ARCHEOLOGICAL INVESTIGATIONS ON 571 PREHISTORIC SITES AT FORT HOOD, BELL AND CORYELL COUNTIES, TEXAS

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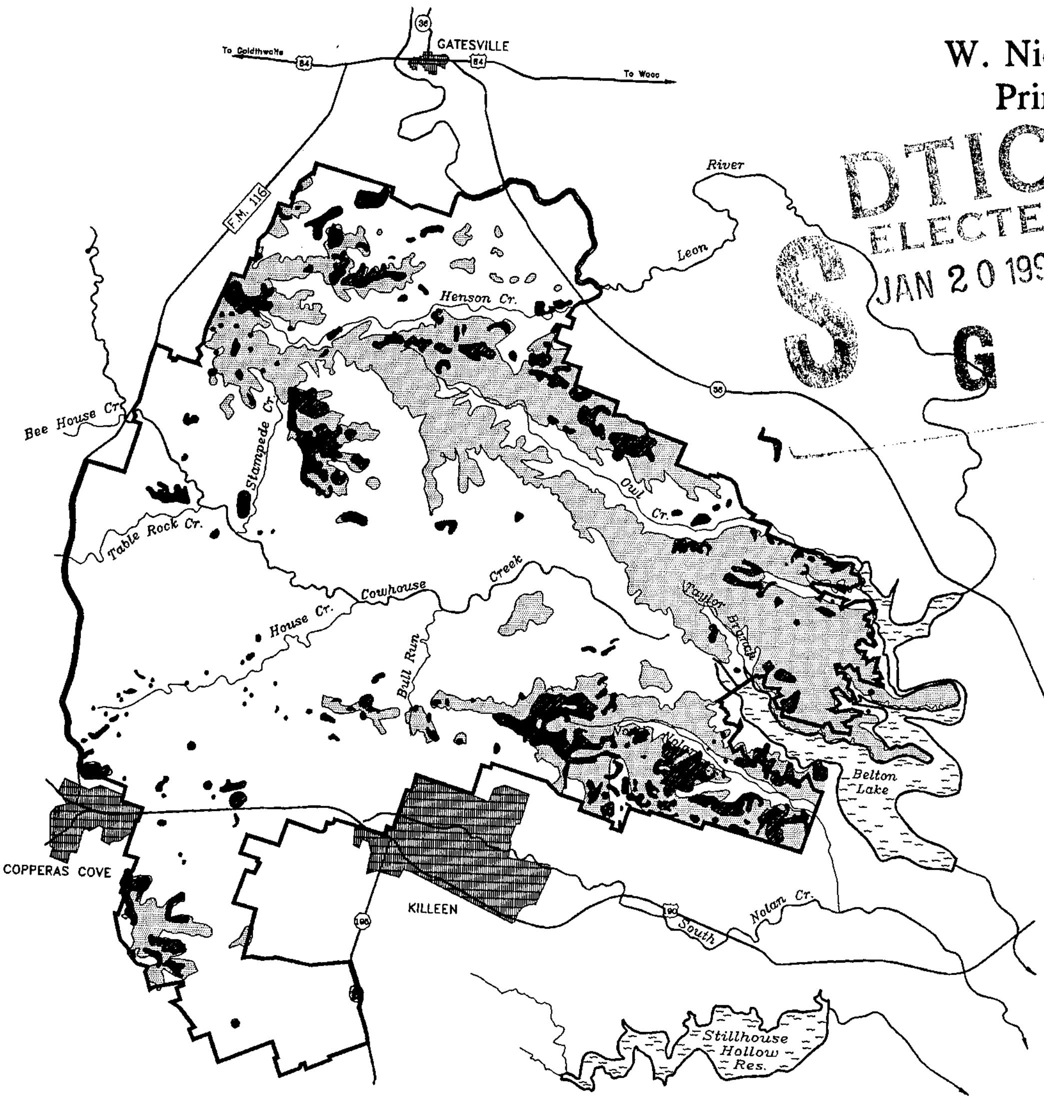
Principal Investigator



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UNITED STATES ARMY FORT HOOD
ARCHEOLOGICAL RESOURCE MANAGEMENT SERIES
RESEARCH REPORT NO. 31

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prepared for

Directorate of Engineering and Housing
Environmental Management Office
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19. ABSTRACT *(Continue on reverse if necessary and identify by block number)*

This report presents the results and conclusions of archeological investigations on 571 prehistoric sites at Fort Hood in Bell and Coryell counties, Texas. The primary goal of the work was to evaluate each site with respect to its eligibility for inclusion in the National Register of Historic Places (NRHP). A secondary goal was to assess site boundaries. Between August 1991 and June 1993 Mariah Associates, Inc. (Mariah) evaluated 571 prehistoric sites located in maneuver areas. All 571 sites were evaluated by a specialized reconnaissance team which recorded explicit observations of archeological content and natural context. If warranted, sites were subdivided into management areas on the basis of geomorphology and differing potential for intact buried deposits. In all, the 571 sites were subdivided into 897 different management areas. Many small sites consisted of a single management area, while some large sites contained up to eight discrete management areas. (continued)

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All management areas with the potential to contain intact subsurface deposits were subsequently shovel tested at a rate of one test per 900 m^2. A total of 5,814 tests were excavated, and a total of 29,919 artifacts and samples was recovered. In addition, 94 large lithic procurement sites were subjected to a second round of evaluation, including a surface resurvey, which assessed the potential of the site to address questions of chert procurement. As a result of these field procedures, and as supplemented by laboratory analyses, 529 sites/management areas are evaluated as not eligible for inclusion in the NRHP and are recommended for no further management. A total of 36 sites/management areas are evaluated as eligible under criterion D and are recommended for immediate avoidance and protection. The remaining 332 sites/management areas could not be adequately assessed with the reconnaissance, shovel testing, and resurvey tactics; these are recommended for avoidance or for further subsurface testing if avoidance is not possible.

Concurrent with the program of site assessment, Mariah conducted three general archeological studies at Fort Hood. These were carefully designed to facilitate and enhance the ability of Fort Hood to make meaningful and cost-effective NRHP eligibility determinations during the next phase of the assessment program. The first study is a review and analysis of Edwards chert. This study reports on new field work and laboratory analyses to carefully document the spatial distribution of Edwards chert throughout Texas and to assess the variability in its appearance and composition. Using these data, an explicit and working typology is developed for 16 distinct varieties of Edwards chert, tied to specific geographic localities at Fort Hood. Another study investigates the potential of land snail shells (*Rabdotus* sp.) to assist in site dating and site formation studies. Results of preliminary epimerization and radiocarbon assays are presented and the overall utility of land snails to Central Texas archeologists is assessed. The third study investigates the structural and chronometric variability of burned rock mound features at Fort Hood. This study used a highly focused program of test excavations and accelerator mass spectrometry radiocarbon dating to investigate the internal physical structure and the construction-use-reuse sequence of nine burned rock mounds.

On the basis of these studies and analyses, several programmatic recommendations are made for the long- term management of cultural resources at Fort Hood. These recommendations are: (1) the typology of Edwards chert should be refined by identifying the range of variability evident from a series of sampling locales; (2) neutron activation analysis, chert fluorescence studies, and patination research should be pursued as systematically as possible as a means of determining the source and ages of lithic artifacts; (3) additional workability experiments should be performed to inform on the relationship between quality of material and selection of material; (4) using these types of approaches, redundancy in the LRPA inventory should be investigated; (5) further investigation is recommended into the utility of land snails in site dating, both to calibrate the A/I ratios to the radiocarbon scale, but also to refine the paleoclimatic model; (6) the poorly understood and easily damaged Paluxy sites are recommended for avoidance and preservation; if testing and/or mitigation is necessary, then block excavations are suggested to retrieve microenvironmental, geoarcheological, and temporal data; (7) because rockshelters are an exceptionally valuable part of the prehistoric record, because they have suffered considerable damage through vandalism and relic collection, and because no protection measures can be reasonably expected to dissuade determined looters, the shelters with remaining potential should be given a high priority for mitigation; and (8) additional geoarcheological studies are recommended to refine our understanding of depositional sequences in the smaller alluvial tributaries as well as in colluvial contexts.

EXECUTIVE SUMMARY

WHAT IS THIS REPORT?

This report has been prepared in compliance with the existing Fort Hood Historic Preservation Plan (HPP). It reports on the evaluation of 571 prehistoric archeological sites located in maneuver areas, as required by HPP Projects 2, 4, and 6. These 571 sites have been evaluated for their eligibility for inclusion in to the National Register of Historic Places (NRHP).

WHY DID FORT HOOD DO THIS WORK?

Under the National Historic Preservation Act [16 U.S.C. 470(f) and 470h-2(f)] and its implementing regulations (36 CFR 800), all federal installations must inventory and evaluate their cultural resources for eligibility for inclusion in the NRHP. Fort Hood's obligation in this regard was clarified in a Programmatic Agreement (PA) signed in January 1990 between the United States Army, the State Historic Preservation Officer (SHPO) for Texas, and the Advisory Council for Historic Preservation. In accordance with the PA, an HPP was developed which, among other stipulations, called for the evaluation of archeological sites located in areas used for training maneuvers to (1) identify National Register-quality sites and (2) reduce the number of recorded sites that must be avoided by training activities.

WHAT WAS THE SITUATION PRIOR TO THIS WORK?

Previous inventories of Fort Hood had covered over 95 percent of the base and had recorded approximately 2,300 archeological sites. Of these, 1,087 date to the historic period and are not investigated in the current work. Some 210 were deleted as "non-sites." An additional 311 sites are located in the nonmaneuver areas and are not affected by maneuver training exercises.

Of the remaining 692 prehistoric sites in the maneuver areas, only 116 (17%) had been adequately evaluated for NRHP eligibility prior to the current work (Figure 1). These included nine "Eligible" sites (1%) requiring avoidance and protection, and 107 "Not Eligible" sites (16%) requiring no further management. The remaining 576 sites (83%) had not been adequately evaluated, but still required avoidance and protection pending their evaluation. Management of these sites was becoming an increasing burden for DEH, G-3, and individual units, especially since some of the sites were as large as 2 km^2 (500 acres). The 94 largest sites, set aside as a separate class, together encompassed nearly 8,100 acres (12.7 m^2).

WHAT WORK WAS DONE?

Of the 576 prehistoric sites requiring further documentation, the current work evaluates 562. In this process, an additional nine sites were discovered and evaluated, bringing the total number of sites to 571. All of these sites were revisited by a specialized archeological team which assessed their integrity and research potential.

Many of the sites included two or more landforms having completely different potentials. These sites were subdivided into discrete management areas, each of which was independently evaluated. This tactic resulted in the delineation of a total of 897 management areas on the 571 sites. While this tactic resulted

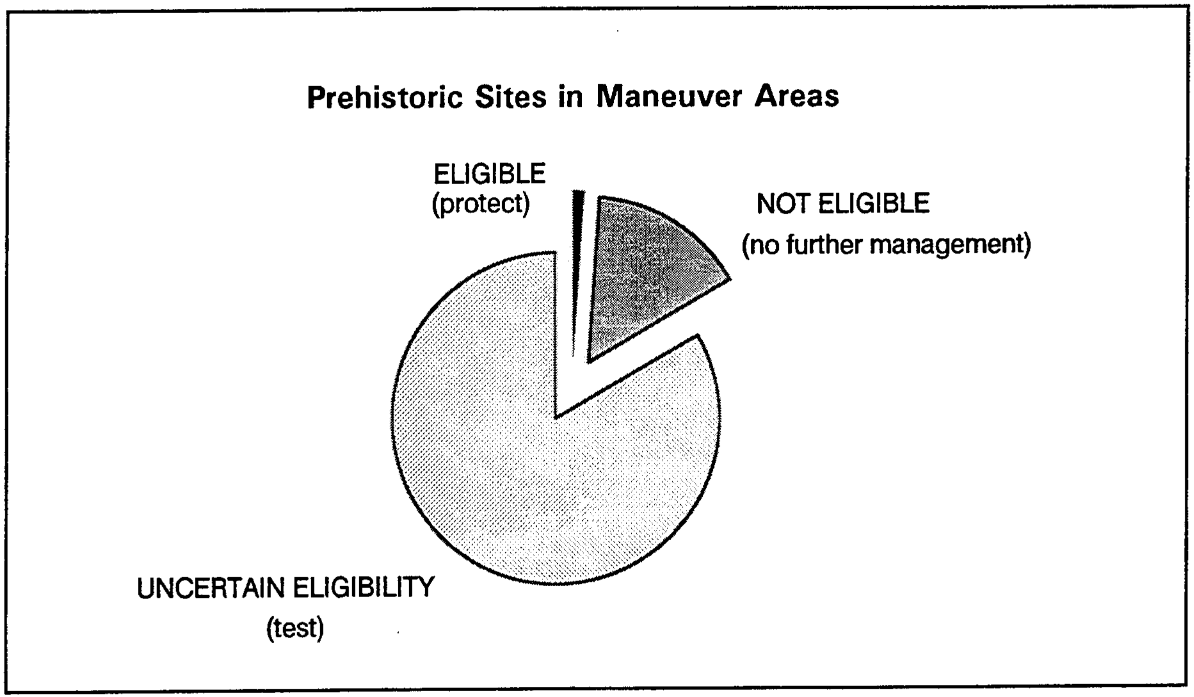

Figure 1 National Register Status at Start of Project.

in an increase in total areas, it allowed for a possible decrease in the number of areas requiring avoidance and also made possible a significant reduction in the total *acreage* requiring avoidance and further management. For example, rather than needing to entirely avoid a very large site which merely has one small area of intact deposits, the tactic could allow the small area to be avoided and protected while releasing the remainder of the site for unimpeded training activities.

On the basis of the reconnaissance team evaluations, 414 of the management areas were visited by a follow-up team which excavated shovel tests to investigate buried archeological deposits. A total of 5,814 tests were excavated to an average depth of 40 cm (16 inches), recovering some 29,900 archeological artifacts. Additionally, the 94 largest sites were visited by a specialized third team which collected additional data about the distribution and variability of chert artifacts on the site surface. This process is schematically illustrated in Figure 2.

WHAT IS THE SITUATION NOW?

Using these tactics, 529 management areas (59%) were evaluated as not significant and not eligible for inclusion in the NRHP. These areas are recommended for no further management. Thirty-six areas (4%) were evaluated as being significant and eligible for inclusion in the NRHP. These areas are recommended for avoidance and protection. The remaining 332 areas (37%) could not be fully evaluated using the procedures specified in the HPP. These areas are recommended for avoidance or for further subsurface testing if avoidance is not possible. For the 94 largest sites, the total acreage requiring avoidance was reduced by nearly 80 percent to 1,810 acres (2.8 square miles).

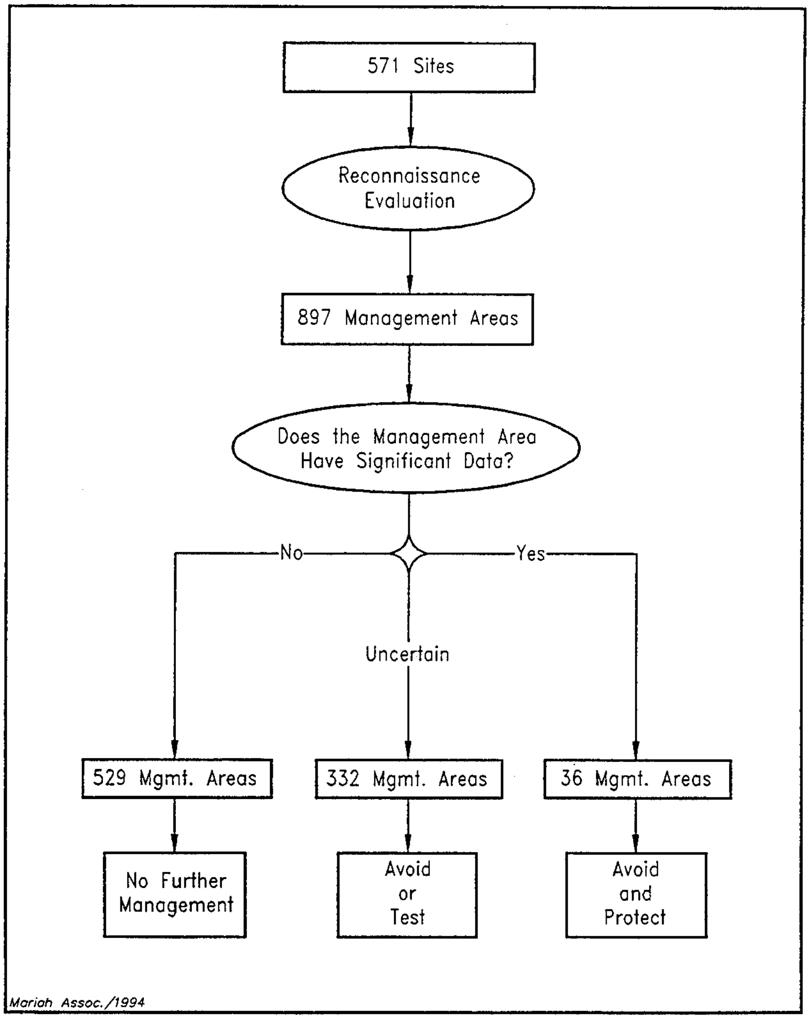

Figure 2 Schematic of Evaluation Process.

Supplementing these 897 site management areas with the 116 sites previously evaluated, the current status of prehistoric sites in the maneuver areas is shown in Figure 3. A total of 45 sites (4%) are eligible, 636 sites (63%) are not eligible, and 332 sites (33%) remain uncertain.

WHAT IS NEXT?

With additional testing, it is likely that 100 percent of all remaining sites may be fully assessed as either eligible or not eligible, thus completing the inventory and evaluation process as required by law. Such testing will require different methods and more detailed evaluation criteria.

In anticipation of these requirements, the current report also presents some preliminary results for three adjunct studies. These will significantly enhance the ability of Fort Hood to assess site significance during forthcoming testing. These studies are: (1) a typology of the local chert from which the prehistoric artifacts were made, allowing for tracking the prehistoric movement of artifacts from one site to another;

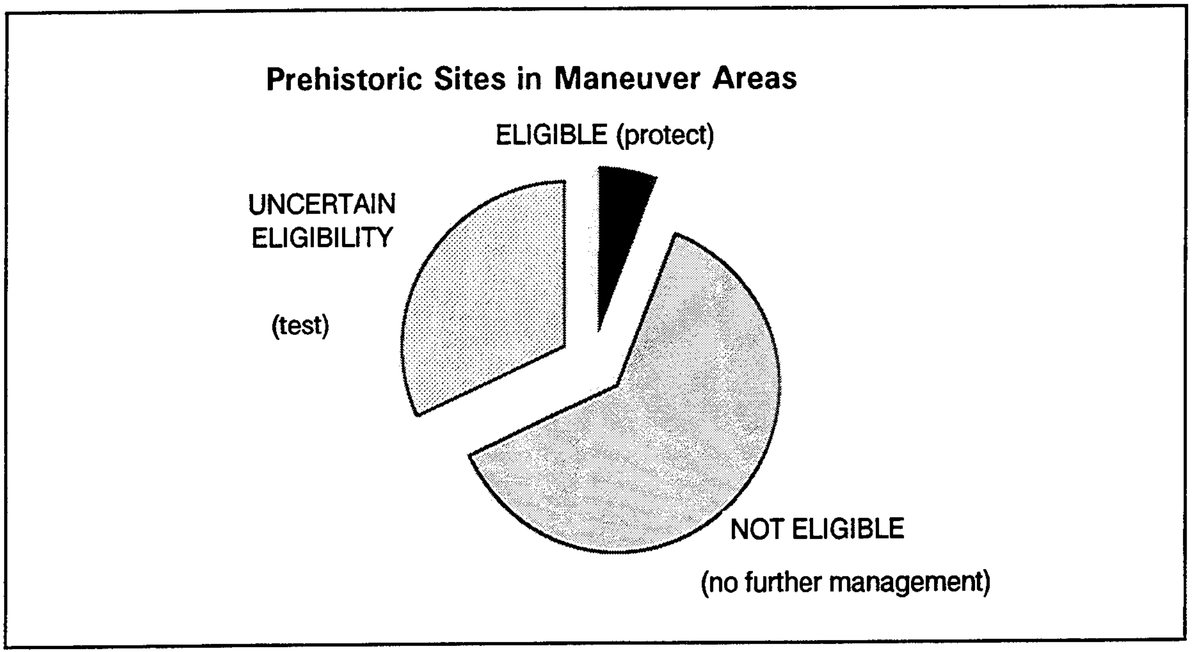

Figure 3 National Register Status at End of Project.

(2) a demonstration of the use of amino acids in the shells of prehistoric land snails as a new and cost-effective method to date sites; and (3) a determination of variability in the structure and antiquity of burned rock mound features, a common type of prehistoric site at Fort Hood.

On the basis of these studies and analyses, several programmatic recommendations are made for the long-term management of cultural resources at Fort Hood. Each of the following recommendations is designed to enable Fort Hood to more accurately and more cost-effectively assess site significance and thereby reduce total inventory needing avoidance and protection: (1) the existing chert typology should be refined; (2) existing techniques for direct dating of chert artifacts should be pursued; (3) experiments should be performed to assess the quality of the different varieties of chert; (4) redundancy in the remaining inventory of very large lithic sites should be investigated; (5) the use of land snails to date sites should be demonstrated and refined; (6) sites in the Paluxy sand deposits should be preserved or mitigated; (7) rockshelters cannot be protected and should be given a high priority for mitigation; and (8) additional geoarcheological studies should be conducted in the smaller tributaries.

ABSTRACT

This report presents the results and conclusions of archeological investigations on 571 prehistoric sites at Fort Hood in Bell and Coryell counties, Texas. The primary goal of the work was to evaluate each site with respect to its eligibility for inclusion in the National Register of Historic Places (NRHP). A secondary goal was to assess site boundaries. Between August 1991 and June 1993 Mariah Associates, Inc. (Mariah) evaluated 571 prehistoric sites located in maneuver areas. All 571 sites were evaluated by a specialized reconnaissance team which recorded explicit observations of archeological content and natural context. If warranted, sites were subdivided into management areas on the basis of geomorphology and differing potential for intact buried deposits. In all, the 571 sites were subdivided into 897 different management areas. Many small sites consisted of a single management area, while some large sites contained up to eight discrete management areas. All management areas with the potential to contain intact subsurface deposits were subsequently shovel tested at a rate of one test per 900 m^2. A total of 5,814 tests were excavated, and a total of 29,919 artifacts and samples was recovered. In addition, 94 large lithic procurement sites were subjected to a second round of evaluation, including a surface resurvey, which assessed the potential of the site to address questions of chert procurement. As a result of these field procedures, and as supplemented by laboratory analyses, 529 sites/management areas are evaluated as not eligible for inclusion in the NRHP and are recommended for no further management. A total of 36 sites/management areas are evaluated as eligible under criterion D and are recommended for immediate avoidance and protection. The remaining 332 sites/management areas could not be adequately assessed with the reconnaissance, shovel testing, and resurvey tactics; these are recommended for avoidance or for further subsurface testing if avoidance is not possible.

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ACKNOWLEDGEMENTS

The success of this program has been the result of the dedicated and hard work of a team of nearly 50 Mariah employees (including archeologists, geomorphologists, lab analysts, programmers, draftpersons, word processors, accountants, and editors), plus numerous consultants, subcontractors, and Fort Hood personnel. All of these persons have played their key roles and are gratefully acknowledged.

As Fort Hood archeologist, Jack Jackson is the person most responsible for the success of this program. His vision has enabled Fort Hood to progress in an orderly, focused, and expeditious manner toward effective management of the staggering quantity and variety of cultural resources to be found on the base. His businesslike attitude and forthright candor have been much appreciated and have allowed Mariah to design and implement this compliance program. In addition, Kimball Smith is thanked for his invaluable assistance in coordinating the field work and arranging access to existing Fort Hood files, maps, data, and collections.

Mariah's field crew for the shovel testing and LRP resurvey were Don Badon, Robin Benson, Susan Burns, Roman Clem, James Dahlberg, Jack Eastman, Leigh Ann Garcia, Bill Harding, George Lewis, Don Lloyd, Darryl Newton, Cathy Peterson, Sheila Powley, Tammy Walter, and Cindy Webb. These archeologists and their crew chiefs excavated over 5,000 shovel tests through rocks and clay, in rain and heat, and in spite of ticks, chiggers, rattlesnakes, cactus, mesquite, razor wire, and erratic battle tanks and attack helicopters.

For the first season of field work (December 1991 through June 1992) Mike Quigg was Field Director and is credited with implementing the field program under sometimes trying circumstances (including the remarkable floods of December 1991). In early 1993, Mike also directed the test excavations of the burned rock mounds, assisted on several sites by Abby Treece. From August 1992 through the completion of fieldwork in July 1993, Gemma Mehalchick served as Field Director. The ultimate success of the overall program is due in no small part to her practical and reliable management of the fieldwork.

Project geomorphologists Jim Abbott and Charles Frederick together evaluated over 90 percent of the 571 sites. In early 1992, they were assisted for several months by Bill Doering of LaRamie Soils Service. The superlative observational and interpretive skills of these geoarcheologists have been absolutely essential to the success of this program. As Crew Chiefs, Karl Kleinbach, Gemma Mehalchick, and Mike Quigg together evaluated nearly two-thirds of the sites during the reconnaissance phase. The remaining sites were evaluated by Lain Ellis, Chris Lintz, Peter Mires, Fred Oglesby, Pat O'Neill, Mike Quigg, Abby Treece, Nick Trierweiler, Jim Truesdale, and Jeff Turpin. These archeologists and geomorphologists are all to be credited for the high quality of the resulting site evaluations. In addition to collecting detailed and replicable field observations, they also wrote much of the descriptive and interpretive text appearing in the Data Compendium (Appendix A). In every case, final management recommendations were made by Mike Quigg, Lain Ellis, and/or myself.

The project Quality Control (QC) Officer was Craig Smith, who made periodic field inspections, compared the ongoing field and lab work against the scope of work, and reported directly to Mariah's upper management. Mr. Smith's suggestions for improving the accuracy and efficiency of data collection have been greatly appreciated. In addition, Mariah's President, Dick McGuire, took a very active interest in ensuring the high quality of the project and also made numerous field inspections. As part of the QC

program, Tammy Walter and Robin Benson reviewed each of the many, many thousands of pages of field data sheets for completeness and consistency and reported to Mr. Smith. During 1993, Mike Quigg made several QC field inspections and also reported to Mr. Smith.

During much of the field phase, Robin Benson served as temporary Laboratory Supervisor and organized the field inventories and the masses of raw data. In December 1993, Kathleen Callister joined the team as Laboratory Supervisor and has been largely responsible for the high quality of the final data base. Her organizational skills and computer expertise have been greatly appreciated and at times have averted potential disaster. Laboratory analysts during the reporting phase included Scott Brosowske, Roman Clem, James Dahlberg, Leigh Ann Garcia, Dale Lynch, Andrea Ohl, Jay Peck, Chris Ringstaff, Marybeth Tomka, and Jocelyn Vinograd. As primary lithic analyst, Dale Lynch is especially to be thanked for his close attention to detail. The Edwards chert typology was developed by Charles Frederick, and Chris Ringstaff conducted the knapping experiments. The customized analysis and data management program was written by Mark Nadig of Wind-2 Software using a Microsoft FoxPro platform.

The exhaustive Data Compendium has been the collaborative work of many people. During field work, the Field Directors and Crew Chiefs wrote early drafts of the site descriptions and interpretations. During the reporting phase, new analysis and writing was done by Marybeth Tomka, Pat O'Neill, and Kathleen Callister. AutoCAD draftspersons were Mike Hilton, Carol Mills, Robin Benson, Beth Ann McVicker, and Wendy Wittenberg. In addition, Velvet Dodson of Ronald Carroll Surveying also prepared some draft AutoCAD drawings. Mike Hilton prepared the final drawings for all sites. Carol Mills also freehand illustrated the projectile points, trench profiles, and other figures. Dee Ann Campbell of Renaissance Editing did a magnificent job as Technical Editor. The draft report was produced by Kim Cooke assisted by Jocelyn Vinograd. Debora White produced the final report. Assistance with bookkeeping, payroll, and accounts payable was supplied by Debora White, Chuck Killion, Marcia Linton, and Dianne Sallee.

Lee Nordt's careful reconstruction of Holocene alluvial stratigraphy at Fort Hood provided an invaluable platform from which to conduct this work. Glenn Goodfriend of the Carnegie Institute of Washington performed the amino acid epimerization assays and contributed significantly to exploring the exciting new potential of land snail analysis at Fort Hood. Radiocarbon assays were performed by Beta Analytic, Inc. Phil Dering did the macrobotanical identifications. Some of the chert samples from distant portions of the Edwards outcrop were provided by Chris Turnbow, Mike Quigg, Doug Boyd, and Steve Tomka. Don Rogers shot the color photographs of chert samples.

Several Fort Hood personnel provided essential assistance during the field work. Kimball Smith of DEH provided a hand-held global positioning system for obtaining provenience of field samples. Sergeant Pruitt of G3 Range Control facilitated vehicle permits, and Russ Allen of G3 coordinated scheduling of field crews. Sergeant Huffman of Graves Registration assisted in the identification of human bones. Gil Eckrich of Fish and Wildlife coordinated access into the restricted preserves. Bill Roberts and James Conors of DEH coordinated scheduling of the backhoe, and Lester Duncan expertly trenched through the burned rock middens.

At the beginning of the program, Chris Lintz was Principal Investigator (PI), and I thank him for the rigorous understanding of the Section 106 process he brought to those early months. Since August 1991 I have been Project Manager and beginning in March 1992 I have served as PI, assisted since March 1993 by Lain Ellis as co-PI. Mr. Ellis's contributions to the program can not be underestimated, and I thank him for his continuing dialectic and unflagging energy.

Through talent, team work, professionalism, and persistence, all of these people created this successful program of cultural resource management. We had fun, too.

Nick Trierweiler
Austin, March 1994

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1.0 INTRODUCTION

W. Nicholas Trierweiler

The Fort Hood military reservation, located in Bell and Coryell counties in Central Texas, encompasses 217,337 acres, or 339.6 m^2. As one of the largest military bases in the United States, its primary mission is to train and maintain the combat readiness of several armored cavalry and mechanized infantry divisions, and since its creation in 1941, Fort Hood has fulfilled this mission.

Under the National Historic Preservation Act [16 U.S.C. 470(f) and 470h-2(f)] and its implementing regulations (36 CFR 800), all federal installations must inventory and evaluate their cultural resources relative to the National Register of Historic Places (NRHP) criteria. Fort Hood's obligation in this regard was clarified in a Programmatic Agreement (PA) signed in January 1990 between the United States Army, the State Historic Preservation Officer for Texas (SHPO), and the Advisory Council for Historic Preservation. In accordance with the PA, a Historic Preservation Plan (HPP) was developed for Fort Hood in 1990 (Jackson 1990), which, among other stipulations, called for evaluation of archeological sites located in areas used for training maneuvers, "both to identify and devise protective strategies for National Register quality sites located in areas of high maneuver impact and to reduce rapidly the number of recorded sites that must be avoided by training activities" (Jackson 1990:3). The HPP also identified the standards of significance to be used as criteria for evaluating sites as eligible for nomination to the NRHP. These standards included "Physical Integrity," defined as in situ remains not severely disturbed by natural or subsequent human activities, and "Cultural Integrity," defined as distinct associations or dateable sequences. Surface deposits of several or unknown cultural associations were specifically excluded.

This volume has been prepared by Mariah Associates, Inc. (Mariah) under contract to Fort Hood and in accordance with the provisions of the HPP and in fulfillment of HPP Projects 2, 4 and 6 (Jackson 1990: 14-17). This volume reports on evaluations of 571 prehistoric archeological sites located in the heavy, moderate, and light maneuver areas at Fort Hood. No work was conducted in the 19 live fire areas located in the center of the base.

1.1 OVERVIEW OF CULTURAL RESOURCE MANAGEMENT AT FORT HOOD

Local residents have long known of the richness of archeology in Bell and Coryell counties, and the area which is now Fort Hood has contributed a wealth of artifacts to local amateur collections. However, under the loose antiquities laws of the time, little formal archeology was conducted prior to the 1970s. One exception was the Fort Hood Archeological Society (FHAS), an unofficial group of soldiers and civilians who shared an avocational interest in the local archeology. Beginning in the late 1960s, the FHAS began to survey the base and record archeological sites, and in 1971, Fort Hood designated a building on base in which to house the artifacts and records. The society ultimately recorded about 100 sites (Thomas 1978) before being gradually supplanted by the development of a formal Fort Hood archeological program.

In compliance with the National Historic Preservation Act, Fort Hood hired a staff archeologist in 1977 and officially began a program of cultural resource inventory. Because of uncertain funding levels during the early years of the program, a primary goal was the design of survey tactics which could inventory the greatest area for the minimum cost. Under subcontract to Science Applications, Inc., systematic archeological surveys were conducted first by Southern Methodist University, then by the University of Texas at Austin, and finally, from 1981 to 1991, by Texas A&M University (Jackson 1994:22-23). By 1990, over 95 percent of the base had been inventoried, with the bulk of the remaining area to be surveyed in the permanently dudded area where access is dangerous (Jackson 1990:6).

In the context of the time, this coverage was recognized as a remarkable achievement, especially for a military installation. Moreover, to ensure comparability, the surveys were conducted using well-defined standard operating procedures and explicit site definitions. Typically, crews surveyed 1 km grid squares using 30 m intervals. Site and artifact data were compiled in a computer database for analysis, and a series of published research reports regularly documented the progress of the program (Jackson 1994:22-23).

However, in retrospect, a fundamental flaw of this otherwise successful program was the assumption that the entire landscape at Fort Hood is geomorphically stable. While this is certainly true for much of the upland Pleistocene surfaces (see Chapter 2.0 of this report), other portions of the base are fluvial in character and have been very active during the Holocene, resulting in the repeated burial of human occupations. The focus of the inventory was only on the modern land surface; no shovel testing was done, and no systematic survey of stream-cut banks was done. As a result, little information was collected on the geomorphic context of sites, especially with regard to their potential for intact buried deposits.

By 1991, these surveys had recorded approximately 2,300 archeological sites. Due to problems in record keeping prior to 1989, the exact number of sites was uncertain. Existing information suggested that some 210 previously recorded sites had been determined to be nonsites, thus leaving about 2,090 legitimate sites (Jackson 1990:9). These were roughly evenly divided between prehistoric and historic sites (sites with both components had been recorded twice, once for the prehistoric component and again for the historic component). At that point, less than 15 percent of the total inventory had been adequately evaluated for eligibility for inclusion in the NRHP (Table 1.1); only 30 sites had been determined to be eligible and 273 sites had been determined to be not eligible. The remaining 1,787 sites were "possibly eligible" or had "insufficient data" on record to permit a determination (Jackson 1990:39). Of these, 959 were historic sites and 828 were prehistoric sites.

In 1990, a HPP was adopted by Fort Hood (Jackson 1990). The plan specified in general terms the priorities and standard operating procedures for the Fort Hood cultural resource management program for the fiscal years 1990 through 1994. One of the objectives of the HPP was a program to complete NRHP evaluations of the 576 prehistoric sites in the light, moderate, and heavy maneuver areas (see Table 1.1).

Much of Fort Hood contains naturally occurring Edwards chert which was the primary raw material for the manufacture of prehistoric lithic tools. As a result, Fort Hood has many localities where raw lithic material was procured, tested, and initially reduced. Some of these localities are areally extensive, encompassing more than 2 km^2 (500 acres). Previous survey results had designated these as Lithic Resource Procurement Areas (LRPAs). As a methodological device, LRPAs were contractually defined by Fort Hood as those sites greater than 75,000 m^2 (18.5 acres).

In August 1991, Mariah was awarded a multiple-year contract by competitive bid to provide cultural resource management services to Fort Hood. The primary goal of the contract was to implement this portion of the HPP. Individual delivery orders directed Mariah to conduct an inventory-level assessment of NRHP eligibility of selected prehistoric sites with respect to (1) their geomorphological context and (2) their archeological potential to contain intact cultural deposits.

Table 1.1 Summary of Fort Hood Sites at Beginning of Program, by NRHP Status.

		Eligible	Possibly Eligible	Insufficient Data	Not Eligible	TOTAL
HISTORIC	All Maneuver areas	14 (1.2%)	926 (85.2%)	33 (3.0%)	114 (10.5%)	1,087
PREHISTORIC	Nonmaneuver Areas	7	214	38	52	311
	Heavy Maneuver Areas	1	126	13	30	170
	Moderate Maneuver Areas	3	268	5	57	333
	Light Maneuver Areas	5	136	28	20	189
	Subtotal	16 (1.6%)	744 (74.4%)	84 (8.4%)	159 (15.9%)	1,003
TOTAL		30 (1.4%)	1,670 (79.9%)	117 (5.6%)	273 (13.1%)	2,090

Note: The 576 prehistoric sites in the boxed cells are the target population for the current work.

Between August 1991 and June 1993, Mariah received delivery orders to evaluate 562 previously located prehistoric sites. All of these sites were located in the light, moderate, or heavy maneuver areas, and all had a previous determination of "possibly eligible" or "insufficient data." In the course of this work, an additional nine prehistoric sites were discovered and evaluated, bringing the total to 571 sites. To accomplish the program of site evaluation, several distinct field tasks were conducted. First, all 571 sites were visited by an assessment team consisting of an archeologist and a Holocene geomorphologist. This team recorded explicit observations of archeological content and natural context, using both quantitative and descriptive data. If warranted, sites were subdivided into management areas on the basis of geomorphology and differing potential for intact buried deposits. In all, the 571 sites were subdivided into 897 different management areas. If the reconnaissance level assessment concluded that the site --or any portion thereof --had the geomorphic potential to contain intact subsurface deposits, then the site was subsequently visited by a field crew and was shovel tested. In general, most sites lacking the potential for intact and stratigraphically separated cultural deposits were considered to have no potential for addressing substantive research issues. However, formally designated LRPAs sites were subjected to a third round of evaluation, including a surface resurvey, which assessed the potential of the site to address questions of chert procurement. All resulting site data were analyzed and were reported in 571 individual letter reports. These data were then holistically reanalyzed and are reported in this volume. This general process is schematically illustrated in Figure 1.1.

In response to a separate delivery order, Mariah concurrently developed a comprehensive and problem-based research design (Ellis et al. 1994) which is intended to serve as the basis for subsequent formal NRHP eligibility determinations. This next phase of work, (in progress, March 1994) involves formal NRHP testing of selected sites.

Also concurrent with the program of site assessment, Mariah has conducted a program of archeological research at Fort Hood. The research program has been carefully designed to facilitate and enhance NRHP eligibility determinations during the next phase of the assessment program at Fort Hood.

