



Department of Defense Legacy Resource Management Program

PROJECT 04-106

H. L. HUNLEY PROJECT: 2004
ARCHAEOLOGICAL FINDINGS AND
PROGRESS REPORT

Maria Jacobsen
Senior Archaeologist & Excavation Manager

February, 2005

THIS REPORT IS UNCLASSIFIED AND MAY BE RELEASED TO THE PUBLIC

H.L. HUNLEY PROJECT
2004 ARCHAEOLOGICAL FINDINGS AND PROGRESS REPORT

By Maria Jacobsen
Senior Archaeologist & Excavation Manager

February 2005

FOREWORD

In 2004 the archaeological investigations of the Civil War submarine *H.L. Hunley* have focused on the ongoing forensic research of the vessel's crew, the internment of their remains, completion of the excavation of the submarine's interior, and the documentation of artifacts recovered during the excavation.

The objectives of the 2004 investigations have been to collect data that can help answer critical questions such as: Who were the servicemen that were found inside *H.L. Hunley*, and what happened to them and their vessel following the historic naval engagement on February 17, 1864, when they became the first submariners in history to sink an enemy ship in combat and, thus, help launch the modern era of submarine warfare?

I. FORENSIC INVESTIGATION OF THE *H.L. HUNLEY* CREW

Recording and naming of the human remains prior to identification

Skeletal remains of eight servicemen were found during the excavation of the *H.L. Hunley's* crew compartment. Each bone uncovered was documented (i.e., mapped, photographed, identified, and given a unique number in the Hunley database) before it was removed. Some bones, however, had over time become embedded in the concretion that formed over the corroding iron hull. These bones had to be painstakingly de-concreted from the cement-like matrix that encased them, before they could be recorded and removed. Other bones were found associated with very fragile, waterlogged textiles. In those cases, the bones and the textiles were block-lifted together with the sediment supporting them. These sediment blocks were later excavated in the laboratory. In almost every instance, fully or partially articulated foot bones were contained within the leather shoes belonging to the crew. The shoes were treated as block lifts and excavated in the laboratory as well.

After a morphological study of the entire skeletal inventory was completed, it was possible to assign each bone to a specific individual. The full skeletons were then tentatively labeled AA, BB, CC, DD, EE, FF, GG, and HH. Individuals were named in alphabetical order according to where they were found in the crew compartment. The crewman whose remains were found furthest forward, near the forward bulkhead and beneath the forward conning tower, was called AA, the individual behind him was labeled BB, and so forth. Finally, the last crewman, whose remains were found in the stern end near the aft pump, was named HH.

Crew remains excavated in 2004

A number of sediment and artifact block lifts that were previously removed from the submarine's interior were selected for excavation and documentation in 2004. Priority was given to sediment blocks thought to contain skeletal remains or personal artifacts (such as military buttons) that could help with the identification of the crew.

The final two and most poorly preserved leather shoes in the assemblage were excavated in 2004. One heavily concreted Brogan-style half boot contained the left foot bones of Individual BB; the other, a regular shoe, held the left foot bones of HH. With the entire foot bone assemblage exposed and recorded, the bones were reexamined, and it was possible to correct a previous error in the assignment of the foot bones within two sets of shoes.

A number of finger bones were uncovered while removing concretion from around the many ballast blocks that lined the bottom of the crew compartment. Finger bones were also found in a sediment block lift that contained extremely degraded textile remains associated with Individual AA. A total of 140 bones that were previously missing from the skeletal inventory were recovered and documented.

Post-excavation documentation of the skeletal inventory

Archaeological documentation of the entire skeletal inventory was completed in 2004. The documentation regime included photography of the human remains (with full body layouts of each individual) and macro-photography of the dentition and bones that exhibited pathologies. 1:1 scaled drawings were made of the left long bones, as well as bones from the shoulder and pelvic girdles. Laser scans were used to precisely record the primary bones in the skeletal assembly. In addition, Magnetic Resonance Imaging (MRI) was used to accurately document any soft tissue remains preserved within the crania of the eight crewmen. X-rays and Computed Tomography (CT) scans were also made of the crania, the mandibles, the left long bones, and any other bones in the assemblage that exhibited unusual pathologies.

