance. We now

propose a great white way from the A.C.L. [Atlantic Coast Line] depot to the head of Main Street (Dunn 1977:219).

Another infrastructural change welcomed by all throughout the county was a newly improved highway. In 1914, Citrus County had only one stretch of highway that could be considered, as one driver put it, “magnificent.” The segment stretched from Holder south to Floral City along present-day US 41 (Dunn 1977:226). Most of the secondary roads in Citrus County at that time were still in a poor or unimproved state, consisting mostly of sand. As late as 1925, State Highway 15 (present-day US 19 and US 98) from Inglis south through Red Level to Crystal River



Figure 3.9. Rand McNally Auto Map showing the state of Citrus County’s road development in 1927.

Source: us-highways.com.

was still an unimproved road (Dunn 1977:268). By 1927, the highway had been “improved” but was still used as a secondary or connecting road (**Figure 3.9**). In 1929, however, the corridor became part of the US highway system and was incorporated as part of US 19, which stretched over 14,000 miles from Erie, Pennsylvania, to Memphis, Florida, just north of Bradenton (US Highways 2010). The other main route through Citrus County was State Highway 5, designated as US 41 when it became part of the US highway system in 1927 (US Highways 2010).

By 1958, rural communities located between US 19 (State Highway 55) and US 41 (State Highway 495)—such as Red Level and Citronelle—were still relatively small, with a substantial amount of undeveloped land around them (Florida Department of Transportation [FDOT] 1936 [revised 1958]). With its open spaces and lack of built features, the land around the project area typifies the rural nature of Citrus County during the 1930s through the 1950s, shaped predominantly for agricultural production or cattle grazing (Citrus County Property Appraiser 2009). By contrast, the community of Red Level during this period featured a built environment that included a church, a school, a few residences, and a phosphate mine just west of US 19 and a group of dwellings, a store, a town hall, and four farms along the east side of the highway. Similarly, the town of Citronelle had a school, tenant housing, and a group of dwellings clustered around the railroad tracks paralleling US 41 (FDOT 1936 [revised 1958]).

Much of the post-World War II development in northern Citrus County was centered in Citrus Springs, just east of Citronelle. The Citrus Springs area, along with new subdivisions around Beverly Hills, Inverness, and Homosassa Springs, accounted for most of the growth in Citrus County during the second half of the twentieth century. From 1950 to 2000, the population of Citrus County rose rapidly from 6,111 to 118,085, contrasting sharply with the slow demographic growth experienced during the first half of the twentieth century (**Table 3.2**).

To accommodate the growing energy needs of the region, the Florida Power Corporation began researching nuclear energy during the early 1960s. In 1968, the company took the next step and began construction of a nuclear unit at its Crystal River plant, which at the time was equipped with two fossil-fuel units. After several delays, the nuclear unit went into operation in March 1977. Today, there are four fossil-fuel units in addition to the nuclear unit, and the majority owner and operator of the Crystal River facility is Progress Energy Florida (PEF).

Table 3.2. Citrus County Census Data, 1900 to 2010.

Year	Population	Year	Population
1900	5,391	1960	9,268
1910	6,731	1970	19,196
1920	5,220	1980	54,703
1930	5,516	1990	93,515
1940	5,846	2000	118,085
1950	6,111	2010	141,236

Citrus County remains an area of substantial growth. Census estimates for 2010 indicate that the population of the county has surpassed 141,200, an increase of over 23,100 new residents since 2000. Although much of the economy in the county is still centered on agriculture, the growth of Inverness and Crystal River has sparked a middle-class retail boom. The county is also rapidly becoming a favored location for Northern retirees and vacationers.

History Specific to the Project Area

The Holcim mine property was formerly owned by the Hollins family, who moved to Florida from Texas following World War II to cattle ranch in Citrus County. Dixie M. Hollins, Sr. began purchasing land in the project area in 1942 and amassed 16,000 acres of flatland and gulf hammock. He named his landholdings Hollinswood Ranch (Miller 1973:1).

The US Army Corps of Engineers began building the Cross Florida Barge Canal through a portion of Hollinswood Ranch in 1964. After several years of dredging and decades of planning, the Citrus/Levy County portion of the cross-state canal was opened at the start of 1970. The canal was envisioned to connect the Atlantic coast of Florida with the Gulf coast and thereby foster economic expansion in the state. A grassroots movement led by environmentalist Marjorie Harris Carr led to the suspension of the project in 1971, and 20 years later the project was officially canceled (Noll and Tegeder 2009).

Over the last several decades, large portions of Hollinswood Ranch have been purchased by the State of Florida through the Conservation and Recreational Lands program. The Florida Power Corporation (now Duke Energy) and Holcim, Inc., also have acquired acreage from the Hollinswood Ranch property. The Hollins family holdings presently represent about 1,500 acres to the north of the Marjorie Harris Carr Cross Florida Greenway State Recreation and Conservation Area (Miller 1973).

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CHAPTER 4

RESEARCH DESIGN AND METHODS

The goals of this survey were to locate and document evidence of historic or prehistoric occupation or use within the project area (archaeological or historic sites, historic structures, or archaeological occurrences) and to evaluate these for their eligibility for listing in the NRHP. The research strategy was composed of background investigation, a historical document search, and field survey.

The background investigation involved a review of relevant archaeological literature and previous archaeological work undertaken near the project area. The FMSF was checked for previously recorded sites within the project area, and this provided an indication of historic and Native American settlement and land-use patterns for the region. General Land Office (GLO) maps and early aerial photographs also were checked for information pertaining to the existence of historic structures and/or sites of historic events. Current soil surveys, vegetation maps, and relevant literature were consulted to provide a description of the physiographic and geological region of which the project area is a part and to develop expectations regarding the types of archaeological sites that may be present.

FLORIDA MASTER SITE FILE REVIEW

Nine cultural resource studies have been conducted within one mile of the DEF 2018 CC Parcel. Three of these studies (Florida Master Site File [FMSF] Survey Nos. 104, 4732, and 10856) were completed for the proposed Crystal River Power Plant Transmission Corridor Access Road, the proposed Holnam/HCR Limestone Crystal River Quarry Expansion, and the proposed 180-Foot Barge Canal Wireless Telecommunications Tower (Environmental Science and Engineering, Inc., 1978; Archaeological Consultants, Inc. (ACI), 1995; Florida Archaeological Consulting, Inc., 2004) and were all conducted within the current project area (**Figure 4.1**). The 1995 cultural resource survey by ACI included 6000 acres, but only 384 shovel tests were dug. Because no shovel test map was included in the 1995 report, it could not be determined how much of the current tract was tested. SEARCH recommended that a new Phase I survey be conducted within the project area to meet FDHR qualifying standards. In addition to the three studies conducted within the current study parcel, an archaeological assessment survey was conducted adjacent to the southern boundary of the study tract for the proposed Crystal River Plant New Coal Ash Storage Facility (Archaeological Consultants, Inc., 2010).

No archaeological sites or historic structures have been recorded within the DEF 2018 CC Parcel, although sixteen archaeological sites (8CI00092, 8CI00105, 8CI00108 through 8CI00110, 8CI00114, 8CI00116, 8CI00117, 8CI00120, 8CI00993 through 8CI00999) have been recorded north, west and southwest of the project area (**Figure 4.2**). Sites 8CI00993 through 8CI00999 contained prehistoric lithic material, one of which also contained prehistoric pottery and bone.

These previously recorded sites have been determined to be ineligible for listing in the NRHP by the Florida State Historic Preservation Officer (SHPO). Sites 8CI00105, 8CI00108 through 8CI00110, 8CI00114, 8CI00116, 8CI00117 are shell middens and have not been evaluated by SHPO for eligibility. Sites 8CI00092 and 8CI00120 are multi-component sites containing shell middens as well as historic remains. Neither of those sites has been evaluated by SHPO for eligibility. No historic buildings or potential districts were identified in the project area during the desktop screening, windshield survey, or field investigation.

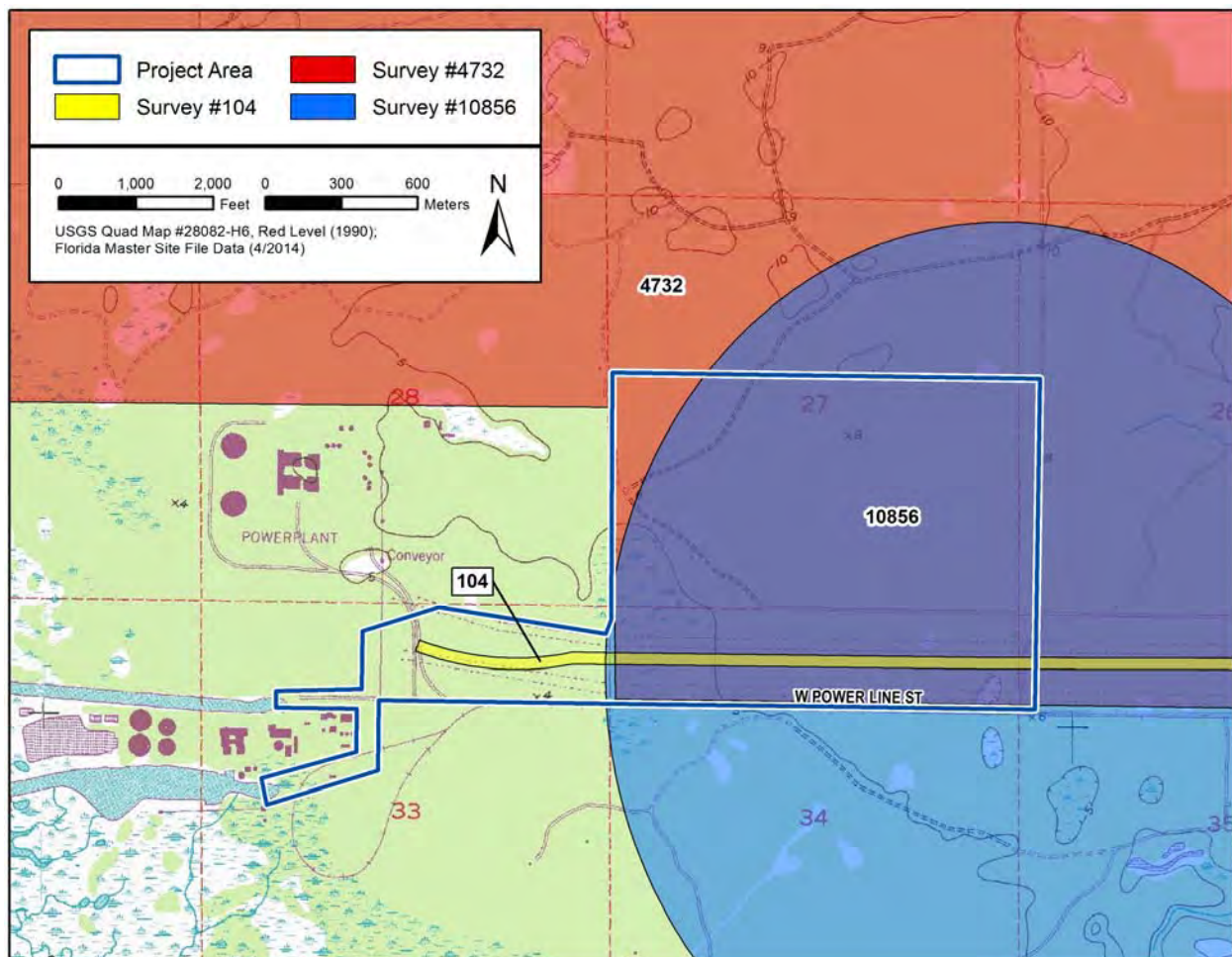


Figure 4.1. Previous cultural resource surveys conducted within the DEF 2018 CC project area.

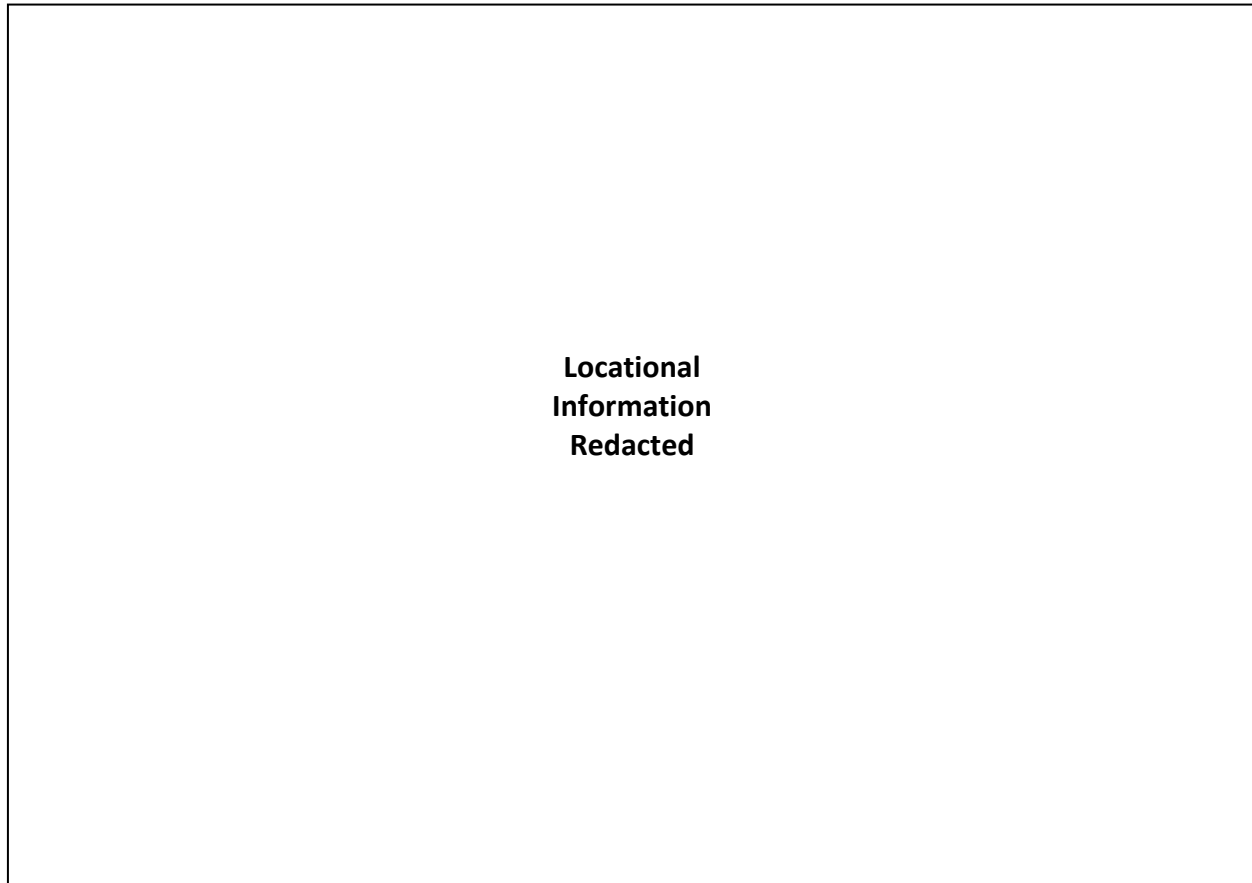


Figure 4.2 Previously recorded cultural resources within one mile of the project area.

HISTORIC MAP AND AERIAL REVIEW

Historic maps and aerial photographs were examined in order to identify past land use in the vicinity of the DEF 2018 CC Parcel, which lies within Sections 27, 28, 33, and 34 of Township 17 South, Range 16 East. The earliest detailed maps consulted were General Land Office (GLO) survey maps. The GLO are early maps created by US government land surveyors during the nineteenth century as part of the surveying, platting, and sale of public lands dictated by the Land Ordinance of 1785. In Florida, these maps characteristically show landscape features such as vegetation, bodies of water, roads, and Spanish land grants. The level of detail in GLO maps varies, with some also depicting structures, Indian villages, railroads, and agricultural fields. The GLO first created maps of the project area in the 1830s. A GLO map from 1835 depicts an undeveloped landscape with several bayous, rivers, and tributaries. There are no visible communities, roads, or other indications of human settlement within the project area (**Figure 4.3**).

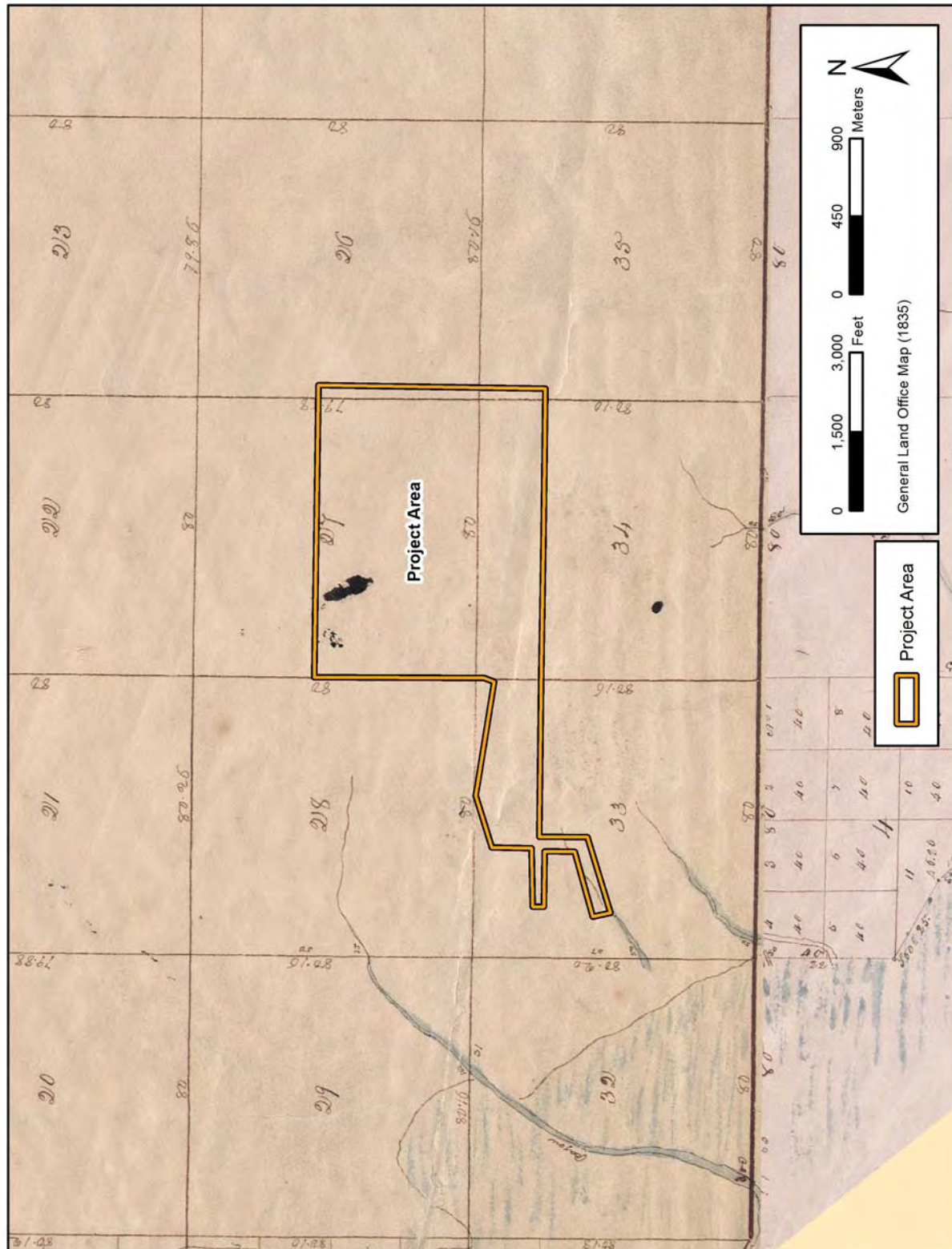


Figure 4.3. 1835 General Land Office Map showing the project area in yellow.

Prior to the establishment of Citrus County in 1887, the project area was located within Hernando County. Citrus County was formed when Hernando was divided into three separate counties (History of Citrus County 2008). This included Citrus to the north and Pasco to the

south. Nineteenth-century and early twentieth-century maps provide an overview of development in the region, but they do not show the current project area in detail. Hernando County maps prior to its division show the community of Crystal River in 1874, but again there is no other indication of settlement in the DEF 2018 CC Parcel (Drew 1874).

While a majority of the project area appears to have been undeveloped through the 1880s, the construction of rail lines through Citrus County centered development, in conjunction with the railroad, to the east of the project area (Rand McNally 1888). In 1888, the Silver Springs, Ocala and Gulf (SSO&G) Railroad was the first line constructed through western Citrus County. The SSO&G ran west from Ocala to Dunellon and then south to Homosassa. The line was owned by investors from New York and played a major role in the transportation of phosphate and limestone from the eastern portion of Citrus County (Turner 2008:129). While the phosphate industry spurred development in east Citrus County, the western portion of the county, which included the DEF 2018 CC parcel, remained relatively wooded and undeveloped.

While important for phosphate transportation, the SSO&G remained relatively obscure in the Florida railroad system until it constructed a branch in 1890-1891 from Dunellon to Inverness. The branch connected with the Florida Central and Peninsular (FC&P) railroad and provided a connection point to Archer (Pettengill 1998:86). This drew the attention of investor Henry B. Plant who had begun developing and expanding railroads in Florida in the 1880s under the Plant System (Pettengill 1998:63). The Dunellon to Inverness line was attractive because it would allow the Plant System to expand by connecting with the FC&P and constructing a line from Archer to High Springs (Pettengill 1998:86). Plant obtained a financial stake in the SSO&G, but it was not acquired by the Savannah Florida and Western (SF&W) Railroad, a component of the Plant System, until 1901 (Turner 2008:129). Plant continued to acquire lines and grow the SF&W into the Plant System throughout Florida until his death on June 23, 1899. The Plant System had grown to 1,745.5 miles of track when it was sold by Plant's widow, Margaret, to the Atlantic Coast Line (ACL) on June 30, 1902 (Turner 2008:155). The ACL remained the largest controller of Florida railroads until the 1960s. In 1967, the Seaboard Air Line (SAL) merged with the ACL and became the Seaboard Coast Line (SCL) Railroad, which, when formed, became the eighth largest railroad in the nation (Turner 2008:222). In 1980, the SCL and the Chessie System merged to become CSXT, which continues to operate the line.

A 1929 Geological Map of the State of Florida identifies soil types in the vicinity of the project area (**Figure 4.4**). This image also shows nearby transportation infrastructure including the ACL; however, no development within the project area is indicated. Beginning in the 1930s, the United States Department of Agriculture (USDA) took aerial photographs of the state of Florida. Aerial photographs of the project area from the 1940s and 1950s depict a wooded and undeveloped landscape. No geographical features or indication of settlement are present (USDA 1952) (**Figure 4.5**).

The project area remained undeveloped until the late 1960s. Florida State Road Department Maps and USDA aerial photographs from 1969 portray the first images of development within the project area. The current rail line running along the south side of Power Line Street through

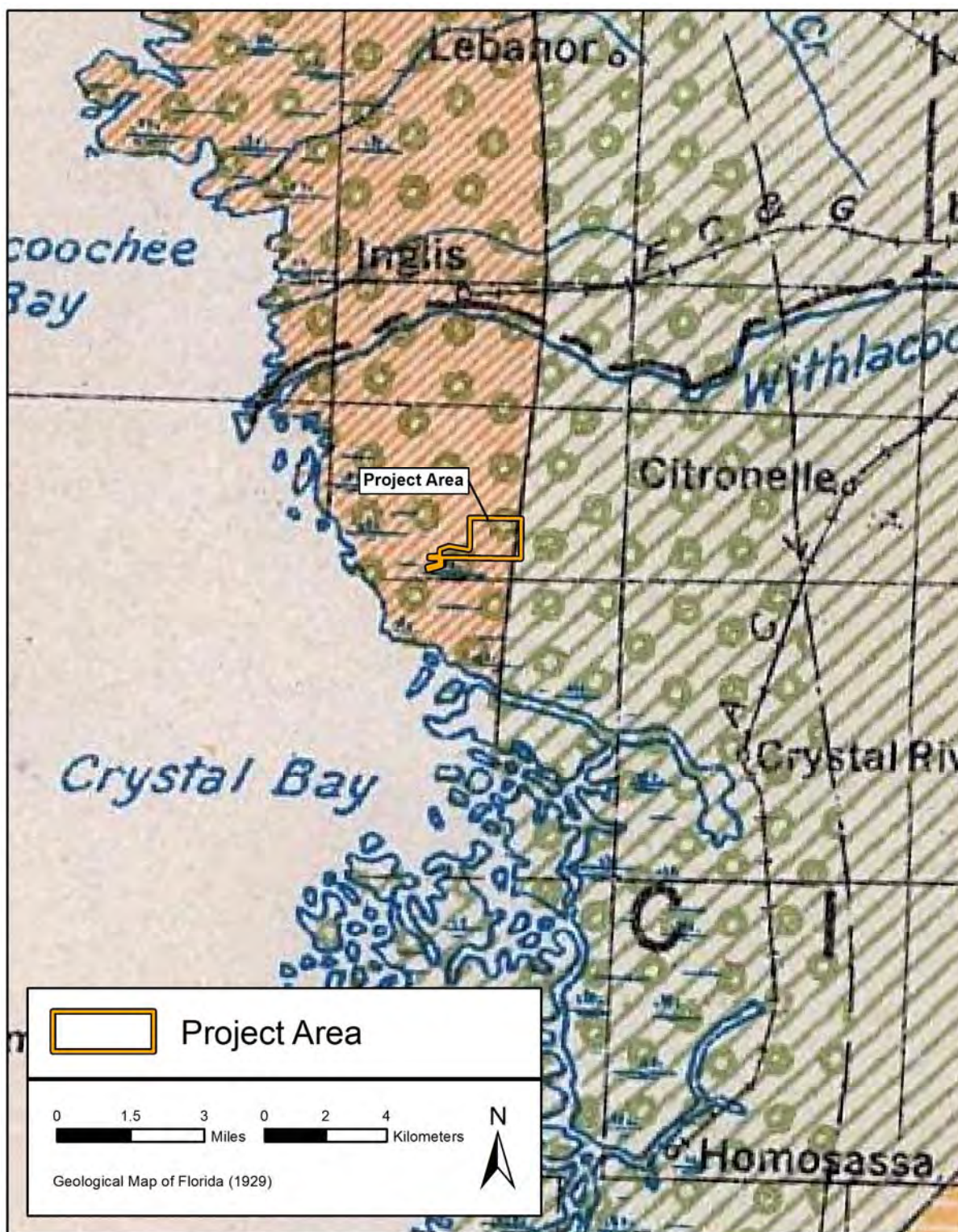


Figure 4.4. 1929 Geological Map of Florida showing the project area in yellow.

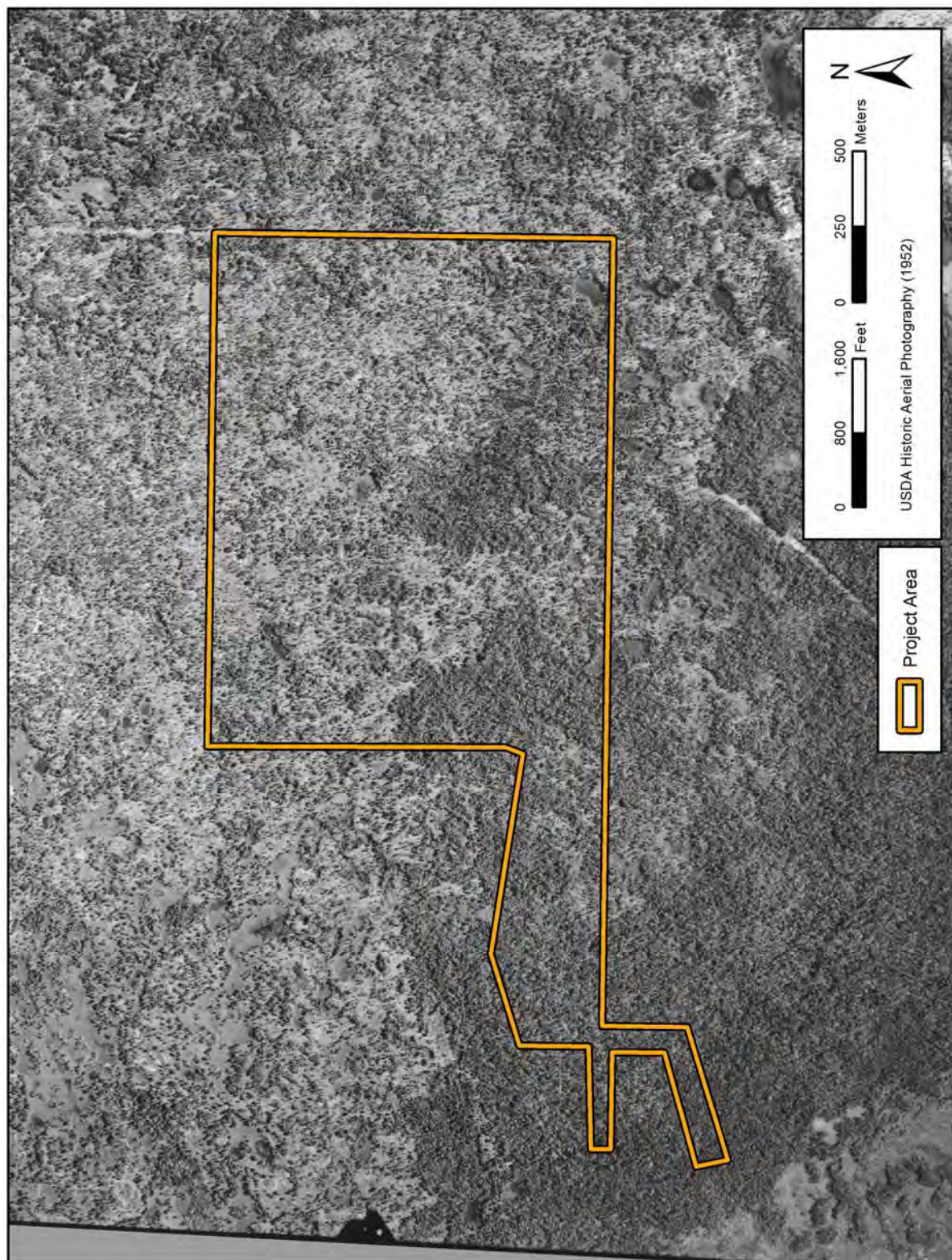


Figure 4.5. 1952 USDA aerial photograph showing the project area in yellow.

the DEF 2018 CC Parcel was completed ca. 1966 by the SCL in conjunction with the construction of the Crystal River Nuclear Plant in the late 1960s and 1970s (Florida State Road Department 1969) (**Figure 4.6**). The east-west spur line connected the nuclear plant with the main line of the aforementioned Seaboard Coast Line Railroad. Like the rest of the SCL, the current spur line continues to be operated by CSX following the 1980 merger of the SCL and the Chessie System.

By 1969, the beginnings of the southern portion of the Crystal River Nuclear Plant are evident on aerial photographs, but the portions to the north had not yet been constructed (USDA 1969) (**Figure 4.7**). The plant would not be operational until 1977. Aerial photographs also depict the SCL rail line with a spur track to the south section of the plant crossing through the southwest portion of the project area. In the 1980s, the southern spur was altered to form a continuous loop, likely to allow trains to exit more efficiently as there appeared to be no other turnaround (see **Figure 4.6**). The portion of the SCL to the north of the main line appears to be added after 1980.

CULTURAL RESOURCE POTENTIAL

Based on the background research summarized above, roughly 95 percent of the Duke Energy 2018 CC Parcel exhibits low potential for containing archaeological sites and low potential for containing historic structural remains. Based on the project area's poor soil drainage capacity, lack of relief across most of the parcel, distance to fresh water, and proximity to known cultural resources, the project area exhibits an overall low potential for the occurrence of archaeological deposits. High-potential zones are typically located on well-drained to moderately drained areas in close proximity to wetlands, ponds, and creeks. Approximately 5 percent of the Parcel contains well drained rock outcrops, which suggest the high potential for a lithic quarry site.

It was anticipated that prehistoric sites, if present, would consist of small campsites or activity areas perhaps related to the exploitation of nearby lithic raw materials (i.e., chert) that are present within the local limestone deposits. Elevated areas in proximity to relict or seasonal water sources also were considered to exhibit relatively higher potential for the presence of archaeological deposits. Although the rock outcrops may be optimal for prehistoric activities, these areas are still surrounded by poorly drained soils and would likely not contain historic structures.

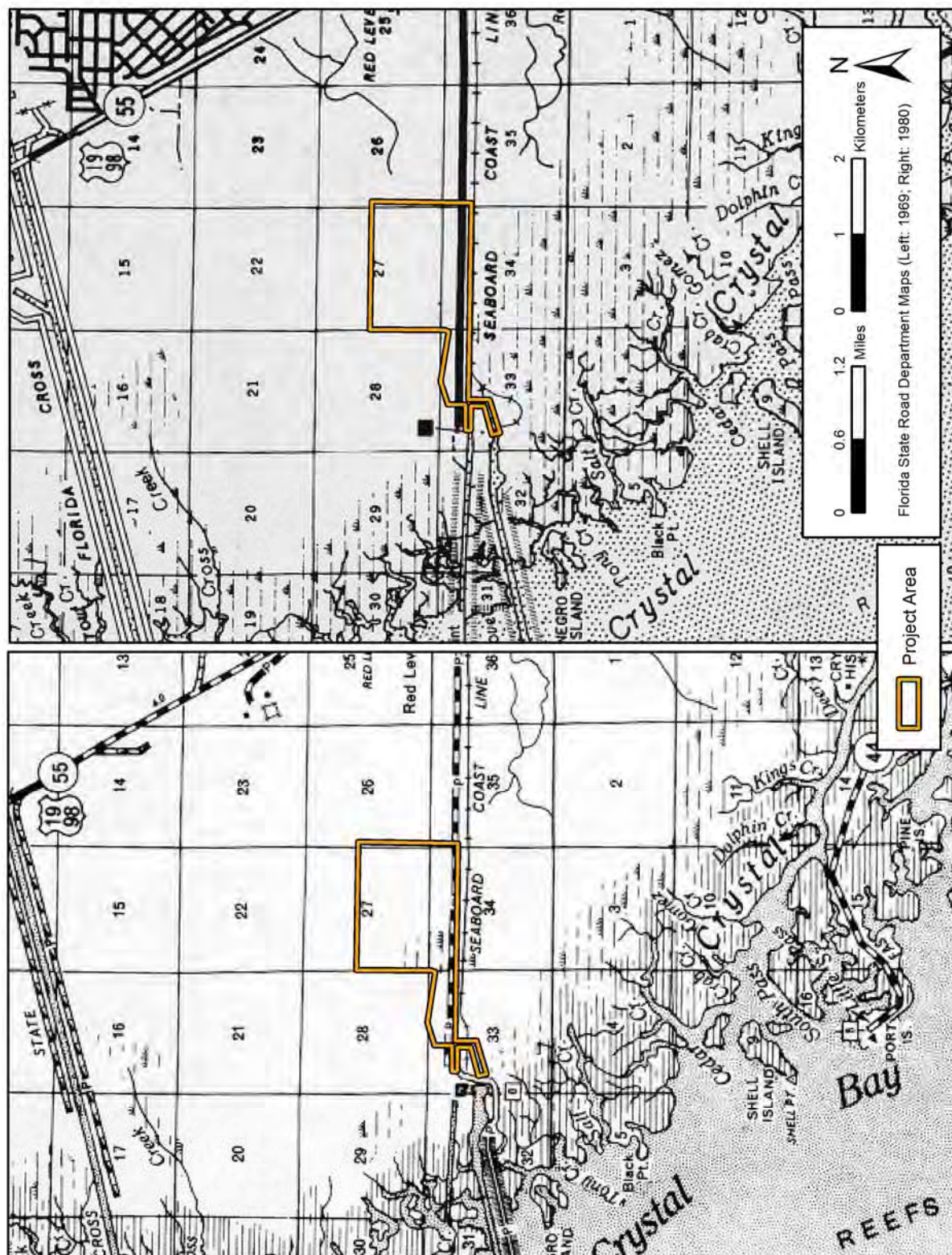


Figure 4.6. 1969 and 1980 Florida State Road Department maps showing the project area in yellow.

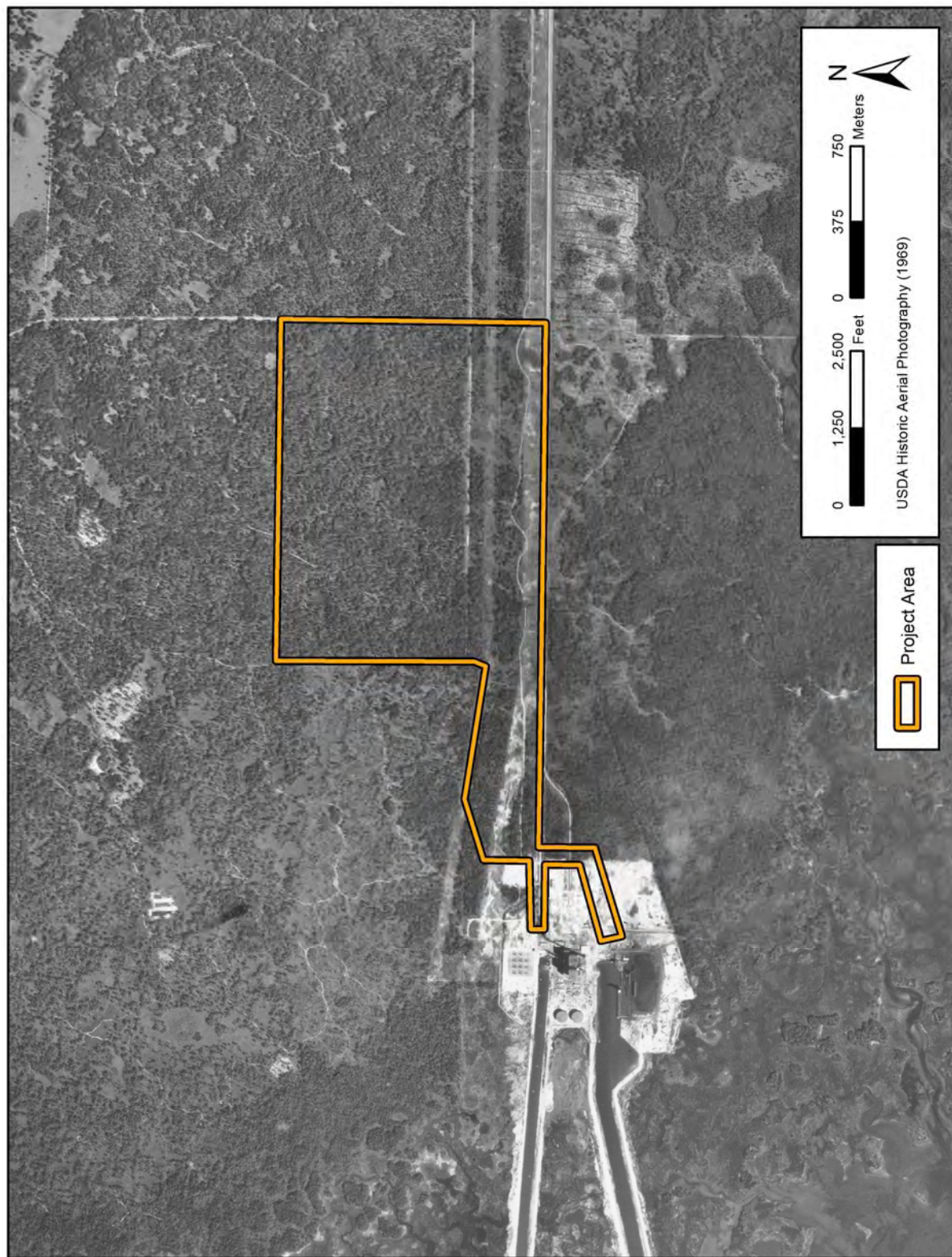


Figure 4.7. 1969 USDA aerial photograph showing the project area in yellow.

METHODS

Archaeological Survey

The cultural resource assessment strategy was designed to identify archaeological resources and to evaluate their eligibility for inclusion in the NRHP. Pedestrian inspection in areas of exposed ground surface complimented subsurface testing. Following the FDHR's *Cultural Resource Management Standards & Operational Manual, Module Three: Guidelines for Use by Historic Preservation Professionals* (FDHR 2012), low-probability zones were subjected to discretionary subsurface testing at 100-m intervals. Shovel tests measured 50 cm in diameter and were excavated to depths exceeding 100 cmbs, subsurface conditions permitting. At the discretion of the field archaeologists, projected shovel tests were not excavated in areas of standing water or wetlands or in areas that were perceived to pose a danger to the field crew. Excavated soil was screened through ¼-inch-mesh hardware cloth. The cultural content (if any), strata, and environmental setting of each shovel test were recorded on shovel test forms, and the location of each shovel test was recorded using a handheld Global Positioning System (GPS) device. All notes, GIS layers, photographs, and maps are on file at the Jacksonville SEARCH office.

Laboratory Methods and Curation

Artifacts recovered during the cultural resources survey were returned to the SEARCH laboratory facilities for cleaning and processing. Artifacts were washed clean of sand and dirt and allowed to air-dry. Materials were then rebagged and organized by field specimen number (FS#) and provenience. Artifacts were classified using appropriate reference materials, and the information was recorded in a database. The artifacts were given code numbers, which allow for systematic, comparable data entry. Prehistoric artifacts were analyzed by source material, method of manufacture, and artifact function; no historic artifacts were encountered. The artifacts were packaged in acid-free, 4-mil polyurethane bags with acid-free paper label inserts following federally accepted standards.

Architectural Methods

The architectural survey for the project utilized standard procedures for the location, investigation, and recording of historic properties. In addition to a search of the FMSF for previously recorded historic properties within the project area, US Geological Survey (USGS) quadrangle maps and USDA aerial photographs were reviewed for structures that were constructed prior to 1965. No historic structures or buildings were encountered during the investigation.

Informant Interviews

Kathy Turner-Thompson, Historical Resource Officer at the Citrus County Historical Society, and Curtis Peters, Quarry Manager at Holcim Inc., were previously interviewed by SEARCH about the history of the project vicinity (Turner-Thompson, personal communication, 2011; Peters, personal communication, 2011). Neither was aware of the presence of historical or archaeological resources within the area.

Citrus County is not a Certified Local Government (CLG) and does not presently have a historic preservation ordinance. As a result, the county does not employ a CLG contact for coordination and interview.

NRHP Eligibility Criteria

In assessing the NRHP eligibility of any site, standard criteria are used as the basis for interpretations and recommendations. Significant cultural resources are those meeting the criteria of eligibility for inclusion in the NRHP, as defined in 36 CFR Part 60.4, and in consultation with the Florida SHPO. According to established guidelines, significance is judged when sites, structures, or objects possess integrity of location, design, setting, materials, workmanship, feeling, and association, and:

- A. are associated with events that have made a significant contribution to the broad patterns of our history; or
- B. are associated with the lives of persons significant in our past; or
- C. embody the distinctive characteristics of a type, period, or method of construction, or possess high artistic values, or represent a significant and distinguishable entity whose components may lack individual distinctions; or
- D. have yielded, or may be likely to yield, information important in prehistory or history.

While most NRHP-eligible archaeological sites are significant under Criterion D, the potential to yield “information important in prehistory or history,” this criterion requires a level of clarification to illuminate the issue of site importance. As such, the following attribute evaluations add a measure of specificity that can be used in assessing site significance and NRHP eligibility:

- Site Integrity – Does the site contain intact cultural deposits, or is it disturbed?
- Preservation – Does the site contain material suited to in-depth analysis and/or absolute dating such as preserved features, botanical material, faunal remains, or human skeletal remains?
- Uniqueness – Is the information contained in the site redundant in comparison to that available from similar sites, or do the remains provide a unique or insightful perspective on research concerns of regional importance?

- Relevance to Current and Future Research – Would additional work at this site contribute to our knowledge of the past? Would preservation of the site protect valuable information for future studies? While this category is partly a summary of the above considerations, it also recognizes that a site may provide valuable information regardless of its integrity, preservation, or uniqueness.

Procedures to Address Unexpected Discoveries

Every reasonable effort has been made during this investigation to identify and evaluate possible locations of prehistoric and historic archaeological sites; however, the possibility exists that evidence of cultural resources may yet be encountered within the project limits. Should evidence of unrecorded cultural resources be discovered during construction activities, the finds should be reported to the FDHR. Evidence of cultural resources includes aboriginal or historic pottery, prehistoric stone tools, bone or shell tools, historic trash pits, and historic building foundations.

In the unlikely event that human skeletal remains or associated burial artifacts are uncovered within the project area, all work in that area must stop. The discovery must be reported to local law enforcement who will contact the medical examiner. The medical examiner will determine whether or not the State Archaeologist should be contacted per the requirements of Chapter 872.05, Florida Statutes. Additional details regarding unanticipated discoveries are presented in **Appendix A**.

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CHAPTER 5 SURVEY RESULTS

ARCHAEOLOGICAL SURVEY

SEARCH excavated a total of 230 shovel tests within the approximately 643-acre Duke Energy 2018 CC Parcel. The fieldwork identified one previously unrecorded archaeological site (8CI01456) (**Figure 5.1**). An FMSF form was completed for the archaeological site and is contained in **Appendix B**. The survey log is included in **Appendix C**.

Figure 5.1 presents the locations of all shovel tests as well as areas where no shovel tests could be excavated due to standing water, extensive disturbance or safety concerns within the Duke Energy 2018 CC Parcel; numerous shovel tests in the southern portion of the parcel were not dug due to inundation at the time of the survey. This low, wet area was historically associated with a wetland before its utilization for multiple transmission lines and retention ponds (see **Figures 4.6** and **4.7**). **Figure 5.1** indicates the CREC property with hash lines. Extensive paving, underground utilities, and disturbance were consistent throughout that portion of the parcel. No shovel testing was conducted within this area, and no photographs were taken due to strict privacy regulations.

Newly Recorded Site

8CI01456, Duke Energy 2018 CC Parcel

<u>Location:</u>	T17S, R16E, southern portion of Section 27
<u>Setting:</u>	Wooded area; vegetation consists primarily of live oak, palmetto, cabbage palm, and leather leaf fern (see Figure 5.2)
<u>Soils:</u>	Hallandale Rock outcrop complex, poorly drained. Soils consist of gray sand, 0–20 cmbs (0–8 in); light brown sand, 20–95 cmbs (8–37 in); and strong brown sand with concretions, 95–100 cmbs (37–39 in).
<u>Survey Methods:</u>	Shovel testing at 12.5-m (41-ft) and 25-m (82-ft) intervals; one positive shovel test, one surface find
<u>Site Type:</u>	Lithic scatter
<u>Site Size:</u>	Site is an ovate scatter measuring 5-by-5 m
<u>Depth of Deposits:</u>	0–60 cmbs
<u>Chronology:</u>	Indeterminate prehistoric
<u>Artifacts:</u>	Prehistoric artifacts included four flakes

The Duke Energy 2018 CC Parcel site (8CI01456) is a small, low-density artifact scatter. The site consists of one positive shovel test (ST 54) containing three flakes and one surface find yielding one flake. All artifacts in the shovel test were recovered from a depth range of 0–60 cmbs (12–24 in). The presence of natural chert in the area could suggest the potential for a quarry site,

**Locational
Information
Redacted**

Figure 5.1. Shovel test excavation plan and results.



Figure 5.2 Environment at 8CI01456, south view.

but the lack of cultural materials did not provide evidence of extensive prehistoric activities.

Due to the lack of temporally diagnostic cultural materials, the site is identified as having indeterminate prehistoric components. No subsurface features were identified in the positive shovel tests.

The low density of artifacts and the absence of ceramics suggest that the resource is a lithic reduction campsite, possibly dating to the preceramic Archaic period. The small size of this site and the absence of temporally diagnostic artifacts indicate that the potential for additional research is limited. Consequently, the site does not appear to meet the eligibility criteria for listing in the NRHP. No additional work is recommended.

ARCHITECTURAL SURVEY

The architectural survey resulted in the identification and evaluation of one newly recorded linear resource, the Seaboard Coast Line Railroad (8CI01455) (**Figure 5.3**). No other historic resources were identified. The linear resource identified within the DEF 2018 CC Parcel is described and evaluated below. An FMSF form was completed for the resource and is provided in **Appendix B**. The survey log sheet is provided in **Appendix C**.

**Locational
Information
Redacted**

Figure 5.3. Historic resources recorded within the project area.

The identified historic resource was evaluated to determine its significance and potential for listing in the NRHP. The linear resource within the DEF 2018 CC Parcel lacks the architectural distinction and significant historical associations necessary to be considered for listing in the NRHP and is recommended ineligible. No potential NRHP districts were identified.

8CI01455, Seaboard Coast Line Railroad

The Seaboard Coast Line (SCL) Railroad (8CI01455) is a newly recorded resource in Citrus County, and the portion within the project area is located in Sections 28, 33, and 34 of Township 17 South, Range 16 East, as shown on the 1990 *Red Level, Fla.* USGS quadrangle map (see **Figure 5.3**). The rail line was constructed ca. 1966 in conjunction with the development of the Crystal River Nuclear Plant, although the plant was not operational until 1977 (Duke Energy 2014; Florida State Road Department 1969). The east-west spur line connects the nuclear plant with the main line of the SCL to the east. Like the rest of the SCL, the current spur line continues to be operated by CSX Transportation following the 1980 merger of the SCL and the Chessie System.

The line runs along the southern portion of the project area parallel on the south side of West Power Line Street. The rail corridor consists of a single-track, standard-gauge rail with wooden cross ties and metal tie plates set on a bed of crushed-stone ballast (**Figure 5.4**). At the western end of the line there is a loop that circles to the south of the line and a branch that arcs to the north. Originally a straight branch to the south side of the plant, the line was altered to form a continuous loop by 1980, likely to allow trains to exit more efficiently as there appeared to be no other turnaround within the plant (Florida State Road Department 1969; 1980). The original straight branch has been removed through the current project area, likely at the time that the line was reconfigured.

The main line of the SCL was constructed in 1888 as the Silver Springs, Ocala and Gulf (SSO&G) Railroad. The SSO&G was the first line constructed through western Citrus County and ran west from Ocala to Dunnellon and then south to Homosassa. The line was owned by investors from New York and played a major role in the transportation of phosphate and limestone from the eastern portion of Citrus County (Turner 2008:129). While the phosphate industry spurred development in east Citrus County, the western portion of the county, which included the project area, remained relatively wooded and undeveloped.

Florida's Historic Railroad Resources, the NRHP Multiple Property Nomination form, was used as a guide to evaluate 8CI01455 (Johnston and Mattick 2001). To be eligible for listing in the NRHP, Florida's roadbeds must have served a historic railroad transportation function and have been constructed during one of Florida's historic railroad periods. NRHP eligibility must also be supported by association with an important local historical event or person. Additionally, the railroad must retain its original appearance to a high degree (Johnston and Mattick 2001:67).



Figure 5.4. Views of resource 8CI01455. Left: View northeast along the loop at the western end of the spur line; right: View east along West Powerline Street on the south parcel boundary.

8CI01455 was built as a spur line solely to provide access to the Crystal River Nuclear Plant, never functioned as a major transportation corridor, and it was constructed during the mid-twentieth century, which is not considered a historic Florida railroad period (Johnston and Mattick 2001:6–10). Furthermore, the development of Resource 8CI01455 lacks association with any local historical event or individual. According to the nomination form, a rail roadbed is an F3 property type (Rail Structure: Roadbed), and would consist of ballast, cross ties, rails, and tie plates (Johnston and Mattick 2001:63), which are not all present in this section of 8CI01455. The section of the line within the current project area has been altered since it was originally constructed including the removal of the original rails and cross ties and the reconfiguration of the line to form a loop. Also, the line was not constructed during one of Florida’s historic railroad periods, and due to the lack of historical association and significance, it is the opinion of the Principal Investigator that this portion of the railroad corridor within the project area be recommended ineligible for listing in the NRHP.

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

A cultural resource assessment survey was conducted on the 643-acre DEF 2018 CC Parcel in northwest Citrus County, Florida in May 2014. The project was completed by SEARCH at the request of the Duke Energy Florida as Due Diligence in anticipation of permitting requirements associated with proposed construction activities in the Crystal River Energy Complex. This study was conducted to comply with Chapters 267 of Florida Statutes and Rule Chapter 1A-46, Florida Administrative Code. All work was performed in accordance with the Florida Division of Historical Resources (FDHR) recommendations for such projects as stipulated in *Cultural Resource Management Standards & Operations Manual, Module Three: Guidelines for Use by Historic Preservation Professionals* (FDHR 2012). The Principal Investigator for the project meets the Secretary of the Interior's *Standards and Guidelines for Archaeology and Historic Preservation* (48 FR 44716-42).

A total of 230 shovel tests were excavated within the overall low potential project area resulting in the identification of one archaeological site (8CI01456). This low-density lithic scatter lacks temporally diagnostic artifacts or subsurface features. In addition, the architectural survey resulted in the identification of one newly recorded historic linear resource, the Seaboard Coast Line Railroad (8CI01455). In the opinion of the Principal Investigator, neither resource meets the criteria for inclusion in the NRHP, as established in 36 CFR, Part 60.4 (NHPA).

Based on the information presented above, SEARCH recommends that plans for the DEF 2018 CC Parcel proceed without further consideration for cultural resources. No additional work is recommended. Any unanticipated discoveries found subsequent to this report should be treated in accordance with the Unanticipated Discoveries Statement provided in **Appendix A**.

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REFERENCES CITED

Archaeological Consultants, Inc.,

- 1995 A Cultural Resources Assessment Survey of Holnam/HCR Limestone Crystal River Quarry Expansion Project, Citrus County, Florida. Florida Master Site File Survey No. 4732. On file, Florida Division of Historical Resources, Tallahassee.
- 2010 Cultural Resource Assessment Survey, Progress Energy Crystal River Plant, New Coal Ash Storage Facility, Citrus County, Florida. Florida Master Site File Survey No. 18701. On file, Florida Division of Historical Resources, Tallahassee.

Brooks, H. K.

- 1981 *Guide to the Physiographic Divisions of Florida*. Florida Cooperative Extension Service. University of Florida, Gainesville.

Bullen, Ripley P.

- 1958 *The Bolen Bluff Site in Paynes Prairie, Florida*. Contributions of the Florida State Museum, Social Sciences, No. 4. University of Florida, Gainesville.
- 1975 *A Guide to the Identification of Florida Projectile Points*. Revised edition. Kendall Press, Gainesville.

Carbone, V. A.

- 1983 Late Quaternary Environments in Florida and the Southeast. *The Florida Anthropologist* 36(1-2):3-17.

Citrus County Property Appraiser

- 2009 Property Card for Parcel #17E17S29 31000. Electronic file accessed September 24, 2009.

Clausen, Carl J.

- 1964 The A-356 Site and the Florida Archaic. Master's thesis, Department of Anthropology, University of Florida, Gainesville.

Cooke, C. Wythe

- 1929 *Geological Map of Florida*. Florida Geological Survey. On file at the University of Florida Map and Imagery Library, Gainesville. Electronic document, <http://ufdc.ufl.edu/mapfl>, accessed June 9, 2014.

Daniel, I. Randolph, and Michael Wisenbaker

- 1987 *Harney Flats: A Florida Paleoindian Site*. Baywood, Farmingdale.

Drew, Columbus

- 1847 *Hernando County*. Columbus Drew, Jacksonville. Electronic Document, <http://fcit.usf.edu>, accessed June 9, 2014.

Duke Energy

- 2014 Crystal River Steam Plan. Electronic Document, <http://www.duke-energy.com/power-plants/coal-fired/crystal-river.asp>, accessed June 13, 2014.

