September 25, 2020

Willbrook Plantation Association
426 Tidewater Circle
Pawleys Island, South Carolina 29585

Attention: Mr. Samuel Kirk

Reference: **Report of Pavement Exploration Results with Recommendations**
Willbrook Plantation
Murrells Inlet, South Carolina
S&ME Project No. 1363-20-023

Dear Mr. Kirk:

S&ME, Inc. has completed an exploration of the pavements at the referenced project site. Our work was performed in general accordance with our proposal number 13-2000158, dated April 10, 2020, and authorized on behalf of Willbrook Plantation Association by Lisa Hergenrother of Waccamaw Management, LLC on June 26, 2020.

This report presents the findings of our exploration and our general recommendations for the maintenance and repair of the pavement areas explored, both in the short term, and over the long term.

- This report completes Tasks 1, 1-A, and 2 of our proposed scope of services.

♦ Project Information

Project information was initially received by Melvin Williams (S&ME) on March 26, 2020 in an email solicitation issued by Samuel Kirk of the Willbrook Plantation Association (Willbrook). We understood from this communication that the Board of Directors Road Committee of the Willbrook Plantation Association determined the necessity to solicit engineering firms to perform a pavement evaluation and the development of a Pavement Management Program for the community's private road system.

Additional project information was obtained during a site visit by Ron Forest, Jr., P.E. and Adam Limeburner, E.I.T of S&ME, Inc. (S&ME) on July 13, 2020, during which we visually observed the roadways within the community, noting various distresses. We further understand that this residential roadway system is roughly 6 miles in total length and consists of approximately 82,000 square yards of asphalt. Evaluation of the roadway drainage system was not part of this study.

S&ME was requested to initially review the available roadway plans and perform a visual review of the existing pavement surface conditions. Based on these two data sources, Willbrook further requested that we recommend short-term (e.g. two year) general pavement repair requirements, and suggest a number and locations of pavement core testing necessary to develop a long-term pavement management plan. S&ME also proposed and performed a Ground Penetrating Radar (GPR) survey of the roadways.

♦ Exploration Procedures

GPR Methodology, Field Survey, and Data Processing

On July 23, 2020, S&ME conducted a Ground Penetrating Radar (GPR) survey to estimate the layering and thicknesses of the pavement structures within the community. For presentation purposes, the GPR survey area was divided into three sub-areas, labeled Areas A, B and C on **Figure 1.**

GPR transmits electromagnetic waves into the pavement from an antenna at a specific frequency and measures the travel time for wave reflections to be received from interfaces between materials with differing dielectric properties (e.g. asphalt/base course, etc.). The intensity of the reflected GPR signal is a function of the contrast in the electrical properties (i.e. dielectric permittivity) at the interface, the conductivity of the material that the signal is traveling through, and the frequency of the signal. GPR antennas can be either air-launched (horn-type) or ground-based. However, horn antennas are generally necessary for high speed data acquisition as they are suspended about 18 inches off the ground. Layer-specific dielectric permittivity used for depth calculations are also automatically generated when using an air-launched antenna and preferred for pavement evaluations. A distance measuring interval (DMI) encoder, attached to the vehicle, is used for triggering the GPR signal and to have a distance reference. These measurements are also typically supported with a global positioning system (GPS), which sends a continuous data output stream to the GPR controller during acquisition.

We used a Geophysical Survey Systems, Inc. (GSSI) RoadScan™ 30 system equipped with a 2 GHz air-launched horn antenna using a sub-meter GPS as positioning support in general accordance with ASTM D4748 "*Determining the Thickness of Bound Pavement Layers Using Short-Pulse Radar*". GPR profiles were collected in both directions at 12 scans per foot (i.e. every 1 inch). GPR data was post-processed using the GSSI Radan® 7 software with RoadScan™ module.

Twelve core test locations (Cores C-1 through C-12) where chosen based upon the initial GPR data, which were assigned to help calibrate and more accurately define the final layer thicknesses.

GPR Methodology Limitations

Regardless of the thoroughness of a geophysical survey, there is always a possibility that actual conditions may not match the interpretations. The results should be considered accurate only to the degree implied by the method used and the method's limitations and data coverage. Accordingly, the possibility exists that not all features at a project site will be located due to either pavement/subsurface conditions or the occurrence of features outside the lateral limits and below the depth of penetration of the method used. As with most surface geophysical methods, resolution of the subsurface also decreases with depth. As such, the size and/or contrast of features compared to the imaged subsurface media must be significant enough to produce the anticipated response. The location and/or determination (or the lack thereof) of pavement structure thickness was based on our review of provided information and of the geophysical survey. Under no circumstances does S&ME assume any responsibility for damages resulting from the presence of subsurface features that may exist but were not identified by our survey.

The GPR method used for this survey also has inherent limitations. Items such as target age, pavement structure thicknesses, lack of dielectric contrast, etc. may make the determination of layer boundaries and target locations difficult. The average maximum depth of penetration for the 2 GHz horn antenna is typically about 24 inches below the pavement surface. However, properties of the subsurface materials (e.g. moisture, etc.) can have a significant impact on the effective depth of penetration of the GPR survey. In addition, the GPS that was used for this survey is limited to sub-meter accuracy or higher when used at high speeds.

Pavement Core Sampling

On August 13, 2020, S&ME visited the site to core through the pavement at 12 locations in the asphalt to help calibrate and ground truth the GPR data. These coring locations are shown on **Figures 2 through 7** attached to this report, and are labeled as C-1 through C-12. Asphalt pavement layers were sampled using a diamond bit coring device in general accordance with ASTM D 979, "*Standard Practice for Sampling Bituminous Paving Mixtures*." Coring of the pavement also allowed penetration of the underlying layers by soil drilling equipment.

The base layer and subsoils encountered were identified in the field by cuttings brought to the surface. Penetrations of asphalt surfaces made during the drilling process were patched with commercially available asphalt patch material after drilling and sampling was complete. Patch material was placed to provide a surface flush with the existing pavement adjacent to the boring. These patches are intended to be temporary until new paving work is performed.

♦ Summary of Findings

The pavement conditions that we observed appear to be generally consistent with our expectations for pavements of these types and ages. The forms of distress that we observed are summarized in Table 1 below, followed by brief descriptions and example photos of the observed distress types.

Types of Distress Observed

The forms of distress primarily observed within the study area included polished surface aggregates, shallow depressions, fatigue cracking (both longitudinal and transverse), root heaves, and percolation of subsurface water at some places on the roadway surfaces. Patch work from previous repairs was also observed at several locations, and in some cases the previously patched areas were distressed.

Table 1 – Observed Pavement Distresses

Roadway	Distress Types							
	Longitudinal Cracking	Transverse Cracking	Alligator Fatigue Cracking	Patches	Polished Aggregate	Depressions or Sinkholes	Percolation Venting	Potholes	Root Heave
Tidewater Dr.	X	X	X	X	X				
Tidewater Cir.	X	X		X	X			X	X
Brickell Ct.	X	X		X	X				
Brickfall Ct.	X	X	X	X	X				
Ellington Ln.	X	X			X	X			
Hamby Dr.	X	X		X	X			X	
Baldwin Lp.	X	X		X	X	X			
Coleman Ct.	X	X			X	X			
Black Duck Rd.	X	X	X	X	X				
Oatland Lake Dr.	X	X	X	X	X	X		X	X
Lupton Ln.		X	X		X	X			X
McLeod Ct.		X	X	X	X				
Elderberry Ln.			X		X			X	X
Warnock Ct.	X	X	X	X	X				
Wood Duck Ct.	X	X	X		X				
Chapman Lp.	X	X		X	X	X			X
Blackwell Ln.	X	X			X				
Flat Boat Landing	X	X			X				
Heston Point Dr.	X	X	X	X	X		X	X	X
Sandy Meadow Lp.			X	X	X	X	X		
Barred Owl Trl.	X	X	X		X				
Summer Duck Ln.	X	X		X	X	X			X
Red Squirrel Ln.	X	X	X	X	X				X
Ruddy Duck Ln.	X	X	X				X		
Harrington Ct.	X	X			X				
Main Gate	X	X		X	X				
Back Gate	X	X	X	X	X				

Although distresses were present in each road that we observed, this is not uncommon for pavements of this age. Where cracking was present the cracks were typically thin and spread apart, not resulting in complete pavement failure. Where depressions are present it is possible that there is some subsoil subsidence and that over time areas of the pavement settled following the soil beneath it. Where depressions occur over or around catch basins or storm sewer pipes, this could indicate a joint separation or crack through which loss of ground is occurring.

Aggregate Polishing

Polished aggregates were observed on nearly all of the pavement surfaces observed to some degree. Polishing occurs when the bitumen (the asphaltic material) on top of the aggregates in the asphalt mixture has worn away. Over time, most aggregates are susceptible to wearing to a smooth finish or texture under repeated traffic. This may reduce traction and contribute to loss of ductility. It also reduces the adhesion of surface sealers that may be applied. See **Photo 1** below for an example of the distress observed.

Photo 1: Aggregate Polishing

Date: 9/23/2020

Photographer: K. Fugate

Location / Orientation	Lupton Lane
Remarks	Moderate aggregate polishing with fatigue cracking.

Longitudinal Cracking

Slight to moderate longitudinal cracking was observed on many of the roadways. Longitudinal cracks are those oriented generally parallel to the pavement centerline. In flexible pavements, this cracking may be caused by poor joint construction or adhesion, shrinkage of the asphalt, cracking in a lower layer that is reflecting up through the pavement, or general fatigue (loss of ductility) of the material. Most of the longitudinal cracks that we observed were relatively thin (less than ¼ inch wide).

Transverse Cracking

Slight to moderate transverse cracking was observed on most of the roadways observed. Transverse cracks are those oriented generally perpendicular to the pavement centerline. This type of cracking may be caused by fatigue or shrinkage of the asphalt, or deformation of the base or subgrade, or in some cases may be associated with root heaves. See **Photo 2** below for an example of transverse cracking.