Completion of the osteology study

The osteological study of the skeletal remains was likewise completed in 2004. This work was conducted in collaboration with research partners Dr. Doug Owsley of the Smithsonian Institution and Prof. Richard Jantz of the University of Tennessee at Knoxville. Owsley checked and verified new bone pathologies discovered during the recording effort, finished analysis of each crewman's dentition, and finalized the age determinations for all eight men. Jantz

completed the post-cranial calculations and was able to reconstruct the height of each individual.

Replication of bones

Because the skeletal remains of *Hunley's* crew were to be buried in 2004, and because they constitute a very exceptional and well-preserved osteological collection from the American Civil War era, the decision was made to replicate a number of bones from each crewman. This would ensure their use for future reference and study. Forensic anthropologist Dr. Diane France of France Casting in Fort Collins, Colorado created the molds of the bones and produced the casts. The bones that were replicated included all eight crania, mandibles, left humeri, femora, and tibiae, as well as other bones with unusual pathologies.

Genealogical research and exhumation of DNA candidates

Forensic genealogist Linda Abrams is the person responsible for conducting research into the genealogical background of each man who served aboard *H.L. Hunley*. The focus of this investigation has been threefold: First, to identify the servicemen who were aboard *H.L. Hunley* on its last mission; second, to trace each crewman's personal history and ancestry; and finally, when possible, to locate direct maternal descendants or relatives of the crew who can provide mitochondrial DNA (mtDNA) to positively identify the remains found in the submarine.

The genealogical and historical research associated with the submarine and its crew is notoriously difficult to conduct, however. This is due in large part to the lack of documents pertaining to the South's effort to conduct submarine warfare. Few of these archival sources survived the war, probably because they were destroyed so that they did not fall into enemy hands. To make matters more difficult, the few surviving Confederate service records that pertain to *H.L. Hunley's* crew lack many of the personal details found in contemporary Union records. Despite these problems, Abrams has succeeded in locating the names and service records of seven of the *Hunley's* eight-man crew.

The crew was made up of servicemen that came from the Confederate States Army (CSA) as well as the Confederate States Navy (CSN). Submarine commander Lt. George E. Dixon and crewmember J. F. Carlsen transferred from the CSA to serve aboard *H.L. Hunley*. Five seamen joined them: James A. Wicks, Joseph F. Ridgaway, Frank G. Collins, Arnold Becker, and C. Lumpkin(s). The exact spelling of Lumpkin's name has not been confirmed, because it only appears in rosters written by others, and is transcribed both as Lumpkin and Lumpkins. All five seamen were stationed in Charleston on the Confederate

receiving ship *CSS Indian Chief*, before they volunteered for special duty aboard the submarine.

Practically nothing is known about the eighth man that served aboard *H.L. Hunley*. His last name may be Miller, but no archival records have yet been found that confirm that an individual with that name served aboard the submarine. Mention of a crewmember named Miller first appears in a post-war letter written by former *H.L. Hunley* crewmember William Alexander. The letter was written more than 36 years after the submarine was lost and, unfortunately, does not provide the man's initials, his military affiliation, or origin. Unless additional personal data surfaces for this particular individual, his identity will be exceedingly difficult to track.

George E. Dixon

Lt. George E. Dixon commanded *H.L. Hunley's* crew and navigated the submarine on its final mission on the night of February 17, 1864. His ancestry is unknown, but he was a steamboat engineer by profession, and in 1859 he received a second-class engineering license in St. Louis, Missouri. At the outset of the war in April 1861 he was a member of the Washington Light Infantry in the Alabama State Militia, located in Mobile. The militia unit later became Company A of the 21st Alabama Infantry Regiment in the Confederate States Army. In October 1861, the 21st Alabama regiment was accepted into Confederate service. On April 6, 1862, during the Battle of Shiloh (Tennessee), Dixon received a severe gunshot wound to his upper thigh. According to contemporary records, including one from his company commander, the bullet that struck him hit a coin that Dixon carried on his person. The coin took the brunt of the impact, thus saving his leg and possibly his life. After his injury Dixon convalesced in Mobile for a period of time. He served with the CSA until the summer of 1863, when he was transferred to Charleston for duty aboard the *H.L. Hunley*. He earned the rank of 1st Lieutenant and died at the age of 24 or 25.

