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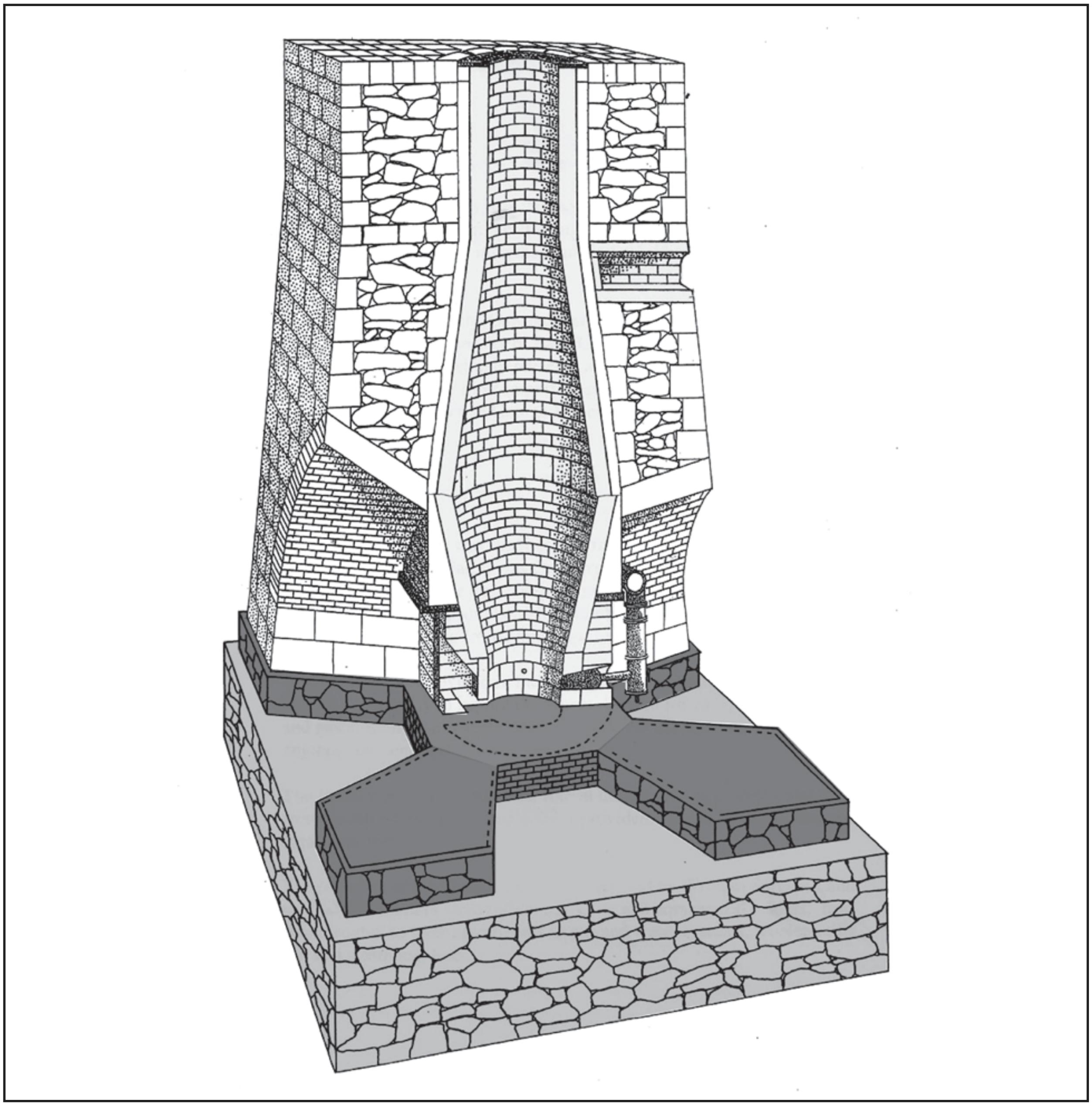

Volume 42, Number 1, 2016

IA

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COVER: Cutaway illustration of the Oswego Furnace (1866) by Susanna C. Kuo.
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Railroad Tracks belonging to the South Carolina Canal and Railroad Company, *c*.1839–1852

Howard Wayt

Abstract

Wood and iron railroad tracks belonging to the South Carolina Canal and Railroad Company (SCCRR) were discovered near Aiken, South Carolina, in early 2017. Historic maps, modern satellite photos, and Light Detection and Ranging (LIDAR) data identified locations where the tracks of the SCCRR likely originally ran in the vicinity of the discovery. Period documentation details the construction and operation of the tracks by the SCCRR. Field observations and preliminary searches determined the extent and configuration of the find and confirmed the predicted nearby route of the original SCCRR tracks. Field observations of the original and additional artifacts compared well with period documentation of the construction of the tracks of the SCCRR. The locations of these artifacts also compared well with the predicted route of the original SCCRR tracks. As a result, it became clear that the railroad tracks were part of what was called "the Inclined Plane" built at Aiken between 1830 and 1833. They represent the configuration of those tracks as used between 1839 and 1852.

A structure reminiscent of railroad tracks constructed of wooden rails capped with iron was discovered in Hitchcock Woods, a large, privately owned natural preserve within the city of Aiken, South Carolina, in early 2017 during an extensive and significant cultural resources survey commissioned by the Hitchcock Woods Foundation and performed by archaeologists Carl Steen and Bobby Southerlin.[1] Because such railroad construction was generally abandoned in the United States in the 1840s to 1850s, the wooden parts of the rails would have had to survive at least 160 years in the soil—an unlikely but not impossible proposition.

Hitchcock Woods encompasses *c*.2,100 acres of mature longleaf pine and is a natural habitat for several protected species of flora and fauna, including the Red-Cockaded Woodpecker. The Woods have had a long history of human occupation, but for most of the past 300 years have remained largely undeveloped and sparsely occupied. The Hitchcock Woods Foundation, a 501(c)(3) charitable non-profit organization established by the Hitchcock family in 1939, protects and maintains the Woods for the enjoyment of the Aiken community. Almost all of the Hitchcock Woods is included in the Aiken Winter Colony Historic District I on the National Register of Historic Places Inventory, and the South Carolina Department of Natural Resources (SCDNR) maintains a natural and cultural easement over the Woods.

Steen and Southerlin identified what they believed to be approximately 2.6 miles of original railroad roadbed in the Hitchcock Woods, and they provided extensive documentary and archaeological field evidence to support their conclusion that this roadbed had been built by the South Carolina Canal and Railroad Company (SCCRR) between 1830 and 1833 as part of its original main line between Charleston and Hamburg, South Carolina. They also postulated that the intact wooden tracks they had discovered might belong to what was called the Inclined Plane, built by the SCCRR to overcome a steep change in elevation *c*.16 mi. from Hamburg. This Inclined Plane was a pair of parallel tracks laid on a slope too steep to be climbed by the steam locomotives of the time. This problem necessi-

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Howard Wayt, Aiken, SC. howard@waytawhile.com.

tated mounting a large hoisting wheel at the top of the slope with a rope wound around it and extending the length of the Inclined Plane. Rail cars from Charleston on their way to Hamburg accumulated at the top of the Inclined Plane, and from Hamburg on their way to Charleston at the bottom, each waiting to be transferred across it. As cars arrived at the top of the slope and at the bottom of the slope they were arranged to counterbalance one another during transfer. One set of cars at the top and one set at the bottom were connected to "brake cars," one at each end of the hoisting rope. A stationary steam engine then drove the wheel, simultaneously raising cars to the top of the slope on one track while lowering cars to the bottom on the other. A dedicated steam locomotive transferred rail cars between the bottom of the Inclined Plane and Hamburg, while those delivered to the top were made into trains headed for Charleston. This Inclined Plane was likely similar in construction and operation to Inclined Plane No. 8 on the contemporary Allegheny Portage Railroad in Pennsylvania (figure 1).[2]

One of the earliest railroads chartered in the U.S. and the first built in the South, the 136-mi. SCCRR mainline at its completion in 1833 was by far the longest continuous mainline of railroad track in the world (figure 2). For comparison, the well-known Baltimore and Ohio Railroad (B&O)—the first railroad chartered (Feb. 28, 1827) in the U.S. to carry general merchandise and passengers—reported its longest continuous mainline as extending only 69.5 mi. in 1834.[3] The SCCRR represented significant first achievements in the history of railroading: its use of steam locomotives for regular service predates that of all other railroads in the U.S., and it put into scheduled service the first two steam locomotives (the "Best Friend of Charleston" and the "West Point")—which were also the first two locomotives built in the U.S., by the West Point Foundry in New York.[4] The SCCRR established precedents for locomotive design, rail car design, and railroad operations and maintenance in the U.S., and in the South in particular.[5] In commemoration of the achievements of this railroad, the American Society of Civil Engineers (ASCE) designated the Charleston to Hamburg Railroad as a National Historic Engineering Landmark in 1970.[6]

The Incline Plane was crucial to the extension of the SCCRR to the Savannah River at Hamburg, thereby connecting much of the upland South Carolina and Georgia commercial traffic to Charleston. The construction of the Inclined Plane was also the reason for the founding of the city of Aiken itself in 1834—only the second town in the U.S. founded by a railroad company. (In fact, Summerville, South Carolina, was the first and was also founded by the SCCRR).[7] However, the path of the main line railroad tracks and the Aiken Inclined Plane was not preserved or maintained, and over time became lost.

The structure discovered by Steen and Southerlin was revealed in a geographic feature local to Hitchcock

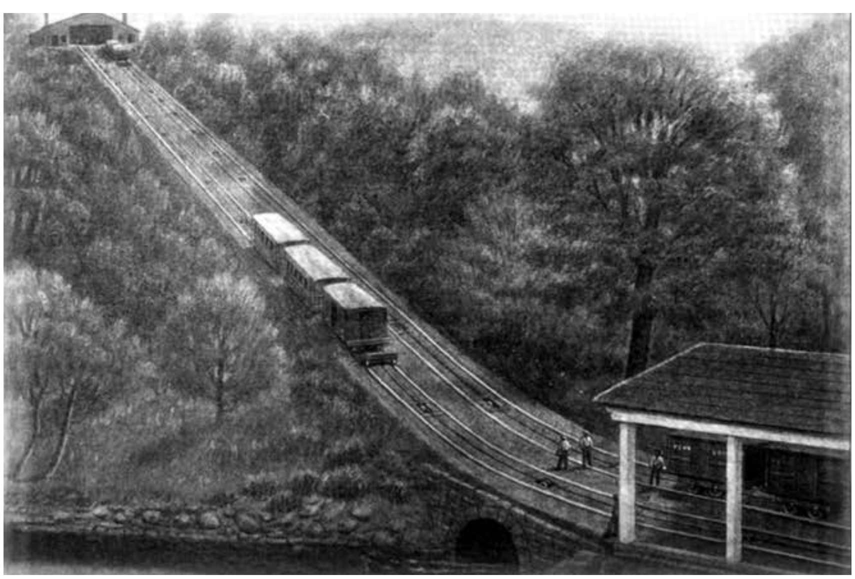

Figure 1. "Old Portage Railroad. Inclined Plane No. 8" as depicted by George W. Storm, eyewitness and "distinguished Pennsylvania artist." From William Bender Wilson, "The Evolution, Decadence and Abandonment of the Allegheny Portage Railroad," (Harrisburg, 1900), xl and lxxii.

