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Terrestrial Laser Scanning 3D Survey of the Bulow Plantation Ruins and the Dummett Sugar Mill Ruins, Florida

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This report documents the use of terrestrial laser scanning (TLS) and global positioning system (GPS) documentation for the 3D surveys of the Bulow Plantation Ruins and the Dummett sugar mill ruins recently undertaken for the Florida Park Service (FPS), Department of Environmental Protection (FDEP). This summary report details the methods used in the project, as well as provides a discussion for further applications of the collected data and on-going research work that is being conducted at the Bulow Plantation Ruins Historic State Park as part of masters’ thesis projects by graduate students at the University of South Florida.

**Florida’s Historic Sugar Mills in 3D: High Definition Digital Documentation and Survey**

Historic sugar mill ruins and structures associated with the early Florida sugar industry are made from coquina and or limerock and brick. Along with these stone-types, the mortars used face issues of deterioration from weathering of their exposed surfaces. Previous restoration efforts used materials like Portland cement to repair coquina and limestone structures, methods now known to cause structural concerns, such as cracking and fissuring of surface features (Ferro, et al. 2000). Developing new methods for examination, documentation, and analysis of structural integrity, and pinpointing areas for restoration and conservation is a statewide and national need for heritage management. Researchers at the University of South Florida’s Alliance for Integrated Spatial Technologies are using new laser scan mapping techniques to more completely document these structures in three dimensions. They are working with restoration specialists, heritage preservation architects, and land resource agency managers to develop improved ways of protecting these heritage sites. The ability for managers and restoration specialists to more completely visualize and study these mill ruins, remote from the site, will enhance conservation strategies and lead to better and more effective restoration.

A spatial documentation surveys using TLS and GPS were conducted at the Bulow Plantation Ruins State Historic Site (8FL7) in Flagler County, and at the nearby Dummett Sugar Mill Ruins (8VO241) in Volusia County. Additionally, at Bulow, several coquina block features, likely associated with the remains of slave quarters and out-building structures were identified and their locations recorded using a sub-meter GPS. The purpose of the project is to assist in preserving and promoting the cultural, historic, and architectural heritage engendered by the state’s sugar mills. The project is designed to maximize participation of graduate students in history, architecture, archaeology, and anthropology at the University of South Florida. The results of this project will provide local, regional, and state planners and managers of Florida’s cultural heritage a variety of new data that can be used to conserve, restore, and protect these non-renewable resources. A larger objective of this project is to survey, document, record, and analyze the early history of the Florida sugar industry from its inception in the 1760s and its development through the late 1800s.
The Project

Through the use of state-of-the-art spatial technologies, along with progressive and conventional data acquisition and recording techniques, information about Florida's historic sugar mills is being assembled into a centralized data base with the long-term goal of being made freely available to researchers, educators, students, and the general public through a web-based platform (e.g., www.cyark.org). Data from sugar mill ruin sites will be acquired through the use of TLS, GPS, high-resolution photography, and other techniques. These web databases will provide the spatial design template for the inclusion of a variety of other lines of research and inquiry including the use of ethno-historic accounts, historic documents, and images. At the Bulow and Dummett sites, the focus of this project, data that was collected is provided in a variety of formats to the Florida Park Service, including 3D point cloud models, video visualizations, and screen capture images. This archival documentation can be utilized for the creation of CAD 2D renderings, used in restoration and architectural analysis, and can be used as an as-built model for monitoring and long-term restoration goals.

High Definition Digital Documentation (H3D) is an approach that entails the acquisition, processing, and visualization of exceedingly rich and highly accurate, three-dimensional spatial data (Collins and Doering 2006; Doering and Collins n.d.). Three-dimensional laser scanning for architectural and archaeological documentation is considered as “best available technologies” (United Nations 2005) and includes a suite of techniques that are non-contact, non-invasive, and non-destructive methods of total recordation. Acquisition of the data is accomplished through the integration of conventional and state-of-the-art spatial data collection techniques that can include mapping and survey-grade Real Time Kinematic-Global Positioning Systems (RTK-GPS), robotic laser total stations, geophysical surveys, aerial and sub-surface remote sensing, and multiple types of three-dimensional laser scanners. Used for architectural structures, point clouds, consisting of millions of x, y, and z coordinates, are captured with a precision of < 3mm, and provide three-dimensional rendering of the built environment. These data can then be used to create CAD line work and HABS/HAER level metrological documentation (Collins and Doering 2008).