J. F. Carlsen

J.F. Carlsen's ancestry and age is unknown, but before Carlsen enlisted in the Confederate States Army he was helmsman aboard a Charleston-based brig that was commissioned as a privateer in June of 1861. The crew of the ship successfully captured several vessels during her short career. In August 1861 the ship ran aground and wrecked off the coast of Florida. Carlsen survived the wreck and returned to Charleston where he enlisted with Company A of the South Carolina Volunteers Light Artillery, a

unit that was also known as Captain Wagener's Company or the German Artillery. During his tenure with the artillery unit, Carlsen attained the rank of Corporal. Shortly thereafter, he joined *H.L. Hunley's* crew.

C. Lumpkin(s)

Almost nothing is known about C. Lumpkin(s) other than that he served in the Confederate States Navy. He must have been an experienced seaman, because he attained the rank of Quartermaster before volunteering to serve aboard the submarine.

Arnold Becker

Seaman Arnold Becker's background and age is also unknown, but his military rank is well documented. During his Confederate Navy service in Charleston he was promoted to Captain's Cook.

In 2004, new data surfaced regarding the identities and backgrounds of *H.L. Hunley* seamen James A. Wicks, Joseph F. Ridgaway, and Frank G. Collins. Among other things, the ancestry and marital status of each of the aforementioned has now been determined.

James A. Wicks

James A. Wicks was a native of North Carolina. He was a career seaman, was married and had four daughters. Before the outset of the Civil War he served in the United States Navy. He remained in the U.S. Navy until March 8, 1862, when the Confederate ironclad CSS *Virginia* sank the Union ship on which he was stationed during the Battle of Hampton Roads. Wicks survived the sinking, but in the resulting chaos decided to desert the Union Navy. He later enlisted with the Confederate States Navy in Richmond, Virginia. During his service with the Confederate Navy, he earned the rank of Boatswain's Mate. He was 44 years old when he died aboard *H.L. Hunley*.

James Wicks is the only submarine crewmember currently known to have been married and have children. Living descendants of those children have been identified and located in the United States. Unfortunately, none of them are direct maternal descendants of Wicks; consequently, they do not carry the mtDNA that can be used to positively identify his remains.

Joseph F. Ridgaway

Joseph F. Ridgaway was born in Maryland. He was an experienced seaman who earned his Seaman Protection Certificate at the age 16. Ridgaway never married and did not have any children. In August of 1862, he enlisted in the Confederate States Navy in Richmond, Virginia. He earned the rank of Quartermaster before transferring to the *Hunley* crew. He died at age 29 or 30.

Living relatives of Joseph Ridgaway have been located in the United States, but none of these individuals are direct maternal descendants. As a result, they do not share his mtDNA lineage. A number of deceased relatives of Joseph Ridgaway have also been identified.

Two of Ridgaway's sisters were buried together in a public cemetery in Philadelphia, Pennsylvania. Since the three siblings had the same mother, they would all have her mtDNA lineage in common. Project scientists reasoned that if the sisters' remains were well preserved, a tooth or a bone sample from one or both of them could be used to positively identify the remains of their brother. Consequently, the decision was made to pursue the exhumation of those remains. In order to obtain permission for the exhumation, a search was initiated to locate the oldest living direct descendant of the women in question. That individual was contacted, and permission to exhume the bodies for the purpose of conducting a comparative DNA study was secured from the family and cemetery officials.

Owsley and a team of archaeologists from the Smithsonian Institution undertook the exhumation and collected samples of the remains, which were sent to Jackie Raskin-Burns of the Armed Forces DNA Identification Laboratory (AFDIL) in Washington, DC, for processing and DNA sequencing. One sample yielded mtDNA that matched the DNA sequence extracted from the remains of individual HH. Consequently, it is now possible to identify these remains as those of Joseph F. Ridgaway. Ridgaway became the first *H.L. Hunley* crewmember to be positively identified through DNA analysis.