Photo 2: Transverse Cracking

Date: 9/23/2020

Photographer: K. Fugate

Location / Orientation	Black Duck Road
Remarks	Note moderate transverse cracking.

"Alligator" Fatigue Cracking

Fatigue ("alligator") cracking was observed on several of the roadways, usually (but not always) in areas where depressions have developed in the surface of the pavement. Alligator cracking generally indicates areas where the base course and/or subgrade are weaker than necessary to support the applied traffic loads, and/or the asphalt is too thin for the wheel loads applied. The deflection of the pavement under traffic loading in these areas eventually causes the asphalt to break up and separate into small pieces (which resemble the skin texture of an alligator, thus the name). This pattern is due to excess tensile stress and strain at the bottom of the asphalt layer. Some of the roadways that we explored displayed moderate alligator cracking, indicating a prolonged period of distress. See **Photo 3** below for an example of the distress observed.

Photo 3: "Alligator" Fatigue Cracking

Date: 9/23/2020

Photographer: K. Fugate

Location / Orientation	Heston Point Drive
Remarks	Moderate alligator cracking.

Patches

Previously patched areas were observed on many of the roadways evaluated. These may represent areas where either potholes or depressions were present in the past and have been previously repaired. In some cases, patches may represent utility line crossings. See **Photo 4** below for an example of the patches observed.

Photo 4: Existing Patch

Date: 9/23/2020

Photographer: K. Fugate

Location / Orientation	Baldwin Loop
Remarks	Note the large patch in this area near a recently repaired curb and catch basin throat.

Depressions in the Pavement

We also observed depressions (with or without significant associated cracking) on most of the roadways in the exploration area. These depressions appeared randomly through the pavement and may be a result of loose of softened subgrade or base materials underneath. Percolation (described below) can also cause depressions to form as base material is transported by water from beneath the asphalt to the surface.

Percolation Venting

Evidence of percolation damage was observed on Heston Point Drive, Sandy Meadow Loop, and Ruddy Duck Lane. Percolation results from the presence of water beneath the asphalt, combined with a poorly draining base course, and/or lack of adequate subsurface drainage. Water becomes trapped beneath the pavement and is unable to escape to the sides or infiltrate downward; sometimes, often during the hottest periods of the year, the water will escape by percolating up through the cracks in the surface. This symptom is often associated with base materials that have a low drainage capacity. Evidence of percolation includes the deposition of fines on the pavement surface, often seen as a tan or gray stain; these deposits are actually small particles of the base material that have been transported to the surface by the percolating water. See **Photo 5** below for an example of the distress observed.

Photo 5: Percolation

Date: 9/23/2020

Photographer: K. Fugate

Location / Orientation	Ruddy Duck Lane
Remarks	Moderate percolation with surface staining in combination with some fatigue cracking.

Potholes

There were a few small potholes observed several of the roadways. Only Heston Point Drive exhibited moderate pothole damage. These areas likely began as depressions, then experienced cracking and deterioration. Finally, the upper layer of asphalt displaced, and the underlying layer became exposed. Although not widespread currently, areas with alligator cracking or depressions subjected to traffic can lead to additional potholes.

Root Heave

Root heave was also observed on several of the roadways. Root heave occurs when trees are too close to the pavement or when densely compacted soil causes large roots to grow towards the surface, eventually resulting in the roots lifting the pavement. Generally, the only way to permanently remedy this problem is to remove the tree and its roots. When root heaves are simply paved over, the heave usually returns relatively quickly.

GPR Results

1. Assisted by the cores performed at the site, two primary pavement section layers were identified in the GPR data sets: asphalt, and marine limestone base course.

   A. The asphalt thickness ranged from 1 to 5 inches.
   B. The base course thickness ranged from 4 to 16 inches.

2. Interpreted color-coded thickness plots are located in **Figures 2 through 7** in the appendix, and are separated into "Area A", "Area B", and "Area C" for presentation purposes (See **Figure 1** for the location of each area). Places where gaps are shown in the thickness plots are typically the wooden bridges.

   A. Areas colored in **orange** and **red** on **Figures 2, 4, and 6** indicate areas where the asphalt appears to be less than 2 inches thick.
   B. Areas colored in **orange** and **red** on **Figures 3, 5, and 7** indicate areas where the base course layer appears to be less than 6 inches thick.

3. Two example GPR cross-sectional data profiles highlighting the two identified layers that we used for our interpretations are presented in **Figures 8 and 9**. These example profiles help to illustrate the significant variability in the asphalt and base layer thicknesses over relatively short distances.

   A. **Figure 8** illustrates the profile of an approximate 775 ft. long section surrounding core test location C-10 on Tidewater Drive.
   B. **Figure 9** illustrates the profile of an approximate 775 ft. long section surrounding core test location C-6 on Chapman Loop.

The color-coded thickness plots can also be provided digitally in a Google Earth (.KMZ) file format.

Asphalt and Base Layer Thickness Findings

This section describes the results of the core sampling that was performed at test locations C-1 through C-12.

The pavement was observed to typically consist of a single layer of asphaltic concrete ("asphalt"), overlying a marine limestone base course. At each test location, the individual thickness of the layers observed within the pavement section were measured and recorded, and these results are summarized in Table 1 below.

Asphalt thicknesses ranged from 1 to 4 $^{1}/_{4}$ inches at the core test locations and averaged just under 2$^{1}/_{2}$ inches overall. Marine limestone base course thicknesses ranged from 2$^{1}/_{2}$ to 11 inches at the core test locations and averaged just over 6$^{1}/_{4}$ inches overall. The base course was tan to light gray in color, was mostly dry, and consisted mostly of sand and gravel sized limestone particles.

Table 2: Existing Pavement Section Thicknesses at Core Test Locations

Core Location ID	Street Name	Asphalt (inches)	Marine Limestone (inches)
Core 1	Barred Owl Trail	2 $^{3}/_{4}$	7
Core 2	Sandy Meadow Loop	1 $^{1}/_{4}$	8
Core 3	Heston Point Dr. at Oatland Lake Dr.	2 $^{3}/_{4}$	9
Core 4	Heston Point Drive	4 $^{1}/_{4}$	5 $^{1}/_{2}$
Core 5	Heston Point Drive	1 $^{3}/_{4}$	7 $^{1}/_{2}$
Core 6	Chapman Loop	3 $^{1}/_{2}$	5 $^{1}/_{2}$
Core 7	Oatland Lake Drive	3 $^{1}/_{2}$	2 $^{1}/_{2}$
Core 8	Black Duck Road	1 $^{1}/_{8}$	4 $^{1}/_{2}$
Core 9	Oatland Lake Drive	1	11
Core 10	Tidewater Drive	3	7 $^{1}/_{2}$
Core 11	Tidewater Dr. at Tidewater Cir.	2 $^{3}/_{8}$	2 $^{1}/_{4}$
Core 12	Hamby Drive	1 $^{1}/_{2}$	5
Average		2 $^{1}/_{2}$	6 $^{1}/_{4}$

Underlying Subgrade Soils

Immediately beneath the marine limestone base course at each of our test locations, the subgrade soils typically consisted of fine to medium-grained natural sand (USCS Classification "SP"), which was generally tan to light brown in color and was moist.

Subsurface Water

Subsurface water was not encountered within the base course layer or the immediate subgrade sands at any of our test locations. Of course, water levels may fluctuate seasonally at the site, being influenced by rainfall variation, irrigation, and other factors, and since there was some evidence of percolation venting along some of the pavements in this community, this is evidence that under wet weather conditions some subsurface water may be present in the upper subgrade soils or base materials on at least an occasional basis.

♦ Conclusions

Based upon our observations as described in Table 1, the core samples, and the geophysical test results, we have grouped the streets into three qualitative risk categories, as follows.

Category 1 may be at highest risk due to either the volume of traffic these streets experience, a particularly thin layer of asphalt, and/or particularly thin base materials. Based on the GPR data, the streets in Category 1 contain large sections of roadway with thin asphalt, and in some cases such as Tidewater Circle and on Oatland Lake Dr. near Elderberry Lane, for example, exhibit both thin asphalt *and* thin base course. **Category 2** is also at risk but may experience less traffic volume than the streets in Category 1, may have somewhat thicker asphalt, or may have somewhat thicker base materials. The streets in **Category 3** appear to be at less risk due to their significantly lower traffic volume and/or thicker pavement sections; these streets may contain small portions of roadway with either thin asphalt or thin base course, but generally do not contain many areas of both.

1. **Category 1: Highest Risk**

    A. Tidewater Circle (primary risk factors: high traffic, thin asphalt, thin base)
    B. Tidewater Drive (primary risk factor: high traffic, areas with both thin asphalt and thin base)
    C. Heston Point Drive between Oatland Lake Dr and the west end of Chapman Loop (primary risk factors: high traffic, thin base)
    D. Black Duck Road (primary risk factors: thin asphalt and areas of very thin base)
    E. Oatland Lake Drive (primary risk factors: high traffic, areas of thin asphalt and/or thin base)
    F. Ellington Lane (primary risk factors: high traffic, thin asphalt, thin base)
    G. Hamby Drive (primary risk factors: very thin asphalt)
    H. Main entry gate (primary risk factors: high traffic, thin base)
    I. Rear entry gate (primary risk factors: high traffic, very thin base)

2. **Category 2: Second-highest Risk**

    A. Coleman Court (primary risk factors: thin asphalt, thin base)
    B. Chapman Loop (primary risk factors: moderate traffic, isolated sections with thin base)
    C. Brickfall Court (primary risk factor: thin asphalt)
    D. Wood Duck Court (primary risk factor: thin asphalt)
    E. Ruddy Duck Court (primary risk factor: thin asphalt)
    F. Heston Point Drive beyond the Chapman Loop west intersection (primary risk factor: thin asphalt)
    G. Sandy Meadow Loop (primary risk factor: thin asphalt)
    H. Lupton Lane (primary risk factor: thin asphalt)
    I. Warnock Ct. (primary risk factor: thin asphalt)
    J. Elderberry Lane (primary risk factor: thin asphalt, thin base)
    K. McLeod Court (isolated sections with thin asphalt)