Major advantages of an H3D approach include the ability to collect spatially accurate and three-dimensional data at multiple scales (e.g., artifact, feature, architecture, and landscape levels), and to have a system that allows seamless movement between varying scales of analysis to approach issues from a variety of perspectives. Many of these features have not been previously possible. Another benefit of the approach is the capability to include or compare with previously collected spatial and quantitative data (e.g., topographic mapping, photo imagery, or tabular data) that will further enrich the overall understanding. In a similar fashion, the methodology has the capacity to include data that may be acquired in the future, so that monitoring and management issues can be addressed using spatially accurate and detailed information. Standard software platforms now available, such as AutoCAD and ArcGIS, allow inclusion and preservation of a variety of information classes, with three-dimensional data able to be exported and imported to a wide range of file types and three-dimensional viewing software. Moreover, once an artifact, feature, site, or landscape is digitally captured, analysis
can take place in an off-site near ‘virtual’ environment, and the need to return and re-survey in the future is minimized if not eliminated. The data sets generated through use of H3D techniques can be cataloged and made available electronically to continue research and analysis (Doering and Collins 2007).

**Structural Documentation**

**Bulow Plantation Ruins Historic State Park**

The sugar mill at the Bulow Plantation Ruins Historic State Park are the primary focus of the current documentation project utilizing H3D technologies including TLS and GPS. Investigations into the other plantation structures are being undertaken as part of a Master’s Thesis by USF Anthropology graduate student, Rebecca O’Sullivan. O’Sullivan’s internship with the Florida Park Service in May and June 2009 and her continuing research concern an analysis of the social space and landscape at the Bulow Plantation. Her work, which also includes some of the plantation’s historical setting is included as part of this report (see Appendix 2).

The Bulow ruins include the structural remains associated with the steam-powered mill that was constructed circa 1831, with the site largely destroyed in 1836, during the Second Seminole War, when the major buildings on site were burned (Florida Department of Environmental Protection 2003; Stanton 1949; Wilson 1945). Structural components of the plantation that are still visible include a springhouse, the sugar factory (Figure 1), several coquina block foundations relating to the slave cabins, the main plantation house foundation, a water well, and remnants of three boat slips (Florida Department of Environmental Protection 2003). The current H3D survey work conducted at the plantation included GPS documentation of the main manor house site, the recording of numerous structural elements and building ruins, and any extant slave house location elements (Figure 2). The results of this GPS location survey will assist in securing locations and understanding the built environs at Bulow, which although alluded to in documents and land claims (United States Senate 1846), have not previously been securely located or understood (Baker 1999; Daniel et.al. 1980).

![Figure 1. A portion of the sugar mill factory ruins at Bulow Plantation.](image-url)
The Bulow sugar mill ruins consist of two separate structures: the engine house and a large T-shaped boiler room that included the purgeries (Baker 1999:118). Preliminary statements regarding condition assessment indicate fair structural integrity of elements such as the chimney stack and masonry remains (Florida Department of Environmental Protection 2003) however, a formal condition assessment is called for in the management plan. The H3D survey data can be used to assist in this assessment, with stability of structural elements and masonry remains able to be examined in 3D and 2D analyses for architectural and structural engineering examinations in the future. Further, the TLS point clouds acquired in the current survey can be used to produce the most detailed CAD drawings ever produced of Bulow, showing the current conditions at the site. These drawings will play an important role in the assessment of changes through time at the site, with comparisons with previous architectural drawings from the past possible.