Frank G. Collins

Frank Collins' birth records have not been found, but based on other family records he was most likely a native of Virginia. He

was single for the duration of his life and did not have any children. Prior to joining *H.L. Hunley's* crew, he served in the Confederate States Navy, where he attained the rank of Seaman. He would have been 25 or 26 at the time of his death.

A number of living relatives of Collins have been located in the United States, but unfortunately, none of the people identified share Collins' mtDNA lineage. Among Collins' deceased relatives whose graves have been located are Frank's father and younger brother. They are both buried in the Congressional Cemetery in Washington, DC. Since the Collins brothers had the same mother, they shared the same mtDNA lineage; consequently, Frank Collins' brother's remains could provide concrete proof of his identity. A study of Frank's brother's grave was initiated and the grave probed. Unfortunately, when the sedimentary stratigraphy of the grave was examined, it became evident that the local soil conditions were not conducive to preservation of skeletal remains. As a result, project scientists reasoned that any existing DNA would be poorly preserved. For this reason, the effort to exhume the remains of Frank Collins' brother was abandoned.

The grave of a second Collins relative and potential mtDNA candidate was found in Pittsburgh, Pennsylvania. The grave belonged to Edward C. Goznell, who according to family records was Collins' maternal cousin (i.e., the son of his mother's sister). In this case the preservation conditions at the gravesite looked very promising and permission was obtained from the family and cemetery officials to exhume the body. Owsley performed the exhumation and extracted DNA samples, which were processed by AFDIL. The samples yielded mtDNA, which in turn yielded puzzling results: specifically, Goznell's DNA did not match that belonging to any of *H.L. Hunley's* crew. However, further research revealed that the family records were misleading. Collins' mother and Goznell's mother were indeed sisters; but while they had the same father, they had different mothers. Apparently, their father had married twice, and both times to women with the exact same name. Since Goznell's mother and Collins' mother were half-sisters, Goznell could not have provided a mtDNA match for Frank Collins' remains.

Results of stable isotope analyses

In 2003 samples of teeth and bones from each of the *H.L. Hunley's* servicemen were obtained for stable isotope analyses. The results of the analyses were surprising, as they revealed that four of the men (Individuals AA, DD, GG, and HH) were born in North America, while Individuals BB, CC, EE, and

FF (i.e., half of the crew) were foreign born and most likely originated from northern Europe.

Crew Identification

By combining data from the archaeological, osteological, and genealogical investigations and the recent skeletal analyses, it is now possible to develop a preliminary profile for each of the eight servicemen, as well as begin the process of identifying the individuals by name. At this point the remains of the four American-born men have been identified, but more personal data is needed to confirm the tentative identification of the four men of European birth.

Individual AA (Lt. George E. Dixon)

Individual AA is without a doubt the submarine's commander, 1st Lieutenant George E. Dixon. Several facts support this identification: 1) AA's skeleton was found at the submarine's control post, where the commander would have been stationed; 2) the age of the individual matches the age for Dixon; and 3) a unique gunshot wound found on AA's upper left femur match war records that state Dixon had previously suffered a severe gunshot wound in the upper thigh. In addition, the coin mentioned in contemporary records that reportedly saved his life was discovered among Dixon's remains during the excavation of the submarine. The coin was a deformed \$20 gold piece that had been warped around the impact point of the projectile, which had struck the coin's obverse face. On the reverse face, a reminder of the momentous day when the coin had saved his life was recorded. George Dixon had had his good luck charm engraved with a hitherto unknown inscription that read:

*SHILOH
April 6th 1862
My life Preserver
G.E.D.*

Individual HH (Joseph F. Ridgaway)

As previously noted, DNA analysis has confirmed that the remains of Individual HH belong to Quartermaster Joseph F. Ridgaway. Based on the location of his remains, it is reasonable to assert that seaman Ridgaway was stationed at the last bench seat position nearest the aft conning tower. This position, according to former crewmember William Alexander, was reserved for the second in command aboard the submarine.

Ridgaway was responsible for securing the aft hatch before *H.L. Hunley* got underway and, from his station, he operated the aft seacock and pump mechanism that controlled the water level in the aft ballast tank. When necessary, Ridgaway also operated the 7th crank handle and, together with the other crewmembers, helped propel the hand-driven submarine through the water.