3. **Category 3: Lower Risk**

   A. Baldwin Loop (primary risk factor: thin asphalt)
   B. Blackwell Loop (short section near the end with thin base)
   C. Brickell Court (primary risk factors: thin asphalt, thin base)
   D. Flat Boat Landing (thin base)
   E. Summer Duck Lane (primary risk factors: thin asphalt, thin base)
   F. Barred Owl Trail (primary risk factors: thin asphalt, thin base)
   G. Red Squirrel Lane (primary risk factors: thin asphalt, thin base)

Drainage

We also observed that there are several drainage issues within the community that will need to be addressed. On August 5, 2020, Ron Forest, Jr. met on site with a storm water design engineer Mr. Austin Graham, P.E. from Development Resource Group, LLC (DRG) of Myrtle Beach. While on site, we also met with John Kurgan of Willbrook Plantation. During this site visit, Mr. Forest and Mr. Kurgan showed Mr. Graham several locations of concern regarding the community drainage. These areas included:

- The intersection of Tidewater Circle at Oatland Lake Drive
- The intersection of Flat Boat Landing and Chapman Loop
- An area near 279 Chapman Loop
- An area near 648 Chapman Loop
- An area near 445 Heston Point Drive
- The intersection of Heston Point Drive and Chapman Loop

Of these six observed areas, Mr. Graham believed that the area that floods near 279 Chapman Loop is likely a system capacity issue and may not be related to site grades or topography. He believed that the other five areas listed above may be able to be corrected with grade elevation adjustments.

♦ Recommendations

This section of our report describes our general recommendations for pavement rehabilitation at Willbrook Plantation. Our recommendations do not contain specific area measurements or quantities, nor should this report be considered as specifications for construction.

Short Term Plan Outline

The following recommendations are to address short term needs while the scope of the first long-term pavement rehabilitation plan is more fully developed.

Civil Engineering

Prior to performing any major pavement rehabilitation work, we recommend that a stormwater/civil engineer be hired to further evaluate the community regarding drainage grade improvement needs.

- We solicited a proposal for services from DRG, LLC to survey the five areas described in the previous section of this report, and to provide grade elevation adjustment recommendations that could be incorporated into a new pavement overlay design in the future. Their proposal is transmitted to you separately for your review and consideration.
- We recommend that DRG, LLC be hired to perform their proposed scope of work. If authorized by the association, S&ME, Inc. can subcontract DRG, LLC to perform these services under our current agreement by executing a change order to Willbrook Plantation.

Storm Sewer Pipe Cleaning and Inspections, Repairs

We also recommend that existing storm water drains be vacuum cleaned and video camera inspected for possible blockages, joint separations, or collapses. At a minimum, all of the pipes that travel underneath the roadways should be cleaned and inspected; however, the Association may also wish to consider cleaning and inspecting the storm water pipes that travel under landscaped areas as well, especially if this has never been done before (or if it has been a very long time since it was last performed). We understand that some of the storm sewer pipes travel beneath the golf course. Damage to pipes beneath the golf course can potentially cause stormwater to backup into the road system as well. So, it may be advisable to consider a possible collaboration and cost sharing effort between the golf course and the Association on a more thorough pipe cleaning and inspection program.

- S&ME has not solicited a proposal for this work from any contractors.
- As a result of the video inspection, it may be determined that some of the pipe joints require repair. Repairs to pipe joints may involve spot repairs, or may involve pipe section and/or catch basin replacement, depending upon the type and severity of the damage.
- If drainage system repairs are made as a result of the pipe inspection, it may also become appropriate and necessary to perform some isolated full-depth patching to fix any sinkholes in the pavement or other areas requiring immediate attention located near the damaged systems.
- All clogged surface flumes should also be cleaned out, such as those on Ruddy Duck Lane and the one at the end of Red Squirrel Lane; ditches should also be maintained.

Crack Sealing

Several of the roadways in the community, such as Ellington Lane for example, may benefit from a crack sealing program to help extend their life in the short term until a long-term repaving plan is implemented.

- S&ME has not solicited a proposal for this work from any contractors.
- We typically recommend sealing longitudinal and transverse cracks that are ¼ inch wide or greater. *Exception:* sealing cracks in severely fatigue-cracked pavement (such as where alligator cracking has occurred) is not typically effective and is not recommended.
- While drainage improvements are being made as a result of the pipe inspection, it may also be appropriate to perform some isolated full-depth patching to fix any sinkholes and other small areas requiring immediate attention.

Seal Coating

We do not recommend coating any of the pavements with liquid sealer as part of the short-term plan.

Long Term Plan Outline

We recommend that you prioritize your paving budgets over the coming years to work through the categories described above, generally starting with Category 1, and working towards Category 3. However, it is not imperative that all of the roads in a particular category be combined into one pavement rehabilitation project. Developing the scope of a paving project should also consider where each road is located and to which other roads it connects. For ease of construction, you may want to combine some elements of each category into fewer, larger projects. For example, if you are re-paving Ellington Lane and Hamby Drive, which are listed in Category 1, you may also want to address Coleman Court and Baldwin Loop at the same time, even though they are in Categories 2 and 3, because they are in the same vicinity of the community.

Based upon our observations, we recommend that the roads in Categories 1 and 2 be addressed within the next 24 to 36 months, if possible.

Rehabilitation Approaches

The following recommendations for rehabilitation approaches apply to all the roads listed in each of the three risk categories.

Full-depth Patching

In areas which are exhibiting moderate to severe fatigue cracking, alligator cracking, or severe root heave damage, it will be necessary to remove and replace the asphalt pavement in these localized areas. We do not anticipate these areas to be widespread, but there will be several of these areas that should be prepared by full-depth patching prior to constructing any new pavement overlay. S&ME can identify, quantify, measure, and mark each of these specific areas during development of project specifications for construction.

Root/Tree Removal

In order to address heaved portions of asphalt, large trees which are very close to the roadway may need to be removed, and their roots excavated from underneath the roadway. For example, there are two such trees at 158 Oatland Lake Drive that should be removed. If the roots are cut and removed without removing the tree, then the tree may die and could eventually become a safety hazard. Following root excavation, the excavated material should be replaced with new Graded Aggregate Base Course (GABC). The GABC material will have to be imported to the site. We can provide a backfilling specification for this work during development of the project specifications for construction. If the trees and roots in the heaved areas are not removed, then the client should recognize that the pavements in these areas will likely experience similar heave deformation over a relatively short period of time after the mill and overlay operation is performed.

Underdrain Installation

Based upon our observations, we recommend that pavement underdrains be installed along the side of the road near 280 Oatland Lake Drive. Underdrains should also be installed along Coleman Court from the intersection with Hamby Drive to the nearest catch basin, and along the side of the road near 629 Chapman Loop. There may be additional areas of underdrain to recommend after the civil engineering work is complete (see short term plan).

More specifically, we recommend that a fabric-wrapped, high-density polyethylene (HDPE), vertically-oriented slot drain such as ADS AdvanEDGE, or similar, be installed along the entire length of the affected sections. The underdrain can be placed behind the curb or in front of the curb; however, it is likely preferable in this case to install the underdrain immediately in front of the curb to reduce disruptions to existing driveways and utilities. Alternatively, the underdrains may be placed behind the curbs, although this approach would likely require cutting and patching of the residential concrete driveways, or borings under each driveway. A typical installation detail drawn by ADS is attached to this report in the appendix as **Figure 10** for reference regarding these options.

To discharge the subsurface water collected by the slot underdrains, they should be sloped towards the closest storm sewer catch basins and tied into the storm water drainage system, or daylighted to the nearest adjacent pond or ditch above its waterline, whichever is more convenient. The underdrains should be installed in accordance with the manufacturer's recommended procedures.

S&ME can help determine the alignment of the underdrains, including the starting and termination points, and estimate the required length of the underdrain during development of the project specifications for construction.

Hot Mix Asphalt Mill and Overlay

Most of the pavements in this community have concrete curb and gutter on both sides. In order to prevent from creating a lip of asphalt in front of the gutter when the pavement is overlaid, the pavement in front of the gutters should be milled prior to overlaying the existing pavement. See **Figure 11** attached in the appendix for a typical milling detail instruction that we usually present to the contractors.

Once the areas requiring special treatments as discussed in the preceding sections have been remedied, then the outermost 6 feet of the existing pavement surface along both sides of each road should be taper-milled to a nominal depth of about 1 ½ to 1 ¾ inches below the existing surface immediately in front of the gutter, tapering up to a milling depth of zero inches approximately 6 feet off the gutter face, as depicted in **Figure 11**. Adjustments may be made to the milling depth to accommodate desired surface grade adjustments. For example, if the surface is slightly depressed in a certain area, the milling depth may be slightly reduced, and if a small root heave is present in a certain area, the milling depth may be slightly increased.

- Some of the roads appear to have been overlaid in the past without performing tapered edge milling first. This appears to be the case on Chapman Loop, for example. On these streets, there is already a lip of asphalt at the gutter edge. In these cases, it may be necessary to perform full-width milling of the entire roadway surface prior to overlaying the pavement with new hot mix asphalt in order to try and restore a more appropriate cross slope and reduce the height of the asphalt lip at the gutter interface.

Meter valve covers or manhole covers that are located within the center third of the roadway and therefore outside of the taper-milled edge zones may require that riser collars be installed to accommodate the increase in the post-overlay road surface elevation.

After milling, the surface is cleaned and tacked, and then a new hot mix asphalt (HMA) overlay is constructed on top of the milled surface. We typically recommend 2 inches of HMA Surface Course Type C be constructed as a hot mix asphalt overlay. (1 ½ inches may also be considered as an overlay thickness, depending upon conditions.)