Woods known as the Sand River. The Sand River is so named because for most of the year it is just that, a river of white sand, with little or no standing or running water in it. It does, however, become deluged with water during local rainstorms. The river currently acts as a storm drain for the city of Aiken flowing downhill to the south and west away from the southwest corner of downtown Aiken. Increased development in Aiken in recent decades has significantly increased water runoff and consequential erosion of the banks of the Sand River, undercutting and collapsing the embankments in several locations. One collapse, in 2007, and subsequent erosion of the soil and sand revealed the railroad tracks in the bottom of the river.

Identification of original wood and iron-strap railroad tracks belonging to the SCCRR would be a discovery of major significance, both nationally and internationally. This study was implemented to confirm that the tracks belonged to the SCCRR, that erosion had displaced them from their original location, and to ascertain the potential risk to their preservation. Achievement of this goal would identify both the original location of the main line and Inclined Plane railroad tracks and the construction methods used for building those tracks.

Historic Maps

Currently, four historic maps of the Aiken vicinity, indicating the location of the original SCCRR tracks, have been discovered. The earliest is a map of a section of what was called "The Sixth Residency" of the SCCRR, completed as part of the original survey of the railroad before Aiken was established (figure 3). Though no exact date can be attributed to it, the map must pre-date 1834. Although it contains handwritten notes showing distances and locations in reference to a survey marker, the map cannot be used to indicate the route of the tracks because the location of that survey marker is unknown and no other reference points shown on the map still exist. The second is the original map of Aiken as laid out by railroad surveyors Andrew Alfred Dexter and Cyril Ouviere Pascalis in 1834, showing the route of the

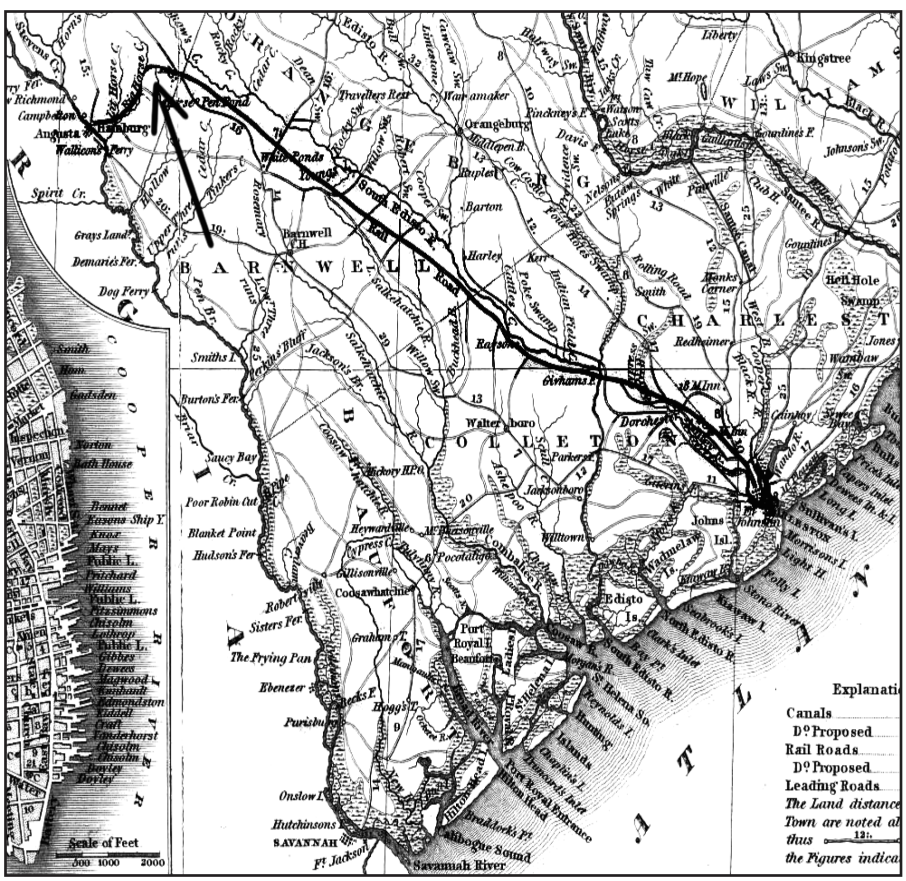

Figure 2. Route of the SCCRR in 1833. Aiken was founded in 1834 by the SCCRR at the sharp bend in the railroad where it meets Big Horse Creek *(indicated by the arrow)*. Detail from H. S. Tanner, "A new map of South Carolina with its canals, roads & distances from place to place along the stage & steam boat routes," *A New Universal Atlas* (Philadelphia, 1836). Courtesy of the Library of Congress, loc.gov/98688556.

railroad tracks through the town, and also the location of the top of the Inclined Plane.[8] The third is an undated but very early copy of the original 1834 Dexter and Pascalis map, showing greater detail of the railroad and also some additional information about lots that had been sold since the original map was drafted (figure 4). The fourth is of Aiken from 1869 by A. de Caradeuc depicting the location of the then-abandoned Inclined Plane intersected by a new railroad bed—the result of the 1852 re-routing of the tracks to eliminate use of the Inclined Plane (figure 5).[9] The new track location required considerable excavation and a longer, more gradual route south of the original railroad tracks. This route is still in use and is known colloquially as the "Aiken Cut."

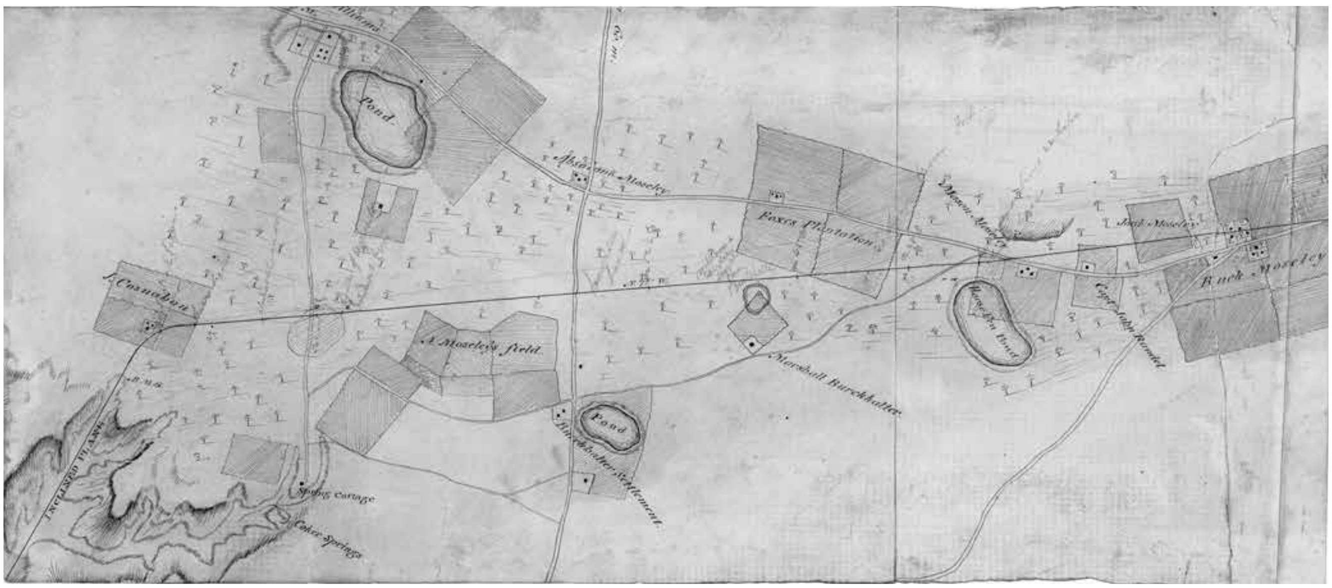

Figure 3. SCCRR "Sixth Residency" map, 1830–33 (detail). The rail line runs straight from Buck Moseley on a slightly south of westerly bearing before taking a distinct left-hand turn to dive down a gully below J. Cashoban's farm, indicating how crucial it was to develop the Inclined Plane in that gully. Courtesy of Norfolk Southern Corp.

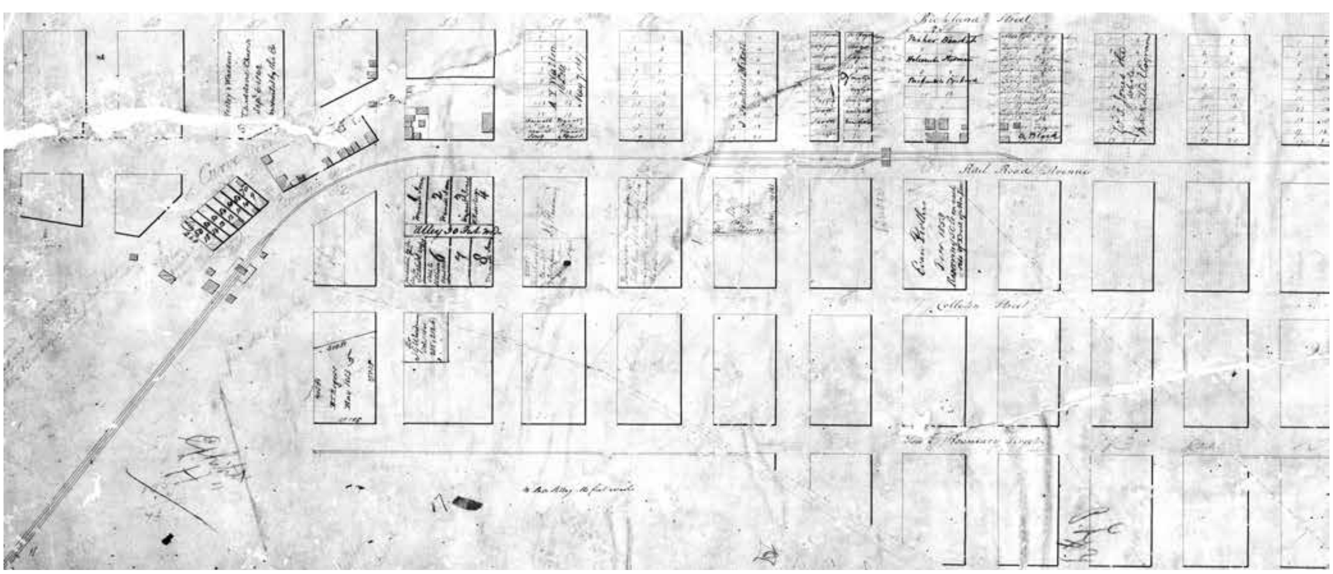

Figure 4. Detail of the 1834 A.A. Dexter and C.O. Pascalis map for Aiken, SC, showing the location of the mainline tracks and the head of the Aiken Inclined Plane *(lower left)*. Courtesy of the Aiken County Historical Museum.