Looking at the design and layout of the submarine, it is clear that Ridgaway worked closely with Dixon, who navigated the submarine and controlled the forward seacock. He also would have worked in close conjunction with Individual BB who operated the forward pump. The three men would have synchronized their efforts to insure the proper trim of the vessel, and would have worked together to control the descent and ascent inclination of the submarine when it submerged and resurfaced.

Individual GG (James A. Wicks)

Boatswain's Mate James A. Wicks was 44 years old at the time of his death. There are three individuals who served aboard *H.L. Hunley* who are estimated to have been in their late thirties or early forties when they died. These individuals are CC, FF, and GG. Only one of the aforementioned (Individual GG) was American-born, based on the results of the stable isotope analyses. Since historical sources indicate that Wicks was born in the United States, it can be concluded that Individual GG is James Wicks. Wicks sat in the stern end of the crew compartment, just forward of Ridgaway, where he was responsible for operating the 6th crank handle.

Individual DD (Frank G. Collins)

Armed with the knowledge that there were only four American-born crewmembers aboard *H.L. Hunley*, a simple process of elimination dictates that the remains of the last American-born individual, namely DD, are those of Seaman Frank G. Collins. Collins was stationed in the middle of the crew compartment and was responsible for operating the 3rd crank handle.

Individuals BB and CC

Although Confederate service records have been located for three of the four European-born crewmembers (J. F. Carlsen, Arnold Becker, and C. Lumpkin(s)), the ages of these men are not

specified. Unfortunately, without these data the remains of the aforementioned individuals cannot be identified with any certainty.

However, the osteological data and artifacts associated with the four foreign-born men can be used to interpret their remains. For example, it is possible to say that Individual BB was ca. 20 years old at the time of death, and that he wore an article of clothing—likely a vest—adorned with small Navy fouled-anchor buttons. Although the textile had long since disintegrated, several of these buttons were discovered in clear association with his torso. This means that Individual BB is without a doubt one of two unidentified seamen (Arnold Becker or C. Lumpkin(s)) that served aboard the submarine. Individual BB sat at the forwardmost crew bench position, and was responsible for a number of tasks in the submarine. He operated the 1st crank handle and the forward pump mechanism that controlled the water level in the forward ballast tank. He also controlled the snorkel and bellows system, which was used to replenish the air supply in the submarine.

Individual CC was between 37 and 44 years of age at the time of his death. He sat immediately aft of Individual BB and was responsible for operating the 2nd crank handle. Navy buttons were also found near CC's station, but because his remains were disarticulated, it is not possible to say that he was wearing the clothing on which the buttons originally were attached. However, the fact that Navy buttons were present near his remains suggests that he, like Individual BB, was a seaman.

Both Seaman Becker and Seaman Lumpkin(s) were detached from the Confederate States Navy to serve aboard *H.L. Hunley*. While in the Navy, Becker achieved the rank of Captain's Cook; Lumpkin(s) attained the rank of Quartermaster. Since Quartermaster was one of the highest ranks for enlisted men in the Confederate Navy, the rank suggests a very experienced and likely older seaman. As a result, it seems reasonable that the older of the two individuals (Individual CC) would be a better candidate for C. Lumpkin(s). Therefore, Individual CC has been (very) tentatively identified as C. Lumpkin(s) and Individual BB as Arnold Becker.

Individual EE

According to osteological analyses, Individual EE was approximately 20 to 23 years old when he died. He was stationed in the middle of the crew compartment and was responsible for operating the 4th crank handle. Confederate artillery buttons were

found near his station, but the buttons were not directly associated with his torso. In this case, however, archaeological evidence suggests that the buttons were once attached to a piece of clothing, most likely a shell jacket, which had been slung over the crew bench next to EE's seat. Since it is historically documented that J.F. Carlsen served as artillerist in the Confederate States Army prior to joining the submarine's crew, it seems probable that Individual EE could be Carlsen.

Individual FF

Individual FF was born in Europe. At 40 to 45 years of age, he was one of the oldest crewmembers aboard the submarine. This man sat in the aft section of the crew compartment between EE (possibly J.F. Carlsen) and James A. Wicks, and he was responsible for operating the 5th crank handle.