Taking the milling depth into account, a 2-inch overlay will result in a net grade elevation increase of about ¼ to ½ inch above current grade elevations at the gutter interface, and a net grade elevation increase of about 2 inches above current grade elevations in the center portion of the road. Note that this will typically result in an increase in the cross-slope gradient of the pavement surface, which may help improve the runoff of water towards the gutters on either side. The specific procedures that should be used for the milling and the HMA overlay are addressed in the project specifications for construction.

♦ Next Steps

Implement the Short-Term Recommendations

The next step in the pavement rehabilitation process is for Willbrook Plantation to implement the short-term recommendations described in this report.

Task 2-A

Once the short-term tasks are completed, then "Task 2-A" as described in our proposal for services may begin. The first step of "Task 2-A" is for Willbrook Plantation, with assistance from S&ME, to define the scope of work for the first pavement rehabilitation construction project that the Association wishes to pursue as part of the long term rehabilitation plan.

Once a preliminary scope of work for the first rehabilitation project has been defined, S&ME can then measure the quantities for the defined scope of work elements and prepare a preliminary engineer's estimate of the potential construction cost for the Association, if desired. The next step after that would be for S&ME to write up project specifications for contractors to propose upon, and then solicit contractor proposals for the work and help the Association select a contractor to perform the work.

♦ Limitations of Report

This report has been prepared in accordance with generally accepted engineering practice for specific application to this project. The conclusions and recommendations in this report are based on the applicable standards of our practice in this geographic area at the time this report was prepared. No other warranty, express or implied, is made.

The analyses and recommendations submitted herein are based, in part, upon the data obtained from the exploration. The nature and extent of variations of the materials at the site in general to those encountered at our test locations may not become evident until construction. If variations appear evident, then we should be provided the opportunity to re-evaluate the conclusions and recommendations of this report. In the event that any changes in the nature, design, or location of the project are planned, the conclusions and recommendations contained in this report will not be considered valid unless the changes are reviewed, and the conclusions and recommendations are modified or confirmed in writing by the submitting engineers.

Assessment of site environmental conditions; sampling of soils, ground water or other materials for environmental contaminants; civil design work; surveying; the development of project plans and specifications; contractor bid documents; identification of jurisdictional wetlands, rare or endangered species; identification of geological hazards; or potential air quality and noise impacts, and traffic studies were beyond the scope of this exploration.

- **This is an exploration results report and is not intended to be used as a specification for construction. Specifications will be developed during Task 2A of our scope of services.**

Closure

S&ME appreciates this opportunity to provide engineering consulting services to you on this project. Please do not hesitate to contact us with any questions or comments.

Sincerely,

S&ME, Inc.

SOUTH CAROLINA CERTIFICATE OF AUTHORIZATION S&ME, INC. No. C00473

Adam R. Limeburner, E.I.T.
Staff Professional

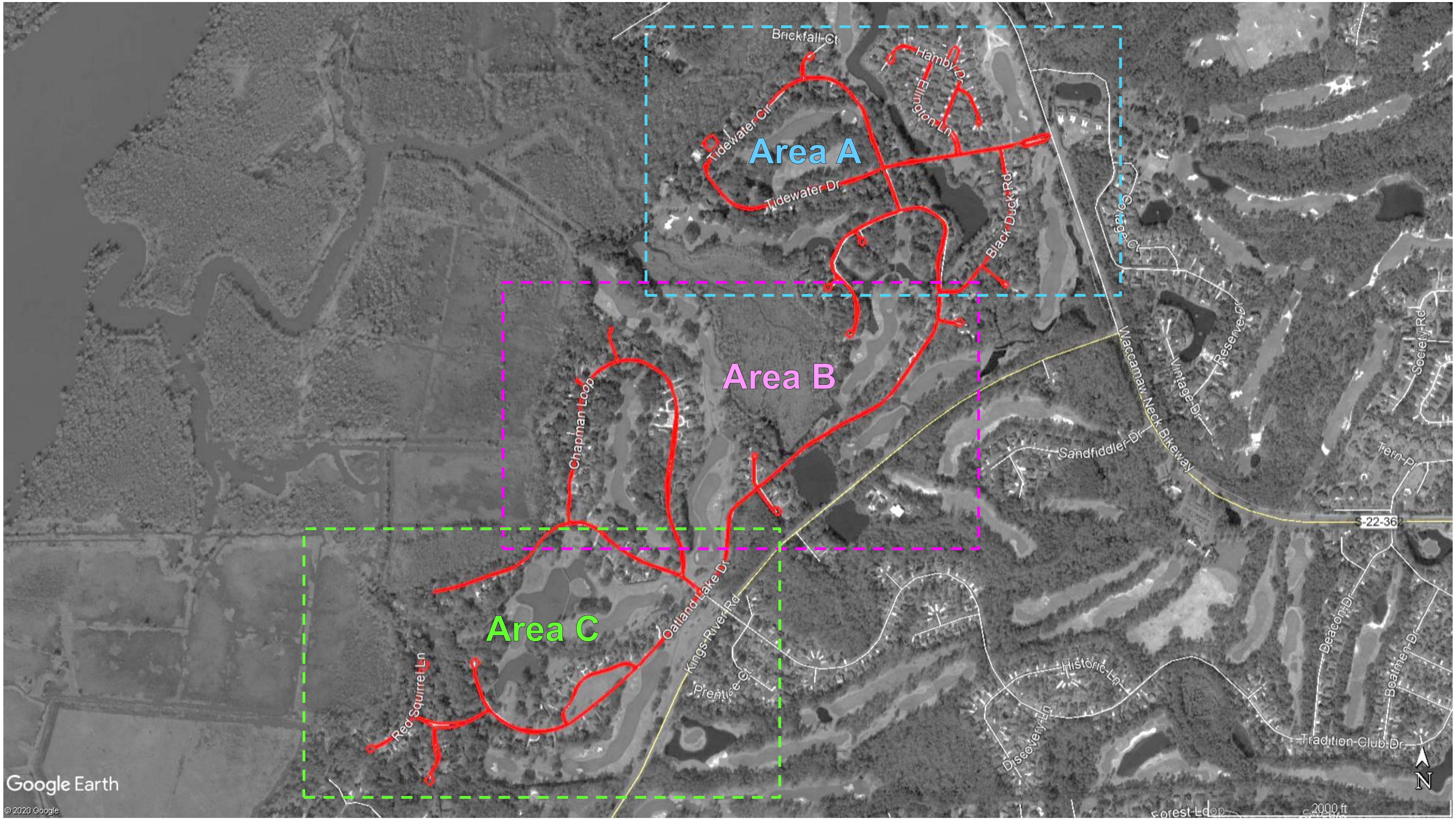
Ronald P. Forest, Jr., P.E.
Senior Engineer
S.C. Registration No. 21248

SOUTH CAROLINA REGISTERED PROFESSIONAL ENGINEER No. 21248 RON FOREST JR. 9/25/20

Attachments: Appendix

Appendix

REFERENCE:
GOOGLE EARTH PRO AERIAL PHOTOGRAPH
(DATED FEBRUARY 4, 2019)

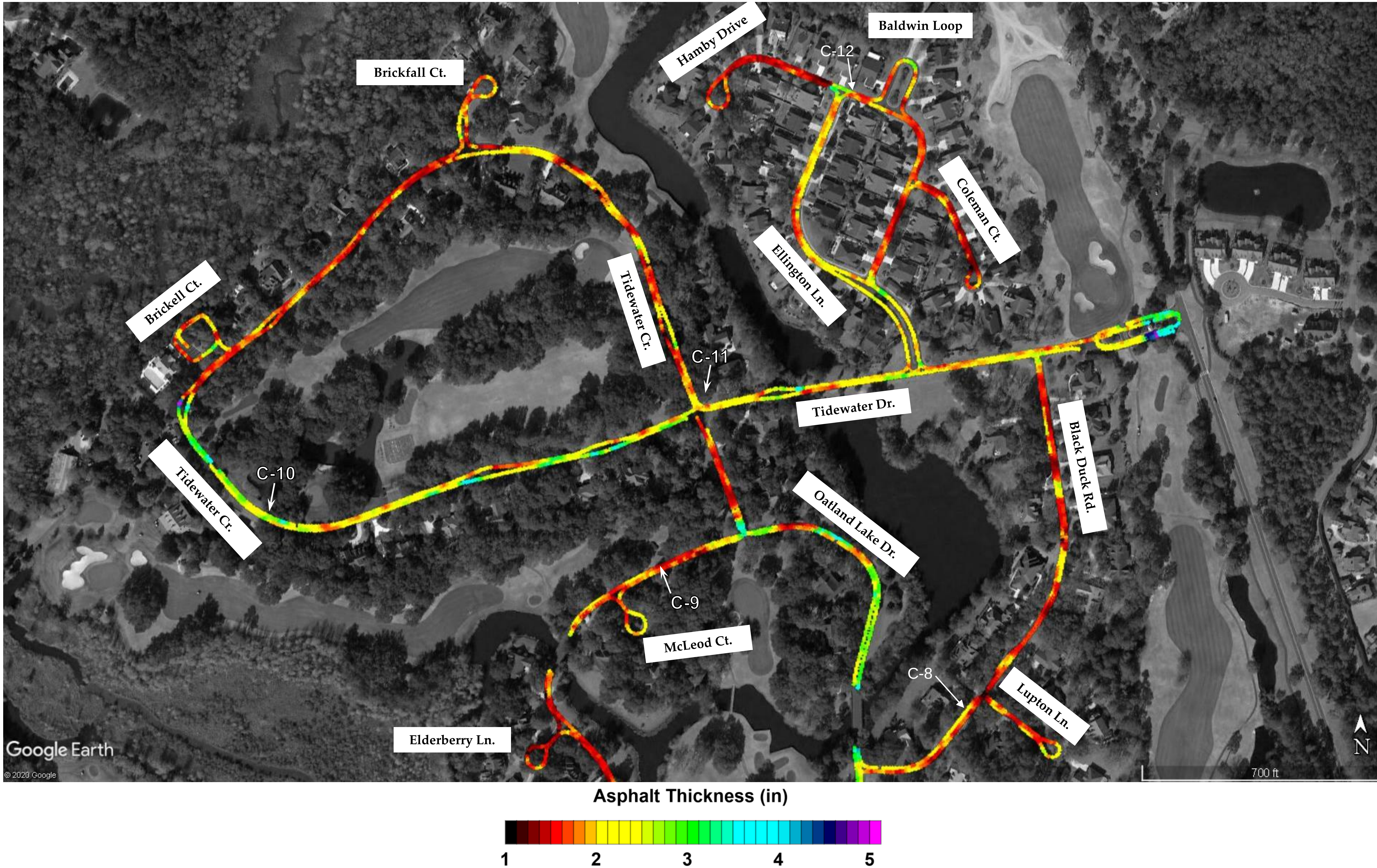


GPR SURVEY LOCATION PLAN - OVERVIEW

WILLBROOK PLANTATION
PAWLEYS ISLAND, SOUTH CAROLINA

SCALE:	AS SHOWN
DATE:	9/25/2020
PROJECT NUMBER	1363-20-023
FIGURE NO.	1

REFERENCE:
GOOGLE EARTH PRO AERIAL PHOTOGRAPH
(DATED FEBRUARY 4, 2019)