The latter three maps indicate the presence of a stationary engine at the top of the Inclined Plane that was used in the first several years of the operation to haul cars up and down the Inclined Plane. These maps compare well to one another, including the detail of the lot numbers originally assigned by the railroad when Aiken was laid out. Landmarks on all three maps show that the Inclined Plane was located in an area that is now the southwest corner of downtown Aiken. This area also borders Hitchcock Woods, within a ½ mile of where the tracks were discovered. The 1869 parcel boundaries in particular were found to compare well with modern parcels. An overlay of the Dexter and Pascalis maps and the 1869 map with current GIS data indicates that the base of the stationary engine, built at the top of the Inclined Plane, was near the intersection of what are now Highland Park Avenue and Highland Park Terrace roads (figure 6). At this location, the 1869 map shows a rectangle marked "old stationary engine" near the location of a structure labeled "Engine House" on the original Dexter and Pascalis map. The Engine House on the original Dexter and Pascalis map is represented by two shaded square brackets on either side of the tracks, suggesting a building with open ends and, presumably, a truss roof covering the engine and machinery. On the copy of the Dexter and Pascalis map, the engine house is shown in opposite contrast: two unshaded square brackets, with the tracks covered by a shaded square in the middle.

The length of the Inclined Plane is not entirely clear. An article in the 1833 *American Railroad Journal (ARJ)* reported that the Inclined Plane extended 3,800 ft. (0.73 mi.) over three grades, the steepest of which had a gradient of 1 in. 13 ft., and changed 180 ft. in elevation over this distance.[10] Poussin's 1836 book *Chemins de fer Américains* described the Inclined Plane changing "a height of 51 meters [167ft] over a length of 1,158 meters [3,800 ft]." Von Gerstner's 1843 book *Die Innern Communicationen der Vereinigten Staaten von Nordamerica* said that the Inclined Plane "is 3,800 ft. long and 167 ft. high." Both of these books contradict the change in elevation given in the 1833 *ARJ* report.[11] Both Poussin and von Gerstner do, however, state that the steepest slope was 1 in 13, which agrees with the "steepest gradient" from the 1833 *ARJ* article.[12] To further complicate matters, a 1847 *ARJ* article lists several facts about the South Carolina Railroad Company (SCRR, which had succeeded the original SCCRR by that time), includ-

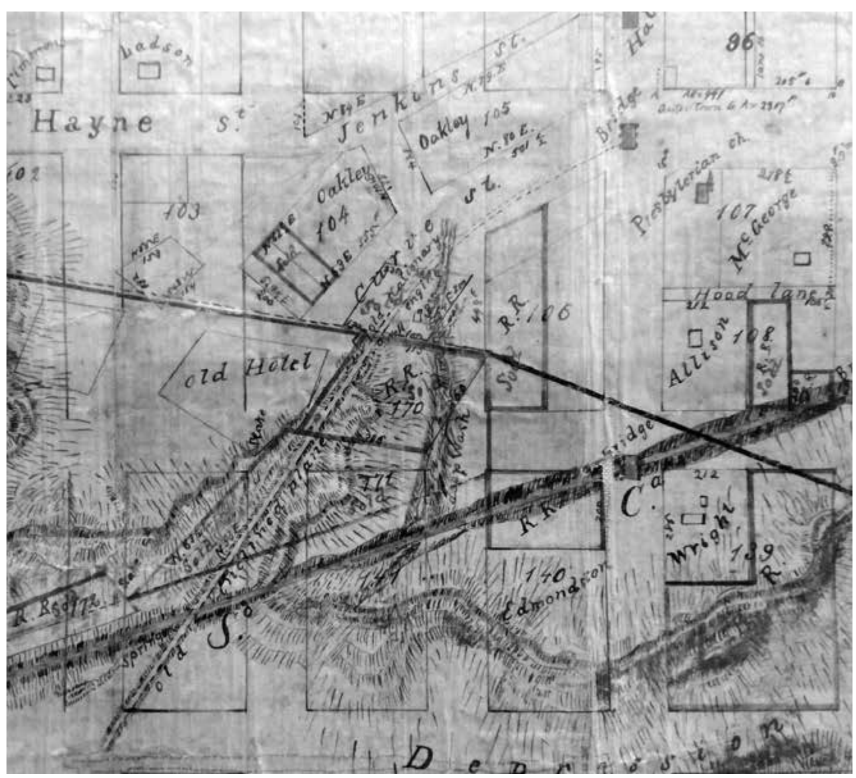

Figure 5. Detail of A. de Caradeuc map of Aiken, SC, in 1869. The Aiken Cut that cuts through and replaced the Inclined Plane in 1852 crosses the map *(from lower left to middle right).* Courtesy of Judith V. Warner, Registrar of Mesne Conveyance for Aiken County, SC. Photo by the author.

Figure 6. Overlay of the 1834 Dexter and Pascalis map and the de Caradeuc map on current Aiken GIS data. Dashed Line is approximately ½ mi. long, starts at the top of the Inclined Plane *(center-right)*, and ends beyond where the tracks were found, passing over them. GIS data from Aiken County Government Geoservices Division, Government Center, Aiken, SC.

ing that the Inclined Plane at Aiken was at that time approximately ½ mi. long and changed 176 ft. in elevation over that distance.[13] A gradient of 1 over 13 would drop 180 ft. over a calculated distance of 2,340 ft. (0.44 mi.), 167 ft. over a calculated distance of 2,171 ft. (0.41 mi.), or 176 ft. over a calculated distance of 2,288 ft. (0.43 mi.), all very similar distances. This means that the 1847 measurement probably refers only to the steepest slope of the Inclined Plane as reported in 1833, 1836, and 1843. Samuel Derrick reports that plans were made in 1835 to shorten the Inclined Plane by 1,100 ft., making it 2,700 ft. (0.51 mi.) to one uniform grade, but there is currently no documentary evidence that this was actually done.[14]

The 1833, 1836 and 1843 measurements may also include the additional lengths of the necessary transition tracks and staging tracks placed at the top and bottom of the Inclined Plane, while the 1847 measurement does not. The Inclined Plane would have had the shape of an elongated and slanted *"S"* if it were possible to view it from the side. The center of the Inclined Plane would have been straight but steep for most of its length. At the top and bottom of this central slope would have been tracks that gradually transitioned to level tracks. The very top and bottom of the *"S"* would have consisted of flat and level staging tracks where cars would have waited either to be transferred up and down the Inclined Plane or to be picked up by trains headed for Charleston (at the top) or Hamburg (at the bottom). All three sections were double-tracked and switches at both ends of the staging tracks merged the Inclined Plane tracks with the single-tracked mainline. Examples of all three track sections (central slope, transition, and staging) can be seen in the illustration of Inclined Plane No. 8 from the Allegheny Portage Railroad (figure 1). Since the previous calculations yielded predicted central slope distances short of 3,800 ft. between 1,460 ft. and 1,630 ft., it follows that 730–815 ft. of space was available for the required transitional and staging tracks at both the top and bottom of the Inclined Plane.

A line was overlaid on the GIS map, anchored at the predicted top of the Inclined Plane, and aligned through its path, to help predict where remnants of the Inclined Plane might be found (figure 6). The rails were found *c.*½ mi. from where the top of the Inclined Plane was assumed to be and adjacent to the line drawn. This line runs parallel to and partially in the modern-day bed of the Sand River. Tracing down the slope along the line from the top of the Inclined Plane, the first level area encountered is *c.*3,000 ft. (0.57 mi.) from the top, a wide clearing which today is known as Memorial Gate. This is larger than the largest predicted length for the central slope of 2,340 ft. Continuing to trace the line, at *c.*3,800 ft. from the top of the Inclined Plane, the Sand River begins a wide bend to the south. It is not likely that the Inclined Plane extended beyond this point since horizontal curves would have significantly and needlessly complicated its design and operation. This also means that there is room along the predicted path for the greatest overall length reported for the Inclined Plane.

This information only indicates the general location of the Inclined Plane. Preliminary field scouting of the slope south of the Aiken Cut was hindered by the density of local vegetation in the area of interest. The private property north of the Aiken Cut was not scouted, and most of it has been significantly redeveloped over the last century.

LIDAR Data

Given the difficulty of field scouting, better identification of likely significant locations came from Light Detection and Ranging (LIDAR) data from the U.S. Geologic Survey (USGS). Its use generated both three-dimensional ground surface images and high resolution topographical overlays for satellite images. Examination of the generated surface images revealed what appeared to be a fabricated linear embankment running in a straight line parallel to the predicted path of the Inclined Plane, converging on—and running parallel to—the current northern bank of the Sand River (figure 7). To the southwest of this embankment is a linear slope wide enough to have contained the Inclined Plane, running into the same location where the intact railroad tracks were found. A high-resolution topographic map was generated from the LIDAR data and overlaid on satellite imagery. This overlay shows more clearly the shape of the terrain lying to the southwest of the linear embankment, indicating possible search sites for additional track or railroad artifacts.

The suspected tracks were found in the river *c.*25 ft. below the elevation of what would have been the Incline as shown by the LIDAR data. If these are original tracks from the Inclined Plane, then it appears that they have been displaced over time by the erosion of the Sand River. Further, the LIDAR data also indicates that much of the lower part of the proposed Inclined Plane roadbed has also likely eroded to such a great extent that much of it is now gone. If other remains of Inclined Plane track could be found near the Sand River, they would likely be in the riverbed itself.