As indicated above, there is no personal historical data pertaining to the eighth crewmember, and his name has not yet been confirmed. However, if the tentative identifications of the other three European-born servicemen are correct, the best candidate for the man whose name may be Miller is individual FF.

Photo super-imposition study

Two period photographs, one thought to portray George E. Dixon and the other James A. Wicks, were initially studied in 2003 and re-examined in 2004 after Wicks' remains had been identified.

The cranium and mandible of each man were articulated and the heads photographed so that their faces matched as closely as possible the inclination and angle of the faces on the portraits. The period photographs and the cranial images were then scanned and the data sent to Dr. Nicholas Herrmann at the University of Tennessee for photo super-imposition analysis. The objective was to determine how well facial landmarks on Dixon and Wicks' crania fit the same landmarks on the faces in the photographs. In order to quantify a relative fit, the photographs were compared to cranial data from a random sample of 70 Civil War era soldiers, as well as the other *H.L. Hunley* crewmembers.

According to Herrmann, Dixon's cranium shows a good fit with the face depicted on the possible Dixon portrait. Interestingly, it ranks number one out of the study group of 78 men. However, Dr. Doug Owsley believes that, aside from the face, the overall morphology of Dixon's cranium does not match the head shape of the unknown man shown on the photograph. As a result, he has concluded that the person is not George Dixon.

With regards to the second photograph, the data are unambiguous and have shown that it cannot be a portrait of James Wicks. This means that, to date, there are no known photographs of any of the men who served aboard *H.L. Hunley* during its final historic mission.

Facial reconstructions

Because the skeletal remains of the servicemen recovered from *H.L. Hunley's* crew compartment were so exceptionally well preserved, an integral part of the forensic investigations has been to attempt to reconstruct how these men may have looked. For this purpose, Dr. France of France Casting in Fort Collins, Colorado, made a set of replicas of the eight crania and mandibles. The casts were then sent to forensic artist Sharon Long in Laramie, Wyoming, to serve as a base for reconstructing the head shape and the faces of the men. The process of the facial reconstructions was a collaborative effort between the artist and Dr. Owsley of the Smithsonian Institution.

In 2004, the initial sculpting of the faces in clay was completed and the heads molded and cast in a solid form. The eight finished faces are currently on public display at the Warren Lasch Conservation Center (WLCC) in Charleston.

II. INTERMENT OF *H.L. HUNLEY'S* CREW

In preparation for the interment of *H.L. Hunley's* crew, all the skeletal remains excavated were checked and verified, and a final burial inventory comprising 1,586 bones was compiled. The bones were wrapped in degradable tissue paper, and each skeleton placed in a rectangular copper coffin engraved with its individual identity (AA through HH). These coffins were then sealed and secured inside hexagonal, period-correct wooden coffins.

The State of South Carolina Hunley Commission and the Friends of the Hunley planned and arranged the funeral of *H.L. Hunley's* crew. They sought to insure that the burial ceremonies were as historically accurate as possible and that the servicemen were buried with what in 1864 would have been considered full military honors.

During the week of April 12th, 2004, the eight coffins lay at state in the Patriots Point Naval Museum and in several churches in the Charleston area, where multi-denominational memorial services were held for the men. On April 17, a military Honor Guard of Civil War re-enactors escorted the caskets on horse-drawn caissons to Charleston's Magnolia Cemetery, where Lt. Dixon and his seven-man crew were laid to rest alongside the graves of the men who had previously served aboard *H.L. Hunley*.

It is estimated between 30,000 and 40,000 people participated in the weeklong memorial events, and that some 20,000 people attended the burial ceremonies for the crew. Among the participants were descendants of James Wicks, Joseph Ridgaway, and Frank Collins, dignitaries from the U.S. government and the U.S. Navy, and many submariners from around the globe, all of who had come to pay their respects to the pioneering submarine crew.

III. EXCAVATION OF THE INTERIOR OF THE SUBMARINE

Excavation of the crew compartment

A number of objects that had become concreted to the bottom of the hull in the very forward section of the crew compartment were de-concreted, mapped, and removed for conservation. These included an iron wrench and T-handle, fragments of copper wire, match or toothpick remains, a canteen cork, and a number of metal rods and straps that appear to be part of the locking mechanism for the forward hatch.