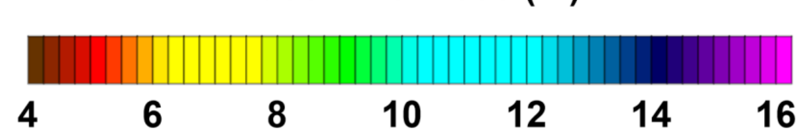
ASPHALT THICKNESS PLOT – AREA A

WILLBROOK PLANTATION
PAWLEYS ISLAND, SOUTH CAROLINA

SCALE:	AS SHOWN
DATE:	9/25/2020
PROJECT NUMBER	1363-20-023
FIGURE NO.	2

REFERENCE:
GOOGLE EARTH PRO AERIAL PHOTOGRAPH
(DATED FEBRUARY 4, 2019)

Base Thickness (in)

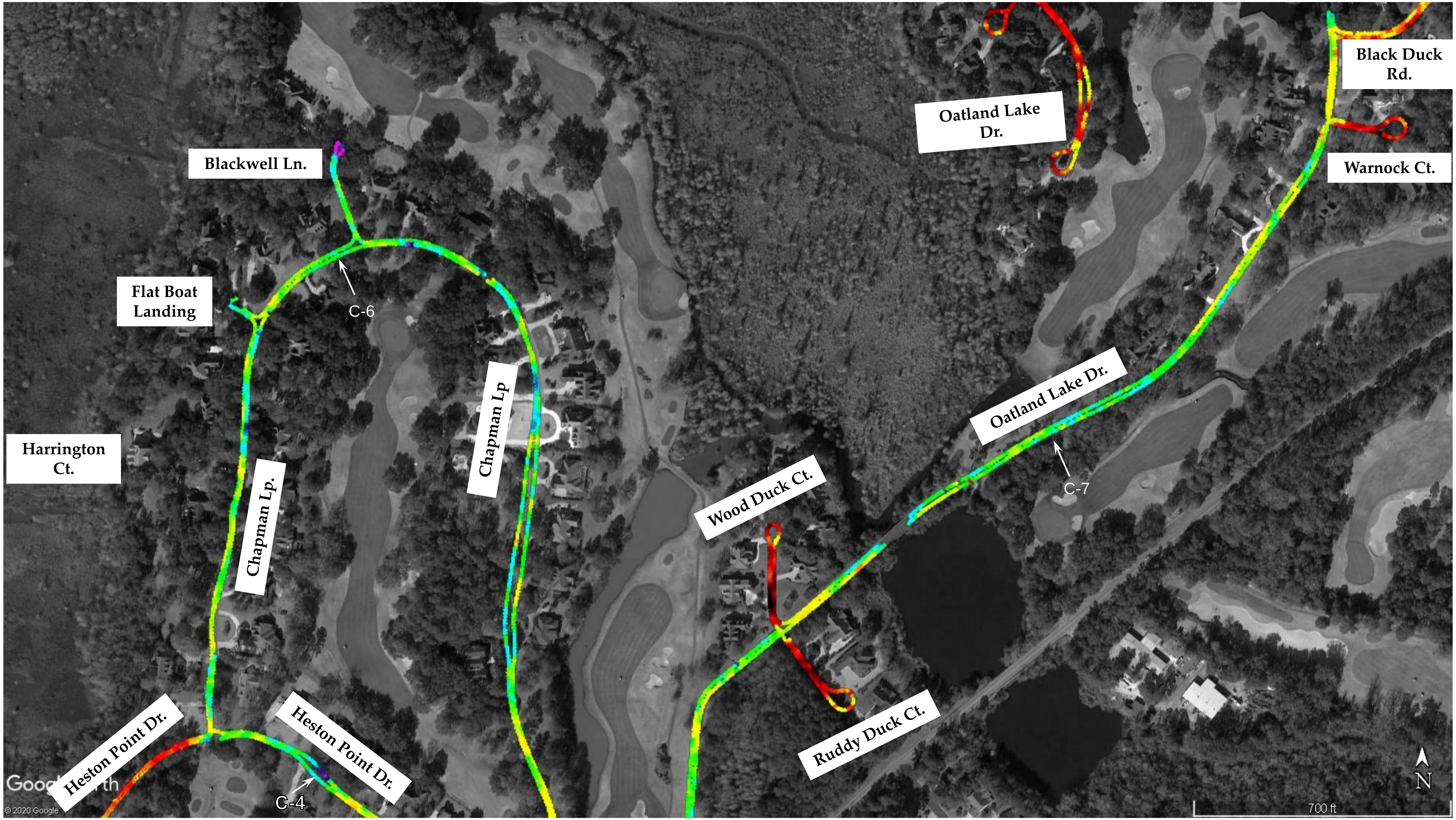


BASE THICKNESS PLOT – AREA A

WILLBROOK PLANTATION
PAWLEYS ISLAND, SOUTH CAROLINA

SCALE:	AS SHOWN
DATE:	9/25/2020
PROJECT NUMBER	1363-20-023
FIGURE NO.	3

REFERENCE:
GOOGLE EARTH PRO AERIAL PHOTOGRAPH
(DATED FEBRUARY 4, 2019)



Asphalt Thickness (in)

1 2 3 4 5

ASPHALT THICKNESS PLOT – AREA B

WILLBROOK PLANTATION
PAWLEYS ISLAND, SOUTH CAROLINA

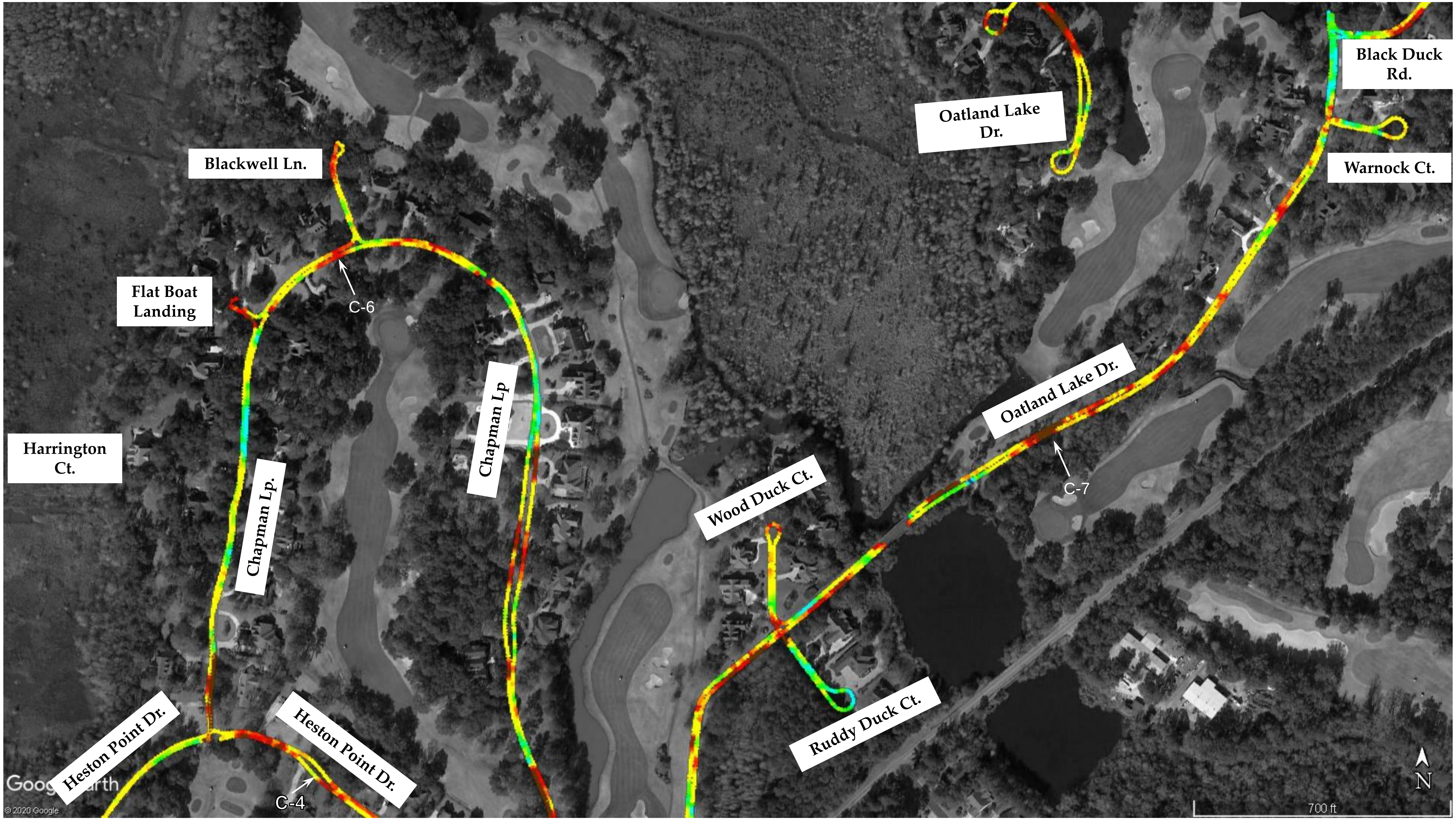
SCALE: AS SHOWN

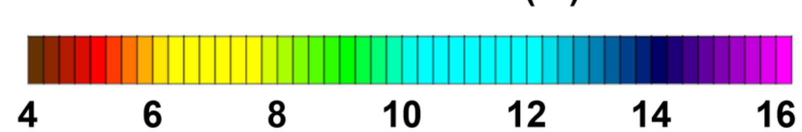
DATE: 9/25/2020

PROJECT NUMBER 1363-20-023

FIGURE NO. 4

REFERENCE:
GOOGLE EARTH PRO AERIAL PHOTOGRAPH
(DATED FEBRUARY 4, 2019)