Dunbar, James S.

- 1991 Resource Orientation of Clovis and Suwannee Age PaleoIndian Sites in Florida. In *Clovis: Origins and Adaptations*, edited by R. Bonnicksen and K. Turnmire, pp. 185-213. Center for the First Americans, Oregon State University, Corvallis.

Dunbar, James S., and B. I. Waller

- 1983 A Distribution Analysis of the Clovis/Suwannee Paleoindian Sites of Florida: A Geographic Approach. *The Florida Anthropologist* 36:18-30.

Dunn, Hampton

- 1977 *Back Home: A History of Citrus County, Florida*. Citrus County Bicentennial Steering Committee, Inverness, Florida.

Environmental Science and Engineering, Inc.

- 1978 Archaeological-Historical Survey of Lake Rousseau to Crystal River Power Plant Water Supply Pipeline and Transmission Corridor Access Road, Citrus County, Florida. Florida Master Site File Survey No. 104. On file, Florida Division of Historical Resources, Tallahassee.

Fabel, Robin F. A.

- 1996 British Rule in the Floridas. In *The New History of Florida*, edited by Michael Gannon, pp. 134-149. University Press of Florida, Gainesville.

Faught, Michael K.

- 2004 Submerged Paleoindian and Archaic Sites of the Big Bend, Florida. *Journal of Field Archaeology* 29:273-290.

Fernald, Edward A., and Elizabeth D. Purdum

- 1992 *Atlas of Florida*. University Press of Florida, Gainesville.

Florida Archaeological Consulting, Inc.

- 2004 Assessment of Potential Effects Upon Historic Properties: Proposed 180-Foot Barge Canal Wireless Telecommunications Tower (Progress Telecom FL-23941), Citrus County, Florida. Florida Master Site File Survey No. 10856. On file, Florida Division of Historical Resources, Tallahassee.

Florida Department of Transportation (FDOT)

- 1936 Citrus County General Highway Map. Rev. 1958. Florida Department of Transportation, Tallahassee.

Florida State Road Department

- 1969 General Highway Map of Citrus County. Florida Department of Transportation, Tallahassee. Electronic document, <http://ufdc.ufl.edu/mapfl>, accessed June 10, 2014.
- 1980 General Highway Map of Citrus County. Florida Department of Transportation, Tallahassee. Electronic document, <http://ufdc.ufl.edu/mapfl>, accessed June 10, 2014.

Franklin, Marianne, and John W. Morris III

- 1996 *A Remote Sensing Survey of St. Augustine, Florida*. Southern Oceans Archaeological Research, Pensacola.

Gannon, Michael (editor)

- 1996 *The New History of Florida*. University Press of Florida, Gainesville.

Garnault, Agassiz

- 1925 Florida in Tomorrow's Sun. *Suniland* 3(2).

General Land Office (GLO)

- 1835 Township 17 South, Range 16 East. Electronic document, <http://www.glorerecords.blm.gov/>, accessed June 10, 2014.

Hemmings, C. Andrew

- 2004 The Organic Clovis: A Single Continent-wide Cultural Adaptation. PhD dissertation, Department of Anthropology, University of Florida, Gainesville.

Hemmings, E. T., and T. A. Kohler

- 1974 The Lake Kanapaha Site in North Central Florida. *Bureau of Historic Sites and Properties Bulletin* 4:45-64.

History of Citrus County

- 2008 History of Homosassa. Electronic document, <http://www.homosassahistory.com/>, accessed June 10, 2014.

Johnston, Sidney, and Barbara Mattick

- 2001 *Florida's Historic Railroad Resources*. Florida Master Site File Survey No. 6289. On file, Florida Division of Historical Resources, Tallahassee.

Johnson, Kenneth W.

- 1986 Archaeological Survey of Contact and Mission Period Sites in Northern Peninsular Florida. Miscellaneous Project Report 37. DA.
- 1987 *The Search for Aquacaleyquen and Cali: Archaeological Survey of Portions of Alachua, Bradford, Citrus, Clay, Columbia, Marion, and Sumpter Counties, Florida*. Survey No. 1410. On file, Florida Division of Historic Resources, Tallahassee.

1991 *The Utina and Potano Peoples of Northern Florida: Changing Settlement Systems in the Spanish Colonial Period*. PhD dissertation, Department of Anthropology, University of Florida, Gainesville. University Microfilms, Ann Arbor.

Johnson, Kenneth W., and Bruce C. Nelson

1990 The Utina: Seriations and Chronology. *The Florida Anthropologist* 43:48-62.

Mahon, John K.

1967 *History of the Second Seminole War, 1835-1842*. University of Florida Press, Gainesville.

Milanich, Jerald T.

1994 *The Archaeology of Precolumbian Florida*. University of Florida Press, Gainesville.

Milanich, Jerald T., and Charles H. Fairbanks

1980 *Florida Archaeology*. Academic Press, New York.

Milanich, Jerald T., and Charles Hudson

1993 *Hernando de Soto and the Indians of Florida*. University of Florida Press, Gainesville.

Miller, James J.

1973 *An Archaeological Survey of the Florida Power Corporation Crystal River Tract, Citrus County, Florida*. On file, Florida Division of Historical Resources, Tallahassee.

Morris, Joan Perry

1995 *Florida Place Names: Alachua to Zolfo Springs*. Pineapple Press, Sarasota.

National Park Service

1997 *National Register Bulletin 16: How to Complete the National Register Registration Form*. US Department of the Interior, National Park Service, Cultural Resources. US Government Printing Office, Washington, DC.

Noll, Steven, and David Tegeder

2009 *Ditch of Dreams: The Cross Florida Barge Canal and the Struggle for Florida's Future*. University Press of Florida, Gainesville.

Pettengill, George W.

1998 *Bulletin No. 85: The Story of the Florida Railroads 1834-1903*. The Railway and Locomotive Historical Society, Inc., Jacksonville.

Pluckhahn, Thomas J., Victor D. Thompson, and Brent R. Weisman

2010 Toward A New View of History and Process at Crystal River (8CI1). *Southeastern Archaeology* 29:164-181.

Rand McNally & Co.

1888 Map of Citrus County. In *Atlas of the World*. Rand McNally & Co., Chicago. Electronic document, <http://fcit.usf.edu/>, accessed June 9, 2014.

Rohling, E. J., M. Fenton, F. J. Jorissen, P. Bertrant, G. Ganssen, and J. P. Caulet

1998 Magnitudes of Sea-Level Lowstands of the Past 500, 000 Years. *Nature* 394:162-165.

Sassaman, Kenneth E.

1993 *Early Pottery in the Southeast: Traditions and Innovation in Cooking Technology*. University of Alabama Press, Tuscaloosa.

Smith, Bruce D.

1986 The Archaeology of the Eastern United States: From Dalton to de Soto, 10,500-500 B.P. *Advances in World Archaeology* 5:1-93.

State of Florida

1945 *The Seventh Census of the State of Florida, 1945*. State of Florida, Tallahassee.

State Road Department

1936 Citrus County [map]. State Road Department, Tallahassee.

Ste. Claire, Dana

1987 The Development of Thermal Alteration Technologies in Florida: Implications for the Study of Prehistoric Adaptations. *Florida Anthropologist* 40(3):203-208.

Tebeau, Charlton W.

1971 *A History of Florida*. Revised 1980. University of Miami Press, Coral Gables.

Turner, Gregg M.

2008 *A Journey into Florida Railroad History*. University Press of Florida, Gainesville.

US Department of Agriculture (USDA)

1952 Aerial Photographs: Citrus County. Florida Aerial Photography, University of Florida Digital Collection. Electronic document, <http://ufdc.ufl.edu/aerials>, accessed June 9, 2014.

1969 Aerial Photographs: Citrus County. Florida Aerial Photography, University of Florida Digital Collection. Electronic document, <http://ufdc.ufl.edu/aerials>, accessed June 9, 2014.

US Highways

2010 US Highways: From US 1 to US 830. Historic Roads and Highways of Florida. Electronic document, <http://www.us-highways.com/flus.htm#US 19>, accessed January 26, 2011.

Watts, W. A.

- 1969 A Pollen Diagram from Mud Lake, Marion County, North-Central Florida. *Geological Society of America Bulletin* 80:631-642.
- 1971 Postglacial and Interglacial Vegetation History of Southern Georgia and Central Florida. *Ecology* 52:676-690.
- 1975 A Late Quaternary Record of Vegetation from Lake Annie, South Central Florida. *Geology* 3:344-346.
- 1980 The Late Quaternary Vegetation History of the Southeastern United States. *Annual Reviews of Ecology and Systematics* 11:387-409.

Watts, W. A., and B. C. S. Hansen

- 1988 Environments of Florida in the Late Wisconsin and Holocene. In *Wet Site Archaeology*, edited by Barbara Purdy, pp. 307-323. Telford Press, Caldwell, New Jersey.

Watts, William A., Eric C. Grimm, and T. C. Hussey

- 1996 Mid-Holocene Forest History of Florida and the Coastal Plain of Georgia and South Carolina. In *Archaeology of the Mid-Holocene Southeast*, edited by Kenneth E. Sassaman and David G. Anderson, pp. 28-38. University Press of Florida, Gainesville.

Webb, S. David, and James S. Dunbar

- 2006 Carbon Dates. In *First Floridians and Last Mastodons: The Page-Ladson Site in the Aucilla River*, edited by S. David Webb, pp. 83-102. Springer, The Netherlands.

Webb, S. D., J. T. Milanich, R. Alexon, and J. S. Dunbar

- 1984 A *Bison Antiquus* Kill Site, Wacissa River, Jefferson County, Florida. *American Antiquity* 49:384-392.

Weisman, Brent R.

- 1995 *Crystal River: A Ceremonial Mound Center on the Florida Gulf Coast*. Florida Archaeology No. 8. Florida Bureau of Archaeological Research, Tallahassee.

Worth, John E.

- 1992 The Timucuan Missions of Spanish Florida and the Rebellion of 1656. PhD dissertation, Department of Anthropology, University of Florida, Gainesville.

APPENDIX A.

UNANTICIPATED DISCOVERIES STATEMENT

UNANTICIPATED DISCOVERIES OF ARCHAEOLOGICAL AND HISTORIC SITES INCLUDING HUMAN REMAINS

Although a project area may receive a complete Cultural Resources Assessment Survey, it is impossible to ensure that all cultural resources will be discovered. Even at sites that have been previously identified and assessed, there is a potential for the discovery of previously unidentified archaeological components, features, or human remains that may require investigation and assessment. Therefore, a procedure has been developed for the treatment of any unexpected discoveries that may occur during site development.

If unexpected cultural resources are discovered, the following steps should be taken:

- (1) Initially, all work in the immediate area of the discovery should cease, and reasonable efforts should be made to avoid or minimize impacts to the cultural resources.
- (2) A qualified Professional Archaeologist should be contacted immediately and should evaluate the nature of the discovery.
- (3) The Archaeologist should then contact the State Historic Preservation Officer (SHPO) and, if necessary, the State Archaeologist.
- (4) As much information as possible concerning the cultural resource, such as resource type, location, and size, as well as any information on its significance, should be provided to the SHPO.
- (5) Consultation with the SHPO should occur in order to obtain technical advice and guidance for the evaluation of the discovered cultural resource.
- (6) If necessary, a mitigation plan should be prepared for the discovered cultural resource. This plan should be sent to the SHPO for review and comment. The SHPO should be expected to respond with preliminary comments within two working days, with final comments to follow as quickly as possible.
- (7) If a formal data recovery mitigation plan is required, development activities in the near vicinity of the cultural resource should be avoided to ensure that no adverse impact to the resource occurs until the mitigation plan can be executed.

If human remains are encountered during site development, the stipulations of Chapter 872.05 (Offenses Concerning Dead Bodies and Graves) should be followed. All work in the near vicinity of the human remains should cease and reasonable efforts should be made to avoid and protect the remains from additional impact. In cases of inclement weather, the human remains should be protected with tarpaulins. A qualified Professional Archaeologist should be retained to investigate the reported discovery, inventory the remains and any associated artifacts, and assist in coordinating with state and local officials.

- (1) The County Medical Examiner should be immediately notified as to the findings. If the remains are found to be other than human, any construction will be cleared to proceed. If the remains are human, and are less than 75 years old, the Medical Examiner and local law

enforcement officials will assume jurisdiction. If the remains are found to be human and older than 75 years, the State Archaeologist should be notified and may assume jurisdiction of the remains.

- (2) If jurisdiction is assumed by the State Archaeologist, he will (a) determine whether the human remains represent a significant archaeological resource, and (b) make a reasonable effort to identify and locate persons who can establish direct kinship, tribal community, or ethnic relationship with the remains. If such a relationship cannot be established, then the State Archaeologist may consult with a committee of four to determine the proper disposition of the remains. This committee shall consist of a human skeletal analyst, two Native American members of current state tribes recommended by the Governor's Council on Indian Affairs, and "an individual who has special knowledge or expertise regarding the particular type of the unmarked human burial."
- (3) A plan for the avoidance of any further impact to the human remains and/or mitigative excavation, reinterment, or a combination of these treatments will be developed in consultation with the State Archaeologist, the SHPO, and, if applicable, appropriate Indian tribes or closest lineal descendants. All parties will be expected to respond with advice and guidance in an efficient time frame. Once the plan is agreed to by all parties, the plan will be implemented.

The points of contact for Florida are:

Robert Bendus, State Historic Preservation Officer
Florida Division of Historical Resources
R.A. Gray Building
500 S. Bronough St.
Tallahassee, FL 32399-0250
PH: 850-245-6333

Mary Glowacki, Ph.D., Chief and State Archaeologist
Bureau of Archaeological Research
B. Calvin Jones Center for Archaeology at the Governor Martin House
1001 de Soto Park Drive
Tallahassee, FL 32301
PH: 850-245-6301

APPENDIX B.

FMSF RESOURCE FORMS

☐ Original
☒ Update



RESOURCE GROUP FORM

FLORIDA MASTER SITE FILE

Version 4.0 1/07

Site # CI01455
 Field Date 5-22-2014
 Form Date 7-22-2014
 Recorder# _____

NOTE: Use this form to document districts, landscapes, building complexes and linear resources as described in the box below. Cultural resources contributing to the Resource Group should also be documented individually at the Site File. **Do not use this form for National Register multiple property submissions (MPSs).** National Register MPSs are treated as Site File manuscripts and are associated to the individual resources included under the MPS cover using the Site File manuscript number.

Check ONE box that best describes the Resource Group:

- ☐ **Historic district** (NR category "district"): buildings and NR structures only: NO archaeological sites
- ☐ **Archaeological district** (NR category "district"): archaeological sites only: NO buildings or NR structures
- ☐ **Mixed district** (NR category "district"): includes more than one type of cultural resource (example: archaeological sites and buildings)
- ☐ **Building complex** (NR category usually "building(s)"): multiple buildings in close spatial and functional association
- ☐ **Designed historic landscape** (NR category usually "district" or "site"): can include multiple resources (see *National Register Bulletin #18*, page 2 for more detailed definition and examples: e.g. parks, golf courses, campuses, resorts, etc.)
- ☐ **Rural historic landscape** (NR category usually "district" or "site"): can include multiple resources and resources not formally designed (see *National Register Bulletin #30, Guidelines for Evaluating and Documenting Rural Historic Landscapes* for more detailed definition and examples: e.g. farmsteads, fish camps, lumber camps, traditional ceremonial sites, etc.)
- ☒ **Linear resource** (NR category usually "structure"): Linear resources are a special type of rural historic landscape and can include canals, railways, roads, etc.

Resource Group Name Seaboard Coastline Railroad Multiple Listing [DHR only] _____
 Project Name CRAS of Duke Energy 2018 CC Parcel FMSF Survey # _____
 National Register Category (please check one): ☐ building(s) ☒ structure ☐ district ☐ site ☐ object
 Linear Resource Type (if applicable): ☐ canal ☒ railway ☐ road ☐ other (describe): _____
 Ownership: ☒ private-profit ☐ private-nonprofit ☐ private-individual ☐ private-nonspecific ☐ city ☐ county ☐ state ☐ federal ☐ Native American ☐ foreign ☐ unknown

LOCATION & MAPPING

Address: Street Number Direction Street Name Street Type Suffix Direction
 City/Town (within 3 miles) _____ In Current City Limits? ☐ yes ☒ no ☐ unknown
 County or Counties (do not abbreviate) Citrus
 Name of Public Tract (e.g., park) _____
 1) Township 17S Range 16E Section 33 ¼ section: ☐ NW ☐ SW ☐ SE ☐ NE Irregular-name: _____
 2) Township _____ Range _____ Section _____ ¼ section: ☐ NW ☐ SW ☐ SE ☐ NE
 3) Township _____ Range _____ Section _____ ¼ section: ☐ NW ☐ SW ☐ SE ☐ NE
 4) Township _____ Range _____ Section _____ ¼ section: ☐ NW ☐ SW ☐ SE ☐ NE
 USGS 7.5' Map(s) 1) Name RED LEVEL USGS Date 1990
 2) Name _____ USGS Date _____
 Plat, Aerial, or Other Map (map's name, originating office with location) _____
 Landgrant _____
 Verbal Description of Boundaries (description does not replace required map) The Seaboard Coast Line (SCL) spur runs along the southern end of the Duke Energy nuclear plant property, connecting with the main line of the SCL to the east.

DHR USE ONLY		OFFICIAL EVALUATION		DHR USE ONLY	
NR List Date	SHPO – Appears to meet criteria for NR listing: ☐ yes ☐ no ☐ insufficient info	Date		Init.	
☐ Owner Objection	KEEPER – Determined eligible: ☐ yes ☐ no	Date			
	NR Criteria for Evaluation: ☐ a ☐ b ☐ c ☐ d (see <i>National Register Bulletin 15</i> , p. 2)				

HISTORY & DESCRIPTION

Construction Year: 1966 ☒ approximately ☐ year listed or earlier ☐ year listed or later
 Architect/Designer(last name first): _____ Builder(last name first): _____
 Total number of individual resources included in this Resource Group: # of contributing _____ # of non-contributing _____
 Time period(s) of significance (choose a period from the list or type in date range(s), e.g. *1895-1925*)
 1. Twentieth C American 3. _____
 2. _____ 4. _____

Narrative Description (*National Register Bulletin 16A* pp. 33-34; fit a summary into 3 lines or attach supplementary sheets if needed) The main line of the SCL was constructed in 1888 as the Silver Springs, Ocala and Gulf (SSO&G) Railroad. The SSO&G was the first line constructed through western Citrus County and ran west from Ocala to Dunnellon and then south to Homosassa.

RESEARCH METHODS (check all that apply)

☒ FMSF record search (sites/surveys) ☒ library research ☐ building permits ☐ Sanborn maps
☐ FL State Archives/photo collection ☐ city directory ☐ occupant/owner interview ☐ plat maps
☒ property appraiser / tax records ☐ newspaper files ☐ neighbor interview ☐ Public Lands Survey (DEP)
☒ cultural resource survey ☐ historic photos ☐ interior inspection ☐ HABS/HAER record search
☒ other methods (specify) Pedestrian survey
 Bibliographic References (give FMSF Manuscript # if relevant) _____

OPINION OF RESOURCE SIGNIFICANCE

Potentially eligible individually for National Register of Historic Places? ☐ yes ☒ no ☐ insufficient information
 Potentially eligible as contributor to a National Register district? ☐ yes ☒ no ☐ insufficient information
 Explanation of Evaluation (required, see *National Register Bulletin 16A* p. 48-49. Attach longer statement, if needed, on separate sheet.) 8CI01455 was built as a spur line solely to provide access to the Crystal River Nuclear Plant, never functioned as a major transportation corridor, and it was constructed during the mid-twentieth century, which is not considered a historic Florida rr.
 Area(s) of Historical Significance (see *National Register Bulletin 15*, p. 8 for categories: e.g. "architecture", "ethnic heritage", "community planning & development", etc.)
 1. _____ 3. _____ 5. _____
 2. _____ 4. _____ 6. _____

DOCUMENTATION

Accessible Documentation Not Filed with the Site File - including field notes, analysis notes, photos, plans and other important documents
 1) Document type All materials at one location Maintaining organization Southeastern Archaeological Research
 Document description photos, maps, field notes, aerials File or accession #'s 3176
 2) Document type _____ Maintaining organization _____
 Document description _____ File or accession #'s _____

RECORDER INFORMATION

Recorder Name Melissa Dye Affiliation Southeastern Archaeological Research
 Recorder Contact Information 315 NW 138th Terr, Newberry, FL 32669/melissa@searchinc.com
 (address / phone / fax / e-mail)

Required Attachments

- ① PHOTOCOPY OF USGS 7.5' MAP WITH DISTRICT BOUNDARY CLEARLY MARKED
- ② LARGE SCALE STREET, PLAT OR PARCEL MAP WITH RESOURCES MAPPED & LABELED
- ③ TABULATION OF ALL INCLUDED RESOURCES (name, FMSF #, contributing? Y/N, resource category, street address or township-range-section if no address)
- ④ PHOTOS OF GENERAL STREETSCAPE OR VIEWS (Optional: aerial photos, views of typical resources)
 Photos may be archival B&W prints OR digital image files. If submitting digital image files, they must be included on disk or CD AND in hard copy format (plain paper is acceptable). Digital images must be at least 1600 x 1200 pixels, 24-bit color, jpeg or tiff.



Views of newly recorded Linear Resource CI01455, Seaboard Coast Line Railroad, within the Duke Energy 2018 CC Survey Area in Citrus County, Florida. Top: View northeast along the loop at the western end of the spur line; bottom: View east along West Powerline Street on the south parcel boundary.

**Locational
Information
Redacted**

**Locational
Information
Redacted**



ARCHAEOLOGICAL SITE FORM

FLORIDA MASTER SITE FILE

Version 4.0 1/07

Consult Guide to Archaeological Site Form for detailed instructions

Site #8 **CI01456**Field Date 5-28-2014Form Date 6-19-2014

Recorder # _____

☒ Original☐ UpdateSite Name(s) Holcim Site 1 Multiple Listing (DHR only) _____Project Name Duke Energy 2018 CC Parcel Survey # (DHR only) _____Ownership: ☒ private-profit ☐ private-nonprofit ☐ private-individual ☐ private-nonspecific ☐ city ☐ county ☐ state ☐ federal ☐ Native American ☐ foreign ☐ unknown

LOCATION & MAPPING

USGS 7.5 Map Name RED LEVEL USGS Date 1990 Plat or Other Map _____City/Town (within 3 miles) _____ In City Limits? ☐ yes ☒ no ☐ unknown County CitrusTownship 17S Range 16E Section 27 ¼ section: ☐ NW ☒ SW ☐ SE ☐ NE Irregular-name: _____Township _____ Range _____ Section _____ ¼ section: ☐ NW ☐ SW ☐ SE ☐ NE

Landgrant _____ Tax Parcel # _____

UTM Coordinates _____

Other Coordinates: X: _____ Y: _____ Coordinate System & Datum _____

Address / Vicinity / Route to: Site is north of Transmission Line access road, approximately 0.35 miles east of the Crystal River Power PlantName of Public Tract (e.g., park) Holcim Property

TYPE OF SITE (select all that apply)

SETTING	STRUCTURES OR FEATURES	FUNCTION
☒ Land (terrestrial)	☐ log boat	☐ road segment
☐ Lake/Pond (lacustrine)	☐ agric./farm building	☐ midden
☐ River/Stream/Creek (riverine)	☐ burial mound	☐ shell midden
☐ Tidal (estuarine)	☐ building remains	☐ shell mound
☐ Saltwater (marine)	☐ cemetery/grave	☐ shipwreck
☐ Wetland (palustrine)	☐ dump/refuse	☐ subsurface features
☐ usually flooded	☐ earthworks (historic)	☐ surface scatter
☐ usually dry	☐ platform mound	☐ well
☐ Cave/Sink (subterranean)	☐ fort	☐ campsite
☐ terrestrial	☐ mill	☐ extractive site
☐ aquatic	☐ mission	☒ habitation (prehistoric)
	☐ mound, nonspecific	☐ homestead (historic)
	☐ plantation	☐ farmstead
		☐ village (prehistoric)
		☐ town (historic)
		☐ quarry

Other Features or Functions (Choose from the list or type a response.)

1. _____ 2. _____

CULTURE PERIODS (select all that apply)

ABORIGINAL	NON-ABORIGINAL
☐ Alachua	☐ First Spanish 1513-99
☐ Archaic (nonspecific)	☐ First Spanish 1600-99
☐ Archaic, Early	☐ First Spanish 1700-1763
☐ Archaic, Middle	☐ First Spanish (nonspecific)
☐ Archaic, Late	☐ British 1763-1783
☐ Belle Glade	☐ Second Spanish 1783-1821
☐ Cades Pond	☐ American Territorial 1821-45
☐ Caloosahatchee	☐ American Civil War 1861-65
☐ Deptford	☐ American 19th Century
☐ Englewood	☐ American 20th Century
☐ Fort Walton	☐ American (nonspecific)
☐ Glades (nonspecific)	☐ African-American
☐ Glades I	
☐ Glades II	
☐ Glades III	
☐ Hickory Pond	
☐ Leon-Jefferson	
☐ Malabar I	
☐ Malabar II	
☐ Manasota	
☐ Mississippian	
☐ Mount Taylor	
☐ Norwood	
☐ Orange	
☐ Paleoindian	
☐ Pensacola	
☐ Perico Island	
☐ Safety Harbor	
☐ St. Augustine	
☐ St. Johns (nonspecific)	
☐ St. Johns I	
☐ St. Johns II	
☐ Santa Rosa	
☐ Santa Rosa-Swift Creek	
☐ Seminole (nonspecific)	
☐ Seminole: Colonization	
☐ Seminole: 1st War To 2nd	
☐ Seminole: 2nd War To 3rd	
☐ Seminole: 3rd War & After	
☐ Swift Creek (nonspecific)	
☐ Swift Creek, Early	
☐ Swift Creek, Late	
☐ Transitional	
☐ Weeden Island (nonspecific)	
☐ Weeden Island I	
☐ Weeden Island II	
☒ Prehistoric (nonspecific)	
☒ Prehistoric non-ceramic	
☐ Prehistoric ceramic	

Other Cultures (Choose from the list or type a response. For historic sites, give specific dates.)

1. _____ 2. _____ 3. _____ 4. _____

OPINION OF RESOURCE SIGNIFICANCE

Potentially eligible individually for National Register of Historic Places? ☐ yes ☒ no ☐ insufficient informationPotentially eligible as contributor to a National Register district? ☐ yes ☒ no ☐ insufficient informationExplanation of Evaluation (required if evaluated; use separate sheet if needed) Site is a low density lithic scatter.Recommendations for Owner or SHPO Action Ineligible, no further work needed.

DHR USE ONLY

OFFICIAL EVALUATION

DHR USE ONLY

NR List Date _____

SHPO - Appears to meet criteria for NR listing: ☐ yes ☐ no ☐ insufficient info

Date _____ Init. _____

KEEPER - Determined eligible: ☐ yes ☐ no

Date _____

☐ Owner ObjectionNR Criteria for Evaluation: ☐ a ☐ b ☐ c ☐ d (see National Register Bulletin 15, p. 2)

FIELD METHODS (select all that apply)

SITE DETECTION

- ☐ no field check ☐ exposed ground ☐ screened shovel
☐ literature search ☐ posthole tests ☒ screened shovel-1/4"
☐ informant report ☐ auger tests ☐ screened shovel-1/8"
☐ remote sensing ☐ unscreened shovel ☐ screened shovel-1/16"

- ☐ bounds unknown ☐ remote sensing
☐ none by recorder ☐ exposed ground
☐ literature search ☐ posthole tests
☐ informant report ☐ auger tests

SITE BOUNDARY

- ☐ unscreened shovel
☒ screened shovel
☐ block excavations
☐ estimate or guess

Other methods; number, size, depth, pattern of units; screen size (attach site plan) Shovel tests were excavated at 12.5 and 25-meter intervals to determine boundary of site.

SITE DESCRIPTION

Extent Size (m²) 5 Depth/stratigraphy of cultural deposit 0-60 cmbs

Temporal Interpretation - Components (check one): ☐ single component ☐ multiple component ☒ uncertain

Describe each occupation in plan (refer to attached large scale map) and stratigraphically. Discuss temporal and functional interpretations:

Non-diagnostic lithic materials did not indicate any temporal occupation.

Integrity - Overall disturbance: ☒ none seen ☐ minor ☐ substantial ☐ major ☐ redeposited ☐ destroyed-document! ☐ unknown
Disturbances / threats / protective measures _____

Surface collection: area collected _____ m² # collection units _____ Excavation: # noncontiguous blocks _____

ARTIFACTS

Total Artifacts # 4 ☒ count ☐ estimate Surface # 1 Subsurface # 3

COLLECTION SELECTIVITY

- ☐ unknown ☒ unselective (all artifacts)
☐ selective (some artifacts)
☐ mixed selectivity

SPATIAL CONTROL

- ☐ uncollected ☐ general (not by subarea)
☐ unknown ☒ controlled (by subarea)
☐ variable spatial control
☐ other (describe in comments below)

Artifact Comments _____

ARTIFACT CATEGORIES and DISPOSITIONS

A - Lithics

select a disposition from the list below for each artifact category selected at left

A - category always collected
S - some items in category collected
O - observed first hand, but not collected
R - collected and subsequently left at site
I - informant reported category present
U - unknown

DIAGNOSTICS (type or mode, and frequency: e.g., *Suwanee ppk*, *heat-treated chert*, *Deptford Check-stamped*, *ironstone/whiteware*)

1. _____ N= _____ 4. _____ N= _____ 7. _____ N= _____
2. _____ N= _____ 5. _____ N= _____ 8. _____ N= _____
3. _____ N= _____ 6. _____ N= _____ 9. _____ N= _____

ENVIRONMENT

Nearest fresh water: Type Other Name Gulf of Mexico Distance from site (m) 10,000
Natural community WET FLATWOODS Topography Other Elevation: Min 2 m Max 3 m
Local vegetation pine, saw palmetto, cypress, bay, and sweet gum
Present land use none
SCS soil series Boca Soil association Boca, Boca-Pineda and Broward fine

DOCUMENTATION

Accessible Documentation Not Filed with the Site File - including field notes, analysis notes, photos, plans and other important documents

1) Document type All materials at one location Maintaining organization Southeastern Archaeological Research
Document description _____ File or accession #'s _____
2) Document type Field notes Maintaining organization _____
Document description _____ File or accession #'s _____

RECORDER & INFORMANT INFORMATION

Informant Information: Name Michael Arbuthnot

Address / Phone / E-mail 904-379-8338

Recorder Information: Name Melissa Dye

Affiliation Southeastern Archaeological Research

Address / Phone / E-mail 904-379-8338

Required Attachments

① PHOTOCOPY OF 7.5' USGS QUAD MAP WITH SITE BOUNDARIES MARKED *and* SITE PLAN
Plan at 1:3,600 or larger. Show boundaries, scale, north arrow, test/collection units, landmarks and date.

**Locational
Information
Redacted**

**Locational
Information
Redacted**

APPENDIX C.

FDHR SURVEY LOG SHEET

Ent D (FMSF only) _____



Survey Log Sheet

Florida Master Site File
Version 4.1 1/07

Survey # (FMSF only) _____

Consult *Guide to the Survey Log Sheet* for detailed instructions.

Identification and Bibliographic Information

Survey Project (name and project phase) Phase I for Duke Energy 2018 CC Parcel.

Report Title (exactly as on title page) Cultural Resource Assessment Survey of the Duke Energy 2018 CC Parcel, Citrus County, Florida

Report Authors (as on title page, last names first) 1. Arbuthnot, Michael 3. VanDyke, Ryan
2. Dye, Melissa 4. _____

Publication Date (year) 2014 Total Number of Pages in Report (count text, figures, tables, not site forms) 50

Publication Information (Give series, number in series, publisher and city. For article or chapter, cite page numbers. Use the style of *American Antiquity*.)

Cultural Resource Assessment Survey of the Duke Energy 2018 CC Parcel, Citrus County, Florida
SEARCH Report of Investigations, Pensacola, FL.

Supervisors of Fieldwork (even if same as author) Names Michael Arbuthnot

Affiliation of Fieldworkers: Organization Southeastern Archaeological Research City Jacksonville, FL

Key Words/Phrases (Don't use county name, or common words like *archaeology, structure, survey, architecture, etc.*)

1. Duke Energy 3. Holcim 5. _____ 7. _____
2. Crystal River 4. Seaboard Coast Line 6. _____ 8. _____

Survey Sponsors (corporation, government unit, organization or person directly funding fieldwork)

Name Duke Energy Organization Southeastern Archaeological Research

Address/Phone/E-mail _____

Recorder of Log Sheet Melissa Dye Date Log Sheet Completed 7-22-2014

Is this survey or project a continuation of a previous project? ☒ No ☐ Yes: Previous survey #s (FMSF only) _____

Mapping

Counties (List each one in which field survey was done; attach additional sheet if necessary)

1. Citrus 3. _____ 5. _____
2. _____ 4. _____ 6. _____

USGS 1:24,000 Map Names/Year of Latest Revision (attach additional sheet if necessary)

1. Name RED LEVEL Year 1990 4. Name _____ Year _____
2. Name _____ Year _____ 5. Name _____ Year _____
3. Name _____ Year _____ 6. Name _____ Year _____

Description of Survey Area

Dates for Fieldwork: Start 05-20-2014 End 05-29-2014 Total Area Surveyed (fill in one) _____ hectares 643 acres

Number of Distinct Tracts or Areas Surveyed 1

If Corridor (fill in one for each) Width: _____ meters _____ feet Length: _____ kilometers _____ miles

Research and Field Methods

Types of Survey (check all that apply): ☒ archaeological ☒ architectural ☒ historical/archival ☐ underwater
☐ damage assessment ☐ monitoring report ☐ other(describe): _____

Scope/Intensity/Procedures Phase I survey anticipation of permitting requirements associated with proposed construction activities in the Crystal River Energy Complex (CREC).
Shovel tests placed at 100-, 25- and 12.5-meter intervals throughout the project area.

Preliminary Methods (check as many as apply to the project as a whole)

☐ Florida Archives (Gray Building) ☐ library research- *local public* ☒ local property or tax records ☒ other historic maps
☐ Florida Photo Archives (Gray Building) ☐ library-special collection - *nonlocal* ☐ newspaper files ☒ soils maps or data
☐ Site File property search ☐ Public Lands Survey (maps at DEP) ☒ literature search ☐ windshield survey
☒ Site File survey search ☐ local informant(s) ☐ Sanborn Insurance maps ☒ aerial photography
☐ other (describe): _____

Archaeological Methods (check as many as apply to the project as a whole)

☐ Check here if **NO** archaeological methods were used.
☐ surface collection, controlled ☐ shovel test-other screen size ☐ block excavation (at least 2x2 m)
☐ surface collection, uncontrolled ☐ water screen ☐ soil resistivity
☒ shovel test-1/4" screen ☐ posthole tests ☐ magnetometer
☐ shovel test-1/8" screen ☐ auger tests ☐ side scan sonar
☐ shovel test 1/16" screen ☐ coring ☒ pedestrian survey
☐ shovel test-unscreened ☐ test excavation (at least 1x2 m) ☐ unknown
☐ other (describe): _____

Historical/Architectural Methods (check as many as apply to the project as a whole)

☐ Check here if **NO** historical/architectural methods were used.
☐ building permits ☐ demolition permits ☐ neighbor interview ☐ subdivision maps
☐ commercial permits ☒ exposed ground inspected ☐ occupant interview ☒ tax records
☐ interior documentation ☒ local property records ☐ occupation permits ☐ unknown
☐ other (describe): _____

Survey Results (cultural resources recorded)

Site Significance Evaluated? ☒ Yes ☐ No

Count of Previously Recorded Sites 0 Count of Newly Recorded Sites 2

Previously Recorded Site #'s with Site File Update Forms (List site #'s without "8". Attach additional pages if necessary.) _____

Newly Recorded Site #'s (Are all originals and not updates? List site #'s without "8". Attach additional pages if necessary.) CI01456, CI01455

Site Forms Used: ☐ Site File Paper Form ☒ Site File Electronic Recording Form

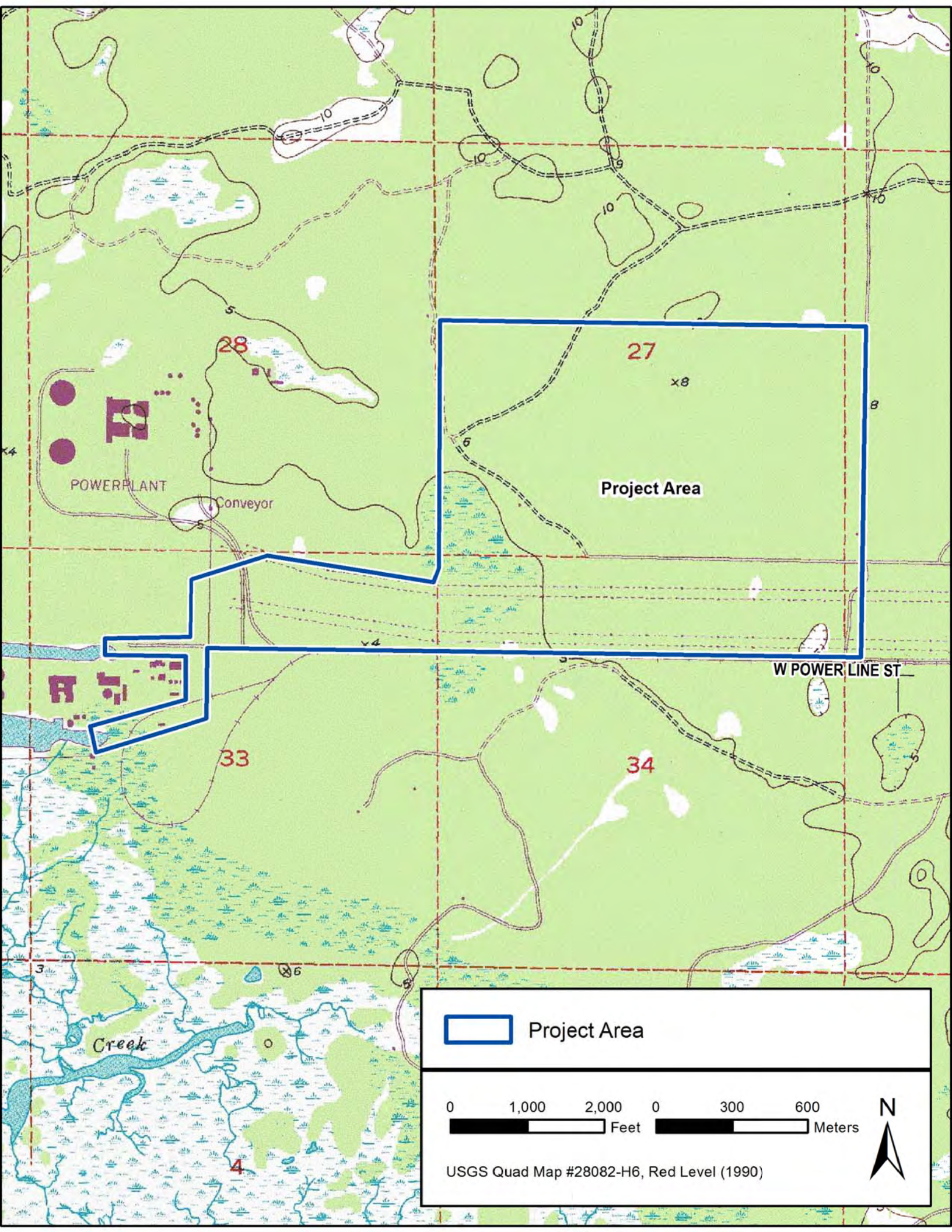
*****REQUIRED: ATTACH PLOT OF SURVEY AREA ON PHOTOCOPY OF USGS 1:24,000 MAP(S)*****

SHPO USE ONLY

SHPO USE ONLY

SHPO USE ONLY

Origin of Report: ☐ 872 ☐ CARL ☐ UW ☐ 1A32 # _____ ☐ Academic ☐ Contract ☐ Avocational
☐ Grant Project # _____ ☐ Compliance Review: CRAT # _____
Type of Document: ☐ Archaeological Survey ☐ Historical/Architectural Survey ☐ Marine Survey ☐ Cell Tower CRAS ☐ Monitoring Report
☐ Overview ☐ Excavation Report ☐ Multi-Site Excavation Report ☐ Structure Detailed Report ☐ Library, Hist. or Archival Doc
☐ MPS ☐ MRA ☐ TG ☐ Other: _____
Document Destination: _____ Plotability: _____



Project Area

W POWER LINE ST

Creek



Project Area

0 1,000 2,000 Feet

0 300 600 Meters



USGS Quad Map #28082-H6, Red Level (1990)

Cultural Resource Assessment Survey of
the Duke Energy 2018 CC Parcel
Citrus County, Florida



APPENDIX 10.7.2

SITE CHARACTERIZATION AND PRELIMINARY GEOTECHNICAL DESIGN RECOMMENDATIONS

**SITE CHARACTERIZATION AND PRELIMINARY
GEOTECHNICAL DESIGN RECOMMENDATIONS**

CITRUS COUNTY COMBINED CYCLE PROJECT

CRYSTAL RIVER, FLORIDA



Prepared for:

DUKE ENERGY FLORIDA

Prepared by:

AMEC Environment & Infrastructure, Inc.
2000 East Edgewood Drive, Suite 215
Lakeland, Florida 33803

AMEC Project No: 300743x2

December 2013

CERTIFICATION

Engineering Certification

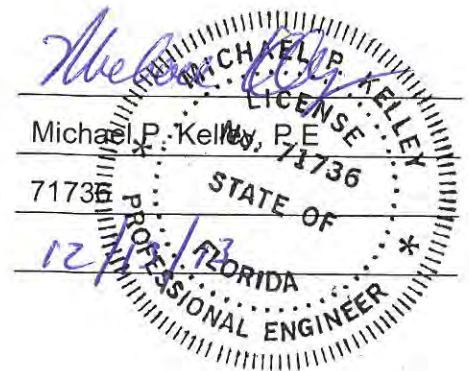
I hereby certify that I am a registered professional engineer in the State of Florida practicing with AMEC Environment & Infrastructure, a corporation authorized to operate as a business providing engineering consulting services (EB 5392) by the State of Florida Department of Professional Regulation, Board of Engineers. I further certify that I, or others under my direct supervision, have prepared the geotechnical engineering evaluations, findings, opinions, calculations, conclusions or technical advice hereby represented in this report.

SIGNATURE:

NAME:

LICENSE No.:

DATE:



Report Title: Site Characterization and Preliminary
Geotechnical Design Recommendations
For Citrus County Combined Cycle Project
Crystal River, Florida

AMEC Project No. 300743x2

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1.0 INTRODUCTION

Based upon the information provided by Duke Energy Florida (Owner), AMEC Environment & Infrastructure, Inc. (AMEC) understands that the Owner plans to develop a new energy power plant and substation to the east of existing power plant as shown on **Figure 1**.

AMEC was tasked with performing a preliminary geotechnical investigation for the proposed site development and structures. The results of the geotechnical investigation were used to develop geotechnical recommendations for the design and construction of the proposed structure foundations.

1.1 SCOPE OF SERVICES

Based on the information provided by the Owner, AMEC's field investigation program included the following items:

- A field Ground Penetrating Radar (GPR) survey was performed at the subject site primarily in the vicinity of the boring locations, to identify possible buried utilities, assess possible karst features, and classify risks for sinkhole development.
- Twenty-five Standard Penetration Test (SPT) borings were performed in general accordance with ASTM D 1586. The locations and depths of the borings were specified by the Owners representatives. The initial scope of works called for SPT borings to depths of between 35 and 100 feet. Where possible, samples for an adequate characterization of the subsurface materials were collected at the boring locations on 2.5-foot intervals to a depth of 20 feet below ground surface or shallower depending on the depth of bedrock, and 5.0-foot intervals within bedrock to the boring termination depths.
- Rock coring in bedrock was performed with a swivel type double split tube core barrel and side-discharge diamond bit in accordance with ASTM D 2113. When hard bedrock was encountered, rock core runs of 5 feet were performed with an SPT split-spoon sample performed directly above and below. The rock cores were placed in partitioned core boxes separating each core run. Rock cores were labeled and arranged in the core boxes, with clear markings for depths of the run and the amount of recovery.
- Seven piezometers were installed after completion of drilling and sampling of designated boring locations. Groundwater measurements were taken on a daily basis during the fieldwork. The piezometers remain active on site for future measurements and use.
- Laboratory index testing was performed on selected soil samples for classification; recovered rock core samples were also tested to determine rock mass strengths.

2.0 PROJECT SITE CHARACTERISTICS

2.1 Site Location and Existing Site Use

The project site is located 2.5 miles west of US-19 and north of West Power Line Street in Crystal River, Citrus County, FL in Section 27, Township 17 and Range 16 as shown on **Figure 2**. The project site is a generally flat with moderately to heavily wooded areas. The site also includes multiple wetland and shallow pond areas.

The project site is undeveloped without any significant structures and is currently not being used for agricultural purposes. Based on a review of published historical aerial photographs, the site does not appear to have been modified from its original state. An existing power plant facility is located to the west of the site and mining operations are located to the north of the site; however, no mining operations or industrial activities are currently evident at the project site.

2.2 Site Geology

Structure

The geologic structure that underlies the subject site is the Ocala Platform. The Ocala Platform is the most dominant feature in the central peninsular region of Florida. The shallow or exposed carbonate rocks of the Ocala Group in areas of Citrus, Levy, Marion, and Sumter Counties reflect the influence of the platform. In places, the rock is blanketed by a thin veneer of Pleistocene and Holocene sands.

Geomorphology

The subject site is located in the Gulf Coastal Lowlands geomorphic province (White, 1970). The subject site is relatively flat with an approximate elevation of 6 feet National Geodetic Vertical Datum (NGVD). The topography and geomorphology of Florida have been influenced by interactions of sea-level changes, karst processes, and subtle tectonic forces. Within the Gulf Coastal Lowlands, elevations range from sea-level to approximately 100 feet NGVD. Diverse ecosystems are present within the Gulf Coastal Lowlands including: dry prairies, pine flatwoods, and to a lesser extent, swamps, scrub, and high pine and salt marshes (Crumpacker, 1992). The Gulf Coastal Lowlands do not coincide with any mappable marine terrace and are generally characterized by wide, flat marine karstic plains, including paleo-dunes (White, 1970).

Hydrogeology

Water-bearing sediments and sedimentary rocks can generally be divided into two types: siliciclastics and carbonates which comprise the aquifers encountered regionally. The two aquifers recognized at the subject site are the Surficial aquifer system (SAS) and the Floridan aquifer system (FAS).

The Surficial aquifer system is the upper permeable hydrogeologic unit nearest to land surface that is comprised predominantly of unconsolidated siliciclastic deposits. Rocks and sediments making up the SAS belong to all or part of the Miocene to Holocene lithologic units. The SAS contains the water table and water within it is under mainly unconfined conditions.

The Floridan aquifer system is a thick, predominantly carbonate sequence that includes all or part of the Paleocene to Lower Miocene lithologic units. The FAS is present throughout Florida and parts of Georgia, Alabama, and Mississippi and is primary water supply for most of the state. When overlain directly by the SAS, the FAS may or may not contain water under confined conditions depending on the extent of low permeability material within the base of the SAS (Arthur, et al. 2008). Arthur et al. also notes that where the carbonate rocks of the FAS crop out or are covered only by a thin veneer of permeable siliciclastics, the FAS generally contains water under unconfined conditions near the top of the aquifer system, but because of vertical variations in permeability, deeper zones may contain water under confined conditions.

Stratigraphy

The stratigraphic units expected to be encountered during our exploration include the Eocene aged Avon Park Formation and Ocala Limestone. Beds of Oligocene age are not present in the area, although the Oligocene aged Suwannee limestone is present in some areas of peninsular Florida. Much of the Eocene aged rock mapped as being either at or near land surface is actually covered by a veneer of Pleistocene sand and clayey sand distributed as marine terrace deposits at high stands of the sea during interglacial periods (Faulkner, 1973). Faulkner (1973) also indicates some of the sandy cover is material from the Miocene and younger deposits.

Lithology of the Avon Park Formation varies between limestone and dolostone. Arthur, et al. (2008), describes the limestone as: *generally cream to light brown, poorly to well indurated, variably fossiliferous, skeletal/peloidal wackestone to grainstone with minor mudstone; the limestone can be interbedded with dark brown to tan very-fine to coarse-grained, vuggy, fossiliferous dolostones. Incomplete to complete dolomitization of limestone is also observed. Dolostone textures range from very fine-grained to a coarsely re-crystallized sucrosic texture. Minor clay beds and organic-rich laminations may occur, especially at or near the top of the unit.* Sedimentary structures are not common in the Avon Park Formation. Porosity in the Avon Park Formation is generally inter-granular in the limestone section. Fracture porosity occurs in the more densely re-crystallized dolostone and inter-crystalline porosity is characteristic of sucrosic textures. Pinpoint vugs and fossil molds are present to a lesser extent.

The Ocala Limestone unconformably overlies the Avon Park Formation throughout subject site and the mineralogy is predominantly calcite, and to a lesser extent, dolomite. The contact between these two units is readily apparent to difficult to determine. Arthur, et al. (2008), indicates the more obvious contact relations occur where: 1) lithology of the Avon Park Formation is tan to brown dolostone, overlain by white to cream limestone of the Ocala Limestone, in the case where both units are limestone, the uppermost Avon Park Formation is grain supported and contains disseminated organics or thin beds of peat, whereas the lowermost Ocala Limestone is finer grained and skeletal. The lower Ocala Limestone varies from white to light gray, is variably indurated, ranging from a packstone to a grainstone (Gaswirth, 2004). Where present, dolomite content increases with depth in the Ocala Limestone. Gaswirth (2004) also noted this pattern and documented textural end-members within these dolostones: 1) friable, light to medium brown, sucrosic and 2) indurated, dark gray to dark brown, dense, crystalline. The upper part of the Ocala Limestone varies from white to light orange and tends to be more mud-supported (i.e., mudstone to wackestone) and chalky.

Photo-linear Study

Through the use of remote sensing studies such as aerial photography, topographic features, or space imagery, it is possible to delineate subsurface fracture traces, which are projected to the surface as lineaments and photo-linears. A fracture trace is a linear structural geologic trend which, based upon field investigations, is proven to be associated with a high-angle, near-vertical fracture/crack in the rock mass (e.g., joint, fault, or fissure). A lineament is a linear topographic feature (such as a straight stream course or scarp), typically greater than 1 mile in length that presumably reflects a hidden structural feature; while a photo-linear is a linear trend discerned from aerial photographs that may or may not have any structural geologic significance.

In Central Florida, the existence of lineaments is often associated with vertical fractures in the underlying limestone bedrock. Lineaments may be expressed as alignments of vegetation; straight segments of stream courses; alignment of lakes, ponds, depressions and springs; changes in photographic tones, drainage and erosional textures on opposite sides of a linear feature; alignments of varied topographic features (e.g. saddles, knobs, or straight scarps). Major lineaments contained within Citrus County have previously been mapped by Vernon (Florida Department of Transportation - FDOT, 1951) and the FDOT (1973). Portions of the respective maps are presented in **Appendix A** as Figure A.1. Major lineaments mapped by FDOT show two proximal to the subject site, while no lineaments mapped by Vernon were located near the subject site.

Criteria used for determination of photo-linears for this study was an identified linear alignment of connecting streams and small tributaries, or an alignment of three prominent geomorphic features (linear and/or circular) or 4 less prominent geomorphic features on low-altitude historic aerial photographs.

Figure A.2 in **Appendix A** presents historical aerial photographs of the subject site from 1944 with boring locations and identified photo-linears as determined by AMEC. A total of five photo-linears were constructed which extend within the subject site. Borings were completed in the general vicinity of three of the constructed photo-linear locations. One of the borings (B-15) completed near (+/- 900 feet) a photo-linear location encountered subsurface conditions showing evidence of vertical erosional/karst activity as discussed below.

Karst Activity Maps

Karst limestone and sinkhole activity are common geological formations in Citrus County. A sinkhole is a landform that has been created by the subsidence or collapse of sediment or rock as underlying limestone or dolostone layers are dissolved by slightly acidic groundwater.

A review of the Map Series 110 by Florida Department of Natural Resources, Bureau of Geology (**Appendix A**, Figure A.3) indicates the project site is located in an area where solution sinkhole is the dominant type among the four classified sinkhole types. Solution sinkholes occur in areas where limestone is exposed at land surface or is covered by thin layers of soil and permeable sand. Solution is most active at the limestone surface and along joints, fractures or other openings in the rock that permit water to move easily into the subsurface. Dissolved limestone and some insoluble residue are carried downward by percolating water along enlarged openings as solution of the limestone progresses. Large voids commonly do not form because subsidence of the soil layer occurs as the limestone surface dissolves. The result is a gradual downward movement of the land surface and development of a depression that collects increasing amounts of surface runoff as its perimeter expands.

2.3 Site Seismicity

Seismic Hazard Maps produced by the U.S. Geological Survey (<http://earthquake.usgs.gov>) indicate an approximate peak ground acceleration (PGA) of 0.05g (for 1Hz or 0.1 second spectral acceleration) for a 2 percent in 50 years probability of exceedence. This value is considered to be relatively low in comparison to seismically active areas in the U.S. No active faults are identified in the central Florida and Gulf Coast regions.

The Federal Emergency Management Agency (FEMA) and International Building Code (IBC) classifies areas by Seismic Design Categories (SDC), which reflect the likelihood of experiencing earthquake shaking of various intensities. The central Florida area has a SDC A classification, which is described as “very small probability of experiencing damaging earthquake effects”.

The probability and risk of an earthquake occurring in the vicinity of the project site large enough to cause structural damage is considered very low. No additional structural design features to accommodate earthquake loads are considered necessary for the proposed project.

2.4 Planned Facilities

We understand that Owner intends to construct three facilities and a stormwater pond at the proposed site. The three facilities will consist of a plant facility, substation facility and an administration/warehouse/maintenance facility. The Owner informed AMEC that the plant and substation grade is expected to be raised approximately 6 feet to promote drainage.

3.0 GEOTECHNICAL PROGRAM

3.1 Existing Geotechnical Data

Natural Resources Conservation Services Soil Survey Map

The Soil Survey of Citrus County, prepared by the United States Department of Agriculture - Natural Resources Conservation Services (USDA-NRCS 2012), was reviewed as part of the investigation. The predominant soil unit encountered at the proposed site is identified as Boca Fine Sand (Soil Unit #53) which generally consists of a 3-foot thick sandy and loamy marine deposit over lithic bedrock limestone. Neighboring mapped soil units includes Boca-Pineda, limestone substratum complex (Soil Unit #51), which is very similar to the Boca Fine Sand soil unit, and Hallandale-Rock outcrop complex, rarely flooded (Soil Unit #39), which includes a 1-foot thick surficial layer of fine sand and then extending immediately below is a hard limestone layer. The Soil Survey map and data for the site are presented in **Appendix B**.

The site appears to be undeveloped from its original state and as such, the soil survey should represent a relatively accurate description of the shallow ground profile at the site.

Previous Site Investigations

Site investigations were completed by others at the existing Crystal River Energy Complex to the west of the project site. This information was not made available to AMEC for consideration in this report. However, our previous experience at the site indicates the ground conditions are generally similar to the project site.

3.2 Drilling and Sampling Program

Twenty-five SPT borings were performed in general accordance with ASTM D 1586. The SPT borings were completed between October 30 and November 27, 2013 using a Central Mining Equipment (CME) truck-mounted drilling rig and an all-terrain vehicle-mounted drilling rig operated by Independent Drilling Inc. (IDI) of Leesburg, Florida using the mud rotary drilling method.

