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February 24, 2005

Sydney F. Cook
U.S. Department of Justice
Environment and Natural Resources Division
General Litigation Section
PO Box 663
Ben Franklin Station
Washington, D.C. 20044-0663
Fax No. (202) 305-0506

VIA FAX AND MAIL

RE: Bonnichsen et.al. v. U.S.
Civil No. CV 96-1481JE

Dear Ms. Cook:

Enclosed is a description of the procedures or process that plaintiffs propose to use for taphonomic study of the Kennewick skeleton. By separate letter, I will send you a description of the microsampling tests that Dr. Stafford wishes to conduct on the archived bone remnants from the earlier radiocarbon and DNA tests.

I have forwarded your letter of February 11, 2005 to the members of the taphonomy study team, and am waiting to hear back from them on possible alternative dates for the taphonomic study session. The week of June 20, 2005 does not appear to be a viable option since Dr. Owsley has been subpoenaed to testify in court that week. In addition, another member of the study session has a prior commitment for that week that cannot be rescheduled. As soon as we have some possible alternatives, I will send them to you. We will try to provide you with as many alternatives as possible.

Very truly yours,

Alan L. Schneider

Alan L. Schneider

ALS/kfk
cc: T. Simmons
P. Barran
Clients
C. Hawkinson
H. Berryman
W. Smith
T. Stafford

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Description of Study Process
Kennewick Man Skeleton
June 2005 Study Session
February 24, 2005

This paper describes the process to be used for the Kennewick Man taphonomic study session that has been scheduled for June 2005. Pursuant to an agreement between the parties to the litigation, a small team of plaintiffs' representatives inspected the skeleton on December 14, 2004. The inspection visit went smoothly, and provided the participants with a useful orientation to the collection and the facilities used for its storage. The information obtained was important since only one member of the inspection team had any prior contact with the skeleton. The following discussion incorporates relevant observations and information from the inspection visit. Other relevant details concerning the purpose, methods and objectives of the taphonomic investigations to be conducted by plaintiffs are set out in their October 10, 2002 Study Plan.

The June 2005 study session will consist of the following components (or steps in the process). Some of these will proceed simultaneously, while others will occur in sequence.

I. Assemblage Verification and Completion

The bones and fragments that make up the Kennewick Man collection are presently grouped in assemblages based upon the anatomical elements involved. These assemblages appear to be accurate in most respects. However, there are still a number of bone fragments that have not been identified, and some of the existing identifications may be inaccurate. One area of particular concern in this regard is with the ribs, all of which are broken into numerous fragments. Some of the rib fragments have not yet been identified and matched; some of the others appear to have been misidentified.

Because of these concerns, the first step in the taphonomic study process will be to verify the accuracy of the existing element assemblages, and to attempt to identify as many of the

unidentified fragments as possible. Accurate identification of all pieces that can be identified is an essential foundation for taphonomic evaluation of the skeleton (and for any other studies that may be conducted). For example, some of the unidentified (or misidentified) rib fragments could hold important clues for taphonomic evaluation of postmortem rib fractures, for interpretation of rib pathology and for other questions concerning the ribs.

2. Data Collection/Phase One

Part of the study team will begin collecting taphonomic data as soon as the first element assemblages (or parts of assemblages) have been determined to be as accurate and complete as possible. While these investigations are pursued, other members of the team will continue to work on the assemblage verification and completion process. Such overlapping work tracks will promote efficiency and help to keep the study session as short as possible.

It is anticipated that taphonomic data collection will begin with the long bones. Other elements will follow in an appropriate sequence depending upon progress in the assemblage verification process and other considerations. The first step in taphonomic examination of an element assemblage will be a piece by piece examination of each bone or fragment in the assemblage. Each piece will be examined for all observable taphonomic characteristics. Some of these characteristics include fractures, color, staining, adhering concretions and sedimentary deposits.