Configuration and Operation of the Inclined Plane

Original sources from 1828 onward described the construction of the SCCRR and the Inclined Plane tracks. The *ARJ* regularly published stockholders' and similar reports for railroads of the time, including those of the SCCRR and its successor the SCRR. The 1833 issue of the *ARJ* reported on the construction of the Charleston-to-Hamburg railroad including the Inclined Plane. The Inclined Plane is described as being "only 21 miles south of Edgefield Court House," since the town of Aiken had not yet been founded. At that time the 136-mi. railroad was essentially complete, and the same article declares that "if the [locomotive] engines which have so long disappointed us should arrive in the course of this month, the whole road can be in use by the 15th day of September."[15] Poussin provides many details not found in *ARJ* on the construction as well as illustrations.[16] Because von Gerstner's survey of American railroads is less detailed than the *ARJ* or Poussin, and often contradicts both of them, its details about construction were useful only when no other source was available.[17] Several eyewitness accounts, published in the years following the completion of the railroad,

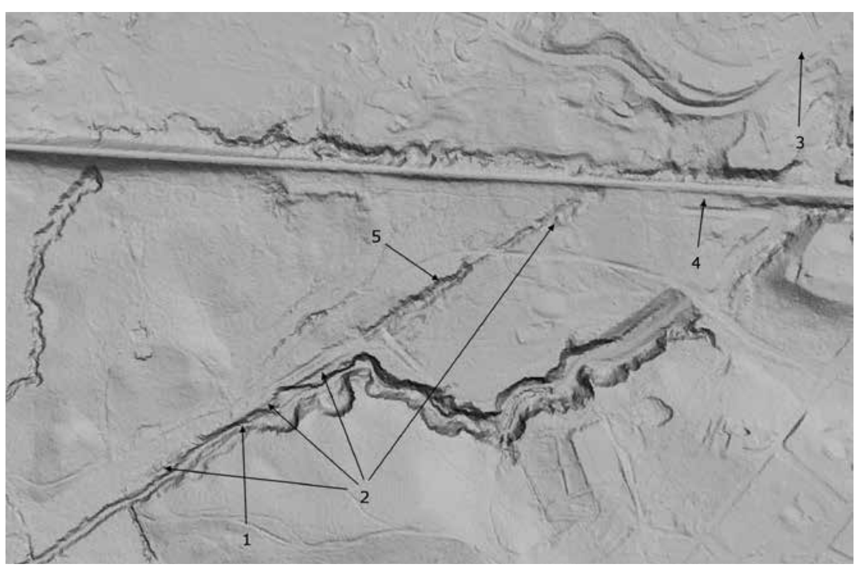

Figure 7. Top view of shaded 3D model of the Aiken Inclined Plane rendered from USGS Lidar Point Cloud (LPC) data. **1.** Where the tracks were discovered. **2.** Traces of linear embankments. It is believed that the roadbed of the Inclined Plane lies southeast of (below) these embankments. **3.** The beginning of the Inclined Plane as indicated on the Dexter and Pascalis and de Caradeuc maps. **4.** Roadbed of the 1852 Aiken Cut which replaced the Inclined Plane. **5.** A deep, irregular trench beside and to the northwest of the linear embankments along the predicted route of the Inclined Plane. USGS Lidar Point Cloud SC 6County-AikenCo 2012 7672-02 LAS 2017.

and in particular, one by J.H. Stockton in 1891, provided significant details about the configuration and operation of the Inclined Plane.[18] Others include writings by J.W. Robertson and Rev. James Daniel.[19]

According to these sources, the Inclined Plane consisted of two parallel tracks with switches located at the top and bottom of the incline transitioning from the double-tracked Inclined Plane to the single track main line.[20] The two tracks were operated as a funicular, with a 2½-in. or 3-in. rope cable (*i.e.*, not wire) wrapped around wooden drums and/or wheels at the top of the Incline and under the tracks, with each end of the cable connected to a brake car.[21] The brake cars, one per track, were to be used in the event the cable broke during transfers.

> [The brake car is] a strongly built short platform car . . . so designated from the fact that these cars were provided with a lever brake, no other cars being at that time supplied with brakes. In descending the incline the brake car was ahead of and holding back the freight or passenger cars, and in ascending the brake car was behind, pushing cars to be brought from the foot to the head of the plane. As one set of cars descended on one of the parallel tracks, another set was ascending on the other track, all suspended on the one rope.[22]

A series of horizontal wheels (rollers) set every 20 ft. in the center of each track for the entire length supported and guided the cable over the length of the Plane.[23] At the top of the Inclined Plane stationary engines, housed in an Engine House, were built to power the wooden drums and move the counterbalanced sets of cars up and down the Inclined Plane: "Two stationary engines, which work on the same crank, of about 25 horse power each, now erected at the head of the inclined plane, and nearly in readiness for operation, will effect the passage of loaded cars over the plane at a rate of about ten miles an hour."[24] The stationary engines drove a crankshaft which operated a central drum or wheel around which the rope was wrapped. Daniel's description offers additional detail.

> Upon the crest of the hill was located a stationary engine, which operated a large horizontal wheel, about fifteen feet in diameter, with a groove in the rim, or fellies [the outer rim of a spoked wheel], in which worked, as a belt, an enormous rope, as long as the track constituting the inclined plane. This wheel was placed between the tracks. . . . As the great wheel revolved one car descended slowly into the valley, while the other ascended the heights. Thus one by one the coaches were let down and drawn up.[25]

Poussin provides an even more detailed description of the stationary engine and the operation of the Inclined Plane.

> The towing on the inclined plane is made by means of two stationary machines [steam cylinders] of the force of 25 horses each; these two machines act on the same crank, they are capable of towing carts loaded with goods, and passenger cars with a total weight of about 36 tons, with a speed of 16 kilometers (4 leagues) an hour [10 mph].
>
> The mechanism by which the towing is carried out has been extraordinarily simplified, so that the service is very regular. The cable for the towed car is wound on a grooved wheel attached to a perpendicular axis and one end of which is provided with a gear wheel. Two cylinders, perpendicular to each other, communicate to it the movement which, in this way, is regulated and dispensed from the flywheel.
>
> The boiler is in two separate compartments, by means of shut-off valves; so that each compartment can serve independently of the other, and that the necessary repairs can be made to one, while the other continues its service.
>
> The cylinders and the steam pipes are provided with shut-off valves, which have the same purpose; so that this machine is, so to speak, made double. In addition, care is taken to keep spare parts for those that would require immediate repairs; in this way, one is entirely free from any delay in the service of the inclined plane.[26]

The Engine House burned in 1840, significantly damaging the stationary engines, and from that time the Inclined Plane was operated using a single locomotive running on one of the tracks and hauling cars behind it while connected by the cable to the cars of the other track.[27] No plans or contemporary illustrations of the Engine House, the stationary engines, or the Inclined Plane are currently known to exist, and nothing is known about who constructed the stationary engines themselves. However, in his 1845 report on the condition and possible replacement of the Inclined Plane for SCRR President James Gadsden (who would many years later, as a minister to Mexico from South Carolina, be responsible for the Gadsden Purchase of southern Arizona and New Mexico), Engineer John McRae identified three railroads with Inclined Planes similar in operation to the one at Aiken: The Philadelphia and Columbia Railroad and the Allegheny Portage Railroad, both in Pennsylvania; and the Liverpool and Manchester Railroad of Great Britain.[28] Out of these, the Allegheny Portage Railroad is the best researched in the U.S., and provides many examples of how Inclined Planes of the period were designed and operated.[29]

Track Construction

The 1833 and 1842 *ARJ* articles describe the construction of the railroad tracks as being composed of three layers all of wood: a base of "longitudinal sills" running the length of the tracks and buried in the ground, topped by cross-ties (referred to in the period texts as "tangential sills," "sleepers," or sometimes "caps") laid perpendicularly across them, and finally the rails themselves laid longitudinally on top of the cross-ties. Further, to reduce wear on the wooden rails and extend their life, they were originally capped with "iron plate," a flat bar (now called "strap" in modern references), which was later replaced by a heavier iron "flanged plate" or flanged bar (or "L-strap"). The gauge of the rails was fixed at 5 ft. These articles taken together provide significant details about the construction of the Inclined Plane, which is generally described as being built to "Sleeper Plan No, 2." Based on these articles, as well as field observations of the found rail, I built a scale model to aid in illustrating how the tracks on the Inclined Plane were constructed (figure 8). The longitudinal sills were constructed of 12 × 12-in. timbers, "all heart of the best pitch pine, well hewed on all sides, and the ends lapped." Their length is not specified. They were placed 6 ft. apart, each 3 ft. from the center of the roadbed.[30]

Though it is not stated directly in period sources, it is likely that these sills were cut with rectangular notches at least 3 in. deep, made to accept the ties placed across them, in such a way that the ties could be held in place in each notch using a wedge.[31] The sills used on the Inclined Plane differ from those used on the rest of the railroad in several ways. Sills were 12 × 12 in. on the Inclined Plane, while sills as small as 9 × 9 in. were used on the rest of the railroad. Only on the Inclined Plane were the timbers hewn on all sides (that is, worked using tools to yield four flat, squared surfaces running the length of the timber). Instead, sills on the rest of the railroad were only well-hewn on the top and bottom, with sides left roughly finished. On much of the rest of the railroad the longitudinal sills were not notched and instead left flat. After the cross ties were laid across them, a 2-in.-diameter hole was drilled through the top of each end of the cross ties and into the longitudinal sill below it, and a wooden peg (or *trenail*) was driven through both to fix the cross-ties in place.[32] Presumably, the wedges would have been placed on the up-slope side of the cross-ties to reduce the likelihood of the cross-ties shifting down-slope, as the wedges would be prone to loosen over time.

The cross-ties were set approximately 6½ ft. apart down the length of the track, so that every four ties spanned 19½ ft. center-to-center. They, too, were notched so that the rails could be held in place using wedges, similarly to how the cross-ties themselves are believed to have been fastened to the longitudinal sills. The cross-ties are believed to have been 10 × 10 in. by 20 ft. long, running under both tracks of the Inclined Plane. Unfortunately, the dimensions of the cross-ties are described in conflicting ways in the *ARJ* articles. In the Aug. 24, 1833 article, the description of Sleeper Plan #2 states that the cross-ties are "6 [in.] by 9 [in.] and 9 ft. long," and the rails are set in notches in the top of the cross-ties 3 in. deep and wedged.[33] However, the 1842 article, addressing an experiment performed to test the preservative properties of the "Kyanizing" process on wood (which soaked it in a bath of mercuric chloride), says that "one hundred and thirty pieces of prime timber, all twenty feet long and ten inches square, and Kyanized . . . were placed as cross-ties under both tracks of the Inclined Plane, at Aiken, supporting joints of the rails, laying about twenty feet apart the whole length of the plane."[34] As mentioned above, four cross-ties placed 6½ ft. apart would span 19½ ft. However, such timbers would not fit in notches in longitudinal sills cut to fit a 6-in.-wide cross-tie, and would be 1 in. taller than a 9-in.-high cross-tie, putting this description in conflict with that of Sleeper Plan #2. Since the 1842 article directly states these ties are placed on the Inclined Plane, unlike Sleeper Plan #2 (which is a generic description of railroad construction used many places), the 10 × 10 in. by 20-ft. dimensions for every third cross-tie are accepted here as correct for 1842. Furthermore, it is highly likely that the experimental Kyanized cross-ties installed in 1842 were designed to be drop-in replacements for existing cross-ties. This implies that all cross-ties on the Inclined Plane were 10 in. × 10 in. in cross-section when it was completed in 1833.