BASE THICKNESS PLOT – AREA B

WILLBROOK PLANTATION
PAWLEYS ISLAND, SOUTH CAROLINA

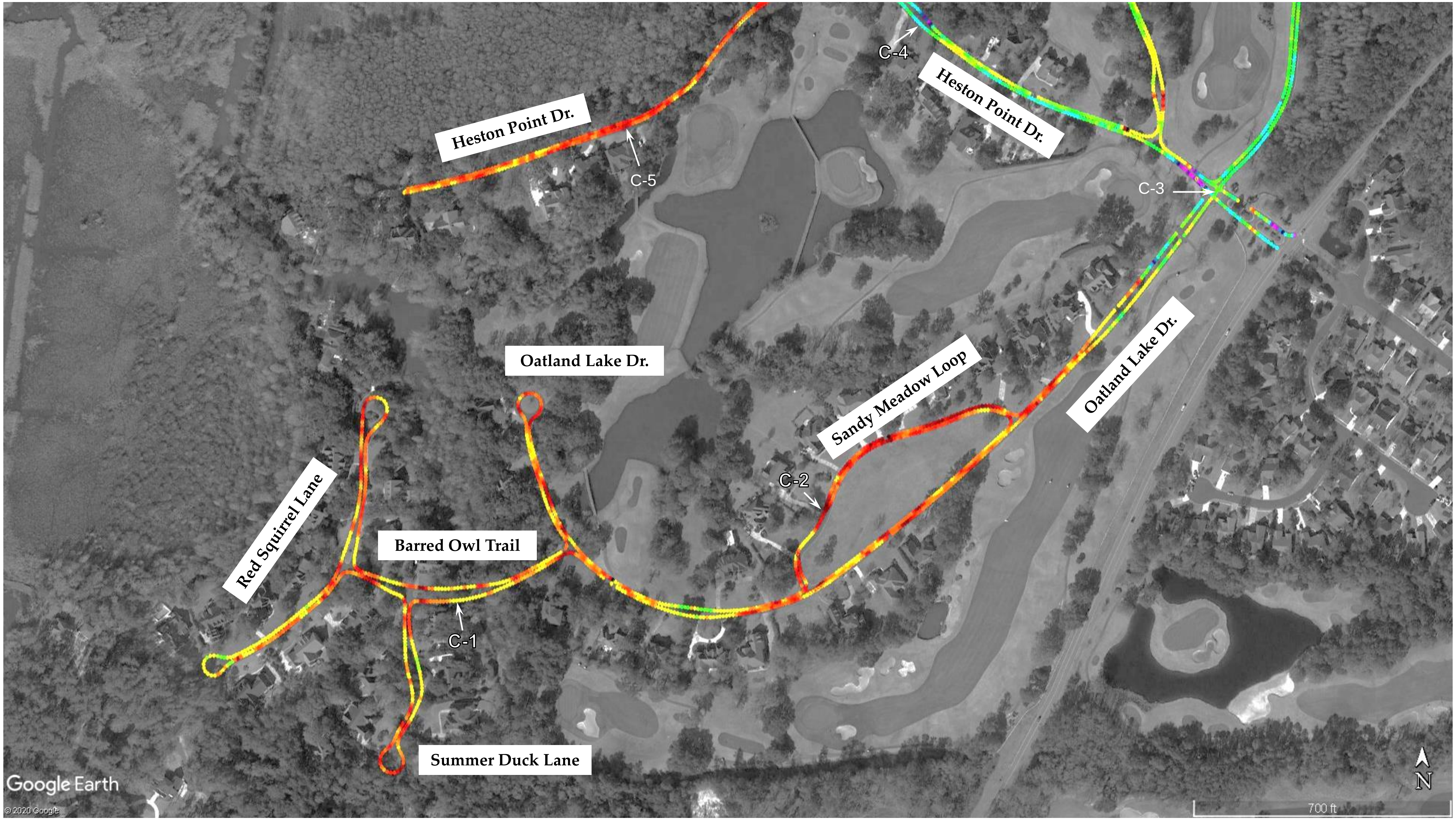
SCALE: AS SHOWN

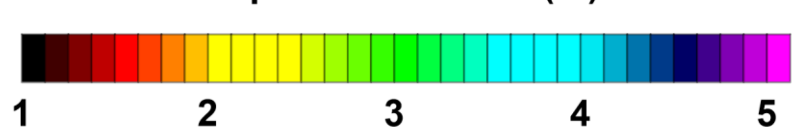
DATE: 9/25/2020

PROJECT NUMBER 1363-20-023

FIGURE NO. 5

REFERENCE:
GOOGLE EARTH PRO AERIAL PHOTOGRAPH
(DATED FEBRUARY 4, 2019)



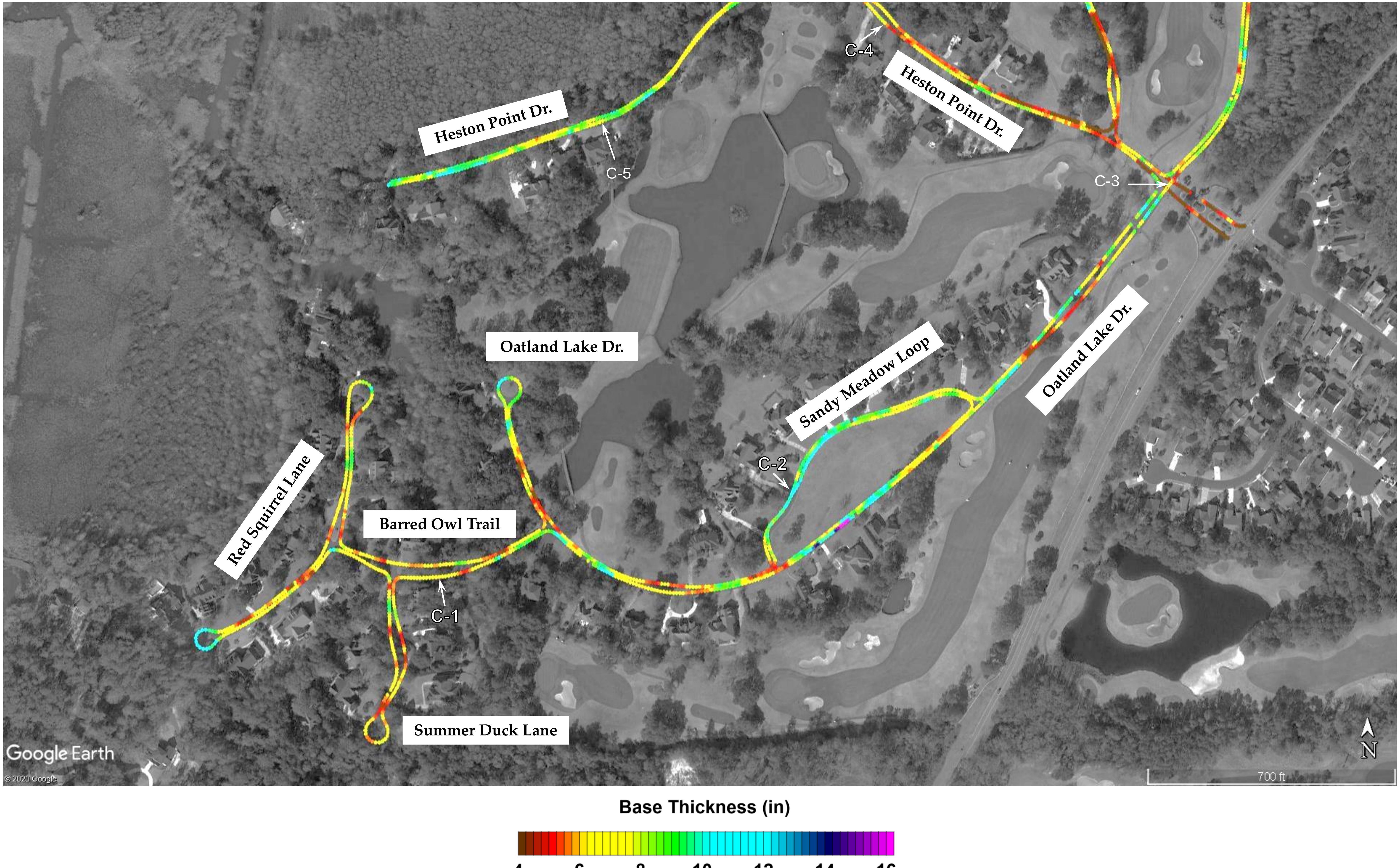


ASPHALT THICKNESS PLOT – AREA C

WILLBROOK PLANTATION
PAWLEYS ISLAND, SOUTH CAROLINA

SCALE:	AS SHOWN
DATE:	9/25/2020
PROJECT NUMBER	1363-20-023
FIGURE NO.	6

REFERENCE:
GOOGLE EARTH PRO AERIAL PHOTOGRAPH
(DATED FEBRUARY 4, 2019)