The December 2004 inspection visit confirmed that significant information concerning the skeleton can be obtained from analysis of the bone fractures that it sustained over time. One area of interest in this regard is examination of fracture morphology and patterns in order to obtain insights into the taphonomic mechanisms involved in their production. Analysis of such characteristics could help to determine how and when different breaks occurred. For example, fracture surfaces can be examined to: (a) identify the fixed or cantilevered side of the fracture

and the free side; and (b) determine the anatomic direction that the free end moved to produce the fracture. The angle and contour of the fracture surface as well as the presence of a breakaway spur will indicate the fixed end of the bone. The morphology of the fracture surface, orientation of secondary fractures, and location of the breakaway spur can be used to differentiate the tension and compression sides of the fracture, and thus the anatomic direction that the free end moved to produce the fracture. This information, especially in conjunction with other taphonomic data, could provide insights into the mechanics involved in erosion of the Kennewick skeleton into the river channel, and possibly the *in situ* orientation of the remains.

Staining or color of fracture surfaces is also important. Such characteristics could help to place fractures into groups that represent similar postfracture environments and possibly a temporal relationship. For example, it might be possible to distinguish fractures associated with the erosional event from fractures produced by other mechanisms. Staining, color and other fracture data will be analyzed to determine the relationship of the tension/compression sides of each fracture surface relative to anatomic orientation (i.e., an anatomic map will be made that depicts the way the bone was angled to produce each specific fracture). Then, the fixed/cantilevered and free end of the bone at each fracture site will be identified. Potentially, this could provide insight as to how the skeleton eroded from the riverbank, and in conjunction with other observations, the positioning of the remains *in situ*.

The right femur shaft of the skeleton illustrates how these data can be used. This femur is complete, but exhibits two fractures resulting in three bone segments identified as follows: segment 1 is the portion containing the femoral head; segment 2 is the midshaft; segment 3 contains the articulation for the knee. Based upon preliminary observations of the most proximal fracture (i.e., the fracture that produced segment 1), it appears that segment 2 was fixed and segment 1 was displaced posteriorly and laterally to produce the fracture. Likewise,

observations of the distal fracture (i.e., the fracture that separated segments 2 and 3) seems to indicate that the fracture was produced when segment 2 was displaced posteriorly and laterally while segment 3 remained fixed. An examination of the fractures to the left femur suggests a similar pattern. Although more detailed examination is needed, these initial observations suggest that both femora were fractured under the same mechanism and in the same direction. These fractures may have resulted from the proximal ends being displaced posteriorly and to the right, and may have occurred when portions of the riverbank with embedded bone incrementally eroded away. By incorporating this information with other taphonomic data that may reflect bone position (e.g., bone color, sediment deposition within the bone, and micro-crystal formation within those sediments), it may be possible to reconstruct *in situ* positioning of the remains and the river action that was responsible for its erosion into the river.

Other questions to be addressed during the taphonomic study session are discussed in the October 12, 2002 Study Plan. Among other things, previous assessments of pathological conditions need affirmation and clarification, including specifics of the embedded projectile point, antemortem rib fractures, and upper limb developmental asymmetry. Color gradients and stains are evident on different bones, although no evidence for red staining from ocher was detected during the inspection visit. Even the issue of Kennewick Man's age at time of death needs consideration, as the indicators briefly observed during the inspection visit gave inconsistent determinations. The information obtained from examination of the skeleton will be recorded manually and/or through entry into a computerized database. Color variations will be documented using Munsell Color Charts as a standard reference.

Fractures in bones will also be examined to determine their temporal origin (i.e., perimortem or different postmortem episodes). Although no perimortem fractures were noted during the inspection visit, a comprehensive and detailed study is required before more definite

conclusions can be reached. Examination of cranial and rib fractures will provide additional taphonomic information.

3. Data Collection/Phase Two

Following examination of their individual pieces, skeletal elements will be temporarily reassembled for further taphonomic evaluation. Such reassembly will involve placing the pieces in correct anatomical position and holding them in place with temporary means such as Styrofoam (or other appropriate) props and/or Parafilm (where appropriate). No glues or other permanent fixatives will be used.

Reassembly of the elements is an important step in the study process since it will permit the individual pieces to be viewed in the context of an integrated functional unit. Such a perspective will aid in determining whether the taphonomic characteristics displayed by each piece are consistent with those displayed by other pieces of the same element. Observations concerning relevant characteristics (e.g., fractures, color, staining, adhering concretions, sediment deposits) will be made and recorded.