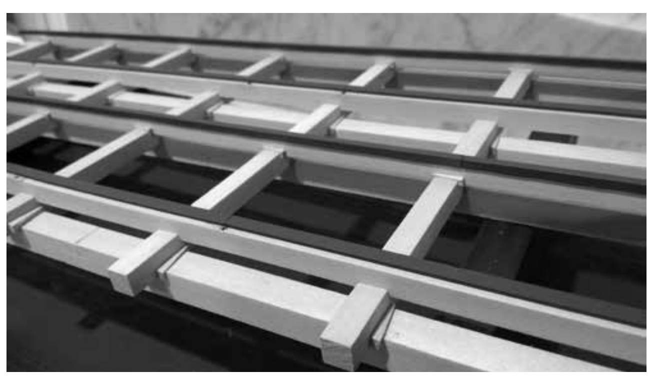

Figure 8: Scale model (½ in. =1 ft.) by author to illustrate the conjectured reconstruction of the railroad tracks on the Inclined Plane at Aiken in 1839.

The question of the length of the cross-ties remains, however. In 1833 they might all have been 9 ft. long and under each track separately, 20 ft. long spanning both tracks, or a mixture of both. For example, it is possible that originally the two tracks were laid independently of one another on 9-ft. cross-ties, and only connected together by 20-ft. cross-ties later. If the adjacent ends of 9-ft. cross-ties were placed 2 ft. apart across the center of the Inclined Plane, their outer ends would span 20 ft. This would make the outer ends of the 9-ft. cross-ties line up with 20-ft. cross-ties if such were used every third tie beginning in 1833, or if the 20-ft. ties were first used in 1842. Such an arrangement would imply that the center-lines of the two tracks would have been 11 ft. apart. The only description of parallel tracks made in the 1833 article refers to passing sidings having been placed 30 ft. from the mainline, which would have been an impractical distance for construction of the Inclined Plane.[35] Unfortunately, no description of the distance between parallel tracks has yet been found for the Inclined Plane itself.

Note also that it is highly unlikely that 20-ft.-long timbers could have been used to tie the two tracks together in 1842 if they had not been connected originally. It is doubtful that the two tracks would have settled consistently with one another over the intervening nine years if they were not connected by 20-ft. cross ties from the beginning. However, this leaves open the possibility that only every third cross-tie was 20 ft. long, and the rest were only 9 ft. long. It is also certain that enough resources were available to use 20-ft.-long timbers for every cross-tie. We therefore hypothesize that every cross-tie on the Inclined Plane was 10 × 10 in. by 20 ft. long from the beginning.

The rails, made entirely of wood, measured 6 × 10 in., sitting taller than wide, and "never less than three stretches, or 19½ ft. in length."[36] Rail length would have had to have been a multiple of 6½ ft., so that their ends would rest in the center-width of the cross-ties. "The wood was the Southern pine, the hard, resinous surface of which was as suitable for the iron bars as wood could be," as Chief Engineer Horatio Allen reminisced in his memoir.[37] The 1833 article stated that, "About ¾ of an inch is taken off the inner sides of the rails by a chamfer four inches deep, to a line on which the edges of the iron plates are laid, precisely five feet apart across the road, in the clear. Great care is necessary that the top surface of the rail be perfectly smooth and uniform, so as to afford the iron a solid bearing." The wooden rails were capped with iron bars, which provided the wheels of the locomotives and cars a smooth, hard surface to run on, and significantly increased the life of the rails in service. Note that these iron bars or "plates" were not considered part of the rails themselves, and the term "rail" was never used in English to refer to them during the period of their use. As mentioned earlier, two types of iron bar were used, flat and flanged. The original flat bar is described as

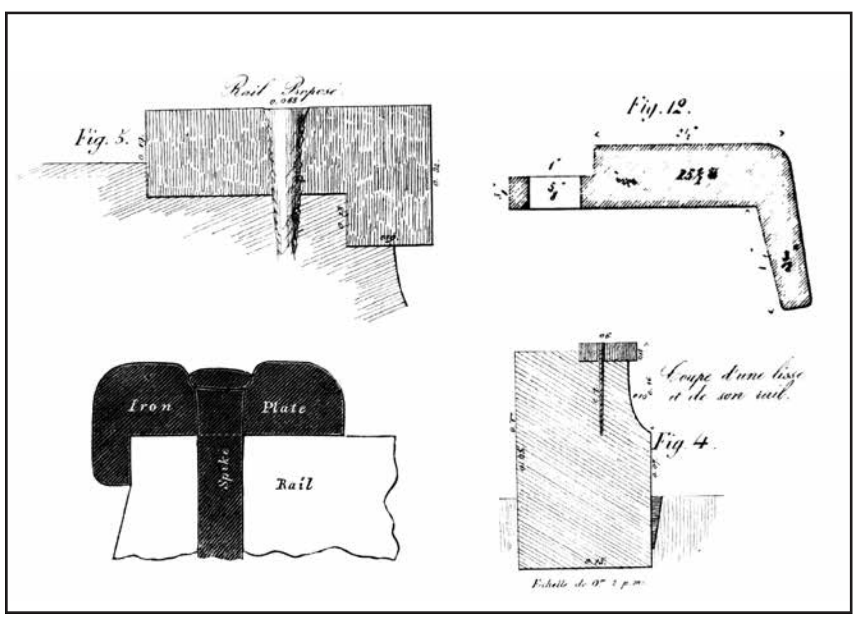

Figure 9. Flanged and flat bar for the SCCRR *(clockwise from top left):* Proposed Flanged Bar from Poussin, pl. VI, fig. 5 (see n. 11); 1843 Flanged Bar from Franz Antonvon Gerstner,(Vienna, 1842-43), pl. XXXII, fig. 12, courtesy of Bayerisches StaatsBibliothek Digitale Sammlungen; 1833 Flat Bar from Poussin, pl. IV, fig. 4 (see n. 11); 1835 proposed Flanged Bar from 4, no. 25 (June 27, 1835): 396. Measurements in figs. 4 and 5 are in meters; in fig. 12, inches, except the center notation of "25½ ℔" signifying a weight of 25½ lbs. per yd.

follows: "The iron plates [flat bar] used on this road are 2¼ inches wide, ½ inch thick, and [vary] in length from 10 to 15 feet, secured to the rails by spikes 5 inches long, the heads of which fall into a countersink below the level of the surface."[38]

Poussin describes them similarly: "The flat bars used are flat, 6 centimeters [2.3 in.] wide, 13 millimeters [0.5 in.] thick, and 3 to 4 meters 50 centimeters [10–15 ft.] long; they are secured to the rails by iron spikes, 12 centimeters [5 in.] in length; the heads of these spikes were kept a little below the level of the outer surface of the flat bar."[39] These bars (figure 9, *bottom right*) were imported from England, but used an American design. Though the 1833 article does not state the location of origin, it does give the cost of the iron: "A mile of road requires 17 tons of this iron, costing something like $45 per ton landed in Charleston. Spikes cost about 9 cents per lb. or $90 to the mile."[40] Poussin, though clearly parroting the 1833 article, adds the origin as England: "It was placed 10,565 kilograms [23,292 lbs. or 12 US tons] of such flat bars within a kilometer [0.6 mi.], which cost about 14fr 75c [about $2.75 in 1833] per 100 kilograms [220 lbs.] imported from England and delivered to Charleston."[41] Though there may have been several suppliers of rolled iron rails available in England in 1831–33, it is likely that the first source of this flat bar iron was the W.&I. Sparrow Company, of Wolverhampton. We know this because SCCRR Chief Engineer Horatio Allen was the first engineer in the U.S. to try to source flat bar iron for railroad use during his previous work for the Delaware and Hudson Canal Company. (The D&H was the first railroad to have a steam locomotive, the Stourbridge Lion, run across its tracks, coincidentally also with Allen at the controls.[42]) Allen ordered the flat bar for the D&H in 1828, agreed to become Chief Engineer for the SCCRR the very next year, and began laying track toward Hamburg in early 1831.[43] Because this is a milestone in railroad construction in the U.S., and had a direct impact on the construction of the SCCRR tracks, Allen's full account is worth repeating here.

> The iron for the railroad first required attention, and as its manufacture, although executed in England, was on a plan of American origin, some reference to its manufacture is appropriate in this article.
>
> The instructions which accompanied the authority to contract, etc., describe a mode of making the iron. On reading the description it appeared to me that a less expensive plan could be used. This I explained to the committee of the Delaware and Hudson Canal Company. It was thought proper to have the judgment of some one [*sic*] having experience in rolling iron, which I had not, as I had not even seen a bar of iron rolled. The proprietor of the only rolling-mill near New York, at the request of the committee, came to New York to consider the plan proposed, and after examination he stated that in his judgment the plan would not be a success. Nevertheless I thought it would be well to suggest the plan at the rolling-mills in England.
>
> This being the first order for iron made expressly for a railroad from this country, it was deemed advisable to go to the mills and explain what was wanted, and to suggest one way in which the iron could be made, as it appeared to me. Of the seventeen mills visited, and from which proposals were received, only three thought well of my suggestion.
>
> With one of the three, the Guests, of Merthyr Tydvil, a contract was made. When the time for examination of the iron came it was not satisfactory, and I said that I could not accept iron of that character; they refused to deliver any other.
>
> Application was then made to W. & I. Sparrow, of Wolverhampton, another of the three, and reference to what had occurred at Merthyr Tydvil. I described very plainly what I expected. In reply I was informed that the intention in their proposals was what I had fully explained. The contract was therefore made with W. & I. Sparrow. My wish in this case to remain and see the preparations made being acceded to, the rolls to be fitted up were on hand, and in ten days the iron was being made on the plan proposed, and subsequently the iron was delivered in every respect satisfactory. The large amount of iron of the same character made for this country in after years, was all made on that plan. If the mechanical details of the plan were described, there would be surprise that there ever had been any question, or that it had been thought worth the time to refer to it.[44]

Horatio Allen originally specified use of flanged bar instead of flat bar on the SCCRR, as he also recalled in *The Railroad Era:* "I desired to use iron of the same width and thickness, but with a flange on one edge, but the cost per mile multiplied by 150 had too large a product for the treasury of the company; and the expense was incurred only on the curves, which being few and small in extent, the expense was admissible."[45] This assertion is backed up by the 1833 *ARJ* article, which also gives the dimensions of the proposed flanged bar:

> Iron ¾ of an inch thick, having a rectangular flange on one side, to project down on the inner edge of the rail, about ½ inch, would have been greatly preferable to that used, in preserving a rigid uniformity of top surface, and lessening lateral friction on the wheel of the locomotive. The use of Iron of this description was strongly recommended by the chief engineer [Allen], but was not adopted, from considerations of economy. The increased cost of using iron ¾ of an inch thick, with a flange ¾ of an inch in thickness, would not exceed $200 per mile, while it would be of incalculable benefit in promoting the successful running of the engines.[46]

Allen's assertions were proven right over the next few years, and the SCCRR began replacing all flat bar iron with flanged bar between 1835 and 1839.[47] In December 1837, that flanged bar was being ordered through a "very respectable house in London," and it was reported that about "700 tons . . . is now going up for distribution on the worst parts of the road, particularly on the curves between Aiken and Hamburg, that is beyond the foot of the Incline.[48] This implies the flat bar on the Inclined Plane was replaced with flanged bar in either 1838 or 1839. A date of 1839 also coincides with the installation of Kyanized ties on the Inclined Plane, suggesting a major rebuild at the time.[49]

The presence of flanged bar would be a strong indicator of track belonging to the SCCRR as it was one of the early adopters of that particular technology despite the increased cost per mile.