The Bulow mill is comprised of cut coquina block with bricks used to line the heated areas. Mechanical disruption of coquina stone occurs in a variety of ways. For example, dissolved salts and water can penetrate the porous coquina causing structural problems. Normal evaporation processes can cause micro-fissures, which over time, can cause cracks and spalling (Ferro, et al. 2000). Human induced damage such as vandalism and graffiti and biological deterioration caused by plant growth and root intrusion are also problems noted in coquina structures. Observations made during survey site visits noted areas of spalling, abrasion, and attritional wear of block and other masonry elements (Figure 3 and 4). Additionally, old repairs from numerous re-pointing projects showed variability in the types of materials used (Figure 5). Several bracing elements, both wooden and metal, have been used at the site to alleviate stress-related problems in the purgery area and on the chimney structures (Figure 6 and 7).
Figure 3. Attrition and structural collapse of walls, and evidence of variable mortars used in historic re-pointing along with numerous bonding cracks and fissures are noted at the Bulow Mill Ruins.
Figure 4. Exposed coquina surfaces at the Bulow Mill Ruins show indications of weathering and wear. Indications of vandalism and graffiti are also evident.

Figure 5. An area of old repair with Portland cement.
Figure 6. Structural bracing has been installed as a stress-related corrective measure on walls of the purgery.

Figure 7. Metal bracing elements on the stack features at the Bulow Mill Ruins. Also noted is plant growth occurring on the coquina surface.
Vegetation at the Bulow Mill includes several large oak trees with extensive root systems that have penetrated portions of the mill including the wells and vents. Tree trimming and elimination is an on-going management issue, and resource planners have noted that obstructive tree branches and root penetration to the structure is a problem (Florida Department of Environmental Protection 2003). Our current survey includes existing landscape data capture that can be used to better consider these natural impacts when an architectural condition assessment is performed. For architectural modeling and visualization, these trees can be ‘digitally-removed' to allow better analysis and sight of the structural elements (Figure 8).

![3D point cloud](image)

Figure 8. Screen capture of a 3D point cloud consisting of millions of x, y, and z locations that comprise the east elevation of the Bulow Mill Ruins. Landscape terrain features including visible below-ground features were captured in the survey. Note that the vegetation has here been digitally removed to improve analytical viewing.

Several screen captures, or two dimensional representations of scan images, are provided as an appendix to this report and are in power point and video file formats. These visualizations demonstrate the metrological, or measurement, capability as well as the documentary and archival preservation aspects of the data (Appendix 1).

**Dummett Sugar Mill**

The Dummett Sugar Mill (8VO241), are ruins that are associated with the circa 1825 sugar factory with rum distillery belonging to Thomas Dummett. The mill ruins are part of what is thought to be the first steam-operated mill in the area (Daniel et.al. 1980), with a boiler that Dummett purchased from Barbados for his operation (Payne 1999; Stanton 1949). The ruins today consist of the foundation, northern wall of the structure, chimneys, portions of the kettle structure, and water supply features (Figure 9). The structure was made from coquina and brick, with the bricks used to line the heating areas. The north wall contains masonry arches as an architectural support mechanism for stress-relief on the structure (Florida Department of Environmental Protection 2003; Payne 1999:111). Vegetation has largely been controlled at the site, but evidence of root intrusion is still apparent. Previous issues with vandalism at the site
have been largely addressed through the erection of a fence around the structure, and public access to the structures now restricted. Remaining elements of the northern wall have been braced in places, but still are experiencing structural instability and areas of recent collapse were noted. The H3D survey here was conducted to capture the extant structural features, inclusive of the site footprint and visible below-surface features (wells). These data can be utilized for visualization of the overall site plan and as-built models and will also prove a useful documentation tool for CAD modeling for conservation, restoration and management purposes (Figures 10 and 11).

Figure 9. The Dummett Sugar Mill Ruins as seen today. The spherical white objects in the photo are targets used for spatial orientation and scan registration.

Figure 10. Screen capture of a 3D Point cloud consisting of millions of x, y, and z location points that comprise the west elevation of the Dummett Mill Ruins
Figure 11. Landscape terrain features including visible below-ground features were captured in the survey.