4. Data Collection/Phase Three

Reassembled elements will be placed in anatomical position in a specially constructed sand enclosure so that an emerging profile can be visualized for individual elements, then for paired bones, and eventually for the entire skeleton. The sand base of the enclosure, together with props and Parafilm where needed, will provide a secure, stable foundation for holding the reassembled elements together and in correct orientation.

The sand enclosure will be constructed in the following manner. An appropriately sized table (3' x 6' or 4' x 6') will be fitted with a low frame (3" in height) that rests on and outlines the surface perimeter. Small C clamps will be used to secure the frame in place. The table surface of this low rectangular box will be covered with a 2"± layer of clean sand, which will be

covered with a soft, photographically appropriate background cloth. Skeletal elements will be positioned in anatomical order on this cloth. In this matter, the skeleton will be assembled in a structurally supported position that will facilitate visualization and photography of taphonomic patterning (e.g., bilateral placement of skeletal fractures in limb bones), as well as overhead photography of the skeleton in anatomical position. A soft covering, such as a sheet, will be used to cover the remains at night. This process will be conservation friendly, as it will reduce handling, limit the need for adhesives, and save time involved in packing and unpacking of the skeleton in those situations where a taphonomic feature needs to be rechecked. Most importantly, final taphonomic assessments can be based on the total skeleton, rather than only temporarily available individual bones.

5. Photography

Scientific photography during the study session will be conducted by R. Clark using two fixed work stations: (a) one station for close-up photography of the type illustrated during the December 2004 inspection visit; and (b) another station for larger scale photography of the complete skeleton in proper anatomical position. Photographic equipment and lighting will be provided by Mr. Clark. He will use low-heat lighting equipment of the kind used during the inspection visit.

6. X-Ray Imaging

New x-rays will be taken of the cranium, mandible, and other key elements of the skeleton. Review of photographs, radiographs and CT images previously taken of the skeleton reaffirms the need for more complete and better imaging. Among other things, maxillary dental pathology cannot be fully evaluated due to the lack of maxillary radiographs, and the existing CT images of the embedded projectile point in the right innominate are less than optimal because they were taken in one millimeter increments and because three bands of data are missing along

the long axis of the projectile point. The new x-rays will be conducted at an offsite location in the Seattle area under the supervision of Owsley, Hunt and/or Bruwelheide in consultation with experts. This work will be completed after or during the last few days of the study session.

Analysis of the skeleton would also be aided if new CT images were taken with equipment that records data in increments smaller than one millimeter. For example, such higher resolution images would make it possible to better assess the distribution and thickness of the sediments that remains in the cranial vault. A proposal for new CT imaging will be submitted to Army Corps representatives if suitable arrangements can be made with a qualified facility.

7. Other Comments

The taphonomic study team will consist of Drs. D. Owsley, H. Berryman, T. Stafford, D. Hunt, and W. Smith, Ms. K. Bruwelheide, Ms. K. Spradley, Mr. R. (Chip) Clark, and an experienced note taker. One or two other individuals may be added to the study team as substitutes for Dr. Bonnichsen who died unexpectedly on December 24, 2004. Defendants will be notified of such substitution(s) in advance of the study session.

As indicated at the conclusion of the December 2004 inspection visit, taphonomic examination of the skeleton will require a minimum of five full working days. The possibility that additional time may be needed cannot be ruled out given the highly fragmented nature of the skeleton and the amount of information that must be obtained and recorded.

In order to carry out the June 2005 study session, the following facilities will be needed from the Burke Museum: a large room (such as the classroom on the loading dock floor); six work tables (3' x 6' or 4' x 6'); chairs for at least 10 individuals); a step ladder (6'high); and electrical power. Other equipment such as measuring devices, data recording forms and materials for constructing the sand enclosure will be provided by the study team.