The borehole locations were typically located within 10 feet from the original planned locations using a hand held Global Positioning System (GPS) system. The borings locations were reviewed against existing survey data to determine the final coordinates. The boring locations are shown on **Figure 3**. The following **Table 1** summarizes the drilling locations and depths.

TABLE 1 – Boring Elevations and Locations

Boring	Approximate Ground Elevation (feet)	Location		Boring Depth (feet)
		Latitude	Longitude	
B-01	7.1	28° 58' 07.7"	82° 40' 28.7"	39.7
B-02	5.6	28° 58' 07.8"	82° 40' 20.8"	38.8
B-03	5.7	28° 58' 06.7"	82° 40' 26.9"	58.1
B-04	7.9	28° 58' 06.7"	82° 40' 22.6"	72.0
B-05	6.9	28° 58' 05.4"	82° 40' 28.7"	73.6
B-06	7.4	28° 58' 05.4"	82° 40' 25.3"	74.8
B-07	8.6	28° 58' 05.4"	82° 40' 20.8"	66.0
B-08	6.5	28° 58' 03.7"	82° 40' 26.9"	73.8
B-09	5.8	28° 58' 03.8"	82° 40' 22.5"	99.3
B-10	7.9	28° 58' 03.8"	82° 40' 19.2"	73.6
B-11	5.2	28° 58' 02.9"	82° 40' 28.7"	68.4
B-12	7.7	28° 58' 02.9"	82° 40' 25.3"	70.0
B-13	7.6	28° 58' 02.9"	82° 40' 20.8"	98.5
B-14	7.1	28° 58' 01.4"	82° 40' 26.9"	98.6
B-15	7.7	28° 58' 01.4"	82° 40' 22.5"	26.0
B-16	8.1	28° 58' 01.5"	82° 40' 19.2"	54.6
B-17	6.3	28° 58' 00.2"	82° 40' 28.6"	63.7
B-18	7.5	28° 58' 00.2"	82° 40' 20.8"	56.0
B-19	6.8	28° 58' 04.1"	82° 40' 32.6"	28.3
B-20	7.2	28° 58' 03.3"	82° 40' 16.7"	55.0
B-21	6.6	28° 57' 53.4"	82° 40' 25.1"	58.7
B-22	6.2	28° 57' 53.4"	82° 40' 17.8"	58.1
B-23	7.5	28° 57' 50.3"	82° 40' 21.4"	98.6
B-24	6.7	28° 57' 47.3"	82° 40' 25.1"	58.8
B-25	7.0	28° 57' 47.4"	82° 40' 17.8"	63.9

Note: Horizontal Datum: North American Datum NAD 83 (2011)
North American Vertical Datum: NAVD 88, State Plane System Zone: FLORIDA WEST

Soil samples were collected from the boreholes using a 1.5-inch inside diameter (ID) split-spoon sampler driven with a 140-pound automatic slide hammer falling a distance of 30 inches. AMEC staff engineers and staff geologists familiar with the field procedures and soil classification logged the borings in the field in general accordance with ASTM D 2487.

Limestone core runs were performed in general accordance with ASTM D 2113 when SPT refusals in hard bedrock were encountered, using a core barrel with 2.5-inch and 4-inch ID in accordance with the Project Specifications (minimum diameter of 2.125 inches).

A representative number of samples for characterization of the subsurface materials were collected at the boring locations with a typical 2.5-foot and 5-foot sampling interval. The SPT samples collected from the field program were placed in sealed containers and returned to our laboratory for classification and analysis in accordance with the Unified Soils Classification System (USCS) designations. The laboratory testing program included Grain Size Analysis (ASTM D 422 and D 1140), Natural Moisture Content (ASTM D 2216), Liquid Limit, Plastic Limit, and Plasticity Index of Soils (ASTM D 4318), Unconfined Compressive Strength of Rock Cores (ASTM D 7012), and Split Tensile Testing of Rock Cores (ASTM D 3967). The recommendations presented in this report are based upon a review of the soil test data and AMEC's experience with similar projects and subsurface conditions. The boring logs are included in **Appendix D**.

During the early phase of the drilling operation, the ground conditions encountered at the site warranted modifications to the drilling procedures to improve rock core recovery and collect the most representative data of the existing ground conditions. Coring in the upper strata, typically to approximately 50 feet below ground surface, was terminated as the interbedded hard and soft limestone and loose sand layers caused very poor core recovery. SPT drilling was performed until hard limestone was encountered after multiple SPT refusals, then rock coring was attempted. Rock core recovery lengths ranged from 6 inches to 55 inches with recovery percentage ranging between 10 and 92 percent. Photographs of rock core recovery are shown in **Appendix E**.

Subsurface Conditions

The subsurface geology at the site is illustrated in the soil boring logs shown in **Appendix D**, which should be consulted for detailed descriptions of the subsurface conditions encountered at each boring location. The boring profiles are shown on **Figures 4 – 4D** and represent AMEC's interpretation of the subsurface geotechnical conditions based on the soil boring logs and a visual re-examination of the samples by a geotechnical engineer in our laboratory. The lines designating the interface between various strata on the boring profiles represent the approximate interface location. It should be noted that the actual transition between strata may be gradual. The computer generated boring logs should imply no increased accuracy.

The following generalized strata were identified within the termination depths of the twenty-five SPT borings are summarized below:

STRATUM 1:

Loose SAND: Typically encountered from ground surface to a relatively shallow depth of 0 to 6 feet below existing ground surface (bgs). The USCS classification varied from SP (sand with

trace of silt or trace of clay) to SP-SM (sand with silt) to SP-SC (sand with clay). At few isolated locations, the soil was classified as SM (silty sand) to SC (clayey sand).

STRATUM 2:

Upper LIMESTONE: Poorly to moderately indurated LIMESTONE: This stratum was highly variable and was encountered immediately below the surficial sandy soils. This stratum is predominantly composed of soft and hard limestone interbedded with relatively thin and thick lenses of sand, silt, or clay. The limestone is predominantly white to pale brown and yellow, fine-grained with occasional coarse-grained (gravel & shell) lenses, predominantly weakly to moderately indurated, with occasional thin lenses of well indurated fine grained limestone.

No consistent order of interbedded layers was identified during the investigation. This layer typically extended between depths of 5 and 40 feet bgs, and occasionally extending to 60 feet bgs.

STRATUM 3:

Lower LIMESTONE: Moderately to well indurated LIMESTONE: This stratum was highly variable and was interbedded with poorly indurated limestone. The limestone was typically pale brown to gray limestone, dolomitic, fine to coarse-grained, with local sucrosic texture, very well indurated to moderately indurated extending to the borehole termination depths of up to 100 feet bgs. An interbedded layer of brown, vuggy, porous, fossiliferous, coarse-grained, very weakly indurated dolomitic limestone was occasional encountered between depths of 50 and 80 feet bgs typically vuggy, porous, fossiliferous.

Due to the friable and very weakly indurated nature of some of portions of the limestone and interbedding comprised of loose soil lenses, the limestone recovery was lower than anticipated, when compared to SPT boring data and rock coring times. The soft and hard designations are relative descriptions for classification of strata and do not indicate specific rock mass strength characteristics.

An interpretation of the geologic formation designations suggests that most of the bedrock (soft and hard limestone) was from the lower Ocala Limestone formation. The typically brown to gray, dolomitic, hard limestone of Stratum 3 was interpreted to be Avon Park Formation and was encountered in seven of the borings at approximate elevations ranging between 55 and 65 feet as indicated on **Figures 4A – 4D**.

Groundwater Conditions

At the time of SPT drilling, groundwater was encountered prior to the introduction of drilling fluid, typically at a depth of 3 feet below existing grade. In order to record more precise groundwater levels throughout the site, seven piezometers were installed and groundwater levels were measured on a daily basis during the fieldwork (**Tables 2 and 3**). The measured groundwater levels remained relatively constant throughout the monitoring period with deviations of less than 0.9 foot in November 2013.

TABLE 2 – Groundwater Monitoring Depths below Ground Surface (feet)

Date	Piezometer Locations						
	B-01	B-02	B-09	B-17	B-18	B-19	B-23
11/4/2013	4.0	2.2	-	-	-	-	-
11/5/2013	4.1	2.5	2.7	-	-	4.1	-
11/6/2013	4.3	2.5	2.7	-	-	4.0	-
11/7/2013	4.2	2.6	2.8	-	-	4.0	-
11/8/2013	4.3	2.6	2.7	3.1	4.5	4.1	-
11/11/2013	4.8	2.7	2.8	3.5	4.6	4.1	-
11/12/2013	4.3	2.8	2.9	3.4	4.6	4.1	-
11/13/2013	4.4	2.8	2.9	3.5	4.7	4.1	-
11/14/2013	4.4	2.8	3.0	3.6	4.8	4.2	5.0
11/15/2013	4.4	2.8	3.0	3.6	4.7	4.2	5.0
11/18/2013	4.4	2.7	2.9	-	4.4	4.2	4.8
11/19/2013	4.3	2.7	2.9	3.3	4.5	4.2	4.6
11/20/2013	4.3	2.7	2.9	3.4	4.5	4.1	4.5
11/21/2013	4.3	2.7	2.8	3.3	4.5	4.1	4.6
11/22/2013	4.2	2.6	2.9	3.3	4.5	4.1	4.7
11/25/2013	4.3	2.8	3.0	3.4	4.6	4.2	4.8
11/26/2013	4.4	2.8	3.0	3.5	4.7	4.2	4.8
11/27/2013	3.9	2.4	2.5	2.8	4.1	3.7	4.2

TABLE 3 – Groundwater Table Elevations (feet-NAD83)

Date	Piezometer Locations						
	B-01	B-02	B-09	B-17	B-18	B-19	B-23
11/4/2013	-3.1	-3.4	-	-	-	-	-
11/5/2013	-3.0	-3.1	-3.1	-	-	-2.7	-
11/6/2013	-2.8	-3.1	-3.1	-	-	-2.8	-
11/7/2013	-2.9	-3.0	-3.0	-	-	-2.8	-
11/8/2013	-2.8	-3.0	-3.1	-3.2	-3.0	-2.7	-
11/11/2013	-2.3	-2.9	-3.0	-2.8	-2.9	-2.7	-
11/12/2013	-2.8	-2.8	-2.9	-2.9	-2.9	-2.7	-
11/13/2013	-2.7	-2.8	-2.9	-2.8	-2.8	-2.7	-
11/14/2013	-2.7	-2.8	-2.8	-2.7	-2.7	-2.6	-2.5
11/15/2013	-2.7	-2.8	-2.8	-2.7	-2.8	-2.6	-2.5
11/18/2013	-2.7	-2.9	-2.9	-	-3.1	-2.6	-2.7
11/19/2013	-2.8	-2.9	-2.9	-3.0	-3.0	-2.6	-2.9
11/20/2013	-2.8	-2.9	-2.9	-2.9	-3.0	-2.7	-3.0
11/21/2013	-2.8	-2.9	-3.0	-3.0	-3.0	-2.7	-2.9
11/22/2013	-2.9	-3.0	-2.9	-3.0	-3.0	-2.7	-2.8
11/25/2013	-2.8	-2.8	-2.8	-2.9	-2.9	-2.6	-2.7
11/26/2013	-2.7	-2.8	-2.8	-2.8	-2.8	-2.6	-2.7
11/27/2013	-3.2	-3.2	-3.3	-3.5	-3.4	-3.1	-3.3

Based on historical data, the wet season in Florida is typically between June and September of any given year. As this investigation was conducted during the dry season, the seasonal high groundwater table would be anticipated to be higher. The NRCS reports a seasonal high groundwater table of 0.5 feet bgs. Furthermore, due to the site proximity to the Gulf of Mexico, the groundwater table might also be influenced by tidal fluctuations.

3.3 Laboratory Testing

Selected soil samples collected during the field exploration were tested for index parameters to assist with soil classification including the natural moisture content (ASTM D 2216), gradation and percent passing a No. 200 sieve (ASTM D 422 and D 1140), and Atterberg Limit tests (ASTM D 4318). In general, the test results were in good agreement with the typical field classifications, with the exception that some of the samples were reclassified due to minor differences in fines content.

Selected rock core samples collected during the field exploration were tested for Unconfined Compressive Strength of Rock Cores (ASTM D 7012) and Split Tensile Testing of Rock Cores (ASTM D 3967). The Unconfined Compressive Strength (Q_u) of the tested rock cores ranged between 297 and 9,010 pounds per square inch (psi), indicating a very wide range from weakly to very well indurated rock mass strength. The Splitting Tensile (Q_t) test on the rock cores indicated a range between 48 and 869 psi. Due to the fractured nature of the rock cores collected, portions of the cores were not suitable for testing requirements. The test data are summarized and shown in **Appendix F**.

3.4 Geophysical Survey

Ground Penetrating Radar Survey

A site-specific GPR (Ground Penetrating Radar) survey of the subject property was conducted on November 4, 2013 and November 5, 2013 in conjunction with the SPT borings, to aid in the characterization of subsurface conditions at the site. The purpose of the survey was to evaluate the lateral continuity, depth, and thickness of soil, sediment, or bedrock. The goal was to identify existing subsurface utilities, cultural conditions, or geologic features that may be of interest in our investigation and to aid in the positioning of the test borings. The GPR survey lines were conducted throughout the project site, and included areas within the general vicinity of the twenty-five proposed boring locations.

The GPR survey consisted of 73 transects totaling over 11,000 linear feet across the project site. Data collection was difficult to obtain near all of the boring locations due to overgrowth of vegetation at the subject site. Where GPR transects were conducted and data collection possible, vegetation remained an issue. Abundant trees, roots, and tall grass can hinder signal penetration of the sensor and obscure data collected in these areas. The approximate locations of the GPR transects in relation to the borings are provided on **Figures 5A** and **5B**.

An additional GPR survey was conducted on November 25, 2013 and November 26, 2013 near borings B-15 and B-18, respectively. The survey was completed to address possible karst or sinkhole features in these areas. The survey consisted of thirteen transects and totaled over 500 linear feet. Eight transects were conducted near boring B-15 to address possible sinkhole conditions that were recorded within the boring. A circular water-filled, sinkhole was observed during the field work in an area to the northwest of boring B-18. Five GPR transects were

conducted within this area to determine the extent of the observed sinkhole. The approximate locations of the GPR transects in relation to the listed borings and the observed sinkhole are provided on **Figure 5C**.

Information on settings and equipment used during the survey are included in a GPR information sheet in **Appendix C**. Representative examples of the GPR transects are provided in **Appendix C**. Copies of the digitally recorded GPR transect profiles are also provided on accompanying CD.

Geophysical Survey Results

The GPR data typically shows a shallow reflective surface and two distinct (intermediate and deeper) reflective series in the transect profiles. SPT boring data was used to aid interpretation of the GPR survey data.

Shallow hyperbolic reflections are typical of reflective patterns created by objects such as underground utilities, or other types of buried objects. No apparent subsurface utilities or cultural (manmade) conditions were identified on any of the transect profiles. Multiple hyperbolic reflections indicative of tree roots and root systems were observed on a few of the transect profiles.

A discontinuous to continuous, sub-parallel, planar horizontal reflective surface ranging from 10 nanoseconds (ns) to 20ns was identified in several of the transect profiles. This shallow reflective surface is interpreted to be the groundwater table, which ranged from 2 to 4 feet below grade across the project site.

Below this shallow reflective surface, two distinct reflective series (intermediate and deep) of generally continuous, subparallel to diffuse reflections of varying thicknesses were observed on most of the transect profiles. The intermediate reflections appear to represent approximate compositional and density variations associated with an approximate bedding contact between the friable limestone and unconsolidated shallow sandy soils from the indurated limestone formation. Similar to the intermediate reflections, the deep series of reflections were somewhat continuous are interpreted to be changes in composition and/or induration of the limestone formation.

The transect T60 profile showed shallow anomalous reflections from 0 to 24ns located in the vicinity (162 feet northwest) of the proposed location of boring B-22. The boring location was subsequently moved to the location of the anomaly. Boring B-22 did not show any indication of sinkhole activity. The anomalous area is shown on Figure 1B of **Appendix C**.

The additional GPR surveys completed near boring B-15 and near the observed sinkhole encountered similar reflective series noted above. The transect data collected within the vicinity of boring B-15 (transects T0 to T8) also appear to show local zones of increased signal penetration and down-dipping reflections indicative of possible karst related activity. The GPR data collected near the observed circular water-filled, sinkhole (transects T9 to T13) show an increase in signal penetration with associated down-dipping reflections on the transect profiles. These types of reflections are typical of active karst processes. The anomalous area is shown on Figure 1B of **Appendix C**. The results of the geophysical testing is limited to the extent and depth of the survey completed. Geologic features may exist beyond the area surveyed.

Sinkhole Potential

The lithologic profile encountered in boring B-15 indicates raveling soils/voids within the limestone associated with active karst processes. Aside from an N-value of 33 recorded in the sampling interval of 2 to 4 feet bgs, very soft soils and possible voids/cavities within the limestone were encountered as evidenced by little to no penetration resistance that included a Weight of Hammer/Weight of Rod (WOH/WOR) interval from 4 feet to 26 feet bgs. The boring was terminated at 26 feet bgs. The potential of agitating subsurface conditions by continuation of drilling and introducing drilling fluid into the borehole after encountering a shallowly occurring, extensive WOH/WOR event, coupled with a loss of drilling fluid circulation was deemed unsafe and the boring was terminated.

A loss of drilling fluid circulation occurred at the top of the WOH/WOR interval in this boring. The associated loss of circulation in may indicate that a preferential pathway exists that facilitates the downward migration of soils (raveling) into joints, fractures and cavities within the underlying limestone.

Based on the results of the SPT borings, the geophysical survey, the photo-linear survey, and the regional geologic environment, the potential for a sinkhole to occur is greatest at the location tested by borings B-15. Additionally the circular, water-filled sinkhole observed at the site correlated well with a GPR anomaly having reflections consistent with active karst conditions.

The data indicates the soils overlying the limestone within boring B-15 are being weakened by active karst processes that are causing reduced soil densities by the downward raveling of soil into joints, fractures, or cavities within the limestone. It is likely that a continued upward propagation of weakening soils will occur as the raveling of the overburden continues to migrate into the underlying limestone. Without a cohesive soil unit or rock layer of significant thickness overlying these raveling soils, there is a potential for sinkhole formation.

Florida Geological Survey's Hydrogeology Program has developed criteria to determine sensitive karst areas for land-use decisions; they utilize a Geographic Information System incorporating spatial data layers such as the state geologic map, land surface topography and overburden thickness maps (Cichon, et. Al.).

Overburden sediments will act to protect the Floridan aquifer system from potential contamination sources where it is present. At the subject site, the overburden is thin to absent and carbonate units comprising the FAS are exposed at or near land surface. In these areas, the potential for development of karst terrain (sinkholes and collapse features) is increased.

Considering the geologic setting, shallow depth to limestone, the lack of a confining layer of the limestone formation, the subject site can be identified as a sensitive karst area. Sensitive karst areas have increased potential development of karst terrain including development of solution-type sinkholes at subject property and it is possible that additional karst features will be encountered during subsequent subsurface site work.

4.0 EARTHWORKS RECOMMENDATIONS

4.1 Basis for Analyses and Recommendations

The following recommendations for earthworks are based upon the previously presented project information, typical construction practices and specifications, along with the data obtained during this exploration.

4.2 Stripping and Grading Recommendations

The site has significant areas of wooded and dense vegetation growth, typically consisting of pine trees and palmettos. A clearing and grubbing operation will be required to remove this dense vegetation.

The topsoil layer is relatively thin, typically less than 6 inches deep from the surface. Stripping will be required to remove the vegetative matter and roots within the proposed construction areas. The stripped material will likely be suitable for re-use as topsoil on landscaped areas.

In general, the surficial soils at the site are composed of granular soils (Typical USCS classifications of SP, SP-SM, SM, and SC) which are suitable for general fill in grading operations. No other unsuitable materials (peat, soft clays, etc.) were encountered; therefore, over-excavation to prepare the subgrade for the construction is unlikely unless deeper soft organic sediments are found in wetland areas that were not investigated.

Prior to construction, the Contractor should strip within the limits of excavations, borrow areas, and any ground which will become the foundation of the proposed facilities and stormwater areas. Stripping should include removal of all vegetable matter, roots, debris, and other perishable or objectionable materials (mud, soft sediment, or highly compressible materials) that are unsuitable for the proper bonding of the compacted soils with their foundations, prevent the proper compacting of the fill materials may yield excessive consolidation under loading, or might be otherwise objectionable as determined by the Engineer. Unsuitable materials should be hauled to and disposed or stockpiled at the locations specified by the Owner.

The contractor should provide survey control during the work to determine cut and fill quantities and to verify lift thickness. The Contractor should grade the site to prevent and control erosion and water pollution as per Florida Department of Environmental Protection (FDEP) regulations and permit conditions. Each working area should be developed with due consideration for drainage and runoff from the excavated surface so as not to cause erosion of the adjacent terrain.

4.3 Fill Requirements

It is anticipated that General Fill and Structural Fill will be required for the site grading and foundation construction.

General Fill may be composed of mixed soils with USCS classifications of SP, SP-SM, SP-SC, SM, and SC with organic contents less than 5%.

Structural Fill may be composed of clean, durable, well-graded granular soil with typical USCS classifications of GW or SW with less than 1% organic content.

The fill used in the compacted sections of the foundations should be mixed such that the soil lift will be free from lenses, pockets, or layers of material differing in texture, gradation, or moisture from the surrounding material. The compacted surface of each lift should be scarified by light disking or by any other method approved by Engineer/Owner, before the succeeding layer is placed. Each lift of fill material should be spread and leveled by graders or dozers prior to processing and compaction. The Contractor should place the fill in maximum 12-inch thick (loose) lifts for machine placed fill and maximum 6-inch thick (loose) lifts for hand-place fill. The fill lift thickness should not be greater than the vertical reach of the soil mixing equipment. Lift thickness should be controlled by the Contractor. The entire surface of any section under construction should be maintained in such condition that construction equipment can travel on any part of any one section. Ruts in the surface of any layer should be removed by scarifying before placing and compacting additional material.

4.4 Compaction Requirements

Compaction of the existing subgrade is required prior to placement of compacted fill for the foundation design sections. Prior to startup of fill placement, a family of Modified Proctor Test Method (ASTM D 1557) compaction curves should be prepared for the chosen construction materials.

Areas without structural loads should be compacted to a minimum of 92% of the Modified Proctor Maximum Dry Density. Areas with structural loads including shallow foundations and paved area should be compacted to a minimum of 98% of the Modified Proctor Maximum Dry Density. Moisture contents of placed materials should be controlled to achieve the minimum specified compaction percentage at time of testing. Material that is not within the specified limits at the time of compaction should be reworked, regardless of density.

It is not anticipated that adequate borrow material will be available on site. Therefore, specified fill may be required to be imported for the designated construction areas.

4.5 Excavation Dewatering Considerations

Based on the measured groundwater levels, dewatering will likely be required to permit excavations greater than 2 feet deep from the existing ground surface. Dewatering of excavations in sandy soils can typically best be performed using a single stage of fully sanded vacuum well-points. Some supplemental sump pumping may be required. Dewatering of excavations by pumping from sumps alone should be avoided due to side-slope stability problems and the disturbance and loosening of typical sandy soils at the sump inlets. The well-points should be installed by jetting or drilling. Coarse sand or fine gravel should be placed around each well-point and riser pipe to act as a filter to provide a positive drainage connection between all soil layers being dewatered. All sump inlets should be located outside the bearing areas to avoid loosening of the fine-grained, sandy bearing soils. The groundwater level should be maintained at least one foot below the bottom of the excavation to provide a stable working platform for fill placement or foundation construction.

Given the shallow porous limestone near the surface, installation of well points may not be feasible in some areas. Excavations in the shallow limestone will require additional effort, possibly including ripping and rock breaking.

5.0 FOUNDATION RECOMMENDATIONS

5.1 Basis for Analysis and Recommendations

The following recommendations are based upon the project information provided by the Owner, typical construction practices and industry specifications, along with data obtained during this exploration.

The proposed development consists of:

- four combustion/turbine generators (CTG) and heat recovery steam generators (HRSG) and their associated equipment (stacks, transformers duct banks, etc.);
- two steam turbine generators (STG);
- cooling towers; pipe rack; water treatment facilities and storage tanks;
- administration, warehouse, maintenance, and control buildings;
- parking areas and plant access road.

Foundations for the CTG's, HRSG's, and steam STG's will be the most heavily loaded and the CTGs and STGs are subject to dynamic loading. It is anticipated that these structures will be founded on large mat foundations supported by piling or drilled shafts.

For soil supported mats, bearing pressures on the order of 2,000 to 2,500 psf are anticipated for static loading with an additional 500 psf from dynamic loading.

Settlements on the order of 1 inch total and 1/2 inch differential are considered tolerable. The remaining equipment, pipe-rack and building foundations are expected to be relatively low and may be founded on shallow spread footings or deep foundations as dictated by soil conditions. Tanks are expected to apply loads on the order of 2,000 to 3,000 psf on the base of the foundations.

Structures at the substation include dead-ends, switch stands, bus supports, and miscellaneous equipment stands. The dead-ends, switch stands, bus supports, and miscellaneous equipment supports are anticipated to be supported by drilled shafts or piles. Loads for other substation foundations are relatively small and are anticipated to be installed on shallow foundations.

The plant and substation is expected to be raised approximately 6 feet to promote drainage. Assuming a typical compacted soil unit weight of 120 pounds per cubic foot (pcf), the 6-foot fill (required to raise the existing grade) is equivalent to a 720 pounds per square foot (psf) static load.

5.2 Shallow Foundation with Surface Compaction

It is anticipated that shallow spread or strip foundations will be utilized for relatively lightly loaded structures (less than 3,000 psf allowable bearing capacity) as discussed in Section 5.1 above.

For the foundation subgrade preparation, it is recommended the existing stripped ground surface is compacted with a relatively large (10 to 20 ton) vibrating drum roller to compact the loose surficial sands. The compaction may also densify loose (raveled) zones within shallow limestone strata. If any depressions are created by the compaction, they should be assessed for further treatment (back filling, pressure grouting, etc.) to stabilize the area before final grading and foundation construction.

It is understood that the site will be raised by approximately 6 feet using a granular fill material and that the shallow foundations may be embedded on the existing ground or within the fill.

Assuming a soil friction angle of 30° to 32° for the compacted surface sands or granular fill, the ultimate bearing capacity for shallow foundations would be on the order of 10,000 to 15,000 psf (assume a minimum embedment depth of 6 feet). Using a Factor of Safety of 3 to 5, an allowable bearing capacity of 3,000 psf for static loading is considered appropriate for preliminary design. An allowable bearing capacity of 5,000 psf for dynamic loading (wind or construction) is considered acceptable for short-term loading conditions.

Without sinkhole activity, it is estimated that with an applied load of 3,000 psf, the long-term settlement would be within 1 inch, with a maximum 1/2 inch differential settlement. However, sand particles can migrate into the soft porous limestone or the structure of the soft limestone can collapse. These types of sinkhole activities can cause unexpected settlement. The likelihood of sinkhole activity is low to moderate over the entire site. However, if localized sinkhole activity occurs, the magnitude of this type of settlement is unpredictable; it can be between one inch to a few feet of settlement.

5.3 Shallow Foundation with Subsurface Treatment

In areas identified with karst activity (exposed surface fractures and holes, soil raveling, depressions, etc.) subsurface treatment may be used to stabilize the raveled and weakened soil zones that underlie the site, by sealing and fill the karst-related fractures and/or cavities in the underlying limestone bedrock surface. With this treatment, the risk of developing sinkhole activity beneath the foundation is substantially reduced. Typical methods of subsurface treatment include the following:

Stone Columns

Stone columns would help to pre-collapse the subsurface voids, fill and densify the raveled zones, and improve soils to increase bearing capacity and reduce settlement potential. The stone columns can be constructed by Vibrocompaction, vibro-replacement, or by reverse flight auger methods. In the reverse flight auger method, there is no soil spoil coming out of the subsurface. Instead, the stone is fed to the auger flight and is compacted during the stone column construction.

The additional advantage of this method is that the treated area would not disrupt the natural water flows due to the high permeability of the stone, thus it would not cause water ponding in certain isolated areas. The requirements for subsurface treatment will need to be evaluated within each specific area of concern. Additional ground investigation will likely be necessary to adequately determine the level of treatment required. It is anticipated that the depth of treatment will vary across the site. The depth of treatment is typically determined by a specialty ground improvement contractor. Hayward Baker, Moretrench, and Berkel & Company are some of the local contractors providing the subsurface treatment methods.

Pressure and Compaction Grouting

This stabilization method involves injecting low strength cement grout into the karst features through hollow stem casing. The grout fills voids, densifies loose soils and bridges weak zones. Grouting of substantial areas throughout the site may interrupt the natural groundwater and drainage flow in the vicinity of the grouted area.

As the subsurface treatment would strengthen the soil shear strength of the existing shallow sandy soils, an increased soil friction angle of 32° to 34° may be used to estimate the allowable bearing capacity. An allowable bearing capacity of 3,000 to 4,000 psf may be achievable after treatment. In-situ testing should be undertaken after treatment to confirm the shear strength or modulus parameters prior to foundation design.

5.4 Auger Cast Pile Foundation

An auger cast pile (ACP) foundation system is typically ideal to utilize side resistance (skin friction) in sandy or clayey soils, and in some cases soft limestone layers. A typical ACP can provide an approximate pile load of 100 tons, but is highly dependent on the site specific ground conditions.

Given the variability of the ground conditions with soft and hard limestone layers (Q_u varying between 300 and 9,000 psi) at relatively shallow depths, drilling and installation of ACP may prove difficult with unwanted early auger refusal.

Furthermore, unsuitable augering rates and grouting rates can cause grout contamination, negatively affecting the pile integrity as well as pile capacities (both axial and lateral capacities). The grout takes may be substantial and loss of grout pressure can frequently make it difficult to construct a good quality pile. Given the uncertainty of the ground conditions, pre-drilling of the auger cast pile locations to identify the ground conditions may be required to confirm suitability.

5.5 Drilled Shaft (Drilled Pier or Drilled Caisson) Foundation

Drilled shafts have been traditionally used for several Duke Energy plants, such as for Units 4 and 5 at the existing Crystal River plant. Drilled shafts, having typical diameters ranging from 3 to 6 feet, can provide a much higher lateral bearing capacity per a single shaft than that of a single driven pile. However, without tip grouting, drilled shafts typically have very low end bearing capacity. As such, it is a normal practice in Florida to disregard the end bearing capacity. Therefore, to provide the required axial bearing capacity for this specific project, the shafts will need to be socketed into limestone to develop side resistances.

Based on the Unconfined Compressive Strength Q_u , Split Tensile Strength Q_t , and rock core recovery, the estimated unit side resistances range from 3 to 15 tsf. Therefore, a 3 to 6-foot shaft with 10 to 20 feet socketed into hard limestone is expected to provide 450 tons of ultimate bearing capacity. The design should take in account the possibility of bearing on a soft limestone layer, as such the pile should be designed with a conservative end bearing value and conservative socket length. To minimize this uncertainty, it is recommended that pilot holes be drilled to confirm the ground conditions prior to installation.

During the soil exploration program, loss of circulation was frequently encountered. Therefore, drilled shaft construction would typically require full-length casing, which can be difficult to install due to the vuggy nature of limestone.

Due to the relatively large diameter of the piles, each group of shafts (under a cap) will typically consist of 1 to 5 shafts. Therefore, the redundancy factor is relatively low if one or more of the shafts fail(s) or is compromised.

During drilled shaft construction, a Shaft Inspection Device (SID or mini-SID) or Ding Inspection Device (DID) may need to be utilized to inspect the cleanliness of shaft bottom. The SID and mini-SID devices are accepted by Florida Department of Transportation. The DID is a newer, simpler, and much smaller device and has been recently introduced for acceptance in Florida. Even when the end bearing is disregarded, shaft bottom quality control may still be necessary to avoid contamination migrating upward with the flow of the concrete as the shafts are being constructed.

To confirm the capacities of the drilled shafts, many different methods can be used such as Conventional Static Load Test, STATNAMIC test, or Osterberg test. Alternatively, a Pile Driving Analyzer (PDA) test, a more economical test, can also be performed on drilled shafts. However, the PDAs on drilled shafts are typically not as reliable as compared to testing of driven piles. Furthermore, a separate large energy hammer needs to be imported to the site, frequently making it impractical.

5.6 Driven Pile Foundation

Driven Pile Foundation is typically an ideal deep foundation alternative to transfer significant axial load to the hard limestone. For the subsurface encountered at the site, most of the capacity would develop from end bearing. Due to the extremely high variability of the limestone at this site, driven pile foundations appear to be the most suitable foundation option from a performance and installation perspective:

- The pile lengths can vary from 20 to 100 feet to reach to the hard limestone layer;
- The production piles will not be accepted based on tip elevations, but rather based on required pile driving hammer blow counts per foot; However, the pile tip elevations also need to satisfy lateral and uplift loading combinations, which may require pre-drilling or pre-forming;
- A group of driven piles typically consists a higher number of piles. Some or many piles in the group can have a much higher actual Ultimate Bearing Capacity (UBC) than the design UBC. Thus even in the rare case of one or some isolated pile(s) within the group that fail(s) or is compromised due to unforeseen sinkhole activities, the remaining piles may still be able to carry the load for the whole pile cap (higher redundancy factor than drilled shafts);

- The test piles can be inspected by Pile Driving Analyzer (PDA) to assess pile bearing capacities and pile integrities.

Concrete driven piles typically vary between 18 to 30 inches in size. Experience has shown that 18-inch piles can have integrity issues when driving into pinnacle of limestones. Thus, 24 to 30-inch sizes are recommended. The 30-inch piles are sturdier, but more difficult to handle.

Based on our experience, the hard limestone at this site can provide up to 1,200 tons of ultimate end bearing capacity for the 24-inch pile. Per the Florida Department of Transportation Structural Design Guideline, the maximum designed Ultimate Bearing Capacity (UBC) for 24-inch pile is 450 tons. Therefore, the pile should be designed with an UBC of 450 tons or less. At some locations, the hard limestone was relatively thin. Therefore, even though the hard thin limestone can provide more than 450 tons of ultimate end bearing capacity, it is safer to design the piles at a lower UBC of 200 to 300 tons. The following table (**Table 4**) estimates the expected pile lengths and the corresponding ultimate bearing capacities of the 24-inch piles.

TABLE 4 – 24-inch Concrete Pile Estimated Ultimate Bearing Capacity

Boring Location	Pile Depth (feet)	Estimated Ultimate Bearing Capacity (UBC) - tons
B-01	15-30	350-450
B-02	30	350-450
B-03	20-35	200-300
B-04	50-60	350-450
B-05	25-30	350-450
B-06	30	350-450
B-07	30-40	200-300
B-08	20-50	100-200
B-09	30-50	200-400
B-10	40-60	350-400
B-11	35	350-450
B-12	40	200-400
B-13	30-35	350-450
B-14	20-40	200-300
B-15	Not Applicable – Karst Void	
B-16	30-40	350-400
B-17	35	350-400
B-18	30	350-450
B-19	Not Applicable – Retention Pond	
B-20	Not Applicable – Admin Building and Parking Area	
B-21	40-50	200-300
B-22	30-60	200-300
B-23	20-30	200-300
B-24	35	350-450
B-25	30-65	200-300

In order for the concrete piles to reach to a depth below 15 feet (for lateral stability), preformed holes in the upper 5 to 15 feet will be required. Since these preformed holes are shallow, it is anticipated that the Contractor should not have much difficulty augering the holes through shallow limestone layers. However if required lateral or tension loads are relatively high, and if lateral or tension pile analyses indicate that the piles need to have deeper pile tips (such

as to 30 or 35 feet), some pile location areas will require deeper preformed holes and the augering may be more difficult. Tips of concrete piles are typically heavily reinforced to resist damage from hard driving.

Steel pipe piles, with size varying from 14-inch to 30-inch can be an alternate option to concrete piles. Steel piles are more expensive; however, they are easier to drive than concrete piles, especially if the pipes are driven open ended. Another advantage of steel pipe piles is that the piles can be spliced much easier to extend pile length. However, it is not anticipated that relatively long piles are needed for this project.

Steel pile piles can be driven as closed end or open ended and tips of steel piles can be fitted with specially made shoes to help driving deeper into limestone. The closed end pipe piles will provide similar end bearing capacity as concrete piles presented above. Open ended pipe piles, especially short piles for this project, will have significantly less bearing capacity due to the loss of end area bearing.

To combine the benefit of easy driving of an open ended pipe pile with higher end bearing capacity of a closed end pipe pile, a composite pipe pile may be an alternative. The composite pile will be first driven as open ended and then the pipe is augered to extract the loose material. Hard limestone in the base of the pile will not need to be augered out. The pipe is then filled with concrete to a higher top elevation than the top of the steel pile. After one to two weeks, the Contractor would resume driving on top of the concrete to engage the end bearing capacity. It should be noted that driving on top of the concrete (not directly on the steel pipe) is a required to maintain the bond between the concrete and the pipe. PDA can be instrumented on the composite pipe piles to ensure adequate bearing capacity.

HP steel piles are a viable option. However, as most of the capacity would develop from end bearing, the design ultimate bearing capacity of HP piles would be relatively small.

Driven Pile Construction

Pile damage, either for driven concrete or steel pile options, can be prevented by monitoring the pile driving stresses and integrity during the PDA instrumentation for the test piling program. During the subsequent production piling program, a pile driving criteria, based on the PDA test data, should be implemented to control the driving stresses and to obtain the required bearing capacities.

During production pile driving, a Saximeter should be used to record the blow counts and corresponding hammer stroke (drop) heights on the pile driving logs. Upon reviewing the production pile driving logs, if there is any concern on any pile, the PDA should be instrumented on a restrike on the pile for approximately 10 to 20 additional blows to verify pile capacity as well as pile integrity.

As pile driving generates very high dynamic stresses and very high vibration levels, it may positively help to pre-collapse some loose and soft zones. If the hard limestone lenses are thin, the pile can be driven through the thin lenses into a thicker hard layer. The ultimate end bearing capacity of the pile is typically 3 to 10 times higher than the required bearing capacity. As the hard bearing layer at the tip of the piles (upon accepting the piles) does not collapse during pile driving, where the pile moves at an acceleration of typically 40g to 80g and the soil in the vicinity vibrates at a level of typically 1 to 10 in/sec, the likelihood of future collapse of the bearing layer is very low.

Prior to pile driving, existing ground surface should be compacted with a relatively large (10-20 ton) vibrating drum roller to compact the loose sand or limestone near the existing ground surface. Pile driving would be performed next from the existing surface, then site filling with the expected 6-ft of fill would be carried out last. It should be noted that if compaction of the fill, if it is within a general 15 foot area from the pile, should be done with small compacting equipment, such as less than 1,000 pounds.

6.0 CLOSING AND LIMITATIONS

The findings presented in this report are based on the test borings performed at the sites, laboratory testing, and AMEC's professional judgment at the specific locations at the time of the investigation.

The boring logs represent the subsurface conditions at the specific location at the time of the investigation. The subsurface conditions at other locations may differ, and no warranty as to the subsurface conditions elsewhere is neither expressed nor implied by the data presented herein. Furthermore, the soil depths on the boring logs designating the interface between the various soils may only be approximate boundaries where the transition is gradual or could not be detected by the boring operations. In addition, the depth of the groundwater table is only indicative of the conditions at the time of the investigation as groundwater level may fluctuate significantly because of various factors.

The recommendations provided in this report are based on the scope of the exploration and testing program. In addition, this report does not reflect the soil conditions below the tested depth. This report should not be used without the guidance of the soil engineer who prepared this report. AMEC is not responsible for improper use of this report, which could lead to erroneous assumptions, faulty conclusions, and other problems.

7.0 REFERENCES

Arthur, J., Fischler, C., Kromhout, C., Clayton, J., Kelley, G., Lee, R., Li, L., O'Sullivan, M., Green, R., and Werner, C., 2008, Hydrogeologic Framework of the Southwest Florida Water Management District: Florida Geological Survey, Bull. 68

Cichon, J., Wood, A., Baker, A., Arthur, J., 2004, Application of Geologic Mapping and Geographic Information Systems to Delineate Sensitive Karst Areas for Land-Use Decisions: Florida Geological Survey, Poster

Crumpacker, D., 1992, Chapter 1-Natural Environments: Ecosystems, in Fernald, E.A. and Purdum, E.D., eds., Water Resources Atlas of Florida: Tallahassee, Florida State University

Faulkner, G., 1973, Geohydrology of the Cross-Florida Barge Canal Area with Special Reference to the Ocala Vicinity: United States Geological Survey, Water-Resources Investigation Report I-73

Florida Department of Transportation, (1973), Map of Lineaments in the State of Florida: State Topographic Office, Remote Sensing Section, Tallahassee, FL

Gaswirth, S., 2004, Maturation of regional dolomite bodies in the Late Eocene Ocala Limestone and Early Oligocene Suwannee Limestone, west-central Florida: Processes and effects [PhD Dissertation]: Boulder, University of Colorado

Vernon, R., 1951, Geology of Citrus and Levy Counties, Florida: Florida Geological Survey, Bull. 33

White, W., 1970, The Geomorphology of the Florida Peninsula, Bureau of Geology, Bul. 51

FIGURES

FIGURE 1	Site Location Map
FIGURE 2	Existing Site Use
FIGURE 3	Boring Location Plan
FIGURE 4	Soil Boring Profiles
FIGURE 5	Ground Penetrating Radar Transect Locations

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DUKE ENERGY FLORIDA
CITRUS COUNTY COMBINED CYCLE PROJECT
FIGURE 1
PROJECT LOCATION MAP
CRYSTAL RIVER, FLORIDA

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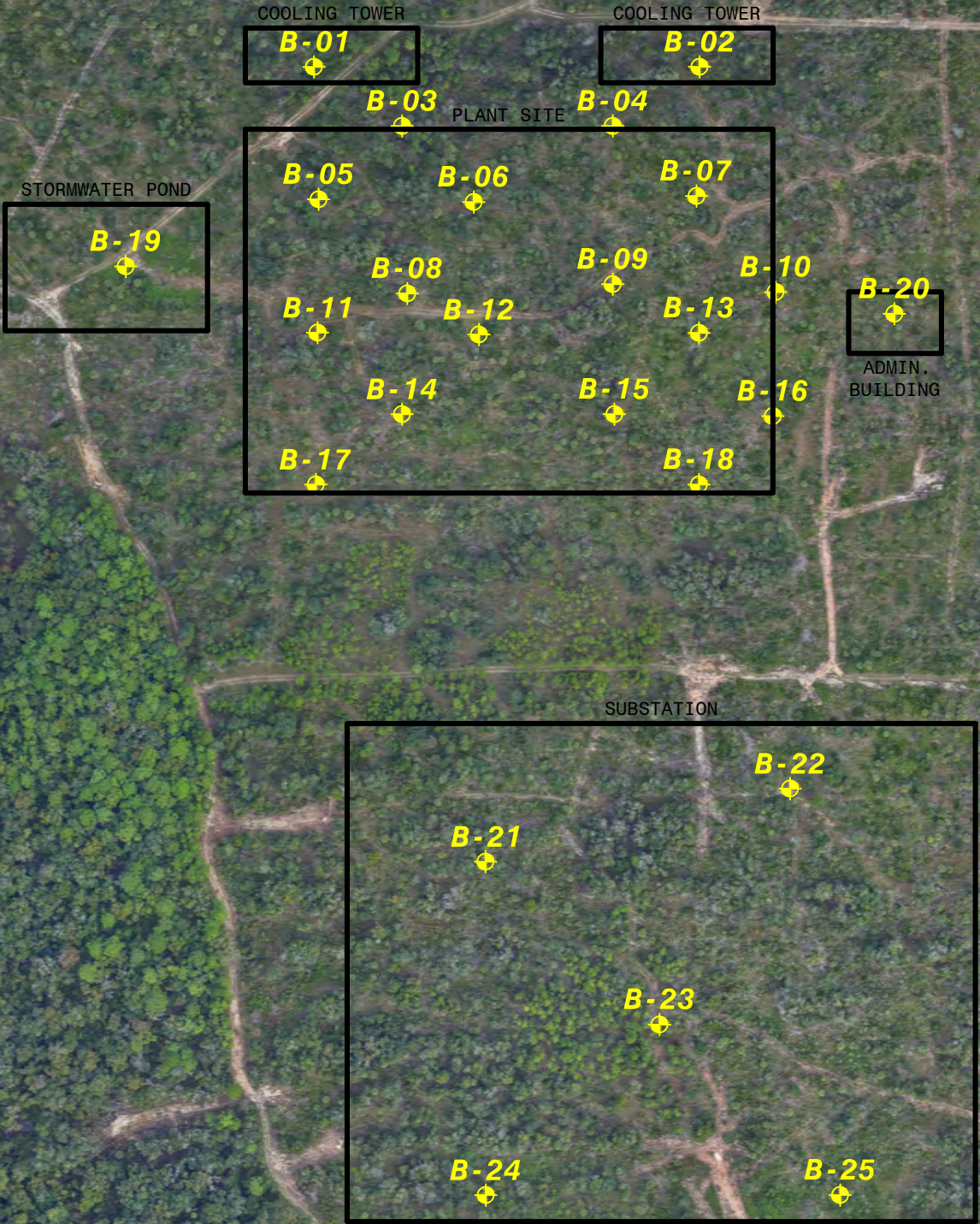
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FIGURE 2
EXISTING SITE AND LANDUSE MAP
CRYSTAL RIVER, FLORIDA

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Boring ID	Elevation	Location		Total Depth (ft.)
		Latitude	Longitude	
B-01	7.1	28° 58' 07.7"	82° 40' 28.7"	39.7
B-02	5.6	28° 58' 07.8"	82° 40' 20.8"	38.8
B-03	5.7	28° 58' 06.7"	82° 40' 26.9"	58.1
B-04	7.9	28° 58' 06.7"	82° 40' 22.6"	72.0
B-05	6.9	28° 58' 05.4"	82° 40' 28.7"	73.6
B-06	7.4	28° 58' 05.4"	82° 40' 25.3"	74.8
B-07	8.6	28° 58' 05.4"	82° 40' 20.8"	66.0
B-08	6.5	28° 58' 03.7"	82° 40' 26.9"	73.8
B-09	5.8	28° 58' 03.8"	82° 40' 22.5"	99.3
B-10	7.9	28° 58' 03.8"	82° 40' 19.2"	73.6
B-11	5.2	28° 58' 02.9"	82° 40' 28.7"	68.4
B-12	7.7	28° 58' 02.9"	82° 40' 25.3"	70.0
B-13	7.6	28° 58' 02.9"	82° 40' 20.8"	98.5
B-14	7.1	28° 58' 01.4"	82° 40' 26.9"	98.6
B-15	7.7	28° 58' 01.4"	82° 40' 22.5"	26.0
B-16	8.1	28° 58' 01.5"	82° 40' 19.2"	54.6
B-17	6.3	28° 58' 00.2"	82° 40' 28.6"	63.7
B-18	7.5	28° 58' 00.2"	82° 40' 20.8"	56.0
B-19	6.8	28° 58' 04.1"	82° 40' 32.6"	28.3
B-20	7.2	28° 58' 03.3"	82° 40' 16.7"	55.0
B-21	6.6	28° 57' 53.4"	82° 40' 25.1"	58.7
B-22	6.2	28° 57' 53.4"	82° 40' 17.8"	58.1
B-23	7.5	28° 57' 50.3"	82° 40' 21.4"	98.6
B-24	6.7	28° 57' 47.3"	82° 40' 25.1"	58.8
B-25	7.0	28° 57' 47.4"	82° 40' 17.8"	63.9



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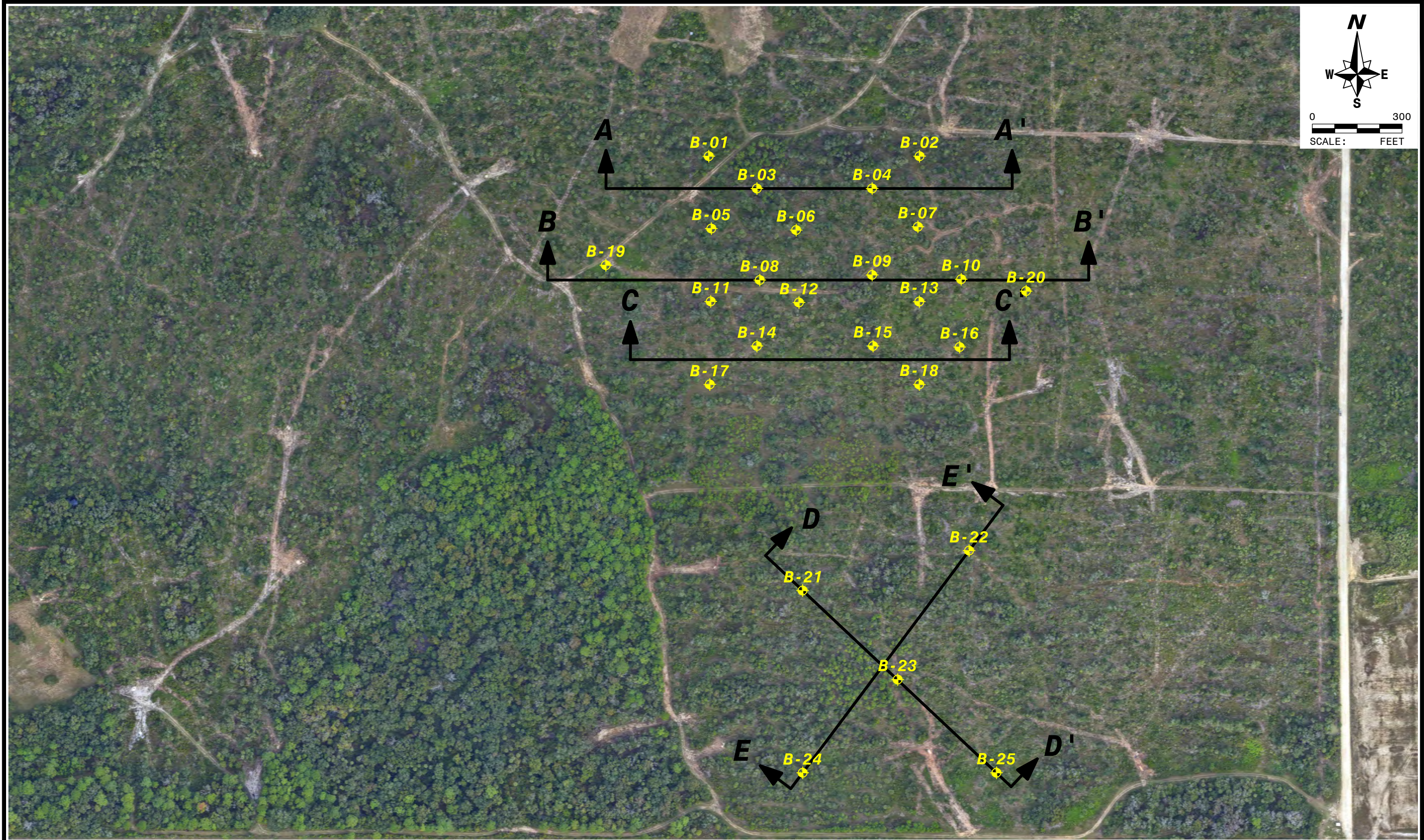


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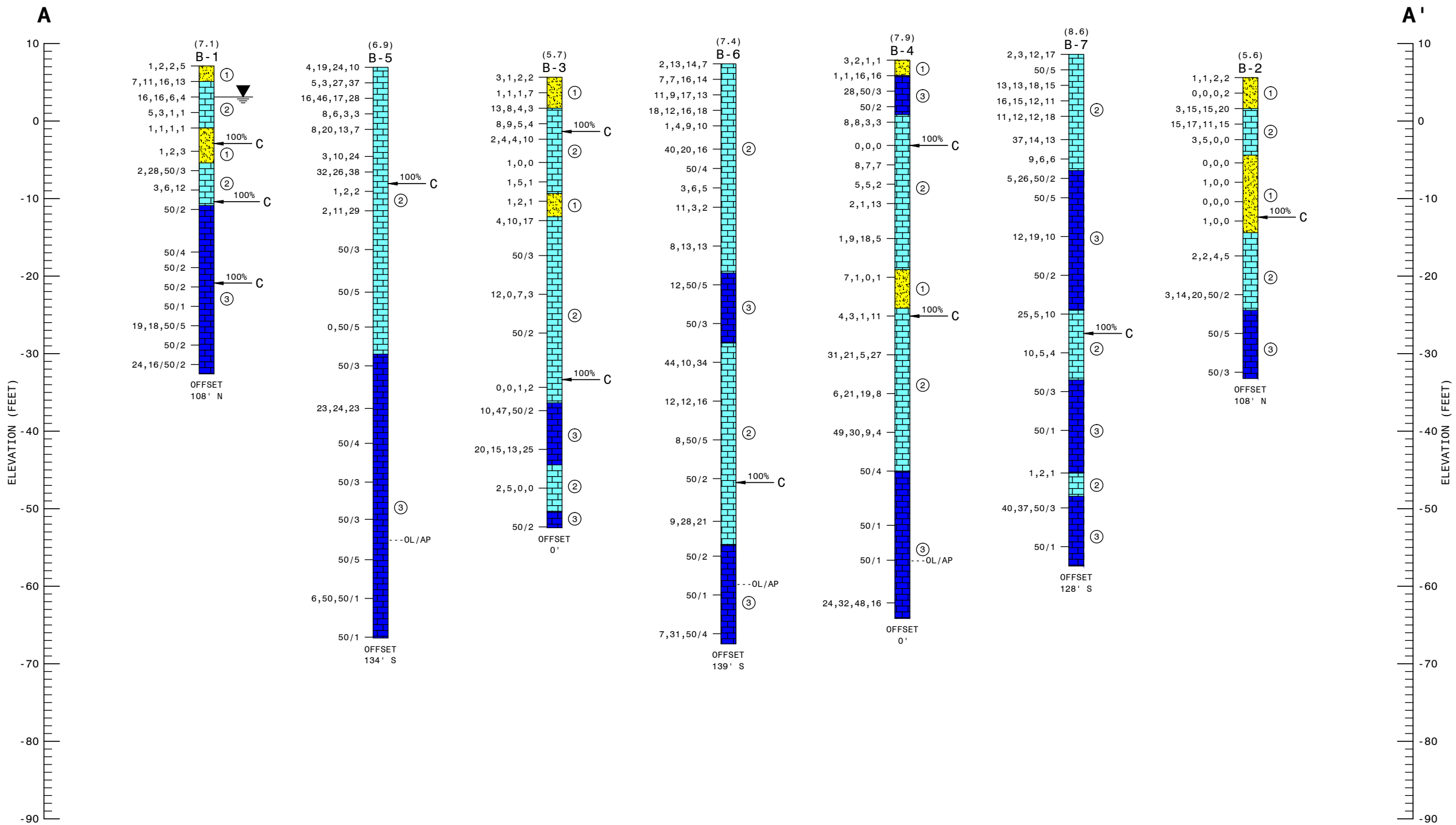
DUKE ENERGY FLORIDA
CITRUS COUNTY COMBINED CYCLE PROJECT
FIGURE 3
BORING LOCATION PLAN
CRYSTAL RIVER, FLORIDA

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EXPLANATION

	① SAND; VARIABLY COLORED (USCS = SP TO SM/SC)	SP	UNIFIED SOIL CLASSIFICATION SYSTEM classification
	② LIMESTONE; PALE BROWN, WHITE POORLY TO MODERATELY INDURATED		Depth of water table
	③ LIMESTONE; BROWN, PALE BROWN, GRAY MODERATELY TO WELL INDURATED		Loss of Circulation
		WR	Weight of Rod
		WH	Weight of Hammer
		NR	No Recovery
		(4.2)	ELEVATION DATUM (NAD83) 2011
		---OL/AP	APPROXIMATE CONTACT BETWEEN OCALA LIMESTONE AND AVON PARK FORMATION

NOTES:

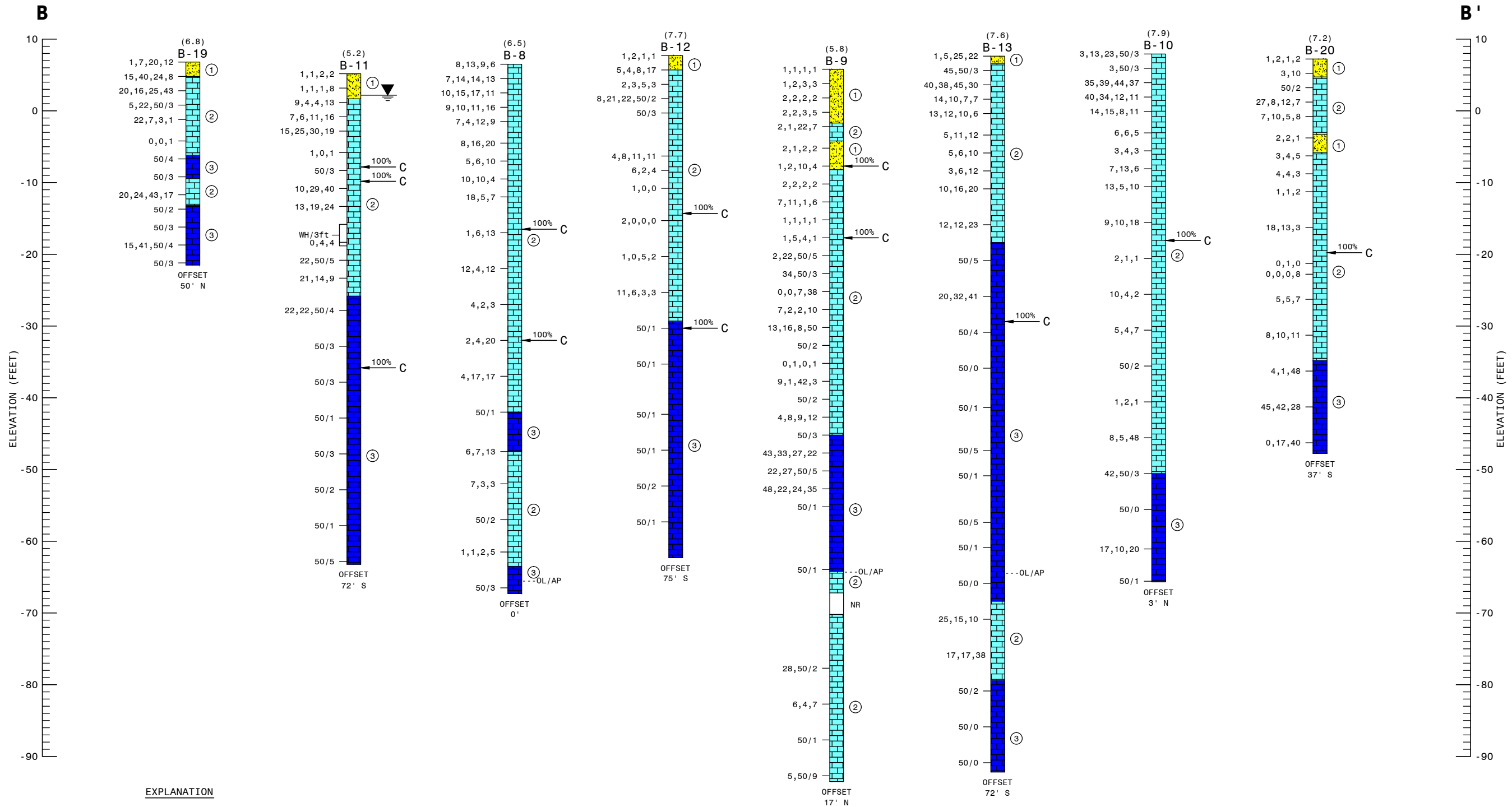
1. DRILL AND PENETRATION TESTING WHERE PERFORMED IN ACCORDANCE WITH ASTM D 1586. NUMBER TO THE LEFT OF BORING INDICATES BLOWS OF 1 3/8" I.D., 2" O.D. SPLIT-SPOON FOR EACH 6" PENETRATION (UNLESS OTHERWISE NOTED) WITH A 140 LB HAMMER DROPPED 30 INCHES.
2. THE BORING LOGS SHOWN REPRESENT SUBSURFACE CONDITIONS WITHIN THE BOREHOLE AT THE TIME OF DRILLING. NO WARRANTY AS TO THE SUBSURFACE CONDITION, STRATA DEPTH, OR SOIL CONSISTENCY BETWEEN OR OUTSIDE BORING LOCATIONS IS EXPRESSED OR IMPLIED BY THIS DRAWING.
3. REFER TO GEOTECHNICAL REPORT BY AMEC FOR DETAILED BORING INFORMATION.