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Appendix 1: Terrestrial Laser Scanning 3D Survey of the Bulow Plantation Ruins and the Dummett Sugar Mill Ruins, Florida

Conducted for: The Florida Department of Environmental Protection,
Bureau of Natural and Cultural Resources
Florida Park Service

By: Alliance for Integrated Spatial Technologies
Travis F. Doering, Ph.D. and Lori D. Collins, Ph.D.

Office of Research and Scholarship
College of Arts and Sciences
Comparison overlays

- For the Bulow Mill Ruins, comparisons are made with previous drawings and historic documents in an effort to examine structural integrity, any previous spatial documentation errors, and to look at form and function of structural elements.
- For the Dummett Mill, elevations are shown using screen captures of the scan point clouds. These point clouds can be used now for archival documentation and to produce highly accurate scaled architectural drawings.
1934 architectural drawing of Bulow Sugar Mill

BULOW VILLE
JAN. 26, 1831

DETAIL OF NAMEPLATE SHOWING DATE.
THIS PLATE IS ON NORTH WALL OF THE SMALLER BUILDING.

THIS OLD SUGAR MILL IS 2 STORIES HIGH AND IS BUILT OF VERY FINELY CUT AND LAID COQUINA.

WALLS STANDING FOUNDATIONS ONLY
SCALE 1 INCH = 32 FEET
AUG 13, 1934
FELIX BENTON

FLORIDA FOREST SERVICE
Elevation drawing from a 1934 document

ELEVATION OF RUINS LOOKING FROM SOUTH
WALLS OF HIGHEST PART ~ 20 FT HIGH.
CHIMNEYS 40 FT HIGH.
Elevation showing south and east views
Eastern Elevation of the “Engine House”
East (above) and West Elevation (below) of Purgery and Boiler Room
Area of newly-discovered document showing building foundation – compared to location of piers found in scan data corresponding to yellow area.
Conjectural Drawing of Mill works at Bulow (Southarc, Inc. 1997)
Overlay of scan data with conjectural drawing
Previous Conjectural drawing of the Engine House
Plan view of the Engine House
Previous Conjectural drawing of the Engine House shown in overlay on scan data

Red circles indicate well locations from scan data; conjectural drawing shown in green
Plan view of Purgy and Boiler Room
Previous Conjectural drawing of the Purgery and Boiler areas shown in overlay on scan data
Center and Loading Area plan view – note wall deformation and tension areas
Slice of point cloud showing cross-section of braced wall (right) vs. un-braced wall on left
Center and Loading Area South Wall Elevation - exterior
Dummett Sugar Mill Ruins south (below) and west elevations
Appendix 2: Internship Report for the Florida Park Service, Cultural Resources Section
of the Bureau of Natural and Cultural Resources by: Rebecca O'Sullivan, MA Student,
University of South Florida, Department of Anthropology

History of Bulow Plantation

We turned down the broad avenue, once flanked by noble oaks whose scathed and
blackened trunks and leafless limbs alone remained to attest their former
magnificence. On either side were extensive fields, most luxuriant once with
richest sugar crops but now presenting a scene in which the demon of desolation
stalked with unchecked sway. On our left arose…the ruined arches and columns
of the once stately sugar mill while before us lay a smouldering, ashy heap, the
only vestige to show where once stood the hospitable mansion…

- Dr. J. Rhett Motte, on visiting the ruins of Bulow Plantation, 1836

On the 8th of July, 1812 a portion of the land that would eventually become Bulow
Plantation was granted to John Russell by the Spanish government (Wilson 1945). Russell
arrived in St. Augustine, along with his wife, five children, and eighteen of his slaves, aboard the
schooner *Perseverance*, a vessel he had built as payment for the approximately 4,675 acres he
was expecting to receive  (Florida State Archives [FSA], Spanish Land Grants [SLG] 6:2:4).
After acquiring the title to his new lands, Russell found it difficult to import the remainder of his
belongings and the rest of his slaves from his holdings in the Bahamas due to the British
blockades during the War of 1812  (FSA:SLG 6:2:15). This fact, in addition to the short amount
of time John Russell lived at the site make it unlikely that he was able to institute many
improvements to the property.