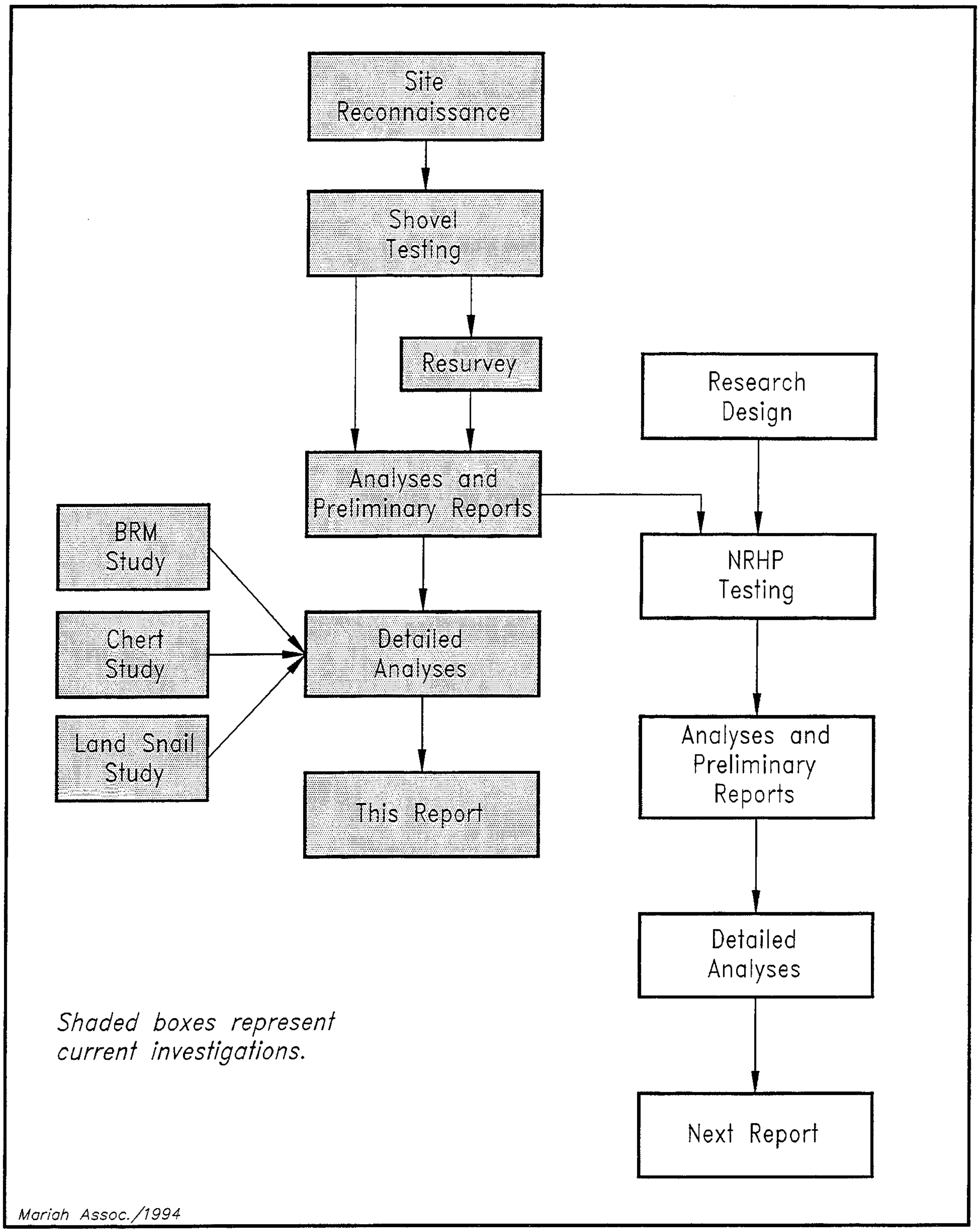


Figure 1.1 Schematic of Evaluation Process.

It has included highly focused studies on the structure and formational processes of burned rock mounds, the utility of amino acid epimerization in land snails as a chronometric indicator, the distribution and variability of Edwards chert, and the utility of chert patination as a chronometric indicator. Results of the first three of these research studies are reported in this volume; the chert patination study will be reported separately (Frederick 1994).

1.2 ORGANIZATION OF THIS REPORT

This volume is structured into 11 chapters, plus bibliographic references and several appendices. Following this introduction, Chapter 2.0 introduces the Fort Hood study area. This chapter reviews key environmental considerations since these are relevant to understanding the theoretical and methodological approach to site evaluation, and emphasizes variability in landforms, hydrology, geomorphology, and lithology.

Chapter 3.0 presents the research design issues which shaped development of the methods used to evaluate research potential and site significance. As a point of departure, the chapter begins by discussing several alternative uses of the term "context." A focused application of these context concepts is then applied as a measure of research potential. Next, the general problem of the LRPA sites is introduced, and the concept of context is again examined for applicability. Finally, the chapter briefly reviews the synthetic- and problem-oriented research design (Ellis et al. 1994) which was developed concurrently with the present fieldwork and which will be used during the next phase of work at Fort Hood.

Together, Chapters 4.0 and 5.0 discuss the specific strategies and tactics which were implemented during the site evaluation program. Chapter 4.0 focuses on the methods which were used on sites (and portions thereof) located in depositional contexts. Field, laboratory, and analytical methods are discussed. This chapter also reviews the program of Total Quality Management which was adopted to ensure the accuracy, replicability, and comparability of the collected archeological information. Chapter 5.0 discusses the special considerations which were given to the LRPA sites (and portions thereof) located in nondepositional contexts.

The next three chapters present some results and conclusions which resulted from three ancillary studies that were undertaken by Mariah to further enhance the abilities of Central Texas archeologists to assess the overall research potential of prehistoric sites. Chapter 6.0 is an in-depth review and analysis of Edwards Chert, the prehistoric "wealth" of Central Texas. This chapter uses new field work and laboratory analyses to carefully document the spatial distribution of Edwards chert throughout Texas and assess the variability in its appearance and composition. Using these data, the chapter develops an explicit and working typology for the varieties of Edwards Chert on Fort Hood and ties these varieties to geographic localities. The chapter concludes with an investigation into the relative workability of these varieties, including alteration by heat and immersion in water.

Chapter 7.0 investigates the potential of land snail shells (*Rabdotus* sp.) to assist in site dating and site formation studies. Designed as an adjunct to the overall site evaluation program, this study discusses the epimerization of amino acids, and direct radiocarbon dating as complementary methods. Some results of preliminary epimerization and radiocarbon assays are then presented and the overall utility of land snails to Central Texas archeologists is assessed.

Chapter 8.0 presents the results of a focused program which investigated the structural and chronometric variability of burned rock mound features. Also, designed as an adjunct to the overall site evaluation program, this study investigated the internal physical structure and the construction-use-reuse sequence of nine burned rock mounds through a highly focused program of test excavations and radiocarbon dating. The chapter also contains a case study on the use of landsnails for dating burned rock mounds and assessing their formation. As a largely self-standing study, the chapter contains its own problem statement, literature review, discussion of methods, analyses, and conclusions.

The final three chapters synthesize and present the results of the 571 site specific evaluations. First, Chapter 9.0 presents several independent analyses of data. These employ information about site distributions, artifact variability, and data collection tactics to derive several substantive and methodological conclusions.

Chapter 10.0 summarizes the results of field work on the 571 sites and 897 management areas and develops explicit evaluations according to the criteria set forth in Chapter 3.0. As called for under the Section 106 process, these evaluations of research potential are linked to overall assessments of significance and, thereby, eligibility for inclusion in the NRHP. Explicit recommendations for further management are made for each site or site management area.

Finally, Chapter 11.0 suggests a series of nonsite specific (or programmatic) recommendations which would serve to enhance effective and long-term management of the prehistoric cultural resources at Fort Hood. Based on the results and conclusions of the 571 site assessments as well as those of the ancillary studies, these "programmatic" recommendations include both suggestions for pragmatic policies and procedures as well as suggestions for future research which would enhance Fort Hood's ability to develop historic contexts and make meaningful assessments of research potential and site significance. Chapter 12.0 contains cited bibliographic references.

Appendix A is a lengthy compendium of descriptive documentation and primary data for all 571 sites evaluated under this work phase. Insofar as Appendix A contains sensitive information detailing site location and content, it is bound separately and has a limited distribution (researchers with a legitimate interest may consult the appendix at the Fort Hood DEH Environmental Office, the Texas Historical Commission (THC), the Texas Archeological Research Laboratory (TARL), or the Austin office of Mariah Associates, Inc.). Bound within this report, Appendix B presents examples of all forms which were used to record baseline site data. Appendix C documents the typology of Edwards chert which was developed in Chapter 6.0. Appendix D identifies the typology used for projectile points, and includes illustrations of at least one artifact for each clearly defined type identified at Fort Hood. Appendix E presents the typology of features which was used in the field. Appendix F consists of a condensed data listing of all 571 sites and 897 site management areas. Appendix G includes supplementary tables and figures to the discussion of chert artifacts in Section 9.1. Finally, Appendix H consists of raw descriptive and metric data recorded for all projectile points.

2.0 NATURAL ENVIRONMENT

James T. Abbott

2.1 INTRODUCTION

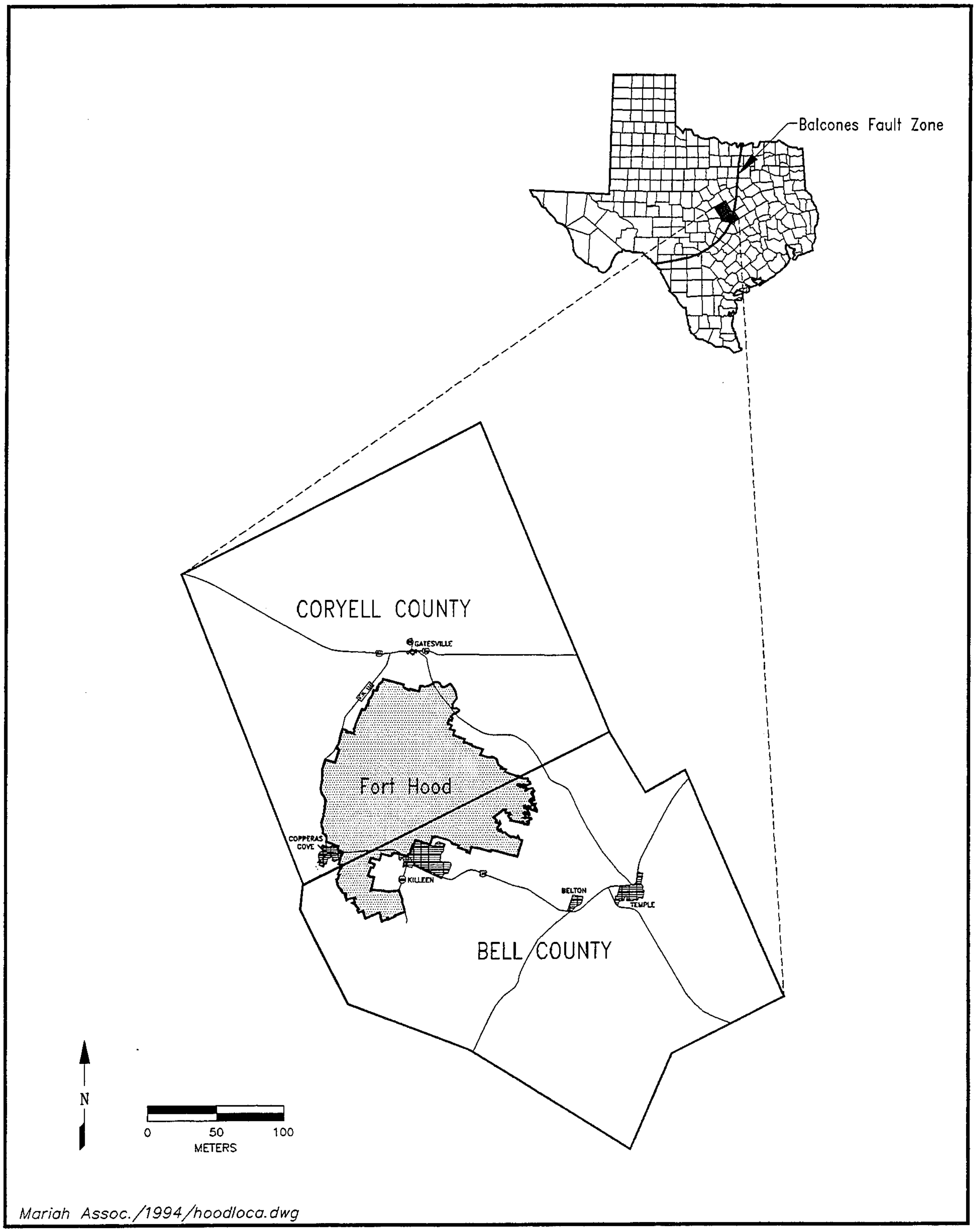
Mariah's investigation of cultural resources on Fort Hood is conducted under a research approach which stresses an ecological perspective to understanding the area's prehistory. Geomorphic, geoarcheologic, and paleoenvironmental studies conducted in association with archeological research provide two broad information categories that are invaluable to interpreting the prehistoric record under an ecologic paradigm. The first major category involves identifying the landscape context of the site during the original occupation, including identifying local landforms, depositional context, local biotic and geologic resources, and other types of penecontemporaneous environmental data. The second major category is the identification of post-occupational formation processes. These processes govern the transformation of the site matrix that in turn affect the integrity of the original artifact associations in a cultural scatter.

The purpose of this chapter is twofold: (1) to provide an environmental data outline relevant to understanding the landscape context in which prehistoric people interacted; and (2) to identify strengths and weaknesses in the existing paleoenvironmental database. As with the cultural record (Ellis et al. 1994), the state of knowledge about the Central Texas paleoenvironmental record is in a constant state of flux. Information is added slowly, piece by piece, from a wide variety of sources. One of the most difficult tasks in the overall effort is the identification, interpretation, and synthesis of relevant data. Rather than presenting an exhaustive review of the Central Texas paleoenvironment, this chapter is intended to provide a brief but useful summary of current knowledge, together with the references necessary for anyone wishing to delve more deeply into the specifics of the record.

A second major goal of this chapter, and this report as a whole, is to highlight aspects of the paleoenvironmental record that remain poorly understood. Over the previous two years, Mariah has had the opportunity to revisit hundreds of archeological sites on the facility and traverse countless miles of back roads that honeycomb the maneuver areas. One of the results of this process is that a number of specific and pertinent paleoenvironmental questions have come to light. While some of these problems have been previously recognized, a few of the questions are identified for the first time here, and all are lacking the attention that we believe they merit. Much of this chapter is devoted to identifying these questions and many of them will be expanded on in subsequent chapters.

2.2 LOCATION AND CLIMATE

Fort Hood is situated in northwestern Bell and southeastern Coryell counties, Central Texas, adjacent to the city of Killeen (Figure 2.1). The fort encompasses an area of approximately 878 km^2 (339 m^2) and lies in the Grand Prairie Land Resource Area. This part of the state occupies the transition zone from the humid east to the semi-arid west, and the environmental gradient is steep enough that distinct changes in landscape and vegetation are observable moving east to west across the reservation. Geologically, the facility is situated a few tens of kilometers west of the NNE-SSW-trending Balcones Fault Zone, which is a major physiographic and ecologic break within Texas (Woodruff and Abbott 1986). Although no pronounced scarp exists along the fault zone in Bell County, the character of soils and vegetation developed on the upper Cretaceous rocks east of the fault zone is markedly different than exists on the lower Cretaceous rock to the west.



Mariah Assoc./1994/hoodloca.dwg

Figure 2.1 Location of Fort Hood.

Thus, the fort is situated in an ecotonal situation that would have allowed the prehistoric population to exploit differing sets of resources by foraging either to the east or west. A second aspect that would have made the area attractive is the abundance of water available from the numerous springs and seeps that dot the landscape and from the stream network that they feed. Finally, a very important factor in the area's overall attractiveness to prehistoric peoples is the tremendous quantity of chert that literally paves many parts of the modern landscape. This material represents a lithic resource that would have strong appeal both to indigenous groups and to inhabitants of relatively chert-poor areas to the east, northwest, and southeast. The physiography of Fort Hood is notable for the presence of two distinct, flat-lying to gently rolling upland surfaces (Hayward et al. 1990; Nordt 1992) reflecting geological controls on long-term landscape development.

2.2.1 Modern Climate

The modern climate of the Fort Hood area is humid subtropical, characterized by long, hot summers and relatively short, mild winters. Summer temperatures are high, with an overall average of 83°F (28.3°C) and an average daily maximum of 96°F (35.5°C) in Coryell County. Summers are also characterized by relatively high humidity, which combines with the temperature to provide sweltering summer days and balmy to sticky nights. Average temperature in winter is 49°F (9.4°C), however, rapidly moving invasions of arctic air originating over the northern Plains (known locally as "blue northers") are common, and can send temperatures plummeting tens of degrees in the span of less than an hour. The lowest temperature on record for Bell and Coryell counties is -4°F (-20°C), recorded in Temple on February 11, 1899. Overall, summers are unremittingly hot while winters are a sequence of short periods of bitterly cold and relatively pleasant days. The frost-free period averages 260 days, with freezing temperatures occurring after April 11 or before October 23 one year in ten.

Total annual precipitation is approximately 386 mm (34 inches). Rainfall occurs year-round, with frontal storms dominant in winter and convectional thunderstorms dominant in summer. A little more than half of the precipitation (55%) occurs during the summer months (April through September). However, this precipitation is concentrated in two peaks occurring in late Spring and early Autumn; the period from mid-June to late August is relatively dry, and the precipitation that does fall typically occurs as brief, localized thunderstorms of variable intensity. Snow is rare in the area, and measurable accumulations only occur once or twice a decade since most snow melts as fast as it falls. In all months, average evaporation exceeds average precipitation (Larkin and Bomar 1983).

The climate of Central Texas is the result of several interacting controls. Synoptic weather patterns are dominated by meridional flow during the summer months and zonal flow in winter. The primary sources of moisture for all parts of Texas are warm Maritime Tropical air masses originating over the Gulf of Mexico, but moist Pacific air masses can provide considerable moisture at times (Carr 1967). During winter months, frequent frontal passages typically prevent moist Gulf air from invading inland as far as the Balcones escarpment, resulting in the winter precipitation minima. In late spring, the frequency of the frontal passages decreases markedly, allowing moist gulf air to invade Central Texas. The primary precipitation maxima occurs in late spring due to thunderstorms generated in the warm, conditionally unstable air and frontal storms generated as infrequent late Spring cold fronts encounter and force aloft the maritime air mass. The dry midsummer results from the dominance of a semi-permanent high pressure cell that develops over the Plains, and is broken as late summer easterly waves once again bring Gulf moisture to the region. Occasionally, unusual conditions in the Pacific can result in intense rains during the winter months. This pattern was responsible for the heavy rains of the winter of 1991-1992, when intense development of the El Niño current off the western coast of Mexico resulted in a strong influx of Pacific moisture that led to weeks of heavy rains and intense flooding.

The collision of very moist tropical and very cold polar air masses in the region has, in fact, occasionally resulted in rainfall of staggering intensity (Slade 1986). One storm, which occurred on September 9-10, 1921, resulted in a total of 971 mm (38.2 inches) of rainfall in a single 24-hour period at Thrall, located in eastern Williamson County, far exceeding the average annual rainfall of the area and setting a record for the continental United States. Even more incredible is the storm that occurred May 31, 1935, when a record 560 mm (22 inches) fell in 2 hours and 45 minutes near D'Hanis, in Medina County. This potential for extremely heavy rains has considerable geomorphic implications. Such storms far exceed the ability of the rocky landscape to absorb the increase in precipitation, leading to catastrophic flooding capable of profoundly altering the landscape in a matter of hours. Flooding of Cowhouse Creek at Fort Hood has raised the elevation of the stream more than 11 m (35 ft) and increased flow by roughly four orders of magnitude at least four times during the period of record. Such floods have strong potential to accelerate bank erosion and affect cultural material resting on terrace surfaces. Following the El Niño event of December 1991, Mariah personnel noted at least one locality (41CV1105) where fist-sized burned rock clasts had been mobilized and transported dozens of meters downstream on a terrace surface 12 to 15 m above the modern channel. This example illustrates the power of the streams on Fort Hood during flood stage, and calls into question the integrity of many burned rock scatters and other sites stratified within their terraces.

2.2.2 Late Quaternary Paleoclimate

Climate provides the driving force behind landscape change, influences the spatial matrix of flora, fauna, and soils, and directly or indirectly determines the environmental parameters within which the prehistoric population had to operate. Although much information exists detailing the character of climatic and environmental change through the late Quaternary in Central Texas, the record is still not fully understood. One of the major weaknesses of paleoclimatic reconstruction in general is that most indicators of fossil climates are proxy indicators; that is, they do not measure paleoclimatic parameters directly, but rather characteristics of the biotic or physical environment that respond to climate. Although these various factors are strongly influenced by climatic trends, the response of each is tempered to some degree by differing sensitivities and variable lag times. This is particularly true of biotic indicators that are used to model paleoclimatic conditions on the basis of the modern range of various animal and plant species. Thus, interpretation requires the integration of a variety of data sources, many of which present somewhat contradictory evidence.

2.2.2.1 Lines of Evidence for Reconstructing Former Climates in Central Texas

Several lines of proxy data have been used to reconstruct the paleoecologic sequence that prevailed in the region through the late Quaternary, and others have potential for useful application. Although pollen records provide the bulk of existing paleoenvironmental information in most parts of the United States, productive pollen sites are rare in the semiarid climate of Central Texas. The few existing bogs on the upper coastal plain have been examined with varying degrees of success (Bryant and Holloway 1985), and some pollen has been extracted from alluvial sequences (e.g., Dering and Bryant 1992) and cave sites in the hill country (Bryant and Holloway 1985). However, the information obtained from these latter sources is sparse and frequently suspect due to rapid and differential degradation of pollen grains. Macrobotanical remains have also provided some knowledge, particularly in the drier western part of the Edwards Plateau, but rarely provide an accurate picture of the overall composition of regional vegetation. Opal phytoliths, which are microscopic siliceous particles formed inside plant cells, have considerable potential to address paleoecological questions (Piperno 1988; Brown 1984), but have yet to be effectively utilized in the region. An indirect indicator of the composition of vegetation in the area is provided by ∂13C ratios from organics contained in soils and sediments (e.g, Nordt 1993a; Nordt et al. 1994), which indicates the relative proportion of tropical grasses (C4 pathway) and temperate grasses and woody plants (C3 pathway) contributing to the organic pool. A similar approach is possible through the analysis of the isotopic composition of the faunal remains of animals that were eating and metabolizing the grasses (e.g., Huebner and Boutton 1990). Although this work is promising, more isotopic research is necessary before regional trends can be confidently identified.

Much our knowledge of Central Texas paleoecology comes from faunal assemblages preserved in caves and rockshelters (c.f. Graham 1987; Toomey 1993; Lundelius 1986). Although faunal material is commonly addressed in all cultural resource investigations, very little representative data has been recovered from open-air sites due to the processes of cultural selection involved and relatively poor preservation potential. In contrast, remains of large mammals are relatively rare in cave settings, while skeletal material of the more environmentally sensitive microfauna are abundant. Unfortunately, many archeological excavations have overlooked microfauna as a data source by not following field procedures necessary to retrieve fine bones, and a wealth of information has therefore been lost (Toomey 1993). Malacological studies from open-air sites provide an additional avenue of investigation of late Quaternary trends (Neck 1992), and have proven particularly sensitive to localized microenvironmental changes as well as broader environmental shifts.

Soil development is another potential paleoenvironmental indicator that has been little utilized in Central Texas. The character of soils reflects the climate or succession of climates under which they developed, and careful study of the macroscopic and microscopic characteristics of relict soils and paleosols can indicate a great deal about former conditions (Birkeland 1984; Courty et al. 1989). In particular, examination of the amount and physical arrangement of infiltrated clay, the degree and character of iron and magnesium segregation and oxidation, the character and development of secondary carbonate, and the degree of dissolution of weatherable primary minerals can shed considerable light on climatic characteristics during pedogenesis.

A few techniques theoretically capable of providing a direct measure of climatic parameters also exist, but have yet to see wide application in the region. Oxygen isotope ratios on a wide variety of biotic and abiotic calcareous materials, such as tufa, travertine, soil carbonates, ostracoda, and snails have the potential to provide relatively straightforward indications of ambient temperature during their formation (Seigenthaler and Eichler 1986; Lamb 1977; Schwarcz and Eyles 1991). Because many of these substances are also amenable to radiometric and/or amino acid dating techniques (Goodfriend 1992; Lauritzen et al. 1994), it should be possible to construct a relatively detailed record of temperature variations throughout the late Quaternary. Another technique that has demonstrated potential to yield paleotemperature data is analysis of the noble gas content of groundwater, which is also amenable to radiometric dating (Stute et al. 1992).

To date, application of geomorphic evidence to the interpretation of late Quaternary climatic changes along the Balcones escarpment and on the Edwards Plateau is limited to a few studies. Like most types of paleoclimatic evidence, geomorphic data only provides an indirect record of climatic change. The evidence preserved in the record reflects systemic responses to shifts in climatic variables, and requires two discrete analytical steps before a paleoclimatic interpretation can be obtained. First, the character and timing of changes in geomorphic activity must be identified. Once this is accomplished, the causes of the specific responses must be interpreted to arrive at the character of the paleoclimate. Because the process-response framework is quite complex, this latter step is a difficult undertaking. As a number of authors have pointed out (e.g., Schumm 1969; Wilson 1973; Butzer 1980; Knox 1983; Chorley et al. 1984; Blum and Valastro 1989), a change in climate can result in a number of possible systemic responses depending upon (1) the relative amount and direction of change in temperature and precipitation, (2) the magnitude and duration of the change, and (3) the pre-existing climatic, hydrologic, and biotic conditions. For this reason, paleoclimatic reconstruction based on geomorphic data also requires the integration of other, independent lines of evidence.

2.2.2.2 Central Texas Climate During the Late Quaternary

Although much refinement is necessary before a detailed late Pleistocene/Holocene paleoclimatic record can be established, extant studies have provided a useful outline of prevailing trends. In general, the few middle Pleistocene faunal assemblages described thus far indicate a moderate climate with diverse habitats (e.g., Taylor 1982), and late Pleistocene assemblages indicate a climate cooler and moister than today (Graham 1987; Toomey 1993; Lundelius 1986). Pollen records suggest that grasslands were expanding at the expense of open deciduous forest through the late glacial period (Bryant and Holloway 1985), indicating a tendency toward warming and drying. Stable carbon isotopes from the Fort Hood streams suggest that the ratio of warm season (C4 pathway) grasses during the terminal Pleistocene was 45 to 50 percent, which is similar to the ratio on the modern northern Great Plains (Nordt et al. 1994).

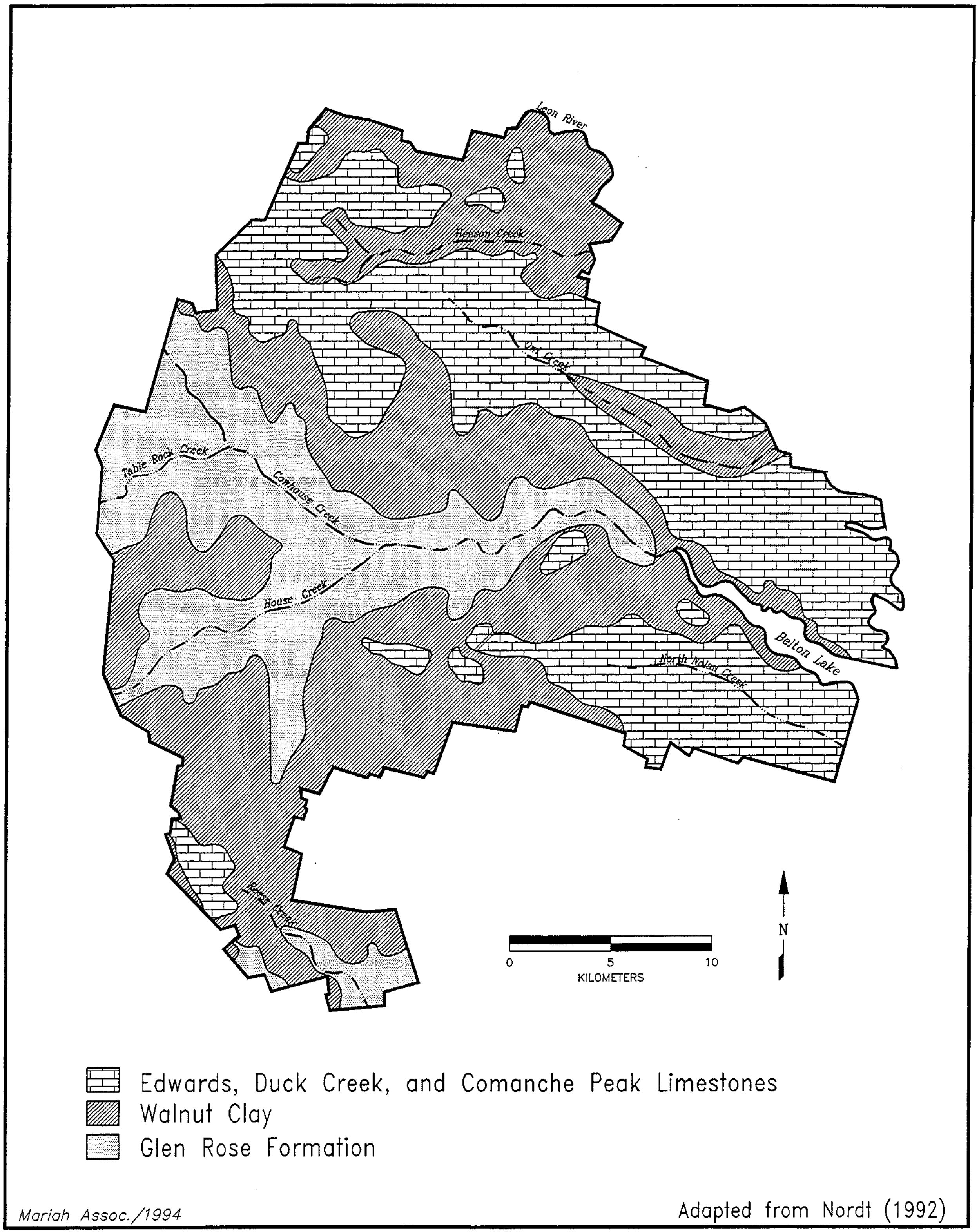
Pollen records for the early to middle Holocene show a gradual warming and drying trend characterized by further loss of arboreal taxa (except oak) and corresponding increases of grasses (Bryant and Holloway 1985). Holocene cave faunas typically show a similar trend and also frequently indicate an accompanying period of widespread soil erosion, as evidenced by the disappearance of burrowing rodents like *Thomomys* and *Geomys* (Toomey 1993; Graham 1987). Most cave assemblages provide little evidence for climatic fluctuation, such as the dry "Altithermal" period, during middle to the late Holocene (Lundelius 1986; Graham 1987). In contrast to the faunal and pollen data, geomorphic studies from the eastern side of the plateau (e.g, Blum and Valastro 1989; Nordt 1992; Mandel 1991; Blum 1992) indicate a series of cut-and-fill episodes and periods of pedogenesis indicative of environmental shifts during this interval. Middle Holocene sediments, in particular, are relatively rare, possibly indicating a pronounced dry interval. Carbon isotopes from Cowhouse Creek on Fort Hood indicate that those sediments deposited between 6000 and 4000 B.P. contained organic residue from an assemblage composed of up to 95 percent warm season grasses, a sharp contrast to the modern configuration of 65 to 70 percent C4 pathway species. Around 4000 B.P., the climate apparently shifted to a slightly more mesic state, and oak woodland became the dominant vegetation assemblage (Bryant and Holloway 1985). This shift was accompanied by renewed aggradation in many area streams (e.g., Nordt 1992; Blum 1987; 1990). Apparent temporal variation in bison populations on the southern Plains also indicate fluctuating moisture and vegetation assemblages during the later Holocene (Dillehay 1974). Late Holocene pollen records suggest that around 1500 B.P., the climate shifted toward slightly drier conditions again, resulting in the establishment of an oak savannah environment (Bryant and Holloway 1985). By approximately 1000 B.P., many streams on the southern Plains and Edwards Plateau once again abandoned their floodplains and began to entrench (Hall 1990), probably as a result of another (or the same) subtle shift toward drier conditions. In the last few hundred years, the climatic signal in vegetation and geomorphic records is largely masked by the much more significant impact of agriculture and grazing on the natural system.

2.3 BEDROCK GEOLOGY

The Fort Hood landscape is a result of dissection of the eastern margin of the uplifted Edwards Plateau, and reflects variability in the resistance of various geologic formations to erosion. The fort lies a few miles to the west of the Balcones Fault trend, which is a major physiographic and structural feature that trends northeast-southwest from north of Dallas to San Antonio, then turns east-west, continuing out of the United States into Mexico in the vicinity of Del Rio. The escarpment separates the dissected Edwards Plateau to the north and west from the gently rolling upper Gulf Coastal Plain to the south and east. The system was primarily formed by faulting in the Miocene, although some structural adjustments probably began as early as the Cretaceous (Woodruff and Abbott 1986). Although the relief provided by the escarpment is typically less than 100 m (and barely perceptible in Bell County), major differences in character of relief, climate, soils, and vegetation are apparent between the two sides of the fault zone.

Structurally, the region is situated between the stable continental interior and the subsiding Gulf Coast basin, and is underlain by a deep-seated extension of the Paleozoic Ouachita orogen. During the Cretaceous Period, Central Texas was the site of a very broad shelf covered by a shallow sea. For more than 80 million years, calcareous limestones and marls were deposited on the shelf as the shoreline oscillated back and forth. Occasionally, relatively thin deposits of terrigenous clastics were washed onto the shelf from the west, forming interbedded formations like the Paluxy Sandstone, Hensell, Sandstone, and Antlers Formation that tend to pinch out to the east. As the Gulf Basin subsided in the Miocene, severe extensive stresses developed in the formerly flat-lying Cretaceous marine rocks across a hinge formed by the Ouachita subcrop, and fracturing occurred, forming the Balcones fault system (Woodruff and Abbott 1986). The Balcones fault system is an extensional fracture zone composed of a series of roughly parallel normal step faults arranged en echelon and broken by relatively small-scale transverse faults, grabens, and horsts. In general, the upthrown side of the fault exposes lower Cretaceous rocks of the Trinity, Fredericksburg, and Washita Groups, including the Edwards and Glen Rose Limestones. In the fault zone, a sequence of upper Cretaceous limestones, marls, chalks, and clays, including the Del Rio Clay, Buda Limestone, Eagle Ford Group, Austin Chalk, and Navarro Group are exposed at the surface. East of the fault, increasingly young Tertiary clastics are successively onlapped toward the modern coastline, and the Cretaceous rocks are buried deeper and deeper beneath these younger rocks in the subsiding basin.

Fort Hood is situated west of the fault zone in an area underlain by flat-lying lower Cretaceous rocks (Figure 2.2). The oldest rocks exposed on the fort belong to the Trinity Group, including the Glen Rose Formation and Paluxy Formation. The Glen Rose Formation consists of alternating beds of fossiliferous limestone, dolomite, and marl that achieves a total thickness of up to 114 m (375 ft), although only the upper part is exposed on Fort Hood. The formation is relatively thin-bedded and tends to alternate between relatively resistant limestone and erodible marl resulting in a characteristic stair-step topography. The Glen Rose is exposed primarily by the valleys of Cowhouse Creek and its major tributaries (House Creek, Table Rock Creek, Clear Creek, Turkey Run Creek, etc.) on the western side of the fort. The Paluxy sand consists of fine to very fine quartz sand with interbeds of shale and limestone that rests on top of the Glen Rose Formation. Although it can achieve thicknesses of 21 m (70 ft), on Fort Hood the unit is present as a thin, eastward-pinching wedge of material that rarely exceeds 3 to 6 m (10 to 20 ft) in thickness and does not even appear on the regional geologic map (Barnes 1970). Despite its limited outcrop within Fort Hood, the Paluxy sand is an important substrate in terms of archeological site location, and is discussed further below.



Mariah Assoc./1994

Adapted from Nordt (1992)

Figure 2.2 Geological Formations on Fort Hood.

Resting on top of the Trinity Group rocks are rocks of the lower Cretaceous Fredericksburg Group. The lowest unit is the Walnut Clay, which consists of highly fossiliferous clays, limestones, and shales up to 53 m (175 ft) thick. The Walnut Clay is widely exposed on the fort through lateral stripping of the overlying rocks, and forms the principle substrate of the broad, intermediate upland (Killeen) surface. Above the Walnut Clay lies the Comanche Peak Limestone, which consists of hard, thin-bedded limestones and shales that form the intermediate slopes of the higher upland (Manning) surface. The highest extensive rock unit is the Edwards Limestone, a thick-bedded, cherty limestone up to 18 m (60 ft) thick that forms the resistant cap of the high upland mesas. Geologic mapping by Barnes (1970) does not differentiate between the Edwards Limestone and overlying rocks of the Washita Group, including the Kiamichi Clay, Duck Creek Limestone, Fort Worth Limestone, and Denton Clay in the eastern half of the facility, but field examination of the area suggests that the massive Edwards is usually the uppermost rock unit on the higher surfaces. Edwards Limestone is the overwhelming source of chert on the base, occurring as tabular or nodular forms in the bedrock, as a residual lag on the surface and in soils on chert-bearing strata, and as alluvial and colluvial gravels.

2.4 BIOTA

According to Gould (1975), Fort Hood lies in the southern part of the Cross Timbers and Prairies Vegetation Area. Allred and Mitchell (1955) term the vegetation of Fort Hood the Hill Country Savannah, while Kuchler (1964) identifies it as a Juniper-Oak Savannah. Blair (1950) places the area on the northeastern margin of the Balconian province, a short distance west of the boundary of the Texan province along the Balcones fault zone (Figure 2.3). All recognize that the biotic assemblage in the area of the fort represents a transitional zone between elements of the Blackland Prairie to the east and the Edwards Plateau to the west.

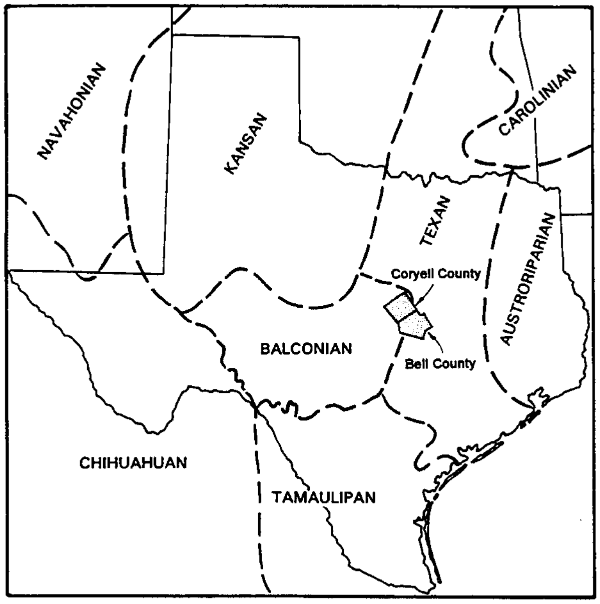


Figure 2.3 Biotic Provinces of Texas Defined by Blair (1950).