DATE	REVISIONS

AMEC Environment & Infrastructure, Inc.
2000 E. Edgewood Dr., Ste #215 Lakeland, FL 33803
Phone: 863.667.2345 Fax: 863.667.2662
www.amec.com CA-5392

DESIGNED BY:	ND	SCALE:	AS SHOWN
DRAWN BY:	MAJ	DATE:	12/13/13
CHECKED BY:	ND	PROJECT NO.	300743X2
APPROVED BY:	MPK		

DUKE ENERGY FLORIDA
CITRUS COUNTY COMBINED CYCLE PROJECT
FIGURE 4A
BORING PROFILE A-A'
CRYSTAL RIVER, FLORIDA



EXPLANATION

	① SAND; VARIABLY COLORED (USCS = SP TO SM/SC)	SP	UNIFIED SOIL CLASSIFICATION SYSTEM classification
	② LIMESTONE; PALE BROWN, WHITE POORLY TO MODERATELY INDURATED		Depth of water table
	③ LIMESTONE; BROWN, PALE BROWN, GRAY MODERATELY TO WELL INDURATED		Loss of Circulation
		WR	Weight of Rod
		WH	Weight of Hammer
		NR	No Recovery
		(4.2)	ELEVATION DATUM (NAD83) 2011
		---OL/AP	APPROXIMATE CONTACT BETWEEN OCALA LIMESTONE AND AVON PARK FORMATION

NOTES:

1. DRILL AND PENETRATION TESTING WHERE PERFORMED IN ACCORDANCE WITH ASTM D 1586. NUMBER TO THE LEFT OF BORING INDICATES BLOWS OF 1 3/8" I.D., 2" O.D. SPLIT-SPOON FOR EACH 6" PENETRATION (UNLESS OTHERWISE NOTED) WITH A 140 LB HAMMER DROPPED 30 INCHES.
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3. REFER TO GEOTECHNICAL REPORT BY AMEC FOR DETAILED BORING INFORMATION.

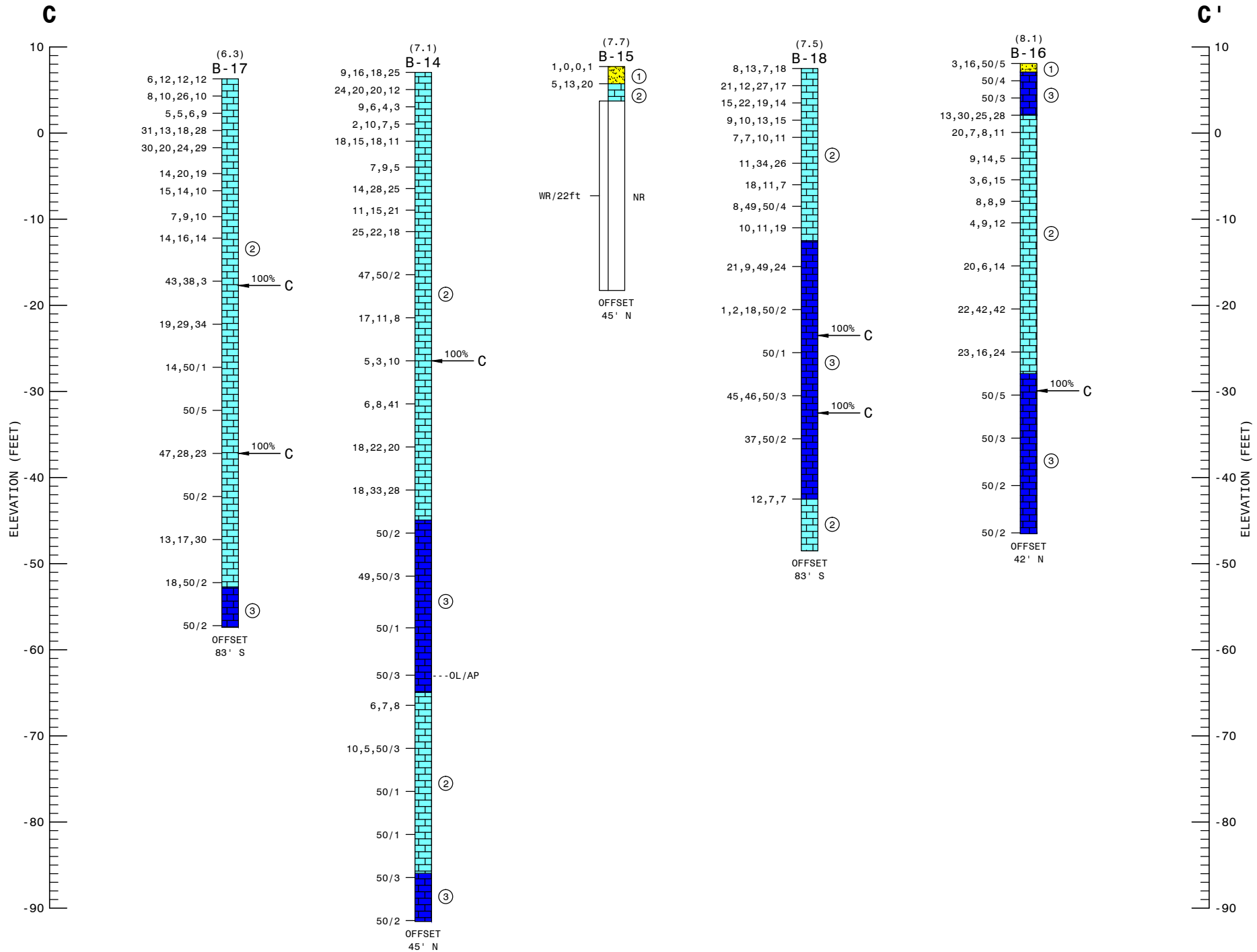
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DRAWN BY:	MAJ	DATE:	12/13/13
CHECKED BY:	ND	PROJECT NO.	300743X2
APPROVED BY:	MPK		

DUKE ENERGY FLORIDA
CITRUS COUNTY COMBINED CYCLE PROJECT
FIGURE 4B
BORING PROFILE B-B'
CRYSTAL RIVER, FLORIDA

P:\PROJECTS-C3D\300743X2 DUKE CITRUS COUNTY CRYSTAL RIVER\DWG\300743X2 FIG_BORINGS. DWG



EXPLANATION

	① SAND; VARIABLY COLORED (USCS = SP TO SM/SC)	SP	UNIFIED SOIL CLASSIFICATION SYSTEM classification
	② LIMESTONE; PALE BROWN, WHITE POORLY TO MODERATELY INDURATED		Depth of water table
	③ LIMESTONE; BROWN, PALE BROWN, GRAY MODERATELY TO WELL INDURATED		Loss of Circulation
		WR	Weight of Rod
		WH	Weight of Hammer
		NR	No Recovery
		(4.2)	ELEVATION DATUM (NAD83) 2011
		---OL/AP	APPROXIMATE CONTACT BETWEEN OCALA LIMESTONE AND AVON PARK FORMATION

NOTES:

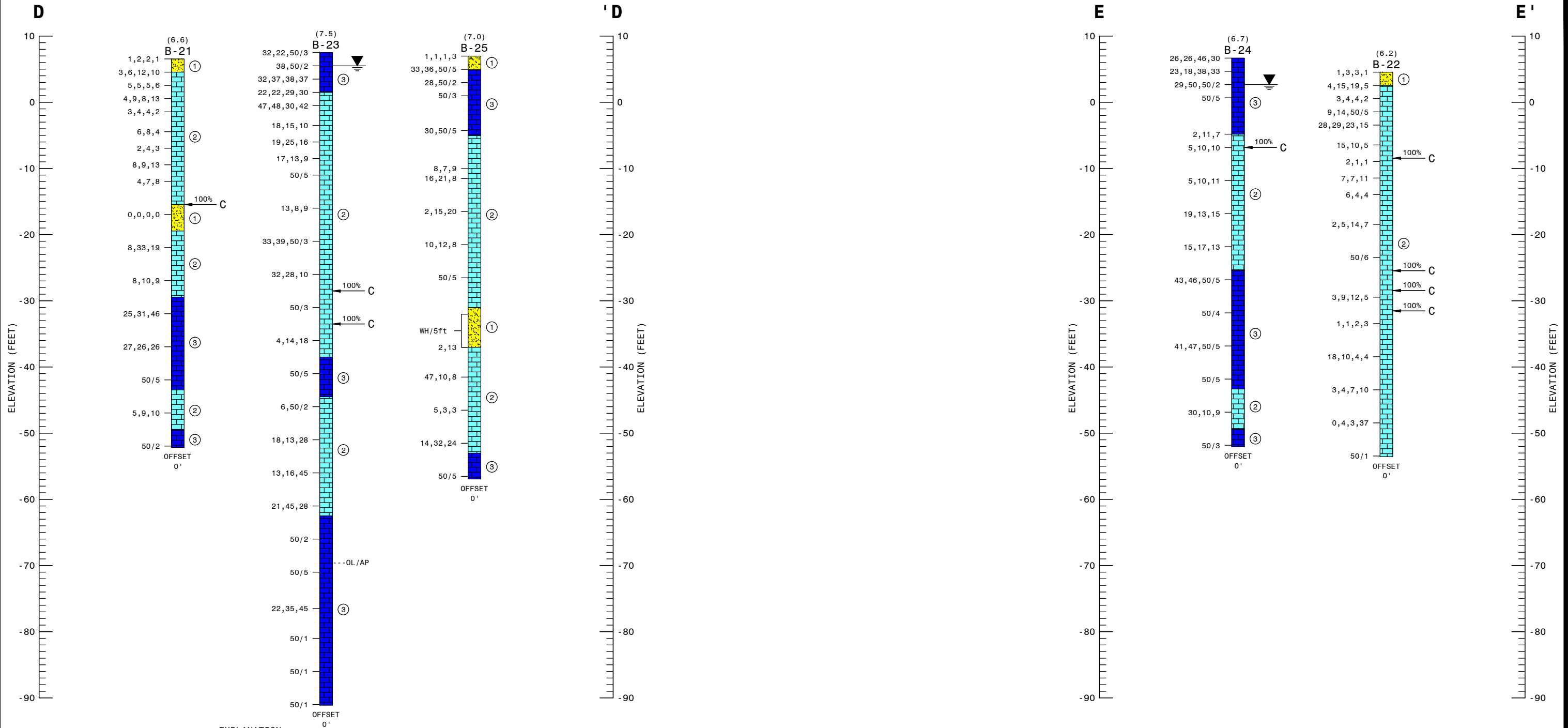
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CHECKED BY:	ND	PROJECT NO.	300743X2
APPROVED BY:	MPK		

DUKE ENERGY FLORIDA
CITRUS COUNTY COMBINED CYCLE PROJECT
FIGURE 4C
BORING PROFILE C-C'
CRYSTAL RIVER, FLORIDA



EXPLANATION

- | | | | |
|--|--|----------|--|
| | ① SAND; VARIABLY COLORED
(USCS = SP TO SM/SC) | SP | UNIFIED SOIL CLASSIFICATION
SYSTEM classification |
| | ② LIMESTONE; PALE BROWN, WHITE
POORLY TO MODERATELY INDURATED | | Depth of water table |
| | ③ LIMESTONE; BROWN, PALE BROWN, GRAY
MODERATELY TO WELL INDURATED | | Loss of Circulation |
| | | WR | Weight of Rod |
| | | WH | Weight of Hammer |
| | | NR | No Recovery |
| | | (4.2) | ELEVATION DATUM (NAD83) 2011 |
| | | ---OL/AP | APPROXIMATE CONTACT BETWEEN
OCALA LIMESTONE AND AVON PARK FORMATION |

NOTES:

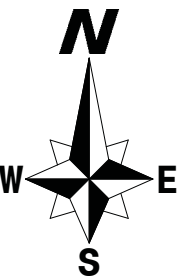
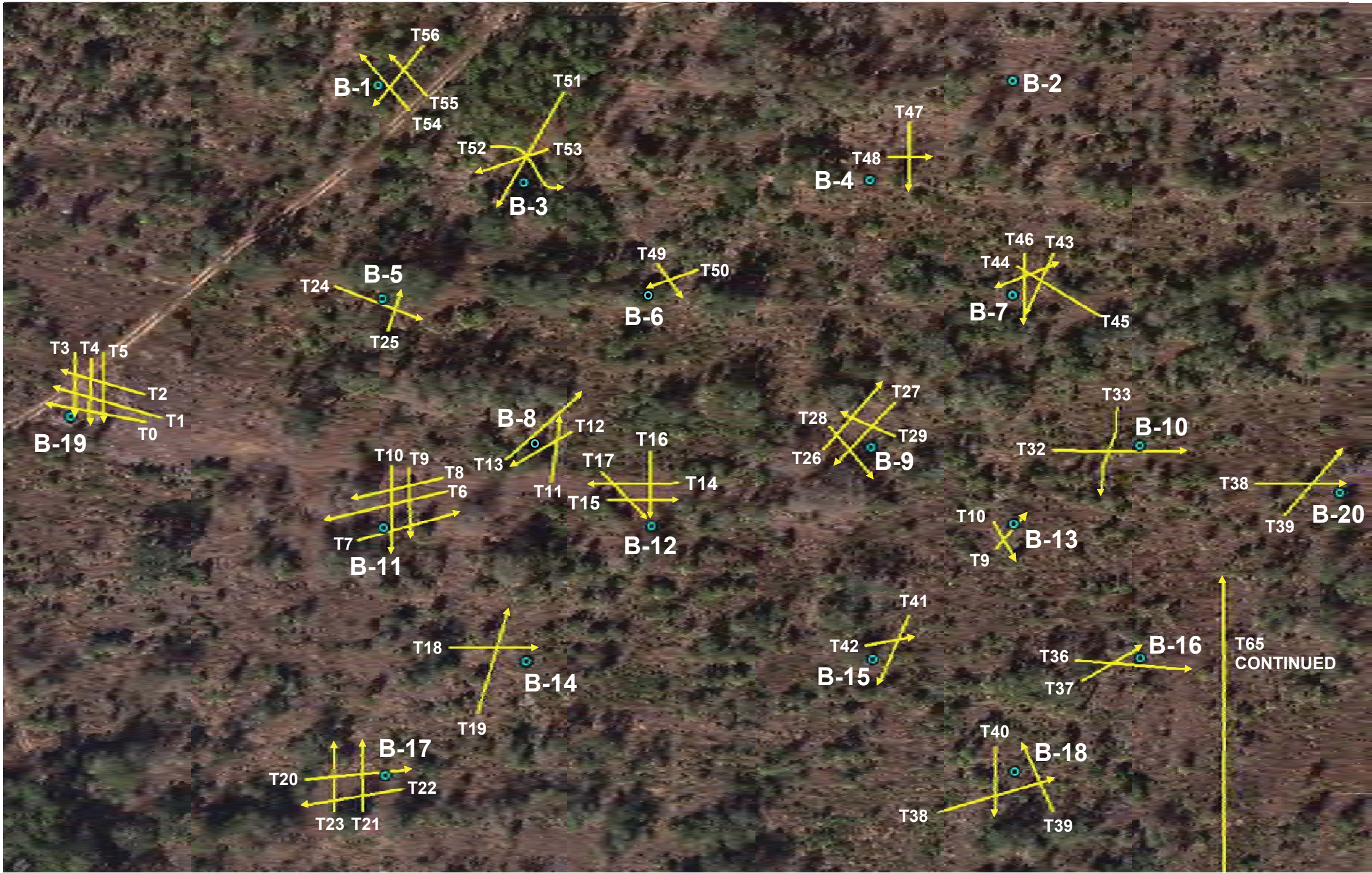
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3. REFER TO GEOTECHNICAL REPORT BY AMEC FOR DETAILED BORING INFORMATION.

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DRAWN BY:	MAJ	DATE:	12/13/13
CHECKED BY:	ND	PROJECT NO.	300743X2
APPROVED BY:	MPK		

DUKE ENERGY FLORIDA
CITRUS COUNTY COMBINED CYCLE PROJECT
FIGURE 4D
BORING PROFILE D-D' & E-E'
CRYSTAL RIVER, FLORIDA



0 100
SCALE: FEET

SUBJECT SITE

A
B

LEGEND

- B-1  Boring Location
T1  GPR Transect

DATE	REVISIONS

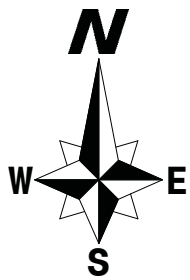
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DRAWN BY:	SDB	DATE:	12/13/13
CHECKED BY:		PROJECT NO.	300743X2
APPROVED BY:			

DUKE ENERGY FLORIDA
CITRUS COUNTY COMBINED CYCLE PROJECT
FIGURE 5A
GPR TRANSECT LOCATIONS
CRYSTAL RIVER, FLORIDA

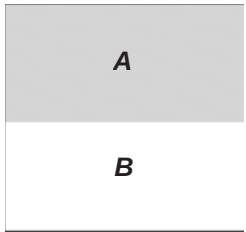


A
B



0 100
SCALE: FEET

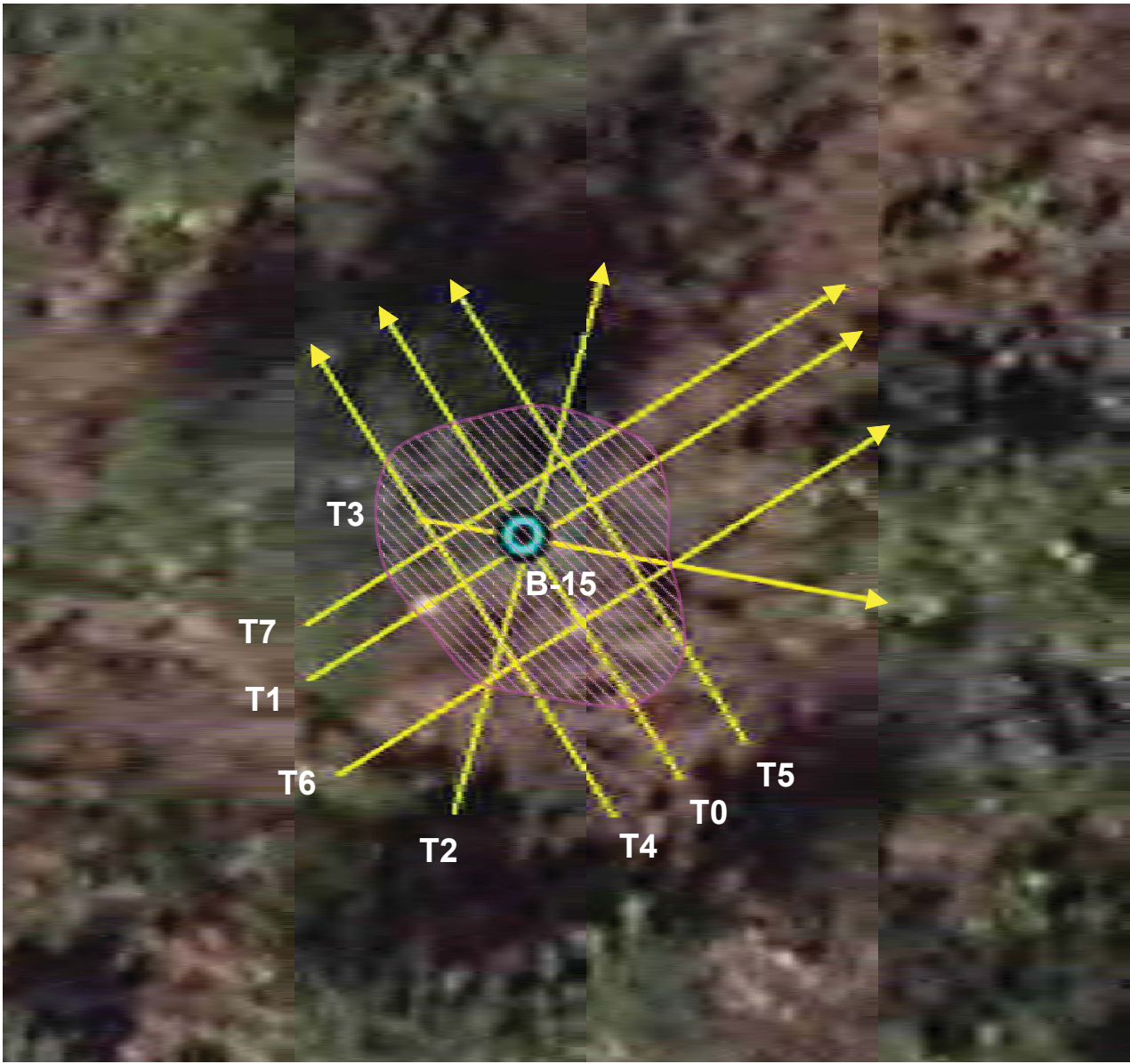
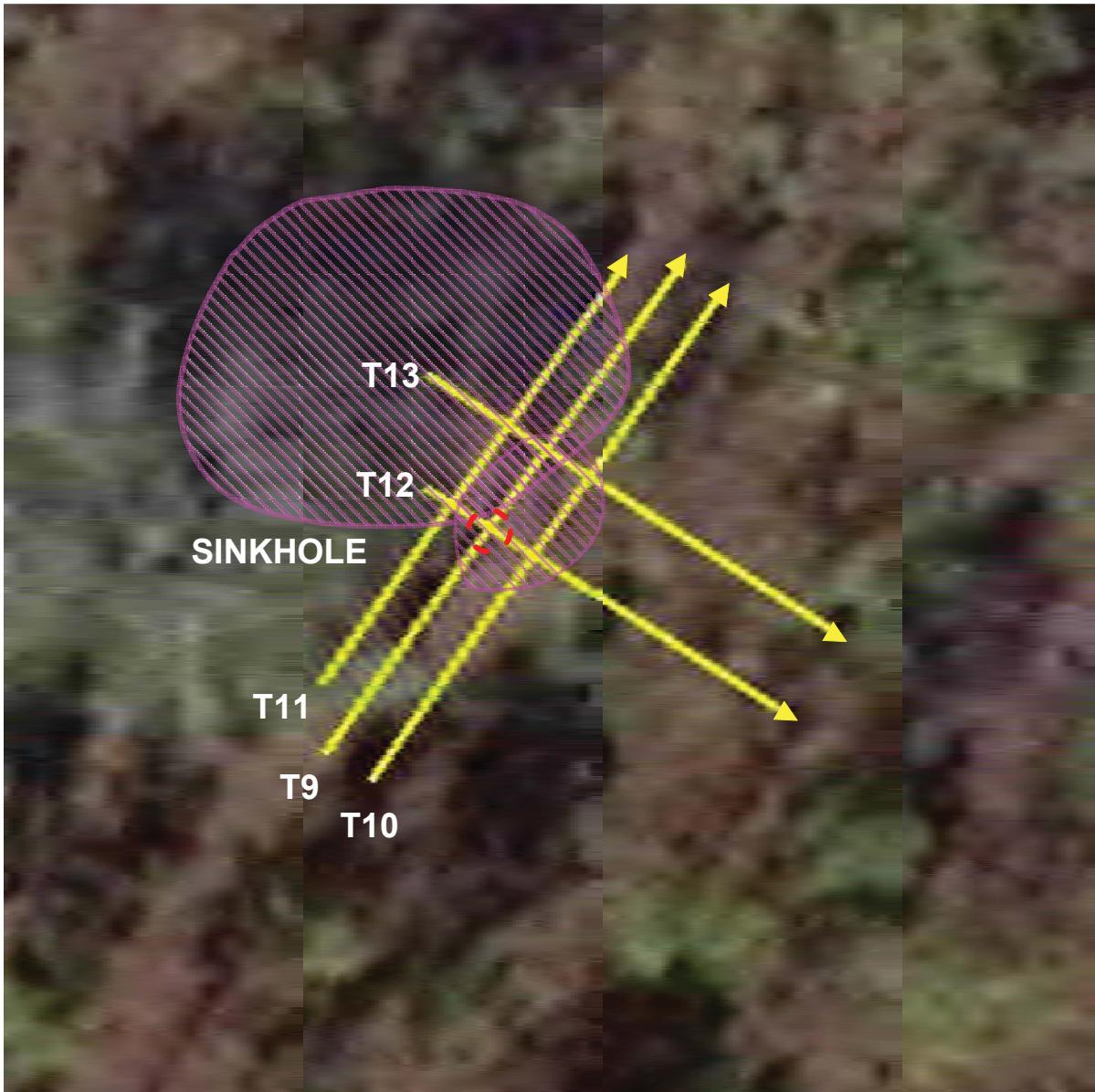
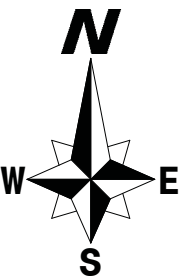
SUBJECT SITE



LEGEND

- B-1  Boring Location  Observed Sinkhole Location
T1  GPR Transect

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						DRAWN BY:	SDB	DATE:	12/13/13		
						CHECKED BY:		PROJECT NO.	300743X2		
						APPROVED BY:					

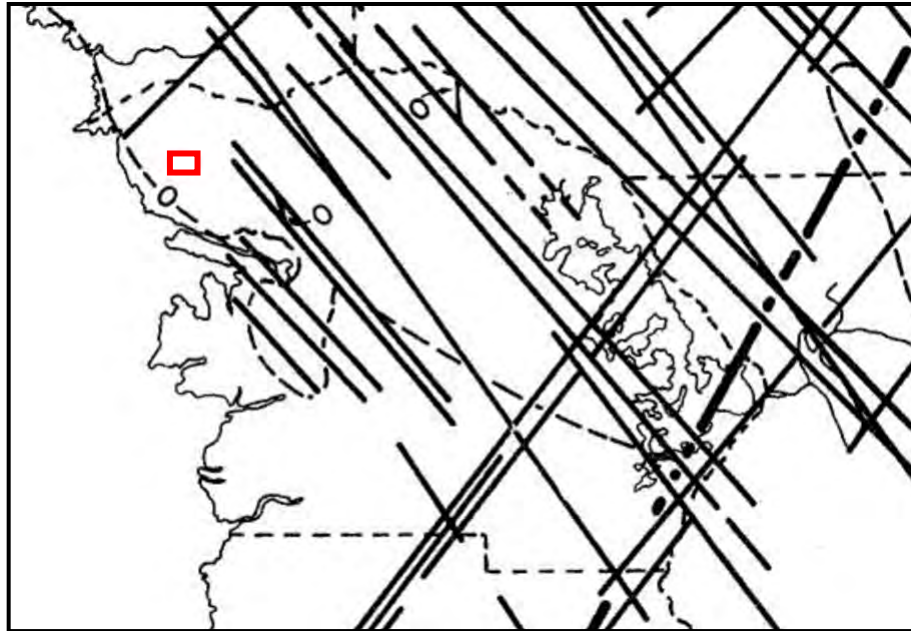


LEGEND				
B-1		Boring Location		Observed Sinkhole Location
T1		GPR Transect		GPR Anomaly

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						DRAWN BY:	SDB	DATE:	12/13/13		
						CHECKED BY:		PROJECT NO.	300743X2		
						APPROVED BY:					

APPENDIX A

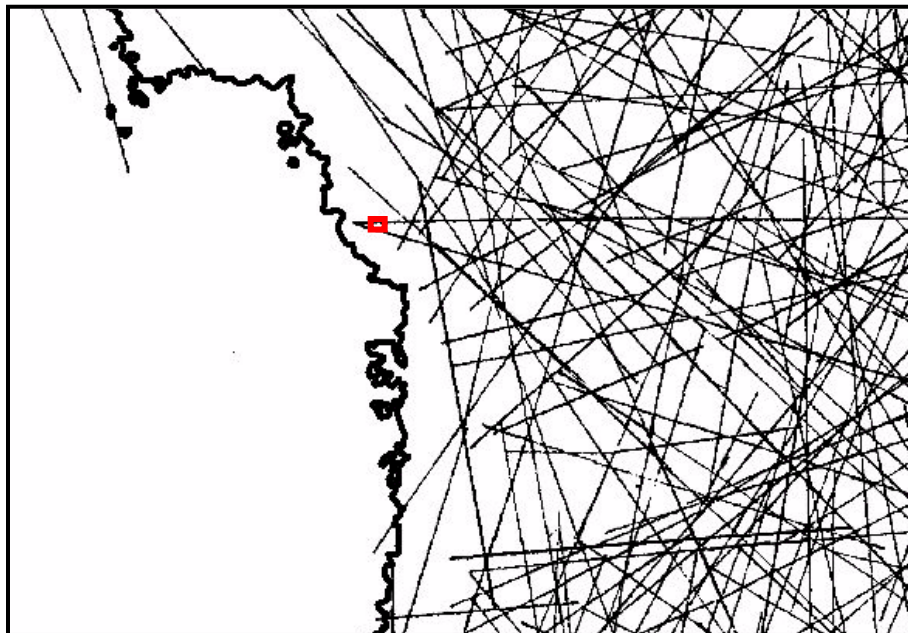
Karst Evaluation



— Joints and possible faulting
 - - - Contour of the Inglis mbr. over the Ocala Uplift
 D Possible Post-Paleozoic graben fault
 U boundary (after Paul Applin)

Source:

Fracture Pattern of the Northern Portion of the Florida Peninsula
 Taken from: Geology of Citrus and Levy Counties, Florida by R. O. Vernon
 Published by Florida Geological Survey, 1951



Source:

Lineaments
 Prepared by the Remote Sensing Section, State Topographic Office
 Published by Florida Department of Transportation, 1973

 APPROXIMATE SUBJECT SITE



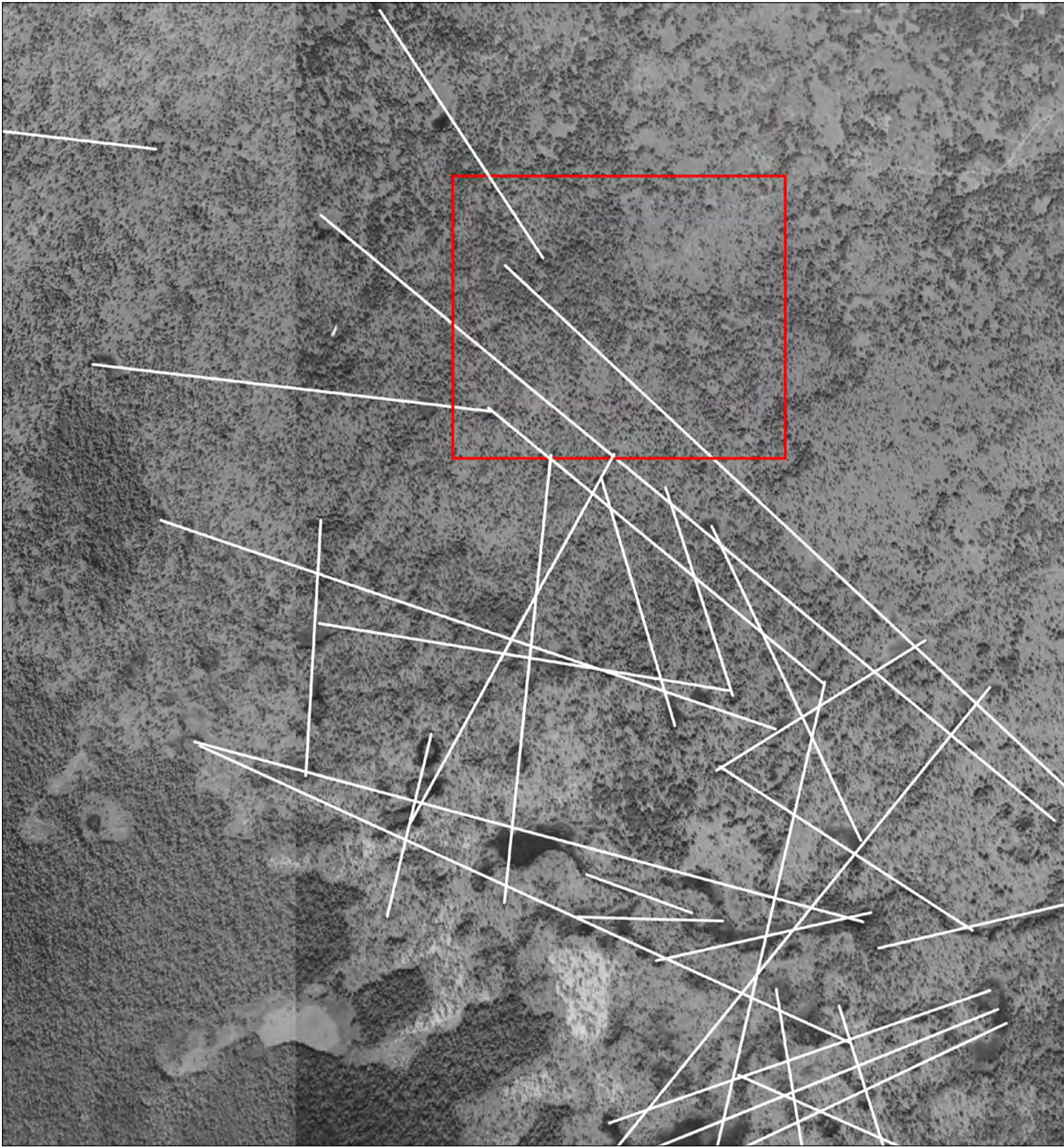
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CITRUS COUNTY COMBINED CYCLE PROJECT

Photo-linear Map (Vernon & FDOT)

APPENDIX A - Figure A1

P:\PROJECTS-C3D\300743X2 DUKE CITRUS COUNTY CRYSTAL RIVER\DWG\300743X2 FIG_PHOTO LINEAR.DWG



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CHECKED BY:	ND
APPROVED BY:	MPK

SCALE:	N.T.S.
DATE:	12/13/13
PROJECT NO.	300743X2

DUKE ENERGY FLORIDA
CITRUS COUNTY COMBINED CYCLE PROJECT
FIGURE A-2
PHOTO-LINEAR MAP
CRYSTAL RIVER, FLORIDA



- AREA I. BARE OR THINLY COVERED LIMESTONE**
Sinkholes are few, generally shallow and broad and develop gradually. Solution sinkholes dominate
- AREA II. COVER IS 30 - 200 FEET THICK**
Consists mainly incohesive and permeable sand. Sinkholes are few, shallow of small diameter and develop gradually. Cover-subsidence sinkholes dominate
- AREA III. COVER IS 30 - 200 FEET THICK**
Consists mainly cohesive clayey sediments of low permeability. Sinkholes are most numerous, of varying size, and develop abruptly. Cover-collapse sinkholes dominate
- AREA IV. COVER IS MORE THAN 200 FEET THICK**
Consists of cohesive sediments interlayered with discontinuous carbonate beds. Sinkholes are very few, but several large-diameter, deep sinkholes occur. Cover-collapse sinkholes dominate

Solution sinkholes occur in areas where limestone is exposed at land surface or is covered by thin layers of soil and permeable sand. Solution is most active at the limestone surface and along joints, fractures or other openings in the rock that permit water to move easily into the subsurface. Dissolved limestone and some insoluble residue are carried downward by percolating water along enlarged openings as solution of the limestone progresses. Large voids commonly do not form because subsidence of the soil layer occurs as the limestone surface dissolves. The result is a gradual downward movement of the land surface and development of a depression that collects increasing amounts of surface runoff as its perimeter expands.

This type of sinkhole usually forms as a bowl-shaped depression with the slope of its sides determined by the rate of subsidence relative to the rate of erosion of the walls of the depression from surface runoff. Surface runoff may also carry sand and clay particles into the depression, which may form a relatively impermeable seal in the bottom. A marsh or lake forms when water is ponded because infiltration is restricted by the clayey seal. The gently rolling hills and shallow depressions typical of solution-subsidence topography are common over large parts of Florida.

Source:

Map Series No. 110, Sinkhole Type, Development, and Distribution in Florida
Prepared by the U.S. Geological Survey
Published by Bureau of Geology, Florida Department of Natural Resources, 1985



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**CITRUS COUNTY COMBINED
CYCLE PROJECT**

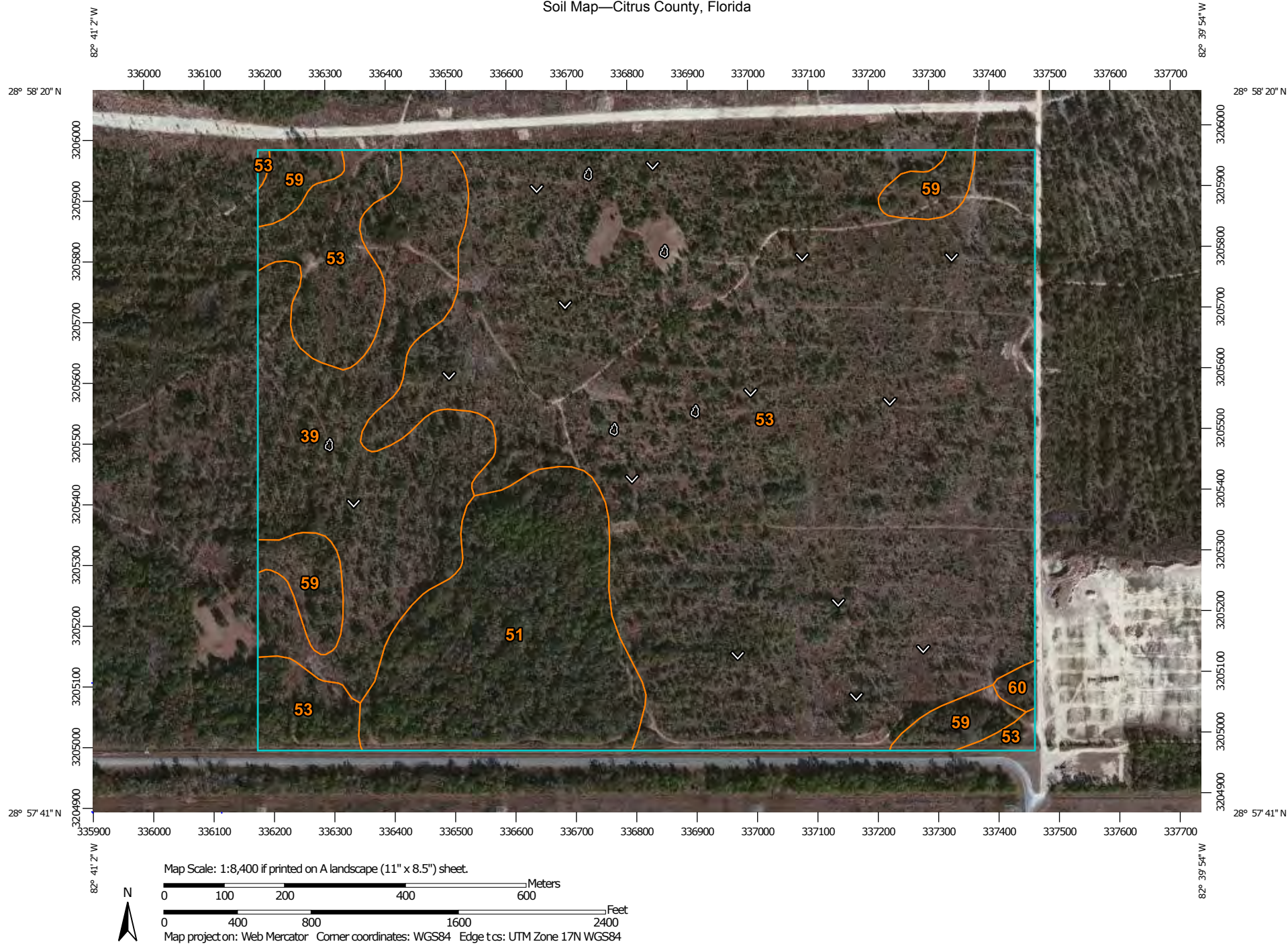
DOMINANT SINKHOLE TYPE MAP (1985)

APPENDIX A - Figure A3

APPENDIX B

NCRS Citrus County Soil Survey

Soil Map—Citrus County, Florida



Soil Map—Citrus County, Florida

MAP LEGEND

Area of Interest (AOI)

 Area of Interest (AOI)

Soils

 Soil Map Unit Polygons

 Soil Map Unit Lines

 Soil Map Unit Points

Special Point Features



Blowout



Borrow Pit



Clay Spot



Closed Depression



Gravel Pit



Gravelly Spot



Landfill



Lava Flow



Marsh or swamp



Mine or Quarry



Miscellaneous Water



Perennial Water



Rock Outcrop



Saline Spot



Sandy Spot



Severely Eroded Spot



Sinkhole



Slide or Slip



Sodic Spot



Spoil Area



Stony Spot



Very Stony Spot



Wet Spot



Other



Special Line Features

Water Features



Streams and Canals

Transportation



Rails



Interstate Highways



US Routes



Major Roads



Local Roads

Background



Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: <http://websoilsurvey.nrcs.usda.gov>
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Citrus County, Florida
Survey Area Data: Version 10, Jul 20, 2012

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Feb 13, 2010—Mar 11, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Citrus County, Florida (FL017)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
39	Hallandale-Rock outcrop complex, rarely flooded	46.1	14.6%
51	Boca-Pineda, limestone substratum complex	38.1	12.1%
53	Boca fine sand	217.5	68.9%
59	Boca fine sand, depressional	13.1	4.1%
60	Broward fine sand	1.0	0.3%
Totals for Area of Interest		315.8	100.0%

Citrus County, Florida

39—Hallandale-Rock outcrop complex, rarely flooded

Map Unit Setting

Mean annual precipitation: 48 to 56 inches

Mean annual air temperature: 66 to 73 degrees F

Frost-free period: 287 to 317 days

Map Unit Composition

Hallandale, non-hydric, and similar soils: 50 percent

Rock outcrop: 25 percent

Hallandale, hydric, and similar soils: 10 percent

Minor components: 15 percent

Description of Hallandale, Non-hydric

Setting

Landform: Flats on marine terraces

Landform position (three-dimensional): Interfluve, talf

Down-slope shape: Convex

Across-slope shape: Linear

Parent material: Sandy marine deposits over limestone

Properties and qualities

Slope: 0 to 2 percent

Depth to restrictive feature: 7 to 20 inches to lithic bedrock

Drainage class: Poorly drained

Capacity of the most limiting layer to transmit water (Ksat): High to very high (2.00 to 20.00 in/hr)

Depth to water table: About 6 to 18 inches

Frequency of flooding: Rare

Frequency of ponding: None

Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)

Sodium adsorption ratio, maximum: 4.0

Available water capacity: Very low (about 0.6 inches)

Interpretive groups

Farmland classification: Not prime farmland

Land capability (nonirrigated): 4w

Hydrologic Soil Group: A/D

Ecological site: Wetland Hardwood Hammock (R154XY012FL)

Other vegetative classification: Sandy soils on flats of mesic or hydric lowlands (G154XB141FL)

Typical profile

0 to 2 inches: Fine sand

2 to 6 inches: Fine sand

6 to 8 inches: Fine sand

8 to 10 inches: Fine sand

10 to 14 inches: Unweathered bedrock

Description of Rock Outcrop**Setting**

Landform: Flats on marine terraces
Landform position (three-dimensional): Talf
Down-slope shape: Convex
Across-slope shape: Linear

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: 0 inches to lithic bedrock
Frequency of flooding: Rare

Interpretive groups

Farmland classification: Not prime farmland
Land capability (nonirrigated): 8
Other vegetative classification: Forage suitability group not assigned
(G154XB999FL)

Description of Hallandale, Hydric**Setting**

Landform: Flats on marine terraces
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy marine deposits over limestone

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: 7 to 20 inches to lithic bedrock
Drainage class: Poorly drained
Capacity of the most limiting layer to transmit water
(Ksat): Moderately high to high (0.60 to 6.00 in/hr)
Depth to water table: About 0 to 6 inches
Frequency of flooding: Rare
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 4.0
Available water capacity: Very low (about 0.6 inches)

Interpretive groups

Farmland classification: Not prime farmland
Land capability (nonirrigated): 4w
Hydrologic Soil Group: B/D
Ecological site: Wetland Hardwood Hammock (R154XY012FL)
Other vegetative classification: Sandy soils on flats of mesic or hydric
lowlands (G154XB141FL)

Typical profile

0 to 2 inches: Fine sand
2 to 6 inches: Fine sand
6 to 8 inches: Fine sand
8 to 10 inches: Fine sand

Map Unit Description: Hallandale-Rock outcrop complex, rarely flooded---Citrus County, Florida

10 to 14 inches: Unweathered bedrock

Minor Components

Basinger

Percent of map unit: 4 percent

Landform: Drainageways on marine terraces

Landform position (three-dimensional): Dip

Down-slope shape: Linear

Across-slope shape: Concave

Ecological site: Slough (R154XY011FL)

Other vegetative classification: Sandy soils on flats of mesic or hydric lowlands (G154XB141FL)

Lauderhill

Percent of map unit: 4 percent

Landform: Depressions on marine terraces

Landform position (three-dimensional): Dip

Down-slope shape: Concave

Across-slope shape: Concave

Other vegetative classification: Organic soils in depressions and on flood plains (G154XB645FL)

Citronelle

Percent of map unit: 4 percent

Landform: Flats on marine terraces

Landform position (three-dimensional): Talf

Down-slope shape: Convex

Across-slope shape: Linear

Ecological site: Cabbage Palm Flatwoods (R154XY005FL)

Other vegetative classification: Shallow or moderately deep, sandy or loamy soils on rises and ridges of mesic uplands (G154XB521FL)

Redlevel

Percent of map unit: 3 percent

Landform: Flats on marine terraces

Landform position (three-dimensional): Talf

Down-slope shape: Convex

Across-slope shape: Linear

Ecological site: Cabbage Palm Flatwoods (R154XY005FL)

Other vegetative classification: Sandy soils on rises and knolls of mesic uplands (G154XB131FL)

Data Source Information

Soil Survey Area: Citrus County, Florida

Survey Area Data: Version 10, Jul 20, 2012

Citrus County, Florida

51—Boca-Pineda, limestone substratum complex

Map Unit Setting

Elevation: 0 to 60 feet

Mean annual precipitation: 48 to 56 inches

Mean annual air temperature: 66 to 73 degrees F

Frost-free period: 287 to 317 days

Map Unit Composition

Boca, non-hydric, and similar soils: 55 percent

Pineda, non-hydric, and similar soils: 20 percent

Pineda, hydric, and similar soils: 10 percent

Boca, hydric, and similar soils: 10 percent

Minor components: 5 percent

Description of Boca, Non-hydric

Setting

Landform: Flats on marine terraces

Landform position (three-dimensional): Talf

Down-slope shape: Convex

Across-slope shape: Linear

Parent material: Sandy and loamy marine deposits over limestone

Properties and qualities

Slope: 0 to 2 percent

Depth to restrictive feature: 24 to 40 inches to lithic bedrock

Drainage class: Poorly drained

Capacity of the most limiting layer to transmit water

(Ksat): Moderately high to high (0.60 to 2.00 in/hr)

Depth to water table: About 6 to 18 inches

Frequency of flooding: None

Frequency of ponding: None

Calcium carbonate, maximum content: 10 percent

Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)

Sodium adsorption ratio, maximum: 4.0

Available water capacity: Very low (about 2.3 inches)

Interpretive groups

Farmland classification: Not prime farmland

Land capability (nonirrigated): 3w

Hydrologic Soil Group: C/D

Ecological site: South Florida Flatwoods (R154XY003FL)

Other vegetative classification: Sandy over loamy soils on flats of hydric or mesic lowlands (G154XB241FL)

Typical profile

0 to 3 inches: Fine sand

3 to 22 inches: Fine sand

22 to 32 inches: Sandy clay loam

32 to 36 inches: Unweathered bedrock

Description of Pineda, Non-hydric

Setting

Landform: Flats on marine terraces

Landform position (three-dimensional): Talf

Down-slope shape: Convex

Across-slope shape: Linear

Parent material: Sandy and loamy marine deposits

Properties and qualities

Slope: 0 to 2 percent

Depth to restrictive feature: 40 to 80 inches to lithic bedrock

Drainage class: Poorly drained

Capacity of the most limiting layer to transmit water

(Ksat): Moderately high to high (0.60 to 2.00 in/hr)

Depth to water table: About 6 to 18 inches

Frequency of flooding: None

Frequency of ponding: None

Calcium carbonate, maximum content: 15 percent

Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)

Sodium adsorption ratio, maximum: 4.0

Available water capacity: Very low (about 3.0 inches)

Interpretive groups

Farmland classification: Not prime farmland

Land capability (nonirrigated): 5w

Hydrologic Soil Group: B/D

Ecological site: South Florida Flatwoods (R154XY003FL)

Other vegetative classification: Sandy over loamy soils on flats of hydric or mesic lowlands (G154XB241FL)

Typical profile

0 to 2 inches: Fine sand

2 to 5 inches: Fine sand

5 to 25 inches: Fine sand

25 to 28 inches: Fine sand

28 to 42 inches: Sandy clay loam

42 to 46 inches: Unweathered bedrock

Description of Boca, Hydric

Setting

Landform: Flats on marine terraces

Landform position (three-dimensional): Talf

Down-slope shape: Linear

Across-slope shape: Linear

Parent material: Sandy and loamy marine deposits over limestone

Properties and qualities

Slope: 0 to 2 percent

Depth to restrictive feature: 24 to 40 inches to lithic bedrock

Drainage class: Poorly drained

Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: About 0 to 12 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 15 percent
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 4.0
Available water capacity: Very low (about 2.3 inches)

Interpretive groups

Farmland classification: Not prime farmland
Land capability (nonirrigated): 3w
Hydrologic Soil Group: C/D
Ecological site: South Florida Flatwoods (R154XY003FL)
Other vegetative classification: Sandy over loamy soils on flats of hydric or mesic lowlands (G154XB241FL)

Typical profile

0 to 3 inches: Fine sand
3 to 22 inches: Fine sand
22 to 32 inches: Sandy clay loam
32 to 36 inches: Unweathered bedrock

Description of Pineda, Hydric**Setting**

Landform: Flats on marine terraces
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy and loamy marine deposits

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: 40 to 80 inches to lithic bedrock
Drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: About 0 to 12 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 15 percent
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 4.0
Available water capacity: Very low (about 3.0 inches)

Interpretive groups

Farmland classification: Not prime farmland
Land capability (nonirrigated): 5w
Hydrologic Soil Group: B/D
Ecological site: South Florida Flatwoods (R154XY003FL)
Other vegetative classification: Sandy over loamy soils on flats of hydric or mesic lowlands (G154XB241FL)

Map Unit Description: Boca-Pineda, limestone substratum complex---Citrus County, Florida