Around 1815 John Russell died, and by 1821 his descendants sold the property to a
wealthy native of South Carolina, Charles Wilhelm Bulow, for $9,944.50 (FSA:SLG 6:2:58).
Bulow was a successful businessman, and owned houses in Charleston and St. Augustine as well
as his plantation in East Florida  (Payne 2001 :82). Upon arriving at his new property in Florida
he quickly began making improvements, laying out the buildings necessary for a successful venture and getting his new plantation in order. Unfortunately, Charles Bulow died in May of 1823, only a few years after his arrival to the area, leaving his teenage son John Joachim Bulow to continue the work of running the plantation (Gordon 2002:231).

Although John J. Bulow was referred to by his neighbor James Ormond III as “well educated, but very wild and dissipated” (Strickland and 1980:14), Bulow Plantation, or Bulowville as it was also known, prospered under his ownership through its crops of sugar cane and cotton (Gordon 2002:211). This relative affluence was evident in the number and quality of the buildings located on the property, as well as the large number of people enslaved there. In the 1830 United States Federal Census, John J. Bulow was recorded as having 193 slaves living on his property, only two of whom were over the age of fifty five. This was almost four times the number of people enslaved at neighboring plantations during the same time period, indicating that Bulow was one of the wealthiest planters in the area.

In regards to the plantation structures, the main house was constructed of wood framing and coquina blocks and was “two and a half stories high, sixty-two by forty-two feet in dimension with a piazza all around” (Wilson 1945:234). Gordon (2002), states that the second floor of the structure housed the main living quarters and was also surrounded by a ten foot wide wooden piazza or deck. The largest structure, and the one most visible today, is the Bulow Plantation sugar mill. The coquina block structure features two chimneys as well as several different rooms which were designed to hold a steam engine, boiler, cane crusher, kettles, and storage (Gordon 2002:212).
Support structures and outbuildings included:

- Saw-mill house 60 by 20 feet and two stories high
- Sugar-house and related buildings 116 by 89 feet and 12 feet high
- Corn-house 36 by 25 feet
- Store-houses 20 by 30 feet
- Kitchens 20 by 20 feet
- Stable 25 by 30 feet
- 46 slave quarters, 12 by 16 feet
- Gin-house 42 by 42 feet
- Cotton house 40 by 40 feet
- Small gin-house 10 by 20 feet, two stories high
- Engine-house 14 by 25 feet, one and a half story high
- Fowl-house 20 by 30 feet
- Blacksmith’s shop 16 by 20 feet

(United_States_Senate 1846)

Although John Bulow is said to have cultivated a positive relationship with the Seminole Indians living in the vicinity of his plantation, he could do little to stop what would happen next when the Second Seminole War broke out (Wilson 1945:236). Bulow resisted the use of his plantation by the militia to fight the Seminole but when they arrived to commandeer his property in December of 1835 he could do little to stop them, he "objected to the troops occupying his place and manifested his opposition in a very decided manner. On our approach to his place he continued to fire upon us with a four pounder, charged with powder, with the expectation, I presume, of preventing our going to his place" (Wilson 1945:237). Under the command of Major Benjamin A Putnam, Bulow was taken prisoner in his own home while the troops fortified the area around the main house and made use of the plantations resources (Payne and Griffin 2001:85).

When the plantation was finally abandoned by the militia early in 1836, most of the structures that made up Bulowville were burned to the ground by the Seminole. A few months later, after an attempt to recoup his losses from the Federal Government, John J. Bulow died in St. Augustine on May 8, 1836 (Gordon 2002:213). Based on plat maps made around 1850
(Figure 1), by the time of his death John J. Bulow had amassed around 5,000 acres of land, making him one of the wealthiest land owners in the state before his property was destroyed.