> The difference in cost of construction, when comparatively heavy edge rails were used, was at one time estimated at about $6,000 per mile, and this outlay was considered too great to be borne by most of the early companies. The result was that flat bars continued to furnish the iron for many tracks during a protracted period. . . . All the railways of Virginia, North and South Carolina, Georgia, and Florida used flat bars, varying in dimensions from 2 × ½ to 2½ × ¾, except the South Carolina, and portions of the Georgia and Central roads, of Georgia.[50]

Poussin and von Gerstner both included in their work illustrations of cross-sections of these important flanged iron bars (figure 9, *top left and top right*), the latter providing the only known contemporary description of the dimensions: "The portion on which the wheel runs is 2½ inches wide and ¾ inch thick. On the inner side of it is an edge section extending an additional 1¼ inches toward the track center. On the opposite side there is a downward projection 1 inch long and 3/8 inch thick. Every 18 inches apart longitudinally there are 7/8-by-5/8-inch holes in this projection to admit track spikes. These rails are 15 to 18 feet long and weigh 25½ lbs. per yard."[51]

The illustration of the flanged bar in von Gerstner (figure 9, *top right*), however, shows the "edge section" is 3/8-in. thick, but unfortunately it extends only 1 in. instead of the 1.25 in. described in the text. This description is suspect due to the discrepancies between it and other sources mentioned earlier. Further evidence of the dimensions of the flanged bar comes from a report by A.A. Dexter on a proposed expansion of the SCCRR into Georgia:

> I would respectfully recommend the use of bars, having the dimensions shown in the accompanying drawings [figure 9, *bottom left*].
>
> This iron is 2 1-2 [*i.e.*, 2½] inches wide, by 6-8 [¾] inches thick, with a flange, or rectangular projection, 1-2 inch by 3-8 inch, the bars tongued at the extremities. The spikes 5 inches long by 1–2 in., sunk at every 18 inches in length a full 1-16 in. below the face of the iron. Iron plates of this description will weigh about 29 tons, costing $1450 per mile—adding the spikes, 2500 wt. at 7cts.—$1625 total, for the iron and spikes in a mile.
>
> A small quantity of flanged iron was ordered from Liverpool, for the curves of the South Carolina road. The iron was placed on a portion of the work, and answers an admirable purpose.[52]

The dimensions Dexter gives for the proposed flanged bar are identical to von Gerstner's dimensions for the main part of the flanged bar, but Dexter's bar does not include the 1.25-in. recessed extension for spiking the rail that von Gerstner shows. Though it follows that this would make Dexter's bar lighter in weight than von Gerstner's flanged bar, his specified weight of 29 tons per mile translates into approximately 33 lbs. per yd., which is also heavier than the 25.25 lbs. per yd. reported by von Gerstner.

The 5-ft. gauge—"the edges of the iron plates are laid, precisely five feet apart across the road, in the clear"[53]—was chosen by Horatio Allen and adopted by the SCCRR as being superior to the English gauge of 4 ft. 8½ in. used elsewhere in the U.S.[54]

Field Observations and Comparison

Exploration of the Sand River

During their original survey, Steen and Southerlin discovered two apparent tracks in the bed of the Sand River, parallel to one another, partially revealed.[55] (figure 10) These tracks consisted of L-shaped iron straps, spiked to the top of wooden rails. The rails sat at a sloped angle and disappeared downstream into the sand of the riverbed. Upstream they were covered by concrete and rebar panels that were once part of a retaining wall which had collapsed many years previously. The end panels of this wall remained in place. One rail was exposed for a significant distance upstream, where some of the wood was missing and well-preserved rail and spikes could be seen. The survey team also found several loose artifacts, including a four-spoked iron wheel, *c.*15 in. in diameter, lying horizontally between the rails (figure 11, *top left*), and also a 7 ft. long iron strap with tapered holes running down the middle (figure 12, *top left*). These loose artifacts were recovered and taken offsite for storage and conservation by Carl Steen and archaeologists from the South Carolina Department of Natural Resources (SCDNR).

Gauge between the exposed rails measured exactly 5 ft. The rail timbers were very worn, but the exposed parts measured at approximately 6 in. wide and 10 in. tall. These measurements are consistent with rails used on the SCCRR.

The flanged iron measured *c.*3.5 in. wide at the base but 2.5 in. wide and 0.75 in. thick in its main part, with a flange protruding *c.*0.5 in. below the lower surface of the bar (figure 11, *bottom left*). One bar still attached to rail was fully exposed for its entire length, measuring *c.*15.5 ft. long. These measurements are consistent with the heaviest flanged bar proposed for use on the SCCRR.

Figure 10. Suspected railroad tracks *(bottom left and center)* as found by Steen and Southerlin (see n. 1). The protrusion to the right is a piece of flanged iron that is not attached to any wood. Photo by the author.

The survey team used metal detectors to search the riverbed for a second set of tracks parallel to the first pair. They dug two search holes and located a third and fourth rail beneath the sand, parallel to the original tracks. Gauge could not be measured between the third and fourth rails because the search holes revealing them had not been dug parallel to one another. However, the distance between the center rails (the second and third) measured approximately 4 ft. 5 in. between the backs of the flanged bars. Factoring in the relationship between the flanged bars and the rails with the gauge of the rails, this placed the centers of the tracks at almost exactly 10 ft. from one another, which is 1 ft. narrower than the distance estimated earlier if a mixture of 9- and 20-ft. cross-ties had been used (11 ft. center-to-center). This measurement is not consistent with the proposition that the Inclined Plane tracks were originally laid down using a mixture of 9- and 20-ft. cross-ties, or 9-ft. cross-ties exclusively, but it is consistent with the proposition that 20-ft. cross-ties under both tracks were used exclusively from the beginning.

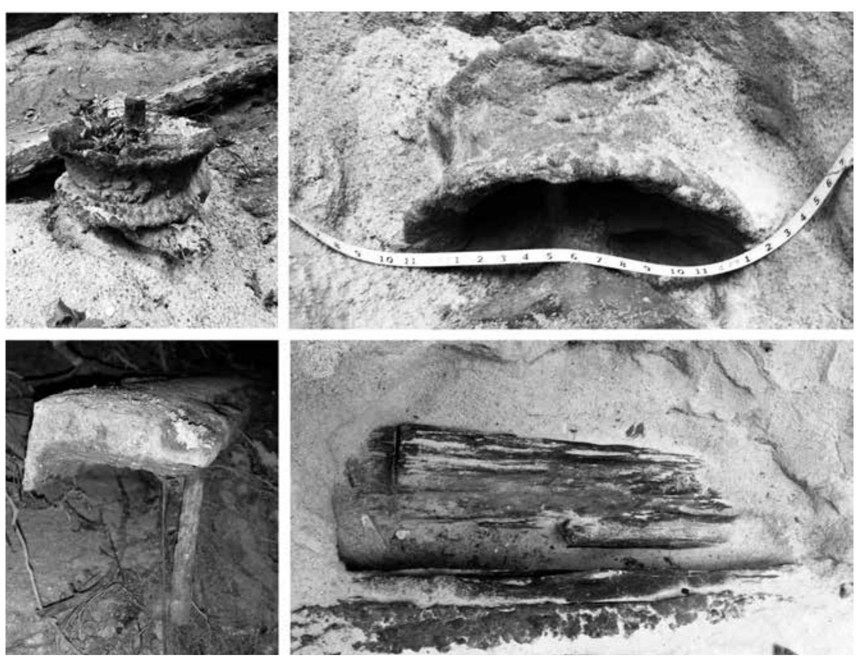

Figure 11. Some artifacts found near the revealed tracks *(clockwise from top left):* First roller, second roller, longitudinal sill with part of a cross-tie notch, and cross section of a well-preserved flanged bar. Top left photo by Roy McLain; others by the author.

Figure 12. Pieces of flat bar. Detail *(top left)* of a conical hole in the 7-ft. piece found by Steen and Southerlin near the revealed tracks; short pieces *(top right, center left and center right)* found on Bennett's Hill; and close-ups of 11-ft. piece *(bottom left and bottom right)* found in the Sand River upstream from the revealed tracks. Photo *(top left)* by Carl Steen; others by the author.

Metal detectors, searching the riverbed between the two pairs of rails for additional cable rollers, discovered two more wheels in line with the center of the third and fourth rails, 20 ft. from one another. Each was found in an upright position and aligned with the tracks. The second wheel (with *c.*15-in. diameter) was excavated enough to show that it was still attached to a bracket by its axle, photographed and measured, and then re-buried. The top of the third wheel was uncovered enough to identify it and then re-buried. Given their positions, each is believed to still be fixed to a cross-tie, but excavations have yet to confirm this. The positions of these wheels are consistent with the descriptions of the rollers that supported the cable used to hoist cars up and down the Inclined Plane.

A metal detector equipped to detect metals at a depth of up to 6 ft. non-invasively traced all four rails beneath the sand downstream from where they were exposed in the river bottom. Metal signatures were lost abruptly for each rail a short distance beyond where the search hole for the fourth rail had previously been dug. This is consistent with the proposition that the tracks have moved from their original positions.

Since the first and second rails maintain a 5-ft. gauge, it is believed that they are still attached to one another by at least one cross-tie. To locate such a cross-tie, the team dug a shallow search trench to the outside of—and adjacent to—the first rail exposed in the river bottom. A cross-tie was not found, but a large timber was found just below the bottom of the rail (figure 11, *bottom right*). Approximately 4 ft. of the timber was uncovered in a continued effort to find a cross-tie, and though such a cross-tie was not found, part of a rectangular notch was discovered in the top of the timber before suspension of the search. Only the top of the timber was unearthed, measuring *c.*12 in. wide. The location of this timber and its dimensions are consistent with those of the longitudinal sills used on the Inclined Plane. The notch is also consistent with how the sills would have been notched to accept a cross-tie, if notches and wedges were used to secure the cross-ties to the sills instead of 2-in. *trenails.* It is possible that the cross-tie that fit in this notch was damaged over time and displaced.