Typical profile

0 to 2 inches: Fine sand
2 to 5 inches: Fine sand
5 to 25 inches: Fine sand
25 to 28 inches: Fine sand
28 to 42 inches: Sandy clay loam
42 to 46 inches: Unweathered bedrock

Minor Components**Rock outcrop**

Percent of map unit: 5 percent
Landform: Flats on marine terraces
Landform position (three-dimensional): Talf
Down-slope shape: Convex
Across-slope shape: Linear
Other vegetative classification: Forage suitability group not assigned
(G154XB999FL)

Data Source Information

Soil Survey Area: Citrus County, Florida
Survey Area Data: Version 10, Jul 20, 2012

Citrus County, Florida

53—Boca fine sand

Map Unit Setting

Elevation: 0 to 40 feet

Mean annual precipitation: 48 to 56 inches

Mean annual air temperature: 66 to 73 degrees F

Frost-free period: 287 to 317 days

Map Unit Composition

Boca, non-hydric, and similar soils: 55 percent

Boca, hydric, and similar soils: 20 percent

Minor components: 25 percent

Description of Boca, Non-hydric

Setting

Landform: Flats on marine terraces

Landform position (three-dimensional): Talf

Down-slope shape: Convex

Across-slope shape: Linear

Parent material: Sandy and loamy marine deposits over limestone

Properties and qualities

Slope: 0 to 2 percent

Depth to restrictive feature: 24 to 40 inches to lithic bedrock

Drainage class: Poorly drained

Capacity of the most limiting layer to transmit water

(Ksat): Moderately high to high (0.60 to 2.00 in/hr)

Depth to water table: About 6 to 18 inches

Frequency of flooding: None

Frequency of ponding: None

Calcium carbonate, maximum content: 10 percent

Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)

Sodium adsorption ratio, maximum: 4.0

Available water capacity: Low (about 3.3 inches)

Interpretive groups

Farmland classification: Not prime farmland

Land capability (nonirrigated): 3w

Hydrologic Soil Group: C/D

Ecological site: Cabbage Palm Flatwoods (R154XY005FL)

Other vegetative classification: Sandy over loamy soils on flats of
hydric or mesic lowlands (G154XB241FL)

Typical profile

0 to 5 inches: Fine sand

5 to 21 inches: Fine sand

21 to 38 inches: Sandy clay loam

38 to 42 inches: Unweathered bedrock

Description of Boca, Hydric**Setting**

Landform: Flats on marine terraces
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy and loamy marine deposits over limestone

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: 24 to 40 inches to lithic bedrock
Drainage class: Poorly drained
Capacity of the most limiting layer to transmit water
(Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: About 0 to 12 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 10 percent
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 4.0
Available water capacity: Low (about 3.3 inches)

Interpretive groups

Farmland classification: Not prime farmland
Land capability (nonirrigated): 3w
Hydrologic Soil Group: C/D
Ecological site: Cabbage Palm Flatwoods (R154XY005FL)
Other vegetative classification: Sandy over loamy soils on flats of hydric or mesic lowlands (G154XB241FL)

Typical profile

0 to 5 inches: Fine sand
5 to 21 inches: Fine sand
21 to 38 inches: Sandy clay loam
38 to 42 inches: Unweathered bedrock

Minor Components**Basinger**

Percent of map unit: 5 percent
Landform: Drainageways on marine terraces
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Concave
Ecological site: Slough (R154XY011FL)
Other vegetative classification: Sandy soils on flats of mesic or hydric lowlands (G154XB141FL)

Myakka, non-hydric

Percent of map unit: 5 percent
Landform: Flatwoods on marine terraces
Landform position (three-dimensional): Talf

Map Unit Description: Boca fine sand---Citrus County, Florida

Down-slope shape: Convex
Across-slope shape: Linear
Ecological site: South Florida Flatwoods (R154XY003FL)
Other vegetative classification: Sandy soils on flats of mesic or hydric lowlands (G154XB141FL)

Eaugallie, non-hydric

Percent of map unit: 5 percent
Landform: Flatwoods on marine terraces
Landform position (three-dimensional): Talf
Down-slope shape: Convex
Across-slope shape: Linear
Ecological site: South Florida Flatwoods (R154XY003FL)
Other vegetative classification: Sandy soils on flats of mesic or hydric lowlands (G154XB141FL)

Redlevel

Percent of map unit: 5 percent
Landform: Flats on marine terraces
Landform position (three-dimensional): Talf
Down-slope shape: Convex
Across-slope shape: Linear
Ecological site: Cabbage Palm Flatwoods (R154XY005FL)
Other vegetative classification: Sandy soils on rises and knolls of mesic uplands (G154XB131FL)

Hallandale, hydric

Percent of map unit: 5 percent
Landform: Flats on marine terraces
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Wetland Hardwood Hammock (R154XY012FL)
Other vegetative classification: Sandy soils on flats of mesic or hydric lowlands (G154XB141FL)

Data Source Information

Soil Survey Area: Citrus County, Florida
Survey Area Data: Version 10, Jul 20, 2012

Citrus County, Florida

59—Boca fine sand, depressional

Map Unit Setting

Mean annual precipitation: 48 to 56 inches

Mean annual air temperature: 66 to 73 degrees F

Frost-free period: 287 to 317 days

Map Unit Composition

Boca, depressional, and similar soils: 80 percent

Minor components: 20 percent

Description of Boca, Depressional

Setting

Landform: Depressions on marine terraces

Landform position (three-dimensional): Dip

Down-slope shape: Concave

Across-slope shape: Concave

Parent material: Sandy and loamy marine deposits over limestone

Properties and qualities

Slope: 0 to 2 percent

Depth to restrictive feature: 24 to 40 inches to lithic bedrock

Drainage class: Very poorly drained

Capacity of the most limiting layer to transmit water

(Ksat): Moderately high to high (0.60 to 2.00 in/hr)

Depth to water table: About 0 to 12 inches

Frequency of flooding: None

Frequency of ponding: Frequent

Calcium carbonate, maximum content: 10 percent

Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)

Sodium adsorption ratio, maximum: 4.0

Available water capacity: Low (about 3.0 inches)

Interpretive groups

Farmland classification: Not prime farmland

Land capability (nonirrigated): 7w

Hydrologic Soil Group: A/D

Ecological site: Freshwater Marshes and Ponds (R154XY010FL)

Other vegetative classification: Sandy over loamy soils on stream terraces, flood plains, or in depressions (G154XB245FL)

Typical profile

0 to 8 inches: Fine sand

8 to 25 inches: Fine sand

25 to 38 inches: Sandy clay loam

38 to 42 inches: Unweathered bedrock

Map Unit Description: Boca fine sand, depressional---Citrus County, Florida

Minor Components

Hallandale, hydric

Percent of map unit: 10 percent

Landform: Flats on marine terraces

Landform position (three-dimensional): Talf

Down-slope shape: Linear

Across-slope shape: Linear

Ecological site: Wetland Hardwood Hammock (R154XY012FL)

Other vegetative classification: Sandy soils on stream terraces, flood plains, or in depressions (G154XB145FL)

Rock outcrop

Percent of map unit: 10 percent

Landform: Flats on marine terraces

Landform position (three-dimensional): Talf

Down-slope shape: Convex

Across-slope shape: Linear

Other vegetative classification: Forage suitability group not assigned (G154XB999FL)

Data Source Information

Soil Survey Area: Citrus County, Florida

Survey Area Data: Version 10, Jul 20, 2012

Citrus County, Florida

60—Broward fine sand

Map Unit Setting

Elevation: 0 to 40 feet

Mean annual precipitation: 48 to 56 inches

Mean annual air temperature: 66 to 73 degrees F

Frost-free period: 287 to 317 days

Map Unit Composition

Broward and similar soils: 80 percent

Minor components: 20 percent

Description of Broward

Setting

Landform: Rises on marine terraces, flats on marine terraces

Landform position (three-dimensional): Talf

Down-slope shape: Convex

Across-slope shape: Linear

Parent material: Sandy marine deposits over limestone

Properties and qualities

Slope: 0 to 2 percent

Depth to restrictive feature: 20 to 40 inches to lithic bedrock

Drainage class: Somewhat poorly drained

Capacity of the most limiting layer to transmit water (Ksat): High to very high (2.00 to 20.00 in/hr)

Depth to water table: About 18 to 30 inches

Frequency of flooding: None

Frequency of ponding: None

Calcium carbonate, maximum content: 15 percent

Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)

Sodium adsorption ratio, maximum: 4.0

Available water capacity: Very low (about 2.2 inches)

Interpretive groups

Farmland classification: Not prime farmland

Land capability (nonirrigated): 4w

Hydrologic Soil Group: A/D

Ecological site: Cabbage Palm Flatwoods (R154XY005FL)

Other vegetative classification: Shallow or moderately deep, sandy or loamy soils on rises and ridges of mesic uplands (G154XB521FL)

Typical profile

0 to 5 inches: Fine sand

5 to 35 inches: Fine sand

35 to 39 inches: Unweathered bedrock

Map Unit Description: Broward fine sand---Citrus County, Florida

Minor Components**Redlevel***Percent of map unit:* 10 percent*Landform:* Flats on marine terraces*Landform position (three-dimensional):* Talf*Down-slope shape:* Convex*Across-slope shape:* Linear*Ecological site:* Cabbage Palm Flatwoods (R154XY005FL)*Other vegetative classification:* Sandy soils on rises and knolls of
mesic uplands (G154XB131FL)**Boca, non-hydric***Percent of map unit:* 10 percent*Landform:* Flats on marine terraces*Landform position (three-dimensional):* Talf*Down-slope shape:* Convex*Across-slope shape:* Linear*Ecological site:* Cabbage Palm Flatwoods (R154XY005FL)*Other vegetative classification:* Sandy over loamy soils on flats of
hydric or mesic lowlands (G154XB241FL)**Data Source Information**

Soil Survey Area: Citrus County, Florida

Survey Area Data: Version 10, Jul 20, 2012

APPENDIX C

Ground Penetration Radar Survey Information GPR Transect Profiles

GROUND PENETRATING RADAR SURVEY INFORMATION

Ground Penetrating Radar (GPR) survey is a non-invasive geophysical test method that utilizes high frequency electromagnetic (EM) waves to evaluate subsurface geological conditions. The waves are reflected back to the receiver by changes in the soil conditions. These changes can be associated with a change in grain size, orientation, or packing, a change in moisture content, changes in material i.e. sand to clay or rock or surfaces of buried objects. The maximum depth that the signal can penetrate is very site specific and depends on the subsurface soil strata or rock and the moisture content. Conditions that may exist beyond the effective depth of penetration may not be detected.

The procedures used for testing were in general accordance with industry standards of care and established practices (*Standard Guide for Using the Surface Ground Penetrating Radar Method for Subsurface Investigation ASTM D 6432*). The survey consisted of recording GPR data along transect lines established in a grid across accessible areas of the site. Test transects were first completed across the site to determine the optimum equipment settings for the particular property site. A computer then processes the reflected signals and produces a graphic cross-section of the soil profile. Features of interest are mapped out prior to drilling to aid in placement of borings. Following drilling, the GPR interpretation is reconciled with the boring data.

GPR Equipment Information:

The GPR survey was completed using cart based digital GPR profiling systems manufactured by Sensors & Software, Inc. Signal processing was completed using either Pulse/ EKKO software or RadExplorer. Filters were applied to optimize the images. These filters may vary depending on site conditions.

Date of GPR Survey (#1): November 4, and November 5, 2013

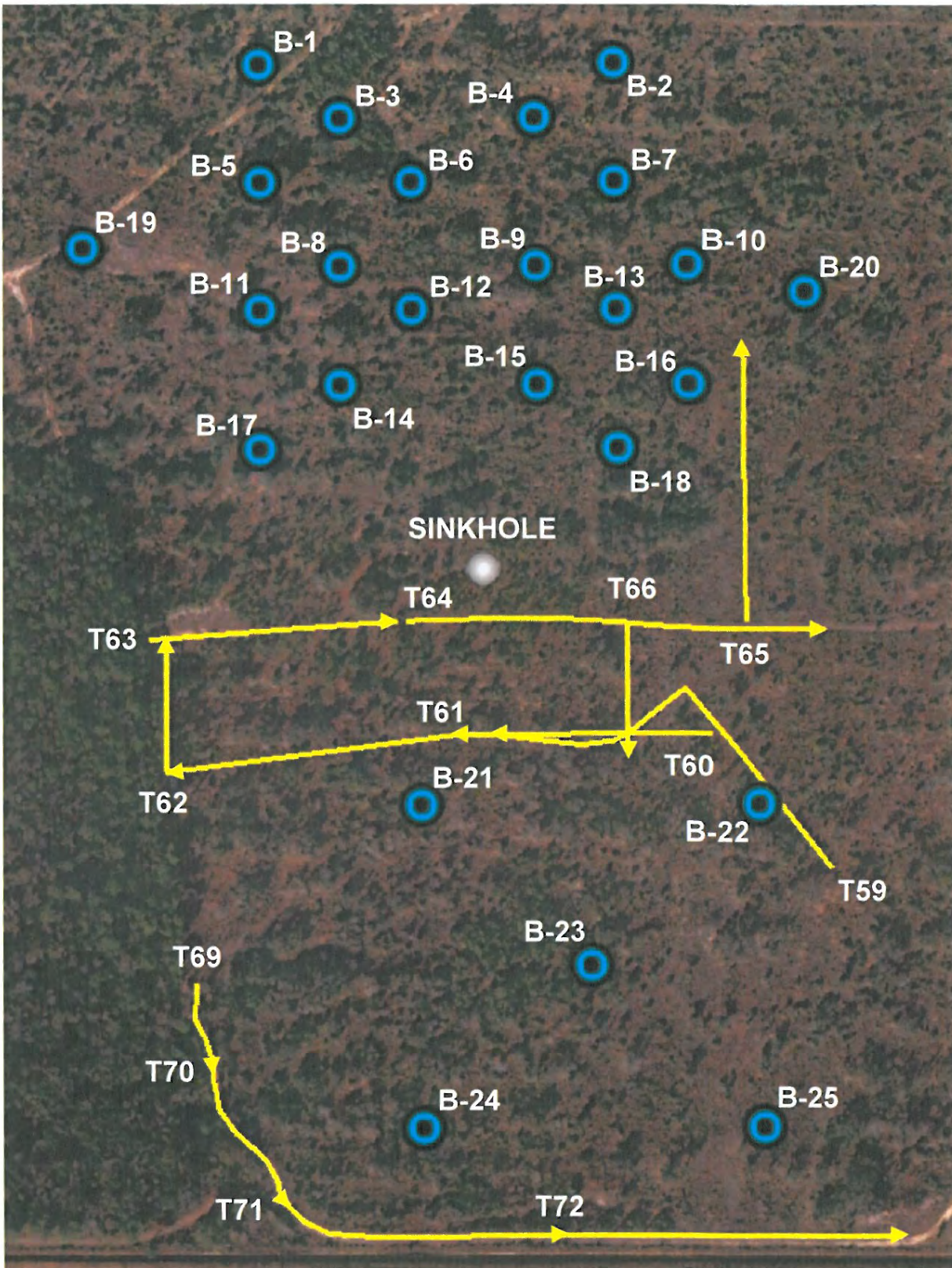
Antenna: Transects T0 to T72 were completed with a 250 MHz antenna with a time window of 140 nanoseconds (ns).

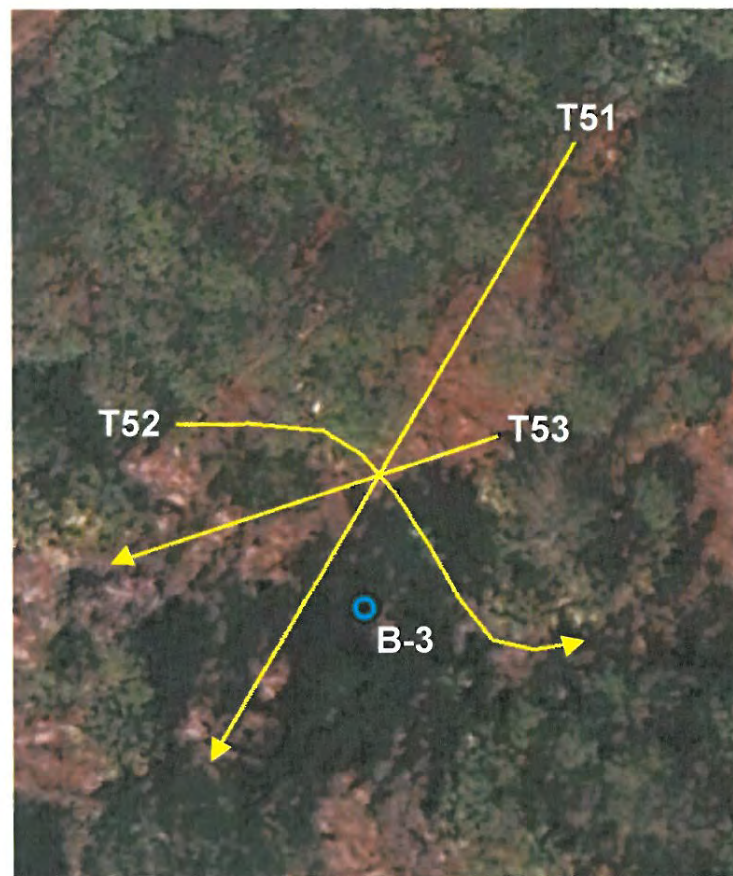
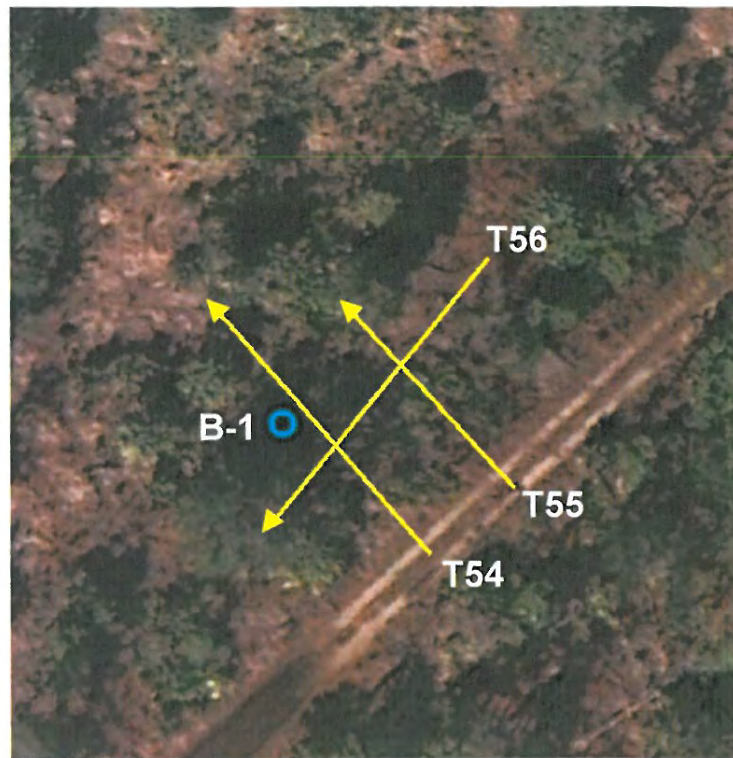
Date of GPR Survey (#2): November 25, 2013

Antenna: Transects T0 to T7 were completed with a 250 MHz antenna with a time window of 140 nanoseconds (ns).

Date of GPR Survey (#3): November 26, 2013

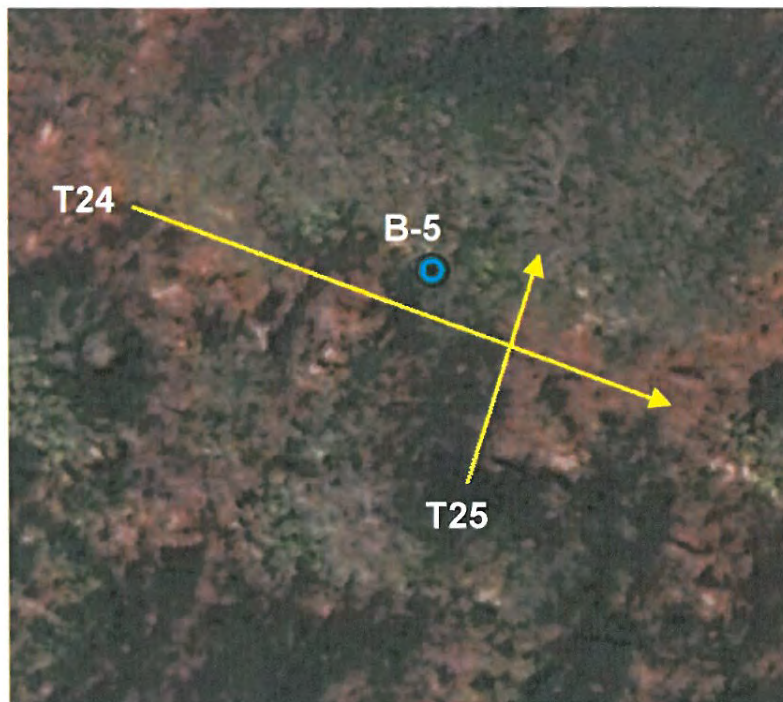
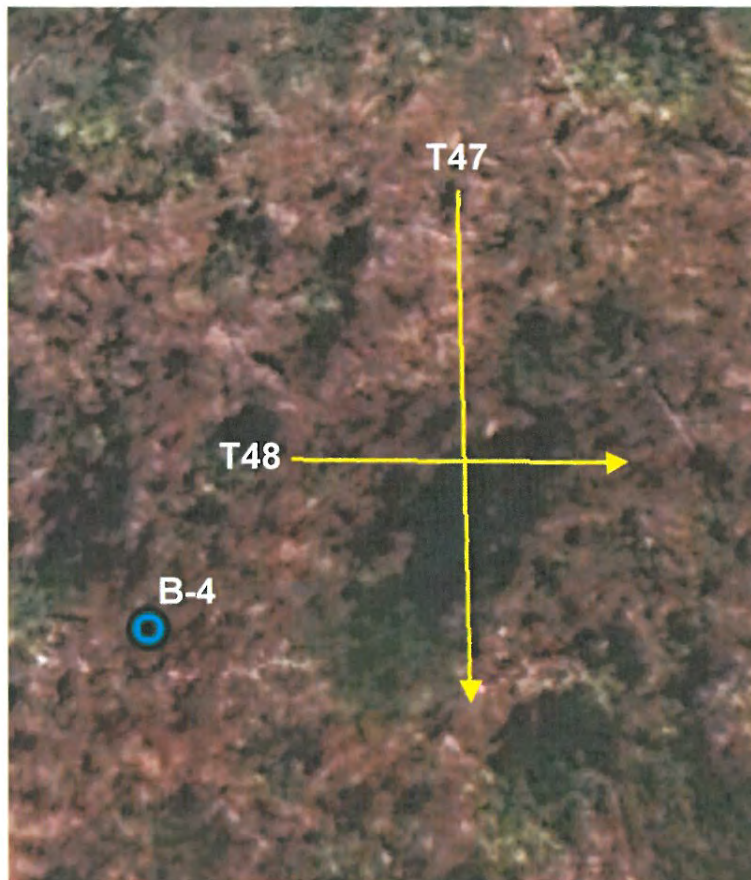
Antenna: Transects T0 to T4 were completed with a 250 MHz antenna with a time window of 140 nanoseconds (ns).





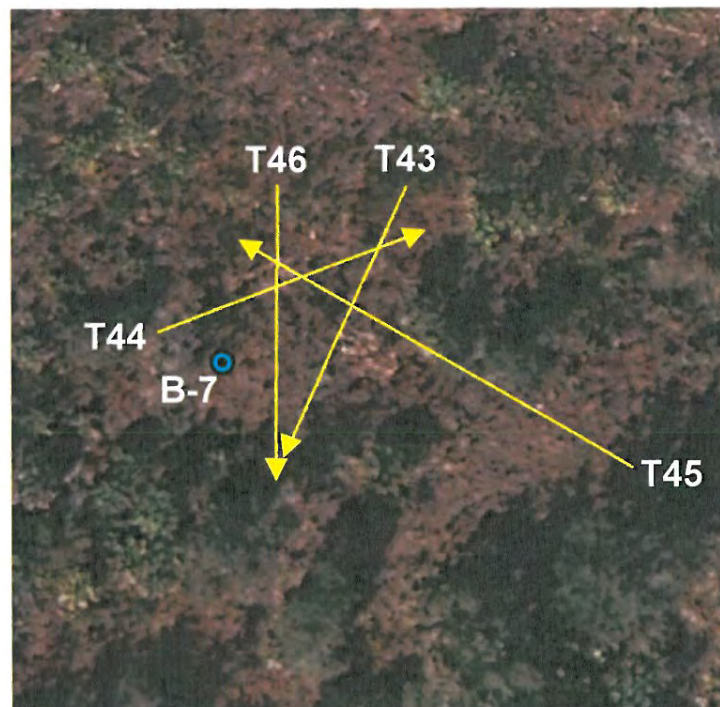
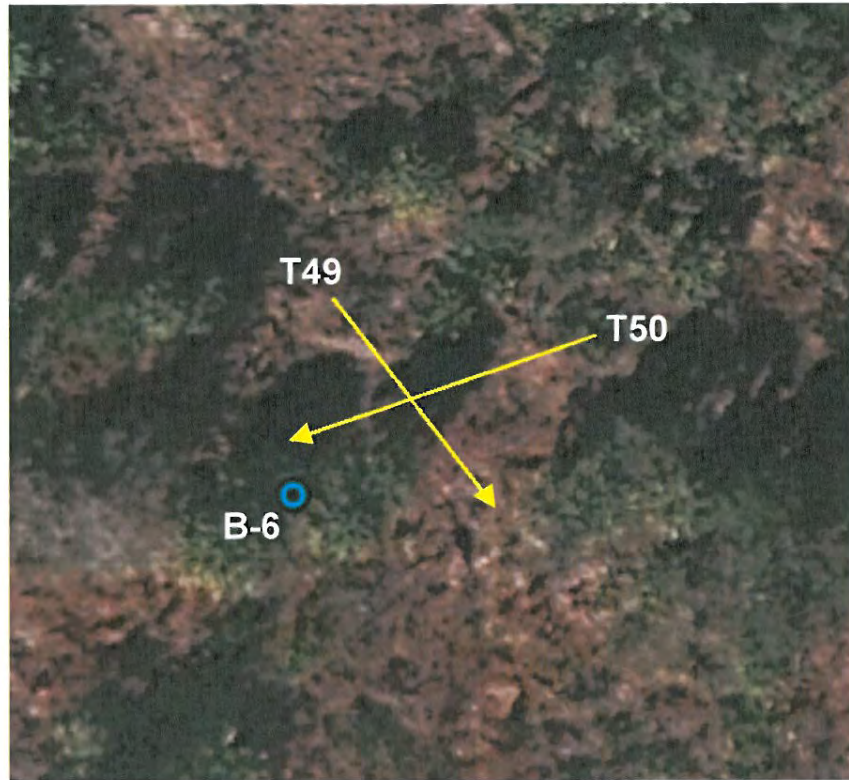
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B-1	Boring Location
T1	GPR Transect

Note: Transect and Boring locations are approximate



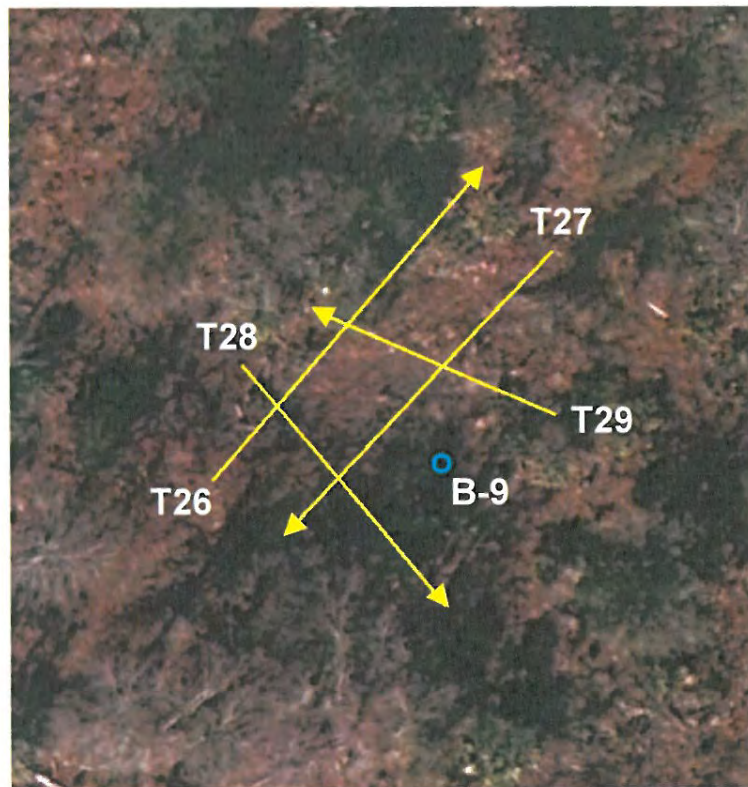
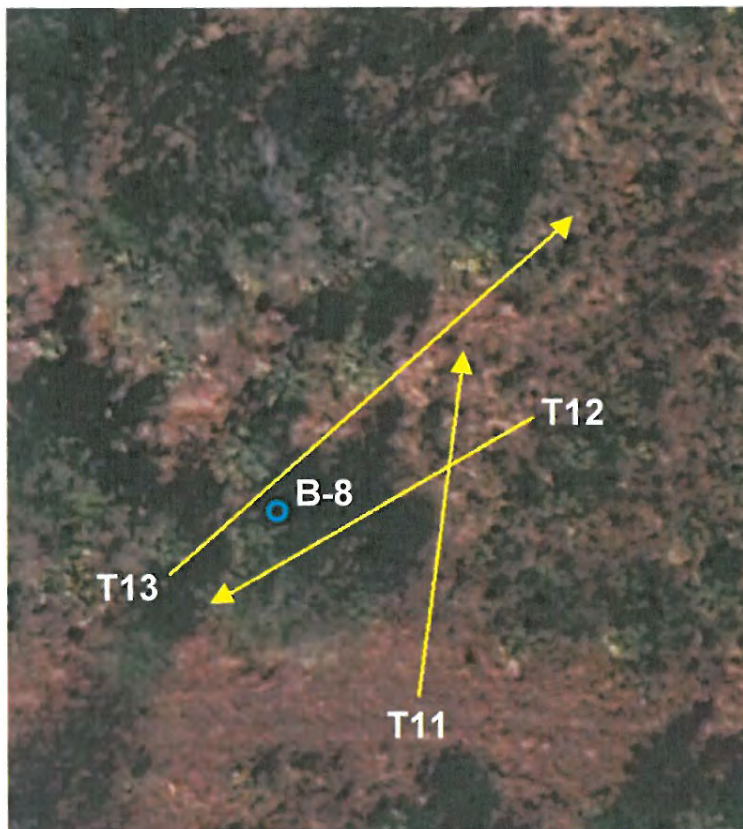
LEGEND		
B-1		Boring Location
T1		GPR Transect

Note: Transect and Boring locations are approximate



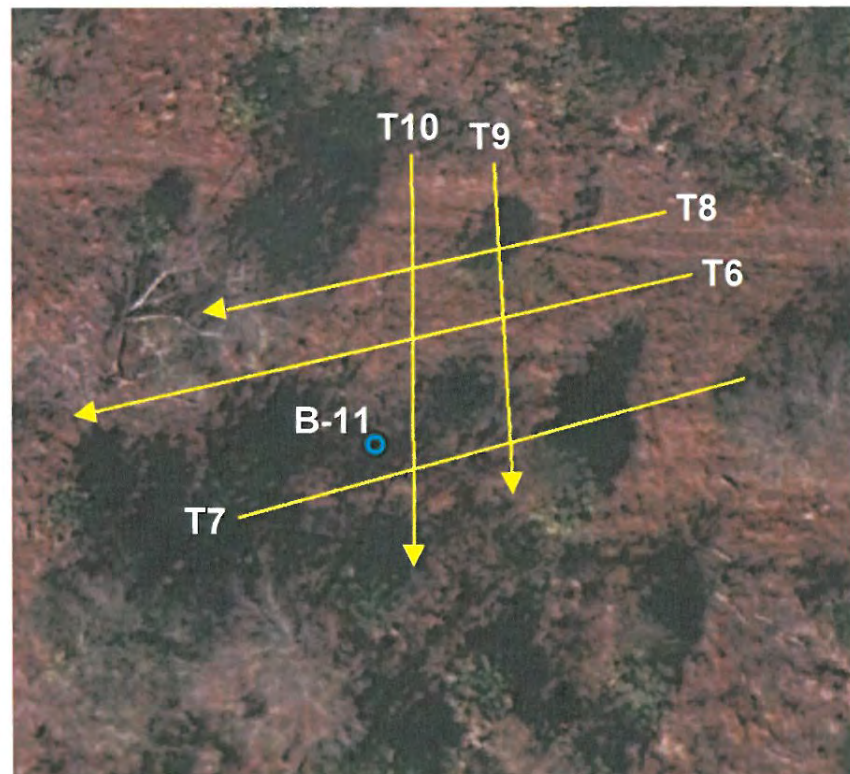
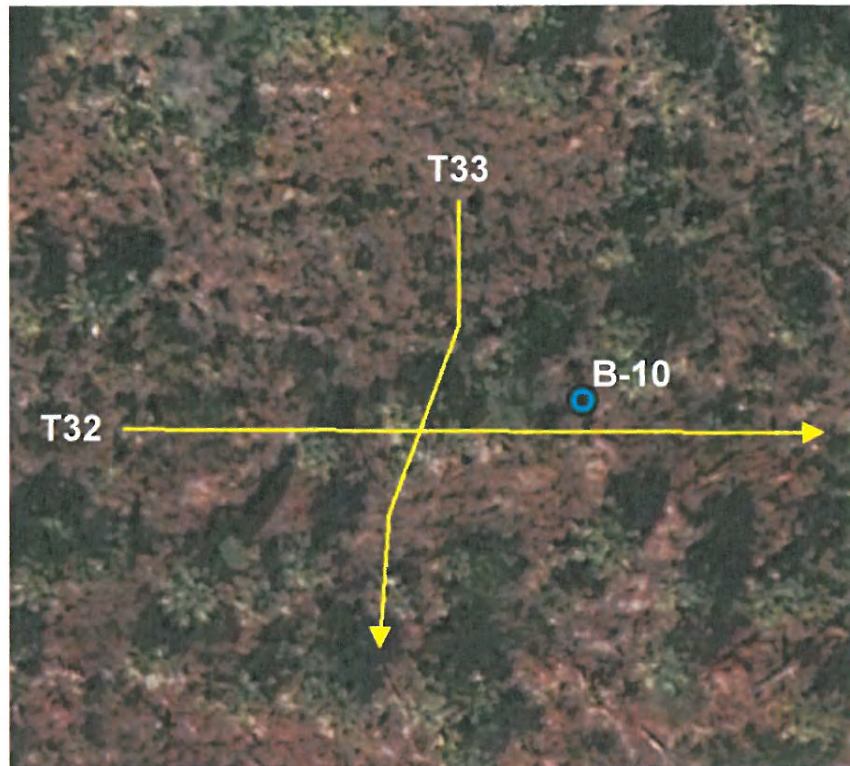
LEGEND	
B-1	Boring Location
T1	GPR Transect

Note: Transect and Boring locations are approximate



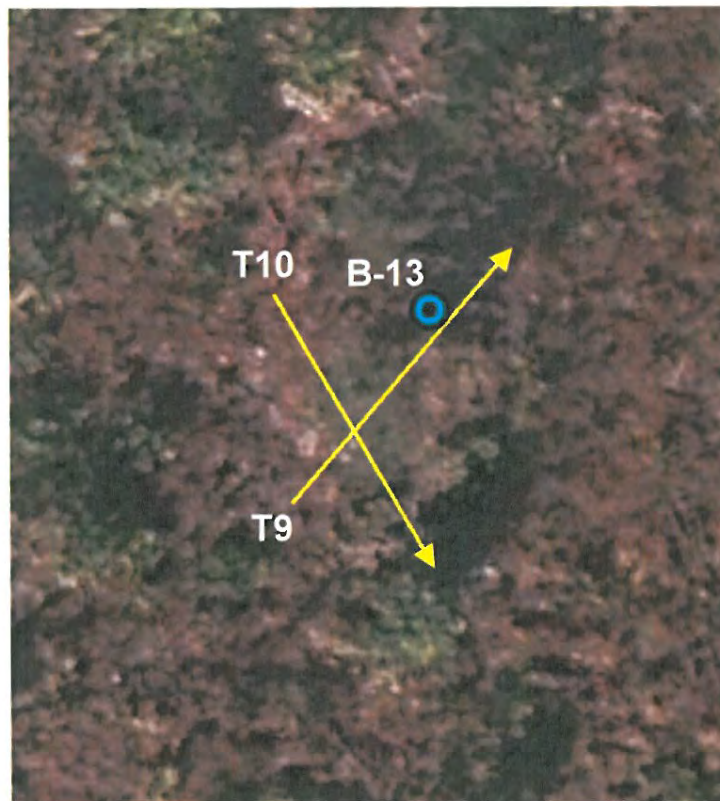
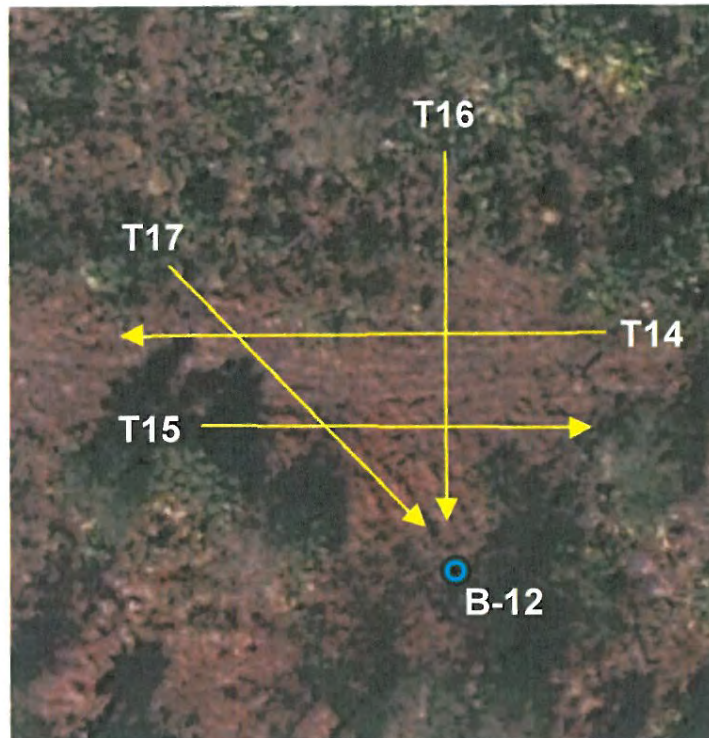
LEGEND		
B-1		Boring Location
T1		GPR Transect

Note: Transect and Boring locations are approximate



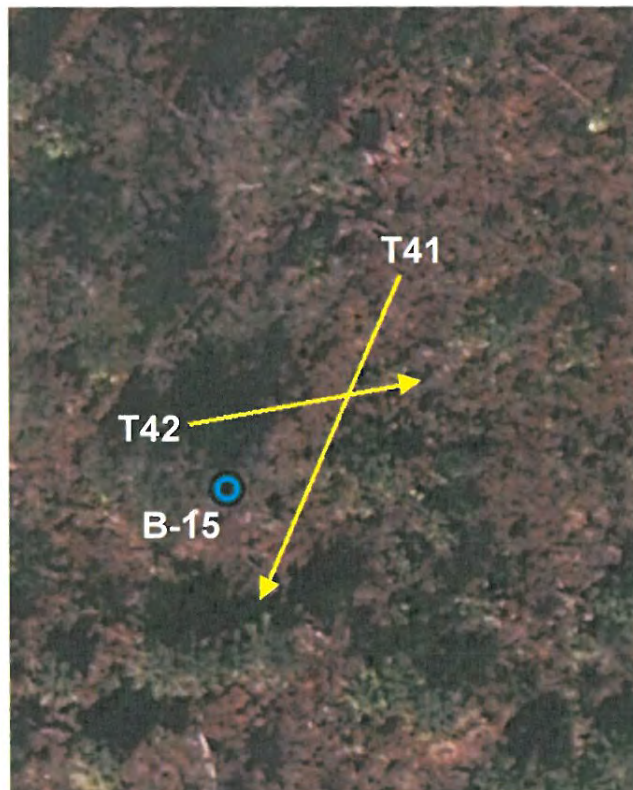
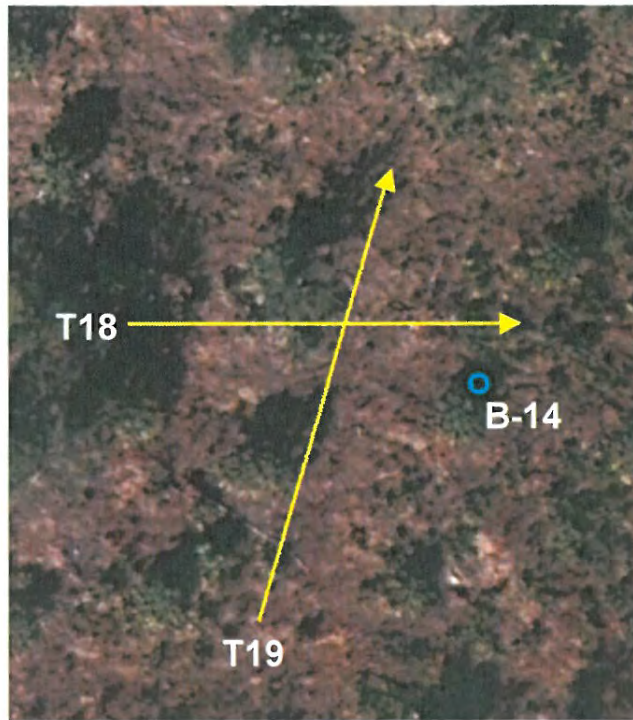
LEGEND	
B-1	Boring Location
T1	GPR Transect

Note: Transect and Boring locations are approximate



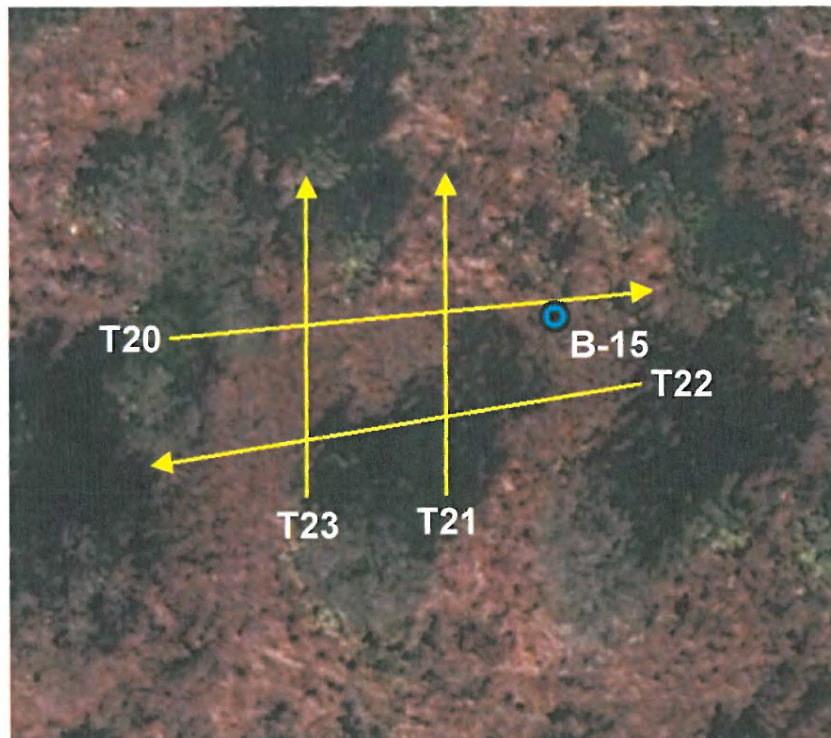
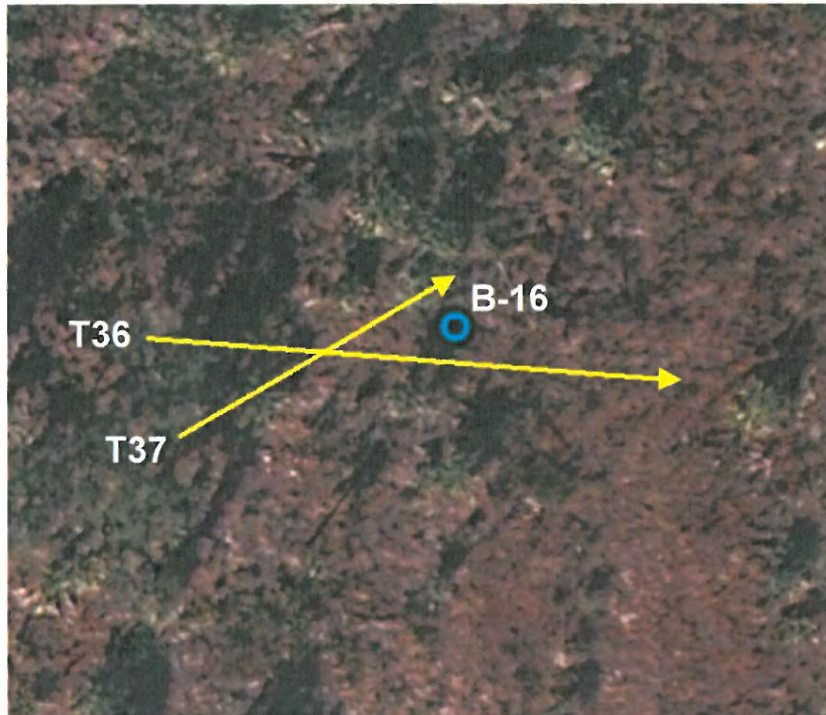
LEGEND	
B-1	 Boring Location
T1	 GPR Transect

Note: Transect and Boring locations are approximate



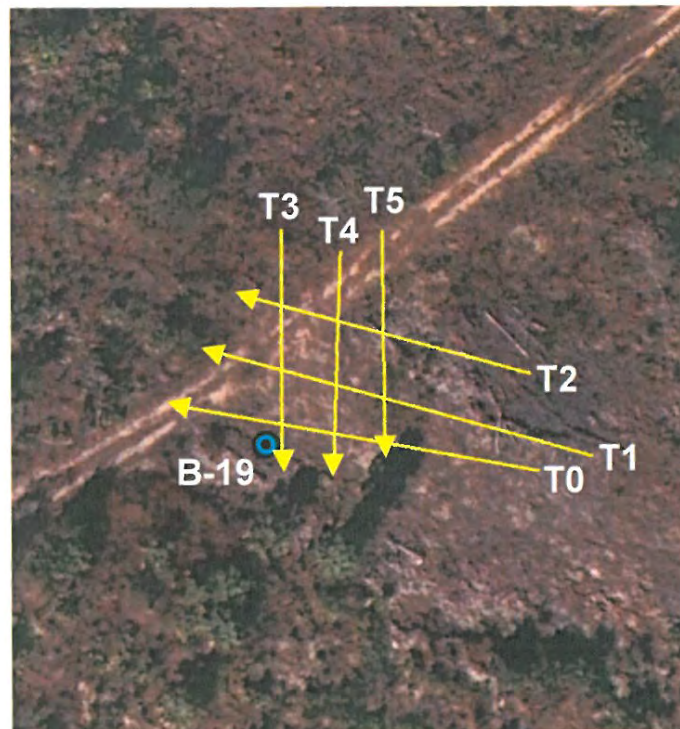
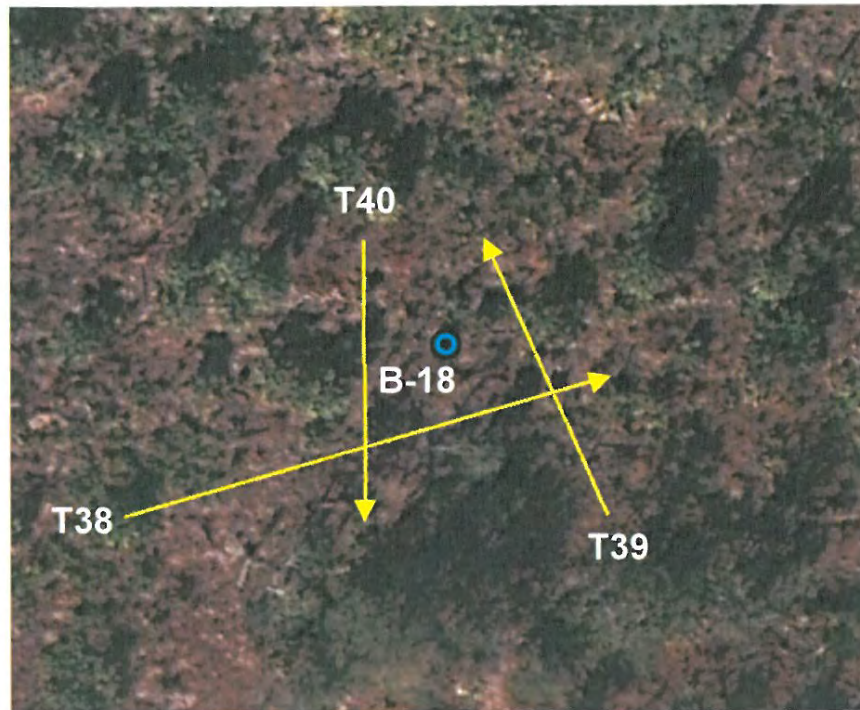
LEGEND	
B-1	 Boring Location
T1	 GPR Transect

Note: Transect and Boring locations are approximate



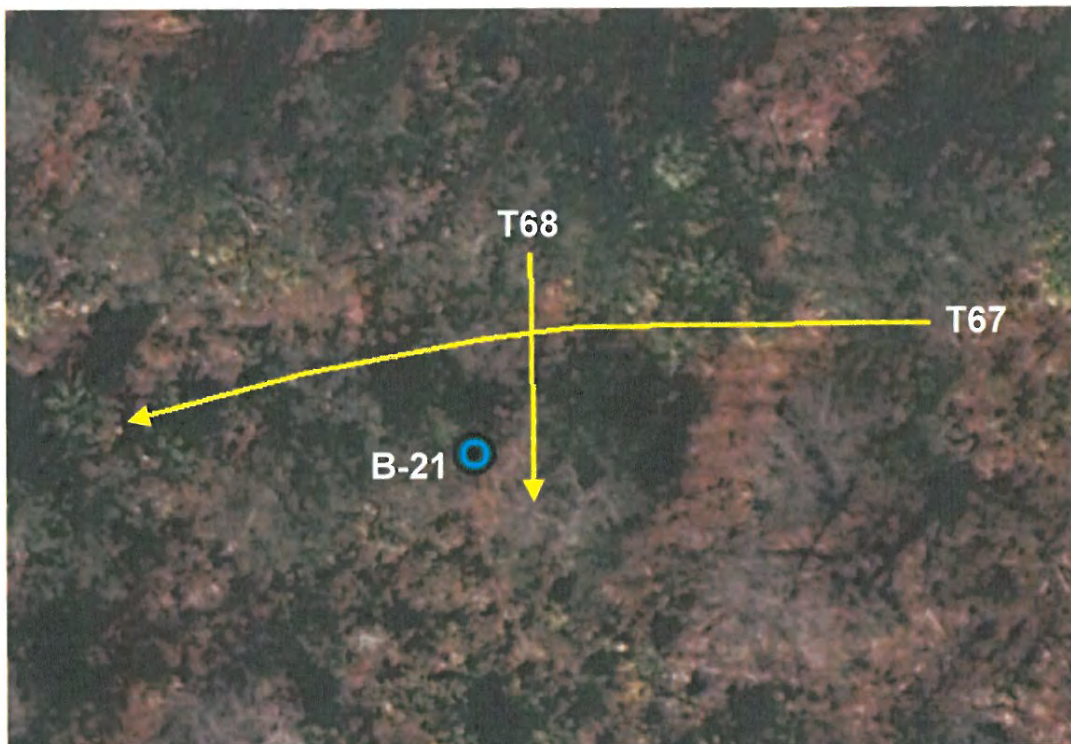
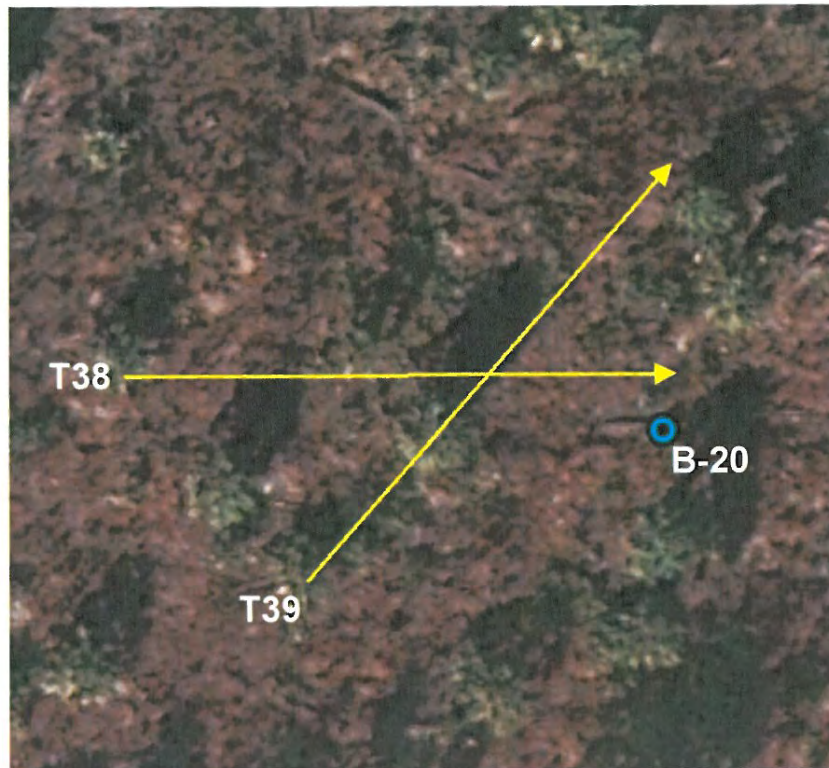
LEGEND	
B-1	 Boring Location
T1	 GPR Transect