2.4.1 Vegetation

A detailed examination of vegetation on the facility (Espey Huston and Associates 1979) indicates that the fort as a whole is composed of 57 percent woodland and scrub, 38 percent grassland and savannah, and 5 percent developed urban areas, and includes 267 distinct species or varieties of plants. The eastern side of the facility (East Range) is typified by dense oak/juniper forest and scrub, while upland areas on the west (West Range) and south (West Fort Hood) are generally more open, ranging from open forest to an open savannah populated with scattered stands of trees. Juniper forests are relatively rare, and typically indicate areas that were previously cleared. Grasslands are most common on the intermediate upland surface within the live fire area and in West Range, while the high upland surface is typically wooded. Riparian habitats are common along drainages, and exhibit a variety of hardwood species. The Impact area in the center of the base is dominated by grasslands even on the high upland surface, probably as a result of artillery impact and resulting fires. Mosses and liverworts occur in profusion around localized springs and seeps, and forbs, grasses, and other pioneering species are common in areas of vehicle impact.

Woody vegetation on Fort Hood is dominated by a few arboreal species, primarily ashe juniper (*Juniperus ashei*), live oak (*Quercus fusiformis*), Texas red oak (*Quercus texana*), Texas ash (*Fraxinus texana*), Texas persimmon (*Diospyros texana*), and cedar elm (*Ulmus crassifolia*). A variety of woody scrub, vines, and leafy species occur in the understory, including flameleaf sumac (*Rhus lanceolata*), redbud (*Cersis canadensis*), Mexican buckeye (*Ungnadia speciosa*), fragrant sumac (*Rhus aromatica*), poison ivy (*Rhus toxicodendron*), mustang grape (*Vitis mustangensis*), and the ever present greenbrier (*Smilax bonanox*). Post oak (*Quercus stellata*) and blackjack oak (*Quercus marilandica*), the dominant trees in the cross timbers, are of relatively minor importance on Fort Hood, which conforms more closely to the assemblage typical of the eastern Edwards Plateau. Mesquite (*Prosopis glandulosa*), typical of areas to the west, also occurs in relatively low numbers. A relict population of bigtooth maple (*Acer grandidentatum*) also occurs on the Fort, far removed from its natural range in the southern Rocky Mountains. Riparian habitats support a diverse assemblage of woody species, including pecan (*Carya illinoinensis*), slippery elm (*Ulmus rubra*), burr oak (*Quercus macrocarpa*), black walnut (*Juglans nigra*), plum (*Prunus americana*), American elm (*Ulmus americana*), netleaf hackberry (*Celtis reticulata*), and red mulberry (*Morus rubra*).

Grasslands on the Fort consist of a mix of species typical of both the tall-grass prairie to the east and short-grass prairie to the west. Common species include blue grama (*Bouteloua gracilis*), sideoats grama (*Bouteloua curtipendula*), hairy grama (*Bouteloua hirsuta*), Texas grama (*Bouteloua rigidiseta*), little bluestem (*Schizachyrium scoparium*), Indian grass (*Sorghastrum avenaceum*), silver bluestem (*Bothriochloa saccharoides*), buffalo grass (*Buchloe dactyloides*), and bermudagrass (*Cynodon dactylon*). Equally common, and usually more abundant in disturbed areas, is a variety of forbs and weedy species including broomweed (*Xanthocephalum texanum* and *X. dracunculoides*), prairie-tea (*Croton monanthogynus*), painted euphorbia (*Euphorbia cyanthrophora*), ragweed (*Ambrosia artemisiifolia*), triple-awn (*Aristida* sp.), and snow-on-the-prairie (*Euphorbia bicolor*).

2.4.2 Fauna

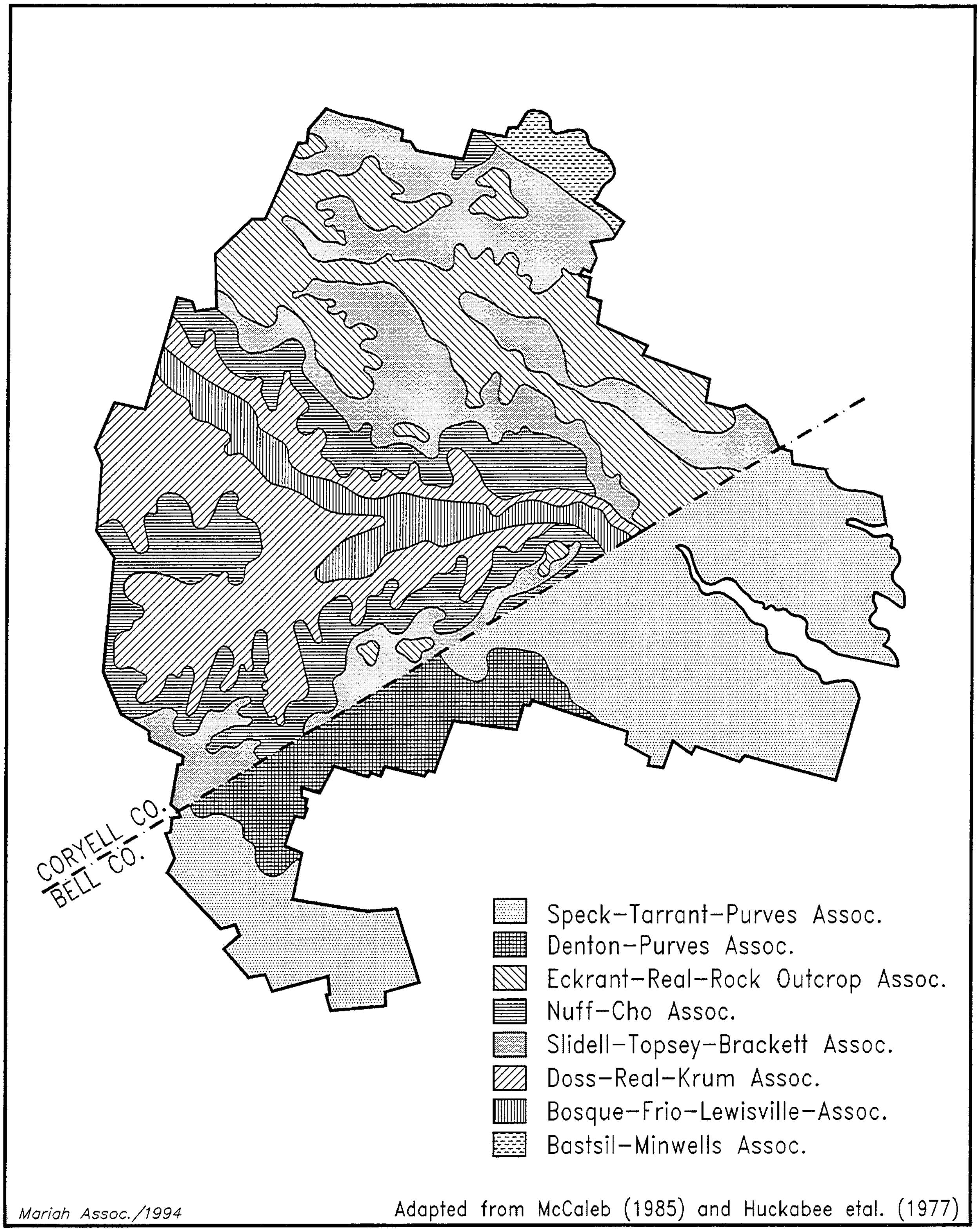
The installation lies in the Balconian biotic province of Blair (1950) and includes wildlife species characteristic of the surrounding Austroriparian, Texan, Tamaulipan, Kansan, and Chihuahuan provinces. An inventory of species by Espey Huston and Associates (1979) documented the presence of 22 species of amphibians and reptiles, 80 species of birds, and 15 species of mammals. Many more species are likely to occur because the Fort lies within the range of over 48 species of mammals, 79 species of reptiles and amphibians, and 324 species of birds (Espey Huston and Associates 1979). Bird species occurring in the greatest numbers include the tufted titmouse (*Parus bicolor*), cardinal (*Cardinalis*), Carolina chickadee (*Parus carolinensis*), bobwhite (*Colinus virginianus*), house sparrow (*Passer domesticus*), and lark sparrow (*Chondestes grammacus*). The turkey vulture (*Cathartes aura*), while not occurring in numbers as great as the smaller birds, is a particularly prominent fixture on Fort Hood. Wild turkey (*Meleagris gallopavo*) is another local species that has considerable significance as a food resource for prehistoric inhabitants. Common mammals occurring include white-tailed deer (*Odocoileus virginianus*), northern raccoon (*Procyon lotor*), black-tailed jackrabbit (*Lepus californicus*), fox squirrel (*Sciurus niger*), gray fox (*Urocyon cinereoargenteus*), nine-banded armadillo (*Dasypus novemcinctus*), eastern cottontail (*Sylvilagus floridanus*), and deer mouse (*Peromyscus maniculatis*). With the exception of the gray fox, predators are relatively uncommon, but documented species include the coyote (*Canis latrans*), and bobcat (*Lynx rufus*).

2.5 SOILS

A number of soil associations have been mapped by the USDA Soil Conservation Service within the boundaries of Fort Hood (McCaleb 1985; Huckabee et al. 1977) (Figure 2.4). These soil associations are composed of multiple soil series that tend to develop under similar topographic and lithologic conditions and share predictable spatial relationships. Soil formation reflects the interacting influence of climate, organisms, relief, parent material, and time (Jenny 1941). Because the same succession of climates has affected soils within the relatively limited boundaries of Fort Hood on a more or less equal basis, the primary controls on their character and distribution are the lithology of the substrate, the degree of surface slope and local topography, the age of the geomorphic surface they occupy, and (to a much lesser extent) the level of organic additions and bioturbation that they have experienced.

The soil series mapped on the fort are based on the USDA Soil Taxonomy (Soil Survey Staff 1975), which is a complex taxonomic system that emphasizing physicochemical makeup over genetic considerations. As such, there is a tendency to differentiate soils that are genetically related and would be more closely aligned under a classification system with a soil geomorphic emphasis. Much of this tendency can be attenuated by concentrating on the association level, where spatially related soils are grouped. However, the grouping of soils into associations varies considerably, and the level of detail of the two county surveys is markedly different (see Figure 2.4). This discussion uses the soil association format as a springboard to address the soil resource on the facility from a soil-geomorphic perspective. In this approach, important pedogenic processes, lithology, landscape position, and age are integrated to explain the morphology and distribution of soils (Birkeland 1984; Gerrard 1981). Most soils on Fort Hood are the result of a suite of pedogenic processes that occurred under the influence of the semi-arid to subhumid climate prevailing during most of the Holocene. Important processes include the chemical weathering of limestone and input of organic matter; dissolution, translocation, and reprecipitation of calcium carbonate; and formation, translocation, and residual concentration of clay minerals. In general, leaching has been insufficient to remove soluble bases from the profile and most soils are calcareous and cation-rich. A few of the soils on the fort, particularly on more stable parts of the high, upland, dominantly siliceous substrates, and the Pleistocene terraces of the larger streams, may reflect relict climatic conditions from the late Pleistocene when effective moisture was greater and leaching of the soils was more effective. These soils are typically thicker, more strongly leached, and more highly rubified than surrounding soils, and also commonly show signs of erosive truncation.

Most soils in the project area can be grouped into one of four soil orders, which are the highest level of classification in the USDA soil taxonomy. Mollisols are the dominant order on the base, and occur on most of the upland surfaces. These soils have a rich, dark surface horizon (or epipedon) that contains a high percentage of exchangeable cations, making them relatively fertile. However, this fertility is offset in many cases by the thin, stony character of the soil mantle, which frequently makes them unsuitable for cultivation (McCaleb 1985). Many of the Mollisols on base are relatively young, and exhibit an A-R profile (that is, the surface horizon rests directly on slightly weathered or unweathered bedrock). With time, the soil mantle tends to thicken and develop a B horizon (or subsoil) that represents a zone where organics, clays, and carbonates leached out of the epipedon are deposited. Older Mollisols developed on the uplands in the region exhibit a relatively thin, but highly horizonated profile, and commonly have a strongly rubified argillic upper subsoil underlain by a calcareous lower subsoil that may be indurated with secondary carbonate.



Mariah Assoc./1994

Adapted from McCaleb (1985) and Huckabee etal. (1977)

Figure 2.4 Soil Associations on Fort Hood (after McCaleb and Huckabee et al. 1977).

However, many of the Mollisols on the uplands appear susceptible to slow, inexorable wasting by surface wash and creep processes that tend to prevent this strong profile from developing. Occasionally, the original soil appears to have been partially truncated, then buried by fresh colluvial or slopewash sediment, resulting in a welded profile that exhibits relatively weak development in the upper solum and strong development at the base.

Alfisols consist of moderately to strongly horizonated soils that differ from Mollisols in that they lack the dark, base-rich mollic epipedon. Alfisols occurring on Fort Hood are typically relict soils associated with low-carbonate parent materials such as older terrace alluvium of the Leon River and the outcrop of the Paluxy sand, and usually have a strongly oxidized subsoil that varies from deep red to reddish yellow. It is likely that most of these soils represent a holdover from quite different pedogenic conditions that prevailed during the late Pleistocene. Like the Mollisols, many of the soils classified as Alfisols appear to be erosionally truncated.

Vertisols are characterized by a thick, poorly horizonated solum containing a considerable quantity of expandable clay. They are prone to cracking and swelling, and typically contain large peds with polished faces termed slickensides. Horizonation is poor due to pronounced vertical mixing as material infiltrates through the cracks. In the project area, most Vertisols are formed in drainages and depressions where clayey material from surrounding slopes and uplands collects.

Inceptisols are soils that exhibit poor horizonation, usually as a result of a relatively short period of pedogenesis. On Fort Hood, most Inceptisols are associated with relatively recent alluvial deposits and upland areas where the rate of erosion is outpacing pedogenesis.

Two major soil associations are mapped in Bell County. The Speck-Tarrant-Purves Association consists of soils formed on limestone uplands. Speck soils are relatively shallow, well-horizonated soils with a dark epipedon and a deep reddish argillic subsoil that rests on indurated limestone. They are typical of the high upland surfaces underlain by Edwards Limestone and commonly contain considerable quantities of residual Edwards chert. Tarrant and Purves soils are relatively thin, stony soils that rest on hard bedrock and show much less horizonation than the Speck soils (typically an A-R profile). They are typical of the margins and gentler slopes of the high upland surface and the intermediate upland surface, and may rest on the Edwards Limestone, Comanche Peak Limestone, or Walnut Clay. All three series are classified as Mollisols. Brackett and Real soils are important secondary soils within the association. Brackett soils are typical of limestone escarpments, particularly on the margin of the high upland surface, and Real soils are thin, stony Mollisols commonly developed on moderate to steep slopes.

The Denton-Purves Association consists of soils developed primarily on the intermediate upland surface around the city of Killeen. Denton soils are relatively thick Mollisols that exhibit an A-B-Bk-R profile. They are common in topographic saddles, where colluvial and slopewash thickening is likely, and on level to gently undulating intermediate upland surfaces. Purves soils (described previously) are usually topographically higher than soils of the Denton series. Secondary soils within the association include Brackett soils on narrow escarpments of hard limestone, Krum and Lewisville soils on the terraces of North Nolan Creek and its tributaries, and San Saba soils on the modern floodplain.

Soil association mapping of Coryell County is more detailed, and includes six distinct associations within the boundaries of the fort. The Eckrant-Real-rock outcrop Association is typical of top and flanks of the high upland surface. Eckrant soils are commonly developed on hard Edwards Limestone, while Real soils are more typical of steeper slopes underlain by Comanche Peak Limestones and marls. Both soils exhibit a stony

A-R profile less than 18 inches thick. Other soils occurring in the association include relatively thin loamy to clayey soils of the Doss, Evant, and Oglesby series, deeper loamy to clayey soils of the Bolar and Denton series, and Krum and Slidell soils formed in deep, clayey alluvium deposited in tributaries incised into the flanks of the uplands. The absence of well-developed, horizonated Mollisols on the uplands (like the Speck series in Bell County) probably reflects a greater degree of upland erosion due to decreased vegetation density in the western part of the facility.

The Slidell-Topsey-Brackett association and the Nuff-Cho Association are typical of the intermediate upland surface, and are usually underlain by Walnut Clay. Topsey and Brackett soils tend to occur on higher portions of the landscape adjacent to the high upland surface, while Nuff and Cho soils are typical of the lower parts of the intermediate surface near the incised stream valleys. Topsey soils consist of light grayish brown to yellowish brown fossiliferous loam and silt loam, and exhibit an A-Bw-BCk profile roughly 71 cm (28 inches) thick. Brackett soils exhibit a pale brown to pale yellow A-Bk-Ck profile composed of gravelly loam that is typically around 43 cm (17 inches) thick. Slidell soils are typical of broad, shallow drainages and depressions on the intermediate surface. They consist of up to 203 cm (80 inches) of dark gray to grayish brown silty clay, most of which is alluvium derived from the incremental erosion of adjacent Topsey and Brackett soils. Despite the relatively light color of the epipedon, Topsey soils are classified as Mollisols. Brackett soils are classified as Entisols, and Slidell soils are Vertisols. Minor series occurring in the Topsey-Brackett-Slidell series include thick, loamy to gravelly Cranfill soils formed on colluvial deposits at the base of the high upland surface; thin loamy Pidcoke soils developed primarily on fossil shell beds; and Real soils on steeper slopes.

Nuff soils typically form on the sloping surfaces and Cho soils form on ridgetops of the lower Walnut Clay. Nuff soils are Mollisols composed of stony silty clay loam that grades from dark gray to light olive brown with depth. They are up to 91 cm (36 inches) thick and exhibit an A-Bk-Ck profile heavily infused with secondary carbonate. Cho soils consist of less than 28 cm (11 inches) of very stony, dark grayish brown loam over indurated calcrete (A-K profile). Both Nuff and Cho soils are classified as Mollisols. Important secondary soils include the Doss, Topsey, and Real series on the Walnut Clay, and Cisco and Wise soils on the narrow outcrop of the Paluxy sand. These latter soils, while markedly different, are included in the association because of their limited extent. Both Cisco and Wise soils are formed in very fine-grained siliceous sand. Cisco soils are the better developed, and exhibit a strong relict A-Bt-Bk profile up to 178 cm (70 inches) thick. The argillic horizon is up to 102 cm (40 inches) thick and is typically deep red in color and highly structured. Wise soils typically represent areas where the strong relict profile has been erosionally truncated, and typically exhibit an A-Bw-Bk profile approximately 76 cm (30 inches) thick. Cisco soils are classified as Alfisols, and Wise soils are classified as Inceptisols.

The Doss-Real-Krum association is typical of the upland flanks of the modern stream valleys on the western side of the base, and is associated with the stairstep topography of the Glen Rose Limestone outcrop. Doss soils are typically composed of stony clay loam that grades from dark grayish brown to light yellowish brown with depth. They are typically around 46 cm (18 inches) thick, exhibit an A-Bk profile, and are typically associated with the more gently sloping benches. Real soils, described previously, are characteristic of the steeper slope segments. Krum soils consist of up to 200 cm (80 inches) of dark gray to brown silty clay alluvium, and typically exhibit an A-Bk horizon. They are present in small tributary valleys feeding into the major streams.

The Bosque-Frio-Lewisville association is associated with the floodplains and terraces of the major stream valleys. Bosque soils are associated with Holocene terraces, and consist of deep, loamy to clayey soils that typically exhibit a cumulic A-Ak-Bk profile up to 200 cm (80 inches) thick. Frio soils are also associated with the Holocene terraces, and are developed in similar material. They exhibit an A-Bk profile up to 200 cm (80 inches) thick. Secondary carbonate in both series typically occurs as films and filaments, and varies from very slight to strongly developed. Lewisville soils are associated with the Pleistocene terraces. They exhibit a deep A-Bk profile that is frequently sandier than adjacent Holocene deposits, moderately rubified at depth, and commonly contain concretions and soft masses of calcium carbonate in the B horizon. While thin section and carbon isotope analyses have revealed some of these nodules to be dissolving primary lithoclasts (Nordt and Hallmark 1993), pedogenic nodules are also present (Nordt 1993a). All three series are classified as Mollisols by the Soil Conservation Service (McCaleb 1985), but detailed analyses of specific pedons reveal that there is a variant of the Bosque series on the most recent (T0) alluvial surface that classifies as an Entisol, and a variant of the Lewisville series on the late Pleistocene surface that is in fact a weak Vertisol (Nordt and Hallmark 1993).

The Bastsil-Minwells association is associated with high Pleistocene terraces of the Leon River. Both soils consist of a thick loamy to sandy epipedon, and differ primarily in the presence of siliceous gravels in the Minwells subsoil and a strongly leached horizon (E horizon) between the A and Bt horizons of the Bastsil soils. Bastsil soils typically exhibit a thick A-E-Bt-B/E profile, and Minwell soils exhibit an A-Bt-Btk-BCk profile. Both soils are extremely thick and heavily oxidized, giving the subsoil a deep red color. Like the Lewisville soil on the lower Pleistocene terraces, Bastsil and Minwell soils are clearly developed in sediments of (at least) late Pleistocene age, and are therefore very unlikely to contain interstratified cultural material. However, many of the profiles are partially truncated and/or covered with a veneer of similar material derived from sheet erosion of deposits upslope that could well contain buried occupations. At the same time, the vertic nature of many of the surface horizons, particularly on the Lewisville series, may have resulted in soil cracks that allowed younger artifacts to infiltrate into the Pleistocene profile. Therefore, the context of buried archeological materials in these settings should be carefully evaluated to prevent erroneous interpretation.

In addition to the soil series detailed above, a buried alluvial soil termed the Royalty paleosol has been defined by Nordt (1992) from valley fills on Fort Hood. Unlike the soil series discussed above, this paleosol is defined not on its morphology but on its stratigraphic context, and is included in the discussion of alluvial stratigraphy that follows.

2.6 GEOMORPHOLOGY

The geomorphic context of Fort Hood is complex and imperfectly understood at present. While some aspects of the overall picture have been studied in relative detail, others have received very little systematic treatment. One of the primary goals of investigations conducted by Mariah since early 1992 has been the rapid evaluation of geomorphic context, and in particular, the presence or absence and contextual integrity of sediments of culturally-relevant age on archeological sites in a wide variety of physical settings. This process has afforded us the opportunity to examine the landscape fairly intensively, albeit in a field capacity only, in keeping with the reconnaissance level of the investigation. As a result, a number of data gaps and weaknesses have been identified, but little progress has been made toward resolving them. The following overview of the Quaternary geomorphology of Fort Hood highlights many of these data gaps; avenues available to address many of the various issues are outlined in subsequent chapters.

2.6.1 Generalized, Long-Term Landscape Evolution

The sequence of depositional and erosional events responsible for the overall configuration of the Fort Hood landscape can be traced back at least as far as the Miocene, when faulting along the Balcones trend exposed the rocks to dissection, and may extend back as far as the Eocene (Hayward et al. 1990). Fort Hood is situated on a partially dissected portion of the Grand Prairie termed the Lampasas Cut-Plain. The Lampasas Cut-Plain is a complex, two-tiered landscape developed on lower Cretaceous rocks between the Brazos and Colorado Rivers (Hayward et al. 1990). It consists of large, mesa-like remnants of a former planation landscape underlain by the Edwards Limestone and surrounded by a broad, rolling pediment surface underlain primarily by the Walnut Clay. These two surfaces typically differ by 25 to 40 m in elevation and form the "high" and "intermediate" uplands of Hayward et al. (1990) and the "Manning" and "Killeen" surfaces of Nordt (1992) (this report generally follows Nordt's terminology). Modern stream valleys are in turn incised up to approximately 40 to 70 m into the pediment surface, and contain a sequence of strath and fill terraces up to approximately 25 to 35 m above the modern streams (Figure 2.5).

The high upland surface is interpreted as a remnant of a former "mature" landscape that began to develop as early as the Eocene and was well-developed by the late Miocene, when fluvial and fan sediments of the Ogallala Formation encroaching from the west buried the western extent of the surface below what is now the High Plains (Hayward et al. 1990). At some point in the late Tertiary, the Manning surface was abandoned as the valleys breached the Edwards and Comanche Peak Limestones and entrenched into the Walnut Clay. Some time in the past, the entrenching streams achieved grade ceased to actively incise. Gradually, the valley walls began to retreat laterally, eventually forming the broad pediments of the intermediate Killeen surface. This process of lateral slope retreat went on for a very long time, apparently in an episodic manner under the influence of fluctuating climatic and groundwater conditions, throughout the late Tertiary and early Quaternary. The processes responsible for formation of the broad pediment surfaces is poorly understood, but appears related to backwearing evolution of the slopes themselves rather than lateral migration of the major streams (Hayward et al. 1990). Thick, pedogenic calcretes developed on many of the colluvial wedges at the base of the Manning slope suggest that lateral retreat of the high surface has occurred very slowly, if at all, during the late Quaternary.

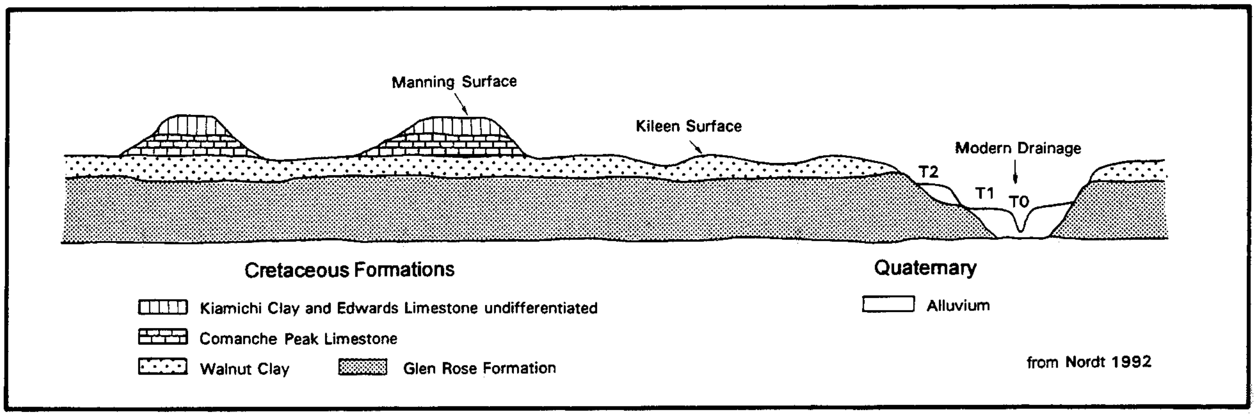


Figure 2.5 Generalized Cross-Section of the Lampasas Cut Plain (after Nordt 1992).

By the mid-Pleistocene, the major streams apparently shifted out of a long period of relative equilibrium and began to incise once again, abandoning the Killeen surface. This entrenchment has also occurred episodically, as demonstrated by the prominent series of alluvial and strath terraces flanking the valleys of the major streams. The last major phase of bedrock incision appears to have occurred around the terminal Pleistocene; although a number of Holocene cut-and-fill episodes are apparent in the more recent valley fills, most of this activity appears to have primarily involved incision of unconsolidated alluvium, as the basal channel elevation of these younger units is rarely more than a few meters above the modern channel.

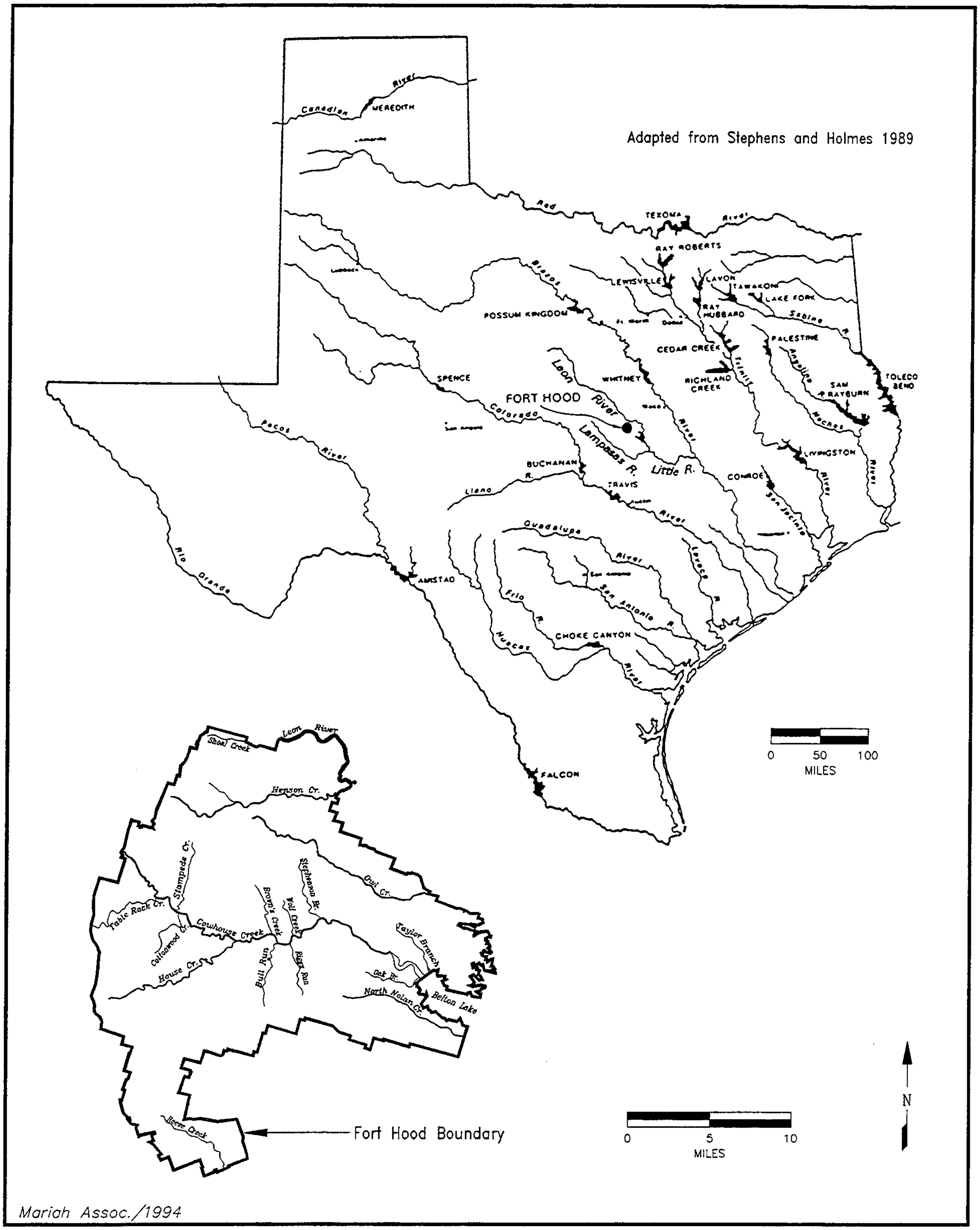
2.6.2 Hydrologic Network

Fort Hood is drained by a series of dominantly eastward-flowing streams, including the Leon River, Owl Creek, Henson Creek, North Nolan Creek, Reese Creek, Cowhouse Creek, House Creek, Clear Creek, and Table Rock Creek (Figure 2.6). These streams are in turn fed by a network of smaller tributaries that flow north to northeast and south to southeast, typically originating on the margins of the Manning surface and flowing across the Killeen surface to the principal valleys. Occasionally, small drainages are present atop the Manning surface, but these features are poorly entrenched into the hard limestone and are relatively subtle.

In contrast, the tributaries feeding across the Killeen surface are deeply entrenched into the softer Comanche Peak, Walnut Clay, and Glen Rose rocks, forming fairly respectable valleys.

The base is dominated by the watershed of Cowhouse Creek, which accounts for better than half of the total area within Fort Hood and subsumes the basins of Table Rock Creek, House Creek, Cottonwood Creek, Slaughter Creek, Clear Creek, Brown's Creek, Bull Branch, Taylor Branch, and many smaller tributaries. Cowhouse Creek joins the Leon River on the eastern side of the base at a confluence now inundated by the impoundment of Belton Lake. North of the Cowhouse watershed, the facility is drained by Shoal Creek, Henson Creek, and Owl Creek, all of which join the Leon River on the eastern margin of the base. The major watersheds south of Cowhouse Creek are North Nolan Creek, which flows into the Leon east of the facility, and Reese Creek, which flows southeast into the Lampasas River. All of the streams eventually feed into the Little River and then into the Brazos River, where they then flow to the Gulf of Mexico.

The stream network is fed by a multitude of springs and seeps within the Fort Hood boundary, particularly on the margins of the Manning surface. The thick Edwards Limestone which caps the upper surface is broken with numerous fractures, macropores, and small sinks. Water filtering through this honeycomb encounters the top of the less permeable, thin limestones and marls of the Comanche Peak formation and flows laterally, emerging at the base of the massive limestone scarps that ring the high surface. Seeps and springs are also present, albeit less common, in the lower formations, particularly the Glen Rose outcrops on the flanks of the modern valleys on the western side of Fort Hood. While a few of these seeps and springs are perennial and may have discharges up to several hundred gallons per hour, the majority are currently ephemeral seeps that are most active for a few weeks following major precipitation events and either slow to a trickle or dry up entirely during dry periods. While all of the surface drainages on the high upland surface are ephemeral, most of the larger tributaries crossing the intermediate upland are either intermittent or perennial due to groundwater discharge.



Adapted from Stephens and Holmes 1989

Mariah Assoc./1994

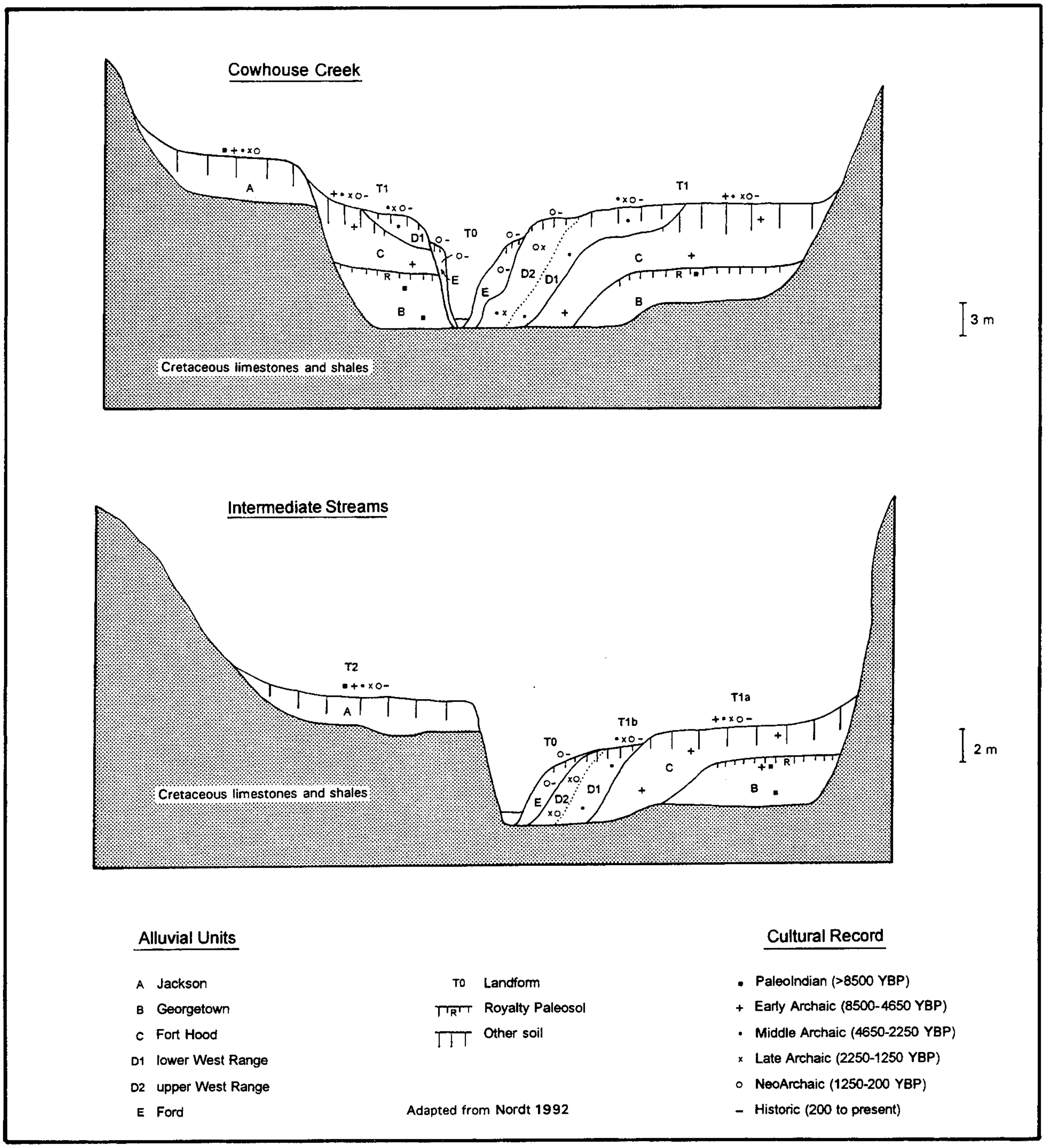
Figure 2.6 Hydrologic Network of Fort Hood.

2.6.3 Late Quaternary Alluvial Sequence

The stratigraphy and soil-geomorphology of a number of larger Fort Hood streams has been studied in detail by Nordt (1992, 1993b). This study has resulted in a generalized stratigraphic framework for streams on the base that was heavily utilized by Mariah geomorphologists during site evaluation reconnaissance. In general, although the identity of relatively poorly exposed fills underlying the T1 surface was sometimes difficult to confidently establish, the stratigraphic framework developed by Nordt has proven to be quite robust for the larger streams. Nordt identifies six principal allostratigraphic units in the study area, four of which are common to most of the streams examined on the facility. From oldest to youngest, these units are termed the Reserve Alluvium, Jackson Alluvium, Georgetown Alluvium, Fort Hood Alluvium, West Range Alluvium, and Ford Alluvium (Nordt 1992). Allostratigraphic units are discrete packages of sediments distinguished by clear bounding surfaces or paleosols (North American Commission on Stratigraphic Nomenclature 1983). They may be internally similar or dissimilar, which makes them extremely useful for defining meaningful sediment assemblages resulting from episodic aggradation of complex alluvial and colluvial deposits within confined valley settings during the late Quaternary. Figure 2.7 illustrates typical architectural relationships common to all the larger streams and the potential of each to incorporate cultural material of different ages. The following section first treats each of the six units in turn, then addresses the deposits in the smaller tributaries and the difficulties encountered attempting to correlate these small tributary fills to the sequence from the larger streams, and finally concludes with a discussion of the experience of Mariah geomorphologists in using Nordt's stratigraphic framework as an interpretive tool.