The riverbed upstream from the revealed rails, explored in a limited and inconsistent way using metal detectors, yielded inconclusive results. Thick undergrowth and the presence of gravel beds in the river rendered parts of the river and embankment largely inaccessible, which made digging difficult. However, on one sortie a length of iron strap was discovered sticking out of the sand in the river near the last of the collapsed retaining wall sections, camouflaged by a low-hanging tree branch. Metal detectors estimated the length and depth of the buried section to be acceptably small, and since the strap was displaced from its original location, it was removed for storage and later preservation (figure 12). The strap measured *c.*2.25 in. wide, 0.5 in. thick, and 11 ft. long, and was bent in a gently curving arc. One end was found with an unusual taper, probably used to smooth over joints between flat bars. The previously buried portion of the strap was too encrusted to examine. A conical dimple, consistent with a countersunk hole that had been crusted over, could be seen near the center of the strap. All of these observations are consistent with descriptions of the flat bar originally used on the SCCRR, later replaced by flanged bar. The presence of this section of flat bar suggests that the original flat bars were abandoned near the tracks from which they were removed, rather than being removed offsite to be salvaged or scrapped. This is likely a combination of condition of the bar and the fact that flat bar rail was already obsolete when it was replaced with flanged bar on the Inclined Plane.

Exploration of Predicted Incline Roadbed

Areas on the slope above the bed of the Sand River were scouted in an effort to find evidence corroborating the theory that the original Inclined Plane roadbed lay to the southeast of the line made by the embankments observed using the LIDAR data. This scouting revealed a long shallow trough, bordered on the northwest by the steep embankments and deep gullies shown in the LIDAR data, but also bordered by shallower embankments to the southeast. This trough is *c.*30 ft. wide or more, and often shows evidence of short, parallel ridges running its length. The trough is also interrupted in many locations by deep perpendicular cuts, holes left by fallen trees and similar soil disturbances, and in many places is heavily overgrown with brush. However, several locations were found suitable for further exploration.

One of these is a long, open area near the top of the slope, free of trees and containing very little underbrush, which was pointed out as a likely spot for searching by Hitchcock Woods Superintendent Bennett Tucker, and consequentially is now referred to as Bennett's Hill. This area was searched non-invasively with metal detectors on several occasions. Long, roughly parallel lines of iron signatures were detected running the length of the trough and their locations flagged. Search holes, later dug at a random sample of these locations, unearthed iron spikes of several sizes along with other small pieces of iron. Typically, the smaller spikes had a tapered head and measured about 4.5 in. long. A more significant find were two short lengths of metal bar matching the description of the flat bar iron originally used on the SCCRR (figure 12, *top right and center right*). Both of these were laying at the surface, barely covered with leaf litter. The first appeared to be cut square at both ends, while the second appeared to be broken off of a longer bar. Each end was pierced with the cross-section of a conical hole (that is, the full bar broke at the anchor points). The smaller spikes fit well in the holes found in the ends of the second piece of flat bar. All of the spikes and other iron pieces on the slope lay at shallow depths, generally in lines running the length of the trough. Several deeper exploratory holes were dug in line with the traces of iron in a futile attempt to find either iron flanged bar or timbers matching the description of those used on the SCCRR. This is not surprising, given the limited size and locations of the investigations. Digging was hindered due to hard clay encountered at a depth of greater than 1 ft. After iron was removed from a hole, the hole was re-scanned with metal detectors, which never indicated the presence of deeper iron. Possibly the iron bars placed in this location by the SCCRR were salvaged sometime after the Inclined Plane was abandoned, and the spikes and other pieces found were probably left nearby in the process. It is unlikely, however, that the wooden rails, cross-ties, and longitudinal sills were salvaged, and traces of timber may yet be found. Archaeologists with the SCDNR later surveyed and documented all flagged metal detector hits and search holes. They also removed some of the found iron spikes for conservation, while other pieces were kept in storage by the Hitchcock Woods Foundation staff.

Metal detectors also non-invasively explored the path of the trough as it continued down the slope to the Sand River. Random search holes uncovered spikes and other pieces of what might have been flat bar, but much of this area was blocked by vegetation and fallen timber. However, near the top of the Sand River another piece of flat bar was found a few inches below the surface, having rectangular tapered holes in it and a square notch at one end. Nearby was a rectangular tapered spike head which fits the hole in the bar well (Figure 12, *center left*). This flat bar and spike were later removed and conserved by SCDNR archaeologists, who also surveyed and documented all flagged locations and search holes in the area.

The LIDAR data indicated that a small length of the trough remained intact on the upper bank just above one of two remaining upright sections of the 1970s-era concrete retaining wall, which stands on the slope above and upstream of where the tracks were found. This trough was searched extensively with metal detectors finding no trace of bars or spikes. Further examination revealed that the downstream part of this trough is significantly lower than what remains of the trough on the upper bank downstream of the collapsed area. This suggests that the tracks found in the river not only slipped sideways into the Sand River over time as the bank collapsed, but that they simultaneously also slid downstream off the slope before coming to rest in the riverbed.

Metal detectors searched a section of the upper bank adjacent to the Sand River downstream from where the original tracks were found, revealing more spikes. This area was greater than 25 ft. above the level of the riverbed; only a narrow ledge remained, too small to accommodate the width of even one track. If tracks had been located there at one time, the erosion of the Sand River over the last century probably resulted in their shifting sideways down into either the side of the bank or the riverbed below. A cursory metal detector exploration was made in the riverbed below this ledge, but no iron was found.

Conclusion

All the evidence gathered is consistent with both maps showing the approximate location of the Inclined Plane at Aiken built by the SCCRR in the early 1830s and with the extensive body of period documents and first-hand accounts related to the Inclined Plane that have been collected so far. The dimensions of the longitudinal sills, rails, and flanged bars found in the Sand River all match period documentation for what was used by the SCCRR, and for the Inclined Plane in particular. The gauge between the rails matches that used on the SCCRR. Two parallel tracks were found, at a distance from one another consistent with the distance predicted for the tracks on the Inclined Plane. Rollers for cable were found in place exactly where the accounts say they would have been on the Inclined Plane. Scraps of flat bar iron found both in Sand River and on the slope above match the description of that originally installed on the SCCRR. Spikes and other iron scraps were found everywhere that the original roadbed of the Inclined Plane was predicted to be. Finally, a plausible theory has been constructed to explain how the tracks found their way into the riverbed from the predicted roadbed of the Inclined Plane, concluding that the tracks found in the Sand River were part of the Inclined Plane at Aiken constructed by the SCCRR between 1830 and 1833. Furthermore, these tracks are in the configuration in which they were operated between 1839—when the original flat bar iron was replaced with flanged bar—and 1852, when the Inclined Plane was abandoned at the completion of the Aiken Cut.

The significance of this find is profound. As far as is known, no original wooden rail track remains in existence in the U.S., even in museums, nor is there any intact iron-capped wooden rail anywhere in the world. The fact that there are not one but two tracks, and that they are not only near their original locations but were also once part of a singular Inclined Plane operated as part of the mainline of the longest railroad in the world in 1833, makes them of extraordinary interest and value as historic artifacts. They also represent the remarkable survival of one of the very earliest and most influential railroads in the U.S.—one which established precedents and pioneered advancements for the railroad industry everywhere and in so doing influenced the history of the U.S. and many other nations. As such, these tracks deserve recognition as one of the most important artifacts of early American industry, and possibly as one of the most important artifacts of the early history of the U.S. in existence today.

Preliminary planning for further archaeological investigation is currently underway, not only of the revealed tracks in the Sand River, but of other parts of the roadbed in Hitchcock Woods. This will hopefully include investigation of the upper slope above the Sand River, the level area at the bottom of the Inclined Plane called Memorial Gate, and the recently identified sections of the original roadbed in other parts of Hitchcock Woods.

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Notes

1. Carl Steen and Bobby Southerlin, "A Cultural Resources Inventory of The Hitchcock Woods, Final Report," 2017, report prepared for the Hitchcock Woods Foundation by Diachronic Research Foundation and Archaeological Consultants of the Carolinas, Columbia, SC, on file with the Hitchcock Woods Foundation, Aiken, SC.
2. William Bender Wilson, "The Evolution, Decadence and Abandonment of the Allegheny Portage Railroad," in *Annual Report of the Secretary of Internal Affairs of the Commonwealth of Pennsylvania, for the Year Ending June 30, 1899. Part IV. Railroad, Canal, Navigation, Telegraph and Telephone Companies* (William Stanley Ray, State Printer of Pennsylvania, 1900), xli–xcvi.
3. Balthasar Henry Meyer and Caroline E. MacGill, *History of Transportation in the United States before 1860* (Washington, DC: Carnegie Institution of Washington, 1917), 397; Baltimore and Ohio Rail Road Company, *Eighth Annual Report of the President and Directors to the Stockholders of the Baltimore and Ohio Rail Road Company* (Baltimore: William Wooddy, 1834), 39.
4. "On January 14, 1830, the Board of Directors adopted the report of Thomas Bennett, a director, containing the following words: 'The locomotive shall alone be used. The perfection of this power in its application to railroads is fast maturing, and will certainly reach, within the period of constructing our road, a degree of excellence which will render the application of animal power a gross abuse of the gifts of genius and science.'" G.E. Mauldin, "South Carolina Canal and Rail Road," *Bulletin of the Railway and Locomotive Historical Society*, no. 17 (Oct. 1928): 71. See also "History of the 'Best Friend of Charleston,'" *Bulletin of the Railway and Locomotive Historical Society*, no. 18 (April 1929): 60–61; William H. Brown, *The History of the First Locomotives in America* (New York: D. Appleton & Co., 1871), 141–153 and 159.
5. For a brief but thorough overview of the SCCRR, see Mauldin, "South Carolina Canal and Rail Road," 70–80 (see n. 4). For the most comprehensive history of the SCCRR, see Samuel Melanchthon Derrick, *Centennial History of South Carolina Railroad* (Columbia, SC: The State Company, 1930). For a more general overview of railroads in the southern U.S. during this time, see Ulrich Bonnell Phillips, *A History of Transportation in the Eastern Cotton Belt* (New York: Columbia Univ. Press, 1908). For a thorough study of the development of early railroads in the U.S. in general, see J.L. Ringwalt, *Development of Transportation Systems in the United States* (Philadelphia: Railway World Office, 1888).
6. "ASCE Designates Charleston-Hamburg Railroad National Historic Engineering Landmark," *Transactions of the American Society of Civil Engineers* 135 (1970): 1102.
7. Stanford Anderson, "Jefferson, Railroad Towns, and the Singular Plan of Aiken," *Places Journal* 20, no. 3 (2008): 65–73.
8. Ibid., 69.
9. "South Carolina Railroad," *American Railroad Journal,* second quarto series, vol. 8 (11 Sept. 1852): 583.
10. "South Carolina Railroad," *American Railroad Journal and Advocate of Internal Improvements* 2, no. 34 (24 Aug 1833): 531–533.
11. Rising "a height of 51 m over a length of 1,158 m" (*une hauteur de 51 mètres sur une longueur de 1,158 mètres*). Guillaume Tell Poussin, *Chemins de fer Américains; Historique De Leur Construction, Prix De Devient Et Produit; Mode D'administration Adopté: Résumé De La Législation Qui Les Régit. Fi Isa Si Suite Aux Travaux* (Paris: Carilian-Goeury, 1836), 147; Franz Anton Ritter von Gerstner, *Early American Railroads: Franz Anton Ritter von Gerstner's Die innern Communicationen (1842–1843)*, ed. Frederick C. Gamst, David J. Diephouse, and John C. Decker (Stanford, CA: Stanford Univ. Press, 1997), 711.
12. "An inclined plane was established divided into three different slopes, the strongest is 1/13" (*a établi un plan incliné divisé en trois pentes différentes, dont la plus forte est au 1/13*). Poussin, *Chemins de fer Américains*, 146–147, and von Gernstner, *Early American Railroads*, 711, recorded that the Inclined Plane "has three gradients, the steepest of which is 1 in 13."
13. "Correction of Railroad Table. South Carolina Railroad and its Branches," *American Railroad Journal* 20, no. 598 (4 Dec 1847): 771.
14. Derrick, 104 (see n. 5).
15. "South Carolina Railroad," 531–533 (see n. 10).
16. Poussin, *Chemins de fer Américains*, 144–155 (see n. 11).
17. Gamst et al., *Early American Railroads*, 710-712 (see n. 11).
18. J.H. Stockton, "Railroading in its Infancy: The First Long Line of Railroad in America," *The Railway Conductor* 8, no. 13 (Aug 1891): 438–440.
19. J.W. Robertson, "Correspondence," *Journal of the Brotherhood of Locomotive Engineers* 28, no. 6 (June 1894): 522–525; James Walter Daniel, *A Ramble Among Surnames* (Nashville: Publishing House of the M.E. Church, South, 1893).
20. "South Carolina Railroad" (see n. 10).
21. Stockton, "Railroading in its Infancy," 438 (see n. 18); Robertson, "Correspondence," 524 (see n. 19).
22. Robertson, "Correspondence," 524 (see n. 19).
23. Stockton, "Railroading in its Infancy," 438 (see n. 18).
24. "South Carolina Railroad," 532 (see n. 10).
25. Daniel, *A Ramble Among Surnames*, 136 (see n. 19).
26. Poussin, *Chemins de fer Américains*, 148 (see n. 11). Translation by Howard Wayt.