Note: Transect and Boring locations are approximate



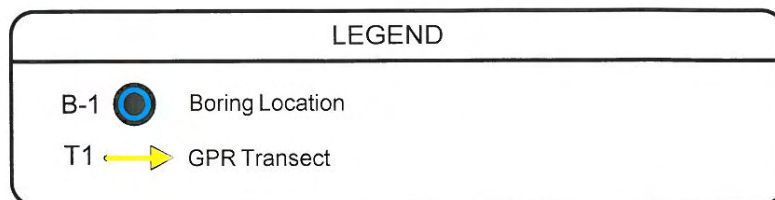
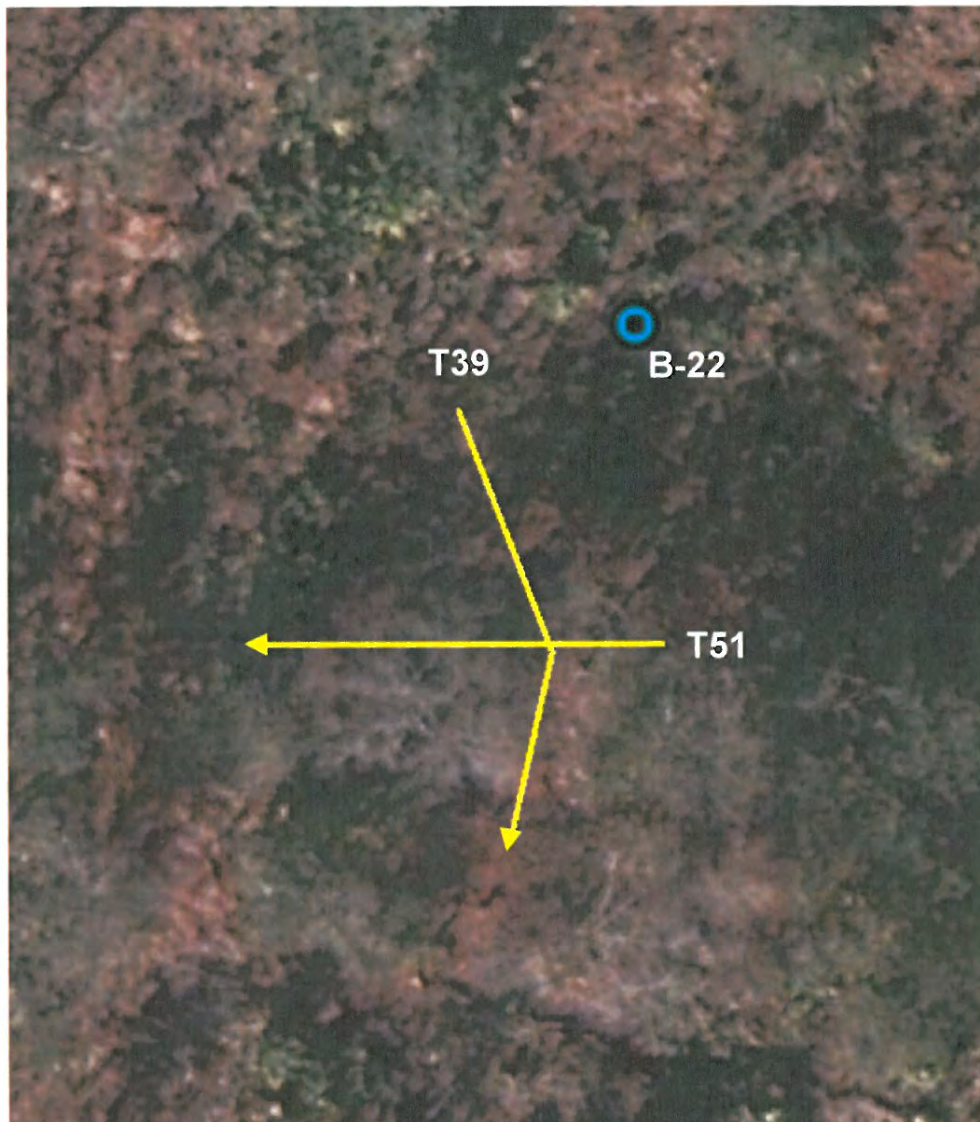
LEGEND	
B-1	 Boring Location
T1	 GPR Transect

Note: Transect and Boring locations are approximate

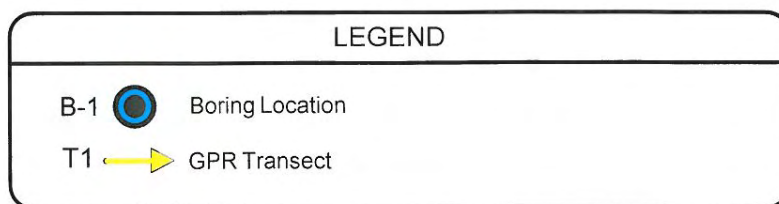
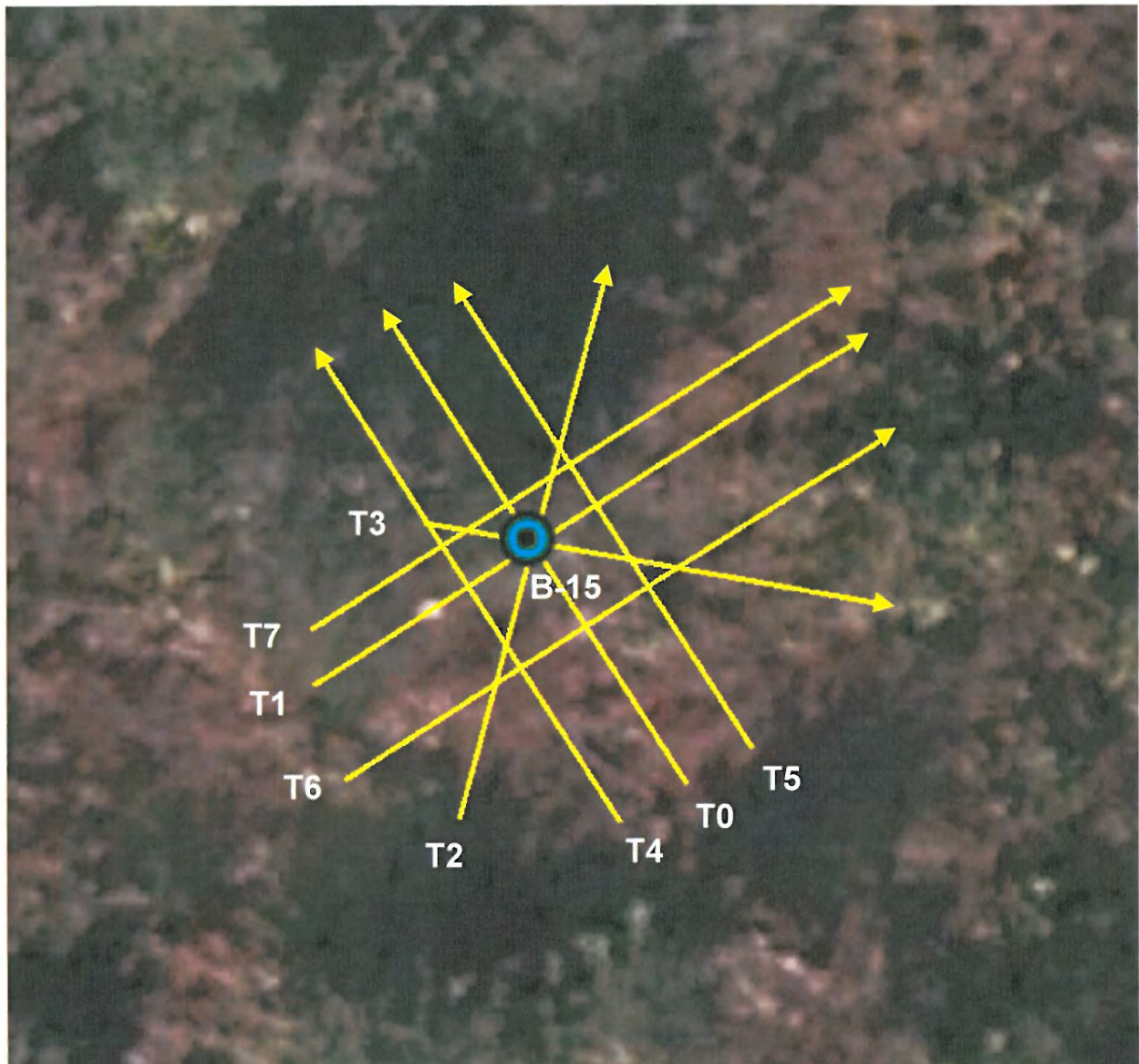


LEGEND	
B-1	 Boring Location
T1	 GPR Transect

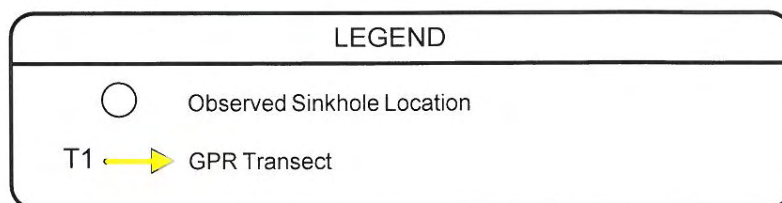
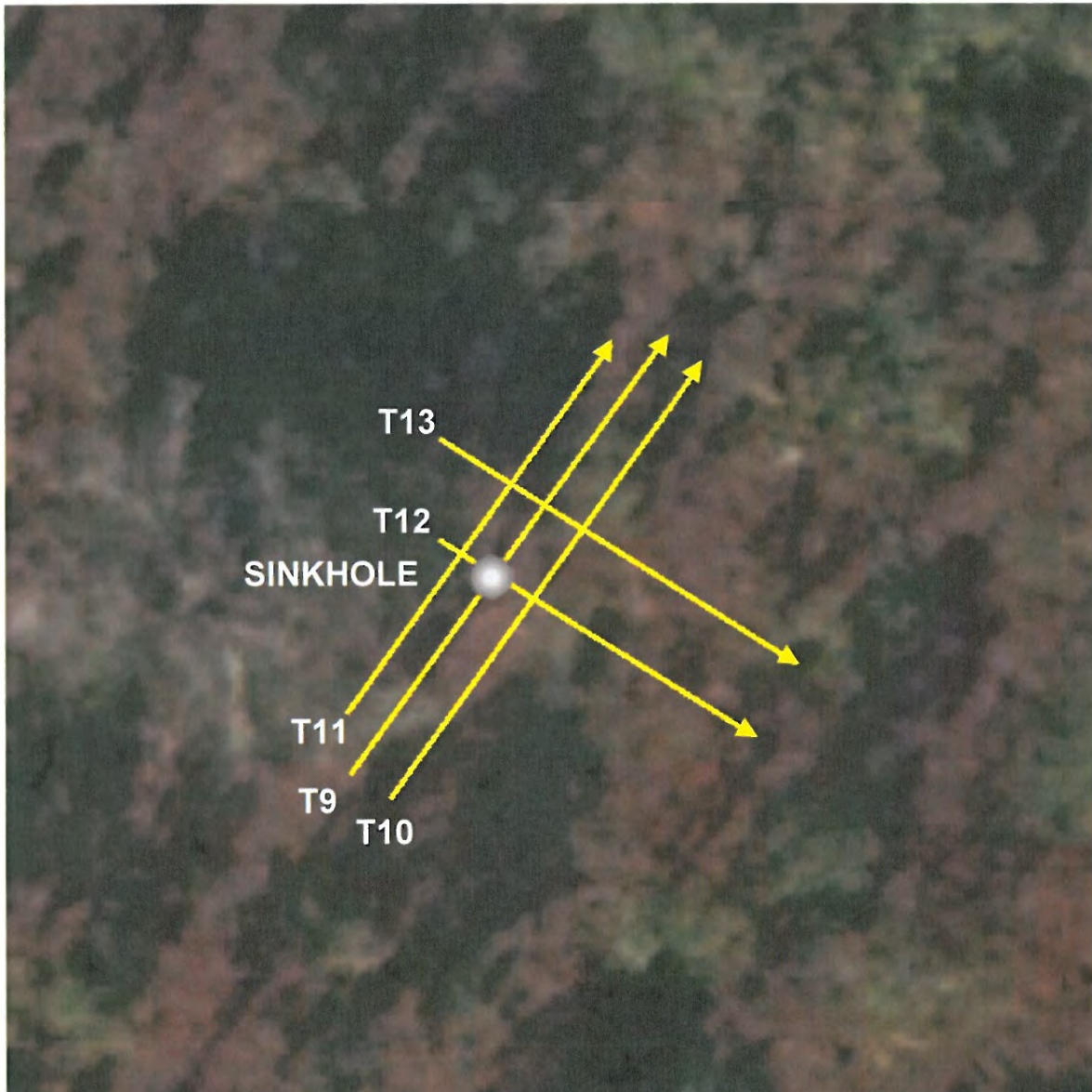
Note: Transect and Boring locations are approximate



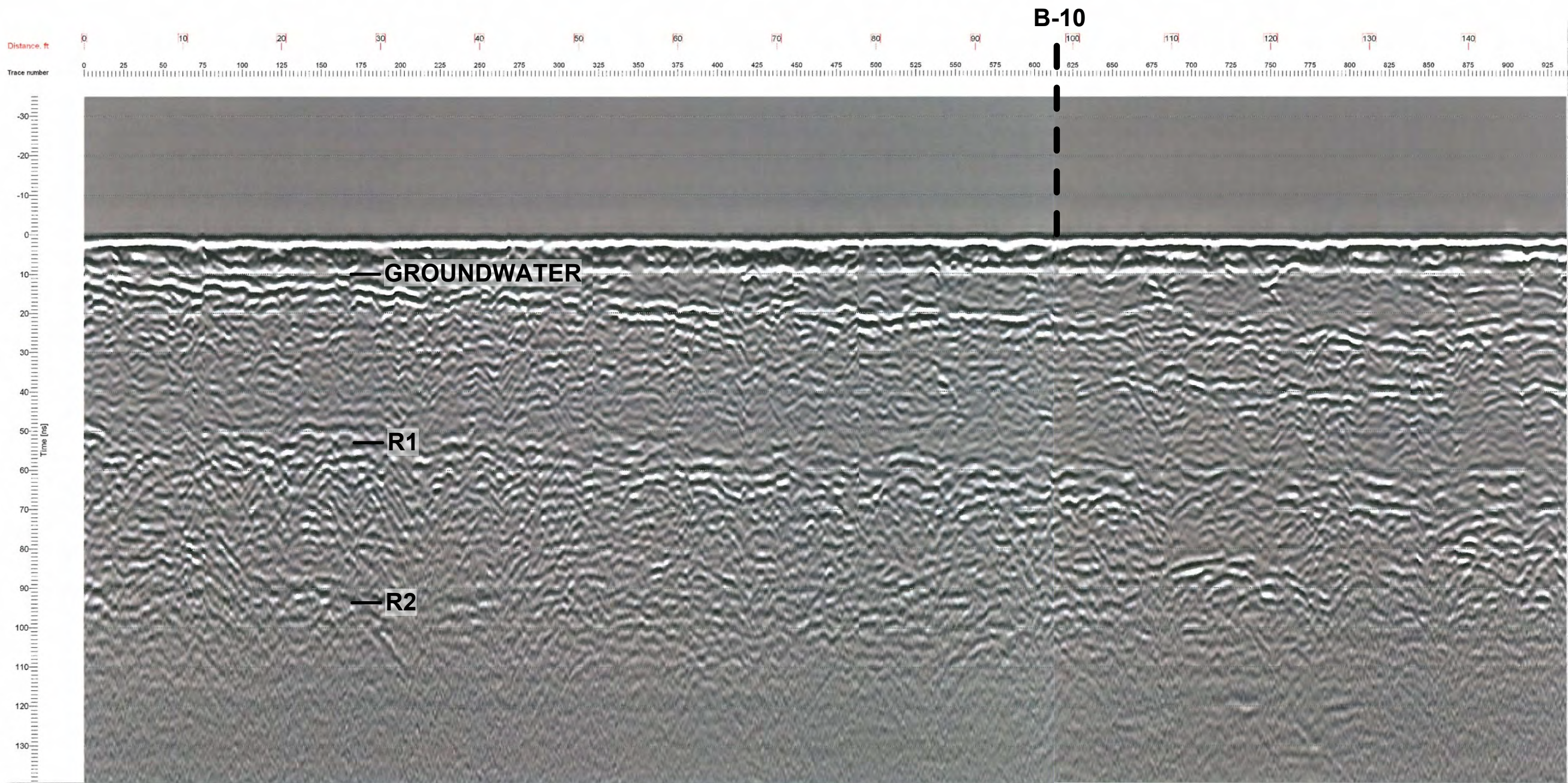
Note: Transect and Boring locations are approximate



Note: Transect and Boring locations are approximate

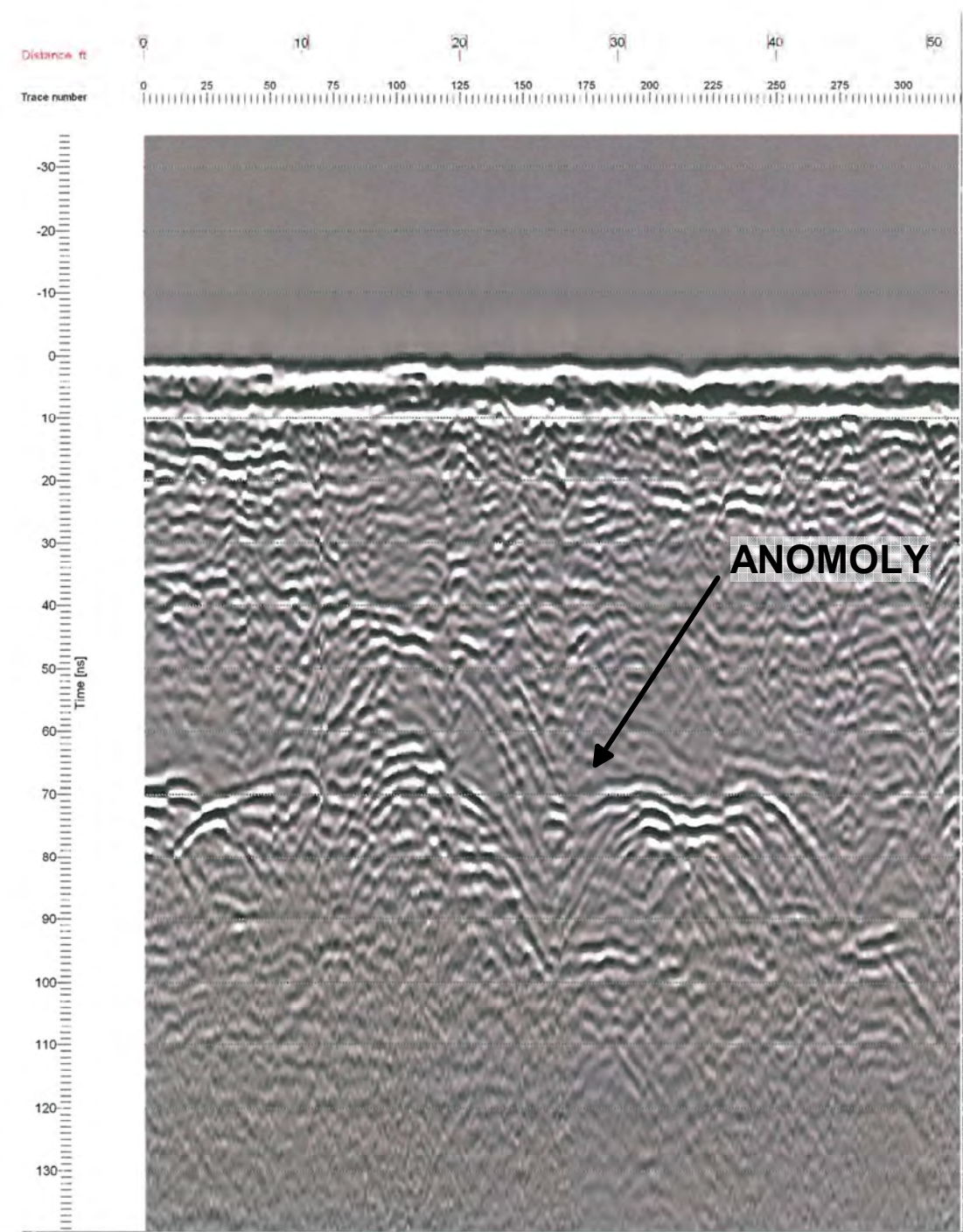


Note: Transect and Boring locations are approximate

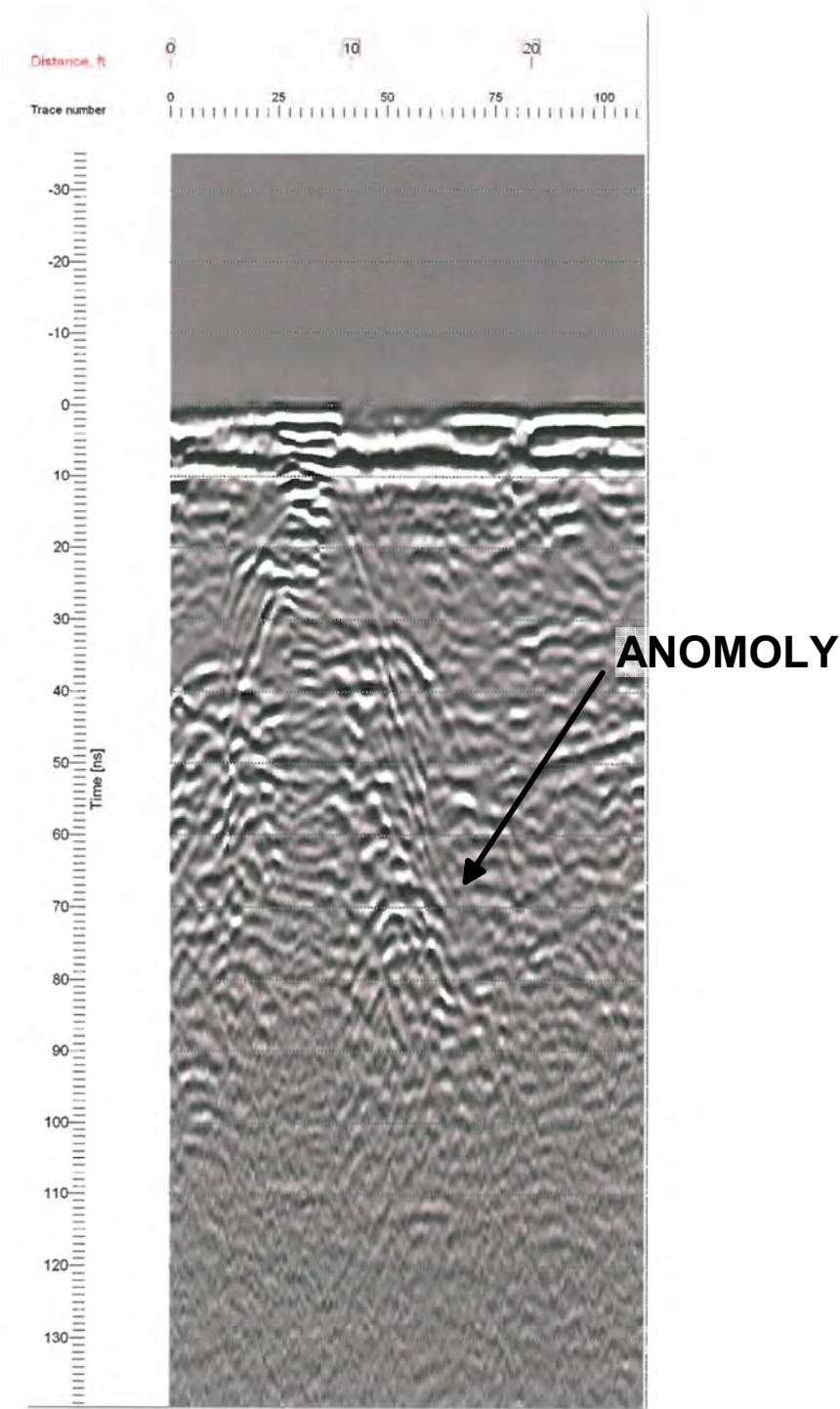


DATE	REVISIONS	 AMEC Environment & Infrastructure, Inc. 2000 E. Edgewood Dr., Ste #215 Lakeland, FL 33803 Phone 863.667.2345 Fax 863.667.2662 www.amec.com CA-5392	DESIGNED BY:		SCALE:	AS SHOWN	DUKE ENERGY FLORIDA CITRUS COUNTY COMBINED CYCLE PROJECT FIGURE 1A APPENDIX C GPR TRANSECT T32 CRYSTAL RIVER, FLORIDA
			DRAWN BY:	SDB	DATE:	12/13/13	
			CHECKED BY:		PROJECT NO.	300743X2	
			APPROVED BY:				

T0



T11



B-15

SINKHOLE

DATE	REVISIONS	 AMEC Environment & Infrastructure, Inc. 2000 E. Edgewood Dr., Ste #215 Lakeland, FL 33803 Phone: 863.667.2345 Fax: 863.667.2662 www.amec.com CA-5392	DESIGNED BY:		SCALE:	AS SHOWN	DUKE ENERGY FLORIDA CITRUS COUNTY COMBINED CYCLE PROJECT FIGURE 1B APPENDIX C GPR TRANSECT T0 AND T11 CRYSTAL RIVER, FLORIDA
			DRAWN BY:	SDB	DATE:	12/13/13	
			CHECKED BY:		PROJECT NO.	300743X2	
			APPROVED BY:				

APPENDIX D

SPT Boring Logs and Rock Core Logs

CLIENT Duke EnergyPROJECT NAME Energy Plant Ho cm SitePROJECT NUMBER 300743x2PROJECT LOCATION Crysta RiverDATE STARTED 10/30/13COMPLETED 10/31/13GROUND ELEVATION 7.1 ftHOLE SIZE 4 inchesDRILLING CONTRACTOR Independent Dr ng, Inc.

GROUND WATER LEVELS:

DRILLING METHOD Standard Penetrat on / Mud Rotary▽ AT TIME OF DRILLING 4.00 ft / Elev 3.10 ftLOGGED BY BBCHECKED BY Tha Nguyen

AT END OF DRILLING

NOTES DR 33 R g CME550 Automat c Hammer

AFTER DRILLING

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
0								
	SS 1		1 2 2 5 (4)		SP		(SP) redd sh brown f ne gra ned quartz SAND, trace s t	
	SS 2		7 11 16 13 (27)				pa e ye ow, wh te LIMESTONE, poor y ndurated, oca weather ng	
5	SS 3		16 16 6 4 (22)	ntroduced dr ng f u d at 4'				
	SS 4		5 3 1 1 (4)					
	SS 5		1 1 1 1 (2)				(SP) brown f ne gra ned quartz SAND abundant LIMESTONE and she fragments	
10				oss of dr ng f u d c rcu at on at 10'	SP			
	SS 6		1 2 3 (5)					
	SS 7		2 28 50/3"	4 nch cas ng nsta ed to 15', dr ng f u d c rcu at on rega ned			pa e brown LIMESTONE, s ty, fr ab e	
15								
	SS 8		3 6 12 (18)				pa e brown LIMESTONE, do om t c, s ty, fr ab e	
				oss of dr ng f u d c rcu at on at 17.5'				
	SS 9		50/2"				pa e brown, pa e ye ow LIMESTONE, do om t c, oca y s ty, fr ab e	
20								

(Continued Next Page)



CLIENT Duke Energy

PROJECT NAME Energy Plant Ho cm Site

PROJECT NUMBER 300743x2

PROJECT LOCATION Crysta River

GENERAL BH / P / WELL - G N S DUS LAB GD - 12/13/13 16 21 - C \ HA CRYSTAL RIVER 300743X2 CRYSTAL RIVER (2) GPJ

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
20	RC 1	10 (0)		4 inch casing installed to 20', drilling fluid circulation resisted			pa e brown, pa e ye ow LIMESTONE, do om t c, oca y s ty, fr ab e (continued)	
25	SS 10		50/4"					
	SS 11		50/2"					
	SS 12		50/2"	loss of drilling fluid circulation at 28'				
30	SS 13		50/1"					
35	SS 14		19 18 50/5"				very s ty	
	SS 15		50/2"					
	SS 16		24 16 50/2"				s ty, grave y	
39.7								

Bottom of borehole at 39.7 feet.

CLIENT Duke EnergyPROJECT NAME Energy Plant Ho c m S tePROJECT NUMBER 300743x2PROJECT LOCATION Crysta R verDATE STARTED 11/4/13COMPLETED 11/4/13GROUND ELEVATION 5.6 ftHOLE SIZE 3 nchesDRILLING CONTRACTOR Independent Dr ng, Inc.

GROUND WATER LEVELS:

DRILLING METHOD Standard Penetrat on / Mud Rotary▽ AT TIME OF DRILLING 4.00 ft / E ev 1.60 ftLOGGED BY HICHECKED BY Tha Nguyen

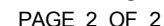
AT END OF DRILLING

NOTES DR 15 R g CME55 Automat c Hammer

AFTER DRILLING

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	REMARKS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
0							
	SS 1	1 1 2 2 (3)		SM		(SM) brown sh orange, dark brown f ne gra ned quartz s ty SAND	
	SS 2	0 0 0 2 (0)	WOH/18", 2				
						4 0	1 6
5	SS 3	3 15 15 20 (30)	dr ng f u d ntroduced at 4'			wh te f ne gra ned to grave gra ned s ze LIMESTONE, sandy	
	SS 4	15 17 11 15 (28)					← benton te sea
	SS 5	3 5 0 0 (5)	3, 5, WOH/12"				
10						10 0	-4 4
	SS 6	0 0 0 (0)	WOR/12", WOH			(SM) brown f ne gra ned quartz s ty SAND, trace c ay	
						few f ne LIMESTONE fragments	
	SS 7	1 0 0 (0)	1, WOH/12"	SM			← sand pack
15							
	SS 8	0 0 0 (0)	WOH/18"				← screen
			oss of dr ng f u d c rcu at on at 18'				
	SS 9	1 0 0 (0)	1, WOH=12"			wh te LIMESTONE at spoon t p	
20						20 0	-14 4

(Continued Next Page)



PROJECT LOCATION Crysta River

Bottom of borehole at 38.8 feet.

GENERAL BH/ P /WELL -GN S DUSLABGD -12/13/13 16 21 - C \ HA \CRY S AL R VER300743X2 CRY S AL R VER (2) GPJ

**BORING NUMBER B-03**

PAGE 1 OF 3

CLIENT Duke Energy **PROJECT NAME** Energy Plant Ho cm Site
PROJECT NUMBER 300743x2 **PROJECT LOCATION** Crysta R ver
DATE STARTED 11/14/13 **COMPLETED** 11/14/13 **GROUND ELEVATION** 6 ft **HOLE SIZE** 4 nches
DRILLING CONTRACTOR Independent Dr ng, Inc. **GROUND WATER LEVELS:**
DRILLING METHOD Standard Penetrat on / Mud Rotary **AT TIME OF DRILLING** _____
LOGGED BY HI **CHECKED BY** Tha Nguyen **AT END OF DRILLING** _____
NOTES DR 33 R g CME550 Automat c Hammer **AFTER DRILLING** _____

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0							
	SS 1		3 1 2 2 (3)		SP		(SP) dark brown, brown, ght brown f ne gra ned quartz SAND, m nor s t
	SS 2		1 1 1 7 (2)				trace organ cs
						4 0	2 0
5	SS 3		13 8 4 3 (12)	dr ng f u d ntroduced at 4'			pa e brown, wh te LIMESTONE
	SS 4		8 9 5 4 (14)	oss of dr ng f u d c rcu at on at 7'			
	SS 5		2 4 4 10 (8)				coarse fragments
10							
	SS 6		1 0 0 (0)	1, WOH/12"			
	SS 7		1 5 1 (6)				
15							
	SS 8		1 2 1 (3)		SP		(SP) brown, pa e brown, gray f ne gra ned quartz SAND
						18 0	-12 0
	SS 9		4 10 17 (27)				brown, pa e brown, orange LIMESTONE, oca y do om t c fr ab e
20							

(Continued Next Page)

**BORING NUMBER B-03**

PAGE 3 OF 3

CLIENT Duke EnergyPROJECT NAME Energy Plant Ho cm S tePROJECT NUMBER 300743x2PROJECT LOCATION Crysta R ver

GENERAL BH / P / WELL - G N S DUS LAB GD - 12/13/13 16 21 - C \ HA C RYS AL R VER 300743X2 C RYS AL R VER (2) GPJ

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
40							
	SS 13		0 0 1 2 (1)	WOH/12", 1, 2			brown LIMESTONE, doom t c, s ty, fr ab e
						42 0	-36 0
							brown LIMESTONE, s ty, fr ab e
	SS 14		10 47 50/4"				
45							
	SS 15		20 15 13 25 (28)				
50						50 0	-44 0
							brown LIMESTONE, fr ab e
	SS 16		2 5 0 0 (5)	2, 5, WOH/12"			
55						56 0	-50 0
							brown LIMESTONE
						58 1	-52 1
	SS 17		50/1"				Bottom of boreho e at 58.1 feet.



CLIENT Duke Energy PROJECT NAME Energy Plant Home Site
PROJECT NUMBER 300743x2 PROJECT LOCATION Crysta River
DATE STARTED 11/12/13 COMPLETED 11/13/13 GROUND ELEVATION 8 ft HOLE SIZE 4 inches
DRILLING CONTRACTOR Independent Drilling, Inc. GROUND WATER LEVELS:
DRILLING METHOD Standard Penetration / Mud Rotary AT TIME OF DRILLING _____
LOGGED BY HI CHECKED BY Tha Nguyen AT END OF DRILLING _____
NOTES DR 33 Rg CME550 Automatic Hammer AFTER DRILLING _____

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0							
	SS 1		3 2 1 1 (3)		SP		(SP) orange fine grained quartz SAND, some silt
	SS 2		1 1 16 16 (17)				2.0 pale brown, white LIMESTONE 6.0
	SS 3		28 50/3"	drilling fluid introduced at 4'			
5	SS 4		50/2"				
	SS 5		8 8 3 3 (11)				7.0 pale brown, gray, white LIMESTONE 1.0
10	SS 6		0 0 0 (0)	loss of drilling fluid circulation at 11'			
	SS 7		8 7 7 (14)				
15	SS 8		5 5 2 (7)				
	SS 9		2 1 13 (14)				
20							

(Continued Next Page)



CLIENT Duke Energy

PROJECT NAME Energy Plant Ho cm S te

PROJECT NUMBER 300743x2

PROJECT LOCATION Crysta R ver

GENERAL BH / P / WELL - G N S DUS LAB GD - 12/13/13 16 21 - C \ HA C RYS AL R VER 300743X2 C RYS AL R VER (2) GPJ

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
20							pa e brown, gray, wh te LIMESTONE (continued)
25	SS 10		1 9 18 5 (27)				
							end of sh ft on 11/12/2013
30	SS 11		7 1 0 1 (1)	4 nch cas ng nsta ed to 30', dr ng f u d rega ned	MH		(MH) pa e brown, o ve SILT
35	SS 12		4 3 1 11 (4)	oss of dr ng f u d c rcu at on at 33'			
40	SS 13		31 21 5 27 (26)				brown, pa e brown LIMESTONE, do om t c, fr ab e

(Continued Next Page)



CLIENT Duke Energy

PROJECT NAME Energy Plant Home Site

PROJECT NUMBER 300743x2

PROJECT LOCATION Crystalline River

GENERAL BH / P / WELL - G N S DUS LAB GD - 12/13/13 16 21 - C \ HA CRYSTAL RIVER 300743X2 CRYSTAL RIVER (2) GPJ

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
40							
45	SS 14		6 21 19 8 (40)				brown, pale brown LIMESTONE, dolomitic, friable (continued)
50	SS 15		49 30 9 4 (39)				
55	SS 16		50/4"				
	RC 1	73 (63)					
60	RC 2	87 (70)					

53.0

-45.0

brown, pale brown, orange LIMESTONE, dolomitic

(Continued Next Page)

CLIENT Duke Energy

PROJECT NAME Energy Plant Ho cm Ste

PROJECT NUMBER 300743x2

PROJECT LOCATION Crysta River

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
60							
	SS 17	38 (0)	50/1"				brown, pale brown, orange Limestone, dolomitic (continued)
	RC 3						
	RC 4	86 (62)					
	RC 5	83 (83)					
65	SS 18		50/1"				65.0 gray DOLOSTONE, silty, calcareous, sugary
	RC 6	48 (35)					
70							
	SS 19		24 32 48 16 (80)				72.0

Bottom of borehole at 72.0 feet.



CLIENT Duke Energy PROJECT NAME Energy Plant Ho c m S te
PROJECT NUMBER 300743x2 PROJECT LOCATION Crysta R ver
DATE STARTED 11/20/13 COMPLETED 11/21/13 GROUND ELEVATION 6.1 ft HOLE SIZE 4 nches
DRILLING CONTRACTOR Independent Dr ng, Inc. GROUND WATER LEVELS:
DRILLING METHOD Standard Penetrat on / Mud Rotary AT TIME OF DRILLING _____
LOGGED BY BB CHECKED BY Tha Nguyen AT END OF DRILLING _____
NOTES DR 15 R g CME55 Automat c Hammer AFTER DRILLING _____

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION
0						
	SS 1		4 19 24 10 (43)			very pale brown LIMESTONE, indurated
	SS 2		5 3 27 37 (30)			sandy
5	SS 3		16 46 17 28 (63)	dr ng f u d ntroduced at 4'		s ty
	SS 4		8 6 3 3 (9)			few grave
10	SS 5		8 20 13 7 (33)			
	SS 6		3 10 24 (34)			
	SS 7		32 26 38 (64)			
15	SS 8		1 2 2 (4)	oss of dr ng f u d c rcu at on at 15'		pale brown, weathered, oca clay ens
	SS 9		2 11 29 (40)			
20						18 0 pale brown LIMESTONE, doom t c, s ty, fr ab e -11 9

(Continued Next Page)



CLIENT Duke Energy

PROJECT NAME Energy Plant Home Site

PROJECT NUMBER 300743x2

PROJECT LOCATION Crystalline River

GENERAL BH / P / WELL - G N S DUS LAB GD - 12/13/13 16 21 - C \ HA \ CRYSTAL RIVER 300743X2 CRYSTAL RIVER (2) GPJ

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION
20						pa e brown LIMESTONE, do om t c, s ty, fr ab e (continued)
22 0						-15 9
						very pa e brown, pa e brown LIMESTONE, do om t c
						we ndurated
25	SS 10		50/3"			
	RC 1	17 (8)				ndurated LIMESTONE and soft fr ab e LIMESTONE or SILT
30	SS 11		50/5"			fr ab e
35	SS 12		0 50/5"			
37 0						-30 9
						very pa e brown, pa e brown LIMESTONE, do om t c
40	SS 13		50/3"			

(Continued Next Page)



CLIENT Duke Energy

PROJECT NAME Energy Plant Home Site

PROJECT NUMBER 300743x2

PROJECT LOCATION Crystalline River

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION
40						
	RC 2	70 (50)				very pale brown, pale brown LIMESTONE, dolomitic (continued) cherty, some vugs, fossiliferous
45	SS 14		23 24 23 (47)			locally cemented
	SS 15		50/4"			pale brown, brown, indurated
50						
						end of day 11/20/2013
	SS 16		50/3"			
55						
	SS 17		50/3"			well indurated, fossiliferous
60				soft drilling from		

GENERAL BH / P / WELL - G N S DUS LAB GD - 12/13/13 16 21 - C \ HA \ CRYSTAL RIVER 300743X2 CRYSTAL RIVER (2) GPJ

(Continued Next Page)

CLIENT Duke EnergyPROJECT NAME Energy Plant Home SitePROJECT NUMBER 300743x2PROJECT LOCATION Crystal River

GENERAL BH / P / WELL - G N S DUS LAB GD - 12/13/13 16 21 - C \ HA CRYSTAL RIVER 300743X2 CRYSTAL RIVER (2) GPJ

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION
60				60' to 63'		very pale brown, pale brown LIMESTONE, dolomitic (continued)
						62.0 -55.9 brown dolomitic DOLOSTONE, well indurated, vuggy, slightly calcareous, sucrose
	SS 18		50/5"			
65						
	SS 19		6.50 50/1"			locally weathered, sandy
70						
	SS 20		50/1"			73.6 -67.5 Bottom of borehole at 73.6 feet.



CLIENT Duke Energy **PROJECT NAME** Energy Plant Ho c m S te
PROJECT NUMBER 300743x2 **PROJECT LOCATION** Crysta R ver
DATE STARTED 11/22/13 **COMPLETED** 11/22/13 **GROUND ELEVATION** 7.2 ft **HOLE SIZE** 4 nches
DRILLING CONTRACTOR Independent Dr ng, Inc. **GROUND WATER LEVELS:**
DRILLING METHOD Standard Penetrat on / Mud Rotary ☒ **AT TIME OF DRILLING** 3.00 ft / E ev 4.20 ft
LOGGED BY BB **CHECKED BY** Tha Nguyen **AT END OF DRILLING** _____
NOTES DR 15 R g CME55 Automat c Hammer **AFTER DRILLING** _____

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION
0						
	SS 1		2 13 14 7 (27)			very pale brown LIMESTONE, ndurated, sandy, s ty
	SS 2		7 7 16 14 (23)			
5	SS 3		11 9 17 13 (26)	dr ng f u d ntroduced at 4'		
	SS 4		18 12 16 18 (28)			
	SS 5		1 4 9 10 (13)			
10						
	SS 6		40 20 16 (36)			
	SS 7		50/4"			13.0 very pale brown LIMESTONE, oca y do om t c -5.8 we ndurated
15						
	SS 8		3 6 5 (11)			poor y ndurated, sandy, s ty
						pale brown, few grave
	SS 9		11 3 2 (5)			
20						

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CLIENT Duke EnergyPROJECT NAME Energy Plant Ho c m S tePROJECT NUMBER 300743x2PROJECT LOCATION Crysta R ver

GENERAL BH / P / WELL - G N S DUS LAB GD - 12/13/13 16 21 - C \ HA \ CRY S AL R VER 300743X2 CRY S AL R VER (2) GPJ

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION
20						
						very pa e brown LIMESTONE, oca y do om t c (continued)
25	SS 10		8 13 13 (26)			
	SS 11		12 50/5"			
30						
	SS 12		50/3"			
35						
	SS 13		44 10 34 (44)			
40						

(Continued Next Page)



CLIENT Duke Energy

PROJECT NAME Energy Plant Ho c m S te

PROJECT NUMBER 300743x2

PROJECT LOCATION Crysta R ver

GENERAL BH / P / WELL - G N S DUS LAB GD - 12/13/13 16 21 - C \ HA C RYS AL R VER 300743X2 C RYS AL R VER (2) GPJ

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION
40						pa e brown LIMESTONE, do om t c, fr ab e, ndurated, s ty (continued)
45	SS 14		12 12 16 (28)			few grave
50	SS 15		8 50/5"			
55	SS 16		50/2"			we ndurated
	RC 1	42 (0)		oss of dr ng f u d c rcu at on at 54'		
60	SS		9 28 21			

(Continued Next Page)



CLIENT Duke Energy

PROJECT NAME Energy Plant Home Site

PROJECT NUMBER 300743x2

PROJECT LOCATION Crysta River

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION
60	17		(49)			pa e brown LIMESTONE, do om t c, fr ab e, ndurated, s ty (continued) s ty
						62 0 -54 8
	SS 18		50/2"			some grave
65						
	SS 19		50/1"			pa e brown, gray DOLOSTONE, we ndurated, sucros c
70						
	SS 20		7 31 50/4"			74 8 -67 6

Bottom of borehole at 74.8 feet.

CLIENT Duke EnergyPROJECT NAME Energy Plant Ho c m S tePROJECT NUMBER 300743x2PROJECT LOCATION Crysta R verDATE STARTED 11/25/13COMPLETED 11/27/13GROUND ELEVATION 7.7 ftHOLE SIZE 4 nchesDRILLING CONTRACTOR Independent Dr ng, Inc.

GROUND WATER LEVELS:

DRILLING METHOD Standard Penetrat on / Mud Rotary

AT TIME OF DRILLING

LOGGED BY BBCHECKED BY Tha Nguyen

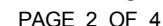
AT END OF DRILLING

NOTES DR 15 R g CME55 Automat c Hammer

AFTER DRILLING

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION
0						
	SS 1		2 3 12 17 (15)			very pale brown LIMESTONE, sandy, poorly indurated
	SS 2		50/5"	dr ng f u d ntroduced at 2'		
5	SS 3		13 13 18 15 (31)			sandy, s ty, ndurated
	SS 4		16 15 12 11 (27)			
	SS 5		11 12 12 18 (24)			
10						
	SS 6		37 14 13 (27)			
	SS 7		9 6 6 (12)			
15						
	SS 8		5 26 50/2"			
	SS 9		50/5"			
20						

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PROJECT LOCATION Crysta River

GENERAL BH/ P /WELL -GN S DUS LABGD -12/13/13 16 22 - C \ HA \CRY S AL R VER\300743X2 CRY S AL R VER (2)GPJ

(Continued Next Page)



CLIENT Duke Energy

PROJECT NAME Energy Plant Home Site

PROJECT NUMBER 300743x2

PROJECT LOCATION Crysta River

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION
40				drilling fluid circulation regained		pa e brown to brown LIMESTONE, s ty, fr ab e (continued)
						42 0 -34 3 very pa e brown LIMESTONE, we ndurated
	SS 14		50/3"			
45						
	SS 15		50/1"			
50						end of day 11/25/2013 very pa e brown, gray, cha ky, vuggy, weathered, foss ferous
	RC 1	47 (37)				
	SS 16		1 2 1 (3)			54 0 -46 3 brown LIMESTONE, sandy, s ty, weathered, fragmented
55						
						57 0 -49 3 brown LIMESTONE, s ty, we ndurated
	SS 17		40 37 50/3"			
60						

GENERAL BH / P / WELL - G N S DUS LAB GD - 12/13/13 16 22 - C \ HA CRYSTAL RIVER 300743X2 CRYSTAL RIVER (2) GPJ

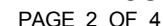
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CLIENT Duke Energy PROJECT NAME Energy Plant Ho c m S te
PROJECT NUMBER 300743x2 PROJECT LOCATION Crysta R ver
DATE STARTED 11/8/13 COMPLETED 11/11/13 GROUND ELEVATION 7.2 ft HOLE SIZE 4 nches
DRILLING CONTRACTOR Independent Dr ng, Inc. GROUND WATER LEVELS:
DRILLING METHOD Standard Penetrat on / Mud Rotary ∇ AT TIME OF DRILLING 3.00 ft / E ev 4.20 ft
LOGGED BY BB CHECKED BY Tha Nguyen AT END OF DRILLING _____
NOTES DR 33 R g CME550 Automat c Hammer AFTER DRILLING _____

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION
0						
	SS 1		8 13 9 6 (22)			very pale brown, white LIMESTONE, oca y do om t c
	SS 2		7 14 14 13 (28)			redd sh ye ow, sandy, poor y ndurated
5	SS 3		10 15 17 11 (32)	dr ng f u d ntroduced at 4'		s ty
	SS 4		9 10 11 16 (21)			
10	SS 5		7 4 12 9 (16)			
	SS 6		8 16 20 (36)			sandy, s ty, some grave , ndurated
	SS 7		5 6 10 (16)			
15	SS 8		10 10 4 (14)			redd sh ye ow
	SS 9		18 5 7 (12)			
20						

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PROJECT LOCATION Crysta River

GENERAL BH/ P /WELL -GN S DUS LABGD -12/13/13 16 22 - C \ HA \CRY S AL R VER\300743X2 CRY S AL R VER (2)GPJ

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CLIENT Duke Energy

PROJECT NAME Energy Plant Home Site

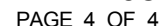
PROJECT NUMBER 300743x2

PROJECT LOCATION Crystalline River

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION
40						
				4 inch casing installed to 40', drilling fluid circulation resisted		pa e brown LIMESTONE, do m t c, s ty, fr ab e (continued)
45	SS 14		4 17 17 (34)			
	SS 15		50/1"			48.5 -41.3 very pa e brown LIMESTONE, do m t c, we ndurated
50	RC 1	80 (73)				vuggy, crysta ne, foss ferous
55	SS 16		6 7 13 (20)			54.0 -46.8 brown LIMESTONE, do m t c, s ty, fr ab e
	SS 17		7 3 3 (6)			
60						

GENERAL BH / P / WELL - G N S DUS LAB GD - 12/13/13 16 22 - C \ HA CRYSTAL RIVER (2) GPJ

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PROJECT LOCATION Crysta River

GENERAL BH/ P /WELL -GN S DUS LABGD -12/13/13 16 22 - C \ HA \CRY S AL R VER\300743X2 CRY S AL R VER (2)GPJ

Bottom of borehole at 73.8 feet.



CLIENT Duke Energy **PROJECT NAME** Energy Plant Ho cm Site
PROJECT NUMBER 300743x2 **PROJECT LOCATION** Crysta River
DATE STARTED 11/1/13 **COMPLETED** 11/4/13 **GROUND ELEVATION** 5.8 ft **HOLE SIZE** 4 inches
DRILLING CONTRACTOR Independent Dr ng, Inc. **GROUND WATER LEVELS:**
DRILLING METHOD Standard Penetrat on / Mud Rotary **AT TIME OF DRILLING** _____
LOGGED BY BB **CHECKED BY** Tha Nguyen **AT END OF DRILLING** _____
NOTES DR 33 R g CME550 Automat c Hammer **AFTER DRILLING** _____

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
0								
	SS 1		1 1 1 1 (2)		SM		(SM) redd sh brown s ty SAND, var ab y cayey oca sand ens	
	SS 2		1 2 3 3 (5)					
5	SS 3		2 2 2 2 (4)	dr ng f u d ntroduced at 4'	SC		(SC) gray, brown cayey SAND	
	SS 4		2 2 3 5 (5)					
	SS 5		2 1 22 7 (23)					
10								
	SS 6		2 1 2 2 (3)					
	SS 7		1 2 10 4 (12)	oss of dr ng f u d c rcu at on at 13.5'			pa e brown LIMESTONE, poor y ndurated, sandy c ayey ens at 8'	
15								
	SS 8		2 2 2 2 (4)					
	SS 9		7 11 1 6 (12)	4 nch cas ng			wh te, brown, very pa e brown LIMESTONE, sandy, s ty, oca she fragments, weathered, fr ab e, oca y do om t c	
20								

(Continued Next Page)



CLIENT Duke Energy

PROJECT NAME Energy Plant Ho cm S te

PROJECT NUMBER 300743x2

PROJECT LOCATION Crysta R ver

GENERAL BH / P / WELL - G N S DUS LAB GD - 12/13/13 16 22 - C \ HA ICRY S AL R VER 300743X2 CRY S AL R VER (2) GPJ

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
20				nsta ed to 20'				
	SS 10		1 1 1 1 (2)	rega ned dr ng f u d c rcu at on at 21'			wh te, brown, very pa e brown LIMESTONE, sandy, s ty, oca she fragments, weathered, fr ab e, oca y do om t c (continued)	
25	SS 11		1 5 4 1 (9)	oss of dr ng f u d c rcu at on at 23.5'				
	SS 12		2 22 50/5"				we ndurated	
	SS 13		34 50/3"				we ndurated	
30								
	SS 14		0 0 7 38 (7)	WOR/12", 7, 38				
35	SS 15		7 2 2 10 (4)					
	SS 16		13 16 8 50 (24)					
	SS 17		50/2"	4 nch cas ng advanced to 40', dr ng f u d c rcu at on rega ned				
40								

(Continued Next Page)



CLIENT Duke Energy

PROJECT NAME Energy Plant Home Site

PROJECT NUMBER 300743x2

PROJECT LOCATION Crystalline River

GENERAL BH / P / WELL - G N S DUS LAB GD - 12/13/13 16 22 - C \ HA \ CRYSTAL RIVER 300743X2 CRYSTAL RIVER (2) GPJ

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
40								
	SS 18		0 1 0 1 (1)	WOR, 1, WOR, 1			brown, very pale brown LIMESTONE, oolitic, sandy, silty, oolitic fragments, weathered, friable, mostly fine grained, with some coarse grained (continued)	
45	SS 19		9 1 42 3 (43)	loss of drilling fluid circulation at 43'				
	SS 20		50/2"					
50	SS 21		4 8 9 12 (17)					
	SS 22		50/3"					
55	SS 23		43 33 27 22 (60)					
	SS 24		22 27 50/5"					
60	SS 25		48 22 24 35 (46)					
							very pale brown LIMESTONE, oolitic, weathered	

(Continued Next Page)



CLIENT Duke Energy

PROJECT NAME Energy Plant Home Site

PROJECT NUMBER 300743x2

PROJECT LOCATION Crystal River

GENERAL BH / P / WELL - G N S DUS LAB GD - 12/13/13 16 22 - C \ HA CRYSTAL RIVER 300743X2 CRYSTAL RIVER (2) GPJ

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
60								
	SS 26		50/1"				very pale brown LIMESTONE, do om t c, we ndurated (<i>continued</i>)	
61.0							-55.2	
	RC 1	60 (57)					gray LIMESTONE, do om t c, very we ndurated	
65								
	RC 2	97 (97)						
70	SS 27		50/1"				end of sh ft on 11/02/13	
							gray LIMESTONE, moderate y to weak y ndurated	
70.0							-64.2	
	RC 3	28 (28)						
73.0							-67.2	
	NR			core advanced w th no down force (73 76')			poss b e vo d or very soft/ oose mater a	
75								
	RC 4	69 (17)					gray LIMESTONE, very soft, porous, foss ferous	
76.0							-70.2	
							gray LIMESTONE, we ndurated, porous, foss ferous	
78.0							-72.2	
							gray LIMESTONE, we ndurated, porous, foss ferous	
79.0							-73.2	
							brown, gray DOLOSTONE, weathered, porous, foss ferous, sandy, s ty	
80								

(Continued Next Page)



CLIENT Duke Energy

PROJECT NAME Energy Plant Home Site

PROJECT NUMBER 300743x2

PROJECT LOCATION Crystal River

GENERAL BH / P / WELL - G N S DUS LAB GD - 12/13/13 16 22 - C \ HA CRYSTAL RIVER 300743X2 CRYSTAL RIVER (2) GPJ

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
80	RC 5	33 (8)					brown, gray DOLOSTONE, weathered, porous, fossiliferous, sandy, silty (continued)	
83.5	SS 28		28 50/2"				brown, gray DOLOSTONE, weathered, friable, sandy, silty	
85								
90	SS 29		647 (11)				with lenses of gray clay	
95	SS 30		50/1"	drilling a transition between hard/soft zones			shelly, fossiliferous	
	SS 31		550/3"				with lenses of greenish gray clay, occasional chert	
99.3								

Bottom of borehole at 99.3 feet.

**BORING NUMBER B-10**

PAGE 1 OF 4

CLIENT Duke Energy **PROJECT NAME** Energy Plant Ho c m S te
PROJECT NUMBER 300743x2 **PROJECT LOCATION** Crysta R ver
DATE STARTED 11/20/13 **COMPLETED** 11/20/13 **GROUND ELEVATION** 7.7 ft **HOLE SIZE** 4 nches
DRILLING CONTRACTOR Independent Dr ng, Inc. **GROUND WATER LEVELS:**
DRILLING METHOD Standard Penetrat on / Mud Rotary **AT TIME OF DRILLING** _____
LOGGED BY JS **CHECKED BY** Tha Nguyen **AT END OF DRILLING** _____
NOTES DR 33 R g CME550 Automat c Hammer **AFTER DRILLING** _____

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0							
	SS 1		3 13 23 50/3"		SC	0.5	(SC) red f ne gra ned quartz SAND, c ayey wh te LIMESTONE var ab y ndurated, fr ab e
	SS 2		50/3"	dr ng f u d ntroduced			we ndurated
5	SS 3		35 39 44 37 (83)				
	SS 4		40 34 12 11 (46)				
	SS 5		14 15 8 11 (23)			8.0	wh te, brown LIMESTONE, oca y do om t c, poor y ndurated, common ca careous s t, fr ab e
10							
	SS 6		6 6 5 (11)				
	SS 7		3 4 3 (7)				
15							
	SS 8		7 13 6 (19)				
	SS 9		13 5 10 (15)				
20							

(Continued Next Page)



CLIENT Duke Energy

PROJECT NAME Energy Plant Home Site

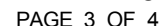
PROJECT NUMBER 300743x2

PROJECT LOCATION Crysta River

GENERAL BH / P / WELL - G N S DUS LAB GD - 12/13/13 16 22 - C \ HA CRYSTAL RIVER 300743X2 CRYSTAL RIVER (2) GPJ

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
20							
25	SS 10		9 10 18 (28)				white, brown LIMESTONE, oolitic, poorly indurated, common calcareous silt, friable (continued)
30	SS 11		2 1 1 (2)	loss of drilling fluid circulation at 26'			
35	SS 12		10 4 2 (6)				
40	SS 13		5 4 7 (11)				
							36.0 -28.3 pale brown LIMESTONE, oolitic, poorly indurated, mostly calcareous silt

(Continued Next Page)



PROJECT LOCATION Crysta River

GENERAL BH/ P /WELL -GN S DUS LABGD -12/13/13 16 22 - C \ HA \CRY S AL R VER\300743X2 CRY S AL R VER (2)GPJ

(Continued Next Page)

**CLIENT** Duke Energy**PROJECT NAME** Energy Plant Home Site**PROJECT NUMBER** 300743x2**PROJECT LOCATION** Crystal River

GENERAL BH / P / WELL - G N S DUS LAB GD - 12/13/13 16 22 - C \ HA \ CRYSTAL RIVER 300743X2 CRYSTAL RIVER (2) GPJ

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
60							
							pa e brown LIMESTONE, var ab y ndurated (continued)
							we ndurated
65	SS 18		50/0"				
	RC 1	70 (67)					
70	SS 19		17 10 20 (30)				pa e brown LIMESTONE
							moderate y ndurated
	SS 20		50/1"				
							Bottom of borehole at 73.6 feet.