2.6.3.1 The Reserve Alluvium

The oldest allostratigraphic unit defined by Nordt is termed the Reserve Alluvium, and is identified only in the valley of the Leon River, where it forms the third (T3) terrace approximately 21 m above the modern stream. Nordt describes this material as a thin (approximately 2 m), loamy sheet of alluvium resting on an elevated bedrock strath. Intense soil development has affected the entire sedimentary unit, resulting in the formation of a rubified Alfisol containing dispersed siliceous pebbles that has typically developed through the entire sedimentary unit. No ages are available from the Reserve Alluvium, but a minimum age of 15,000 B.P. is implied from ages obtained from the stratigraphically-younger Jackson Alluvium 39 on Cowhouse Creek (Nordt 1992). The morphology of soils developed on the unit (essentially the Bastsil and Minwells series) suggests that the deposits are considerably older than this minimum age. In stark contrast to recent alluvium, which may have calcium carbonate equivalents up to 70 percent, soils on the Reserve terrace are almost completely decalcified through the upper solum, and may be completely decalcified and slightly acidic through the entire profile (Nordt 1992; McCaleb 1985). Unlike the other streams on the facility, the sediment load carried by the Leon River is not derived exclusively from calcareous terrain, as extensive areas of lower Cretaceous and Pennsylvanian-age clastics crop out in the upper basin (Barnes 1970; 1976). However, Cretaceous carbonates are dominant for better than 70 km upstream of Gatesville, and the modern alluvium contains a considerable calcareous component. Because the source area for the older Leon River Alluvium is essentially the same as the modern deposits, the Reserve Alluvium soils appear to have been subareally exposed for a considerable period of time, and may have lost up to half of their volume through the dissolution and leaching of the calcareous component.



Adapted from Nordt 1992

Figure 2.7 Schematic Geomorphologic Cross-Section of Cowhouse Creek and Intermediate Streams on Fort Hood, Illustrating Generalized Alluvial Architecture and Potential Archeological Components.

Although Nordt (1992; 1993) does not identify any fluvial deposits above the Jackson Alluvium (T2 terrace) on any of the streams except the Leon River within Fort Hood boundary, Mariah personnel have observed several localities on Cowhouse Creek where Quaternary fluvial deposits are preserved well above the T2 terrace. These deposits consist of thin caps of indurated, chert-dominated gravel calcrete on bedrock benches on the intermediate slopes, and are most extensive on a wide bench on the north side of the valley overlooking Belton Lake. In every exposure examined, all overlying material has long since been removed by erosion. Although these thin, indurated deposits are starkly different in character than the relatively thick, fine-grained sediments forming the T3 terrace on the Leon River, their landscape position suggests that they may be roughly equivalent in age to the Reserve deposits described previously.

2.6.3.2 The Jackson Alluvium

The Jackson Alluvium is the oldest allostratigraphic unit recognized in all the major stream valleys on Fort Hood (Nordt 1992). This alluvial unit forms the broad, discontinuous T2 terrace above the major streams, and has been mapped in detail by Nordt (1992). Compared to the Holocene fills, the Jackson Alluvium is fairly thin (typically 2 to 4 m thick) and relatively coarse grained. It includes interdigitated gravelly channel and loamy, sandy and clayey overbank facies, and indicates a style of fluvial sedimentation characterized by a meandering gravelly channel that probably contained multiple thalwegs and lacked a well-developed, built-up floodplain. Although his model runs counter to most concepts of relatively coarse-grained, braided aggradation (e.g., Miall 1977; Schumm 1977; Ashmore 1991), Nordt (1992) interprets the relatively thin deposits of the late Pleistocene fluvial system as characteristic of a relatively stable landscape that provided the streams with a somewhat meager supply of sediment. In contrast, a bedload-dominated late Pleistocene unit in the Pedernales River drainage (Blum 1987; Blum and Valastro 1989) that Nordt recognizes as possibly equivalent to the Jackson fill (1992) is interpreted by those authors as indicative of a superabundance of sediment supply generated by more effective sustained flow in the system.

Jackson Alluvium is readily recognized by its reddish-orange color, neutral epipedon, and abundance of soft to hard carbonate masses in the subsoil. On the basis of a few thin section examinations and ∂13C determinations, Nordt and Hallmark (1993) assert that these carbonate masses represent etched, pitted, and dissolving lithoclasts. Although primary clasts are clearly present, field criteria lead us to conclude that a high proportion of these masses are probably pedogenic nodules. In support of this argument, most of the masses are distributed through the lower B horizon, and diminish in frequency with depth, as would be expected with pedogenic nodules. Internal bedding of the masses is typically not observable and probable growth ring structures and internal voids can be observed in many broken nodules. Finally, relatively resistant siliceous pebbles of similar size and mass, which co-occur with limestone clasts in all of the demonstrable bedload deposits due to the high incidence of chert on the facility, are generally absent in the nodular horizons. This evidence suggests a pedogenic origin, and may explain the apparent lack of pedogenic carbonate accumulation reported for the Jackson Alluvium (Nordt and Hallmark 1993) if the nodules were assumed a priori to be relict lithoclasts and calculations performed on the fine fraction only.

Two radiocarbon ages are reported from the Jackson Alluvium. The first age is 15,270 ± 260, obtained from bulk humates in fine-grained channel fill sediments 2.8 m below ground surface in the Cowhouse Creek valley (Nordt 1992). The only other radiometric determination reported from the fill is an age of 3870 ± 70 reported from a depth of approximately 1 to 1.2 m in the Jackson surface soil (Nordt 1993a), which clearly reflects mean soil organic matter residence time and bears no relation to the age of deposition. Therefore, on the basis of a single radiocarbon determination on bulk humates, Nordt assigns the Jackson Alluvium a tentative age of 15,000 B.P. However, he recognizes that the Jackson, as defined, probably subsumes several distinct fills (Nordt 1992:60), a conclusion supported by field observations made by Mariah personnel. Clearly, much more work is necessary before the geomorphic and paleoenvironmental significance of the Jackson Alluvium can be firmly established.

2.6.3.3 The Georgetown Alluvium

Although the Jackson Alluvium has the potential to contain pre-Clovis remains (should any exist), the Georgetown Alluvium is the oldest fill on Fort Hood that has the potential to contain cultural materials dating to the incontrovertible span of human occupation in North America. Because the Georgetown Alluvium is always buried by subsequent units, it is the least commonly encountered fill on Fort Hood. It can be encountered only in cutbanks underlying the T1 surface, where it is capped by a buried paleosol termed the Royalty paleosol by Nordt (1992). The Georgetown Alluvium consists of 2 to 5 m of fine, well-sorted channel gravels overlain by light yellowish to grayish overbank Alluvium. The overbank deposits typically grade up from loams and silty loams into clay loams, and exhibit strong pedogenic structure in the Royalty paleosol. The Georgetown fill is inset against bedrock, indicating entrenchment following abandonment of the Jackson surface. Nordt (1992) states that, given current information, it is not possible to determine whether this incision actually breached the bedrock valley floors or simply incised into pre-existing valleys beneath the Jackson surface. The sedimentologic characteristics, pale yellowish to grayish reducing colors of the fill, and frequent occurrence of strong mottling in the substrate, suggests that the Georgetown probably accumulated relatively rapidly under conditions of perennial stream flow and a relatively high water table.

Approximately seven radiocarbon ages on charcoal and bulk humates have been obtained from the Georgetown Alluvium (Nordt 1992). All samples were taken from the Royalty paleosol and range from approximately 11,300 to 8200 B.P. Nordt (1992) concludes, with some validity, that the generally younger ages on charcoal are probably a more accurate indication of the timing of termination of the fill. The lack of ages from the basal Georgetown and paucity of ages from the Jackson make estimation of the timing of initial incision and filling impossible at present.

2.6.3.4 The Fort Hood Alluvium

The Fort Hood Alluvium consists of thick, dominantly loamy to clayey deposits that underlie the T1 terrace in all of the principal valleys on Fort Hood. It forms the most extensive suite of deposits underlying the terrace in most larger valleys. In some cases, the Fort Hood fill is truncated and overlain by a drape of the subsequent West Range fill, but in most instances, it is exposed at the T1 surface. Fort Hood Alluvium is dominated by thick (up to 10 m), loamy to clayey overbank facies overlying a relatively thin (1 to 2 m) channel component. Sediment colors are predominantly brown to slightly reddish-brown, particularly in comparison with the subsequent West Range fill. The lack of clear intercalated stability surfaces suggests that the unit accumulated fairly continuously, while the paucity of primary sedimentary structures suggests that this accumulation was accompanied by consistent turbation of the upper fill by plants and animals. Soil development in the unit is relatively thick but somewhat poorly expressed; A-Bk-C and A-Bw-Bk-C profiles are most common. Typical soil series mapped on the unit include Lewisville and Bosque soils. Twelve radiometric ages on charcoal and bulk humates obtained from the fill suggest that it began to accumulate shortly after cessation of the Georgetown alluviation at roughly 8000 B.P., and continued until changing climatic conditions caused another shift in fluvial style approximately 4500 B.P.

Nordt (1992) interprets the Fort Hood fill as indicative of a fine-grained, meandering depositional style in the larger streams and mixed load, braided deposition in the tributaries. The thick, homogenized silty loams and clay loams of the Fort Hood unit suggest that the larger channels were well established and relatively stable, resulting in the dominance of fine-grained, vertical accretion deposition. In the tributaries, a much higher percentage of coarse sediment was being delivered and incorporated (probably largely as slightly reworked colluvium), but fine-grained sediment still forms the bulk of the fill. Nordt interprets the depositional style to be the result of a strong increase in the rate of fine-grained sediment supply due to pronounced stripping of the upland soils, coupled with a decrease in the persistence of flow resulting from diminishing precipitation as the climate warmed and dried.

The Fort Hood fill has demonstrated archeological potential, although the number of observed cultural manifestations pales in comparison to the subsequent West Range unit. The age range of the sediments suggest that early Archaic remains should be dominant in the bulk of the fill, although incorporation of later materials through subsequent low-magnitude deposition on the terrace surface is clearly possible. Most observed materials are concentrated in the upper few meters of the fill, which may reflect a growing population or simply the increased desirability of the surface as it stabilized.

2.6.3.5 The West Range Alluvium

The West Range Alluvium consists of dominantly loamy to clayey deposits containing a higher proportion of coarse-grained sediment than the preceding Fort Hood fill. The sediments are predominantly grayish brown, gray, and black gravelly clay loams, and typically exhibit a thick, cumulic A-Bk-C profile. The degree of carbonate filament development varies considerably, and overlaps the ranges of carbonate development in both the preceding Fort Hood and subsequent Ford fills. Gravels occur dispersed throughout the unit and as thin, localized gravelly lenses and small, lenticular chute channels. With the exception of these gravelly lenses, little evidence of primary stratification is typically preserved.

The unit is typically inset into the Fort Hood fill, and may be inset into bedrock or the Jackson Alluvium. It usually lies at essentially the same elevation as the Fort Hood fill in the Cowhouse Creek drainage, but does truncate and overlap the older unit in a few locations. In the intermediate streams, the West Range terrace often lies slightly (typically less than 1.5 m) below the elevation of the Fort Hood surface, which led Nordt (1992) to subdivide the T1 terrace into a T1A surface associated with the Fort Hood fill and a T1B surface associated with the West Range fill.

On the basis of approximately 30 radiocarbon assays on charcoal and bulk humates, Nordt (1992) subdivides the West Range into a lower, more gravelly member deposited between 4300 B.P. and 2400 B.P., and an upper, relatively fine-grained member deposited between 2800 B.P. and 600 B.P. These two members are typically inset rather than stacked, and the latter is frequently overlain by a drape of the subsequent Ford Alluvium in the smaller streams. Typically, West Range sediments can achieve thicknesses in excess of 10 m, and buried cultural material has been observed at depths of up to 6 to 7 m in many locations. Multiple, stacked occupation surfaces are common in the upper 5 m unit.

The West Range fill represents an increase in the delivery of coarse sediment to the larger channels over the preceding Fort Hood fill. This increase probably resulted from more sustained flow in the system as conditions once again became slightly cooler and moister following the mid-Holocene "altithermal."

2.6.3.6 The Ford Alluvium

The Ford Alluvium is the most recent alluvial fill identified on Fort Hood, and underlies the T0 surface. Typically, it consists of stratified loamy, sandy, and clayey overbank deposits underlain by 1 to 2 m of channel gravels that form an inset wedge present primarily on the interior of meander bends. The fill may be up to approximately 9 m thick but typically has limited lateral extent in the valleys, except in a few localities where a thin drape of Ford overlies portions of the T1 terrace. Frequently, primary stratification is well preserved in the overbank deposits, reflecting a relatively rapid rate of accumulation and short period of pedogenic modification. Ford sections are composed primarily of clay loams and gravelly clay loams, but frequently display interstratified sandy and gravelly beds, indicating strongly fluctuating discharges and the development of chute channels on the floodplain surface during high stage flow. Although soil development in the Ford deposits is typically very weak (cumulic A/C profiles are common), films and filaments of calcium carbonate are almost always present and may be abundant through the profile. Twelve radiocarbon ages on charcoal from the fill (Nordt 1992) suggest that the unit has been accreting since approximately 700 to 800 B.P. Despite its elevation over the modern channels, the Ford surface is still actively accreting, albeit very sporadically, during unusually high magnitude storm events.

2.6.3.7 Tributary Alluvium

In addition to the fills detailed previously, alluvial deposits are present in the smaller tributaries on the flanks of the Manning surface and the Killeen surface. In the course of reconnaissance assessment, deposits of this type were encountered many times. Overall, these deposits proved to be difficult to correlate with Nordt's sequence from the larger streams. Several possible reasons can be cited for this difficulty, but the bottom line is that the small upland tributary deposits look substantially different than the sediments in the larger streams in terms of architecture and sediment character. There appears to be a much higher ratio of relatively recent sediments to early-to-middle Holocene and late Pleistocene sediments than in the larger streams, suggesting that the smaller upland tributaries may have been periodically flushed of much of their sediment. Alluvium in the smaller tributaries is usually confined within fairly narrow, deep valleys and contains a considerable colluvial component. The fill in the tributary valleys is almost always relatively thin (1 to 4 m) compared to the larger streams, and the more confined valleys and generally steeper gradients have probably resulted in a more effective scour during erosive intervals. However, buried soils and older units are clearly present. Deposits in the small tributaries typically show much more strongly fluctuating energy conditions, with gravelly channels and chutes preserved throughout the sequence. It is currently unclear whether the age of deposits in the upland valleys and in the larger streams are coeval, exhibit a temporal lag, or are completely unrelated, although the first two scenarios are considered much more likely. In short, more work is needed before the context of these archeologically-important deposits can be fully understood.

2.6.3.8 Observations on the Use of the Stratigraphic Model as an Interpretive Tool

Although the primary goal of reconnaissance phase investigations was to make a judgement concerning the relative contextual integrity of the matrix at each site, an attempt was made in each case to provide a broader geomorphic evaluation that also included the approximate age or ages of site sediments and the types of depositional processes responsible for site formation. The baseline study of Nordt (1992) was heavily relied on in this regard, and little fault was found with the basic stratigraphic/architectural model he proposed. However, interpretive problems were encountered on many occasions when broad exposures were unavailable. The most reliable indicator of the identity of alluvial fills on the streams proved to be architectural context; however, this required the fortuitous exposure of multiple fills in cutbanks and gullies that was frequently absent. In contrast, the least reliable indicators of relative age and fill affiliation were unquestionably the degree of carbonate and structural development in associated soils. Although quite useful in many semi-arid and arid areas (Gile et al. 1966), the development degree of carbonate films and filaments in Holocene-age fills in the project area appears primarily related to factors other than age. These factors include differences in sediment texture, parent material composition, biotic inclusions (particularly land snails, which frequently appear to provide localized secondary carbonate enrichment as they dissolve), and local groundwater conditions. Similarly, while soil structural development does show some tendency to increase with age, it appears to be more strongly related to overall clay content, clay mineralogy (and resulting shrink-swell potential), and degree of active bioturbation. In the absence of extensive cutbank exposures, the most reliable diagnostic characteristic for units underlying the T1 terrace proved to be the color of the sediments. In general, late Pleistocene deposits (the Jackson Alluvium) were readily recognized due to both their distinct reddish-yellow color and higher elevation, while the most recent alluvial fill (the Ford Alluvium) was readily recognized on the basis of strong internal primary stratification and inset, lower surface. The greatest problems were encountered attempting to sort out the fills underlying the T1 surface, particularly differentiating the West Range and Fort Hood fills. As a rule, the West Range fill was both more gravelly and more melanized (grayer) than the Fort Hood at any given location, and was readily differentiated when both fills were exposed. However, the color and textural range of Fort Hood and West Range deposits overlapped in the larger perspective, and identification of a single exposed fill as Fort Hood or West Range often proved very difficult. Typically, no attempt was made to differentiate between the two members of the West Range fill. The Georgetown fill, which also underlies the T1 terrace, was encountered only a few times, and was usually readily recognizable by its pale yellowish to grayish color and the presence of the Royalty paleosol.

2.6.4 Colluvium & Slope Evolution

In addition to alluvial deposits in the valleys of tributary and trunk streams, colluvial and slopewash deposits form an integral suite of archeologically significant sediments within Fort Hood. Colluvial deposits represent the accumulation of unconsolidated sediments moving downslope by mass movement (i.e, under the primary influence of gravity). In general, colluvial movement is classified according to three criteria: (1) speed of movement, (2) amount of internal lubrication, and (3) degree of internal cohesion. Rapid mass movements include block falls and glides, landslides, earthflows, mudflows, debris flows, and rotational slumps, while incremental mass movement occurs through the processes of soil creep and talus creep. Slopewash processes involve the downslope movement of sediment under the influence of thin, unconfined sheet flows and erosional rills. Generally, colluviation and sheetwash deposition occur in tandem, and the resulting deposits are difficult to separate. Processes responsible for driving the rate and character of slope evolution include variability in the rate of groundwater discharge and spring sapping, particularly on the slopes of the high upland surface; variability in the amount and character of vegetative groundcover; changes in the amount, intensity, and seasonality of precipitation; and changes in the thickness of the weathered mantle providing the source of colluvium and slopewash.

Our experience in evaluating the geomorphic context of sites on the fort has led to several basic observations. First, colluvial and slopewash deposits are nearly ubiquitous on the fort. They occur both as relatively thick wedges at the base of steeper slopes and as thin mantles on most slopes and uplands, and they overlie and interdigitate with a number of alluvial fills at valley margins. The textural and architectural characteristics of colluvial/slopewash deposits on Fort Hood span the range from relatively thin, fine-grained mantles representing a predominance of slopewash deposition, to coarse, very poorly sorted wedges and aprons of gravity-delivered material at the bases of steeper slopes. They form the matrix of a large number of archeological sites, and clearly contain both primary and secondary cultural material. The texture, color, and degree of soil development of these deposits varies considerably, suggesting that several different temporal episodes of increased slope activity are represented, and that a careful program of study could sort out this sequence.

2.6.4.1 Rockshelters

Rockshelters and small overhangs are extremely common on Fort Hood, and form a very important component of the slope environment. This discussion provides an introduction to the issues associated with the rockshelters which is expanded on in subsequent chapters. Most shelters on the facility are associated with the margins of the high upland (Manning) surface, where they form due to the undercutting of softer and more thinly bedded Comanche Peak rocks beneath massive beds of Edwards Limestone. In addition, some shelters are also developed on the midslopes of the Manning surface beneath unusually thick Comanche Peak beds, and a few vertical shafts and sinkholes are developed on top of the high upland surface. Rockshelters associated with the Walnut Clay and Glen Rose Limestone are very uncommon and typically quite small. Cultural debris associated with rockshelters on the base is extremely common, making them one of the most numerous and readily identified types of archeological sites on Fort Hood. In addition to material within the shelter deposits, associated artifact scatters are common on the talus slopes fronting the shelters and the upland rims above them.

Archeological investigations of rockshelter deposits have a long history in Central Texas (see Chapter 9.0). However, despite this scrutiny, relatively little is known about the types and rates of physical processes that form rockshelters in Central Texas. Only a few of the numerous rockshelter investigations in Central Texas have approached the problem from a geomorphic perspective, and detailed consideration of the physical processes and temporal context of shelter formation are limited to a single study from the Kenyon Rockshelter in Travis County (Coffman et al. 1986). Although this study is clearly a step in the right direction, the interpretive framework used is lifted wholesale from a paradigm developed in the French Perigord (Laville 1976; Laville et al. 1980) and applied with little critical assessment of the global ubiquity of basic tenets. For example, Coffman et al. state categorically that "rockshelters form in a less-resistant zone of limestone through cryoclastic (freeze-thaw) processes" (1986:74). Clearly, this is not the only mechanism for shelter formation or overhangs and shelters in the subtropics and tropics would not exist. It may be argued that the processes of rockshelter formation in Central Texas are not necessarily identical to those in south-central France, and may well be driven primarily by variability in moisture conditions rather than in temperature. Another, related issue is the lack of information regarding rates of evolution; it may be that the preponderance of late Archaic and late Prehistoric remains in Central Texas shelters reflects not on changes in cultural preference or habitability, but rather on the age of sediments preserved in the shelters.

Several different criteria exist that could be used to subdivide the shelters on Fort Hood into like units for analytical purposes. Size is one obvious criterion that has obvious implications for the utility of the feature as a sheltered campsite. The dimensions of rockshelters on the fort vary considerably, ranging from 1 to 2 m long features with roof heights of less than 50 cm, to examples better than 50 m long with roof clearances of 4 m or more. However, calved blocks representing partial roof collapse are quite common, suggesting that many of the shelters may have once been larger, and occasionally much larger, than they are at present. This temporal variability would require a tremendous amount of detailed geomorphic analysis and associated chronometric dating before the size of shelters at various points in the past could be reconstructed. Another obvious and commonly used descriptor is the differentiation between "wet" and "dry" shelters. However, this descriptor only applies to contemporary conditions, and may be misleading when extrapolated back to conditions during occupation. The best single criteria for classification of shelters is probably consideration of the character of internal and talus sediments. At least five distinct classes of shelter fill, occurring separately or in combination, may be recognized in Fort Hood shelters. Probably the most common class of fill consists of white to tan silt with incorporated angular fragments of limestone. This material appears to represent sediments derived from decomposition and collapse of the shelter roof, and typically shows very little postdepositional chemical alteration or soil development. A more complex type of fill is one composed of material with similar textural attributes, but that shows significant color stratification (typically lenses of brown, reddish, yellowish, or gray sediment). This fill type probably represents a variety of chemical alterations of the roof spall in a relatively dry shelter, including redox processes and carbonate mobility, coupled with natural and cultural organic additions. Wet shelters typically contain a black or deep red, stony clay sediment. The black sediment sometimes appears to represent upland soil washed into the shelter, while at other times, it is clearly formed through organic additions and chemical alteration of the roof spall. The reddish sediment usually appears to represent external sediment derived from erosion of the deep reddish Bt horizons typical of Manning surface soils in the East Range. While this sediment sometimes appears to be introduced primarily through surface wash over the upland scarp, more often it can be traced to flow emanating from macropores in the limestone at the rear of the shelter. Finally, a common type of fill consists of tufa and travertine chemically precipitated from groundwater discharged into the shelter, which has tremendous potential as a source of geoarcheological and paleoenvironmental data.

2.6.4.2 Issues Associated with the Paluxy Sand Substrate

One of the most interesting series of questions arising from Mariah's reconnaissance investigations on Fort Hood concerns the outcrop of the Paluxy sand. This discussion provides a brief introduction to these questions; a more thorough treatment is included in Chapter 9.0 of this volume. Although the Paluxy substrate is a relatively minor component in the overall landscape, the number of sites occurring on it is disproportionally large. These sites are also interesting in that they typically include large burned limestone features in an area where limestone is not available; it follows that the rock in these features had to be carried in from distances up to several hundred meters away. Also, unlike burned rock middens in other settings, the frequency of other types of associated cultural material (e.g., lithic debitage and tools, bone, mussel shell) is quite low. This suggests that the burned rock sites were intentionally and preferentially situated on Paluxy substrates as part of a specific adaptive strategy that was different from that of burned rock middens in other landscape contexts. At present, very little information is available to sort out exactly what that strategy was; however, three distinct possibilities stand out:

(1) The prehistoric inhabitants were exploiting biotic resources unique to, or concentrated on, the Paluxy substrate. What these resources may have been is unclear, but the neutral to acidic Paluxy does support a slightly different assemblage of vegetation than occurs on surrounding calcareous substrates. If this is the case, it follows that the resources would have been sufficiently concentrated to make it more efficient to carry the rock to the resources than the resources to the rock.

(2) The prehistoric inhabitants were locating on the substrate because its sandy texture and rapid drainage made it more desirable than surrounding soils with stony clay epipedons.

(3) The prehistoric inhabitants were locating on the substrate because its sandy texture made it easy to excavate pits to concentrate heat or because deep extant gullies could be exploited for the same purpose. There is evidence from several sites that pits or central depressions were commonly associated with burned rock

features (see Chapter 8.0), and excavation into the Paluxy is significantly easier than into the thin clays and limestone of adjacent geologic formations.

A second interesting aspect of the Paluxy sites concerns the implications of soils preserved on the substrate to questions of upland denudation timing. One of the most common interpretations of early to middle Holocene landscape evolution in Central Texas states that it was a period of pronounced erosion of a formerly well-developed upland soil mantle. According to this model, increasing temperatures and decreasing precipitation in the Pleistocene-Holocene transition resulted in a loss of vegetative cover on the uplands, leading to pronounced sheet erosion that stripped a fairly thick Pleistocene soil. Geomorphic evidence for this erosive interval includes the character of early-to-middle Holocene alluvial fills, which are typically somewhat rubified (presumably due to inheritance from a rubified soil) and indicative of an increased supply of fine-grained sediment x(Nordt 1992:64-65; Blum 1987:131-134). The faunal record indicates disappearance of burrowing fauna requiring a thick soil mantle, such as *Thomomys*, *Geomys*, and *Blarina* sp. (Toomey 1993; Graham 1987; Blum 1987), at roughly the same time.

If this model is accurate, an explanation is necessary for maintenance of a thick soil on the Paluxy substrate. As detailed previously, the sandstone is typically capped by soils of the Cisco and Wise series. Cisco soils are classified as udic Haplustalfs (McCaleb 1985), which indicates that they are moderately-horizonated Alfisols formed under conditions slightly moister than the present. Typically, Haplustalfs in Texas are developed on deposits or erosion surfaces of late Pleistocene age (Foth and Schafer 1980:168-169). Although undated, the deep red color (typically 2.5YR 5/6 to 5YR 5/6) and thick A-Bt-Bk-C profile of Cisco soils strongly suggests that they are late Pleistocene in age. At the same time, their sandy texture makes them particularly prone to sheet erosion and gullying. Therefore, an explanation is required how the soil mantle on the surrounding slopes could be eroded off, and in many instances transported across the Paluxy outcrop, without also removing the vulnerable Cisco soils.

2.7 RESOURCE DISTRIBUTION AND UTILIZATION

In an ecologic approach to archeological investigation, landscapes may be viewed as a spatial patchwork of physical and biotic resources, and the adaptive patterns devised by cultural groups to efficiently exploit the resource mosaic is one of the prime topics of investigation (Butzer 1982). Several categories of resources that would have been of considerable value to the prehistoric groups in the area can be identified on Fort Hood.

2.7.1 Chert Resources

One of the most obvious resources is the chert that literally paves portions of the modern landscape. However, as is discussed in Chapter 6.0 of this volume, very little systematic work has been done on the taxonomy and pattern of outcrop of Edwards chert, both on the fort and in the broader perspective. Chapter 6.0 represents an initial approximation of the character and natural distribution of the chert resource, and Chapter 9.0 includes a very preliminary attempt to relate the natural distribution of various classes of Edwards chert on the facility to patterns of use by the prehistoric inhabitants. Neither of these treatments is the last word on the subject, and the examination of utilized chert is particularly incomplete. However, both studies do begin to approach some important and hitherto neglected questions, including:

(1) What is the spatial distribution of various varieties of chert on the base? How do they differ, and how internally variable are they? How suitable are they for lithic manufacture? What are the effects of heat treatment on color, texture, and workability? These question require the development of a taxonomy of Fort Hood cherts before any questions of

distribution can be addressed. Chapter 6.0 of this volume represents a fairly thorough initial attempt to attack this problem. A related question that remains relatively neglected is:

(2) What was the prehistoric availability of the chert resource? Chert is available on the facility in four basic contexts. The most straightforward and spatially limited context is direct outcrop, where interbeds of chert are exposed in the side of limestone slopes and bluffs. Downslope of such outcrops, colluvial chert forms a portion of the slope mantle, and may occur at the surface and buried in wedges of slopewash and colluvium. The magnitude of colluvial activity during different periods probably affected the amount of chert readily available on the slopes, but it is unlikely that there was ever a point in the culturally-relevant past when chert could not be easily obtained from this context. Eventually, slope debris is transferred into the drainage network, where chert clasts present in the bedload of streams on the facility form the third principal source of lithic material. The availability of chert in this environment would have strongly varied with the character of fluvial activity and the amount of incision of area streams. Finally, the majority of readily available chert on the facility exist as lag clasts on top of the Manning surface. This material may either mantle the top of a denuded surface, or it may be contained in the thin, upland soils. The chert in this context represents a residual lag of more resistant siliceous material left over as the limestone matrix that encased it was reduced by chemical weathering and sheet erosion. Based upon the past few years of site reconnaissance, our subjective impression of this aspect of the resource is that availability has been significantly enhanced, and possibly fundamentally changed, by historic disturbance of the high surface and the resulting sheet erosion. In many instances where contemporary disturbance is light and the soil profile intact, no chert is visible on the surface, while adjacent disturbed and deflated surfaces are mantled with a dense chert lag formerly contained in the soil. This suggests that the historic presence has drastically increased ready availability of material that would previously have required excavation to obtain.

(3) A number of questions relating to cultural selection processes can be framed. Some of these questions are largely spatially independent; that is, they can be addressed without considering the location of sources and sites. Examples include: What types of chert were being used and neglected? Did it vary by time period? How was heat treatment employed on the different varieties and through different cultural periods? A second suite of spatially-dependent questions can also be identified, including: What patterns of utilization are apparent? Did reduction and utilization occur in the same place, or does a spatial hierarchy exist in the location of various stages of reduction? How does the distribution of utilized chert compare with the distribution of chert sources? Does the distribution of debitage and tools from specific sources indicate that the latter were commonly transported farther away from the source, indicating continuity of use, or were tools simply expedient constructs that were readily discarded because so much chert was available? Although an initial approach to these kinds of questions is outlined in Chapter 9.0, a tremendous amount of additional data from a large number of sites will be required to address them properly.

2.7.2 Biotic Resources

Biotic resources, including floral and faunal elements, are one of the most important and difficult class of resources to address archeologically due to their ephemeral nature. The spatial patchwork of biotic resources is a function of complex interrelationships between substrate, slope, aspect, moisture, and edaphic factors, tempered by the historical trajectory of environmental change. Ideally, interpretation of economic strategies would be based on a thorough knowledge of the spatial distribution of biotic resources through time. Unfortunately, such a reconstruction is impossible to attain. While an inventory of the species occurring in aggregate at any particular time is possible, and the location of individual species may be firmly established by fortuitous preservation of macrobotanical remains or phytoliths, identification of the overall spatial distribution of resources through time is beyond the limits of both technical expertise and fiscal prudence. Therefore, analysis must proceed at the level of relatively gross subenvironments through analogy with extant assemblages.

Several basic sets of resources with specific environmental contexts can be identified. Upland resources include a variety of plants, many with seasonal availability (e.g., prickly pear fruit, acorns), and many species of game animals. The distribution and density of plant resources can be expected to vary temporally and spatially in response to changes in moisture availability, slope, aspect, and edaphic conditions. Similar fluctuations probably also affected game availability, such as the variable availability of bison documented by Dillehay (1974). Riverine resources include a wide variety of seasonal and perennial plants and a suite of fauna that overlaps, but is typically distinct from, animals available in the uplands. In addition, the suite of riverine resources tends to change with the size of the stream and attendant shifts in sediment thickness, depositional energy, groundwater conditions, and floodplain stability. Finally, the availability of aquatic resources, including fish and shellfish, would vary both temporally and spatially in response to fluctuations in water velocity, water depth, sediment supply, and the width-to-depth ratio of the channel.

2.7.3 Water

Fresh water is available from several sources on the base. The availability of flowing groundwater almost certainly varied over the long term in response to fluctuations in climate, and probably varied spatially as the subterranean delivery network evolved. This spatial variability is currently reflected in the distribution of "wet" and "dry" rockshelters and fossil travertines, suggesting that the activity of individual springs and seeps may increase or decrease independent of broader shifts in groundwater availability as the subterranean network of pores and fractures evolved through dissolution of limestone and reprecipitation of phreatic carbonate in the subsurface at spring heads.

The persistence and character of open-channel flow in the stream network also clearly varied throughout the Holocene, probably in direct relation to the amount of groundwater discharge feeding the net. The availability and quality of this water also probably varied with fluctuations in sediment supply, precipitation timing and intensity, and channel form. A steady supply of surface water was probably enhanced by more uniform, low-intensity precipitation, moderate to low sediment supply, and a deep, meandering channel. Factors that probably would have decreased availability and/or water quality include a decrease in overall precipitation, an increase in the intensity of individual storms, and an increase in coarse sediment delivery to the channel.

2.8 MODERN IMPACTS

One of the major challenges of the landscape approach to archeological investigation is the necessity to see beyond the modern configuration of the landscape. In addition to geomorphic, biotic, and pedologic evolution of the terrain due to the activity of natural processes, human activity tends to modify the character of terrain and soils and the type, density, and distribution of plants and animals. Superficial comparison with the surrounding Central Texas landscape suggests that the military has been particularly effective in altering Fort Hood. It is impossible to drive across the facility without noticing the concentrated network of vehicle trails and broad devegetated areas resulting from the military presence. While this dense and obvious damage typically exceeds that on surrounding civilian property, military activity is clearly not wholly to blame, for prior to establishment of the facility, the activities of historic settlers had already led to extensive disturbance of many parts of the landscape, and civilian impacts continue due to grazing leases in the maneuver areas.

The range of natural and cultural impacts on the fort has been treated by several authors, most recently Lintz (1994), who summarized previous treatments and advanced a summary of the agents, intensities, and areal ubiquity of impacts affecting the facility prior to European settlement, during the civilian use of the area prior to the establishment of Fort Hood in 1942, and during the military presence. A slightly altered version of this summary is presented in Table 2.1. Modifications of Lintz's table include the addition of cutbank erosion and mass movements to the suite of natural impacts; the addition of drainage ditches, irrigation ditches, and reseeding to cultural impacts; deletion of the ambiguous "roof fall" category inherited from Moncure (1989), and revision of the estimated degree of impact in several of the categories.

In addition to its continual alteration of the overall landscape, disturbance affects the integrity of archeological sites to varying degrees depending on a number of factors, including the character of the matrix, depth of burial, intensity of modern traffic, slope, type of vegetation cover, and attractiveness of the site to looters. In general, the degree of recent disturbance of a particular site is inversely correlated with visibility, such that those sites most readily observed in the process of survey are those where internal integrity has suffered the most. Thus, it is likely that the sites with the highest degree of integrity are those in deeply buried contexts, particularly those stratified in the deposits of the larger streams, and that many of these sites remain unidentified due to total lack of exposure.

Although many types of impact can be identified (c.f. Table 2.1), most recent site degradation can be traced back to a few specific processes. The primary continuing agents of disturbance on the facility are (1) the compression and churning of the matrix produced by heavy vehicles, particularly when the sediments are wet; (2) bivouac disturbance, pedestrian disturbance, collecting of surface sites, and vandalism of shallowly buried sites, particularly rockshelters and burned rock middens; (3) grass fires and artillery impacts, which are concentrated in the Impact area at the center of the facility; and (4) continued exacerbation of erosion and bioturbation of wet sediments due to cattle grazing. The impact of military activity on individual archeological sites varies considerably, but is primarily a function of (1) the depth of burial of the site; (2) the character of the site matrix; and (3) the intensity of modern use of the locality. Deeply buried sites are relatively immune to most forms of disturbance, and are really only vulnerable to intentional excavation. The greatest danger is posed to sites that are shallowly buried and therefore vulnerable to intentional and unintentional forms of disturbance. Unlike vegetation and surface relief, which can recover in time following cessation of active disturbance processes, the contextual integrity of disturbed sites can never improve. Thus, one of the greatest dangers to interpretation of the archeological record lies in the "healing" of segments of the landscape that contain disturbed remnants of shallowly buried, palimpsest occupations.

Table 2.1 Intensity and Extent of Impacts by Temporal Period. Shaded cells indicate areally extensive impacts; unshaded cells indicated localized impacts. Modified from Lintz 1994.

	Impacting Agent	Pre-Settlement (before 1860)	Early Historic (1860-1942)	Military (1942-present)
Natural	burning	▨ minimal to moderate	▨ minimal to moderate	▨ moderate
	gully erosion	minimal to moderate	minimal to moderate	▨ moderate to severe
	sheet erosion	▨ minimal to moderate	▨ minimal to moderate	▨ moderate to severe
	Cutbank erosion	minimal to moderate	minimal to moderate	minimal to moderate
	burrowing animals	▨ moderate	▨ moderate	▨ moderate
	mass movement (landslide, mudflow, rockfall, etc.)	minimal	minimal	minimal
Cultural	land clearing	not applicable	▨ moderate to severe	▨ severe
	vegetation cutting	not applicable	▨ moderate	▨ minimal to severe
	vegetation pushing	not applicable	▨ minimal	▨ moderate
	plowing	not applicable	▨ moderate	▨ minimal
	cultivation	not applicable	▨ moderate	not applicable
	reseeding	not applicable	▨ minimal	▨ minimal to moderate
	earth moving	not applicable	▨ moderate	▨ moderate to severe
	drainage/irrigation ditching	not applicable	moderate	minimal
	borrow pits	not applicable	moderate	▨ moderate
	grazing	▨ minimal	▨ moderate to severe	▨ moderate to severe
	historic habitation	not applicable	minimal to moderate	minimal
	structure salvage	not applicable	moderate to severe	minimal
	structure deterioration	not applicable	minimal	minimal to moderate
	pipelines/powerlines	not applicable	minimal	minimal to moderate
	roads/railroads	not applicable	minimal to moderate	▨ moderate to severe
	wheeled vehicles	not applicable	minimal	▨ severe
	tracked vehicles	not applicable	not applicable	▨ severe
	ordnance	not applicable	not applicable	▨ minimal to severe
	pedestrian coverage	minimal	moderate	▨ severe
	vandalism	not applicable	moderate to severe	▨ severe

3.0 RESEARCH DESIGN ISSUES

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The project covered by this report is large and complex by any standards. Because of this, it is necessary to discuss in some detail the various background conditions that affected the development of the methods we used to evaluate sites. These background conditions created the issues that had to be addressed by the methods adopted to evaluate prehistoric sites. As a result, this chapter is an extended introduction (Section 3.1) that describes the background conditions in terms of various contexts that form the conceptual framework for understanding what Mariah did and why we did it. Next comes a discussion (Section 3.2) of the research design issues that underlie development of the methods for small sites and a discussion (Section 3.3) of the research issues that underlie the methods developed for large lithic resource procurement sites. The next Section (3.4) of the report covers the impact of the adoption of a general research design that was accepted by Fort Hood during the course of the project. This is followed by a conclusion Section (3.5).