![Figure 1. 1850 plat map showing the extent of Bulow’s lands, including field lines, roads, and some structures.](image-url)
In 1945, Bulow Plantation was purchased by the Volusia Hammock State Park Association and then given to the Florida Board of Forestry and Parks to ensure its future protection as well as its accessibility to the public (Wayne 2001:91). Little is known about the condition of the remaining structures prior to that time except for a report completed in 1934 by Felix Benton for the Florida Forest Service, a precursor to the current Department of Environmental Protection. Benton surveyed the area and made fairly detailed drawings of the remaining mill complex at the Bulow site (Benton 1934), revealing a structure that was in relatively good shape considering its age, the surrounding environment, and its partial destruction almost a hundred years earlier (Figure 2).

Figure 2. Profile and plan view, respectively, of the remains of the Bulow Plantation sugar mill in 1934, prior to any known restoration work.
Current Work at the Site

Current work at the Bulow Plantation site is part of a larger project being completed by the Alliance for Integrated and Spatial Technologies (AIST) at the University of South Florida which is meant to document sugar mills throughout the state for the Florida Parks Service. Using laser scanning and global positioning technology, AIST is able to digitally document structures with a high degree of accuracy. The models and point clouds that are subsequently generated by these methods can then be used by park managers to quickly and accurately monitor structures. By comparing past scan data to future scans, areas of deterioration or instability can be identified and targeted for repair.

As part of our work at the site we were able to conduct a pedestrian survey of the area in order to locate the foundations or piers of several historic structures which are still extant above the ground surface. Based on this preliminary survey, we were able to locate the remains of eleven possible slave cabins and then record their locations using a mapping grade (sub-meter accuracy) GPS unit. These data will then be used to create a base map for Bulow Plantation using the computer program ArcGIS. Using this base map, we will then be able to compare the structures we located with those found in previous archaeological surveys, it can also be used as a management tool so that park rangers are able to easily locate any known historical resources on the property.

In addition to fieldwork at the site, I was able to conduct extensive background research using the reports, historic documents, historic maps, pictures, and micro fiches held by the Florida Parks Service as part of an internship under the direction of Philip Werndlì at the Cultural Resources Section of the Bureau of Natural and Cultural Resources (BNCR), within the Division of Recreation and Parks, located in Tallahassee, Florida. Using these resources, it will
then be possible to begin the next phase of our work which will involve collaborating with CyArk, a nonprofit group supported by the Kacyra Family Foundation (CyArk 2008). CyArk's (2008) stated mission is "to digitally preserve cultural heritage sites through collecting, archiving and providing open access to data created by laser scanning, digital modeling, and other state-of-the-art technologies", and their website features several different projects from around the world. Each CyArk project uses a base map as a foundation, and other forms of media or documentation are then geo-referenced to the map based on the feature to which they relate. Geo-referenced data can include historic documents, reports, photographs, video, drawings, historic maps, laser scan point clouds, or even 3D models. The web site created for the Bulow Plantation site can then be used for public interpretation, or as a digital archive for further research questions, or even as a tool for park managers.

While there have been several archaeological excavations at the site (Baker 1999), very little is known about the workings of the mill or the everyday lives of those who were forced to work it. As part of our continuing work at the site, we hope to conduct additional non-invasive, non-destructive, remote sensing surveys in order to locate more of the structures that would have made up the plantation. Because most of the plantation’s wooden structures were burned by the Seminole in 1836, it is possible that nail patterns from the collapsing walls may still exist subsurface. Using a controlled metal detector survey of the property it may be possible to detect these patterns and perhaps locate additional outbuildings or slave quarters which are now invisible above the ground. This information would be invaluable in directing future fieldwork or management of the site because it would create areas of high and low probability for finding archaeological remains.
By gaining a better understanding of the past layout of the plantation outbuildings and slave quarters, it might then be possible to say more about life at the site. Although only a few have been located, one interesting aspect of the slave cabins at Bulowville was their semi-circular layout around the main road; a feature also found at Kingsley Plantation, just north of Jacksonville, Florida. Through further fieldwork and research we hope to gain a better understanding of the use and construction of space at the site, perhaps shedding light on the power relations and methods of control used in these plantation systems.
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