   "La remorque sur le plan incliné se fait au moyen de deux machines stationnaires de la force de 25 chevaux chacune; ces deux machines agissent sur la même manivelle, elles sont capables de remorquer des chariots chargés de marchandises, et des voitures de voyageurs d'un poids total d'environ 36 tonnes, avec une vitesse de 16 kilomètres (4 lieues à l'heure).

   On a extraordinairement simplifié le mécanisme par lequel la remorque est effectuée, de manière que le service s'en fait très-régulièrement. Le câble pour la remorque s'enroule sur une roue à rainure, rattachée à un axe perpendiculaire , et dont une des extrémités est munie d'une roue à engrainage: deux cylindres, établis perpendiculaires l'un à l'autre , lui communiquent le mouvement qui, de cette manière, se régularise et dispense du volant.

   La chaudière est à deux compartimens entièrement séparés, au moyen de robinets d'arrêts; de manière que chaque compartiment peut servir indépendamment de l'autre, et que les réparations nécessaires peuvent être faites à l'un, tandis que l'autre continue son service.

   Les cylindres et les conduites de vapeur sont pourvus de soupapes d'arrêt , qui ont le même but; en sorte que cette machine est pour ainsi dire rendue double. De plus on a soin de tenir constamment en magasins des parties de rechange pour celles qui nécessiteraient des réparations immédiates; de cette manière , on est entièrement à l'abri de tout retard dans le service du plan incliné."
27. Derrick, 104 (see n. 5).
28. John McRae, "Engineer's Report upon the Inclined Plane," *Reports by the President of So. Ca. Rail Road Company* (Charleston, SC: Walter and Burke, 1846), 87-98.
29. For more information on archaeological research performed on the Allegheny Portage Railroad, see Michael Raymond Sprowles, "Magnetics, Radar, and Steam: Geophysical Testing of the Allegh-

eny Portage Railroad Industrial Historic Site" (master's thesis, Indiana Univ. of Pennsylvania, 2011); and Wilson, "The Evolution, Decadence and Abandonment" xli–xcvi (see n. 2). On the Philadelphia and Columbia Railroad, see John C. Trautwine Jr., *The Philadelphia and Columbia Railroad of 1834,* vol. 2 of *Philadelphia History* (Philadelphia: City History Society of Philadelphia, 1925), 139–178. On the Liverpool and Manchester Railroad, see Nicholas Wood, *A Practical Treatise on Railroads, and Interior Communication in General* (Philadelphia: Carey and Lea, 1832), 479–486. Wood's chap. 3, "Steam Engine, Fixed Upon Ascending Planes," describes in detail the construction and operation of Inclined Planes of the period, with many examples from the Liverpool and Manchester. On the design and construction of railroads of the period, see also Gamst et. al, *Early American Railroads* (see n. 10).

30. "South Carolina Railroad," 531–533 (see n. 10).
31. All sources consistently describe a standard 3-in. inset for mounting rails to cross-ties, which implies a similar standard depth was used for the inset for mounting cross-ties to longitudinal sills.
32. "South Carolina Railroad," 532 (see n. 10): "The size never was allowed to be less than 9 by 9, generally well-hewed in the upper and lower surfaces, and blocked off on the edges. It is better to jog the caps [cross-ties] into the [longitudinal] sills by a gain [notch] in the latter, and use a wedge in preference to the trenail, as the pin hole admits water and engenders decay."
33. Ibid. Under the "Details of Construction," Sleeper Plan No. 2 says that the "distance apart of the supports remain the same [as described in Sleeper Plan No. 1]." Sleeper Plan No. 1 states that the cross-ties are "laid six and a half feet apart." Simple addition shows that three spans of 6½ ft. cover a distance of 19½ ft. It would require four cross-ties to complete such a span. The question of whether or not the 6½-ft. measurement is applied between the sides of the cross-ties or center-to-center is likely resolved by a statement made about the length of the rails given in the description of Pile Construction that follows Sleeper Plan No. 2: "never less than three stretches, or 19½ feet in length." It would be necessary to support the ends of these rails in the center-width of the cross-ties, resulting in a spacing of 19½ feet between the centers of the first and last of four cross-ties. Sleeper Plan #2 refers to "caps [cross-ties], into which the rails are let a depth of three inches, and secured by wedges."
34. T. Tupper, "Report to the Stockholders of the South-Carolina Canal and Rail-Road Company," *American Railroad Journal and Mechanics Magazine* 15, no. 413 (1 Sept 1842): 152–157 at 155.
35. "South Carolina Railroad," 533 (see n. 10): "A turn out or passing place, about 600 feet in length, the centre [sic.] of which is 30 feet distant from the main tracks, into which it curves easily at each end, is placed at every 7 miles along the road."
36. Ibid.
37. Horatio Allen, *The Railroad Era: First five years of its development* (New York: n.p., 1884), 26.
38. "South Carolina Railroad," 533 (see n. 10).
39. Poussin, *Chemins de fer Américains*, 152 (see n. 11): "Les rails don't on s'est servi sont plats, et ont 6 centimètres de esult, 13 millimètres d'épaisseur, et de 3 à 4 mètres 50 centimètres de longueur; ils sont assujettis aux lisses par des chevilles en fer de 12 centimètres de longueur; on a eu soin de tenir les têtes de ces chevilles un peu au-dessous du niveau de la surface extérieure du rail."
40. "South Carolina Railroad," 533 (see n. 10).
41. Poussin, *Chemins de fer Américains*, 152 (see n. 11): "Il est entré 10,565 kil. De pareils rails dans un esults t, qui ont coûté environ 14f 75c les 100 kilogrammes importés d'Angleterre et esults à Charleston. Les chevilles en fer sont revenues à 1f 6c le kil." This equates to a price of about $1,100 per short ton in modern currency; "Historical currency converter," online at http://www.historicalstatistics.org/Currencyconverter.html.
42. Allen, *The Railroad Era*, 20–22 (see n. 37).
43. "South Carolina Railroad," 532 (see n. 10).
44. Allen, *The Railroad Era*, 15–16 (see n. 37).
45. Ibid., 26 (see n. 37).
46. "South Carolina Railroad," 533 (see n. 10).
47. "Statistics of the South Carolina and Georgia Railroad Companies," *American Railroad Journal and Mechanics Magazine* 15, no. 413 (1 Sept 1842): 138: "This construction proving insufficient, after two or three years trial, the whole was rebuilt between the years 1835 and 1839; the piled portion of the road embanked, and a flat bar having a flangh [*sic*] projecting downwards on the inside and weighing 26 lbs. per yard substituted for the old." See also "Account of the South Carolina Railroad," *American Railroad Journal* 16, no. 426 (July 1843): 214: "This road thus constructed with some alterations and improvements was kept up on *stilts* till 1836. Requiring then heavy repairs, and to be almost rebuilt, which was commenced that year by importing heavy flanged iron, now on the road, throwing up an embankment to support the piles and rails, and replacing timber where it was decayed."
48. "Semi-Annual Report of the South-Carolina Canal and Railroad Company, to December 31, 1837," *American Railroad Journal and Advocate of Internal Improvements* 6, no. 48 (2 Dec 1837): 649.
49. Tupper, "Report to the Stockholders," 155 (see n. 47): "They were put in the road [Inclined Plane] about two years ago, and to this time are perfectly sound."
50. Ringwalt, *Development of Transportation Systems,* 85 (see n. 5).
51. Gamst et al., *Early American Railroads*, 711 (see n. 11).
52. "To the President and Directors of the Georgia Railroad Company," *American Railroad Journal and Advocate of Internal Improvements* 4, no. 25 (27 June 1835): 396.
53. "South Carolina Railroad," 533 (see n. 10).
54. Allen, *The Railroad Era*, 30–32 (see n. 37). For a thorough investigation of the impact of gauge on early railroads, see Douglas J. Puffert, "The Standardization of Track Gauge on North American Railways, 1830-1890," *The Journal of Economic History* 60, no. 4 (2000): 933–960.
55. Steen and Southerlin, "A Cultural Resources Inventory," 311–326 (see n. 1).