3.1 CONTEXTS FOR ARCHAEOLOGICAL RESEARCH AT FORT HOOD

"Context" is a concept central to all archeological practice. Although often used by archeologists to mean the ascriptive/descriptive provenience within which artifacts occur and the partitioning of materials by association to features or other artifacts into interpretable units (cf. Todd 1992), context actually has a much broader set of meanings which influence archeological practice. The following section is a detailed discussion of issues that do not usually find themselves in a Cultural Resource Management (CRM) report. The reason for including them here is that before the project began, there was: (1) a long history of activities that led to the identification of a large number of sites and to the establishment of particular general criteria for evaluating large sites; (2) a historical framework within which archeological theory and practice develop; and (3) an institutional framework within which CRM activities take place. This section, therefore, lays the foundations for discussing the evaluation of sites at Fort Hood by discussing several meanings of "context" that impinge directly on their potential scientific value and, hence, on problems that arise in managing them.

The section begins with a discussion of archeological and systemic contexts that (1) operationalizes a conceptual distinction that is important to the practice of archeology, (2) is reflected in the significance standards for prehistoric sites at Fort Hood, and (3) was applied by Mariah in the field. Next comes a discussion of research context, the theoretical and other elements that structure the content of knowledge of prehistory, and the problems that need to be addressed. Research context is also reflected in the significance standards for Fort Hood.

The discussion then shifts to the notion of CRM context the regulatory and administrative environment for archeology. As a result of the nature of CRM context at Fort Hood, it was not possible for Mariah to use the full range of significance criteria when evaluating sites; this had a major impact on the structure of the research designs we actually implemented. The section then turns to the notion of socioeconomic context --the real-world environment within which CRM activities take place. The socioeconomic context for archeology at Fort Hood was a major factor in determining the selection of sites to be evaluated. Furthermore, determining what to do with large lithic resource procurement sites depends a great deal on the evolving socioeconomic context for archeology at Fort Hood because socioeconomic context will largely determine the level to which military land-use needs can be reconciled with funding availability. The notions of CRM and socioeconomic context are especially germane to the real-world circumstances addressed by Mariah in its evaluation of large sites.

3.1.1 Archeological and Systemic Contexts

The first and most obvious meanings of context refer to notions that already are generally accepted in archeological practice: the distinction between archeological and systemic context (Schiffer 1972). This dichotomy defines the essential difference between the nature of the evidence that archeologists are concerned with (artifacts) and the problems archeologists address with that evidence (human behavior). In this dichotomy, archeological context refers to individual artifacts that have entered the archeological record, and systemic context refers to behavioral systems in which artifacts were used prior to abandonment, loss, disposal, or other events that left them where archeologists find them (Schiffer 1972:157).

One of the conceptual advantages conferred by the archeological/systemic dichotomy is that it calls attention to the fact that the final resting place of an artifact may have little to do with the place where that artifact was used. Thus, the dichotomy leads directly to consideration of the difference between primary and secondary refuse, with the former comprising materials found where they were used (or, in the case of waste materials, where they were produced) and the latter comprising materials deposited as trash in a location relatively remote from the location of use (Schiffer 1972:161-162). This second dichotomy implies that the distinction between primary and secondary refuse is a conclusion about systemic context (behavior) that must be inferred from spatial patterns observed from archeological context (materials). As Schiffer presents it, therefore, the archeological/systemic-context dichotomy is incompletely specified because it contains no explicit role for the spatial relationships between artifacts that would allow for inferences from archeological context to systemic context.

Two developments help flesh out the notion of archeological context so that it can play a more meaningful role as a conceptual guide for visualizing the distinction between artifacts and behavior. One development is the geoarcheological revolution in which archeological artifacts can be regarded as a kind of sediment that has a human origin (Butzer 1982:77-78). The deposition of artifacts is therefore not much different in kind from the deposition of naturally occurring sediments, although regarding artifacts as a kind of sediment clearly entails recognition of the active role of human beings as geomorphic agents (Butzer 1982:39). Once one regards artifacts as a kind of sediment, archeological context (in Schiffer's sense) is expanded to include both traditional classes of artifacts and the other materials they have been deposited with, including materials that may not have human origins (Butzer 1982). As a result, if the notion of archeological context is expanded to include artifacts as well as the matrix within which they are contained, the combination provides a more robust basis for inferring the behavioral significance of artifacts than artifacts can provide by themselves.

Another related development is attention in detail to the notion of site formation and transformation processes (Schiffer 1987). Within this area of inquiry, several important (if also retrospectively obvious) observations have emerged. Archeological sediments with human origins (artifacts) are deposited at rates governed by rates of human activities, whereas other sediments are deposited at rates governed largely by nonhuman processes (Binford 1982). Where rates of deposition of artifacts via human activities are much higher than rates of deposition of natural sediments via natural processes, residues of human activities over a long period can be compressed into palimpsest assemblages within which there are no stratigraphic grounds from which to infer systemic relationships between subsets of the assemblage (cf. Binford 1982). Conversely, where rates of deposition of natural sediments are much higher than rates of deposition of artifacts, very short-duration occupations can be isolated under conditions which also favor preservation of perishable materials that may provide valuable subsistence and/or environmental data (cf. Ferring 1986). Furthermore, the notion of site transformation processes calls attention to the possibility that once archeological sediments have been deposited, they are subject to modification and disturbance by subsequent human activities and/or natural processes (Schiffer 1987; Butzer 1982).

These developments point toward a revised notion of archeological context that includes not only artifacts, but also other kinds of materials. Much of the additional data concern the matrix within which more traditional artifact kinds occur, and from these additional data, it is possible to specify the extent to which stratigraphically co-occurring materials may or may not represent distinct depositional episodes. By adding the notion of variable-duration depositional episodes to the notion of archeological context, one thereby implies that the character of the matrix of archeological sediments and the spatial/stratigraphic relations between components of the matrix are important elements of archeological context. This further expands the notion of archeological context to include not only the various kinds of materials in the archeological record, but also to include evidence of those materials' potential integrity as a source of data from which to draw inferences about systemic context. However, by implication, at least some of the processes relevant to the reconstruction of systemic context are natural rather than behavioral, from which it follows that a thorough reconstruction of systemic context includes a reconstruction of the systemic relationships between human activities and processes occurring in the nonhuman environment both during and after the time at which artifacts enter the archeological record for the first time.

In what follows, we regard "archeological context" not only in Schiffer's (1972) original sense of "artifacts that have dropped out of use," but also in the sense of "artifacts in a depositional matrix." This usage allows us, for example, to refer to "disturbed archeological context" as archeological artifacts and matrix that have been mixed by postdepositional human or natural processes. It also allows us to operationalize "contextless assemblages" as sets of artifacts that (1) occur in surface archeological contexts which contain no systemically relevant depositional matrix and therefore are missing many of the elements needed for a thorough reconstruction of systemic context, or (2) occur in buried archeological contexts for which the time spans represented by the depositional matrix and the artifacts are largely noncontemporaneous (and, therefore, not mutually informative) because most of the artifacts accumulated over long time spans before most of the matrix accumulated.

We also regard "systemic context" not only in Schiffer's original sense of "human behavioral systems," but also in the sense of "human behavioral systems interacting with natural systems." This usage allows us to weight natural environmental processes and events on a par with cultural processes and events in a research perspective that treats cultural and natural phenomena as different sides of the same coin (Ellis 1994a). Distinguishing between archeological and systemic context is important (if also obvious) because it is important to bear consciously in mind that descriptions and explanations of events in systemic context are the goals of archeological inquiry at Fort Hood, and the nature of archeological context at any given place determines to a significant degree the problems that can be addressed in principle. As will be discussed later (Sections 3.2 and 3.3), the potential archeological value of many sites is profoundly affected by the fact that archeological context frequently is unsuited to providing data for reconstructing systemic context according to interpretive methods that require segregation of artifact assemblages into discrete stratigraphic units. As a result, the nature of archeological context was a major element to be assessed when evaluating sites.

3.1.2 Research Context

The foregoing discussion of archeological and systemic context is a highly distilled account of developments that emerged in archeological research over the past several decades, and this research stream has had a profound impact on the practice of archeology in general. The development of site-formation studies as an integral component of archeological practice is an example of the relationship between developments in research practice and developments in empirical results of research. Had this research stream not taken place, archeological practice and empirical results would have been much different. This implies that at any given time, there is a research context that influences archeological practice, although this notion of context is seldom discussed (see Hodder 1986 and Leone and Potter 1992 for two exceptions). Research context can be construed as consisting of several distinct, albeit interrelated, components that each shape archeological practice.

The most obvious and most discussed element of research context is the so-called "paradigm," the large-scale theoretical view that guides research (Kuhn 1970; Lakatos 1978a; Hodder 1986). Paradigms influence research by determining what general vision governs theory-building (Harris 1979), which in turn largely determines what counts as a relevant fact (cf. Binford and Sabloff 1982; Hodder 1986). At any given time, research context may be characterized by more than one paradigm as proponents of different research perspectives pursue different research interests. The fact that different theories in different paradigms may (and often do) require different sorts of facts entails that they frequently look to a given source of data for different reasons. For example, within a culture-history paradigm (cf. Willey and Sabloff 1980), evidence from the depositional matrix of archeological context is primarily valuable because it provides the researcher with evidence to determine whether or not artifacts in the matrix comprise a unitary assemblage. Other evidence from the matrix may be largely irrelevant, at least in the descriptive phase of culture-history research when the focus is on identifying cultural taxonomic units that ultimately are expected to become the objects of explanation (cf. Trigger 1980). On the other hand, within a human-ecology paradigm, chemical, lithological, and pedological characteristics of the matrix are indispensable because they contain environmental data without which research cannot advance (Butzer 1982). Indeed, within a human-ecology paradigm, the presence of human-made artifacts is not even required in some cases, whereas an artifactless deposit may be virtually useless for culture-history research. Hence, even the notion of what counts as archeological context is dependent at least in part on research context, and our definition above clearly reflects the ecological paradigm within which archeology at Fort Hood operates (cf. Ellis 1994a).

A second element of research context is the current state of the art with respect to the development of knowledge within paradigms accepted by practicing archeologists. It is evident that this element is widely appreciated because virtually no proposal, CRM report, journal article, thesis, or dissertation is regarded as adequate without a literature review that sets up the issues to be addressed. Indeed, the current state of knowledge largely defines the directions to be followed in research within any given paradigm because the current state of knowledge distinguishes issues that are well resolved from issues that need further work. It follows, therefore, that the current state of knowledge also defines the topic and problem areas for which more data is necessary, which in turn means that it defines the kinds of data that are needed to advance knowledge of prehistory. It also follows that if there is a paradigm shift (as is happening in Central Texas; see Ellis [1994a]) or a shift in focus within a paradigm, portions of existing knowledge can be rendered largely obsolete if the basis for, or content of, existing knowledge is not compatible with, or applicable to, new research directions. Hence, such shifts also can entail radical changes in the nature of the data needed for research if previously unrecognized or unvalued data become important as a result of basic changes in research perspectives.

A third element of research context is closely related to the first two elements. Since data is only relevant to research in a given paradigm if it can be identified and characterized, the current state of the art with respect to analytical capacity determines what lines of evidence can be pursued at any given time. Analytical capacity includes technical, logical, and conceptual components. Technical components consist of the "hardware" of analysis, including items such as radiocarbon counters, microscopes, computers, Munsell color charts, and reference collections. Logical components consist of the "software" of analysis, including statistical routines, inferential procedures, and classification procedures. The conceptual components consist of the theoretical, heuristic, and definitional constructs one uses to flesh out the content of empirical knowledge about the past. These components range in scope from concepts of culture (e.g., Taylor 1948) and heuristic devices such as optimal foraging theory (e.g., Winterhalter and Smith 1981) to middle-range theories about caching or scavenging behavior (Binford 1979) to the definitions of specific attributes for classifying artifacts (Dunnell 1971). The conceptual components of analytical capacity can be applied to the contents of paradigms and theoretical constructs used to advance research.

The elements of research context are linked in complex systemic ways. The paradigms extant in a research context provide the general frameworks within which research proceeds. The conceptual component of analytical capacity provides the means through which paradigmatic assumptions are clarified and refined, and through which specific theoretical constructs are devised and applied to produce knowledge of the past (see Lakatos [1978a, 1978b] for an example in the natural sciences and Hodder [1991] for an archeological example). The contents of paradigms and the theoretical constructs used to advance research determine what counts as an investigatable problem in the extant paradigms, which in turn determines what would count as legitimate data if it could be obtained. Hence, the state of development of the conceptual component of analytical capacity can impose a major constraint on research because research can yield robust results only to the extent that the conceptual bases for research permit identification of well-defined problems and well-defined means for pursuing them. This means that the current state of development of the technical and logical components of analytical capacity can impose a major constraint on the degree to which research interests in a given paradigm can be pursued because these two components determine whether or not it is possible to marshall any given kind of data for a given problem. It is especially true for new paradigms or for paradigms that have developed new conceptual components. This is because the identification of new data needs can create a need for new technical and logical devices, and archeologists frequently must rely on research in other disciplines (e.g., statistics, applied physics) to provide them. This in turn implies that the technical and logical components of a research context in archeology are contingent on the state of knowledge and analytical capacity of other disciplines.

Given all of these linkages, the development of knowledge of prehistory in a given paradigm either does or does not meet researchers' expectations. If expectations are not fulfilled, researchers may become absorbed with problems of analytical capacity. In some cases, researchers may react by calling for paradigmatic change (e.g., see Black [1992] for a Central Texas example), whereas in others, they may focus on issues at a lower level of conceptual generality (see Collins [1991] for an example in burned rock midden research). In other cases, researchers may see the primary difficulty as a technical problem that can be at least partly resolved by using alternative technical means that already are known in archeology (e.g., Howard 1991; Collins 1991; Black et al. 1994) or by adapting new technical means (e.g., Ahler 1991; Hillsman 1992). In still other cases, researchers may call for refinement of inferential procedures (e.g., Hodder 1991) or classification schemes (e.g., Ellis 1992) as ways to advance research. Even in cases where expectations are being met, researchers can be expected to attend to problems of analytical capacity because even when things are going well within a given paradigm, there is always room for improvement. Therefore, even under circumstances where research is advancing nicely, the current state of knowledge of prehistory may lead archeologists to tinker with the other elements of research context.

Thus, research context is virtually always characterized by some level of dialectically structured change as developments in any one element influence the content of the others. In the case of Fort Hood, the state of development of research context is a major concern for two major reasons. First, paradigmatic change has occurred in Central Texas over the last few years as many archeologists have shifted their focus from basic culture-chronology (e.g., Prewitt 1981, 1985) to more fully fledged forms of culture history (e.g., Johnson 1990) or to problems of adaptive process among hunter-gatherers (e.g., Collins 1991). However, a close reading of the history of archeological research in Central Texas (Ellis 1994a; Black 1989; see Section 3.4) implies that the empirical and theoretical basis for extending the results of these research streams to the Fort Hood area is inadequate for any but the most broadly construed research issues. Second, Fort Hood is home to a class of large sites at chert outcrops for which it would be extremely useful to make advances in analytical capacity (see Section 3.3). As will be discussed next, the state of development of research context has very important impacts on archeological research at Fort Hood.

3.1.3 CRM Context

All archeology takes place within a regulatory and administrative environment of some sort. Because laws specify the conditions under which something must be done about archeological sites, they also establish the default conditions where governmental agencies do not have oversight. In specific cases where law does not provide for governmental oversight, the only effective limitations on archeological practice are the archeologist's conscience, creativity, and financial resources. However, a great deal of research is, "not in" public archeology that takes place under the aegis of federal- and/or state-level cultural resource managers who provide oversight with respect to whether or not public, semipublic, and/or private-sector agencies are complying with legal provisions that govern antiquities. Many public and semipublic agencies have full-time cultural resource managers whose job is to manage archeological properties in their jurisdictions to ensure that the agency is in compliance.

The extent to which federal-, state-, and agency-level resource managers are involved in archeological programs has an impact on the way archeology will be done, and the degree and nature of such involvement constitutes the CRM context for archeology. Where law provides for governmental oversight, archeological practice is structured by regulatory constraints. Where public, semipublic, and private agencies employ resource managers to comply with governmental oversight, archeological practice is further structured by the nature and state of development of the agency's program for managing archeological properties. What follows focuses on the federally mandated regulatory environment because it is most relevant to Fort Hood.

3.1.3.1 The Legal Basis of CRM Context

The legislative basis for conducting cultural resource studies on federally owned or managed properties, including Fort Hood, is derived from the National Historic Preservation Act (NHPA). This act established the NRHP and directed federal agencies to evaluate the impacts of projects on those cultural resources determined to be eligible for inclusion in the National Register. Sections 210 and 101 of the NHPA 1966 also established the Advisory Council on Historic Preservation (ACHP) and the SHPO. The ACHP is an independent agency charged with the responsibility to review and comment on proposed federally funded, approved, or permitted projects that may affect properties eligible for inclusion in the NRHP. Implementing regulations for this section are 36 CFR 800. Under 36 CFR 800, the SHPO is responsible for review of federal undertakings. The SHPO is responsible for preparing and implementing comprehensive state-wide historic surveys and plans for decision-making purposes and for reviewing the specific site recommendations to ensure that important cultural resources are appropriately managed. Subsequent legislation (P.L. 96-515 of 1980) and implementation programs, and the 1983 Standards and Guidelines (issued by the Secretary of Interior) have clarified procedures to be employed by the ACHP and SHPO concerning the NRHP. The interplay between federal regulatory constraints and agency-level CRM program development is an especially important aspect of CRM context. Additionally, in 1971, Executive Order 11593 directed federal agencies to inventory their properties for cultural resources, and in 1979, Executive Order 11519 directed agencies to develop programs and take necessary steps to protect and enhance environmental quality. These Executive Orders have now become part of the NHPA and other acts.

At the most basic level, federal regulatory constraints mandate that agencies inventory sites under their jurisdiction and protect the sites that are significant. Significance is determined in relation to "historic contexts" which delineate the problem areas that research should address. When an agency-level CRM program is established, its object is to obtain an inventory of cultural properties, determine which of those properties are significant with respect to issues identified in historic contexts, and to provide for protection or mitigation of significant properties. The requirement to define historic contexts implies that there must be a close linkage between archeology in a CRM program and the state of development of research context. This further implies that criteria for defining and evaluating sites are dependent on the paradigmatic visions and analytical capacity components of research context.

However, establishment of a CRM program is a starting point in the agency-level compliance process because such programs can be organized in various ways, and it takes time to do baseline inventories and to develop historic preservation plans (HPPs) and historic contexts. Furthermore, because these elements take time, it is possible (even likely) that change occurring in the research context will be sufficient to force revision of HPPs and historic contexts before they have been completed. Still further, in many cases, CRM programs are implemented under conditions where land-use activities that are to be affected by CRM compliance are already well under way, so that an infant CRM program starts off with a backlog of tasks to perform. Thus, it can be the case that an agency's land-use needs call for resolution of CRM compliance issues before the agency's CRM program is in a fiscal or organizational position to do so according to legal requirements established by CRM regulations.

Archeology at Fort Hood started off in this kind of awkward state. Fort Hood's mission and land-use patterns were largely established prior to passage of the NHPA and to the implementation of compliance directives issued under the authority of the NHPA. In the absence of a mandate to pay any heed to cultural resources, land-use patterns evolved without reference to and, hence, without regard for potential impacts to archeological sites. Because Fort Hood is located on a large, archeologically rich landscape, the locations of widespread, long-term military training and construction activities were bound to coincide with the locations of cultural resources. Thus, when compliance directives were issued Fort Hood was automatically out of compliance in the sense that many potentially significant sites already had been impacted, and it was possible that many more were located in places that conflicted with implementation of ongoing activities.

3.1.3.2 Historical Basis of CRM Context at Fort Hood

In the 1970s, Fort Hood responded to directives to comply with cultural-resource regulations by establishing a CRM program. The first goal of the program was to inventory cultural properties on the base, and a long-term survey process was begun. Initially, the program was implemented largely with volunteer labor, but a professionally staffed program evolved after 1977 (Lintz and Jackson 1994). By the late 1980s, about 95 percent of the base had been surveyed to identify site locations, but low funding levels combined with virtually no subsurface prospection helped to guarantee that a minimum amount of empirically useable data would be acquired and that very few sites would be evaluated for their NRHP eligibility. As a result, Fort Hood ended up with a large inventory of sites, virtually all of which had to be regarded, by default, as potentially eligible for NRHP nomination and protection. Indeed, the possibility of making sound eligibility judgments was severely hampered by the fact that (1) no research design or historic contexts had been developed to provide a basis for assessing significance under an HPP; (2) no HPP had been developed to govern resource management under a programmatic agreement (PA); and (3) no PA had been negotiated between Fort Hood, SHPO, and ACHP. Thus, although the CRM program had been enormously successful in terms of identifying a large number of sites on a skimpy budget, by the late 1980s, the program itself lacked the basic structural elements that would promote fulfillment of compliance and scientific objectives. To make matters worse, relations between Fort Hood and SHPO were polite, but strained (Lintz and Jackson 1994).

In the late 1980s, an effort was begun to remedy the situation. These efforts led to development of a PA that was signed in late 1990 and an HPP (Jackson 1990) that was implemented soon thereafter for fiscal years 1990 through 1994. The mechanism for determining NRHP eligibility was to be based on NRHP significance standards that were quoted in full in the HPP and thereby explicitly acknowledged as the guidelines for CRM activities on Fort Hood. These standards ultimately became part of Mariah's contract: "The directives relative to eligibility for the National Register outlined in 36CFR60 and amplified in the HPP are mandatory. Evaluations or nominations to the National Register based on other criteria are not acceptable" (Department of the Army 1991:§C.6.1).

According to the HPP, the NRHP criteria themselves "are general in nature and must be interpreted relative to the merits of each site individually and relative to the number and redundancy of such sites in the entire inventory" (Jackson 1990:41). Two standards, delineated in the HPP and included in our contract as technical exhibits, were set for all historic and prehistoric sites on Fort Hood. These standards refer to stratigraphic and cultural integrity:

1. PHYSICAL INTEGRITY - The archeological deposit must represent the in situ remains of human activity which have not been severely disturbed by natural soil disturbance such as erosion, or by subsequent human activity (Jackson 1990:41-42).

2. CULTURAL INTEGRITY - The particular deposit must represent a distinct cultural association or datable sequence. Highly mixed subsurface deposits and surface deposits of several or unknown cultural associations do not qualify (Jackson 1990:41-42).

With respect to prehistoric archeological sites, these standards refer implicitly, but directly, to archeological and systemic contexts as we have characterized them in Section 3.1.1. According to these standards, a primary dimension against which to judge significance is whether or not some aspect of systemic context is, or is likely to be, represented by artifactual materials embedded in a depositional matrix that has the potential to isolate the artifactual materials in behaviorally or culturally discrete units. Thus, to be significant under the first two standards, a site need merely be characterized by an archeological context that formed, and under conditions that promote the segregation of assemblages that can be analyzed as relatively coherent data bases that have not been compromised by postdepositional transformation processes that would introduce serious difficulties to inferences from archeological to systemic context. These two standards therefore can be regarded as "integrity-driven" standards within which observing a depositional matrix that contains artifacts that have a high likelihood of comprising discrete assemblages is presumptive evidence of cultural integrity.

The HPP delineates two additional standards, also included in our contract, that must be applied specifically when determining the significance of prehistoric sites:

1. CONTEXTUAL RELATIONSHIP - Every individual site or group of similar sites must be related in some systematic way to some well defined series of questions or known gaps in our data on the prehistory of the region. (Questions to be addressed must be from)...a very specific set of contexts in at least 5 research domains. These are (1) environmental change, (2) cultural chronology, (3) subsistence patterns, (4) site function/settlement patterns (5) [sic] cultural affiliations (Jackson 1990:43).

2. INFORMATION CONTENT - To qualify for the National Register..., the deposit must be shown to have yielded, or be likely to yield, information bearing on *one or more of the specific hypothetical questions that has been previously identified...(in a National Register Criteria and Testing Plan), or some subsequent revision of the general research context for the region, or alternative questions which the unique nature of the site makes it possible to frame.* Trivial matters or questions long since answered at other sites cannot be used (Jackson 1990:43, emphasis added).

The second two standards refer implicitly, but directly to, research context as we have characterized it in Section 3.1.2. According to these two standards, a site is significant if, and only if, its data content is of sufficient quantity and quality to be used productively to address a scientifically interesting, but as yet unresolved, problem. The third standard lists the general problem areas of interest with respect to prehistoric sites. The fourth standard refers explicitly to the need to assess significance with respect to established, revised, or newly defined historic contexts within which CRM activities can be expected to advance knowledge of prehistory rather than simply describe additional cases of phenomena that are well understood. The third and fourth standards therefore can be interpreted as "problem-driven" standards according to which a site is significant if, and only if, its data content can be used to address a significant problem.

The integrity- and problem-driven standards are generally mutually reinforcing. Together, they assure that a significant site is significant precisely because it contains information that (1) is relevant to advancing the content of research context, and (2) occurs under conditions in which archeological context provides an adequate foundation for inferences to systemic context. Note that the problem-driven standards can in principle override the integrity-driven standards in some circumstances. The major, explicit case includes circumstances under which a site that meets integrity-driven standards would do very little to advance knowledge of prehistory. In such circumstances, a site would not be significant because it would not address an interesting problem.

There may, however, be cases where either the unique nature of the site or the nature of a specified interesting problem does not require the integrity specified in the first two standards. An example of the former is large, contextless, lithic resource procurement areas (see Section 3.3). An example of the latter is burned rock middens, which frequently represent culturally mixed deposits (violating the second standard), but for which the issue of patterns of formation, use, and reuse is a major factor in understanding hunter-gatherer adaptations in Central Texas (cf. Collins 1991). The problem-driven standards are the central elements of significance evaluations, reflecting the importance federal regulations place on operating within historic contexts.

Thus, the problem-driven standards presuppose reference to a research design and to historic contexts from which current and ongoing information needs can be extracted in order to distinguish between trivial or resolved issues, and nontrivial or unresolved issues. However, at the time Mariah began field work (December 1991), no research design was in place to delineate the specific directions, data needs, or historic contexts for research on Fort Hood. The most recent research design developed for archeology at Fort Hood was in draft form (Carlson and Ensor 1991). This research design clearly was guided by an ambitious, scientifically interesting vision of how to pursue research at Fort Hood, but it did not define research issues at a level of detail that was implementable without substantial additional groundwork.

The draft research design ultimately was not adopted by Fort Hood, and as a result, the National Register eligibility criteria referred to in the fourth standard remained unspecified. Unfortunately, none of the alternatives identified in the fourth standard were available, either. The state has not established historic contexts for Central Texas, and a paper intended to serve as an interim substitute (Black 1989) defines historic contexts and data needs at levels of generality that almost any site would meet, regardless of its quality. Although Mariah was issued a delivery order to develop a new research design and significance standards for Fort Hood (Ellis et al. 1994; see Section 3.4 below), this volume was not completed in time to serve as a guide for the site evaluation program.

Consequently, when Mariah began work, it was not possible to use problem-driven standards as explicit criteria for evaluation. This did not prevent us from judging sites according to integrity-driven standards, and in practice, it also did not prevent us from making certain highly generalized assumptions about what probably would eventually emerge as some important classes of data. However, a major constraint emerged with respect to fulfilling the HPP's directive to evaluate sites on both their individual merits and their redundancy. In the absence of a research design and well-developed historic contexts, there is no legitimate basis for assessing redundancy because there is no way to identify the problems with respect to which the assemblage at any given site represents data overkill. This circumstance had a major impact on Mariah's activities because it largely determined the parameters within which we pursued our work (see Sections 3.2 and 3.3).

3.1.4 Socioeconomic Context

All archeology takes place in a socioeconomic context that includes, among other things, economic, political, and value components (cf. Leone and Potter 1992). It is widely appreciated that modern archeology is an expensive pursuit. Thus, whenever regulatory mandates apply to the development or potentially destructive use of land, the potentially high expense of doing archeology automatically becomes a budget item for any agency attempting to comply with cultural-resource regulations. The availability of funds is therefore a major influence on archeological compliance activities because the lack of adequate funding obviates the possibility of doing adequate CRM research. When public funds are used to perform CRM activities, several major variables come into play to determine the level of fiscal adequacy. The most obvious constraint is the overall size of the tax base from which funds can be drawn, which in turn is related to the economy's ability to support any given level of taxation.

This implies that regardless of the amount of revenues actually collected by a government, archeological programs compete with government and government-supported programs for a share of available revenues. Hence, the amount of public funding available for archeology is directly contingent on perceptions of the value of archeology relative to other potential uses for tax revenues. These perceptions in turn are contingent on perceptions of what archeology does. Paradoxically, although the general public (which includes politicians, scientists, and employees of agencies regulated by CRM laws) appears to have a widespread fascination with archeology, and generalized level of support for it, publicly supported funding levels are low and do not appear to reflect the public's interest in archeology (LeBlanc 1991).

A reason for this low level of support may be partly related to a widespread misunderstanding of the nature of modern archeological practice. Many people perceive archeology as a discipline whose major goal is to collect pretty or interesting artifacts, a perception that would have been largely correct 75 years ago. Indeed, many devoted avocational archeologists and (and, perhaps, some professional archeologists [cf. Black et al. 1992] for such a claim) appear to believe that artifact collection is archeology's primary objective. This situation may actually be fostered by archeologists themselves as a result of the nature of the archeological profession. Professional archeologists are much like scientists in agricultural research (Busch and Lacy 1983; Thompson et al. 1991): their research results are circulated narrowly in media that are unlikely to reach nonspecialists; their careers are advanced by research that enhances developments in research context; and their careers are not advanced very much by efforts to make research relevant to broader social concerns. Indeed, it often appears that archeology is conducted primarily for other archeologists (Black et al. 1992). To the extent that archeological research is made available to the general public, it usually is couched in terms of lists of interesting facts about prehistoric people or in terms of artifacts that have been found (especially pretty ones) rather than being couched in terms of knowledge that could be relevant to public policy (cf. Leone and Potter 1992).

To illustrate, in 1991, one of the authors (Ellis) was part of a research proposal to the National Science Foundation's Ethics and Values in Science program. The proposed research involved a team of philosophers, anthropologists, agricultural scientists, and archeologists who were to explore the nature of "sustainable agriculture" in order to provide an understanding of what it would mean for agricultural scientists to perform basic research upon which to base sustainable agricultural technologies. The reviewers unanimously liked the proposal, but they also unanimously wondered how archeologists could make a meaningful contribution. Since the reviewers, like many members of the avocational community, were unlikely to be familiar with technical archeological literature, it is easy to believe that they would be unfamiliar with archeology as a discipline capable of modelling long-term relationships between people, their technologies, and their environments. Their reaction to the proposal, therefore, was both understandable and predictable.

To the extent that avocational archeologists and members of the nonarcheological scientific communities fail to view archeology as more than the search for artifacts, it is genuinely unsurprising that members of the wider public place a low monetary value on archeological research. If it were true that archeology's goal is to collect artifacts, the general public would be correct in judging that archeology is not worth the price. Since the heads of agencies under the jurisdiction of CRM regulations are members of the general public and, therefore, likely to share its values and concerns, it would not be surprising for them to place a low monetary value on CRM activities. Indeed, even if agency heads appreciate the nature and potential contributions of modern archeology, they still have major incentives to fund archeology at minimal levels because such funding comes from a finite budget, and archeological research therefore necessarily comes at the expense of fulfilling their primary mandates. Since agency heads can expect to be evaluated on how well they fulfill their primary mandates, it is never surprising if they give CRM activities low priority for funding.

The presence of a large number of unevaluated sites on Fort Hood is a direct consequence of the low priority that was assigned to CRM activities in the 1970s and 1980s (Lintz and Jackson 1994). It probably is not a coincidence that increases in funding levels started at a point when the CRM program came under the administration of someone who had knowledge of, and experience with, both the practice of archeology and the socioeconomic realities of Army bureaucracy and the military profession. It probably also is not a coincidence that increases in funding levels began when regulatory pressures started to approach a point where noncompliance on CRM issues could lead to sanctions that might have had severe impacts on Fort Hood's ability to fulfill its primary mandate.

The Fort Hood HPP reflects the conflict between noncompliance and the Army's mission by prioritizing areas within which the assessment process would be completed. Maneuver areas, within which sites may be subject to widespread damage as a result of training activities involving large numbers of armored and other vehicles, were assigned the highest priority because sites there had the highest likelihood of adverse impacts. The live-fire zone, more or less in the center of the base, was assigned a lower priority because sites there are less subject to damage in general. Except in the case of specific construction projects that would impact sites, evaluation and other CRM activities would be deferred. Other areas on the base are designated as environmental set-asides and are off-limits to training and other activities or have very limited access, especially with respect to traffic and construction. CRM activities in such areas will generally be deferred unless vandalism or other circumstances impose a need for immediate treatment. As a result of this prioritization, virtually all of the sites evaluated by Mariah were in maneuver areas.

3.1.5 Summary

The foregoing, overly long discussion lays out the background against which Mariah performed its activities. There are intimate relationships between archeological context, research context, and the significance standards expressed in the HPP under which Mariah worked, and Mariah's methods for small and large sites were contingent on the use of these concepts. The absence of a well-developed research context (which will be discussed further in Sections 3.3 and 3.4) had a direct impact on the possibility of bringing the full range of significance standards to bear in the evaluation process. Thus, the state of development of CRM context at Fort Hood interacts with the state of development of research context to directly shape the results of the project. The discussion of socioeconomic context, although important to the project as a whole, is primarily important with respect to the evaluation of large sites. Its introduction here, however, underscores the fact that real-world concerns are the reason why the project took place *at all*, because putting off decisions about site eligibility is no longer a viable option for high-use areas of Fort Hood.

3.2 EVALUATION OF SMALL SITES

The scope of work (SOW) issued to Mariah by the Army (Department of the Army 1991) called for evaluation of *up to* 692 prehistoric sites out of 1,022 that had been previously identified and placed on the Fort Hood inventory. The prehistoric inventory was divided into five size categories as shown in Table 3.1. Of the 692 sites covered by the SOW, 170 were described as being in heavy-use maneuver areas, 333 in moderate-use maneuver areas, and 189 in light-use maneuver areas. The SOW distinguished between small sites and large sites, classified as lithic procurement areas, and defined small sites as sites less than 75,000 m^2. This section discusses the research design issues relevant to the development of procedures for evaluating small sites. The discussion is relatively brief because foregoing discussions have covered much of the relevant

Table 3.1 Size Categories of Prehistoric Sites at Fort Hood.

Category	Size (m^2)	% of Inventory
1	<25,000	67 %
2	25-50,00	12 %
3	50-75,000	5 %
4	75-100,00	4 %
5	>100,000	11 %

ground. However, it still is necessary to describe the issues to be addressed by the methods for small sites (Chapter 4.0). Research design issues related to methods for evaluating large sites are discussed in Section 3.3.

3.2.1 Archeological and CRM Contexts for Evaluating Small Sites

Stipulations in the SOW recognized the significance of archeological context as expressed in Section 3.1.1 by specifying that:

> Post-depositional taphonomy is of critical importance to eligibility status. Ample evidence exists from on-site inspection and geomorphological studies to indicate that many prehistoric sites in the Hood inventory are eroded, redeposited, or deflated. Except in special and rare circumstances (i.e., Paleoindian occupation sites), totally disturbed sites no longer in primary context have little to offer to the better understanding of Central Texas prehistory other than a record of their presence on the landscape and chronological affiliation if ascertainable. This information is already on record in the Hood inventory (Department of the Army 1991:C-8).

Thus, the SOW stipulated that integrity-driven significance standards would be the primary dimension for evaluating small sites while acknowledging that problem-driven concerns could lead to exceptions. A major goal of evaluation therefore was to provide:

> Determination of the presence/absence of in situ deposits..., both to reduce the inventory of protected sites to those potentially eligible, and to reduce the size of those sites arbitrarily enlarged by previous survey methodology to the actual area of in situ deposits (Department of the Army 1991:C-8).

The SOW outlined the general parameters within which this goal was to be achieved. It specified that a team consisting of a geomorphologist and an archeologist would provide an initial evaluation of each site to determine whether some or all of the stratigraphy at the site was conducive to the preservation of archeological materials in suitable depositional matrices. Although the SOW specifically names erosion, redeposition, and deflation as principal causes that would produce unsuitable archeological contexts, the integrity-driven significance standards also implicate palimpsest overprinting and site destruction via vandalism, training, or other human activities as specific sources of contextlessness that would negate eligibility. As a result, any given small site (or portion thereof) might be judged ineligible for any one of a wide range of reasons or for a combination of reasons. For example, one part of a site with surfaces that have been stable and undamaged since the Pleistocene would be deemed ineligible because of its palimpsest assemblage, whereas another part of the same site might be ineligible because all of its archeological materials occur in a plow zone. If the initial visit showed that all or part of a site had the geomorphic potential to contain archeological materials in secure stratigraphic context, the SOW stipulated that areas with such potential would be subjected to shovel testing to determine whether subsurface archeological deposits were present.

As noted in Section 3.1.3, no general research design or historic contexts were available (1) to sort out the exceptional or rare cases for which integrity-driven standards alone might not be adequate, or (2) to identify the specific kinds of data that must be present to meet problem-driven standards. Archeological common sense and the SOW itself provided some guidance on this issue with respect to data types, and the topic areas specified in the third significance criterion provided some guidance with respect to general problems that eligible sites must be capable of addressing. With regard to appropriate data, the SOW referred to analyses of "archeological, ecological, and geological materials," among other unnamed items (Department of the Army 1991:C-7). It also referred to a wide range of fairly specific botanical and faunal materials and laboratory processes (e.g., radiometric and isotopic) that might be used (Department of the Army 1991:C-7). Since all of these materials can be used to address the topics listed in the significance standard, it was safe to assume that archeological common sense would be a reasonable guide when making judgments about the presence of useful data in appropriate archeological contexts. However, these assumptions about what was likely to be relevant data were not construed to exhaust the list of what would ultimately turn out to be relevant data under a comprehensive research design. Furthermore, even these assumptions were not sufficient to allow for using the redundancy feature of the HPP as a significance criterion because there was no basis for determining the degree to which a given kind of data was unnecessary. Thus, the development of methods for evaluating small sites proceeded under the assumption that future clarification of important research issues could require us to reevaluate some of our previous eligibility judgments.

3.2.2 Impact of Socioeconomic Context

The main influence of socioeconomic context is the impact of site selection on the empirical results that could emerge from the evaluations. The sites Mariah was directed to evaluate were chosen because their geographic locations place them in high-use areas. This selection process had nothing to do with producing a random or otherwise scientifically appropriate data base. While this issue had no impact on Mariah's methods for evaluating sites, it did have an important bearing on what we could do with the data we recovered during the project. Most archeologists, ourselves included, cannot resist trying to do something with a data set once it is in hand, especially when that data comes from a very large number of sites distributed over a fairly large area. The main impact of socioeconomic context, therefore, was that it yielded a sample of sites that may not represent what is present at Fort Hood as a whole. As a result, empirical analyses performed on the data must be appropriately restrained.