Concreted to the lower portion of the forward bulkhead was a very fragile section of metal tubing that formed part of the submarine's depth gauge. The section was deconcreted, and upon its removal was found to still contain mercury in liquid form. On the wooden shelf attached to the forward bulkhead was a heavily corroded but intact oilcan, which still contained an oily residue. It and the wooden shelf were documented and removed from the submarine.

Excavation of the very aft end of the crew compartment, behind the submarine's gear mechanism and flywheel, was completed during 2004. Access to this area was very limited; consequently, its documentation was difficult and time consuming. A series of sediment box cores and push cores were taken of the sediment profile along the forward edge of the aft bulkhead. The box cores were mapped, removed, and x-rayed. These constitute the last sediment samples taken from the submarine. Beneath the sediment in Grid 8 were additional pig iron ballast blocks, and concreted to the ballast blocks were a number of smaller items, such as washers, a straight pin, and fragments of what may be wooden matches or toothpicks.

Removal of pig iron ballast

The submarine carried additional ballast in the form of a series of pig iron ballast blocks. These lined the bottom of the crew compartment and the base of the fore and aft ballast tanks. However, none of the ballast blocks were permanently fastened to the hull. In 2004 the majority of blocks located in the crew compartment, as well as all of those located in the fore and aft ballast

tank areas, were deconcreted, mapped, and removed. During this process, numerous textiles fibers and hairs belonging to the crew were found concreted to the ballast blocks in the crew compartment.

Seven large ballast blocks were removed from the forward tank, eight from the aft ballast tank, and 59 blocks of various sizes from the crew compartment. A number of smaller ballast blocks remain beneath the crew bench, but they cannot be accessed before the bench is removed. The weight of pig iron removed from the submarine to date totals 4,453 lbs.

While de-concreting the ballast blocks in the crew compartment, additional pipes and valves were exposed that were part of *H.L. Hunley's* water balancing system. The forward and aft ballast tanks were not isolated as once thought, but instead connected with a pipe that allowed the tanks to be filled simultaneously, if desired. Although a separate fore and aft pump normally controlled the water level in the fore and aft tanks, the pumps could be isolated, and both tanks emptied using only one pump. This system was employed if one of the pumps failed to operate normally.

Mapping and recording of hull features

A team of surveyors from Pacific Survey Supply visited the WLCC in 2004 to continue work to develop a three-dimensional map of the interior of the submarine. One Perceptron and one Minolta laser scanner were used in conjunction to create a series of highly accurate and detailed scans of areas in the submarine that had not previously been exposed or documented. During their visit, Pacific Survey Supply staff scanned the fore and aft bulkhead regions, the area beneath the crew bench, the interior of the conning towers, and a portion of the forward ballast tank.

IV. DOCUMENTATION OF PERSONAL ARTIFACTS AND HULL EQUIPMENT PRIOR TO CONSERVATION

Excavation of block lifts

Seven sediment block lifts excavated in 2004 contained severely degraded textile remains and several clothing buttons. These blocks were mapped, documented and x-rayed, and all the artifacts found within them sketched and photographed.

Two block lifts associated with Lt. George Dixon's torso contained a number of personal artifacts, including ornate silver suspender buckles with an associated silver chain, a brass clothing buckle, brass vest buttons, ceramic shirt buttons, and an iron pocketknife with an ornate handle. The latter item featured inlays of antler and silver end caps. Another block, removed from Grid

3 in the crew compartment, contained a heavily corroded iron pocketknife or straight razor. This item is too concreted at present to be positively identified.

Efforts to document and reconstruct the degraded remains of a felt slouch hat that was found in the rear of the crew compartment were also initiated. The hat was discovered in close proximity to the remains of Joseph Ridgaway. This item was clearly folded, which indicates that it had been stowed away at the time of the submarine's loss. It may have been carried in a pocket or bag.