BASE THICKNESS PLOT – AREA C

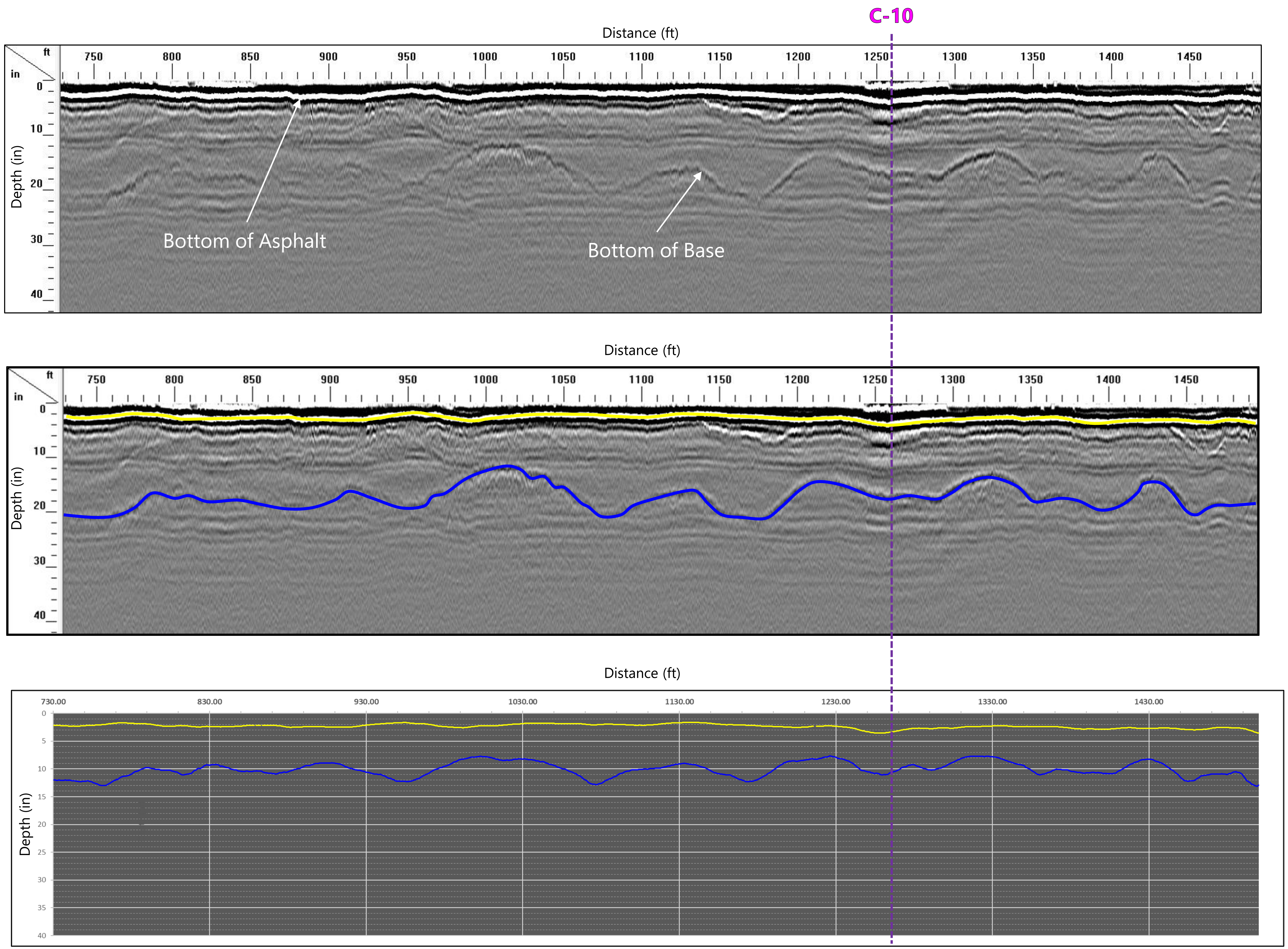
WILLBROOK PLANTATION
PAWLEYS ISLAND, SOUTH CAROLINA

SCALE:
AS SHOWN

DATE:
9/25/2020

PROJECT NUMBER
1363-20-023

FIGURE NO.
7



Legend

Bottom of Asphalt — Bottom of Base Course

Note: Depths in the raw GPR data profiles presented above are based on uncorrected data and should be considered approximate. Final color-coded thicknesses and plots presented in the previous figures, however, are based on corrected dielectric values. In addition, distances in the raw GPR profiles presented above are based on field effort distances rather than actual project distances. Final data distances in the previous figures are presented based on GPS positioning collected during the GPR survey.

EXAMPLE GPR PROFILE – CORE C-10

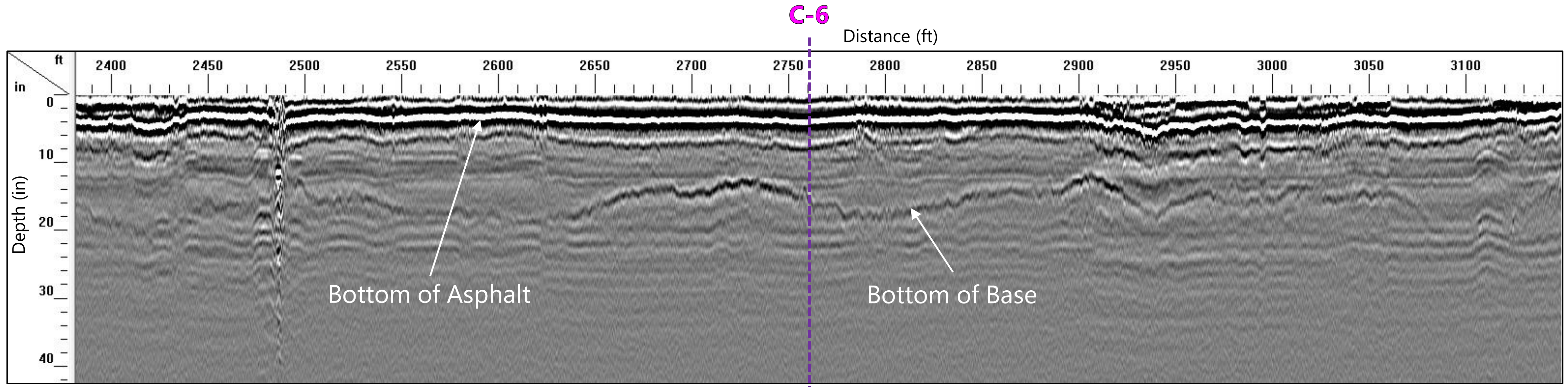
WILLBROOK PLANTATION
PAWLEYS ISLAND, SOUTH CAROLINA

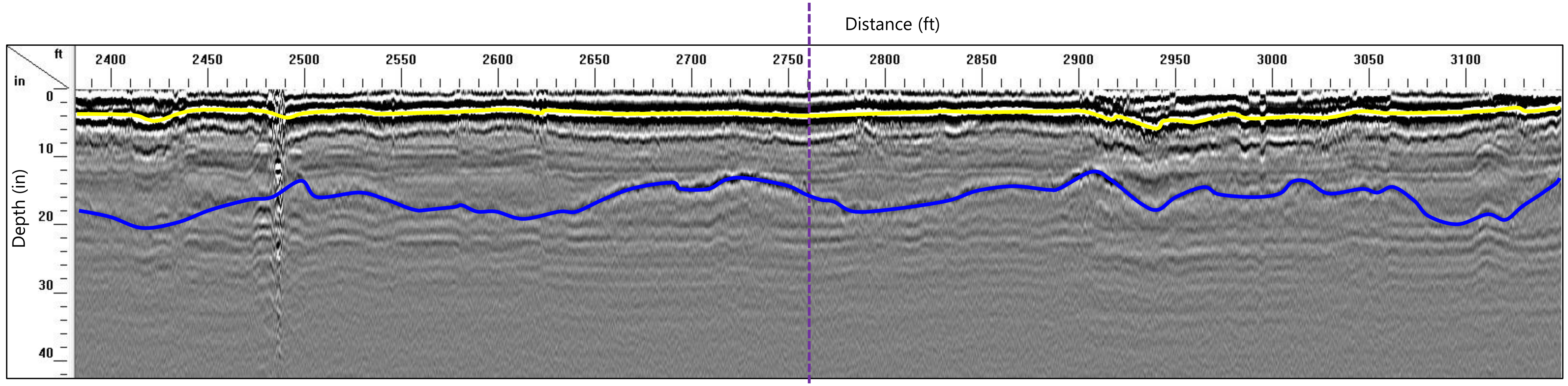
SCALE: AS SHOWN

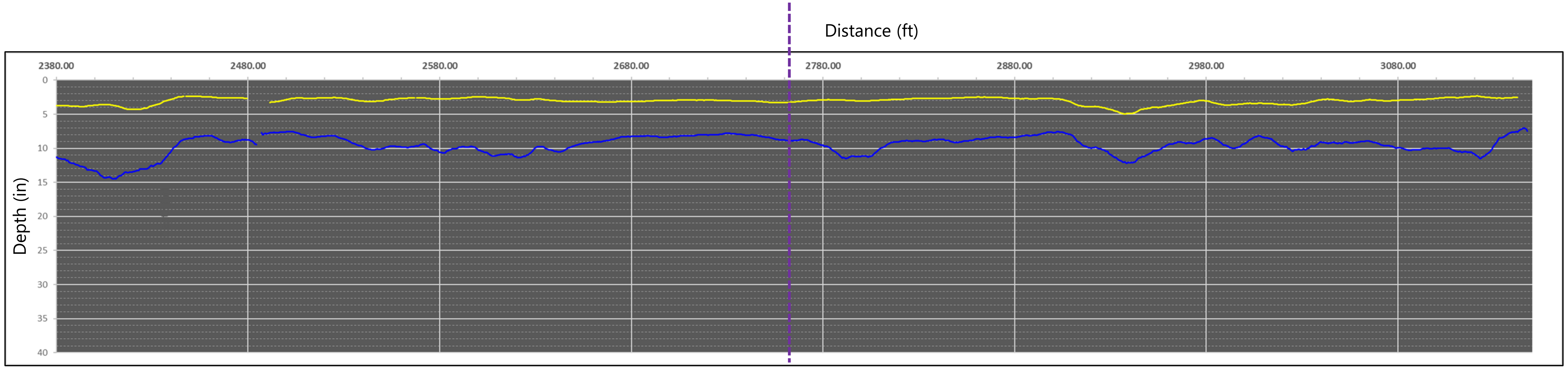
DATE: 9/25/2020

PROJECT NUMBER: 1363-20-023

FIGURE NO. 8







Legend

Bottom of Asphalt

Bottom of Base Course

Note: Depths in the raw GPR data profiles presented above are based on uncorrected data and should be considered approximate. Final color-coded thicknesses and plots presented in the previous figures, however, are based on corrected dielectric values. In addition, distances in the raw GPR profiles presented above are based on field effort distances rather than actual project distances. Final data distances in the previous figures are presented based on GPS positioning collected during the GPR survey.