3.3 EVALUATION OF LITHIC RESOURCE PROCUREMENT AREAS

This section discusses the very large sites that have come to be known as LRPAs on Fort Hood. The processes of site-definition and site-management over the years produced a class of extremely large sites (generally larger than 75,000 m^2) characterized by an absence of documented internal differentiation that could be made relevant to clearly defined archeological goals and, hence, to rational management. The existence of a large number of very large LRPAs, therefore, produced a situation that can best be designated as "the LRPA problem" because LRPAs produce a series of real-world problems that are awkward to resolve in any straightforward way. The procedures used to evaluate LRPAs are fully discussed in Chapter 5.0, but the LRPA problem has conceptual and historical roots which must be understood before the rationale for the evaluation procedures can be fully intelligible. Hence, preliminary considerations are presented here as background for discussing the particular strategies and tactics by which Mariah addressed the LRPA problem. Without this background, our approach to LRPAs will not be fully understood. Furthermore, a full discussion of what we faced at Fort Hood may be helpful for others who may need to address similar problems elsewhere.

This section begins with a discussion (section 3.3.1) of the CRM context within which the LRPA problem evolved. The discussion of CRM context includes a history of the evolution of the definition of the term "LRPA," a discussion of the contractual constraints that govern evaluation of LRPAs, and a discussion of the circumstances under which the evaluation of LRPAs began. Section 3.3.2 characterizes the ways in which the notions of archeological and systemic context affect LRPAs, which raises the crucial issue of whether or not they have anything at all to contribute to archeological research. Section 3.3.3 shows that the current analytical capacity of research context is sufficiently developed to allow LRPAs to contribute to advances in archeological knowledge in ways that are consistent with the research design in place at Fort Hood. It also shows that there are realistic possibilities for technical advances that would improve the data potential of LRPAs. However, the discussion of research context also shows that the current utility of LRPA data is limited by our poor understanding of other elements of prehistoric adaptations. These limitations are crucial because the socioeconomic context for archeology at Fort Hood (Section 3.3.4) is characterized by influences that could lead to interpreting the "limited utility" of LRPA data as "marginal utility" or "low utility." Thus, a major element of the LRPA problem is how to evaluate sites which have assemblages that are difficult to interpret but that also address a small but important archeological problem.

3.3.1 CRM Context of the LRPA Problem

The methods of identifying and recording sites at Fort Hood were not extremely successful at delineating boundaries, internal site structure, or behaviorally meaningful subdivisions of large sites defined on the basis of surface data. Most surveys conducted on Fort Hood were conducted on parcels subdivided on 1 km quadrants (Briuer and Thomas 1986). Each square kilometer was covered by pedestrian surveyors spaced at 30 m intervals. Each surveyor would note artifacts and features on topographic maps or aerial photographs. After the quadrants were covered, tentative locations of sites would be identified from the compilation of information.

The decision to define a site was based on what can be called the "two-tool rule." According to Ensor (1991:23), "Prehistoric sites are defined whenever two or more stone tools (e.g., dart or arrow points, preforms, scrapers, or cores) are found within 5 m of each other." Following decisions to define a site, teams of two would return to formally document the resource. Site recordation involved establishing a site datum, walking six to eight radii from the datum to establish site boundaries, monitoring artifact and vegetation densities along a single "bead line" subdivided into 1 by 5 m intervals through the long axis of the site, and completing site forms, site maps, and photographic documentation of the site. The only artifacts systematically collected were temporally diagnostic arrow or dart points.

Ensor describes the results of site definition as follows:

> Site definitions tend to include a fairly large area within which there were several spots containing a concentration of artifacts or debitage. This is particularly true of areas in which chert outcrops are present at the surface and thousands of square meters contain chert nodules and flakes. Since it is not always readily apparent which flakes are natural and which are the result of human activity, the entire chert field is often designated as a site. These 'sites' obviously represent a complex situation in which human use of the chert field has been repeated over a long period of time....Identifying the entire chert field as a site is an interim strategy to provide the entire area with some protection until a more detailed survey can be conducted. Such a strategy is only possible in situations where sites are not slated for imminent destruction by some construction activity, but will instead be the basis for a site protection

> program....While this approach to site boundaries makes sense from a cultural resources protection perspective, it makes the analysis of the data more complicated, since nearly all of the sites probably represent multiple occupations (Ensor 1991: 23).

Ensor's mention of the problem of distinguishing natural from cultural flakes raises an issue that is relevant to the definition of large LRPAs. Many chert-bearing areas on the base were subjected to long-term cultivation and 35 years of armored-vehicle maneuvers before federal laws required the inventory and management of cultural resources. These impacts have created a great deal of chert debris that frequently has the attributes of lithic artifacts such as flakes, cores, and expedient tools. For example, when sites 41CV114 and 41CV115 (both of which are LRPAs) were recorded, the field archeologists observed that the widespread presence of "tankifacts" made it difficult to identify site boundaries. Moreover, much of the base appears to have been subject to periodic fires that can create pseudoartifacts that resemble the effects of heat-treatment of chert during tool production. Since many of the large sites in chert-bearing areas occur on surfaces that have been heavily impacted, the site-definition process can be assumed to have been affected to an unknown extent by the presence of pseudoartifacts as well as natural flakes.

The recognition of problems associated with large sites in chert-bearing areas has created subtle, yet interesting, conceptual and semantic problems. In the passage cited above, Ensor (1991:23) discusses the fact that some extremely large sites were defined on Fort Hood. In his discussion, large sites in chert-bearing areas are examples of a kind of large site that was defined for CRM purposes, but for which the process of identifying behaviorally significant subdivisions is complicated by the presence of background noise in the form of chert objects with ambiguous origins. In the development of the Fort Hood CRM program, the example somehow evolved into a characterization of virtually all large sites (Department of the Army 1991:C-10). In effect, all large sites came to be designated as LRPAs that "reflect the lumping of many discrete remains of lithic resource procurement activities into huge upland sites or human activity localities, encompassing many isolated and discrete temporal and spatial events...[which] as a general rule have a surface area greater than 75,000 square meters" (Department of the Army 1991:C9-10). Thus, in actual management practice, the term "LRPA" refers specifically to large sites (more than 75,000 m^2) which, because of their very large size, require special attention and merit evaluative procedures different from those employed on smaller, more discretely defined sites. However, Ensor's comment identifies largeness as a problem that affects interpretation of site-level results, and not as a problem that affects management.

Extension of the term "LRPA" to any very large site conceptually undermines the interpretive utility of the term, in much the same way that the burned rock midden concept historically may have inhibited communication and formulation of research objectives which could effectively deal with midden resources (cf. Ellis 1994a). In some instances, LRPA refers to areally extensive distributions of artifacts in settings far from actual chert resource areas. At the other extreme, sites less than 75,000 m^2 occur within chert resource areas and contain evidence of lithic-procurement behavior. These sites are not classified as LRPAs because they fail to meet the size criterion. If size is the only criterion for classifying a site as an LRPA, then the behavioral and functional implications of lithic procurement sites become meaningless. Indeed, the large size of sites classified for management purposes as LRPAs, combined with the semantic implication of the term LRPA, creates an interesting and complex set of issues that must be addressed (in Sections 3.3.2 and 3.3.3) in terms of archeological/systemic context, and current research context as outlined in Section 3.1.

Several of Mariah's delivery orders called for determining the NRHP eligibility for LRPAs. Ninety-four LRPA sites were evaluated under delivery orders covered by this report. The SOW specified that:

> The contractor shall...construct, submit, and upon approval, execute a separate, multi-disciplinary research design to evaluate such LRP areas and other types of sites which may be embedded within their perimeters....The methodology of such a research design shall include cost-effective strategies for...the recovery of data appropriate to the evaluation of such sites for National Register eligibility and potential for scientific research (Department of the Army 1991:C-10).

Because LRPAs comprise a functionally unique kind of site, the possibility of addressing alternative questions creates a tension between integrity-driven significance standards, which emphasize depositional and cultural integrity, and the problem-driven standards, which emphasize utility with respect to addressing nontrivial, unanswered questions. Thus, in order to assess LRPA sites, it was necessary to show that they either could or could not be integrated into a research program as cultural resources capable of providing data suitable for advancing archeological research beyond what has already been well established.

However, as noted in Section 3.1.3, no general research design was in place when Mariah began work. Because the contractual obligation to develop an LRPA-specific research design was contingent on the research issues identified in the general research design for Fort Hood, it was not possible to coherently pursue evaluation of LRPAs for their special attributes (cf. Trierweiler 1994a). However, field work could not await completion of the general- and LRPA-specific research designs. As a result, evaluation of LRPAs was begun according to procedures established to evaluate sites for their potential to contain artifactual assemblages in undisturbed archeological context (see Section 3.2 and Chapter 4.0). Proceeding along these lines was deemed to be reasonable because no matter what research issues would eventually emerge from an acceptable research design, the nature of archeological context would be a variable relevant to determinations of significance for LRPAs, even if it did not end up being decisive in all cases.

3.3.2 LRPAs and Problems of Archeological and Systemic Context

The preceding discussion has alluded explicitly and implicitly to several problems of the relationship between archeological and systemic context. These problems are relevant to whether or not an LRPA can meet the general integrity-related significance standards delineated for all sites in the Fort Hood HPP. The most serious problem is interpreting the behavioral significance of artifacts from contextless assemblages. However, an important problem also emerges from defining LRPAs as any site larger than 75,000 m^2.

As noted above, the boundaries of LRPAs include upland surfaces. The upland surfaces in Fort Hood have been stable or erosional since the Pleistocene (see Chapter 2.0), which means that the rate of net natural deposition has been very low. It therefore follows that whenever prehistoric artifactual materials were deposited on the uplands, they would be left in a stratified matrix only if they were deposited in a rapidly aggrading cultural deposit (e.g., burned rock midden or mound) or in a sinkhole, rockshelter, or other similar natural setting that captured Holocene-age sediments.

As a result, most LRPAs are characterized by artifact assemblages for which archeological context includes no reliable stratigraphic segregation. This means that data from most LRPAs cannot be subjected to analysis in terms of reliable artifact-to-artifact associations because there is no stratigraphic ground upon which to infer that artifacts belong together as a functionally or culturally integrated assemblage. Since identifying artifact associations on the basis of stratigraphic relationships is the mainstay of archeological practice, analysis of data from most LRPAs cannot be performed using archeology's most powerful tool. Moreover, long-term erosion in many cases has redistributed artifacts horizontally in unknown ways across upland surfaces. As a result, spatial contiguity is an especially poor index for establishing assemblage content. This problem is further compounded in many cases by impacts from cultivation, maneuvers, and fires. Cultivation and maneuvers are major cultural transformation processes, and fires and erosion are major natural transformation processes (Schiffer 1987) that have affected sites on the base. These impacts can make it difficult to distinguish reliably between prehistoric artifacts, prehistoric artifacts modified by historic activities and natural processes, and pseudoartifacts created by historic activities and natural processes.

Consequently, inferences from archeological to systemic context are necessarily difficult at best for upland LRPAs. Furthermore, even under the best of circumstances, it is extremely unlikely that small, individual sites reflecting discrete cultural components can be reliably identified within the boundaries of upland LRPAs because to do so would require making reliable inferences about the nature of systemic contexts reflected in the archeological context of LRPAs. This, however, appears to require tight stratigraphic controls. Interestingly, therefore, the preceding considerations largely eliminate any realistic possibility of resolving Ensor's version of the LRPA problem as a problem of replacing large sites defined for CRM purposes with small sites defined to represent probable elements of systemic context. It does not, however, make the LRPA problem go away because it does not change the fact that Fort Hood has very large sites for which it is necessary to determine what to do. At this point, the management definition of LRPAs as large sites complicates matters considerably.

As noted in Section 3.3.2, the boundaries of LRPAs were established on the basis of the two-tool rule and the spatial contiguity of surface artifacts without regard to the depositional nature of archeological context. LRPA boundaries also were established without regard to whether or not naturally occurring chert was an element of the depositional matrix contained within a site's boundaries. Since the effective contractual definition of an LRPA is a large site, any given LRPA may or may not have been composed entirely of ancient surfaces, and any given LRPA may or may not have been a functional LRPA. In principle, therefore, although the discussion so far has implied that LRPAs are upland sites, the process of evaluating LRPAs has to accommodate: (1) the possibility that a large site is composed entirely of ancient surfaces, entirely of Holocene depositional matrices, or some combination of the two; and (2) the possibility that a large site may or may not have been a source of chert.

Indeed, the results of evaluating LRPAs on the basis of their geomorphic potential to preserve artifactual assemblages in segregated stratigraphic context showed that only 23 of the 94 examined are composed entirely of upland or other ancient surfaces. Of the remaining sites, all have some upland or other ancient surfaces within their boundaries. Hence, LRPAs at Fort Hood are highly variable with respect to the stratigraphic nature of archeological context within their boundaries. Moreover, 28 out of 94 sites either had no naturally occurring chert onsite or nearby, or had too little naturally occurring chert to justify inferring that the site had significant potential as a locus of lithic-procurement activities. Other LRPA sites had onsite chert outcrops or had chert available nearby, especially in stream channels. Even in cases where chert was available onsite or nearby, however, the density of the natural chert ranged from dense pavements of cobbles in, and downslope from, outcrops, to sparse distributions of ancient lags left on the surface by long-term erosion (see Chapter 6.0). Hence, LRPAs at Fort Hood also are highly variable with respect to the degree to which it ever was possible for lithic-procurement to be a major onsite activity in systemic context.

Since many of the LRPAs occur on stable upland surfaces with minimal post-Pleistocene deposition, they have negligible chances for containing cultural components in an archeological context that allows for stratigraphic separation of assemblages of different ages. As a result, evaluating them according to integrity-driven standards would lead automatically to judgments that they are not significant. The LRPA problem is therefore not merely a problem of finding a way to divide large sites into behaviorally meaningful small sites (as suggested by Ensor and by SOW specifications; it also is a problem of determining whether or not there is a way to productively use data from large sites in which much of the artifact base is useless for any archeological problem that requires stratigraphic segregation of artifact assemblages. In the case of large sites which lack naturally occurring chert and are characterized in whole or in part by contextless assemblages, solution of the LRPA problem is fairly straightforward: such sites can be evaluated according to procedures used for small sites (see Chapter 4.0) under the assumption that the absence of stratigraphic segregation negates any realistic possibility of contributing significant data to archeological research. Division of such sites into smaller, more manageable units can be based on judgments that some parts of large sites satisfy the integrity-related significance standards, whereas others do not. However, in the case of large sites which have naturally occurring chert and are characterized in whole or part by contextless assemblages, there remains the problem of determining whether research context can provide an overriding rationale that favors preservation of functional LRPAs according to problem-driven significance standards established specifically for prehistoric sites.

3.3.3 Developments in Research Context

While Mariah was evaluating LRPAs according to integrity-related significance standards, drafts of reports on relevant research began to emerge for the Fort Hood area. In 1992, Texas A&M University submitted draft research reports on field work conducted in 1990 at Bull Branch (Carlson 1993) and in 1991 at the Henson Mountain Helicopter Range (Carlson 1992). During the later stages of integrity-driven evaluation of LRPAs, Mariah submitted to Fort Hood a draft of a general research design (Ellis et al. 1994). These drafts contained elements that could influence the significance of LRPAs.

3.3.3.1 The Texas A&M Reports

The Bull Branch report is notable because it contains a chapter (Dickens 1993) which proposes an initial, partial taxonomy of Fort Hood cherts and attempts to describe lithic artifacts from test excavations in terms of this taxonomy. Although the chert taxonomy should be regarded at best as an initial approximation of the cherts available on Fort Hood (see Chapter 6.0, this volume), Dickens' work is nonetheless an important milestone in the development of data bases suited to the development of lithic procurement research. On the basis of the chert taxonomy, tool analysis, and debitage analysis, Dickens (1993:114) concludes that specific cherts were preferred for some specific tools, and that heat treatment of chert may have increased from the Late Archaic to the Late Prehistoric period. Regardless of whether one accepts his technological descriptions and conclusions, Dickens has shown that attempting to relate tools and debitage to chert sources can establish a productive basis for interpreting aboriginal behavior in an area that has abundant, variable chert resources within the foraging and/or logistical radii (per Binford 1980) of any site on the base.

The Henson Mountain report also is notable because it contains chapters relevant to lithic-procurement issues. Included in this draft is a chapter (Shafer 1992) which specifically addresses the research potential of LRPAs, focusing on site 41CV207 (the "Snoopy" site). Shafer's chapter is a good but general overview of the potential of upland LRPAs, a topic that has not been studied in depth in Central Texas. As such, Shafer's chapter serves as an exploratory prospectus for dealing with LRPAs. Major questions addressed by the report are (1) the importance of LRPAs; (2) their data potential; and (3) how they can be managed.

Shafer discusses the importance of the LRPAs by arguing that the Edwards chert was economically valued as a prehistoric resource. The primary research issue for LRPAs is summarized as one of characterizing diachronic variability in the prehistoric strategies which were used to obtain the chert resource. Different procurement strategies are argued to have different implications for substantive questions of prehistoric group size, social structure, mobility, and territoriality. A popular model of resource procurement contrasts so-called embedded and direct strategies (per Binford 1979) that may imply very different approaches to the integration of lithic procurement into other activities.

Shafer sees LRPAs as being amenable to two basic kinds of analyses: technological analysis and source analysis. Investigations of technology include both trajectory analysis and debitage analysis. Trajectory analysis identifies sequential steps in reducing lithic cores from parent material to tool and then statistically characterizes the artifact assemblage along a linear reduction trajectory (Collins 1975). Debitage analysis may include detailed attribute analysis and (more expediently) mass analysis (Ahler 1972). Source analysis may involve trace element fingerprinting using neutron activation (Leudtke 1992) or fluorescence techniques (Hillsman 1992), or may involve focus on microfossil inclusions in the chert (Luedtke 1992). These methods assume that alternative raw material sources have been similarly characterized.

Steps recommended by Shafer (1992) to mitigate LRPAs were: (1) definition of the geologic and geographic context of the immediate lithic source; (2) mapping of the LRPA within that context; (3) collection of a sample of the chert to determine variability in the raw material; and (4) collection of a sample of the artifacts to determine the cultural variability (including technological and chronological) present at the site. Collection of artifacts and chert specimens was recommended to include both random and opportunistic samples. In-field recordation of artifacts was suggested as a means to avoid bulky collections. Observations on the collected (or field-recorded) materials in a sample unit was to include: (1) density and size grade of all materials; (2) frequency of various types of cultural materials vs. noncultural materials; (3) frequency of core types; and (4) variability and condition of the chert material (including burning).

Shafer believes that it is possible to investigate lithic-procurement behavior through in-field analysis of large samples of lithics over the surface of a site. Investigating the extent of trade of Fort Hood cherts could be based on samples of different cherts from the base collected to establish spatially documented reference collections. Determining the degree of horizontal segregation of components was judged to be the key to addressing these questions by using temporal diagnostics to identify the location, size, and number of temporally distinct artifact concentrations. Finally, it was speculated that buried components possibly may be present on or near lithic procurement sites, and that these components would help to identify procurement patterns.

Also in the Henson Mountain report is a chapter that implements some of Shafer's (1992) programmatic suggestions. In addition to investigations at the Snoopy site (41CV207), which contained distinct quarry and campsite components within its boundaries, the Henson Mountain project also involved work at other nearby campsites (41CV869 and 41CV876) that did not have naturally occurring chert within their boundaries. Judging from diagnostic projectile points, these sites were a locus of activities from the Paleoindian through Transitional Archaic periods (Mesrobian et al. 1992). Dickens and Dockall (1992) compare lithic data from collections on the chert outcrop at the Snoopy site to lithic data from collections at nearby campsites.

Surface collections from the Snoopy outcrop showed that there were numerous cores with reduction scars evincing cobble testing and production of primary macroflakes. In contrast, cores recovered off of the Snoopy outcrop and from nearby campsites were too small to produce the macroflakes evident on the outcrop cores and appeared to have been used for production of small flakes and tools. The primary macroflakes themselves were distributed at both the quarry and the nearby campsites, suggesting to Dickens and Dockall (1992:85) that, "Production and initial selection and culling occurred at the quarry/procurement area, with secondary culling occurring at the quarry campsite."

Debitage analysis was performed on collections from the quarry/procurement area, from campsites off of the outcrop at the Snoopy site, and from the nearby campsites (41CV869 and 41CV876). Interestingly, however, a debitage analysis for campsite assemblages showed very large percentages of small primary flakes (i.e., small flakes with cortex covering one side). This result is largely unexpected in the stage-analysis used by Dickens and Dockall, because in an idealized reduction trajectory, most cortex would be removed prior to the production of most small flakes, since most cortex would be removed during the first stages of tool production when the largest flakes are produced. The campsites, therefore, initially appeared to be characterized by primary reduction activities. On the other hand, an examination of debitage from the quarry/procurement area showed that primary flakes represented a very small proportion of the debitage assemblage. The quarry debitage assemblage was dominated by small secondary and interior flakes that are characteristic of later stages of an idealized reduction trajectory. The quarry/procurement area, therefore, initially appeared to be characterized by later stages of tool production, which conflicted with core data that implied early-stage reduction activities.

The debitage evidence was puzzling and led Dickens and Dockall to examine the nature of the chert itself in an attempt to explain the anomaly (Dockall 1992, personal communication to Ellis). Upon working with the chert available at the outcrop, they found that the closer the chert was to the middle of any given cobble, the more difficult it was to work. Thus, they concluded: (1) that macroflakes were the major item procured at the quarry; (2) the anomalous quarry debitage reflected activities to prepare striking platforms on cores; and (3) the anomalous campsite debitage reflected later-stage reduction of lithic nuclei that happened to be largely corticated because the most desirable chert was closest to the cortex. On the basis of these conclusions and the additional assumption that the campsites were occupied for the purpose of procuring lithic materials, Dickens and Dockall inferred that chert materials (primarily macroflakes) were procured on the outcrop. These materials were then taken to the nearby campsites and further reduced into tools for later use at more distant base camps.

3.3.3.2 The Research Design for Fort Hood

In early 1993, a general research design was submitted by Mariah and accepted by Fort Hood. This research design (Ellis 1994a, 1994b; see Section 3.4) focuses on the history of human adaptation at Fort Hood. Consequently, the general research design also focuses on identifying the decision-making patterns that governed human behavior in order to identify patterns of stability or change in the adaptively significant behavior of hunter-gatherers who occupied Fort Hood for any given part of their annual/seasonal activities during any given period of prehistoric time.

The general research design is predicated in large part on a theory of technology in which the concrete components of technologies are combinations of raw materials, tools, and organizations directed toward goals (Ellis 1994a). In this theory, an organization is part of a technology, and not separate from it. Given this concept of technology, the general research design conceives of technological analyses as frameworks within which the researcher attempts to identify sequences of activities performed in certain ways in order to attain goals. The concept of technology distinguishes between *support-technologies* that provide the raw materials and tools and *use-technologies* within which consumption goals are actually achieved. Thus, a technological system for consuming a subsistence commodity may be composed of a number of support-technologies that provide the goods needed for the use-technologies which are used to produce and consume that commodity. This means that part of the problem to be resolved in the identification of adaptively significant decision-making patterns is to determine how hunter-gatherers at Fort Hood equipped themselves with the means to pursue goals, which in turn involves determining how they balanced activities in their support-technologies against activities in their use-technologies.

Given that many of the tools employed in prehistoric use-technologies were made of stone, it is necessary to obtain an understanding of the relationship between the acquisition and use of stone tools if one is to be able to determine how hunter-gatherers at Fort Hood achieved workable trade-offs between their tool-production and commodity-production activities. Any use-technology that involves stone tools is therefore related to a support-technology that produces tools and a procurement technology that acquires raw materials. These activities must be organized around each other and around activities in other technological systems. In other words, given that the production of stone tools was a preliminary step in many other adaptively significant activities, it is necessary to understand how raw-material procurement was integrated into other activities. For example, were raw materials procured on a catch-as-catch-can basis whenever people were near lithic raw materials (i.e., in an embedded strategy)? Were special missions organized to acquire raw material from sources some distance away from residential sites (i.e., in a direct strategy)? Since each of these extremes implies a specific way of balancing procurement activities against other activities, each extreme therefore also implies that raw-material procurement and stone tool production reflect very different decision-making structures.

At any given time, of course, acquisition of raw materials could have been conducted according to a strategy lying somewhere between these extremes. In fact, procurement strategy could have varied from season to season as other activities changed either the distance between people and lithic resources or the scheduling of lithic procurement. Furthermore, the way each question above is framed obscures the fact that the act of procuring lithic raw materials is but the first link in a sequence of decisions that might or might not result in the production of a finished stone tool. For example, it is possible that someone could procure a chert nodule with the intent to use it immediately or to cache it somewhere else for future contingencies. Alternatively, someone could procure a nodule and strike several flakes from it in order to obtain a selection of generally useful flakes for some contingent future use elsewhere. Since raw material procurement need not result in the immediate or eventual production of a tool, raw-material procurement as such is both behaviorally and analytically distinct from tool production, although tool-production data can provide evidence on which to base inferences of some aspects of procurement behavior. Indeed, the spatial relationship between the activities of raw-material procurement and tool production is a primary basis for inferring the extent to which a lithic-resource site was both a procurement and production site. In conjunction with data from contemporary sites without lithic resources, the distinction between procurement-only, procurement-and-production, and no-procurement sites establishes a basis for determining how stone-tool production was balanced against other activities.

Although every site that has lithic artifacts by default contains some evidence relevant to patterns of raw-material procurement, functional LRPAs comprise the only kind of activity locus that can contain direct behavioral evidence of the activities that occurred in conjunction with the procurement of lithic raw materials because, by definition, functional LRPAs are the only places where raw materials are procured. This is not to say that models of lithic procurement patterns cannot be built in the absence of evidence from functional LRPAs. Raw-material-provenance data can show how far raw materials moved from the source after procurement, and evidence of lithic-reduction practices can imply whether raw-material-use was influenced by more or less constant resupply or by distance-related scarcity that led to conservative material consumption. However, knowing that the raw materials represented at a given site came from a source some distance away tells us very little about the decisions that preceded or followed the procurement act, and the absence of direct data regarding the location(s) of the initial stages of a given lithic-reduction strategy means that lithic reduction models cannot be corroborated, which in turn means that inferences of procurement patterns derived from reduction-strategy models are based on conjecture. Hence, functional LRPAs are the only activity loci that can, in principle, provide the direct evidence needed to flesh out and corroborate economic models of tool-production strategies so that such models can be confidently integrated into larger-scale models of adaptive decision-making. As such, functional LRPAs can be sources of significant data. A brief reanalysis of Dickens and Dockall (1992) results illustrates this point.

As noted above, the lithic data acquired from locales away from the chert outcrop in the Henson Mountain project were initially anomalous. In the absence of functional LRPA data, the lithic data in non-LRPA contexts would have remained largely mysterious because the nature of the debitage largely defied conventional wisdom about reduction strategies. Having access to LRPA data was essential for sorting out the lithic assemblages from the campsites. The availability of data from both LRPA and non-LRPA settings allowed Dickens and Dockall to show that the nature of the raw material itself explains why and in what directions the Henson Mountain lithic-reduction trajectory deviates from the idealized trajectory. However, although knowledge of raw-material workability was essential to their analysis, such knowledge by itself would not have produced a well-supported explanation. For example, under other circumstances, attempting to clarify the anomalous campsite assemblages might have led Dickens and Dockall to suspect that the nature of the raw materials was responsible, which in turn might have led them to acquire additional data derived from replication experiments on Snoopy chert. They still would have discovered that the interior of the chert was difficult to use, and they therefore might have inferred that the reason for the anomalous debitage was the easier workability of the exterior portions of the cobbles. However, this conclusion would remain uncorroborated unless and until they had evidence that exterior chert was differentially procured, which is what they actually found in the quarry assemblage. Thus, although knowledge of the performance properties of cherts at the Snoopy quarry would have permitted Dickens and Dockall to reach the same conclusions, knowledge of the artifactual properties of chert at the quarry would still be necessary to evaluate the plausibility of their conclusions. Interestingly, therefore, the Henson Mountain example serves as a model of how to integrate stage analyses and LRPA data in order to use the idealized lithic-reduction trajectory (Collins 1975) as a point of departure in lithic analyses rather than as a rigidly applied a priori interpretive structure (see Sullivan and Rozen 1985).

In addition to containing an example of how LRPA and non-LRPA data can be used to reconstruct a procurement and reduction trajectory, the Henson Mountain example also illustrates how one might use spatial relations among various components of the procurement/reduction trajectory to reconstruct adaptively significant organizational components of technological systems (per Ellis 1994a). Dickens and Dockall (1992:100) conclude that the Henson Mountain data support the existence of a sequence of quarry, quarry-campsite, and base-camp locations. If this characterization is correct, then it would provide a sufficient basis for concluding that chert was procured within a direct procurement strategy (per Binford 1979) or that lithic procurement was a collector-organized technology (per Ellis 1994a). This would mean that the social organization of commodity production was such that, for some reason, it was useful or necessary for some people to go on a logistical mission to procure chert and make tools while other people performed other tasks either at, or originating from, the base camp.

The spatial distribution of lithic evidence supports Dickens and Dockall's claim that people went to the quarry area to get raw materials and returned to the campsites to make tools. The only known basic difference between the campsites inside the Snoopy site and the campsites at 41CV869 and 41CV876 is that the latter are, respectively, about 300 and 900 m farther from the quarry area. In other words, therefore, the lithic evidence implies that people went to the outcrop, found suitable raw materials, reduced the bulk of the raw materials to the portions (i.e., macroflakes) they wanted for tools, and then took the portions they wanted to their current residences. From the viewpoint of the campsites, determining whether lithic procurement occurred according to an embedded or direct strategy (per Binford 1979) depends upon whether or not the primary reason for occupying the campsites was to procure chert.

Within the boundaries of the Snoopy site itself, procurement and reduction activities were differentially distributed, with procurement of macroflakes largely restricted to the quarry area and tool production largely restricted to campsites away from the quarry area. The other non-LRPA sites also were characterized by a combination of tool-production and campsite evidence. This would mean that having arrived at the vicinity of the Snoopy outcrop, there were good reasons to establish temporary campsites at varying distances from the actual quarry locale, perhaps, as Dickens and Dockall (1992:100) suggest, to perform subsistence tasks while on a logistical mission to procure chert. This in turn would mean that although campsites were established as part of a mission to procure chert, the primary determinant of the specific location for campsites was not the chert outcrop itself.

Thus, if Dickens and Dockall are correct, activities in the actual quarry locale reflect bulk reduction of lithic raw materials: the macroflakes represent a drastic decrease in the bulk of raw materials actually transported to tool-production locales. This would represent a major diagnostic hallmark of a direct or collector-organized technology (cf. Binford 1980). Reduction of these raw materials to tools for use back at the base camp would comprise the ultimate form of bulk reduction because it would eliminate the maximum possible amount of unusable material to be transported back to the base camp.

Unfortunately, Dickens and Dockall's claim about a quarry/quarry-campsite/base-camp sequence is not well supported. Proximity to the chert outcrop is the only direct evidence that the campsites were established for the purpose of procuring materials and making tools. Hence, proximity of the campsites to the chert is also the only direct evidence that the campsites were part of a system organized around other activities at relatively distant base camps. However, the variable distance between the Henson Mountain camps and the quarry locale, the presence of burned rock concentrations, hearths, and a probable buried midden at the campsites (Mesrobian et al. 1992:37-39), and the evidence of tool production, use, and discard at the campsites is consistent with an embedded or forager-organized lithic procurement strategy. This is because the evidence is consistent with lithic procurement performed in conjunction with a relatively wide range of activities performed at the same site, which is the hallmark of forager-organized technologies (see Ellis 1994a). Dickens and Dockall's claim about lithic procurement in a quarry/quarry-campsite/base-camp sequence is therefore weak because the evidence from the Henson Mountain campsites is consistent with a contrary claim.

Note, however, that Dickens and Dockall's claim about direct, logistically organized lithic procurement is weak because the data base upon which to establish the function of the *campsites* is not robust enough to allow for a reliable distinction between the generalized activities typical of residences of people whose technologies were forager-organized, and the specialized activities of sites occupied on collector-organized missions (cf. Binford 1982). The reason for the lack of robustness is that the data were acquired during a shovel-testing program rather than from a fine-grained data-recovery program. As such, the data base cannot support inferences about the nature of site function despite the fact that it is robust enough to reconstruct the procurement/reduction trajectory with a high degree of plausibility. Furthermore, Dickens and Dockall could not call on a wide array of well-excavated and well-documented sites elsewhere in order to tell how the Henson Mountain sites fit into a larger system. As a result, their characterization of a quarry/quarry-campsite/base camp sequence relies on the unstated and undemonstrated assumption that human activities in Fort Hood were usually (or, at least, frequently) centered around base camps. As a working hypothesis, this assumption is reasonable enough; as part of an empirical conclusion, however, it adds nothing to our substantiated knowledge of prehistoric adaptation and social organization that has not already been assumed. The claim about a quarry/quarry-campsite/base-camp sequence remains as a hypothesis that has not yet been investigated.

Thus, the primary weakness of Dickens and Dockalls's interpretation has little to do with the fact that it is based on data from a contextless LRPA assemblage. Rather, the weakness emerges from trying to do as much as one can with limited data from non-LRPA assemblages, which shows in turn that using data from contextless LRPA assemblages may be limited by a lack of complementary data from stratified non-LRPA locales. If so, then the general interpretive utility of contextless LRPA assemblages is not much different in principle from the utility of stratified assemblages because interpreting the significance of stratified assemblages at any given hunter-gatherer site is dependent on what we know from other sites.

Despite any possible weaknesses, however, the Henson Mountain example shows that it is feasible to use data from functional LRPAs to make advances in the knowledge base of research context. For example, where we once had no knowledge about how the Snoopy outcrop was exploited, we now have a testable (or, at least, investigatable) hypothesis about the role of the nearby campsites in a larger system. Furthermore, where we once had no knowledge of the kinds of debitage one might expect to find from the use of Snoopy cherts, we now know that it is reasonable to expect radical deviations from the idealized lithic-reduction trajectory at any site with tools made from Snoopy cherts. The foregoing could have important implications for implementing future investigations at nearby campsites and at sites for which the Snoopy outcrop is within logistical range. By default, we also now know that any particular chert may have characteristics that lead to other deviations from the idealized reduction trajectory because it is unlikely that the peculiarities of Snoopy cherts apply to all Fort Hood cherts. Given the currently poor state of development of prehistory in and around Fort Hood, these are substantive things to know.

Unfortunately, it cannot be expected that future research at functional LRPAs will have the luxury of being accompanied by research at other nearby sites. In such cases, it may not be possible to duplicate Dickens and Dockall's success at the Henson Mountain sites because it may not be possible to approach contextless LRPA assemblages with specific questions in mind that can be fruitfully addressed using creative applications of more or less standard elements of current analytical capacity. Another brief reanalysis of the Henson Mountain example illustrates this.

The Snoopy LRPA data was initially mysterious because it appeared that the material being procured consisted of primary (i.e., corticated) macroflakes, whereas the material abandoned at the site consisted of cores (many of which still appeared to be highly useful) and apparent late-stage debitage. The quarry assemblage would have remained mysterious without the non-LRPA data. In other words, the success of the Dickens and Dockall analysis followed from the simultaneous exploitation of artifactual data from LRPA and non-LRPA archeological contexts (Dockall, personal communication to Ellis). Still, even in the absence of campsite data, Dickens and Dockall might have surmised that the nature of the raw material was the source of a puzzling assemblage, and replicative experimentation on Snoopy cherts might have led them to conclude that exterior macroflakes were the only readily usable materials that could be procured at the outcrop. However, this conclusion would be hypothetical unless and until they found evidence that tools made from Snoopy cherts generally were made from primary macroflakes, which is what they actually found in the campsite assemblages.

Given the current poor state of development of prehistory in the Fort Hood area, data-recovery programs from upland LRPAs can expect to be hobbled with respect to advancing the state of substantiated knowledge of prehistoric technological systems and adaptively significant decision-making. The current nature of our analytical capacity would allow us (using data-collection methods outlined by Shafer [1992]) to characterize cores, flakes, preforms, and other such lithic artifacts. In some cases, it might be possible to determine the elements of the idealized reduction trajectory that appear to be missing (i.e., nonrandomly underrepresented) in the LRPA assemblage (per Shafer 1992), in which case it would be possible to frame testable hypotheses about the nature of what was procured and the state of reduction of lithic materials removed from the raw-material source. In other cases, it will be possible to identify individual knapping episodes. By augmenting these kinds of evidence with experimental data about the performance properties of the raw material itself, it would be possible to frame additional hypotheses about the nature of what one would expect to find in non-LRPA assemblages. It also would be possible to identify artifacts made from nonlocal materials. Note, therefore, that the Snoopy site is an example of how interpretation of contextless assemblages at functional LRPAs can lead to the generation of specific hypotheses for which further advancement of knowledge is largely contingent on having access to complementary data elsewhere.

Unfortunately, because the upland surfaces are ancient, it is possible (even likely) that tools and reduction episodes of widely varying ages will be superimposed over each other. Shafer's (1992) optimism notwithstanding, locating temporal diagnostics cannot provide a reliable chronological index for other nearby lithic data, and an ability to frame hypotheses about *what* happened at a contextless LRPA would not be accompanied by an ability to frame reliable hypotheses about *when* it happened. In other words, the potential to exploit the artifactual content of contextless functional LRPAs is limited because there are no stratigraphic controls to permit reliable identification of contemporaneous procurement acts, even in cases where individual procurement events can be isolated as such. Thus, given the current state of the analytical art, even a wildly successful data-recovery and analysis program at a contextless LRPA will not have much impact on our substantiated knowledge of prehistory until we acquire enough data from non-LRPA contexts to place the LRPA data in chronological and behavioral frameworks. However, there is reason to be cautiously optimistic about the chances of making technical advances to expand analytical capacity with respect to contextless assemblages from LRPAs.

Some of the substances in chert fluoresce under ultraviolet (UV) light sources such as "black light." Recently, archeologists have begun to examine chert artifacts under UV light in an attempt to identify the source of the chert and the age of the artifact. Some researchers (e.g., Hoffman et al. 1990) claim that different sources can be distinguished by their fluorescent properties.

Others (e.g., Ahler 1991) claim that differences in fluorescence correlate with the age of artifacts. These issues are far from resolved (e.g., Banks 1990; Hillsman 1992), largely because researchers typically work under uncontrolled conditions and use qualitative means in which fluorescent responses observed under UV light are compared visually with color chips observed under either UV or white light.

One of the keys to resolving the utility of chert fluorescence is to find a means for obtaining quantified data that can be rigorously and intersubjectively evaluated. Relatively inexpensive fluorescence spectrometric equipment (e.g., the AMINCO-Bowman Series 2 Luminescence Spectrometer, manufactured by the Milton Roy Company) is currently available on the market, and equivalent devices can be assembled from components (e.g., Hillsman 1992). Spectrometric devices can provide a means for quantifying the fluorescent response of chert artifacts, with results that can be mathematically characterized and statistically manipulated. Thus, if the qualitative studies performed so far reflect real phenomena, quantified spectrometry may allow for development of analytical techniques that can identify the source and approximate age of chert artifacts. The availability of such means would enable researchers to trace in detail the movement of lithic raw materials from their sources to their places of use, thereby providing important data for topics such as group mobility and trade. Furthermore, if fluorescent response can be shown to yield results at least as precise as chronologically diagnostic artifacts, this capacity would constitute a dramatic improvement in our ability extract useable data from LRPAs because stratigraphic contextlessness would be partially offset by a capacity to directly assign assemblages to rough time intervals.