Documentation of other artifacts

A number of artifacts made of wood, leather, and cork that had previously been recovered from the submarine were photographed and drawn in 2004. These included personal objects such as shoes, leather belts and straps, smoking pipes, canteen stoppers, and remnants of matchsticks and toothpicks. All of the submarine's wooden hull components, excluding the crew bench and depth gauge support board (both of which are still in the submarine), were also completely documented.

All of the buttons recovered in 2004 were documented, as were a pair of binoculars, a folding ruler, and two pieces of gold and diamond jewelry discovered in association with Lt. Dixon's torso. There is no evidence that Dixon was wearing the jewelry in question; rather, it appears that he carried the pieces in his clothing, probably concealed in a pocket.

Excavation of the submarine's bellows system

The bellows system once used to replenish the air supply in the crew compartment had already been removed from the interior of the submarine, and was documented and excavated in the laboratory in 2004. The bellows is a composite artifact made of miscellaneous wooden, leather, and rubber components. These components were fastened together with iron fasteners, copper-alloy wire, and brass fittings. Attached to one side of the bellows is a rubber hose (a section of which had a corrugated shape) that terminates in a brass coupling. Traces of a white, lead-based paint were found on one side of the bellows, suggesting that the other side had originally been mounted on the hull.

Because portions of the bellows had filled with mud, it was partly dismantled to allow for the excavation of its interior. Three additional military buttons were found inside the bellows. These were Navy fouled-anchor buttons, identical to the type of buttons that are known to be associated with Individual BB. Forensic research has revealed that a portion of Individual BB's torso settled on top of the bellows following the submarine's loss. During the subsequent

decomposition of his body and clothing, the buttons fell into the interior of the bellows through the hole that served as the bellows' air intake valve.

V. HISTORICAL RESEARCH

Historical research pertaining to the submarine

Efforts to find historical documents that pertain to the development and operation of *H.L. Hunley* are ongoing. A hitherto unknown letter written by Lt. Dixon was found in a box of Civil War era correspondence and newspaper clippings that belong to a family in Texas. This letter is important because it not only provides insight about Lt. Dixon and his crew and the circumstances surrounding their daily life, but it describes the setting in the besieged port city of Charleston shortly before *H.L. Hunley* sank the Union blockade ship USS *Housatonic* on February 17, 1864.

VI. PUBLIC OUTREACH

In 2004 a number of public talks and presentations were delivered at the WLCC, in addition to the regular tours conducted every weekend at the laboratory facility. Sally Walker published a children's science book exclusively on the H.L. Hunley Project; a second textbook is in development. Two documentaries about the H.L. Hunley Project were completed during 2004. The first, entitled "*Forensic Case: Hunley*" and hosted by Lisa Ling, was produced by National Geographic Television. It first aired on the National Geographic Channel on April 11, 2004. The second documentary, "*Attack From the Deep*," was produced by Engstfeld Film of Germany and was shown in Europe and on the Discovery Science Channel in the United States. Finally, the exhibit "*Hunley Experience: Adventures in Science and Exploration*," opened at Broadway on the Beach in Myrtle Beach, South Carolina.

VII. MATCHING FUNDING

Personnel from the Medical University of South Carolina (MUSC) performed the MRI and CT scans of the remains of the *Hunley* crew, and expenses for the radiology equipment, personnel, and time were donated by MUSC. The Smithsonian Institution and the University of Tennessee in Knoxville funded the salaries of Drs. Owsley, Jantz, and Herrmann for the osteological study and the photo super-imposition analyses. Personnel from the Smithsonian Institution also conducted the exhumations of the relatives of *H.L. Hunley* crewmembers. All steps associated with DNA identification, from the preparation and processing of samples to DNA sequencing and analysis, were conducted at no cost to the

DoD Legacy Project 04-106

H.L. Hunley Project by the laboratories at AFDIL and the Joint POW/MIA Accounting Command (JPAC), formerly known as the U.S. Army Central Identification Laboratory in Hawaii (CILHI). Pacific Survey Supply of Oregon donated the use of their laser scanning equipment for the documentation of human remains and mapping of the interior of the submarine. The South Carolina-based corporation Burroughs & Chapin funded the development and construction of the exhibit *"Hunley Experience: Adventures in Science and Exploration."*