69.0

-61.3

73.6

-65.9

**BORING NUMBER B-11**

PAGE 1 OF 4

CLIENT Duke Energy **PROJECT NAME** Energy Plant Ho cm Site
PROJECT NUMBER 300743x2 **PROJECT LOCATION** Crysta River
DATE STARTED 10/30/13 **COMPLETED** 10/31/13 **GROUND ELEVATION** 4.5 ft **HOLE SIZE** 3 inches
DRILLING CONTRACTOR Independent Dr ng, Inc. **GROUND WATER LEVELS:**
DRILLING METHOD Standard Penetrat on / Mud Rotary ☒ **AT TIME OF DRILLING** 3.00 ft / Elev 1.50 ft
LOGGED BY HI **CHECKED BY** Tha Nguyen **AT END OF DRILLING** _____
NOTES DR 15 R g CME55 Automat c Hammer **AFTER DRILLING** _____

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	REMARKS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0						
	SS 1	1 1 2 2 (3)		SP SM		(SP SM) dark brown, orange SAND with s t
	SS 2	1 1 1 8 (2)				
					3.5	1.0
						wh te, gray LIMESTONE
5	SS 3	9 4 4 13 (8)	dr ng f u d ntroduced at 4'			
	SS 4	7 6 11 16 (17)				
	SS 5	15 25 30 19 (55)				coarse gra ned, weathered
10			hard dr ng, r g chatter ng at 11'			
	SS 6	1 0 1 (1)	poor recovery			
			oss of dr ng f u d c rcu at on at 13'			
	SS 7	50/3"	6 nch cas ng nsta ed to 15'			
15			oss of dr ng f u d c rcu at on at 15'			
	SS 8	10 29 40 (69)				very f ne gra ned, fr ab e from 16' 20'
	SS 9	13 19 24 (43)				
20						

(Continued Next Page)

CLIENT Duke EnergyPROJECT NAME Energy Plant Ho cm SitePROJECT NUMBER 300743x2PROJECT LOCATION Crysta River

GENERAL BH / P / WELL - G N S DUS LAB GD - 12/13/13 16 22 - C \ HA \ CRYSTAL RIVER 300743X2 CRYSTAL RIVER (2) GPJ

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	REMARKS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
40						
			loss of drilling fluid circulation			pa e brown, brown LIMESTONE, do om t c (continued)
	SS 16	50/3"				
45						
			hard drilling, r g chatter ng			
	SS 17	50/1"				
50						
	SS 18	50/3"				
55						
	SS 19	50/2"				
60			hard drilling, r g			

(Continued Next Page)

**BORING NUMBER B-11**

PAGE 4 OF 4

CLIENT Duke EnergyPROJECT NAME Energy Plant Ho cm SitePROJECT NUMBER 300743x2PROJECT LOCATION Crysta River

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	REMARKS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
60			chatter ng			pa e brown, brown LIMESTONE, do om t c (continued)
65	SS 20	50/1"	hard dr ng, rg chatter ng			
	SS 21	50/5"				
					68.4	

Bottom of borehole at 68.4 feet.

-63.9

**BORING NUMBER B-12**

PAGE 1 OF 4

CLIENT Duke Energy **PROJECT NAME** Energy Plant Home Site
PROJECT NUMBER 300743x2 **PROJECT LOCATION** Crystal River
DATE STARTED 11/11/13 **COMPLETED** 11/12/13 **GROUND ELEVATION** 10 ft **HOLE SIZE** 4 inches
DRILLING CONTRACTOR Independent Drilling, Inc. **GROUND WATER LEVELS:**
DRILLING METHOD Standard Penetration / Mud Rotary **AT TIME OF DRILLING** _____
LOGGED BY HI **CHECKED BY** Tha Nguyen **AT END OF DRILLING** _____
NOTES DR 33 Rg CME550 Automatic Hammer **AFTER DRILLING** _____

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0							
	SS 1		1211 (3)		SP		(SP) brown, orange fine grained quartz SAND, some silt
	SS 2		54817 (12)				pa e brown, white, gray LIMESTONE
							sandy
5	SS 3		2353 (8)	drilling fluid introduced at 4'			fine to coarse, sandy
	SS 4		82122 50/2"				coarse
	SS 5		50/3"				
10	RC 1	32 (8)					
15	SS 6		48111 (19)				
	SS 7		624 (6)				
20	SS 8		100 (0)	1, WOH/12"			

(Continued Next Page)



CLIENT Duke Energy

PROJECT NAME Energy Plant Ho cm S te

PROJECT NUMBER 300743x2

PROJECT LOCATION Crysta R ver

GENERAL BH / P / WELL - G N S DUS LAB GD - 12/13/13 16 22 - C \ HA C RYS AL R VER 300743X2 C RYS AL R VER (2) GPJ

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
20							
				loss of dr ng f u d c r c u at on at 22'			pa e brown, wh te, gray LIMESTONE (continued)
25	SS 9		2 0 0 0 (0)	2, WOH/18"			coarse
30	SS 10		1 0 5 2 (5)	1, WOH, 5, 2			
35	SS 11		11 6 3 3 (9)	4 nch cas ng nsta ed to 35', dr ng f u d rega ned			
							end of sh ft 11/11/2013
							37 0
							pa e brown LIMESTONE
							-27 0
40	SS 12		50/1"	loss of dr ng f u d c r c u at on at 38'			

(Continued Next Page)

**BORING NUMBER B-12**

PAGE 3 OF 4

CLIENT Duke EnergyPROJECT NAME Energy Plant Ho cm S tePROJECT NUMBER 300743x2PROJECT LOCATION Crysta R ver

GENERAL BH / P / WELL - G N S DUS LAB GD - 12/13/13 16 22 - C \ HA \ CRYSTAL RIVER 300743X2 CRYSTAL RIVER (2) GPJ

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
40							
	RC 2	61 (61)					pa e brown LIMESTONE (continued)
	SS 13		50/1"				pa e brown, wh te
45							
	RC 3	53 (37)					
50							
	SS 14		50/1"				
	RC 4	31 (24)					
55							
	SS 15		50/1"				do om t c
	RC 5	31 (31)					
60							

(Continued Next Page)

**BORING NUMBER B-12**

PAGE 4 OF 4

CLIENT Duke EnergyPROJECT NAME Energy Plant Home SitePROJECT NUMBER 300743x2PROJECT LOCATION Crystal River

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
60	SS 16		50/2"				pale brown LIMESTONE (continued)
	RC 6	37 (37)					
65	SS 17		50/1"				
	RC 7	32 (24)					
70							

70.0

-60.0

Bottom of borehole at 70.0 feet.

GENERAL BH / P / WELL - G N S DUS LAB GD - 12/13/13 16 22 - C \ HA \ CRYSTAL RIVER 300743X2 CRYSTAL RIVER (2) GPJ

**BORING NUMBER B-13**

PAGE 1 OF 5

CLIENT Duke Energy **PROJECT NAME** Energy Plant Home Site
PROJECT NUMBER 300743x2 **PROJECT LOCATION** Crystal River
DATE STARTED 11/21/13 **COMPLETED** 11/21/13 **GROUND ELEVATION** 7.5 ft **HOLE SIZE** 4 inches
DRILLING CONTRACTOR Independent Drilling, Inc. **GROUND WATER LEVELS:**
DRILLING METHOD Standard Penetration / Mud Rotary **AT TIME OF DRILLING** _____
LOGGED BY JS **CHECKED BY** Tha Nguyen **AT END OF DRILLING** _____
NOTES DR 33 Rg CME550 Automatic Hammer **AFTER DRILLING** _____

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0							
	SS 1		15 25 22 (30)		SM		(SM) brown fine grained quartz sandy SILT
	SS 2		45 50/3"	drilling fluid introduced at 2'			white, pale yellow LIMESTONE
5	SS 3		40 38 45 30 (83)				
	SS 4		14 10 7 7 (17)				poorly indurated
	SS 5		13 12 10 6 (22)				
10	SS 6		5 11 12 (23)				
	SS 7		5 6 10 (16)				some calcareous silt
15	SS 8		3 6 12 (18)				
	SS 9		10 16 20 (36)				moderately indurated
20							

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CLIENT Duke Energy

PROJECT NAME Energy Plant Home Site

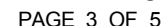
PROJECT NUMBER 300743x2

PROJECT LOCATION Crysta River

GENERAL BH / P / WELL - G N S DUS LAB GD - 12/13/13 16 22 - C \ HA \ CRYSTAL RIVER 300743X2 CRYSTAL RIVER (2) GPJ

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
20							
25	SS 10		12 12 23 (35)				white, pale yellow Limestone (continued)
30	SS 11		50/5"				white Limestone
35	SS 12		20 32 41 (73)				fractured
40	SS 13		50/4"	loss of drilling fluid circulation at 37'			weathered brown Limestone
							mostly calcareous silt

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PROJECT LOCATION Crysta River

GENERAL BH/ P /WELL -GN S DUS LABGD -12/13/13 16 22 - C \ HA \CRY S AL R VER\300743X2 CRY S AL R VER (2)GPJ

(Continued Next Page)



CLIENT Duke Energy

PROJECT NAME Energy Plant Home Site

PROJECT NUMBER 300743x2

PROJECT LOCATION Crysta River

GENERAL BH / P / WELL - G N S DUS LAB GD - 12/13/13 16 22 - C \ HA CRYSTAL RIVER 300743X2 CRYSTAL RIVER (2) GPJ

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
60							
	RC 3	67 (45)					pa e brown LIMESTONE (continued)
65	SS 18		50/5"				some ca careous s t, fr ab e
	SS 19		50/1"				we ndurated
70							
	SS 20		50/0"				dark gray DOLOSTONE, sucros c
75				rock core attempted at 75', unsuccessfu			
	SS 21		25 15 10 (25)				poor y ndurated, sandy
80							

76 0

-68 5

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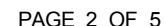
**BORING NUMBER B-14**

PAGE 1 OF 5

CLIENT Duke Energy **PROJECT NAME** Energy Plant Ho c m S te
PROJECT NUMBER 300743x2 **PROJECT LOCATION** Crysta R ver
DATE STARTED 11/11/13 **COMPLETED** 11/13/13 **GROUND ELEVATION** 6.9 ft **HOLE SIZE** 4 nches
DRILLING CONTRACTOR Independent Dr ng, Inc. **GROUND WATER LEVELS:**
DRILLING METHOD Standard Penetrat on / Mud Rotary ☒ **AT TIME OF DRILLING** 4.00 ft / E ev 2.90 ft
LOGGED BY BB **CHECKED BY** Tha Nguyen **AT END OF DRILLING** _____
NOTES DR 15 R g CME55 Automat c Hammer **AFTER DRILLING** _____

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION
0						
	SS 1		9 16 18 25 (34)			very pale brown LIMESTONE, ndurated
	SS 2		24 20 20 12 (40)			sandy, s ty
5	SS 3		9 6 4 3 (10)	dr ng f u d ntroduced at 4'		
	SS 4		2 10 7 5 (17)			s ty, poor y ndurated
10	SS 5		18 15 18 11 (33)			
	SS 6		7 9 5 (14)			
	SS 7		14 28 25 (53)			sandy, s ty, ndurated
15	SS 8		11 15 21 (36)			
	SS 9		25 22 18 (40)			we ndurated
20						

(Continued Next Page)



PROJECT LOCATION Crysta River

GENERAL BH/ P /WELL -GN S DUS LABGD -12/13/13 16 22 - C \ HA \CRY S AL R VER\300743X2 CRY S AL R VER (2)GPJ

(Continued Next Page)



CLIENT Duke Energy

PROJECT NAME Energy Plant Home Site

PROJECT NUMBER 300743x2

PROJECT LOCATION Crystalline River

GENERAL BH / P / WELL - G N S DUS LAB GD - 12/13/13 16 22 - C \ HA \ CRYSTAL RIVER (2) GPJ

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION
40						pa e brown LIMESTONE, poor y ndurated, s ty (continued)
45	SS 14		18 22 20 (42)			
						ssue w th cas ng nsta at on at 30', end of sh ft 11/11/13
50	SS 15		18 33 28 (61)			var ab y ndurated, trace grave
						52 0 -45 1
						very pa e brown LIMESTONE, we ndurated
	SS 16		50/2"			
55	RC 1	28 (0)				
	SS 17		49 50/3"			
60						

(Continued Next Page)



CLIENT Duke Energy

PROJECT NAME Energy Plant Home Site

PROJECT NUMBER 300743x2

PROJECT LOCATION Crystalline River

GENERAL BH / P / WELL - G N S DUS LAB GD - 12/13/13 16 22 - C \ HA \ CRYSTAL RIVER 300743X2 CRYSTAL RIVER (2) GPJ

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION
60						very pale brown LIMESTONE, well indurated (continued)
	RC 2	65 (52)				
65	SS 18		50/1"			sandy, mostly gravel
	RC 3	32 (28)				
70	SS 19		50/3"			dark gray, white DOLOSTONE, poorly indurated, vuggy, sucrose
						72 0 -65 1
75	SS 20		6 7 8 (15)			end of shaft on 11/12/13
						77 0 -70 1
						pale brown to brown DOLOSTONE, poorly indurated, vuggy, sandy
80	SS 21		10 5 50/3"			

(Continued Next Page)



CLIENT Duke Energy

PROJECT NAME Energy Plant Home Site

PROJECT NUMBER 300743x2

PROJECT LOCATION Crysta River

GENERAL BH / P / WELL - G N S DUS LAB GD - 12/13/13 16 22 - C \ HA CRYSTAL RIVER 300743X2 CRYSTAL RIVER (2) GPJ

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION
80						pa e brown to brown DOLOSTONE, poor y ndurated, vuggy, sandy (continued)
85	SS 22		50/1"	soft dr ng from 86' to 88'		
90	SS 23		50/1"			
95	SS 24		50/3"			gray, pa e brown DOLOSTONE, we ndurated, oca y c ayey
	SS 25		50/2"			cherty
						Bottom of borehole at 98.6 feet.

93.0

-86.1

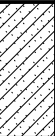
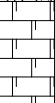
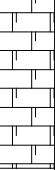
98.6

-91.7

**BORING NUMBER B-15**

PAGE 1 OF 2

CLIENT Duke Energy **PROJECT NAME** Energy Plant Ho cm S te
PROJECT NUMBER 300743x2 **PROJECT LOCATION** Crysta R ver
DATE STARTED 11/22/13 **COMPLETED** 11/22/13 **GROUND ELEVATION** 7.1 ft **HOLE SIZE** 4 nches
DRILLING CONTRACTOR Independent Dr ng, Inc. **GROUND WATER LEVELS:**
DRILLING METHOD Standard Penetrat on / Mud Rotary **AT TIME OF DRILLING** _____
LOGGED BY JS **CHECKED BY** Tha Nguyen **AT END OF DRILLING** _____
NOTES DR 33 R g CME550 Automat c Hammer **AFTER DRILLING** _____

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	REMARKS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0						
	SS 1	1 0 0 1 (0)	1, WOH, WOH, 1	SC		(SC) red c ayey/s ty f ne gra ned quarts SAND
	SS 2	5 13 20 (33)				wh te, pa e ye ow LIMESTONE
5	NR	0	WOH/30"			
10						
15						
	NR	0	WOR/20'			
20						

GENERAL BH / P / WELL - G N S DUS LAB GD - 12/13/13 16 22 - C \ HA \ CRY S AL R VER 300743X2 CRY S AL R VER (2) GPJ

(Continued Next Page)

**BORING NUMBER B-16**

PAGE 1 OF 3

CLIENT Duke Energy **PROJECT NAME** Energy Plant Ho cm Site
PROJECT NUMBER 300743x2 **PROJECT LOCATION** Crysta River
DATE STARTED 11/18/13 **COMPLETED** 11/19/13 **GROUND ELEVATION** 8 ft **HOLE SIZE** 4 nches
DRILLING CONTRACTOR Independent Dr ng, Inc. **GROUND WATER LEVELS:**
DRILLING METHOD Standard Penetrat on / Mud Rotary **AT TIME OF DRILLING** _____
LOGGED BY BB **CHECKED BY** Tha Nguyen **AT END OF DRILLING** _____
NOTES DR 15 R g CME55 Automat c Hammer **AFTER DRILLING** _____

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0							
	SS 1		3 16 50/5"	dr ng f u d ntroduced at 1'	SP SM		(SP SM) redd sh brown f ne gra ned quartz SAND w th s t,
							7 0
	SS 2		50/4"				very pa e brown, pa e brown LIMESTONE, sandy, we ndurated
	SS 3		50/3"				
5							
	SS 4		13 30 25 28 (55)				very pa e brown LIMESTONE, sandy, s ty, we ndurated
	SS 5		20 7 8 11 (15)				poor y ndurated
10							
	SS 6		9 14 5 (19)				
	SS 7		3 6 15 (21)				
15							
	SS 8		8 8 9 (17)				more s ty
	SS 9		4 9 12 (21)				
20							

(Continued Next Page)

CLIENT Duke EnergyPROJECT NAME Energy Plant Ho cm SitePROJECT NUMBER 300743x2PROJECT LOCATION Crysta River

GENERAL BH / P / WELL - G N S DUS LAB GD - 12/13/13 16 22 - C \ HA CRYSTAL RIVER 300743X2 CRYSTAL RIVER (2) GPJ

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
20							very pale brown LIMESTONE, sandy, s ty, we ndurated (continued)
25	SS 10		20 6 14 (20)				do om t c
30	SS 11		22 42 42 (84)				more sandy
35	SS 12		23 16 24 (40)				
40	SS 13		50/5"	loss of dr ng f u d c rcu at on at 38'			36 0 pale brown LIMESTONE, do om t c, fr ab e, s ty, we ndurated -28 0

(Continued Next Page)



CLIENT Duke Energy

PROJECT NAME Energy Plant Home Site

PROJECT NUMBER 300743x2

PROJECT LOCATION Crystalline River

GENERAL BH / P / WELL - G N S DUS LAB GD - 12/13/13 16 22 - C \ HA CRYSTAL RIVER 300743X2 CRYSTAL RIVER (2) GPJ

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
40							
							pa e brown LIMESTONE, do om t c, fr ab e, s ty, we ndurated (continued)
45							
	SS 14		50/3"				
	RC 1	28 (17)					vuggy, cha ky
						46 0	-38 0
							very pa e brown LIMESTONE, we ndurated
50							
	SS 15		50/2"				
	RC 2	52 (25)					vuggy, cha ky, oca y crysta ne, few foss s
	SS 16		50/2"			54 6	-46 6
							Bottom of boreho e at 54.6 feet.



CLIENT Duke Energy PROJECT NAME Energy Plant Ho c m S te
PROJECT NUMBER 300743x2 PROJECT LOCATION Crysta R ver
DATE STARTED 11/4/13 COMPLETED 11/5/13 GROUND ELEVATION 6.3 ft HOLE SIZE 4 nches
DRILLING CONTRACTOR Independent Dr ng, Inc. GROUND WATER LEVELS:
DRILLING METHOD Standard Penetrat on / Mud Rotary ∇ AT TIME OF DRILLING 4.00 ft / E ev 2.30 ft
LOGGED BY BB CHECKED BY Tha Nguyen AT END OF DRILLING _____
NOTES DR 33 R g CME550 Automat c Hammer AFTER DRILLING _____

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
0						
	SS 1	6 12 12 12 (24)			pa e ye ow, pa e brown, wh te LIMESTONE sand to s t s zed gra ns	
	SS 2	8 10 26 10 (36)				
5	SS 3	5 5 6 9 (11)	dr ng f u d ntroduced at 4'		poor y ndurated	
	SS 4	31 13 18 28 (31)			sandy, s ty, poor y ndurated	← benton te sea
10	SS 5	30 20 24 29 (44)				
	SS 6	14 20 19 (39)			sandy	
	SS 7	15 14 10 (24)			few grave s zed gra ns	← sand pack
15	SS 8	7 9 10 (19)				← screen
	SS 9	14 16 14 (30)			sandy, grave s ze gra ns	
20						

(Continued Next Page)



CLIENT Duke Energy

PROJECT NAME Energy Plant Home Site

PROJECT NUMBER 300743x2

PROJECT LOCATION Crystal River

GENERAL BH / P / WELL - G N S DUS LAB GD - 12/13/13 16 22 - C \ HA CRYSTAL RIVER 300743X2 CRYSTAL RIVER (2) GPJ

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
20					pa e ye ow, pa e brown, wh te LIMESTONE (continued)	
25	SS 10	43 38 3 (41)	loss of drilling fluid circulation at 25' 4 inch casing installed to 25', drilling fluid circulation regained		sandy, well indurated	
30	SS 11	19 29 34 (63)			color changed to brown, sandy, friable, domitic	
35	SS 12	14 50/1"			gravel size grains	
40	SS 13	50/5"	4 inch casing advanced to 40'		gravelly, well indurated	
40 0						-33 7

(Continued Next Page)

CLIENT Duke EnergyPROJECT NAME Energy Plant Ho cm SitePROJECT NUMBER 300743x2PROJECT LOCATION Crysta River

GENERAL BH / P / WELL - G N S DUS LAB GD - 12/13/13 16 22 - C \ HA CRYSTAL RIVER 300743X2 CRYSTAL RIVER (2) GPJ

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
40					pa e ye ow, pa e brown LIMESTONE, do om t c	
					co or gradua y changed to pa e brown	
45	SS 14	47 28 23 (51)	oss of dr ng f u d c rcu at on at 45'		s ty, fr ab e	
50	SS 15	50/2"			very pa e brown, sandy	
55	SS 16	13 17 30 (47)			s ty, fr ab e	
60	SS 17	18 50/2"			pa e brown, brown LIMESTONE s ty, fr ab e	

(Continued Next Page)

PAGE 4 OF 4

CLIENT Duke EnergyPROJECT NAME Energy Plant Ho cm SitePROJECT NUMBER 300743x2PROJECT LOCATION Crysta RiverDATE STARTED 11/5/13COMPLETED 11/6/13GROUND ELEVATION 7.5 ftHOLE SIZE 3 inchesDRILLING CONTRACTOR Independent Dr ng, Inc.

GROUND WATER LEVELS:

DRILLING METHOD Standard Penetrat on / Mud Rotary

AT TIME OF DRILLING

LOGGED BY HICHECKED BY Tha Nguyen

AT END OF DRILLING

NOTES DR 15 R g CME55 Automat c Hammer

AFTER DRILLING

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
0								
	SS 1		8 13 7 18 (20)				pa e brown, brown LIMESTONE, sandy	
	SS 2		21 12 27 17 (39)		SM		(SM) pa e brown, wh te SILTY SAND, f ne to coarse mestone fragments	
	SS 3		15 22 19 14 (41)	dr ng f u d ntroduced at 4'			wh te, pa e brown LIMESTONE, f ne to coarse s ze fragments	
5	SS 4		9 10 13 15 (23)					
	SS 5		7 7 10 11 (17)					
10	SS 6		11 34 26 (60)					
	SS 7		18 11 7 (18)					
15	SS 8		8 49 50/4"					
	SS 9		10 11 19 (30)					
20								

(Continued Next Page)



CLIENT Duke Energy

PROJECT NAME Energy Plant Ho cm S te

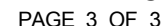
PROJECT NUMBER 300743x2

PROJECT LOCATION Crysta R ver

GENERAL BH / P / WELL - G N S DUS LAB GD - 12/13/13 16 22 - C \ HA C RYS AL R VER 300743X2 C RYS AL R VER (2) GPJ

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
20							wh te LIMESTONE, f ne to coarse s ze fragments	
25	SS 10		21 9 49 24 (58)					
30	SS 11		1 2 18 50/2"	samp e most y cave n				
35	SS 12		50/1"	oss of dr ng f u d c rcu at on at 31' dr ng f u d c rcu at on rega ned at 33' 4 nch cas ng nsta ed to 35', dr ng f u d c rcu at on rega ned hard dr ng, rg chatter ng				
40	SS 13		45 46 50/3"	oss of dr ng f u d			36 0 pa e brown LIMESTONE, f ne to coarse s ze fragments fr ab e, do om t c	-28 5

(Continued Next Page)



PROJECT NAME Energy Plant Ho cm Ste

PROJECT LOCATION Crysta River

GENERAL BH/ P/ WELL - GN S DUS LAB GD - 12/13/13 16 22 - C \ HA \ CRY S AL R VER \ 300743X2 CRY S AL R VER (2) GPJ

Bottom of borehole at 56.0 feet.

CLIENT Duke EnergyPROJECT NAME Energy Plant Ho c m S tePROJECT NUMBER 300743x2PROJECT LOCATION Crysta R verDATE STARTED 10/30/13COMPLETED 10/31/13GROUND ELEVATION 6.8 ftHOLE SIZE 4 nchesDRILLING CONTRACTOR Independent Dr ng, Inc.

GROUND WATER LEVELS:

DRILLING METHOD Standard Penetrat on / Mud Rotary

AT TIME OF DRILLING

LOGGED BY HICHECKED BY Tha Nguyen

AT END OF DRILLING

NOTES DR 15 R g CME55 Automat c Hammer

AFTER DRILLING

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
0								
	SS 1		1 7 20 12 (27)		SP SM		(SP SM) orange brown SAND w th s t, f ne gr a ned, ca careous, m nor s t nc us ons, m nor ron concret on, m nor mestone fragments	
	SS 2		15 40 24 8 (64)				2 0 pa e ye ow sh brown, wh te LIMESTONE, poor y ndurated, sandy, sand to grave s ze	4 8
5	SS 3		20 16 25 43 (41)	dr ng f u d ntroduced at 4' co or gradua y change to wh te shade be ow 5 feet/				
	SS 4		5 22 50/3"					benton te sea
	SS 5		22 7 3 1 (10)				9 0 pa e brown to brown, orange LIMESTONE, do om t c, s ty	-2 2
10	SS 6		0 0 1 (1)	WOH/12, 1				
	SS 7		50/4"	trace do om t zed hard mestone of grave gra ned s ze n SS7 samp e			13 0 pa e brown to brown LIMESTONE, s t gra ned s ze to f ne sand gra ned s ze, fr ab e	-6 2
15	RC 1	67 (0)		attempted 4 n core from 15 ft; R g began stand ng up. Stopped cor ng at 15.5 ft after 03m:13s of cor ng				sand pack
	SS 8		50/3"				16 3 pa e brown to brown LIMESTONE, do om t c	-9 5
	SS 9		20 24 43 17 (67)					screen
20							20 0	-13 2

(Continued Next Page)



PAGE 2 OF 2

CLIENT Duke Energy **PROJECT NAME** Energy Plant Hockmest

PROJECT NUMBER 300743x2 **PROJECT LOCATION** Crysta River

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
20								
	SS 10		50/2"				pa e brown to brown LIMESTONE, ca careous, s ty	
	SS 11		50/3"					
25	SS 12		15 41 50/4"					
	SS 13		50/3"					
							Bottom of borehole at 28.3 feet.	

GENERAL BH/ P /WELL - GN S DUSLABGD -12/13/13 16 22 - C \ HA \CRY S AL R VER\300743X2 CRY S AL R VER(2)GPJ

CLIENT Duke EnergyPROJECT NAME Energy Plant Ho c m S tePROJECT NUMBER 300743x2PROJECT LOCATION Crysta R verDATE STARTED 11/19/13 COMPLETED 11/19/13GROUND ELEVATION 9.1 ft HOLE SIZE 4 nchesDRILLING CONTRACTOR Independent Dr ng, Inc.

GROUND WATER LEVELS:

DRILLING METHOD Standard Penetrat on / Mud Rotary

AT TIME OF DRILLING _____

LOGGED BY BB CHECKED BY Tha Nguyen

AT END OF DRILLING _____

NOTES DR 15 R g CME55 Automat c Hammer

AFTER DRILLING _____

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	REMARKS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0						
	SS 1	1 2 1 2 (3)		SP SM		(SP SM) redd sh brown f ne gra ned quartz SAND, m nor s t
	SS 2	3 10	samp er ang ed, unab e to obta n more samp e dr ng f u d ntroduced at 3'		2 5	6 6 very pa e brown LIMESTONE, sandy
5	SS 3	50/2"				we ndurated
	SS 4	27 8 12 7 (20)				var ab y ndurated, few grave , s ty
	SS 5	7 10 5 8 (15)				
10					10 5	-1 4 (CH) ght green sh gray, redd sh ye ow CLAY, var ab y sandy, oca mestone fragments
	SS 6	2 2 1 (3)		CH		
					13 0	-3 9 very pa e brown LIMESTONE, poor y ndurated
15	SS 7	3 4 5 (9)				oca cay ens
	SS 8	4 4 3 (7)				sandy
20	SS 9	1 1 2 (3)				

(Continued Next Page)



CLIENT Duke Energy

PROJECT NAME Energy Plant Home Site

PROJECT NUMBER 300743x2

PROJECT LOCATION Crysta River

GENERAL BH / P / WELL - G N S DUS LAB GD - 12/13/13 16 22 - C \ HA CRYSTAL RIVER 300743X2 CRYSTAL RIVER (2) GPJ

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	REMARKS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
20						
						very pale brown LIMESTONE, poorly indurated (continued)
25	SS 10	18 13 3 (16)				some grave
			loss of drilling fluid circulation at 27'			
30	SS 11	0 1 0 (1)	WOR, 1, WOH/24", 8			reddish brown, pale brown, sandy
	SS 12	0 0 0 8 (0)				
35	SS 13	5 5 7 (12)	4 inch casing installed to 35', drilling fluid circulation regained momentarily			
40	SS 14	8 10 11 (21)				
						33.0 pale brown LIMESTONE, dolomitic, poorly indurated, sandy, friable -23.9

(Continued Next Page)

CLIENT Duke Energy

PROJECT NAME Energy P ant Ho c m S te

PROJECT NUMBER 300743x2

PROJECT LOCATION Crysta River

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	REMARKS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
40						pa e brown LIMESTONE, do om t c, poor y ndurated, s ty, fr ab e (<i>continued</i>)
						-32 9
42 0						pa e brown LIMESTONE, do om t c, poor y ndurated, s ty, fr ab e
45	SS 15	4 1 48 (49)				
50	SS 16	45 42 28 (70)				
55	SS 17	0 17 40 (57)	WOR, 17, 40			-45 9

Bottom of borehole at 55.0 feet.

**BORING NUMBER B-21**

PAGE 1 OF 3

CLIENT Duke Energy **PROJECT NAME** Energy Plant Ho c m S te
PROJECT NUMBER 300743x2 **PROJECT LOCATION** Crysta R ver
DATE STARTED 11/18/13 **COMPLETED** 11/18/13 **GROUND ELEVATION** 6.2 ft **HOLE SIZE** 4 nches
DRILLING CONTRACTOR Independent Dr ng, Inc. **GROUND WATER LEVELS:**
DRILLING METHOD Standard Penetrat on / Mud Rotary **AT TIME OF DRILLING** _____
LOGGED BY BB **CHECKED BY** Tha Nguyen **AT END OF DRILLING** _____
NOTES DR 15 R g CME55 Automat c Hammer **AFTER DRILLING** _____

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	REMARKS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0						
	SS 1	1 2 2 1 (4)		SP SM		(SP SM) brown f ne gra ned quartz SAND w th m nor s t, m nor roots
	SS 2	3 6 12 10 (18)				2 0 very pa e brown, redd sh ye ow LIMESTONE, sandy, s t, poor y ndurated
5	SS 3	5 5 5 6 (10)	dr ng f u d ntroduced at 4'			
	SS 4	4 9 8 13 (17)				
	SS 5	3 4 4 2 (8)				
10						
	SS 6	6 8 4 (12)				
	SS 7	2 4 3 (7)				s ty
15						
	SS 8	8 9 13 (22)				
	SS 9	4 7 8 (15)				some grave
20						

(Continued Next Page)

CLIENT Duke EnergyPROJECT NAME Energy Plant Ho c m S tePROJECT NUMBER 300743x2PROJECT LOCATION Crysta R ver

GENERAL BH / P / WELL - G N S DUS LAB GD - 12/13/13 16 22 - C \ HA C RYS AL R VER 300743X2 C RYS AL R VER (2) GPJ

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	REMARKS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
20						
			loss of dr ng f u d c rcu at on at 22'			very pa e brown, redd sh ye ow LIMESTONE, sandy, s t, poor y ndurated (continued) -15 8
25	SS 10	0 0 0 0 (0)	WOH/24"	SP		(SP) gray, pa e brown f ne gra ned quartz SAND, ca careous -19 8
30	SS 11	8 33 19 (52)	4 nch cas ng nsta ed to 30', dr ng f u d c rcu at on not rega ned			very pa e brown LIMESTONE, sandy, s ty, ndurated -29 8
35	SS 12	8 10 9 (19)	4 nch cas ng advanced to 35', dr ng f u d c rcu at on rega ned			pa e brown LIMESTONE, do om t c, most y s ty, we ndurated -29 8
40	SS 13	25 31 46 (77)				

(Continued Next Page)



PAGE 3 OF 3

CLIENT Duke Energy **PROJECT NAME** Energy Plant Hockmest

PROJECT NUMBER 300743x2 **PROJECT LOCATION** Crysta River

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	REMARKS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
40						pa e brown LIMESTONE, do om t c, most y s ty, we ndurated (continued)
45	SS 14	27 26 26 (52)				
	SS 15	50/5"				
50						50 0 -43 8 pa e brown LIMESTONE, most y s ty
55	SS 16	5 9 10 (19)				
						56 0 -49 8 very pa e brown, pa e brown LIMESTONE, we ndurated
	SS 17	50/2"				58 7 -52 5 Bottom of boreho e at 58.7 feet.

GENERAL BH/ P / WELL - GN S D US LAB GD - 12/13/13 16 22 - C \ HA \ CRY S AL R VER \ 300743X2 CRY S AL R VER (2) GPJ

**BORING NUMBER B-22**

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CLIENT Duke Energy **PROJECT NAME** Energy Plant Ho c m S te
PROJECT NUMBER 300743x2 **PROJECT LOCATION** Crysta R ver
DATE STARTED 11/15/13 **COMPLETED** 11/15/13 **GROUND ELEVATION** 6.2 ft **HOLE SIZE** 4 nches
DRILLING CONTRACTOR Independent Dr ng, Inc. **GROUND WATER LEVELS:**
DRILLING METHOD Standard Penetrat on / Mud Rotary **AT TIME OF DRILLING** _____
LOGGED BY HI **CHECKED BY** Tha Nguyen **AT END OF DRILLING** _____
NOTES DR 33 R g CME550 Automat c Hammer **AFTER DRILLING** _____

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0							
	SS 1		1 3 3 1 (6)		SP		(SP) brown f n gra ned quartz SAND
	SS 2		4 15 19 5 (34)				2 0 4 2 pa e brown, gray, wh te LIMESTONE
5	SS 3		3 4 4 2 (8)	dr ng f u d ntroduced at 4'			
	SS 4		9 14 50/5"				6 0 0 2 wh te LIMESTONE, coarse s ze fragments
	SS 5		28 29 23 15 (52)				
10	SS 6		15 10 5 (15)				
	SS 7		2 1 1 (2)	oss of dr ng f u d c rcu at on at 13'			13 0 -6 8 pa e brown, wh te LIMESTONE, coarse
15	SS 8		7 7 11 (18)				
	SS 9		6 4 4 (8)				
20							

(Continued Next Page)



CLIENT Duke Energy

PROJECT NAME Energy Plant Ho cm S te

PROJECT NUMBER 300743x2

PROJECT LOCATION Crysta R ver

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
20							
				dr ng f u d c rcu at on rega ned at 22'		22 0	pa e brown, wh te LIMESTONE, coarse (continued) -15 8
25	SS 10		2 5 14 7 (19)	4 nch cas ng advanced to 25'			wh te, gray LIMESTONE
	SS 11		3 50/3"				
30	RC 1	37 (32)		oss of dr ng f u d c rcu at on at 30' dr ng f u d c rcu at on rega ned at 31'			
				oss of dr ng f u d c rcu at on at 33'			
35	SS 12		3 9 12 5 (21)				do om t c, some s t, some c ay
						37 0	-30 8
							brown, pa e brown LIMESTONE, do om t c, fr ab e
40	SS 13		1 1 2 3 (3)				some s t

GENERAL BH / P / WELL - G N S DUS LAB GD - 12/13/13 16 22 - C \ HA C RYS AL R VER 300743X2 C RYS AL R VER (2) GPJ

(Continued Next Page)

CLIENT Duke EnergyPROJECT NAME Energy Plant Home SitePROJECT NUMBER 300743x2PROJECT LOCATION Crystal River

GENERAL BH / P / WELL - GN S DUS LAB GD - 12/13/13 16 22 - C \ HA CRYSTAL RIVER 300743X2 CRYSTAL RIVER (2) GPJ

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
40							
45	SS 14		18 10 4 4 (14)				brown, pale brown LIMESTONE, dolomitic, friable (continued)
50	SS 15		3 4 7 10 (11)				
55	SS 16		0 4 3 37 (7)	WOH/12", 4, 3, 37			
	SS 17		50/1"				
							Bottom of borehole at 58.1 feet.

58.1

-51.9



CLIENT Duke Energy **PROJECT NAME** Energy Plant Ho c m S te
PROJECT NUMBER 300743x2 **PROJECT LOCATION** Crysta R ver
DATE STARTED 11/6/13 **COMPLETED** 11/6/13 **GROUND ELEVATION** 7.5 ft **HOLE SIZE** 4 nches
DRILLING CONTRACTOR Independent Dr ng, Inc. **GROUND WATER LEVELS:**
DRILLING METHOD Standard Penetrat on / Mud Rotary ☒ **AT TIME OF DRILLING** 2.00 ft / E ev 5.50 ft
LOGGED BY BB **CHECKED BY** Tha Nguyen **AT END OF DRILLING** _____
NOTES DR 33 R g CME550 Automat c Hammer **AFTER DRILLING** _____

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
0							
	SS 1		32 22 50/3"			very pa e brown, wh te LIMESTONE	
						we ndurated	
	SS 2		38 50/2"				
5	SS 3		32 37 38 37 (75)	dr ng f u d ntroduced at 4'		s ty, sandy	← benton te sea
	SS 4		22 22 29 30 (51)			very pa e brown, wh te LIMESTONE	
	SS 5		47 48 30 42 (78)			redd sh ye ow	
10	SS 6		18 15 10 (25)			s ty	
	SS 7		19 25 16 (41)			s ty, c ayey	← sand pack
15	SS 8		17 13 9 (22)			s ty, sandy	← screen
	SS 9		50/5"				
20							

(Continued Next Page)

CLIENT Duke EnergyPROJECT NAME Energy Plant Ho cm S tePROJECT NUMBER 300743x2PROJECT LOCATION Crysta R ver

GENERAL BH / P / WELL - G N S D US LAB GD - 12/13/13 16 22 - C \ HA C RYS AL R VER 300743X2 C RYS AL R VER (2) GPJ

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
20						very pale brown, white LIMESTONE (continued)	
25	SS 10		13 8 9 (17)			s ty, sandy	
30	SS 11		33 39 50/3"				
35	SS 12		32 28 10 (38)	4 inch casing installed to 35'		do om t c	
40	SS 13		50/3"	loss of drilling fluid circulation at 36'		ght redd sh brown, do om t c, fr ab e, s ty	
40 0				4 inch casing advanced to 40',			-32 5

(Continued Next Page)

CLIENT Duke EnergyPROJECT NAME Energy Plant Ho cm SitePROJECT NUMBER 300743x2PROJECT LOCATION Crysta R ver

GENERAL BH / P / WELL - G N S DUS LAB GD - 12/13/13 16 22 - C \ HA C RYS AL R VER 300743X2 C RYS AL R VER (2) GPJ

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
40							
				dr ng f u d c rcu at on rega ned oss of dr ng f u d c rcu at on at 41'		very pa e brown LIMESTONE, do om t c	
45	SS 14		4 14 18 (32)			sandy	
						46 0 -38 5	
						pa e brown LIMESTONE, do om t c, we ndurated	
50	SS 15		50/5"				
						52 0 -44 5	
						brown LIMESTONE, fr ab e. sandy, s ty	
55	SS 16		6 50/2"				
60	SS 17		18 13 28 (41)				

(Continued Next Page)



CLIENT Duke Energy

PROJECT NAME Energy Plant Home Site

PROJECT NUMBER 300743x2

PROJECT LOCATION Crystalline River

GENERAL BH / P / WELL - G N S DUS LAB GD - 12/13/13 16 22 - C \ HA \ CRYSTAL RIVER (2) GPJ

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
60						brown LIMESTONE, fr ab e. sandy, s ty (continued)	
65	SS 18		13 16 45 (61)			oca y cemented	
70	SS 19		21 45 28 (73)				
75	SS 20		50/2"			pa e brown LIMESTONE, do om t c, we ndurated	
80	SS 21		50/5"			gray to dark gray DOLOSTONE, sandy, grave y, vuggy, porous, foss ferous	

(Continued Next Page)



CLIENT Duke Energy

PROJECT NAME Energy Plant Home Site

PROJECT NUMBER 300743x2

PROJECT LOCATION Crystal River

GENERAL BH / P / WELL - G N S DUS LAB GD - 12/13/13 16 22 - C \ HA CRYSTAL RIVER 300743X2 CRYSTAL RIVER (2) GPJ

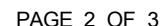
DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
80							
	RC 1	27 (7)				gray to dark gray DOLOSTONE, sandy, gravelly, vuggy, porous, fossiliferous (continued)	
85	SS 22		22 35 45 (80)				
	SS 23		50/1"				
90						90.0 very pale brown LIMESTONE, well indurated -82.5	
	SS 24		50/1"				
95							
	SS 25		50/1"			98.6 Bottom of borehole at 98.6 feet. -91.1	



CLIENT Duke Energy PROJECT NAME Energy Plant Ho c m S te
PROJECT NUMBER 300743x2 PROJECT LOCATION Crysta R ver
DATE STARTED 11/15/13 COMPLETED 11/15/13 GROUND ELEVATION 7.1 ft HOLE SIZE 4 nches
DRILLING CONTRACTOR Independent Dr ng, Inc. GROUND WATER LEVELS:
DRILLING METHOD Standard Penetrat on / Mud Rotary ∇ AT TIME OF DRILLING 4.00 ft / E ev 3.10 ft
LOGGED BY BB CHECKED BY Tha Nguyen AT END OF DRILLING _____
NOTES DR 15 R g CME55 Automat c Hammer AFTER DRILLING _____

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION
0						
	SS 1		26 26 46 30 (72)			very pa e brown, redd sh ye ow LIMESTONE, sandy
	SS 2		23 18 38 33 (56)			s ty
5	SS 3		29 50 50/2"	dr ng f u d ntroduced at 4'		oca s ty sand ens, we ndurated
	SS 4		50/5"			we ndurated
10	RC 1	65 (27)				
	SS 5		2 11 7 (18)			very pa e brown, redd sh ye ow LIMESTONE sandy and s ty
15	SS 6		5 10 10 (20)	oss of dr ng f u d c rcu at on at 13.5'		
20	SS 7		5 10 11 (21)			

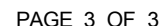
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PROJECT LOCATION Crysta River

GENERAL BH/ P /WELL -GN S DUS LABGD -12/13/13 16 22 - C \ HA \CRY S AL R VER\300743X2 CRY S AL R VER (2)GPJ

(Continued Next Page)



PROJECT LOCATION Crysta River

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION
40						
						pa e brown LIMESTONE, s ty, fr ab e
45	SS 12		41 47 50/5"			do om t c
	SS 13		50/5"			
50					50 0	pa e brown LIMESTONE, do om t c, wea ky ndurated -42 9
	SS 14		30 10 9 (19)			
55					56 0	pa e brown LIMESTONE, do om t c, we ndurated -48 9
	SS 15		50/3"		58 8	Bottom of borehole at 58.8 feet. -51 7

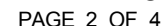
**BORING NUMBER B-25**

PAGE 1 OF 4

CLIENT Duke Energy **PROJECT NAME** Energy Plant Ho cm Site
PROJECT NUMBER 300743x2 **PROJECT LOCATION** Crysta River
DATE STARTED 11/14/13 **COMPLETED** 11/14/13 **GROUND ELEVATION** 6.8 ft **HOLE SIZE** 4 inches
DRILLING CONTRACTOR Independent Dr ng, Inc. **GROUND WATER LEVELS:**
DRILLING METHOD Standard Penetrat on / Mud Rotary ☒ **AT TIME OF DRILLING** 2.00 ft / Elev 4.80 ft
LOGGED BY BB **CHECKED BY** Tha Nguyen **AT END OF DRILLING** _____
NOTES DR 15 R g CME55 Automat c Hammer **AFTER DRILLING** _____

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	REMARKS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0							
	SS 1		1 1 1 3 (2)		SP SM		(SP SM) dark brown fine grained quartz SAND with s t
	SS 2		33 36 50/5"				very pale brown LIMESTONE, sandy, s ty, we ndurated
	SS 3		28 50/2"	dr ng fu d ntroduced at 4'			
5	SS 4		50/3"				
	RC 1	80 (67)					
10	RC 2	80 (30)					
	SS 5		30 50/5"				
	RC 3	61 (39)					
15	SS 6		8 7 9 (16)				sandy, s ty, poor y ndurated
	SS 7		16 21 8 (29)				ndurated
20							

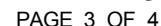
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PROJECT LOCATION Crysta River

GENERAL BH/ P /WELL -GN S DUSLABGD -12/13/13 16 22 - C \ HA \CRY S AL R VER\300743X2 CRY S AL R VER (2)GPJ

(Continued Next Page)



PROJECT LOCATION Crysta River

GENERAL BH/ P /WELL -GN S DUS LABGD -12/13/13 16 22 - C \ HA \CRY S AL R VER\300743X2 CRY S AL R VER (2)GPJ

(Continued Next Page)

PROJECT LOCATION Crysta River

[illegible]

JOB NO. **300743x2 Duke Energy Crystal River**
LOG OF ROCK CORES

B-01

DATE: 10/30/2013

SHEET 1 OF 1

ELEV	SYMBOL	SAMPLE DESCRIPTION	MAP OF JOINTS	DEPTH SCALE	SAMPLES			TIME MIN:SEC	WATER PRESSURE	REMARKS (DRILLING FLUID, DEPTH OF CASING, CASING BLOWS, FLUID LOSS, ETC.)
					TYPE #	RECOVER FT.	RQD			
				19						
				20				0:22	<100 psi	
				21				1:04	150 psi	
				22				0:38	100 psi	
				23				0:12	<100 psi	
				24				0:55	200 psi	

pale brown, pale yellow L MESTONE, indurated, locally friable, micritic, sand to silt sized grains, intragranular to vuggy porosity



Picture scale: 1V:2H

For detailed, clearer pictures, refer to Appendix E

JOB NO. **300743x2 Duke Energy Crystal River**
LOG OF ROCK CORES

B-03

DATE: 11/14/2013

SHEET 1 OF 1

ELEV	SYMBOL	SAMPLE DESCRIPTION	MAP OF JOINTS	DEPTH SCALE	SAMPLES			TIME MIN:SEC	WATER PRESSURE	REMARKS (DRILLING FLUID, DEPTH OF CASING, CASING BLOWS, FLUID LOSS, ETC.)
					TYPE #	RECOVER FT.	RQD			
		pale brown LIMESTONE, well indurated, micritic, sand to silt sized grains, intragranular to vuggy porosity, few molds		35 36 37 38 39 40	RC1	55 in / 60 in = 92 %	78%	0:40 0:55 0:58 1:07 0:40	375 psi 375 psi 375 psi 400 psi 375 psi	

Picture scale: 1V:2H

For detailed, clearer pictures, refer to Appendix E

JOB NO. 300743x2 Duke Energy Crystal River

LOG OF ROCK CORES

B-04

DATE: 11/13/2013

SHEET 1 OF 1

ELEV	SYMBOL	SAMPLE DESCRIPTION	MAP OF JOINTS	DEPTH SCALE	SAMPLES					REMARKS (DRILLING FLUID, DEPTH OF CASING, CASING BLOWS, FLUID LOSS, ETC.)
					TYPE #	RECOVER.	RQD	TIME MIN:SEC	WATER PRESSURE	
		gray, pale brown LIMESTONE, well indurated, micritic, dolomitic, intragranular, vuggy and moldic porosity		55	RC1	22 in / 30 in = 73 %	63%	1:02	375 psi	core barrel clogged
				56				1:22	375 psi	
				57				0:58	375 psi	
				58	RC2	26 in / 30 in = 87 %	70%	1:06	375 psi	
				59				1:13	375 psi	
				60				1:48	375 psi	
				61	RC3	3 in / 9 in =	0%	1:20	375 psi	core barrel clogged
				62	RC4	18 in / 21 in = 86 %	67%	1:19	375 psi	core barrel clogged
				63				0:56	375 psi	
				64	RC5	20 in / 24 in = 83%	83%	1:40	400 psi	core barrel clogged
				65				2:56	400 psi	
				66				0:45	400 psi	
		gray, pale brown LIMESTONE, well indurated, micritic, dolomitic, intragranular to vuggy porosity, few molds		67	RC6	29 in / 60 in = 48%	35%	1:26	375 psi	
				68				2:13	400 psi	
				69				0:20	400 psi	
				70				0:18	375 psi	

Picture scale: 1V:2H

For detailed, clearer pictures, refer to Appendix E

JOB NO. **300743x2 Duke Energy Crystal River**
LOG OF ROCK CORES

B-05

DATE: 11/20/2013

SHEET 1 OF 1

ELEV	SYMBOL	SAMPLE DESCRIPTION	MAP OF JOINTS	DEPTH SCALE	SAMPLES			TIME MIN:SEC	WATER PRESSURE	REMARKS (DRILLING FLUID, DEPTH OF CASING, CASING BLOWS, FLUID LOSS, ETC.)
					TYPE #	RECOVER FT.	RQD			
				24	RC1	10 in / 60 in = 17%	8%	0:14	500 psi	
		pale brown LIMESTONE, indurated, locally friable, micritic, dolomitic, silt sized grains, intragranular vuggy porosity		25				2:17	500 psi	
				26				0:03	500 psi	
				27				0:02	500 psi	
				28				0:21	500 psi	
				29						
				39	RC2	42 in / 60 in = 70%	71%	0:05	450 psi	
		pale brown LIMESTONE, well indurated, dolomitic, sand to silt sized grains, intragranular to moldic porosity, fossiliferous		40				2:30	450 psi	
				41				2:55	450 psi	
				42				4:14	450 psi	
				43				2:28	450 psi	
				44						

Picture scale: 1V:2H

For detailed, clearer pictures, refer to Appendix E

JOB NO. **300743x2 Duke Energy Crystal River**

LOG OF ROCK CORES

B-06

DATE: 11/22/2013

SHEET 1 OF 1

ELEV	SYMBOL	SAMPLE DESCRIPTION	MAP OF JOINTS	DEPTH SCALE	SAMPLES			TIME MIN:SEC	WATER PRESSURE	REMARKS (DRILLING FLUID, DEPTH OF CASING, CASING BLOWS, FLUID LOSS, ETC.)
					TYPE #	RECOVER FT.	RQD			
				54						
		pale brown LIMESTONE, indurated, locally friable, micritic, dolomitic, intragranular to vuggy porosity, few molds		55				1:31	400 psi	
				56				0:41	400 psi	
				57				0:10	400 psi	
				58				0:29	400 psi	
				59				0:21	400 psi	



Picture scale: 1V:2H

For detailed, clearer pictures, refer to Appendix E

JOB NO. **300743x2 Duke Energy Crystal River**
LOG OF ROCK CORES

B-07

DATE: 11/26/2013 and 11/27/2013

SHEET 1 OF 1

ELEV	SYMBOL	SAMPLE DESCRIPTION	MAP OF JOINTS	DEPTH SCALE	SAMPLES					REMARKS (DRILLING FLUID, DEPTH OF CASING, CASING BLOWS, FLUID LOSS, ETC.)
					TYPE #	RECOVER.	RQD	TIME MIN:SEC	WATER PRESSURE	
				49						
		very pale brown, gray L MESTONE, indurated, locally friable, micritic, dolomitic, intragranular to moldic porosity, fossiliferous		50	RC1	28 in / 60 in = 46%	79%	1:14	400 psi	
				51				2:47	400 psi	
				52				12:22	400 psi	
				53				0:05	300 psi	
				54				0:04	300 psi	
				64						
		pale brown LIMESTONE, well indurated, micritic, dolomitic, intragranular to moldic porosity, fossiliferous		65	RC2	12 in / 24 in = 50%	78%	1:30	250 psi	
				66				5:09	300 psi	

Picture scale: 1V:2H

For detailed, clearer pictures, refer to Appendix E

JOB NO. **300743x2 Duke Energy Crystal River**

LOG OF ROCK CORES

B-08

DATE: 11/8/2013

SHEET 1 OF 1

ELEV	SYMBOL	SAMPLE DESCRIPTION	MAP OF JOINTS	DEPTH SCALE	SAMPLES			TIME MIN:SEC	WATER PRESSURE	REMARKS (DRILL NG FLU D, DEPTH OF CASING, CASING BLOWS, FLUID LOSS, ETC.)
					TYPE #	RECOV.FT.	RQD			
		very pale brown L MESTONE, well indurated, micritic, slightly dolomitic, sand to silt sized grains, intragranular to vuggy porosity, few molds		49	RC1	48 in / 60 in = 80%	73%	0:46	350 psi	
				50				0:50	350 psi	
				51				0:45	350 psi	
				52				1:05	400 psi	
				53				0:24	200 psi	
				54						
		very pale brown L MESTONE, well indurated, locally friable, micritic, slightly dolomitic, sand to silt sized grains, intragranular to vuggy porosity, few molds		64	RC2	18 in / 48 in = 38%	31%	0:52	350 psi	
				65				0:32	350 psi	
				66				0:15	350 psi	
				67				0:04	350 psi	
				68						

Picture scale: 1V:2H

For detailed, clearer pictures, refer to Appendix E

DATE: 11/4/2013

SHEET 1 OF 2

ELEV	SYMBOL	SAMPLE DESCRIPTION	MAP OF JOINTS	DEPTH SCALE	SAMPLES				REMARKS (DRILLING FLUID, DEPTH OF CASING, CASING BLOWS, FLUID LOSS, ETC.)
					TYPE #	RECOVER.	RQD	TIME MIN:SEC	
				62					
		gray LIMESTONE, very well indurated, dolomitic, micritic, sand to silt sized grains, intragranular to moldic porosity		63	RC1	36 in / 60 in = 60 %	57%	-	200 psi
				64				1:04	
				65				2:10	
				66				1:28	
				67				1:15	
				68	RC2	31 in / 32 in = 97%	97%	1:53	400 psi
				69				1:52	
				70				0:39	
				71	RC3	10 in / 36 in = 28%	28%	0:04	100 psi
				72				0:11	
				73				0:56	
		Core advanced with no force, possible void or very soft/loose material (73-76 feet)		74					
				75					
				76					