Unfortunately, few spectrometric studies have been performed in order to suggest how useful quantitative fluorescence data will turn out to be. Hillsman (1992) used luminescent spectrometry to analyze cherts from different sources, including Edwards chert from Central Texas, and he detected some differences between some sources. He also stated that a great deal of basic research would be necessary before source studies could be regarded as demonstrably reliable. Staff at Mariah recently used UV spectrometry to identify differences in fluorescence of projectile points of different ages. Initial results showed that intensity of response may decrease with age. However, these results were exactly the reverse of what Ahler (1991) has observed, and it was immediately apparent that the effects of heat-treating, patination, and variation in chert source must be determined before any conclusions about the relationship between age and fluorescence can be confidently demonstrated. Moreover, the Hillsman and Mariah efforts were limited to fluorescent responses to a single wavelength of UV light equivalent to a wavelength of black light used in qualitative studies. Hence, these attempts to quantify variation in fluorescence may have missed diagnostic responses occurring at any number of other wavelengths.

Another potential approach to placing artifacts from contextless assemblages into rough chronological frameworks may be to measure the thickness of patination rinds on chert artifacts. The development of patination rinds on chert is at least partly a function of the length of time that fresh breaks have been exposed to weathering processes. Staff at Mariah currently are working on a project (to be reported elsewhere on completion) whose goal is to determine the relationship between patination thickness and the age of chert artifacts. Scallorn arrow points (Late Prehistoric period), Pedernales dart points (Middle Archaic period), and several varieties of Paleoindian points were obtained from surface collections made during site survey at Fort Hood. Thin sections were made from the points, and the patination rinds were measured using procedures similar to those for obsidian hydration dating.

Preliminary results show that few Scallorn points (15%) have a patination rind, whereas about half of the Pedernales points (49%) and most of the Paleoindian points (89%) have rinds. Results also weakly imply that whereas the rinds on Scallorn points are generally thinner, the rinds on Pedernales points are generally thicker and the rinds on Paleoindian points are generally thicker still. However, within each point type, there is considerable variation in rind thickness, and the range of thicknesses for each type overlaps the range of thicknesses for the others. Variation in patination characteristics could result from variation in chert type and/or some other cause. The projectile points currently are being characterized by neutron activation techniques in order to determine whether trace-element composition can be used to account for rind-thickness variability. If these experimental results are successful, they may indicate that chert patination studies can be used to assign artifacts from contextless assemblages to rough chronological frameworks. However, even if these results are wildly successful, much more research undoubtedly will be needed before patination can be used reliably and expediently. Indeed, because there may be a relationship between degree of patination and fluorescent response, research is necessary to determine whether the two techniques can be combined in some way to yield more informative results than either can produce by itself.

These two examples of possible developments of archaeological analytical capacity show that the ability to effectively exploit LRPAs is at least partly contingent on basic research in nonarcheological fields, although there is no inherent reason why archeologists and geoarcheologists cannot be part of the process. Moreover, the effort needed to develop these techniques may be a lot like the effort that it took to develop and refine radiocarbon dating, and it will be expensive and time consuming to do so.

The upshot, therefore, is that currently available techniques for interpreting a contextless LRPA assemblage by itself are unlikely to produce much more than (1) a catalog of artifacts of various kinds, (2) a description of the properties of the chert resource, and (3) a set of working hypotheses about the possible relationships between the properties of the chert, the properties of the artifacts, and the reduction trajectories reflected by the artifacts. Although such results (especially the working hypotheses) would be valuable for further research, they would not in themselves constitute a particularly well supported advance in our knowledge of prehistory. To advance knowledge much beyond this requires complementary data from other sites, and this data may not be available until some indeterminate future date. Furthermore, although the prospects for obtaining new, useful analytical technologies are good, fulfillment of these prospects is contingent on future developments in nonarcheological fields. This means that despite the current capacity for using contextless LRPA data fruitfully and the eventual possibility of overcoming some of the problems of contextlessness, the archeological value of individual LRPAs probably lies mostly in the future unless contextless LRPA data can be recovered in conjunction with lithic data from nearby stratified deposits. Even then, however, it is not at all certain that answering questions identified from nearby deposits will exhaust the potential contribution of any particular LRPA. Thus, even under conditions where complementary data can be collected and analyzed simultaneously, it still will be necessary to "overcollect" in order to assure that potential data needs for future developments are covered as much as possible. In short, as things are now and are likely to be for the foreseeable future, contextless LRPA data will have a largely unknown, "wait-and-see" value.

Therefore, a major part of the LRPA problem is a conflict between the current and eventual interpretive value of LRPA data. As the Henson Mountain example shows, LRPA data can in fact be used to address significant research issues because it is a data link in inferences regarding the social organization of tool and commodity production. This data link must be supplied either by hypothetical assumption or by empirically derived conclusion in order to model adaptive systems. Thus, although lithic-procurement is a small issue in Fort Hood's prehistory, it is nonetheless an important one. Hence, the main sticking point is whether or not data recovery and analysis is considered to be valuable if it does not produce more or less immediate gains in our substantiated knowledge of prehistory. This value issue is directly related to the socioeconomic context for archeology at Fort Hood.

3.3.4 Socioeconomic Context and the LRPA Problem

In the discussion so far, the LRPA problem started off as a problem of how to make the boundaries of large sites established for CRM purposes coincide with the boundaries of behaviorally meaningful units. This version of the LRPA problem was shown to be unresolvable because of the nature of archeological context in upland LRPAs. Hence, the LRPA problem then evolved from a problem of whether contextless LRPA assemblages can be used at all, into a problem of the extent to which data collected for as yet unknown applications may be valuable. The value of such data depends in one respect on what we can realistically predict will happen to it, and in another respect on how the protection and eventual mitigation of LRPAs fits into the operation of Fort Hood as a military installation rather than as an archeological resource. Determining what to do about LRPAs is therefore a problem of contextual conflicts generated in part by the socioeconomic context of archeology for Fort Hood. Since socioeconomic context is the real-world environment within which LRPAs are to be evaluated, protected, and mitigated, a real-world solution to the LRPA problem must take socioeconomic context into account.

Many LRPAs are huge and located in areas in which the U. S. Army has legitimate needs with respect to training personnel in armored and other units requiring large areas for maneuvers that effectively simulate potential battlefield conditions. This land-use pattern was well established prior to directives to protect cultural resources from damage. Thus, when the Fort Hood CRM program was established, it started off with what turned out to be a large number of LRPAs in localities that were subject to ongoing damage by training activities. This is especially true in the western portion of Fort Hood, which has been subject to repeated large-scale maneuvers by armored units.

To set aside huge LRPAs for protection is, in at least some cases, to interfere with the Army's ability to perform its training mission and, by implication, to interfere with the Army's mandate to maintain a strong national defense. Furthermore, to attempt to protect all huge LRPAs is likely to be ineffective, at least in some cases, because it can be predicted that soldiers whose first duty is to comply with training mandates are likely, in the heat of battle simulations and other activities, to intentionally or unintentionally ignore largely invisible site boundaries that conflict with their purposes. Indeed, since site boundaries often are hard enough for archeologists to recognize on the ground, even tank drivers with good intentions can have a difficult time staying out of protected areas.

A solution to this problem would be to fence off or otherwise demarcate LRPA boundaries, which would be an enormously expensive thing to do. Unless the military population places a higher monetary value on archeological programs than the general public, it probably can be inferred that the history of large expenses for archeology at Fort Hood (Lintz and Jackson 1994) has been a source of irritation for military commanders who can be expected to resist massive additional capital expenditures for site protection because such funds come out of the resources allocated to fulfill Fort Hood's primary mandate. Furthermore, capital investments in site protection probably would have to come from the same funding pool as investments in the hundreds of sites that remain to be evaluated at Fort Hood. Moreover, this same pool funds the investments in mitigation of sites located in places where site-avoidance is not possible because land-use requirements are too important to permit setting them aside indefinitely. Thus, site-protection programs compete for funds with other elements of the CRM program given its current state of development. Given that the CRM program at Fort Hood has been in a "catch-up" mode ever since it started, it can be predicted that funds will be insufficient to cover all CRM needs for years to come, especially as the federal government grapples with problems of reducing defense expenditures.

At this point, the primarily future-oriented value of contextless LRPA data becomes an important issue. It is virtually a universally held truism in archeological circles that almost any archeological site can yield some information. Frequently, this proposition is accompanied by the statement that advances in analytical capacity will someday (perhaps soon) transform currently useless sites into rich sources of data. However, Fort Hood's commanders believe that they need to clear archeological sites as soon as they can, and for many years they have waited for evaluation decisions that would release land for training purposes. They can therefore be expected to resist claims that LRPAs should be preserved because there is a good chance of developing fluorescence, patination, or other analytical technologies in the near future, especially since no one appears yet to have committed large amounts of resources to developing them. Of course, one might reply that it would be in the commanders' interests to fund development of these technologies in order to hasten the process of clearing LRPAs. However, they might still resist because they might still be justifiably reluctant to bear the entire cost of developing technologies that a broader funding base should bear because the new technologies would have wide applications beyond the boundaries of Fort Hood (see Schultz 1974, MacKenzie 1991, and Thompson et al. 1991 for analogous assessments of distributing the social costs and benefits of developing agricultural technologies).

Furthermore, in conversations with members of the Texas archeological community, one frequently hears the comment that years of research at Fort Hood have produced relatively little concrete archeological knowledge. While we at Mariah acknowledge this, we also recognize that Fort Hood's primary CRM problem to date has been to catch up on inventory and evaluation requirements of the regulatory process. Moreover, because so many years and so much money have been spent on archeology, the CRM program is under increasing pressure, much of which is self-imposed, to produce substantive empirical results, ready or not. For Fort Hood's commanders, achieving empirical results means that inconveniently located sites can be cleared from protected inventory because empirical results resolve issues in historic contexts to which such sites are relevant. Although mitigating an LRPA under current circumstances would benefit Fort Hood commanders by clearing a substantial surface area from protected inventory, it would not resolve issues in any historic context much beyond the point of generating working hypotheses and inventories of data for possible future application. It would not be surprising, therefore, if Fort Hood commanders regarded expenditures on LRPAs as yet another incomprehensible exercise that spends scarce resources without fulfilling even archeologists' immediate goals of advancing knowledge of prehistory.

Indeed, the Fort Hood command structure would have good reasons for being skeptical about the value of collecting contextless LRPA data that archeologists are not yet in a position to exploit fully. For any individual LRPA that may be mitigated, in order to have a data base that covers unknown future data needs, it is necessary that the data base be very large, not only because the LRPAs are large, but also because artifactual evidence of different procurement patterns may be spread unevenly across LRPA surfaces. At first glance, this conjures up images of what Jack Jackson (personal communication to Ellis) describes as shelf after sagging shelf of lithic artifacts. The vision of sagging shelves is especially disturbing because archeology, as a discipline, does not afford much prestige to researchers who write reports on materials they did not excavate: most archeologists, after all, became archeologists because they like to dig sites.

Furthermore, because the field and analysis components of archeology are expensive, it is usually extremely difficult to obtain the additional funding needed to look in detail at existing collections. Thus, although an LRPA mitigation would yield basic documentation of what was found, it can be predicted that once described, the assemblage itself will be ignored thereafter. For proof that this is so, go to the Texas Archeological Research Laboratory and look into the number of potentially important collections that remain to be written up, including some excavated by famous names in Texas archeology.

Shafer (1992) rightly suggests that a good way to minimize the storage problem is to do in-field description and recording supplemented by collection of random samples. Unfortunately, Shafer's solution (or any viable alternative) only works as long as there is minimal change in the research context for archeology. The enduring value of an in-field recorded assemblage depends on the enduring value of the attributes used by the recorders (cf. Dunnell 1971). Since in-field recording is based on the current development of research context, it produces a data base that is vulnerable to obsolescence as a result of paradigm change or development of new problems or new analytical techniques within an ongoing paradigm. Since random samples collected for curation probably will be selected to represent the distribution of attributes recorded in the field, it is unlikely that they would be reliable samples for new problems based on analysis of different attributes. And, even if the random samples happen to be appropriate, it still is unlikely that future researchers will go back to the shelves to look at them in detail.

The obsolescence problem is not as serious as it sounds because all archeological reports and collections are subject to the same difficulty. In-field recording and random-sample collections from LRPAs therefore offer the best compromise available to archeologists who can only be expected to do the best they can given the current state of the research art and what they can reasonably expect in the near future. However, the sagging-shelf image is problematic even if relatively small surface collections are made to represent the assemblages distributed at LRPAs. This follows from the fact that the 94 LRPAs issued to Mariah for evaluation contain a total area of about 32.7 million m^2 (about 8,100 acres). Using LRPA-specific procedures, about 7.3 million m^2 (about 1,800 acres) of contextless LRPA surface was eventually determined to have high, or uncertain but possibly high, potential to contribute to lithic-procurement research (see Chapters 5.0 and 10.0), so applying Shafer's strategy would produce an enormous amount of randomly sampled artifacts, even at a minuscule representative sampling rate. Thus, a further complication emerges in the form of the question: How much contextless LRPA surface is necessary to cover reasonably anticipatable future contingencies?

The answer to this question is unknown and, currently, unknowable because little concrete is known about the specifics of lithic-material procurement in Central Texas as a whole. As Chapter 6.0 shows, the notion of Edwards chert that has been used in archeology is extremely vague and geographically ill-informed. Furthermore, most discussions of lithic procurement in general (Ahler 1986; Hoffman et al. 1991) focus on a regional or continental level in which the object of study is the use of chert that comes from one area by people who live in another area. At Fort Hood, however, a principal empirical issue is the patterns of chert use by people who occupied the area on a more or less constant basis (Ellis 1994b). By extension, another empirical issue is the lithic-procurement behavior of people living in a resource-rich area. This issue contrasts markedly with the focus of most studies, but is equally poorly explored. The fact that we know little about chert-use in Central Texas and Fort Hood entails that LRPAs are relevant to research issues for which very little resolution has been achieved at the regional or local levels. Thus, although many LRPAs do not meet the integrity-driven significance standards in the HPP, they are potentially valuable according to the problem-driven standards that apply to prehistoric sites on Fort Hood. However, it is not possible to use redundancy of data as a significance standard because too little is known to determine whether any given LRPA (or even any part of an LRPA) is redundant with respect to any other LRPA.

Part of the LRPA problem, therefore, follows from the relationship between socioeconomic factors that include the value that nonarcheologists will place on the results of collecting contextless data. The fact that archeologists can eventually use such data to address small interpretive problems is unlikely to impress the people who must allocate resources for data collection because they are likely to view the currently limited utility of LRPA data and the smallness of the problems as measures of low importance. In both cases, they would be wrong. The spatial relationship between procurement acts and other activities is a central element in sorting out the social organization of production. Even if the result from mitigating an LRPA is a set of working hypotheses that would be relevant to future research rather than a set of corroborated statements about prehistoric behavior, the working hypotheses would provide a basis for implementing site-specific research in conjunction with the overall research design for Fort Hood. Furthermore, mitigating any given LRPA would provide a basis for beginning to determine whether or not other LRPAs represent redundant data bases. An ongoing program of clearing significant LRPAs, if carefully structured and implemented, could therefore provide a basis for focusing further mitigation efforts on more specific data requirements or for determining whether other significant LRPAs are worth maintaining on protected inventory.

3.3.5 Contextual Conflicts and Parameters for Solving the LRPA Problem

The preceding, admittedly convoluted discussion has shown that the LRPA problem is a web of conflicting contexts. Ensor initially characterized the large-site problem as convenient for CRM purposes, but inconvenient for research purposes. From the Army's perspective, the number and largeness of LRPAs is a major inconvenience, while the relationship between site boundaries and scientific utility is probably largely irrelevant. From the perspective of the Fort Hood HPP, integrity-driven significance standards would justify removing most LRPAs from protected inventory, whereas problem-driven significance standards might give them a new lease on life. Within the perspective of research context, LRPA data currently can be made to count toward advances in knowledge, but it cannot be expected in the near future that data recovery at any given LRPA will immediately resolve any scientific issues in historic contexts to the satisfaction of either archeologists or Fort Hood's command structure. Hence, where archeologists will focus on LRPA data as a source of working hypotheses, nonarcheologists will focus on the fact that the only concrete outcome of data recovery is the accumulation of large amounts of artifacts and data that may never be reexamined once they have been given an initial analysis and description. From the Army's perspective, the costs of protecting and mitigating LRPAs have a low priority relative to training and other activities, and from the CRM program's perspective, the current costs of recovering of large bodies of LRPA data would come at the expense of other backlogged compliance activities or at the expense of data recovery programs that could acquire data leading to more immediate empirical gains. In short, in the real world, LRPAs are a problem in one way or another for everyone concerned.

It is now possible to specify the parameters that must be met by an LRPA-specific research design for significance assessment to successfully resolve the contextual conflicts discussed above:

(1) Evaluation of LRPAs must recognize that the Army has current, ongoing land-use needs that are impeded by the presence of very large, uncleared archeological sites. The mere largeness of many LRPAs produces conflicts between the Army's needs and complying with regulatory constraints. Identifying

archeologically valueless LRPA surfaces and removing them from protected inventory will help resolve the conflict between the Army's mission and CRM mandates. Evaluation procedures should therefore provide a means for identifying the portions of large sites that are archeologically valueless, and the portions that warrant protection. The valueless portions can be removed from protected inventory, thereby partly achieving the Army's goals. However, if whole contextless LRPAs or large contextless parts of LRPAs are to remain on protected inventory, it must be because they have met significance standards which protect sites that have realistic prospects for contributing data to lithic-procurement studies. Furthermore, LRPA-specific eligibility recommendations should recognize that there are some procurement-research issues (e.g., chert provenance) that do not require site protection.

(2) Evaluation procedures should recognize that Fort Hood's CRM program has a tremendous backlog of sites (about 1,500, including historic sites) which still need to be evaluated for compliance purposes, and that mitigation-level data recovery and analysis on sites which do not require immediate clearance will (a) prolong the process of identifying the list of significant sites and (b) use fiscal resources that may need to be applied to mitigation of significant sites that do require immediate clearance. In other words, procedures should focus on determining eligibility, and not on resolving empirical issues in order to help assure that the Fort Hood CRM program can finish the initial evaluation phase upon which all subsequent compliance phases are based.

(3) Significance standards and evaluation procedures for LRPAs should recognize the fact that although lithic-procurement behavior is a small part of adaptively significant prehistoric decision-making processes, it also is a very important part. Therefore, the standards and procedures should be sensitive to the issue of cost-effectiveness of eventual data recovery so that expenses involved in recovering data from functional LRPAs do not absorb an inordinately large proportion of long-term CRM budgets relative to data-recovery needs for non-LRPA settings. Furthermore, even surfaces that are very thoroughly damaged can contain isolated pockets of undamaged artifacts which could be collected by opportunistic sampling. However, despite the fact that opportunistic sampling could locate some relevant data, the problem of distinguishing cultural chert objects from natural ones would be compounded by the problem of distinguishing tankifacts from undamaged prehistoric artifacts. LRPA-specific recommendations therefore should also recognize that there may be surfaces which are too heavily damaged to warrant protection because it would not be cost-effective to cull large numbers of pseudoartifacts from artifact collections prior to the expensive process of describing and analyzing the remaining cultural assemblage.

(4) Evaluation procedures must recognize the tension between the integrity-driven significance standards in the HPP and the problem-driven standards that apply specifically to prehistoric sites. Therefore, evaluation procedures must recognize that the contractual definition of LRPAs as very large sites does not distinguish between large sites that functioned as lithic-procurement locales, and large sites that did not. It also does not distinguish between LRPAs composed entirely of ancient upland surfaces, and LRPAs that contain Holocene-age deposits. Hence, the procedures must accommodate any possible permutation of functional/contractual LRPA and Holocene/ancient depositional matrix in archeological context by allowing for the possibility that different significance standards may be decisive for different LRPAs and even for different portions of any given LRPA. In other words, significance standards and evaluation procedures must distinguish between

a "large-site problem" and a "large, functional LRPA problem."

(5) Evaluation procedures should recognize the poorly developed state of research context for contextless LRPA data. Since it is not yet possible to use contextless data from any given LRPA to clarify issues raised at other well-excavated sites on Fort Hood, and since the contextless nature of the assemblages currently requires such complementary data, the procedures should not depend on collection and analysis of large numbers of artifacts from which little or no substantiated empirical content can be derived and for which there is a reasonable expectation that long-term curation will not be accompanied by detailed post-curation studies. Furthermore, LRPA-specific significance standards should recognize the realistic possibility that there will be relevant advances in analytical capacity. Still further, evaluation procedures should recognize the fact that it is not yet possible to use data redundancy as a significance criterion because too little is known to determine what is redundant and what is not.

(6) Significance standards and evaluation procedures should recognize the fact that within the boundaries of a large functional LRPA, the activities on or immediately adjacent to a chert source may be different from activities only a few tens or hundreds of meters away from the source. Hence, stratified deposits outside the source area but within the boundaries of an LRPA may not contain the same kinds of evidence as stratified or palimpsest deposits in the source area. The presence of stratified deposits within the boundaries of an LRPA therefore does not automatically provide sufficient grounds for determining that nearby palimpsest surfaces are valueless.

3.3.6 Summary

This section has discussed the nature and evolution of the LRPA problem and has characterized it terms of the contexts introduced in Section 3.1. Characterizing the LRPA problem in terms of these contexts makes it possible to identify the impact of the various contexts and, thence, to focus attention on the conflicts that must be resolved in order to deal successfully with LRPAs. However, the foregoing should not be construed as an answer to the LRPA problem. Rather, it is an analysis of the issues that have to be addressed and a description of parameters within which to address them. The significance standards, strategies, and field methods adopted to evaluate LRPAs will be addressed in Chapter 5.0.

3.4 IMPLEMENTATION OF THE GENERAL RESEARCH DESIGN

As noted in Sections 3.1.3 and 3.3.4.2, no general research design was in place when Mariah began the project. As a result, problem-driven significance standards could not be invoked when assessing site significance. Although the general research design volume for Fort Hood (Ellis et al. 1994) was not completed in time to be applied in this phase of the project, it was submitted before the LRPA-specific research design was completed and implemented. The methods presented in Chapter 5.0 reflect procedures that were to evaluate LRPAs according to their utility for technological hypotheses expressed in the general research design (Ellis 1994b). Thus, a major potential conflict between evaluations based only on integrity-driven concerns and evaluations based on LRPA-specific concerns was preempted before LRPA-specific evaluation procedures were implemented.

However, evaluations of hundreds of small sites had been completed before the general research design was accepted. Because problem-driven standards can logically override integrity-driven standards (see Section 3.1.3), it was possible *in principle* that evaluations based solely on stratigraphic integrity might need to be reassessed before being submitted as our final recommendations to Fort Hood. The problem of potential reassessment was partially preempted in the field and in analysis by assuming that evidence of intact features, subsistence remains, human burials, and other similar items would constitute strong presumptive evidence in favor of significance because it would be fairly unlikely for them to be irrelevant under almost any research design. In any case, all evaluations were regarded as tentative pending resolution of research design issues. The eventual emergence of the general research design affected the outcome of integrity-based evaluations in minor, but nonetheless important, ways.

One of the major components of the general research design was a detailed discussion of the history of archeology in Central Texas (Ellis 1994a). This discussion presented an assessment of the state of the archeological art for the region, including assessments of how well research to date has addressed traditional culture-history goals and how well cumulative data serves research that, for Central Texas, reflects a recently emerging focus on adaptive studies. Given the absence of well-defined historic contexts for Central Texas, this discussion constituted a summarization of the nature of research context as it applies to Fort Hood. A major conclusion of the discussion was that knowledge within both culture-history and human-ecology paradigms was too feebly developed to support the identification of any but the most general of historic contexts. This conclusion served as a point of departure for (1) recommending a back-to-basics approach to archeology at Fort Hood, and (2) proposing an ecologically oriented theoretical perspective within which to conduct archeology at Fort Hood.

To the extent that Ellis's (1994a) arguments about the state of the archeological art are well founded, it turns out that integrity-driven significance standards are the only standards that currently can be applied justifiably in the evaluation of small sites at Fort Hood. This follows from the fact that because prehistory has been very poorly described and explained in the Fort Hood area, there simply are no well-resolved historic contexts, especially contexts related to the ecological focus of the research perspective for Fort Hood. As a result, any archeological site that actually meets integrity-driven standards currently has high potential to provide data that would advance research in substantial amounts and substantive ways, although clearly some sites will make more incremental contributions than others. Furthermore, despite the fact that there is now a comprehensive research plan, there still is no basis for invoking the redundancy clause of the HPP because there still is no sound empirical basis for identifying data that is not needed. This, of course, does not mean that a currently eligible site always will be eligible, especially since at least some currently eligible sites are certain to become redundant as time passes and research advances. However, it does mean that the primary challenge facing the CRM program at Fort Hood is to foster management and research in ways that are highly focused so that scarce funds are allocated as productively as possible.

Toward this end, the research design proposed for and accepted by Fort Hood (Ellis 1994b) was structured to serve as a mechanism that would lead as explicitly, directly, and systematically as possible to the accumulation of empirical results that would provide a basis for the eventual definition and resolution of specific historic contexts. To accomplish these goals, the design was divided into sections pertaining to (1) the resolution of fundamental issues of chronology and paleoenvironmental reconstruction and (2) reconstruction of adaptive process. The design itself, especially the latter part, is an extremely, even painfully, detailed document that specifies the basic inferential and analytical architecture for starting with small sets of poorly understood artifacts and environmental data, gradually building models of technological systems and adaptively significant decision-making structures, and eventually integrating these into descriptions and explanations of the adaptive success and failure of people who occupied Fort Hood. Given the poor state of development of research context in and around Fort Hood, the design should be applicable for the near future and until there is a major paradigm change, a massive data recovery program within Fort Hood, or a massive data recovery program in the area surrounding Fort Hood.

In the meantime, therefore, the general research design provides a series of interrelated benefits. A major benefit is that the design identifies in detail the kinds of data that are necessary to establish an empirical foundation for defining and, in many cases, resolving specific problems. The detail and inferential structure of the design also demonstrate how that data will be used, which serves as a justification for collecting and analyzing it. The design therefore also serves as a basis for justifying claims to fiscal resources needed to achieve compliance by providing a negotiating tool that Fort Hood CRM personnel can use in long-term planning and management. As a result, the design assures that efforts will be highly focused on data and issues that are defined specifically enough to prevent allocation of resources to irrelevant issues, but broadly enough to allow wide latitude for scientific creativity and fiscal flexibility. Hence, the design also assures Fort Hood that the CRM program is guided by a research strategy that has specific empirical goals so that funds allocated for CRM activities will be applied in a stable framework devoted to a long-term vision that minimizes the likelihood of squandering money on an archeological whim of the moment.

3.5 CONCLUSIONS

The discussion of various notions of context has served to identify realistic influences on the management of cultural resources at Fort Hood. Achieving and maintaining full Section 106 compliance is a continuing process that takes place in a dynamic environment within which developments in research context, CRM context, and socioeconomic context interact in mutually influential ways. These influences created the conditions under which Mariah was issued delivery orders to evaluate sites. The methods developed for small sites (Chapter 4.0) directly reflect the fact that problem-driven significance standards could not be applied because the CRM context at Fort Hood had neither well-defined historic contexts nor a general research design during the time the work was performed. In contrast, the LRPA-specific methods (Chapter 5.0) reflect the content and goals of the general research design. Indeed, the development of the LRPA-specific methods and the adoption of the general research design during the course of this project illustrate how dynamic the background conditions can be for CRM activities.

The influence of archeological context, CRM context, and socioeconomic context also affect the empirical analyses performed on data recovered during site evaluations. The specific array of sites was determined largely by the prioritization established in the Fort Hood HPP, which directly reflects the fact that the Army's land-use needs call for resolution of compliance issues more urgently in the outlying maneuver areas than in the central live-fire zone or in environmental set-aside areas. As a result, data is geographically distributed in a wide arc around a large data void. This means that our empirical analyses are affected in unknown ways with respect to how well the data represent Fort Hood as a whole.

4.0 STRATEGIES AND RESULTS

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Together, Chapters 4.0 and 5.0 discuss the tactical and analytical approaches which were employed to assess site research potential, site significance, and hence, site eligibility for inclusion in the NRHP. As has been discussed previously in Chapter 3.0, the primary criterion for evaluating site significance was the presence or absence of intact buried cultural deposits. The present chapter addresses the methods by which such deposits were detected and evaluated. All depositional areas of all sites were evaluated according to the methods and criteria discussed here, *regardless of overall site size*. However, for those sites larger than about 75,000 m^2 (18.5 acres) (the so-called "LRPA" sites), additional criteria were applied to assess the research potential of lithic assemblages on contextless surfaces. These LRPA strategies are addressed separately in Chapter 5.0.

This chapter is organized in four major sections. The first part discusses the methods used during field work, including reconnaissance, shovel testing, and data analysis. The second section presents laboratory methods. Within this section, artifact processing and cataloging techniques and attribute recording schemes are discussed. The third part reviews the quality control procedures used to ensure collection of accurate, comparable, and replicable baseline data. Finally, the fourth part briefly presents some summarized results.

4.1 FIELD METHODS

The process of evaluating sites for their potential to contain intact cultural deposits proceeded in a stepwise fashion through three distinct stages. First, all 571 sites were visited by a specialized assessment team consisting of a Holocene geomorphologist and an archeologist. Next, based on the observations and recommendations of this team, all sites with the *potential* for buried deposits were shovel tested by a follow-up crew. The field methods applied during these two stages are discussed in detail below. Finally, those 94 sites which were a priori defined as LRPAs were evaluated according to LRPA-specific methods, including resurvey. This third stage is discussed in Chapter 5.0.

4.1.1 Reconnaissance

The initial visit to each site (the "reconnaissance") was conducted by a specialized team consisting of an archeologist and a Holocene geomorphologist. For each site, the team first reviewed the previous site record(s) and traversed the site, visually inspecting cultural features and deposits as well as the noncultural landscape, geology, and hydrology. Where available, exposures such as rodent holes, cutbanks, and erosional areas were inspected. Based on this inspection, the geomorphologist determined whether or not the site was composed of different land forms with differing potential for intact cultural deposits (for example, a stable upland surface vs. an alluvial terrace. Where appropriate, the site was subdivided into two or more subareas corresponding to geomorphic surfaces having similar ages and depositional characteristics. These subareas became the basic geographic unit to be evaluated and were distinguished with alphabetic designators (e.g., 41CV600A or 41CV600B).

At the same time, the archeologist inspected previously recorded features, recorded new features, and evaluated the validity of the current site boundaries. On several sites, boundaries had never before been delineated. Systematic surface collections were not made, but diagnostic artifacts noticed on the site surface were collected. Of 307 artifacts collected from the surface, 263 are projectile points (86%) and 31 are lithic tools (10%). During this walkover, the team also amended the existing site map, adding features, subareas, collected artifacts, and other new observations, and revising the site boundaries as appropriate.

For each subarea, systematic assessments were made of both archeological content and geomorphological context. The assessments were both descriptive and quantitative, and were recorded on custom-designed data recording sheets. Descriptive observations were recorded on Form 3: Descriptive Archeological Data and Form 5: Descriptive Geomorphological Data (Appendix B). These called for free-form text observations on a number of specific topics. For example, the archeological evaluation noted features, dateable items, cultural material present, and other key archeological topics. The geomorphological evaluation noted exposures, sediment profiles, disturbances, and other geomorphic topics.

Similarly, quantitative assessments were made using Form 4: Quantitative Archeological Data and Form 6: Quantitative Geomorphological Data (Appendix B). These data recording sheets used ordinal scales to quantitatively score multiple criteria for archeological content and geomorphological context. For example, the archeological evaluation assigned a numeric score from 1 to 6 for "Nature of Cultural Occupation," where a score of 1 indicated an unsealed, secondary context and a score of 6 indicated a sealed, primary context. Other archeological criteria included "Potentially Dateable Material," "Area Function," "In-Situ Material," "Ecofacts," and "Artifact Assemblage Uniques." The geomorphic evaluation assigned numeric scores to "Surface Type," where a score of 1 indicated a flat upland surface and a score of 5 was recorded for a rockshelter with obvious deposits. Other geomorphic criteria included "Age of Geomorphic Surface," Position and Context of Remains, "In-Situ Holocene/Late Pleistocene Deposits," "Pedoturbation," and "Erosion." For both the archeological and geomorphological criteria, the rankings were arranged so that the greatest value reflected the most potential for intact buried deposits.

For each site subarea, criteria scores were summed to obtain a total archeological score and, separately, a total geomorphological score. High geomorphology scores indicate sites (or subareas) with a natural context that is conducive to the preservation and/or segregation of discrete cultural components; low geomorphology scores suggest a natural context that is unlikely to preserve or segregate components. Similarly, high archeological scores indicate observed data sets which would probably be relevant to multiple research design issues; low archeological scores suggest that the site (or subarea) largely lacks useable data.

Because the summed scores are the sum of ordinal rankings of arbitrary value, they do *not* indicate an interval (i.e., calibrated unit) scale of research value. That is, a site with an archeological score of 30 does not necessarily have twice the research potential of a site with a score of 15. Nevertheless, the scores do reflect relative position along a continuum of research potential. Cross plotting the geomorphological and archeological scores yielded a useful heuristic framework for discerning the relative research potential within any subset of sites (Figures 4.1, 4.2, and 4.3). In general, sites with low scores for both archeology and geomorphology are ranked low in overall research potential; sites with high scores for both are ranked high in overall research potential. Sites with a low archeological score and a high geomorphological score may have buried deposits but have an uncertain research potential. Sites with a high archeological score and a low geomorphological score probably have intact features on a low potential land form, but also have uncertain research potential.

On the basis of the reconnaissance scoring, sites (or subareas) with the lowest research potential were assessed as not significant and were recommended for no further management; this occurred unless there was some evidence that the low score was offset by a capacity to address some important research issue.

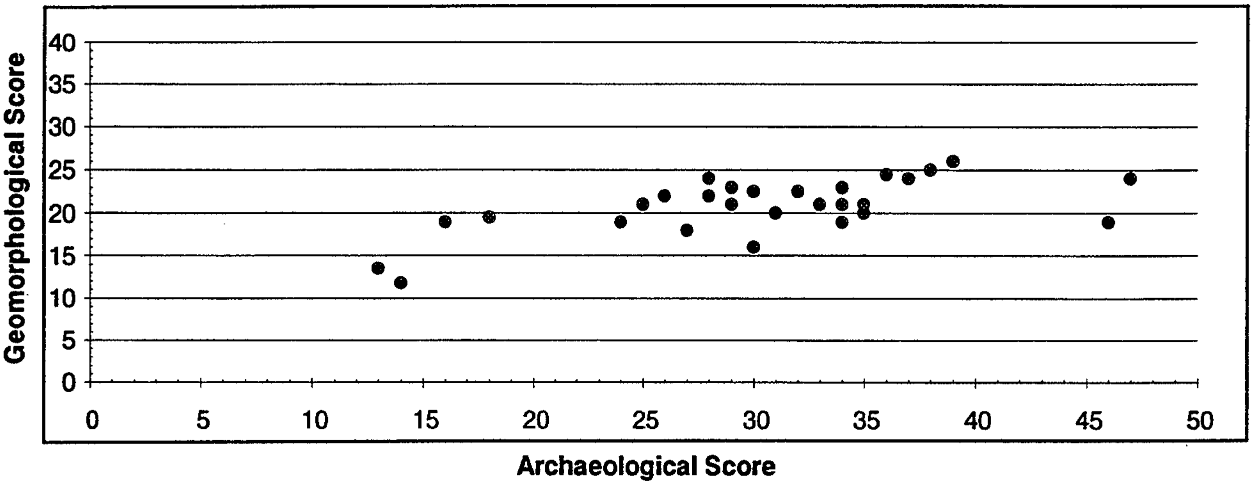


Figure 4.1 Colluvial Sites.

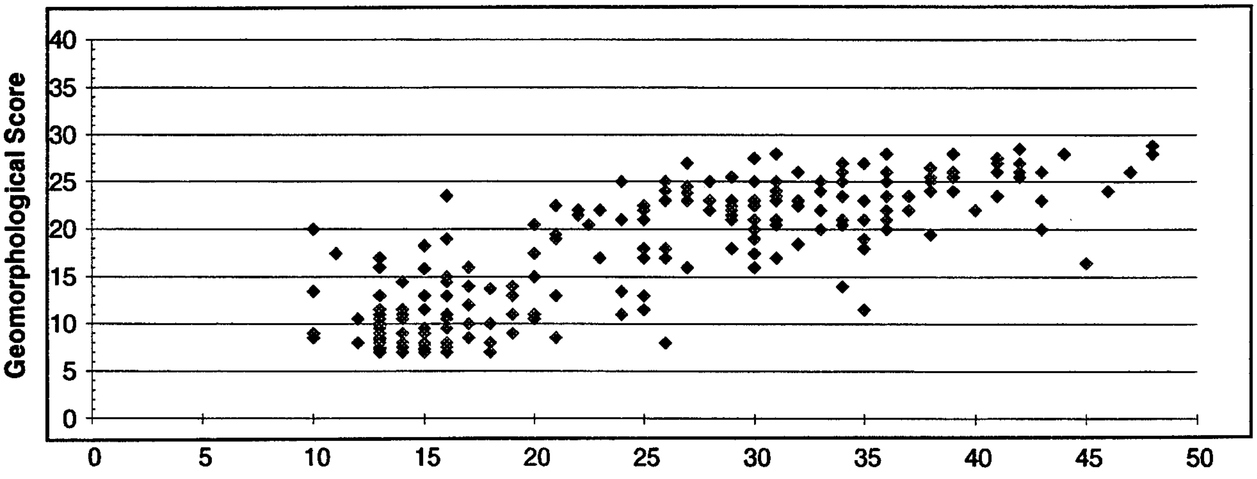


Figure 4.2 Upland Sites. **Archaeological Score**

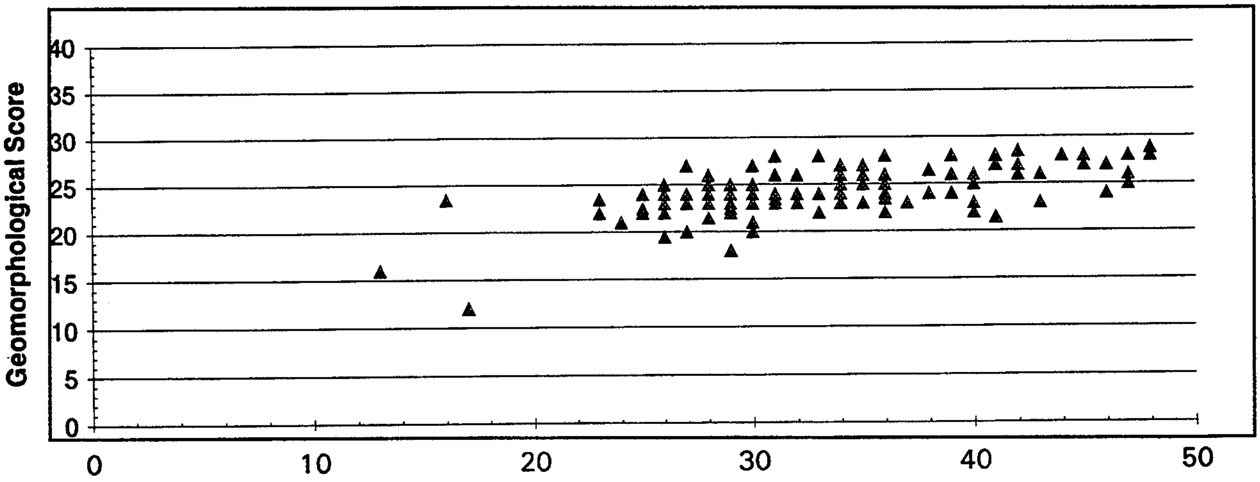


Figure 4.3 T0 & T1 Terrace Sites. **Archaeological Score**

Recommendations that shovel testing was not warranted on any given subarea were made by the project geomorphologist because the subarea (1) demonstrated a complete lack of any potential to contain subsurface deposits (i.e., was exposed bedrock); (2) demonstrated only very thin sediments with negligible potential for containing preserved subsurface deposits (i.e., probe depths less than 20 cm); or (3) demonstrated very old sediments (i.e., the Jackson Alluvium) which had been determined previously as unlikely to contain cultural deposits. Recommendations were conservative; if the geomorphologist had any doubt about the potential of a given subarea, then it was recommended for shovel testing and/or deep testing. All other subareas were shovel tested and/or recommended for deeper testing. While these recommendations were made on the basis of surface inspection of the ground, these were nonetheless made in the context of familiarity with the general geology of Fort Hood and specifically with the geologic processes that have buried, exposed, and disturbed archaeological sites during the Holocene. This geomorphic context is discussed in Chapter 2.0.