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May 11, 2005

Sydney F. Cook
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VIA FAX AND MAIL

Re: Bonnichsen et.al. v. U.S.
Civil No. CV 96-1481JE

Dear Sydney:

This is to acknowledge receipt of your letter dated May 2, 2005. Enclosed is a copy of an ICT Imaging Proposal dated May 10, 2005. The purpose of the proposal is to confirm the information that has been provided orally to your clients and to provide more details of the processes involved in this phase of plaintiffs' investigations of the skeleton.

With respect to the conditions set out in your May 2nd letter, please be advised as follows:

1. Plaintiffs would be pleased to perform the ICT scanning between May 31 and June 3, 2005. Such schedule would enhance the prospects that we could have the prototype replicas of the scanned pieces ready in time for the July taphonomic study session.

2. The scanning facility and other technical consultants to be used for the imaging and replication process described in the Proposal will not be allowed to retain any of the digital data that is generated. Only two sets of such data will be created. One set will be provided to your clients, and the other will be retained by plaintiffs as part of their research documentation.

3. Your condition #3 is acceptable to plaintiffs. We would be happy to work with either Dr. Cassman or Dr. Odegaard.

4. Your condition #4 is acceptable to plaintiffs.

5. The financial resources available to plaintiffs for the project are modest. However, we can commit to pay the following costs: (a) roundtrip airfare for the Army Corps' courier from Seattle to Chicago, assuming that the airfare is priced at government rates; (b) hotel lodging for the courier for up to three (3) nights in Chicago; and (c) ground transportation for the

courier between the Chicago airport, the scanning facility and the hotel. In addition, plaintiffs will absorb the costs of providing your clients with one casted model of each of the following: (i) the complete reconstructed skull; (ii) the individual pieces of the skull (i.e., cranium, midface and mandible); (iii) the individual pieces of right innominate; and (iv) the projectile point.

I look forward to hearing from you.

Very truly yours,

Alan L. Schneider

ALS/kfk
cc: Clients (w/encl.)
P. Barran (w/encl.)
C. Hawkinson (w/encl.)
D. Carlson (w/encl.)
T. Stafford (w/encl.)

ICT Imaging Proposal
Skull and Innominate
Kennewick Man Skeleton
Proposal dated May 10, 2005

Introduction

Plaintiffs propose to use Industrial Computed Tomography (ICT) technology to create dimensionally accurate replicas of the individual pieces of the skull and the right hip bone (innominate) of the Kennewick Man skeleton. This proposal has been developed in response to the concerns expressed by the government's representatives regarding the use of adhesives for mending broken or separated bones of the skeleton. If the use of adhesives is ruled out, some alternative must be found to create a permanently stable reconstruction of the skull to ensure that the configuration measured by all investigators is identical. The proposal described herein seeks to achieve that objective. If successful, it will also: (a) reduce the amount of handling of the original skull pieces during plaintiffs' studies of the skeleton and by future investigators; (b) allow us to visualize the embedded projectile point for purposes of more accurate identification; (c) permit both internal and external bone structural analyses of the skull and the innominate which are critical for determining the distribution of sediments within the endocranial cavity and for evaluating the projectile point; and (d) allow us to test the accuracy of the current reconstruction of the face, and if necessary adjust that reconstruction digitally and in replicas. The scanning process poses no threat to the bones.

1. ICT Scanning

The pieces of the skull and the right innominate will be scanned using a high powered non-invasive ICT scanner. ICT scanners are capable of extracting high-resolution images that are as much as ten times more accurate than those produced by a Medical Computed Tomography (MCT) scanner. Because ICT scanning provides a much higher degree of detail, substantially more data is generated for digital reconstruction of the skull and the projectile point than would be possible with MCT scanning. The technology used for industrial and medical scanners are substantially the same. The primary difference is that in the medical field there is a need to limit patient exposure to radiation, and consequently the resolution of the images is lower. In addition, with an ICT scanner, the specimens being scanned are rotated very slowly on a level turntable while the X-ray source and detector remain stationary (in MCT scanning the X-ray source and detector rotate while the patient remains stationary). ICT scanners make it possible to take exceptionally thin slices of data that translate into much finer detail than MCT. Once the scan data has been collected, it is processed to yield a graphic image of the data slices and is then translated into files that can be analyzed and used for rapid prototyping.