EXAMPLE GPR PROFILE – CORE C-6

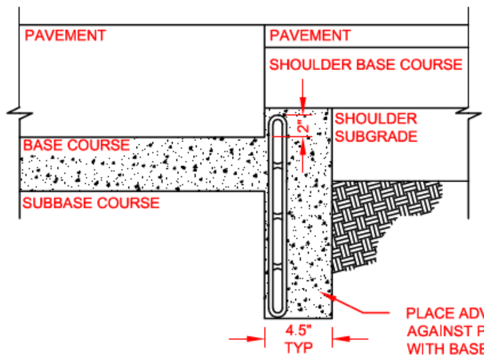
WILLBROOK PLANTATION
PAWLEYS ISLAND, SOUTH CAROLINA

SCALE:
AS SHOWN

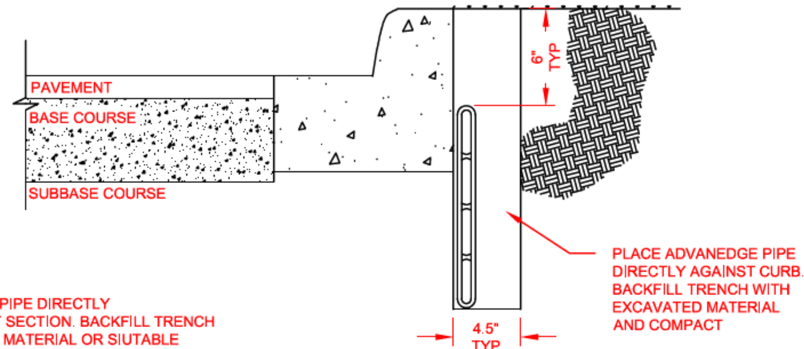
DATE:
9/25/2020

PROJECT NUMBER
1363-20-023

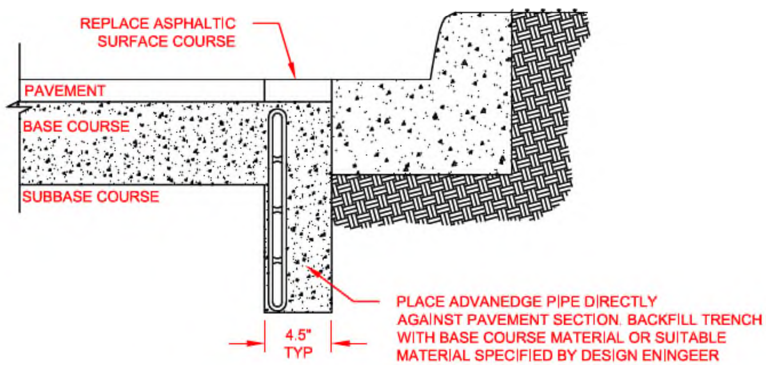
FIGURE NO.
9



ADVANEDGE INSTALLATION DETAIL
(NO CURB & GUTTER)



ADVANEDGE INSTALLATION DETAIL
(CITY STREET W/ CURB & GUTTER)



ADVANEDGE INSTALLATION DETAIL
(CITY STREET W/ CURB & GUTTER)

3	REV. DRAWING NAME OR NUMBER	TJR	01/28/16	
REV.	DESCRIPTION	BY	MM/DD/YY	CHK'D

ADVANCED DRAINAGE SYSTEMS, INC. ("ADS") HAS PREPARED THIS DETAIL BASED ON INFORMATION PROVIDED TO ADS. THIS DRAWING IS INTENDED TO DEPICT THE COMPONENTS AS REQUESTED. ADS HAS NOT PERFORMED ANY ENGINEERING OR DESIGN SERVICES FOR THIS PROJECT, NOR HAS ADS INDEPENDENTLY VERIFIED THE INFORMATION SUPPLIED. THE INSTALLATION DETAILS PROVIDED HEREIN ARE GENERAL RECOMMENDATIONS AND ARE NOT SPECIFIC FOR THIS PROJECT. THE DESIGN ENGINEER SHALL REVIEW THESE DETAILS PRIOR TO CONSTRUCTION. IT IS THE DESIGN ENGINEERS RESPONSIBILITY TO ENSURE THE DETAILS PROVIDED HEREIN MEETS OR EXCEEDS THE APPLICABLE NATIONAL, STATE, OR LOCAL REQUIREMENTS AND TO ENSURE THAT THE DETAILS PROVIDED HEREIN ARE ACCEPTABLE FOR THIS PROJECT.

INSTALLATION DETAIL (ADVANEDGE)

DRAWING NUMBER: STD–105

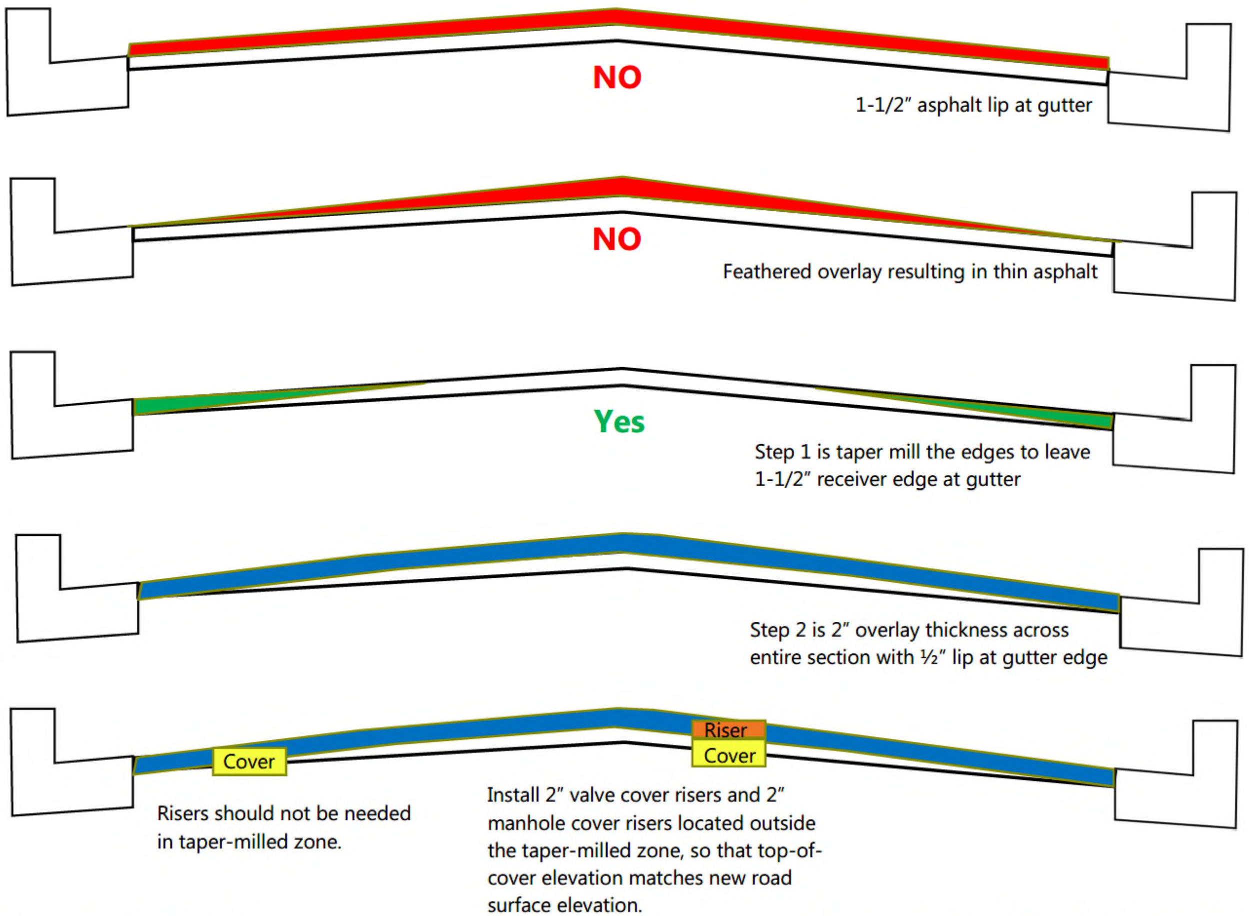
ADVANCED DRAINAGE SYSTEMS, INC.
4640 TRUEMAN BLVD
HILLIARD, OHIO 43026

KMJ
5/6/99
NTS
OF

ADS INSTALLATION DETAIL

WILLBROOK PLANTATION ASSOCIATION.
PAWLEYS ISLAND, SOUTH CAROLINA

SCALE: AS SHOWN
DATE: 9/25/2020
PROJECT NUMBER 1363-20-023
FIGURE NO. 10



NOT TO SCALE

Figure 1: Milling/Overlay Detail

MILLING/OVERLAY DETIAL

WILLBROOK PLANTATION ASSOCIATION.
PAWLEYS ISLAND, SOUTH CAROLINA

SCALE: AS SHOWN

DATE: 9/25/2020

PROJECT NUMBER 1363-20-023

FIGURE NO. **11**