JOB NO. **300743x2 Duke Energy Crystal River**
LOG OF ROCK CORES

B-09

DATE: 11/4/2013

SHEET 2 OF 2

ELEV	SYMBOL	SAMPLE DESCRIPTION	MAP OF JOINTS	DEPTH SCALE	SAMPLES					REMARKS (DRILLING FLUID, DEPTH OF CASING, CASING BLOWS, FLUID LOSS, ETC.)
					TYPE #	RECOVER.	RQD	TIME MIN:SEC	WATER PRESSURE	
				76						
		brown LIMESTONE, friable, micritic, dolomitic, silt sized grains		77	RC4	25 in / 36 in = 69 %	17%	0:04	100 psi	
		gray LIMESTONE, well indurated, intragranular to moldic porosity		78				0:11	100 psi	
				79				0:56	500 psi	
				80	RC5	12 in / 36 in = 33%	8%	0:16	200 psi	
				81				0:09	200 psi	
		brown LIMESTONE, friable, sand to silt sized grains, intragranular to moldic porosity		82				0:25	450 psi	

Picture scale: 1V:2H

For detailed, clearer pictures, refer to Appendix E

JOB NO. **300743x2 Duke Energy Crystal River**
LOG OF ROCK CORES

B-10

DATE: 11/20/2013

SHEET 1 OF 1

ELEV	SYMBOL	SAMPLE DESCRIPTION	MAP OF JOINTS	DEPTH SCALE	SAMPLES					REMARKS (DRILLING FLUID, DEPTH OF CASING, CASING BLOWS, FLUID LOSS, ETC.)
					TYPE #	RECOVER.	RQD	TIME MIN:SEC	WATER PRESSURE	
		pale brown LIMESTONE, indurated, locally friable, micritic, dolomitic, sand to silt sized grains, intragranular to vuggy porosity		64 65 66 67 68 69	RC1	42 in / 60 in = 70%	66%	1:08 1:24 0:43 0:30 0:15	375 psi 375 psi 375 psi 375 psi 375 psi	

Picture scale: 1V:2H

For detailed, clearer pictures, refer to Appendix E

JOB NO. **300743x2 Duke Energy Crystal River**
LOG OF ROCK CORES

B-12

DATE: 11/11/2013

SHEET 1 OF 4

ELEV	SYMBOL	SAMPLE DESCRIPTION	MAP OF JOINTS	DEPTH SCALE	SAMPLES			TIME MIN:SEC	WATER PRESSURE	REMARKS (DRILLING FLUID, DEPTH OF CASING, CASING BLOWS, FLUID LOSS, ETC.)
					TYPE #	RECOVER.	RQD			
				9						
		pale brown, white LIMESTONE, indurated, micritic, sand to silt sized grains, intragranular to vuggy porosity		10				0:32	350 psi	
				11				0:28	350 psi	
				12				0:41	350 psi	
				13				0:24	350 psi	
				14				0:26	350 psi	

Picture scale: 1V:2H

For detailed, clearer pictures, refer to Appendix E

JOB NO. **300743x2 Duke Energy Crystal River**

LOG OF ROCK CORES

B-12

DATE: 11/12/2013

SHEET 2 OF 4

ELEV	SYMBOL	SAMPLE DESCRIPTION	MAP OF JOINTS	DEPTH SCALE	SAMPLES			TIME MIN:SEC	WATER PRESSURE	REMARKS (DRILLING FLUID, DEPTH OF CASING, CASING BLOWS, FLUID LOSS, ETC.)
					TYPE #	RECOVER FT.	RQD			
				38						
		pale brown LIMESTONE, well indurated, micritic, dolomitic, silt sized grains, intragranular to moldic porosity		39	RC2	36 in / 60 in = 60%	60%	1:08	350 psi	
				40				0:53	350 psi	
				41				0:45	375 psi	
				42				0:19	375 psi	
				43				0:19	375 psi	
				44						
				45						
		pale brown, gray LIMESTONE, indurated, locally friable, micritic, dolomitic, silt sized grains, intragranular to moldic porosity		46	RC3	32 in / 60 in = 53%	36%	0:20	350 psi	
				47				0:33	375 psi	
				48				1:12	375 psi	
				49				2:28	375 psi	
				50				0:53	375 psi	

Picture scale: 1V:2H

For detailed, clearer pictures, refer to Appendix E

JOB NO. 300743x2 Duke Energy Crystal River

LOG OF ROCK CORES

B-12

DATE: 11/11/2013

SHEET 3 OF 4

ELEV	SYMBOL	SAMPLE DESCRIPTION	MAP OF JOINTS	DEPTH SCALE	SAMPLES				REMARKS (DRILL NG FLU D, DEPTH OF CASING, CASING BLOWS, FLUID LOSS, ETC.)
					TYPE #	RECOV.FT.	RQD	TIME MIN:SEC	
		pale brown, gray LIMESTONE, indurated, locally friable, micritic, dolomitic, silt sized grains, intragranular to moldic porosity		50	RC4	18 in / 60 in = 30%	23%		
				51				0:28	375 psi
				52				0:32	375 psi
				53				0:20	375 psi
				54				0:24	375 psi
				55				1:04	375 psi
				56	RC5	18 in / 60 in = 30%	30%	0:49	350 psi
				57				0:33	375 psi
				58				0:18	375 psi
				59				0:17	375 psi
				60				0:36	375 psi
				61	RC6	22 in / 60 in = 37%	37%	0:23	375 psi
				62				0:32	375 psi
				63				0:50	350 psi
				64				0:36	375 psi
				65				0:34	375 psi

Picture scale: 1V:2H

For detailed, clearer pictures, refer to Appendix E

JOB NO. **300743x2 Duke Energy Crystal River**
LOG OF ROCK CORES

B-12

DATE: 11/12/2013

SHEET 4 OF 4

ELEV	SYMBOL	SAMPLE DESCRIPTION	MAP OF JOINTS	DEPTH SCALE	SAMPLES			TIME MIN:SEC	WATER PRESSURE	REMARKS (DRILLING FLUID, DEPTH OF CASING, CASING BLOWS, FLUID LOSS, ETC.)
					TYPE #	RECOVER FT.	RQD			
				65						
		brown LIMESTONE, poorly indurated, locally friable, micritic, dolomitic, sand to silt sized grains, intragranular porosity		66	RC7	19 in / 60 in = 32%	23%	0:16	375 psi	
				67				0:29	375 psi	
				68				0:32	375 psi	
				69				0:22	375 psi	
				70				0:28	375 psi	

Picture scale: 1V:2H

For detailed, clearer pictures, refer to Appendix E

JOB NO. **300743x2 Duke Energy Crystal River**

LOG OF ROCK CORES

B-13

DATE: 11/21/2013

SHEET 1 OF 2

ELEV	SYMBOL	SAMPLE DESCRIPTION	MAP OF JOINTS	DEPTH SCALE	SAMPLES			TIME MIN:SEC	WATER PRESSURE	REMARKS (DRILLING FLUID, DEPTH OF CASING, CASING BLOWS, FLUID LOSS, ETC.)
					TYPE #	RECOVER.	RQD			
				44						
		pale brown LIMESTONE, indurated, locally friable, micritic, dolomitic, silt sized grains, intragranular to vuggy porosity, few molds		45	RC1	24 in / 60 in = 40%	25%	0:42	375 psi	
				46				0:57	375 psi	
				47				0:58	375 psi	
				48				1:31	375 psi	
				49				5:10	375 psi	
				50						
				51	RC2	36 in / 60 in = 60%	51%	1:48	375 psi	
				52				1:02	375 psi	
				53				1:43	375 psi	
				54				2:36	375 psi	
				55				1:23	375 psi	

Picture scale: 1V:2H

For detailed, clearer pictures, refer to Appendix E

JOB NO. **300743x2 Duke Energy Crystal River**
LOG OF ROCK CORES

B-13

DATE: 11/22/2013

SHEET 2 OF 2

ELEV	SYMBOL	SAMPLE DESCRIPTION	MAP OF JOINTS	DEPTH SCALE	SAMPLES			TIME MIN:SEC	WATER PRESSURE	REMARKS (DRILLING FLUID, DEPTH OF CASING, CASING BLOWS, FLUID LOSS, ETC.)
					TYPE #	RECOVER FT.	RQD			
				60						
		pale brown LIMESTONE, indurated, locally friable, micritic, dolomitic, silt sized grains, intragranular to moldic porosity		61	RC3	40 in / 60 in = 66%	45%	0:58	375 psi	
				62				1:02	375 psi	
				63				0:59	375 psi	
				64				0:52	375 psi	
				65				0:47	375 psi	

Picture scale: 1V:2H

For detailed, clearer pictures, refer to Appendix E

DATE: 11/12/2013

SHEET 1 OF 1

ELEV	SYMBOL	SAMPLE DESCRIPTION	MAP OF JOINTS	DEPTH SCALE	SAMPLES					REMARKS (DRILLING FLUID, DEPTH OF CASING, CASING BLOWS, FLUID LOSS, ETC.)
					TYPE #	RECOVER.	RQD	TIME MIN:SEC	WATER PRESSURE	
		very pale brown, light gray LIMESTONE, variably indurated		54	RC1	15 in / 54 in = 28%	0%	1:33	350 psi	
				55				2:38	40 psi	
				56				1:21	400 psi	
				57				1:41	400 psi	
				58				2:30	400 psi	
				59						
		very pale brown, light gray LIMESTONE, well indurated, locally friable, micritic, dolomitic, sand to silt sized grains, intragranular to vuggy porosity		60	RC2	39 in / 60 in = 65%	79%	0:05	400 psi	
				61				10:11	400 psi	
				62				6:39	400 psi	
				63				3:44	400 psi	
				64				2:29	400 psi	
				65						
		very pale brown LIMESTONE, well indurated, locally friable, micritic, dolomitic, sand to silt sized grains, intragranular to vuggy porosity		66	RC3	19 in / 60 in = 89%	89%	0:46	400 psi	
				67				3:36	400 psi	
				68				5:03	400 psi	
				69				0:07	400 psi	
				70				0:05	400 psi	

Picture scale: 1V:2H

For detailed, clearer pictures, refer to Appendix E

JOB NO. **300743x2 Duke Energy Crystal River**

LOG OF ROCK CORES

B-16

DATE: 11/19/2013

SHEET 1 OF 1

ELEV	SYMBOL	SAMPLE DESCRIPTION	MAP OF JOINTS	DEPTH SCALE	SAMPLES			TIME MIN:SEC	WATER PRESSURE	REMARKS (DRILL NG FLU D, DEPTH OF CASING, CASING BLOWS, FLUID LOSS, ETC.)
					TYPE #	RECOV.FT.	RQD			
				44						
		very pale brown L MESTONE, indurated, locally friable, micritic, dolomitic, silt sized grains, intragranular to moodic porosity		45	RC1	17 in / 60 in = 28%	59%	0:39	375 psi	
				46				0:24	375 psi	
				47				0:08	375 psi	
				48				0:49	375 psi	
				49				1:30	375 psi	
				50						
				51	RC2	31 in / 60 in = 52%	48%	1:13	375 psi	
				52				0:07	375 psi	
				53				0:19	375 psi	
				54				1:37	375 psi	
								2:38	375 psi	

Picture scale: 1V:2H

For detailed, clearer pictures, refer to Appendix E

JOB NO. **300743x2 Duke Energy Crystal River**
LOG OF ROCK CORES

B-18

DATE: 11/7/2013

SHEET 1 OF 1

ELEV	SYMBOL	SAMPLE DESCRIPTION	MAP OF JOINTS	DEPTH SCALE	SAMPLES			TIME MIN:SEC	WATER PRESSURE	REMARKS (DRILLING FLUID, DEPTH OF CASING, CASING BLOWS, FLUID LOSS, ETC.)
					TYPE #	RECOVER.	RQD			
				45	RC1	18 in / 60 in = 30%	30%			
				46				0:21	400 psi	
				47				0:36	400 psi	
				48				0:26	400 psi	
				49				1:19	400 psi	
		pale brown LIMESTONE, indurated, friable, micritic, dolomitic, silt sized grains, intragranular to vuggy porosity		50				1:13	400 psi	
				51						
		sub-saver broke, 4" core barrel could not be retrieved from bottom of boring		52	RC2	0 in / 52 in = 0%	0%	0:28	400 psi	
				53				1:48	400 psi	
				54				1:24	400 psi	
				55				0:19	400 psi	
				56				2:33	400 psi	

Picture scale: 1V:2H

For detailed, clearer pictures, refer to Appendix E

JOB NO. **300743x2 Duke Energy Crystal River**
LOG OF ROCK CORES

B-19

DATE: 10/30/2013

SHEET 1 OF 1

ELEV	SYMBOL	SAMPLE DESCRIPTION	MAP OF JOINTS	DEPTH SCALE	SAMPLES				REMARKS (DRILLING FLUID, DEPTH OF CASING, CASING BLOWS, FLUID LOSS, ETC.)
					TYPE #	RECOVER.	RQD	TIME MIN:SEC	
		pale brown to brown LIMESTONE, friable, sand to silt sized grains, intragranular porosity		15	RC1	6 in	0	3:13	Attempted 4 inch core from 15 feet. Rig began standing up.
				16					
				17					

Picture scale: 1V:2H

For detailed, clearer pictures, refer to Appendix E

JOB NO. **300743x2 Duke Energy Crystal River**
LOG OF ROCK CORES

B-22

DATE: 11/15/2013

SHEET 1 OF 1

ELEV	SYMBOL	SAMPLE DESCRIPTION	MAP OF JOINTS	DEPTH SCALE	SAMPLES			TIME MIN:SEC	WATER PRESSURE	REMARKS (DRILLING FLUID, DEPTH OF CASING, CASING BLOWS, FLUID LOSS, ETC.)
					TYPE #	RECOVER.	RQD			
				29						
		pale brown, white LIMESTONE, well indurated, micritic		30				4:48	500 psi	
				31				0:48	375 psi	
				32				0:44	375 psi	
				33				0:31	375 psi	
				34				0:23	375 psi	

Picture scale: 1V:2H

For detailed, clearer pictures, refer to Appendix E

JOB NO. **300743x2 Duke Energy Crystal River**

LOG OF ROCK CORES

B-23

DATE: 11/17/2013

SHEET 1 OF 1

ELEV	SYMBOL	SAMPLE DESCRIPTION	MAP OF JOINTS	DEPTH SCALE	SAMPLES			TIME MIN:SEC	WATER PRESSURE	REMARKS (DRILLING FLUID, DEPTH OF CASING, CASING BLOWS, FLUID LOSS, ETC.)
					TYPE #	RECOVER FT.	RQD			
				79						
		gray LIMESTONE, poorly indurated to indurated, micritic, dolomitic, intragranular to vuggy porosity		80				0:12	200 psi	
				81				0:13	200 psi	
				82				0:21	200 psi	
				83				0:14	200 psi	
				84				0:22	200 psi	



Picture scale: 1V:2H

For detailed, clearer pictures, refer to Appendix E

JOB NO. 300743x2 Duke Energy Crystal River					LOG OF ROCK CORES				B-24		
DATE: 11/15/2013					SHEET 1 OF 1						
ELEV	SYMBOL	SAMPLE DESCRIPTION	MAP OF JOINTS	DEPTH SCALE	SAMPLES				REMARKS (DRILLING FLUID, DEPTH OF CASING, CASING BLOWS, FLUID LOSS, ETC.)		
					TYPE #	RECOVER FT.	RQD	TIME MIN:SEC			WATER PRESSURE
				6							
		very pale brown L MESTONE, poorly indurated, micritic, sand to silt sized grains, intragranular to moldic porosity, fossiliferous		7	RC1	39 in / 60 in = 65%	26%	4:49	400 psi		
			8	1:50				400 psi			
			9	1:21				400 psi			
			10	0:53				400 psi			
			11	0:28				400 psi			

Picture scale: 1V:2H

For detailed, clearer pictures, refer to Appendix E

JOB NO. **300743x2 Duke Energy Crystal River**
LOG OF ROCK CORES

B-25

DATE: 11/14/2013

SHEET 1 OF 1

ELEV	SYMBOL	SAMPLE DESCRIPTION	MAP OF JOINTS	DEPTH SCALE	SAMPLES				REMARKS (DRILLING FLUID, DEPTH OF CASING, CASING BLOWS, FLUID LOSS, ETC.)
					TYPE #	RECOVER.	RQD	TIME MIN:SEC	
		very pale brown L MESTONE, well indurated, micritic, sand to silt sized grains, intragranular to vuggy porosity, fossiliferous		6 7 8	RC1	24 in / 30 in = 80%	83%	2:28 4:42 1:34	400 psi 500 psi 500 psi
		very pale brown L MESTONE, poorly indurated, micritic, sand to silt sized grains, intragranular to vuggy porosity, fossiliferous		9 10 11	RC2	24 in / 30 in = 80%	15%	0:30 0:48 1:05	500 psi 500 psi 500 psi
		very pale brown, reddish yellow LIMESTONE, poorly indurated, locally weathered, micritic, sand to silt sized grains, intragranular to vuggy porosity, fossiliferous		12 13 14 15 16 17	RC3	36 in / 60 in = 60%	64%	0:46 0:49 0:43 0:39 0:52	400 psi 400 psi 400 psi 400 psi 400 psi

Picture scale: 1V:2H

For detailed, clearer pictures, refer to Appendix E

APPENDIX E

Rock Core Photographs



Photograph #1: Limestone Core RC-1, Boring B-19.
Core Length Attempted: 6-in; Recovery: 4-in
Consistency: Very dense (SPT N = 50/4" and 50/3" for the spoons above and below RC-1),
but friable LIMESTONE

			
	B-01 RC1 19 to 24 ft	B-03 RC1 35 to 40 ft	B-04 RC1 55 to 57.5 ft
Attempted	60-in	60-in	30-in
Recovery	6-in (10%)	55-in (92%)	22-in (73%)
Qu	1702 psi = 123 tsf	3044 psi = 219 tsf	1722 psi = 124 tsf
Qt	N/A	N/A	N/A
Unit Weight γ	141.9 pcf	139.9 pcf	149.6 pcf
Dry γ	N/A	N/A	N/A

			
	B-04 RC2 57.5 to 60 ft	B-04 RC3 60 to 60.75 ft	B-04 RC4 60.8 to 62.5 ft
Attempted	30-in	9-in	21-in
Recovery	26-in (87%)	3-in (33%)	18-in (86%)
Qu	6414 psi = 462 tsf	N/A	N/A
Qt	257 psi	N/A	606 psi
Unit Weight γ	138.8 to 153.4 pcf	N/A	157.6 pcf
Dry γ	142.4 pcf	N/A	N/A

			
	B-04 RC5 62.5 to 64.5 ft	B-04 RC6 65 to 70 ft	B-05 RC1 24 to 29 ft
Attempted	24-in	60-in	60-in
Recovery	20-in (83%)	29-in (48%)	10-in (17%)
Qu	1392 psi = 100 tsf	N/A	N/A
Qt	N/A	N/A	48 psi
Unit Weight γ	156.1 to 156.4 pcf	N/A	134.8 pcf
Dry γ	144.3 cf	N/A	N/A

			
	B-05 RC2 39 to 44 ft	B-06 RC1 54 to 59 ft	B-07 RC1 49 to 54 ft
Attempted	60-in	60-in	60-in
Recovery	42-in (27%)	25-in (38%)	28-in (46%)
Qu	4647 psi = 335 tsf	N/A	N/A
Qt	102 psi	N/A	312 psi
Unit Weight γ	132.9 to 140.5 pcf	N/A	139.0 pcf
Dry γ	N/A	N/A	N/A

			
	B-07 RC2 64 to 66 ft	B-08 RC1 49 to 54 ft	B-08 RC2 64 to 68 ft
Attempted	24-in	60-in	48-in
Recovery	12-in (50%)	48-in (80%)	18-in (38%)
Qu	N/A	4132 psi = 298 tsf	4295 psi = 309 tsf
Qt	N/A	265 to 486 psi	553 psi
Unit Weight γ	N/A	141.9 to 142.6 pcf	154.5 pcf
Dry γ	N/A	N/A	N/A

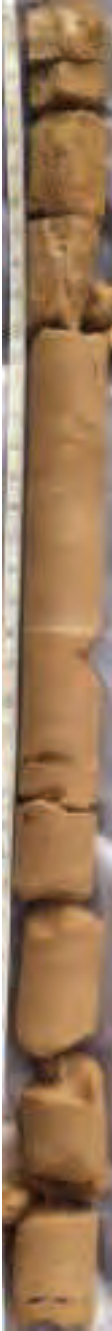
			
	B-09 RC1 62 to 67 ft	B-09 RC2 67 to 69.8 ft	B-09 RC3 70 to 73 ft
Attempted	60-in	32-in	36-in
Recovery	36-in (60%)	31-in (97%)	10-in (28%)
Qu	9010 psi = 649 tsf	8197 psi = 590 tsf	N/A
Qt	591 psi	869 psi	N/A
Unit Weight γ	151.7 to 155.0 pcf	152.9 to 158.2 pcf	N/A
Dry γ	N/A	145.5 pcf	N/A

	Very soft, porous, fossiliferous silty limestone inside the wrap 		
	B-09 RC4 76-79 ft	B-09 RC5 79 to 82 ft	B-10 RC1 64 to 69 ft
Attempted	36-in	36-in	60-in
Recovery	25-in (69%)	12-in (33%)	42-in (70%)
Qu	N/A	N/A	330 psi = 23.8 tsf
Qt	841 psi	N/A	212 psi
Unit Weight γ	152.9 pcf	N/A	116.5 to 136.8 pcf
Dry γ	N/A	N/A	N/A

			
	B-12 RC1 9 to 14 ft	B-12 RC2 38 to 43 ft	B-12 RC3 45 to 50 ft
Attempted	60-in	60-in	60-in
Recovery	19-in (32%)	36-in (60%)	32-in (53%)
Qu	N/A	3700 to 3905 psi = 266 to 281 tsf	7824 psi = 563 tsf
Qt	320 psi	537 psi	214 psi
Unit Weight γ	134.3 pcf	141.1 to 163.2 pcf	138.2 to 165.1 pcf
Dry γ	N/A	115.9 pcf	N/A

			
	B-12 RC4 50 to 55 ft	B-12 RC5 55 to 60 ft	B-12 RC6 60 to 65 ft
Attempted	60-in	60-in	60-in
Recovery	18-in (30%)	18-in (30)	22-in (37%)
Qu	N/A	1586 to 2936 psi = 114 to 211 tsf	6000 psi = 432 tsf
Qt	N/A	426 psi	194 psi
Unit Weight γ	N/A	144.4 to 149.6 pcf	143.8 to 153.7 pcf
Dry γ	N/A	N/A	144.4 pcf

			
	B-12 RC7 65 to 70 ft	B-13 RC1 44 to 49 ft	B-13 RC2 50 to 55 ft
Attempted	60-in	60-in	60-in
Recovery	19-in (32%)	24-in (40%)	36-in (60%)
Qu	N/A	N/A	2351 psi = 169 tsf
Qt	78 psi	N/A	N/A
Unit Weight γ	125.2 pcf	N/A	149.5 pcf
Dry γ	N/A	N/A	N/A

			
	B-13 RC3 60 to 65 ft	B-14 RC1 54 to 58.5 ft	B-14 RC2 59.5 to 64.5 ft
Attempted	60-in	54-in	60-in
Recovery	40-in (66%)	15-in (28%)	39-in (65%)
Qu	N/A	N/A	7747 psi = 558 tsf
Qt	269 psi	N/A	N/A
Unit Weight γ	139.1 pcf	N/A	158.1 pcf
Dry γ	N/A	N/A	N/A

			
	B-14 RC3 65 to 70 ft	B-16 RC1 44 to 49 ft	B-16 RC2 49.5 to 54.5 ft
Attempted	60-in	60-in	60-in
Recovery	19-in (32%)	17-in (28%)	31-in (52%)
Qu	3623 psi = 261 tsf	N/A	4752 psi = 342 tsf
Qt	N/A	147 psi	753 psi
Unit Weight γ	149.4 pcf	134.4 pcf	143.9 to 150.7 pcf
Dry γ	N/A	N/A	N/A

			
	B-18 RC1 45-50 ft	B-18 51.5 to 56.0 ft	B-19 RC1 15 to 15.5 ft
Attempted	60-in	N/A	6-in
Recovery	18-in (30%)	Lost core barrel	4-in
Qu	3027 psi = 218 tsf	N/A	N/A
Qt	219 psi	N/A	N/A
Unit Weight γ	142.8 to 145.4 pcf	N/A	N/A
Dry γ	N/A	N/A	N/A

			
	B-22 RC1 29 to 34 ft	B-23 RC1 79 to 84 ft	B-24 RC2 6.5 to 11.5 ft
Attempted	60-in	60-in	60-in
Recovery	22-in (37%)	16-in (27%)	39-in (65%)
Qu	N/A	N/A	N/A
Qt	226 psi	520 psi	N/A
Unit Weight γ	130.1 pcf	136.1 pcf	N/A
Dry γ	N/A	N/A	N/A

			
	B-25 RC1 6 to 8.5 ft	B-25 RC2 8.5 to 11 ft	B-25 RC3 12 to 17 ft
Attempted	30-in	30-in	60-in
Recovery	24-in (83%)	24-in (15%)	36-in (64%)
Qu	297 psi = 21 tsf	N/A	N/A
Qt	N/A	N/A	288 psi
Unit Weight γ	113.7 pcf	N/A	123.3 pcf
Dry γ	N/A	N/A	N/A

APPENDIX F

Laboratory Test Results



SUMMARY OF LABORATORY TEST RESULTS
For: Moisture Content, Wet Sieve Analyses, Atterberg Limits
ASTM D2216, D4643, C117, D1140, D4318

Client: Duke Energy
Address: _____
Project: Energy Plant - Holcim Site
Location: Crystal River, Florida

Project #: 300743x2.2
Requested By: Thai Nguyen
Tested By: Elmer Wilson
Checked By: Thai Nguyen

Test Date	Bore Hole # Sample ID & Depth (ft)	Solids Content (%)	Moisture Content (%)	% Finer #200 Sieve (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Estimated % Finer Than #40 (%)
11/7/13	B-01; SS7; 13.5 - 15.0	80.6	24.1	98.5		NP		
11/7/13	B-09; SS3; 4.0 - 6.0	83.1	20.3	21.4				
11/7/13	B-19 SS3 4.0 - 6.0	85.9	16.4	16.6				
11/7/13	B-19; RC1; 15.0 - 15.5	90.1	11.0	72.5				
11/7/13	B-19; SS9; 18.5 - 20.0	81.4	22.8	82.5		NP		
11/14/13	B-02; SS1; 0.0 - 2.0	81.3	22.9	22.5				
11/14/13	B-02; SS6-7; 11.0 - 15.0	79.1	26.5	15.2				
12/6/13	B-25; SS11; 38.5 - 40.0	68.0	47.0	93.3		NP		97
12/6/13	B-04; SS-11; 28.0 - 30.0	56.5	76.9	79.6	126	NP		93

Client: **Duke Energy**
 Address:
 Project #: 300743x2.2
 Project: Energy Plant - Holcim Site
 Location: Crystal River, Florida

Requested: Thai Nguyen
 Tested: Elmer Wilson
 Checked: Thai Nguyen

Sieve #	Size (mm)	% Finer
3 "	76.2	
2 "	50.8	
1.5 "	38.1	
1 "	25.4	100
3/4 "	19.05	97
3/8 "	9.5	83
# 4	4.75	71
# 8	2.36	58
# 16	1.18	47
# 30	0.6	38
# 50	0.3	30
# 100	0.15	22
# 200	0.075	17

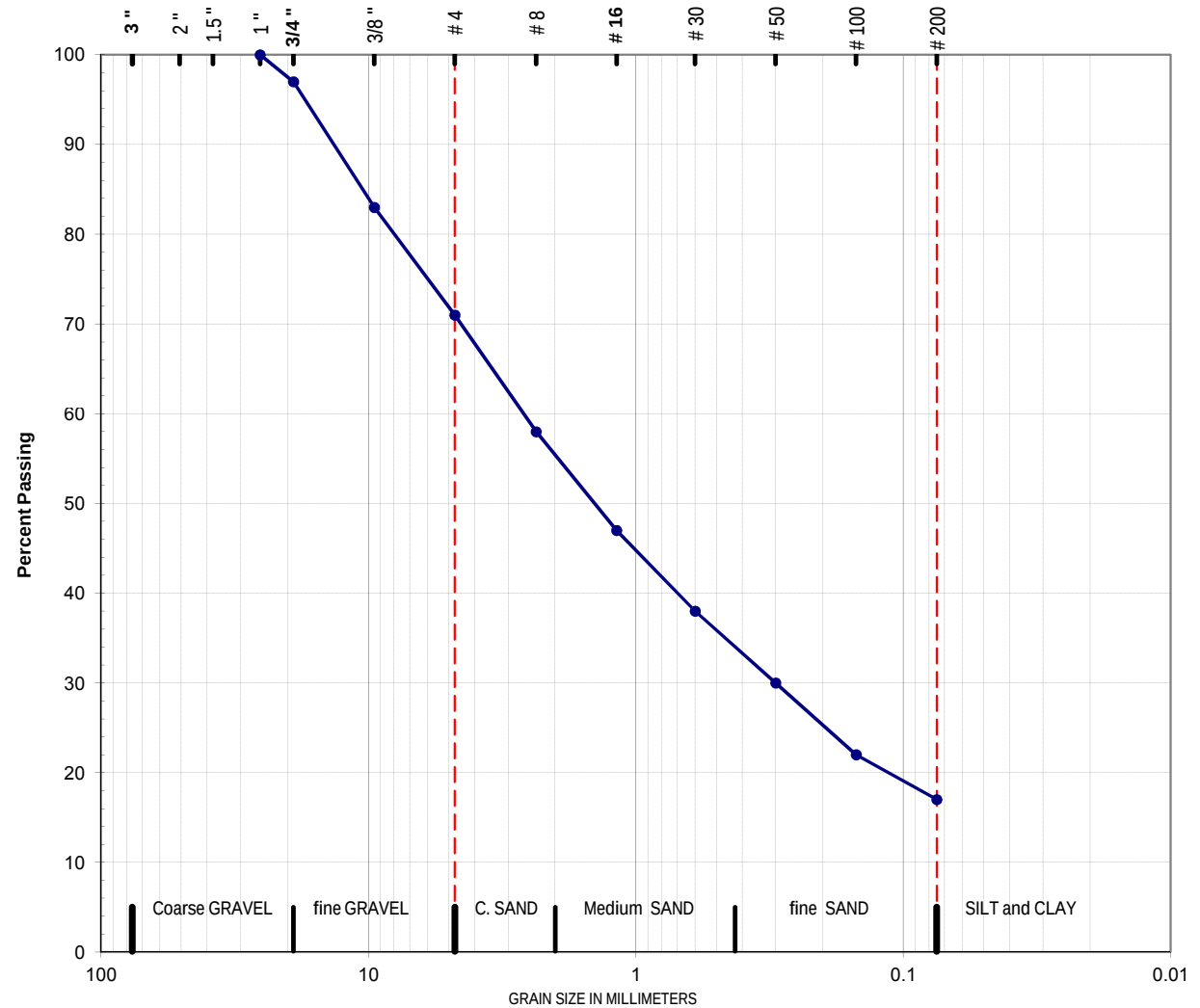
Rec #: 1

D60 ≈ 2.63 mm
 D30 ≈ 0.30 mm
 D10 ≈ mm
 D90 ≈ 13.45 mm
 D50 ≈ 1.43 mm
 Cu ≈
 Cc ≈

Particle Size Analysis - ASTM C136, D421 & D422



Bore Hole #: B-19 Sample ID SS3 Depth (ft) 4.0 USCS:
 Description: Pale yellowish brown LIMESTONE, sand to gravel-grained size % Moisture: 16.4
 Date Tested: 11/7/13



Client: **Duke Energy**
 Address:
 Project #: 300743x2.2
 Project: Energy Plant - Holcim Site
 Location: Crystal River, Florida

Requested: Thai Nguyen
 Tested: Elmer Wilson
 Checked: Thai Nguyen

Sieve #	Size (mm)	% Finer
3 "	76.2	
2 "	50.8	
1.5 "	38.1	
1 "	25.4	
3/4 "	19.05	100
3/8 "	9.5	99
# 4	4.75	99
# 8	2.36	99
# 16	1.18	99
# 30	0.6	98
# 50	0.3	94
# 100	0.15	91
# 200	0.075	83

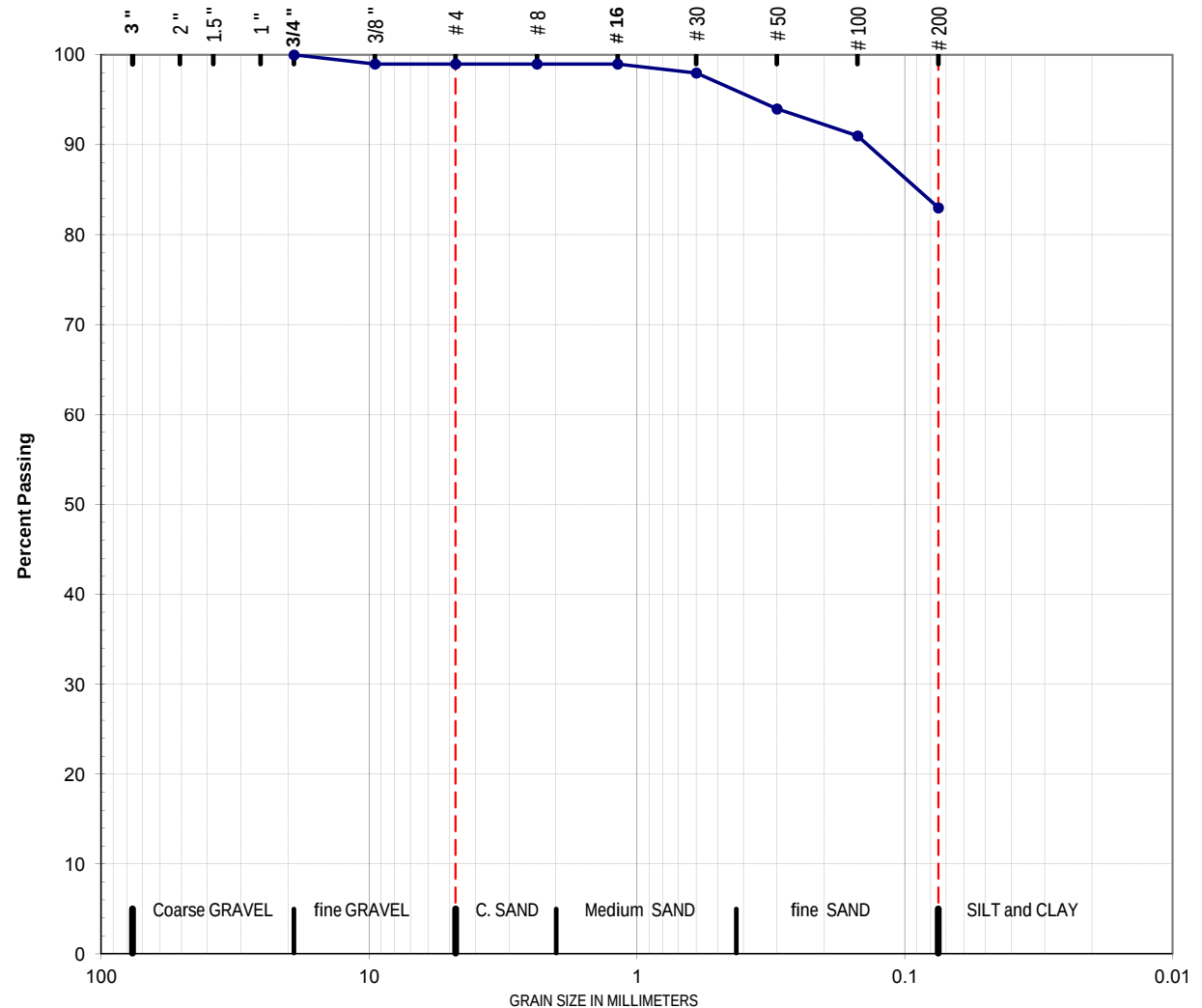
Rec #: 2

D60 ≈ 0.07 mm
 D30 ≈ 0.06 mm
 D10 ≈ mm
 D90 ≈ 0.14 mm
 D50 ≈ 0.06 mm
 Cu ≈
 Cc ≈

Particle Size Analysis - ASTM C136, D421 & D422



Bore Hole #: B-19 Sample ID RC1 Depth (ft) 15.0 USCS:
 Description: Pale brown LIMESTONE, silt-grained size, friable % Moisture: 11.0
 Date Tested: 11/7/13



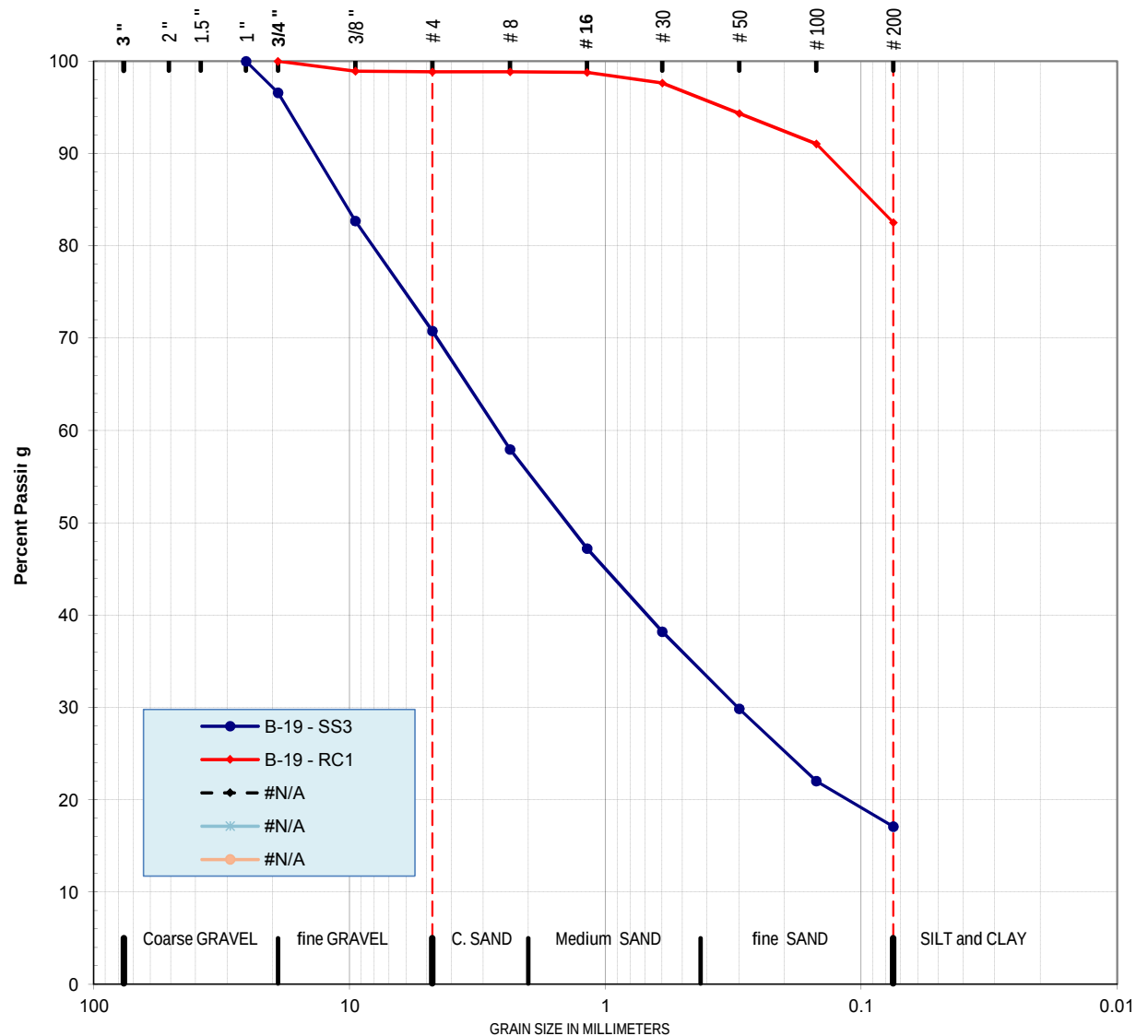
Client: Duke Energy
Address:
Project #: 300743x2.2
Project: Energy Plant - Holcim Site
Location: Crystal River, Florida
Requested: Thai Nguyen

Rec #	Bore Hole #	Sample ID	Depth (ft)	
1	B-19	SS3	4.0	6.0
2	B-19	RC1	15.0	15.5

Tested By: Elmer Wilson

Checked By: Thai Nguyen

Particle Size Analysis - ASTM C136, D421 & D422



LIMESTONE LABORATORY TEST RESULTS

* Unconfined Compressive Strength of Rock Cores (ASTM D 7012)

* Split Tensile Testing of Rock Cores (ASTM D 3967)



ID	Depth (ft)	Dated Tested	Technician	D1 (in)	D2 (in)	D3 (in)	L1 (in)	L2 (in)	L3 (in)	Tested Length w/ Cap	Weight (gr)	Dry Weight (gr)	Time 1 (minutes)	Load when Crack (lbs)	Time 2 (minutes)	Fail Load (lbs)	Fracture Type	Unit Weight γ (pcf)	Dry γ (pcf)	QT (psi)	QU (psi)
B-01 RC1	19.0-24.0	11/4/13	EW/JI	2.445	2.435	2.447	2.278	2.243	2.343	2.626	400.1	x	8:00	7800	10:00	9241	1	141.9			1702
B-09 RC1	62.0-67.0	11/4/13	EW/JI	2.445	2.451	2.443	3.461	3.468	3.479	3.718	650.5	x	13:00	44996	13:00	44996	1	151.7			9010
		11/16/13	CC	2.447	2.444	2.439	4.850	4.849	4.849	x	927.2	x	x	x	x	11000	x	155.0		591	
B-09 RC2	67.0-69.8	11/4/13	EW/JI	2.447	2.447	2.430	4.817	4.838	4.841	5.042	910.0	x	8:00	39138	8:00	39138	2	152.9			8197
		11/4/13	EW/JI	2.439	2.444	2.438	1.404	1.402	1.400	x	265.3	250.9	x	x	x	x	x	153.8	145.5		
		11/16/13	CC	2.444	2.444	2.444	3.537	3.549	3.540	x	691.7	x	x	x	x	11820	x	158.2		869	
B-09 RC4	76.0-79.0	11/16/13	CC	2.448	2.434	2.426	4.904	4.884	4.898	x	917.5	x	x	x	x	15760	x	152.9		841	
B-08 RC1	49.0-54.0	11/12/13	JL	2.450	2.430	2.420	x	x	x	4.950	x	x	4:48	19100	4:59	19600	1				4132
		11/16/13	CC	2.424	2.428	2.438	3.181	3.152	3.081	x	543.2	x	x	x	x	5820	x	141.9		486	
		11/16/13	CC	2.386	2.415	2.373	3.899	3.954	3.980	x	664.5	x	x	x	x	3920	x	142.6		265	
B-08 RC2	64.0-68.0	11/12/13	JL	2.430	2.450	2.430	x	x	x	6.100	x	x	13:33	19951	13:51	20430	1				4295
		11/16/13	CC	2.437	2.440	2.447	3.951	3.954	3.997	x	754.8	x	x	x	x	8410	x	154.5		553	
B-18 RC1	45.0-50.0	11/12/13	JL	3.925	3.910	3.910	3.800	3.790	3.750	4.360	1,740.2	x	6:42	41760	6:42	41760	3	145.4			3027
		11/16/13	CC	3.901	3.930	3.937	3.158	3.189	3.225	x	1,448.4	x	x	x	x	4300	x	142.8		219	
B-23 RC1	79.0-84.0	11/16/13	CC	2.447	2.424	2.435	2.213	2.245	2.282	x	374.7	x	x	x	x	4470	x	136.1		520	
B-04 RC1	55.0-57.5	11/15/13	EW/JI	2.440	2.430	2.430	4.480	4.480	4.470	4.751	819.0	x	4:54	8250	4:54	8250	1	149.6			1722
B-04 RC2	57.5-60.0	11/15/13	EW/JI	2.440	2.440	2.440	4.882	4.888	4.878	5.123	921.2	x	5:57	30590	5:57	30590	1	153.4			6414
		11/15/13	EW/JI	2.435	2.432	2.432	2.287	2.280	2.313		429.7	399.4						153.2	142.4		
		11/25/13	CC	2.427	2.427	2.427	2.970	2.970	2.970	x	501.6	x	x	x	x	2910	x	138.8		257	

LIMESTONE LABORATORY TEST RESULTS

* Unconfined Compressive Strength of Rock Cores (ASTM D 7012)

* Split Tensile Testing of Rock Cores (ASTM D 3967)



ID	Depth (ft)	Dated Tested	Technician	D1 (in)	D2 (in)	D3 (in)	L1 (in)	L2 (in)	L3 (in)	Tested Length w/ Cap	Weight (gr)	Dry Weight (gr)	Time 1 (minutes)	Load when Crack (lbs)	Time 2 (minutes)	Fail Load (lbs)	Fracture Type	Unit Weight γ (pcf)	Dry γ (pcf)	QT (psi)	QU (psi)
B-04 RC4	60.8-62.5	11/25/13	CC	2.427	2.427	2.427	2.857	2.857	2.857	x	547.9	x	x	x	x	6600	x	157.6		606	
B-04 RC5	62.5-64.5	11/15/13	EWJI	2.370	2.360	2.360	4.886	4.827	4.892	4.955	878.5	x	8:10	6230	8:25	6230	2	156.4			1392
		11/15/13	EWJI	2.408	2.407	2.406	1.277	1.290	1.276		239.3	221.3						156.1	144.3		
B-12 RC1	9.0-14.0	11/25/13	CC	2.426	2.426	2.426	3.100	3.100	3.100	x	506.2	x	x	x	x	3780	x	134.3		320	
B-12 RC2	38.0-43.0	11/15/13	EWJI	2.400	2.400	2.400	3.890	3.890	3.900	4.151	756.3	x	4:22	17600	5:14	17600	2	163.2			3700
		11/15/13	EWJI	2.360	2.300	2.360	3.628	3.645	3.646	4.789	585.2	x	4:36	17130	4:56	17130	3	142.1			3905
		11/15/13	EWJI	2.419	2.375	2.393	2.560	2.544	2.553		427.0	350.7						141.1	115.9		
		11/25/13	CC	2.435	2.435	2.435	2.936	2.936	2.936	x	556.8	x	x	x	x	6030	x	154.8		537	
B-12 RC3	45.0-50.0	11/25/13	CC	2.415	2.415	2.415	2.302	2.302	2.302	x	383.2	x	x	x	x	1870	x	138.2		214	
		11/15/13	EWJI	2.400	2.400	2.400	3.720	3.720	3.710	4.032	730.1	x	6:43	37220	6:43	37220	3	165.1			7824
B-12 RC5	55.0-60.0	11/25/13	CC	2.443	2.443	2.443	3.070	3.070	3.070	x	566.3	x	x	x	x	5020	x	149.6		426	
		11/15/13	EWJI	2.400	2.390	2.410	4.876	4.896	4.897	5.238	850.0	x	6:40	13550	6:40	13550	2	146.1			2936
		11/15/13	EWJI	2.410	2.410	2.400	3.190	3.200	3.200	5.170	552.4	x	4:20	7360	4:41	7360	1	144.4			1586
B-12 RC6	60.0-65.0	11/15/13	EWJI	2.370	2.370	2.370	4.971	4.996	4.986	5.180	889.0	x	11:23	27000	11:23	27000	2	153.7			6000
		11/15/13	EWJI	2.435	2.387	2.410	1.539	1.532	1.522		278.8	247.2						151.7	134.5		
		11/25/13	CC	2.425	2.425	2.425	2.889	2.889	2.889	x	506.9	x	x	x	x	2130	x	144.4		194	

LIMESTONE LABORATORY TEST RESULTS

* Unconfined Compressive Strength of Rock Cores (ASTM D 7012)

* Split Tensile Testing of Rock Cores (ASTM D 3967)

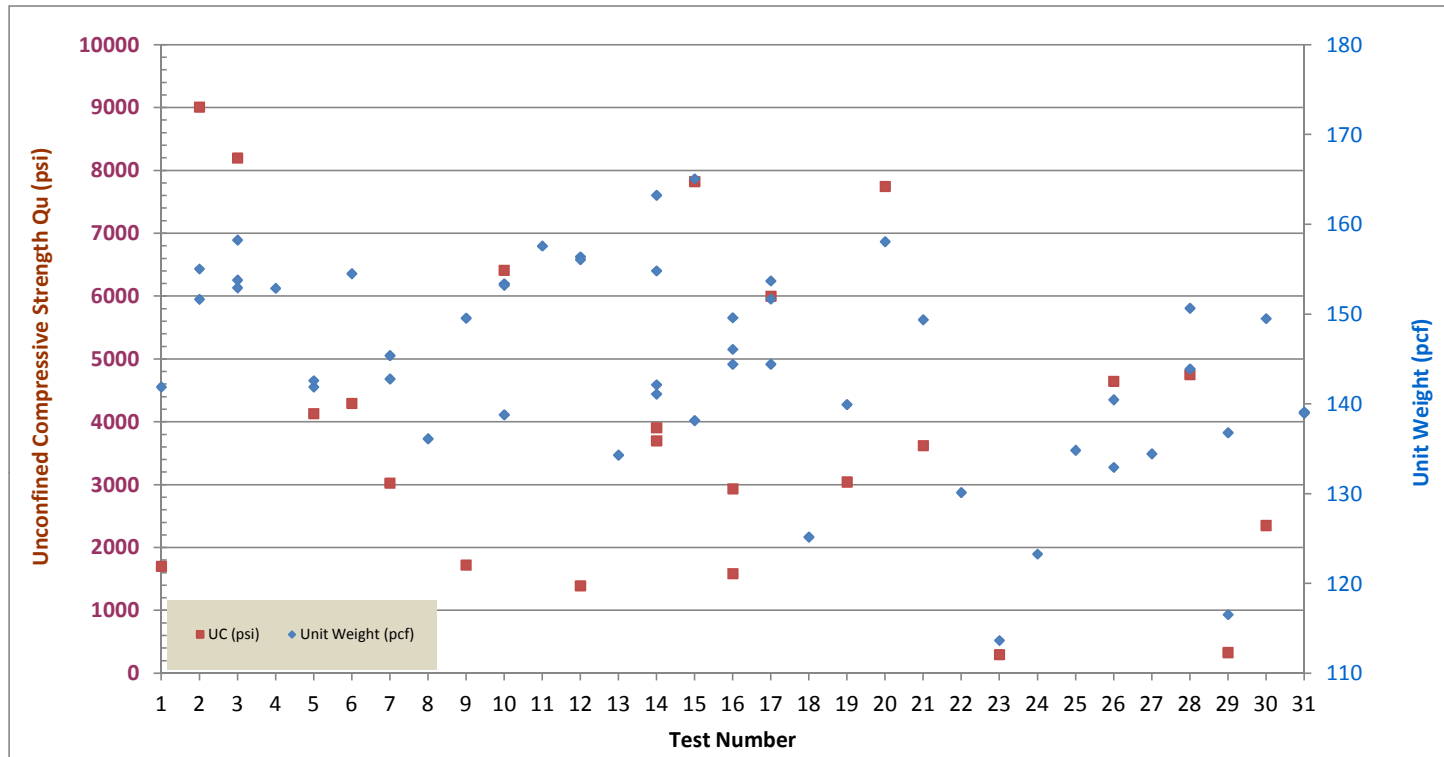


ID	Depth (ft)	Dated Tested	Technician	D1 (in)	D2 (in)	D3 (in)	L1 (in)	L2 (in)	L3 (in)	Tested Length w/ Cap	Weight (gr)	Dry Weight (gr)	Time 1 (minutes)	Load when Crack (lbs)	Time 2 (minutes)	Fail Load (lbs)	Fracture Type	Unit Weight γ (pcf)	Dry γ (pcf)	QT (psi)	QU (psi)
B-12 RC7	65.0-70.0	11/25/13	CC	2.405	2.405	2.405	2.182	2.182	2.182	x	326.4	x	x	x	x	640	x	125.2		78	
B-03 RC1	35.0-40.0	11/22/13	EW	2.390	2.400	2.400	4.500	4.580	4.560	4.780	755.0	x	3:48	14150	3:48	14150	1	139.9			3044
B-14 RC2	59.5-64.5	11/22/13	EW	2.470	2.480	2.480	4.770	4.760	4.770	5.000	954.9	x	3:37	38070	3:37	38070	1	158.1			7747
B-14 RC3	65.0-70.0	11/22/13	EW	2.460	2.480	2.460	4.800	4.800	4.800	5.040	901.3	x	2:50	17660	2:50	17660	1	149.4			3623
B-22 RC1	29.0-34.0	12/12/13	CC	2.367	2.367	2.367	3.024	3.024	3.024	x	455.5	x	x	x	x	2540	x	130.1		226	
B-25 RC1	6.0-8.5	11/22/13	EW	2.430	2.400	2.390	4.000	4.000	4.000	4.200	544.0	x	1:20	1420	2:59	1420	1	113.7			297
B-25 RC3	12.0-17.0	12/12/13	CC	2.448	2.448	2.448	2.968	2.968	2.968	x	453.0	x	x	x	x	3290	x	123.3		288	
B-05 RC1	24.0-29.0	12/12/13	CC	2.463	2.463	2.463	2.789	2.789	2.789	x	471.3	x	x	x	x	520	x	134.8		48	
B-05 RC2	39.0-44.0	12/3/13	JL	2.450	2.450	2.450	3.540	3.550	3.560	4.010	618.4	x	4:29	16781	6:35	23035	1	140.5			4647
		12/12/13	CC	2.465	2.465	2.465	2.919	2.919	2.919	x	487.1	x	x	x	x	1150	x	132.9		102	
B-16 RC1	44.0-49.0	12/12/13	CC	2.478	2.478	2.478	3.103	3.103	3.103	x	529.2	x	x	x	x	1770	x	134.4		147	
B-16 RC2	49.5-54.5	12/3/13	JL	2.470	2.470	2.470	3.850	3.840	3.850	4.010	697.6	x	5:54	18530	7:50	24192	4	143.9			4752
		12/12/13	CC	2.480	2.480	2.480	2.909	2.909	2.909	x	556.9	x	x	x	x	8530	x	150.7		753	
B-10 RC1	64.0-69.0	12/3/13	JL	2.470	2.470	2.480	4.130	4.110	4.120	4.050	606.8	x	5:11	1667	5:15	1668	1	116.5			330
		12/12/13	CC	2.470	2.470	2.470	2.579	2.579	2.579	x	444.7	x	x	x	x	2120	x	136.8		212	
B-13 RC2	50.0-55.0	12/3/13	JL	2.470	2.470	2.470	4.270	4.270	4.260	4.570	804.0	x	6:21	7373	11:52	11726	4	149.5			2351
B-13 RC3	60.0-65.0	12/12/13	CC	2.457	2.457	2.457	3.077	3.077	3.077	x	533.8	x	x	x	x	3190	x	139.1		269	
B-07 RC1	49.0-54.0	12/12/13	CC	2.444	2.444	2.444	2.775	2.775	2.775	x	475.9	x	x	x	x	3320	x	139.0		312	

LIMESTONE LABORATORY TEST RESULTS

* Unconfined Compressive Strength of Rock Cores (ASTM D 7012)

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