2. Digitalization (Development of STL Files)

In this step, the ICT slices of data are combined to generate three-dimensional computer models. This information conversion makes it possible to view images of the scanned bones from a multiple of different perspectives. The scanned/digitized bones can then be physically recreated through the process of Rapid Prototyping (RP).

3. RP Process

The RP process takes the 3D computer model (STL) that was developed during digitalization and converts the model into a series of stacked layers for "3D printing". In most cases these layers are approximately 0.1 mm thick. The layered model file is then sent to a machine that uses a photo polymer liquid plastic to lay down consecutive layers of plastic until the complete unit has been fabricated. This process was initially developed by the automotive and aeronautical industries to ensure the form, fit and function of manufactured parts that require a very high level of accuracy. It is hoped that applying this process to the Kennewick Man skull and innominate will allow accurate reproduction of the bone pieces and the embedded projectile point. The skull pieces can then be glued together to produce a reconstructed skull that can be measured without risk to the original. We propose to use the RP process to prepare replicas of the different skull pieces, the right innominate and the projectile point.

4. Casting

The plastic replicas produced by the RP process can experience some shrinkage, usually small, over an extended period of time. To develop permanent models that do not shrink we propose to make molds and casts of the RP replicas using high quality silicone rubber and Hydrocal Gypsum Cement. These molds and casts will be prepared by Mr. Steve Jabo, Museum Specialist at the National Museum of Natural History (NMNH), Smithsonian Institution, Washington, D.C. Mr. Jabo has done casting for the NMNH for 13 years and is considered an expert in the molding and casting of rare and fragile specimens. He also has had extensive experience creating molds from prototypes. Mr. Jabo will use a silicone molding rubber (Polytek TinSil 70-25 RTV silicone), TAP

Marine Grade Epoxy (314 Resin with slow 143 Hardener), and Hydrocal Gypsum Cement (FGR-95) to construct permanent molds and casts of the RP replicas of the Kennewick Man bones. The use of high-quality supplies will help to maintain the dimensional integrity of the casts.

Mr. Jabo will prepare two types of molds of the Kennewick skull. One set of the plastic skull pieces created through the RP process will be taken to the Burke Museum where they will be measured by Dr. David Hunt against the original bones to verify their accuracy. If they are accurate within an acceptable range of variation, Dr. Hunt will assemble the plastic pieces into a model of the complete skull. This model will be returned to the Smithsonian where it will be used by Mr. Jabo to create a mold of the reconstructed skull. That mold will be used to produce durable casts of the skull. The other set of plastic skull pieces will be used by Mr. Jabo to create molds of each individual piece of the skull. These molds can then be used to make casts of the pieces so that future researchers will be able to test the accuracy of Dr. Hunt's reconstruction of the skull.

Using the RP replicas of the projectile point, Mr. Jabo will create a mold that can be used to produce casts of the projectile point. He will also create molds and casts of the innominate pieces.

5. Transportation and Scanning Logistics

The pieces of the cranium (i.e., the cranial vault, midface, and two sections of the mandible) and pieces of the right innominate will be transported to the ICT scanning facility of Bio Imaging Research (BIR) located at 425 Barclay Blvd. in Lincolnshire, IL. Lincolnshire is located approximately 15 miles north of Chicago's O'Hare Airport. The

bones will be transported via commercial airline by either plaintiffs' representatives (i.e., Dr. Douglas Owsley and Mr. Roy Clark), or by an Army Corps representative. Transportation will be arranged so that a driver and vehicle will pick up the courier and skeletal pieces at the Chicago airport for transport to BIR's facility. Ms. Rebecca Snyder, NMNH's expert in 3D imaging, will arrive separately at BIR and will act as a consultant to ensure that all necessary data are collected and processed according to the desired needs and data standards.

BIR manufactures industrial CT scanners and provides scanning services to both the industrial and scientific communities. BIR also scans critical components of aircraft and other transportation items for the NTSB. Due to the classified research that BIR does for government agencies, it possesses a secure vault with access limited to only two individuals in the company. Once the Kennewick Man remains arrive at the BIR facility, they will either be prepared for immediate scanning or secured in BIR's vault for overnight storage.

Due to the high precision used in the scanning process (which as noted above produces many times more data slices than MCT scans), the scanning process will require one to two days in residence at BIR. Accordingly, it should be anticipated that two nights will be spent in Chicago. An experienced technician will complete the scanning in the presence of plaintiffs' representatives and the Army Corps' representative. In advance of the scanning session, tests will be conducted on a substitute human cranium, mandible, and innominate sent by Dr. Owsley to BIR. The purpose of these tests is to determine the safest and most appropriate procedures and scanner settings to be followed for scanning of the Kennewick remains.

Upon completion of the scanning, the Kennewick remains will be returned to the Burke Museum in the same manner as they were transported to Chicago.

6. Technical Experts

The scan data will be forwarded to Virtual Surfaces Inc. (VSI), at 832 E. Rand Rd. #16 in Mt. Prospect, IL, about 20 minutes south of BIR, for digital editing and STL file generation. During the data editing process, analyses will be conducted to determine if it is possible to digitally reposition the skull fragments that were glued in 1996.

When the editing process has been completed, the data files will be sent to Laser Modeling Inc. (LMI) at 600 Albion Ave. in Schaumburg, IL, for rapid prototyping.

Overall planning, scanning, editing and rapid prototyping will be coordinated by Point Data Marketing Inc. (PDMI), whose offices are located at 6791 Talmedge Drive, Sparks, NV. Mobile Scanning Lab. Inc. (MSLI), also of 6791 Talmedge Drive, Sparks, NV, will oversee the CT scanning, under the direction of PDMI, in conjunction with BIR. VSI will perform all digital editing and LMI will perform the rapid prototyping, again under the supervision of PDMI.

7. ICT and Prototyping Products

The scanning and prototyping processes will provide the following products that can be used to create molds of the scanned pieces and to generate data for research by plaintiffs and future investigators:

- two complete sets of RP plastic replicas of the different bone components of the skull
- two RP plastic replicas of the projectile point
- one set of RP plastic replicas of the different pieces of the right innominate

- two sets of raw CT scan data in TIFF format (one set for plaintiffs; one for the Army Corps)
- two sets of STL and ASCII files for all scanned items (one set for plaintiffs; one for the Army Corps)

8. Scheduling

The preferred time to have the skeletal pieces scanned at BIR would be late May or the first two weeks of June 2005. Such a schedule would allow time to complete analysis of the scan data and production of the RP replicas before the July 5-15, 2005 taphonomic study takes place. It is important that the skull and right innominate replica pieces be available for assembly by Dr. Hunt during the taphonomic study session. Dr. Hunt will glue one set of these pieces together to produce models of those two skeletal elements that are as complete as possible. To ensure that his reconstructions of these elements are as accurate as possible, Dr. Hunt will need access to the original specimens so he can refer to them for guidance.

9. General Comments

It is hoped that the casts to be created from the RP replicas will be accurate enough to provide many of the measurements needed by plaintiffs' study team and other investigators. Even so, it will still be necessary for investigators to have access to the original bones. Among other things, they will need to refer to the original bones to help locate key measurement landmarks that may be difficult to find on the cast models, to verify for themselves that the models are accurate, and to obtain certain types of nonmetric data. However, if the replication process is successful, it will reduce substantially the need for future handling of the original bones. Moreover, it will eliminate the need to glue together the various pieces of the actual cranium, mandible and

innominate. Finally, the replication process proposed here will permit investigations that would not be possible otherwise (e.g., analysis of the endocranial vault, digital repositioning of the malars, etc.).

Digital extraction and high resolution production of an accurate replica of the embedded projectile point will reveal its size and structural details, which will aid in its identification. Computer aided examination of the right innominate will provide information needed in order to interpret the pathology and pathway of the projectile.

Although plaintiffs cannot guarantee in advance the ultimate accuracy of the RP replicas and the casted models to be created as described in this proposal, the prospects are very favorable. These techniques have reportedly been used in other situations with a high degree of success. Plaintiffs are unaware of any circumstances that would preclude their successful application to the Kennewick remains.