Sites (or subareas) with high and intermediate scores were shovel tested to assess the presence, density, and vertical and horizontal distribution of subsurface cultural materials. Occasionally, subareas with high or intermediate scores were not shovel tested because the only deposits with potentially intact deposits were deeper than the maximum depth of shovel testing (effectively, 80 cm). In such cases, shovel testing was bypassed because no useable data would be produced, and the subarea was recommended instead for deep testing including mechanical trenching.

While conducting the reconnaissance, several new and previously unrecorded sites were discovered. These were designated with temporary field numbers and their location and general character was reported to Fort Hood. All of these sites were issued in subsequent delivery orders for evaluation and shovel testing and all are included in this report. Upon returning to the site to conduct the formal reconnaissance, a State of Texas site form was completed in addition to the standard data sheets. After completion of field work, a trinomial was assigned to these sites and archival copies of all field forms were submitted to TARL in Austin.

4.1.2 Shovel Testing

On the basis of the reconnaissance scoring, 414 site subareas with high and intermediate scores were shovel tested to assess the actual presence, density, and vertical and horizontal distribution of subsurface cultural materials. The remaining 482 subareas were not shovel tested. These included 467 subareas with no potential for intact buried deposits as reflected by very low reconnaissance scores, 11 subareas with the potential for deeply buried deposits below the maximum depth of shovel testing, and four subareas which had been previously tested or which could not be relocated. These criteria are further delineated in Chapter 11.0. Pursuant to contractual guidelines, shovel tests were placed at 30 m grid intervals across the entire surface of any subarea with the potential for deposits, and in features on upland surfaces. The resulting sample thus approximated one test per 900 m^2 (30 x 30 m) of any area with a potential for buried deposits. Because of the extremes in overall site size, this rule-of-thumb resulted in many small subareas and single-feature subareas such as rockshelters or burned rock mounds receiving only one or two shovel tests while other very large subareas received dozens and even hundreds of tests. For example, any subarea smaller than 30 m by 30 m (900 m^2) received a single test, a subarea measuring 120 m by 150 m (180,000 m^2) received 20 tests, and a subarea measuring 200 m by 450 m (900,000 m^2) received 100 shovel tests.

Shovel testing in upland settings focused on the fairly restricted areas where eolian, minor alluvial, or slight colluvial deposits were suspected, except where plowing, sheet erosion, or vehicle impacts were excessive. If the reconnaissance identified a restricted portion of an upland land form as having the potential for intact deposits (a burned rock feature resting on bedrock, for example), then only these delimited portions of the upland surface would be tested. By contrast, the alluvial deposits along river and major tributaries had the potential for intact cultural remains at depths much greater than those allowed by shovel testing. The goal of shovel testing in these settings was to document and assess the potential for occupational structure and integrity in the shallow portions of the terrace which are apt to be severely impacted by training maneuvers using tracked and wheeled vehicles. Shovel tests in minor lateral tributaries were placed to search for shallow intact cultural deposits along the alluvial sediments and the base of toe slopes. Shovel tests in rockshelters and associated talus slopes were placed in the least disturbed area having the greatest depth potential. In some rockshelters and other types of small features, 1 by 1 m or 50 by 50 cm tests were determined to be more productive (and less destructive) than the standard 35 cm diameter shovel tests.

Test locations were determined approximately, using paced distances, and all test locations were plotted on the site sketch map. The number of tests per site subarea ranged from one in several small burned rock features and restricted rockshelters to 250 tests on subarea 41CV1275-C5. A total of 5,814 tests (consisting of 5,716 shovel tests and 98 quad tests or test pits) were excavated on 414 site subareas, with an average of 14 tests per site subarea. Twenty-six areas had more than 50 tests, and eight areas had 100 or more tests each (Table 4.1). Tests were identified with an alphanumeric designator. During the first season of shovel testing (January through July 1992), multiple tests were established along multiple parallel transits. In general, each transit was designated by a letter so that individual tests were identified as A3, B5, etc. During the second season, this system was replaced by giving each test a unique number beginning at 1. Final unit designations in the unified database are given as ST-1, ST-A3, QT-1, TP-1, etc.

Table 4.1 Frequency Distribution of Shovel Tests per Site Subarea.

Tests per Subarea	Number of Subareas	Total Tests	Percent of Total Tests
none	484	0	0%
1-10	282	943	16.2%
11-25	66	1,125	19.3%
26-50	40	1,403	24.1%
51-99	18	1,139	19.6%
≥ 100	8	1,204	20.7%
Total	897	5,814	100%

All test units were dug in arbitrary 10 cm levels to at least 40 cm below surface (cmbs) or to bedrock, if shallower. Some tests were dug to 80 cmbs which was effectively the lower limit for a 35 cm diameter shovel test. Quad tests (50 x 50 cm) and test pits (1 x 1 m) could be dug deeper and had a greater retrieval of data per portion of the site which was disturbed by the test. These tests were preferentially used in rockshelters and occasionally in burned rock mound features. Tests in rock shelters attempted to reach bedrock, with the deepest unit dug to 160 cmbs.

All excavated fill was dry screened in the field though 1/4 inch mesh and all cultural items were recovered, except for human bone, burned rock, and nondiagnostic shell fragments. If present, these items were noted on the field forms, but they were not collected. Human bone was exceedingly rare and was observed only in a very few rockshelters; these cases were immediately reported to Fort Hood DEH.

Shovel tests were recorded on a standard data sheet (Appendix B, Form 7), noting placement, sediment condition and material returns from each level of each shovel test. Multiple tests were recorded per sheet. The larger quad tests and test pits were recorded using individual level forms (Appendix B, form 8) which allowed for more detailed observations, including a plan sketch.

4.1.3 Data Analysis and Preliminary Reporting

Following completion of both field phases (reconnaissance and shovel testing), the collected data were reviewed, tabulated, and analyzed. The goal of analysis was to determine for each site subarea whether or not intact buried deposits were actually present.

In general, the sites which had not been shovel tested were already determined to have no potential for intact deposits. In a very few cases, sites were not shovel tested because they had intact cultural occupations below the maximum depth of shovel testing, or it was feared that shovel testing would do more harm than good in a restricted rockshelter or feature. These sites were determined to have a suspected, but not demonstrated, potential for intact deposits and were recommended for testing. These sites are described in detail in Chapter 10.0.

Of the sites which were shovel tested, three outcomes of the analysis were possible. Sites with clearly intact deposits were determined to have high research potential and were recommended for avoidance and protection. Sites lacking intact buried deposits were determined to have low research potential and were recommended for no further management. Finally, sites for which intact buried deposits were suspected but not clearly demonstrated were determined to have an unknown research potential and were recommended for avoidance and further testing.

In achieving these determinations, use of the shovel testing results proved to have considerable limitations. Those test holes with positive artifact recovery provided information on the occurrence and frequency of artifacts, the preservation of ecofacts, the depths of cultural remains, and the relationship of artifacts to recognized sediment units. However, the test holes with negative results did not necessarily provide information on the absence of cultural occupations, because each shovel test was statistically insignificant relative to the area sampled. Negative results could variously indicate that the testing did not go sufficiently deep enough to encounter the occupation zone, the test simply missed sparsely scattered artifacts, or the occupation zone did not in fact extend into the area.

High artifact densities from buried contexts could represent in situ or displaced materials from a single intense occupation layer or a number of stacked palimpsests on a stable land form. Major block excavations (much less limited shovel test holes) are sometimes unable to discern these differences. Nonetheless, the shovel testing documented subsurface stratigraphy and empirically demonstrated buried artifacts and ecofacts. These data provided different and additional information from those gained by the reconnaissance. Although negative and limited positive results did not contribute much new data for evaluating the site importance or drastically change impressions obtained from the field reconnaissance, some sites or portions of sites with artifacts at consistent depths and/or high densities of artifacts and ecofacts were identified as important from a shovel testing program. In some instances, management recommendations were changed as a result of the additional information. For the most part, the geomorphic and field reconnaissance evaluations tended to carry more contextual weight than shovel testing results.

Given these problems in using shovel test results to define context and in situ materials, the site evaluations were based on combinations of three variables: (1) the relative frequency of cultural materials; (2) the relative ubiquity of cultural materials; and (3) the relative vertical distribution of cultural materials. On this project, sites had to have at least five shovel tests before a pattern type could be discerned; sites with less than five shovel tests relied on artifact abundance in conjunction with the reconnaissance interpretations. Different criteria were used for nonfeature settings and feature contexts.

4.1.3.1 Nonfeature Contexts

Low frequency of cultural materials was defined as one or less artifact/ecofacts per shovel test hole; high frequency was defined as two or more artifact/ecofacts per shovel test hole.

Negative artifact ubiquity was defined as a lack of artifacts from any shovel test hole; low ubiquity was defined as artifacts from less than 30 percent of total shovel tests; moderate ubiquity was defined as artifacts from 31 to 70 percent of shovel tests; high ubiquity was defined as artifacts from more than 70 percent of all shovel tests at a given site.

Random vertical distribution was defined as multiple shovel tests with little or no consistency in the vertical distribution of artifact/ecofacts; no trends or patterns were evident in the vertical distribution of artifacts within a site subarea. This artifact distribution pattern tends to occur in sites with mixed deposits, or spatially limited artifact concentrations from stratified ephemeral or palimpsests occupations. The ability to segregate occupations at these kinds of sites tends to be limited.

Patterned vertical distribution was defined as multiple shovel tests within a site subarea with essentially consistent or similar patterns in the vertical distribution of artifacts. The consistency may reflect the accumulation of palimpsests on a buried, yet stable, surface, or discrete occupations which are archeologically segregated. In the former case, the contextual integrity of artifacts on a stable surface may be low; in the latter, stratigraphically segregated materials may have excellent potential for contextual integrity.

The alternative combinations of artifact frequency, ubiquity, and vertical patterning provided information about the consistency or lack of consistency of artifacts from the shovel tests, but they did not provide sufficient information to inform on overall site integrity. The interpretative ambiguities of negative results prevents any use of the data in a rank-order approach. Considerable uncertainties surrounded the contextual interpretations at most sites. For example, even where high frequency of artifacts occurred in highly structured vertical patterns from most shovel test holes, the patterns could represent either clearly stratified discrete occupations or multiple palimpsests on stable land forms. These alternatives represent opposite extremes of the contextual spectrum.

Four contextual considerations are not included in the contingencies outlined above: (1) land form/geomorphic context; (2) site type; (3) stratigraphic observations; and (4) feature matrix. These contextual considerations were excluded since information about their occurrence is based on the reconnaissance data separate and distinct from shovel testing results or, in the case of stratigraphy, the observations cannot be collected with consistent accuracy from the limited window provided from the shovel tests. Nevertheless, a range of attribute combinations involving artifact frequency, ubiquity, and vertical distribution pattern can be used as general guidelines for assessing overall research potential.

Some judgement was also needed to evaluate the importance and co-occurrence of materials recovered from any shovel test. For example, patterned artifact distributions correlated with observed stratigraphic patterns were assigned more weight than material distribution patterns in homogenous sediments.

A matrix of these variables is presented in Table 4.2, which identifies 14 possible combinations of frequency, ubiquity and vertical patterning. These have been grouped into six assessments of context having different management recommendations. Obviously, the geomorphic setting of each site affected the interpretations of the shovel testing results; however, these data were assessed and weighted through the geomorphologist's reconnaissance scoring.

In Table 4.2, score #1 indicates no artifact recovery from any shovel test. The absence of

Table 4.2 Evaluation and Scoring of Shovel Test Results from Nonfeature Contexts.

		Frequency	
	Artifact Ubiquity	Low	High
Negative Test Results	---	#1	#1
Random Distribution	low	#2	#2
	moderate	#2	#2
	high	#3	#3
Patterned Distribution	low	#4	#4
	moderate	#5	#5
	high	#5	#6

cultural remains from all shovel tests suggests that there is no demonstrated potential for shallowly buried deposits. The integrity potential is considered to be poor in shallow sediment localities, or the potential remains unknown in sites with deep Holocene deposits. However, if buried cultural material was observed during reconnaissance, then it is possible that the abundance of artifacts is too low or the distribution is too irregular to be accurately reflected in the shovel test sample.

Score #2 indicates vertically random, low to high artifact frequency with low and moderate ubiquity. Although the density of artifacts from these site subareas is variable, artifacts are recovered in random distribution from few to many of the shovel tests. This lack of consistency in artifact distributions may suggest mixed, disturbed, or spatially limited palimpsest cultural remains. If the site subarea is on a stable landform, then this type of distribution may reflect mixing or disturbance of cultural deposits. Conversely, if the site is within an aggrading or geomorphologically active setting, this pattern may reflect multiple, stratified, but spatially complex occupations and that perhaps low-density occupations may be present. In general, site subareas in this category are considered to have extremely limited archeological potential. The integrity potential for deeper Holocene deposits is considered to be unknown.

Score #3 suggests vertically random, low to high frequency, but high ubiquity artifacts. The density of artifacts from these site subareas is low or high from most shovel tests with random artifact distribution patterns. These distribution patterns on stable land forms may reflect medium to high intensity of activities leaving perishable remains which have become mixed by turbation. However, on an aggrading landform, this pattern may indicate that vertically discrete occupations may be present. These site subareas are considered to have limited potential for buried deposits with integrity. The integrity potential for deeper Holocene deposits is unknown.

Score #4 indicates vertically patterned, low to high frequency, but low ubiquity artifacts. Although the density of artifacts from these site subareas is variable, artifacts are recovered from patterned distributions from only a few shovel tests. The rare occurrence of positive artifact recovery in so few shovel tests may not accurately reflect the geometry and extent of the cultural occupations. This distribution suggests limited archeological potential for the shallow portions of the buried deposits, but the consistency in artifact distributions may reflect either isolatable occupations or a consistent sequence in an aggrading deposit. The archeological context of possible remains from deeper Holocene deposits is unknown.

Score #5 reflects vertically patterned, low frequency, moderate to high ubiquity artifacts. Although the density of artifacts from these site subareas is variable, the patterned distributions is replicated in many to most shovel test areas. The relatively common occurrence of positive artifact recovery strengthened the trend. Unless the artifacts are on shallowly buried stable land surfaces, this distribution suggests moderate to fair archeological potential. However the consistency in artifact distributions may reflect either isolatable occupations or consistent sequence in aggrading deposit. The archeological context of remains from deeper Holocene deposits is unknown.

Finally, score #6 indicates vertically patterned, high frequency and high ubiquity artifacts. The high density of artifacts consistently shows a strong vertical distribution pattern replicated in most shovel test areas. Unless the artifacts are on shallowly buried stable land surfaces, this distribution suggests good to excellent archeological potential. The consistency in artifact distributions may reflect either isolatable occupations with extreme clarity or consistent sequence in aggrading deposit. The archeological context of remains from deeper Holocene deposits is unknown.

4.1.3.2 Feature Contexts

Features may represent the only potential for Holocene deposits on the Manning and Killeen surfaces. Shovel testing on features was intended to obtain information about their depth and content, which was not comparable to nonfeature contexts. Feature-specific observations had higher threshold definitions. Since often a single shovel test was placed in any feature, there was no basis for assessing the ubiquity of artifacts in the features or the patterned trends in vertical material distributions. The kinds of relevant observations for features were: (1) frequency of burned rock; (2) frequency of lithics; (3) frequency of ecofacts (bone, mussels, charcoal, etc., but not snails); and (4) notes on associated matrix (ashy soil, chunks of charcoal, or extent of vandalism, etc.).

A low density of burned rock was defined as at least one but not more than five pieces per feature test, and a high density of burned rock was defined as six or more pieces per test hole. A low density of lithics was defined as 10 or fewer per test hole in the feature; a high density of lithics was defined as 11 or more artifacts per test hole. A low density of ecofacts was defined as four or fewer per feature test, while a high density was defined as five or more per feature test hole.

One point was awarded if burned rock was present in low frequencies; two points were awarded for high frequencies. Similarly, one point was awarded if lithics were present in low frequencies; two points were awarded for high frequencies. For ecofacts, two points were awarded for low frequencies and three points for high frequencies. Note that the ecofact scores are assigned more weight since they tend to be perishable yet yield considerably more information about activities than fire-cracked rock or lithics. One bonus point was added if any shovel test revealed discernable stratigraphy in the feature. Finally, one point was subtracted from the score if an estimated 30 to 60 percent of the total feature deposits had been disturbed or vandalized, and two points were subtracted if more than 60 percent of the total feature deposits had been disturbed or vandalized.

Using this scoring system, total possible scores for features ranged from -2 points for extensively vandalized features with no stratigraphy and low returns of lithics, ecofacts, and burned rock to a maximum of 8 points for fairly pristine features with discernable stratigraphy and high frequencies of burned rock, lithics, and ecofacts. These scores were used as guidelines for rating feature potential. A total score of less than 1 suggested very poor potential; a score of 2 or 3 indicated somewhat limited potential; a score of 4 or 5 suggested good potential; a score of 6 to 8 identified a feature with excellent potential.

4.1.3.3 Summary of Analytical Procedures

Analysis of the results of shovel testing provided alternate kinds of information to that derived from the surface reconnaissance. In combination with site landform, the shovel testing results provided some empirical data on the nature of shallowly buried cultural material. More deeply buried cultural components may occur at alluvial, rockshelter, and colluvially covered sites, but alternate methods of investigations, including backhoe trenches, with or without adjacent manually excavated units, will be necessary to document and evaluate these locations.

Open sites which have cultural materials confined to shallow deposits (upper 20 cm) offer problematic contextual results, especially in stable land form settings. Since stratigraphic segregation is tenuous at best, many sites with lithic materials recovered from only the upper 20 cm of fill may be excluded from management considerations; such decisions were made on a case-by-case basis and justified with supporting reconnaissance or shovel testing documentation.

4.1.3.4 Preliminary Reporting

These guidelines for interpreting shovel test results, assessing integrity potential, and making management recommendations are summarized in Table 4.3. For each site subarea, a preliminary assessment of integrity and management recommendations was made by the field team. The crew chief summarized the information on Forms 3 through 17 and recorded the summary on to Form 1 (see Appendix B), which essentially served as an abstract for the entire site. Descriptive portions of the summary site reports were written by the crew chief(s) and geomorphologist in the field office within 15 days of completing work on the site. These draft reports were submitted along with all primary data sheets to the Principal Investigator who reviewed the entire site module and wrote the interpretations and management recommendations. The revised final site reports were submitted along with the revised sketch map and all original reconnaissance and shovel testing data sheets. Generally, the site reports were submitted within 60 days following completion of the shovel testing.

4.2 LABORATORY METHODS

Broadly speaking, laboratory work occurred in two phases: preliminary processing and analysis in the field laboratory, and later, final processing and detailed recording. Preliminary processing began as soon as artifacts were returned to the field laboratory. The goal of this phase was to quickly obtain preliminary artifact data which could be used in developing initial assessments of research potential. These assessments were presented to Fort Hood DEH in individual letter reports for each site, generally within 30 days of fieldwork. To ensure maximum comparability of artifact recording, final processing and further detailed analysis was postponed until all sites had been completed. This phase began in July 1993 and was completed in January 1994.

4.2.1 Field Phase

All artifacts and samples recovered from the surface during reconnaissance or subsurface from shovel tests were assigned a tracking (lot) number based on their horizontal and stratigraphic provenience. During the first season of work (January through August 1992), artifact lot numbers were referred to as Field Specimen (FS) numbers, and designated a separate class of materials (e.g., bone, lithic debitage, projectile point) within a minimally defined provenience (e.g., a 10 cm level of a shovel test). This traditional system had several problems. First, based on field identifications, different classes of artifacts within the same provenience were assigned different numbers. Sometimes the field identifications were wrong. Further, excavated but sterile proveniences were not given tracking numbers. Because the ubiquity of subsurface artifacts was a key variable in assessing the overall research value of deposits, the frequency and distribution of sterile proveniences was as important as the frequency and distribution of artifacts.

Table 4.3 Guidelines for Interpreting Site Integrity and Assessing Research Potential.

	INTEGRITY POTENTIAL		
	NONE TO LIMITED	UNKNOWN TO UNCERTAIN	GOOD
TYPES OF SITE SUBAREAS	Subareas eliminated from shovel test consideration by reconnaissance crew; Nonfeature subareas with all negative shovel test results and no potential for deeper deposits; Nonfeature subareas on stable land forms with shovel test score 1; Nonfeature subareas with artifacts restricted to upper 20 cm; Features rated Poor; Shallow hearth features in stable land surfaces.	Nonfeature subareas with all negative shovel test results but with some potential for deeper deposits; Nonfeature subareas with shovel test scores 1-2, especially on active landforms; Nonfeature subareas with culture zones > 20 cm thick; Features rated Limited or Good; Shallowly buried features in active land surfaces;	Nonfeature subareas with score 3, especially on active landforms; Features rated Excellent; Rockshelters with cultural depth > 20 cm; Rockshelters with discernable features; Rockshelters with ecofact preservation; Open subareas with stratified deposits, especially on active landforms.
RESEARCH POTENTIAL	Low research potential.	Undetermined research potential.	High research potential.
RECOMMENDATIONS	No further management.	Avoid until evaluation completed; formal testing to better determine significance.	Avoid, protect, and preserve; otherwise test to obtain data necessary for formulating mitigation plan.
SUGGESTED TACTICS	None.	Prohibit tracked vehicles and manual and mechanical excavations; monitor to curtail vandalism. The type and extent of testing should be based on research design issues and site specific situations, such as size, and land form but may include backhoe trenching and/or manual excavation of 1m^2 test units.	Create "off-limits" preserve. Prohibit tracked vehicles and manual and mechanical excavations; monitor to curtail vandalism. Mitigate unavoidable impacts through data recovery excavations.

As a result of these problems, during the second season of work (beginning in September 1992), a new system of artifact tracking numbers was used. This system assigned a unique tracking number, referred to as a provenience number (PNUM), to every excavated provenience *whether or not artifacts were actually recovered.* Further, all artifacts from a given provenience were assigned the same PNUM, *regardless of class.* During detailed laboratory analysis, artifacts from each PNUM were sorted in classes and each class was assigned a unique accession number. During both phases of field work, an inventory of artifacts and samples was kept using Form 10: Field Inventory (see Appendix B). The inventory recorded for each FS or PNUM the horizontal provenience, vertical provenience, contents, and total number of specimens.

At the end of each field day, artifacts and samples were taken to the field laboratory for preliminary analysis. Field analysis was restricted to ensuring the accuracy of the inventory and collecting the frequency and ubiquity data necessary for site evaluation. Recording detailed artifact data was postponed (see below). Because many of the excavated artifacts were muddy, artifacts were cleaned just enough to permit a reliable class identification (e.g., sort the cultural lithic debris from naturally occurring lithic debris). Noncultural material was discarded.

The contents of each lot was checked against the bag label and against the Form 10 field inventory. The resulting artifact frequency data was compiled for each geomorphic subarea by shovel test and depth on Form 11: Summary of Shovel Tests (see Appendix B). For each subarea, these data were used to evaluate the results of shovel testing. Artifacts were stored in boxes and transported to the main archeological laboratory in Austin for further processing and analyses.

4.2.2 Analysis Phase

The analysis phase was conducted in the Austin laboratory after fieldwork had been completed on all sites. This phase consisted of further cleaning, cataloging, detailed recording of attributes, and preparation for curation.

4.2.2.1 Processing

Once in the laboratory, all artifacts and specimens were cleaned and stabilized using procedures specified in contract Technical Exhibit #1: Treatment, Marking, and Delivery of Artifacts and Documentation. Cleaning involved removing adhering dirt by either washing the artifacts in warm water or dry brushing. All flaked stone, groundstone, ceramics, mussel shell, and historic ceramics and glass were cleaned using water; depending on condition, bone was dry brushed or cleaned with water. Extreme care was taken to prevent mixing of bags. Lots were cleaned one at a time and both the provenience insert card and the original bag were kept with the lot.

After cleaning, materials were placed in clean polyethylene bags along with identification tags produced on acid free paper. Radiocarbon samples were wrapped in aluminum foil envelopes and then placed in polyethylene zip bags.

Labeling of artifacts was limited to projectile points, flaked stone tools, and other unique artifacts which underwent specialized analysis and/or illustration. The procedure used entailed writing the accession number (see below) directly on the artifact with black or white ink and then top-coating it with clear fingernail polish. Pursuant to Fort Hood Archeological Laboratory standard procedures, labeling of individual pieces of debitage, bone, and shell was not done (personal communication, Kimball Smith, DEH).

4.2.2.2 Cataloging

Following the guidelines specified in contract Technical Exhibit #1, artifacts and samples were assigned an accession number based on their horizontal and stratigraphic context. Each accession number consisted of three parts. The first part was a single-digit code for the county in which artifacts were recovered (1=Coryell County; 2=Bell County). This digit was followed by the Smithsonian site designation (minus the state and county). The third part was a unique specimen number derived from both provenience and artifact class. Specimen numbers were assigned consecutively for each site beginning with the next available number. For example, if previous surveys had collected six projectile points from site 41BL1125, then the next specimen recovered would have been assigned the accession number 2-1125-7.

Once assigned, this number was used for all identification and analysis purposes. Where multiple specimens of a given artifact class were recovered from the same provenience, all were assigned to the same accession number with the exception of projectile points and other diagnostics which were given individual accession numbers.

4.2.2.3 Detailed Recording of Artifact Attributes

Artifacts and samples recovered from reconnaissance or shovel testing were cataloged and recorded directly into a computer database using a proprietary Data Base Management System (DBMS) developed for Mariah Associates, Inc., by Wind-2 Software. Built on Microsoft's FoxPro platform and run on 486-66 PC computers, this database is designed to provide an integrated framework for the design, collection, management, and analysis of archeological data from the research design phase through final curation. Artifact data is directly entered; site and feature data are entered from primary field data sheets. Data is managed wholly within the program and can be manipulated and analyzed within the proprietary program or exported to other analytical programs such as Microsoft Excel. The program allows for the custom design and error-trapped collection of both provenience data and formal attribute data for a nested series of three levels of information. The macro-level is designed to record information about sites or other supra-feature phenomena. The meso-level is designed to record information about features, localities, strata, or other supra-artifact phenomena. These can be located within sites or within other features. The micro-level is designed to record information about artifacts or samples. These can be located within features, within sites, or both. For each level, attributes and values are custom designed for each project.

For this project, artifact provenience information and detailed attributes were entered into the DBMS program and linked with site provenience and attribute data. Feature data was not used. Once entered, data manipulation was possible on both inter-site and intra-site bases. When possible, an accession number was assigned prior to data entry so that it could be entered simultaneously with the analyses data. In some cases the accession number was entered into the DBMS after analysis data. After provenience information was entered, artifacts were assigned to a class based on their material and manufacture and individual artifact attributes were recorded for each artifact. Classes included bone, shell, ceramic, lithic core, lithic debitage, lithic tool, lithic projectile point, lithic groundstone, historic/recent, and other. Some classes were linked by a "superclass" to allow analysis of larger groupings. A list of artifact classes and their corresponding attributes is presented in Table 4.4.

For each artifact class, the level of detail in the recording scheme was designed to be consistent with the survey level research design. For example, lithic material was seen as a key variable for evaluating site research potential. By contrast, symmetry and complete taxon identification of faunal specimens was not attempted. It is expected that future phases of work at Fort Hood will develop more detailed typologies and attribute recording systems appropriate to testing and data recovery research questions.

Table 4.4 Artifact Classes and Recorded Attributes.

Superclass	Class	Attributes
Bone	Bone	N, skeletal element, taxon size, portion, weight, modified, burned
Shell	Shell	N, symmetry
Ceramic	Ceramic	N, ware, sherd form
Lithic	Core	N, lithic material, core type, cortex
	Debitage	N, lithic material, debitage type, flake size, cortex
	Tool	N, lithic material, tool type, use wear
	Projectile Point	N, lithic material, point type, intact, breakage, symmetry, reworking, flaking, serration, shape, cross-section, basal thinning, basal grinding, notching, stem shape, shoulder shape, tang shape, maximum length, maximum width, stem thickness, blade length, stem width, base width, weight
	Groundstone	N, lithic material, groundstone type, weight
Historic	Historic	N, historic material
Other	Other	N, material

Chert Typology

The chert typology used in recording the lithics from Fort Hood is discussed in depth in Chapter 6.0 of this report. Initially, 17 chert types were identified, distinguished by differences in color, texture, structure, luster, and relative degree of opacity or translucency (see Appendix C). Some of the chert types had preexisting folk names (Owl Creek Black, Fort Hood Gray, etc.) but are here arbitrarily designated as numbers 1 through 17. The type numbers indicate a spectrum of colors and chert textures beginning with the lighter cherts (1=Heiner Lake Blue, 2=Cowhouse White, etc.) and extending into the dark gray and black cherts (14=Fort Hood Gray, 17=Owl Creek Black, etc.). The majority of the chert types fall within the tan, gray, brown, and gray-brown color range (6=Heiner Lake Tan, 9=Heiner Lake Translucent Brown, 14=Fort Hood Gray). During analysis, it became apparent that types 12 and 14 were indistinguishable and were consequently lumped together into Type 14 (see Appendix C), resulting in 16 final types.

Despite this working typology, not all chert artifacts could be reliably assigned to one of the types and it was necessary to create several indeterminate categories for burned, patinated, and otherwise unidentifiable pieces. Aside from cherts that were altered by burning or patination, there was also a high degree of overlap in diagnostic characteristics among the chert specimens which fall at the far ends of the color/texture/luster spectrum for each respective type class. These elements, singularly and in combination, prevented the positive identification of chert type for many of the Fort Hood lithics. Rather than force a dubious specimen into one of the 16 chert types, 10 broadly different indeterminate types were designated. Although many of these indeterminate cherts may have actually belonged to one of the 16 defined types, these pieces often lacked diagnostic attributes to permit reliable typing. The 16 formal chert types are defined in Appendix C; as a methodological device, the 10 indeterminate types are defined below.

Type A-burned chert often displays a color change in the form of a "blush" or reddening of the original color. This effect ranged from a faint reddening when lightly heated (< 300°F), to a pronounced red-shift at high temperatures (> 700°F). Texture changes in the form of heat fractures (pot-lidding) occurred at medium to high temperatures (500-700°F), and luster changes that inhibit positive identification occurred at low, medium, or high temperatures (see Appendix C). Light colored cherts placed in the Type A-burned category might actually be heat altered pieces of chert Type 1 (Heiner Lake Blue - light colored outer part), Type 2 (Cowhouse White), or Type 3 (Anderson Mountain Gray). Darker, indeterminate cherts exhibiting a subtle red-shift may in actuality be burned pieces of Type 10 (Heiner Lake Blue), Type 11 (East Range Flat), Type 13 (East Range Flecked), Type 14 (Fort Hood Gray), or Type 15 (Gray/Brown/Green). Lithics displaying a pronounced reddening of color are possibly burned pieces of Type 6 (Heiner Lake Tan) or Type 8 (Fort Hood Yellow).

Type B-patinated cherts also display color changes (and possibly texture and luster changes) ranging from subtle to pronounced. The most common patination effect among the Fort Hood cherts is a color shift to white or pale yellow. Indeterminate cherts exhibiting this color shift may actually be patinated pieces of Type 4 (Seven Mile Mountain Novaculite), Type 8 (Fort Hood Yellow), Type 9 (Heiner Lake Translucent Brown), Type 10 (Heiner Lake Blue), Type 13 (East Range Flecked), or Type 17 (Owl Creek Black). There are at least two Fort Hood cherts that exhibit a darker patination. Type 14 (Fort Hood Gray) commonly turns percent purple-brown, and Type 3 (Anderson Mountain Gray) turns grayish-red-purple or brown-gray.

Type C-gray was another common indeterminate chert type encountered during lithic analysis. Lithics placed in this category may actually be atypical specimens of Type 5 (Texas Novaculite), Type 11 (East Range Flat), or Type 14 (Fort Hood Gray). When using the Type C-gray category, lithics displaying predominately gray color tones were arranged in a gray color continuum. When the lithic analyst judged that other colors present (such as brown or tan) were more dominant than the grays, another indeterminate color category was used.

Type D-brown was an indeterminate category used for unidentifiable cherts displaying primarily dark brown color tones. Atypical pieces of Type 6 (Heiner Lake Tan), or uniformly patinated pieces of Type 14 (Fort Hood Gray), may be among the cherts placed in this category. Material placed in the Type D-brown category was often similar to indeterminate gray/brown chert (Type F). However, it was judged that chert in the Type D-Brown category contained very little gray as well as a deeper shade of brown.

Type E-Tan was a common indeterminate chert type frequently encountered during lithic analysis. Many of the lithics placed in this category may actually be unidentifiable pieces of Type 6 (Heiner Lake Tan). Small pieces of this chert type may not show the diagnostic mottling that is necessary for positive identification. This category may also include atypical pieces of chert Type 7 (Fossiliferous Pale Brown) or Type 8 (Fort Hood Yellow). Additionally, light burning or patination may obscure some of the diagnostic characteristics in any of the tan cherts without radically altering their color.

The Type F-Gray/Brown category was used for cherts that did not fit easily into the indeterminate gray, brown, or tan categories. This category included atypical specimens of Type 2 (Cowhouse White --darkened inner portion), Type 3 (Anderson Mountain Gray), Type 5 (Texas Novaculite), or Type 15 (Gray/Brown/Green). Type F-Gray/Brown proved to be a catch-all category that accommodated a wide range of indeterminate lithics which did not fit easily into the other descriptive categories. Indeed, certain specimens in many of the sixteen types could be described as "gray/brown."

Type G-White was the category used to describe indeterminate white cherts encountered during lithic analysis. Light chert types such as Type 1 (Heiner Lake Blue - light colored outer part), Type 2 (Cowhouse White), and Type 3 (Anderson Mountain Gray) were among the hardest of the Fort Hood cherts to consistently identify. Aside from the tell-tale diagnostic flecking of Type 2 (Cowhouse White), it was often hard to discern the subtle differences in color, texture, structure, and luster that distinguish these three types. Lithics placed in the Type G-White category may also be unidentifiable specimens of any of these three chert types. It is also possible that lithics displaying a uniformly white patination were occasionally placed in the Type G-White category.

Type H (cortex) was used to describe lithic material that consisted primarily of outer cortex rather than chert. Cortex colors among the Fort Hood cherts included white, orange pink, reddish brown, yellowish brown, and light gray. Cortex material was identified by color and by the observation of weathering effects. The surface of the cortex may have a coarse, rough texture due to extensive weathering. However, it is also possible for stream rolling and other types of elemental exposure to create a smooth, abraded cortex surface. In most cases it was fairly easy to distinguish lithics that were composed primarily of cortex material.

Type D/T-Brown Translucent and Type E/T-Tan Translucent were categories used to describe translucent pieces of chert found in the Fort Hood assemblage. Because of the color contrast between certain pieces of translucent chert, it was decided that the two categories were necessary. However, it is possible that many of the pieces in the Type D/T and Type E/T categories were actually atypical examples of Type 9 (Heiner Lake Translucent Brown). It is the only translucent brown chert known to exist inside of Fort Hood, and is readily identifiable by its diagnostic striations. Lithics placed in the Type D/T and E/T categories did not display these diagnostic striations. However, it is possible to fracture chert Type 9 along a striation plane and produce a nonstriated, translucent specimen. Furthermore, the color contrasts noticed between Type D/T and Type E/T lithics may be no more than the extremes of the Type 9 color range.

The visual identification of the different chert types among the Fort Hood lithics was a tricky proposition at best. Between some specimens, there are only subtle differences of color, texture, luster, or structure. Changes in appearance induced by burning and/or patination may also reduce the certainty of correctly identifying the material type. Atypical chert specimens which fall at the far end of the color/texture/luster scale for their respective type class are another potential impediment to visual identification. Finally, some of the indeterminate cherts may actually be from outside of the Fort Hood area, and therefore not represented in the typology used to analyze the lithics.

The chert type for each individual lithic was determined by matching it with key specimens on the master chert typology board created for the project. This board contained the dominant specimen as well as the full known range of variation of each of the basic chert types. Pieces with an identifiable material type were assigned a number corresponding to one of the 16 basic types and unidentifiable pieces were matched with the 10 indeterminate chert types.

Other Lithic Attributes

Although lithic material type was recorded for all lithic artifacts, other attributes were recorded for the different classes. During direct data entry, debitage from each provenience lot was sorted according to debitage type, size, color, texture, luster, structure, and the presence or absence of cortex. Debitage types used in the analysis included flake, potlid, shatter, and unknown debitage. The debitage size categories consisted of small (less than 1 cm), medium (1-5 cm), and large (greater than 5 cm). Cortex was recorded as absent, abraded or nonabraded.

The entry of nonprojectile point tools followed the same procedure as debitage entry, the only difference being the specific attributes that were observed and recorded for tools. Attributes recorded for nonprojectile point tools included the tool type (e.g., biface, uniface, endscraper, sidescraper, modified flake, hammerstone). The presence or absence of use wear on each tool was also noted and recorded. For groundstone tools, the material type was expanded to include limestone and sandstone, and the tool type (mano, metate, pestle, sinker, etc.) and the weight in grams were recorded.

Projectile points underwent the most detailed and in-depth analysis of all the artifact classes. A total of 27 attributes were recorded for each projectile point. These attributes focused on typology, morphology and metrics. Typology consisted of assigning points to a named type based on classifications established by Turner and Hester (1985) and Suhm and Jelks (1962). Points that could not be assigned to a specific type were identified as Indeterminate Dart or Arrow points. In instances where not enough of the point was present to classify the point as dart or arrow, only indeterminate was used. Morphology included identification of observable traits such as material type, flaking, breakage, notching, and general shape characteristics. Metric measurements were taken on only those aspects of the points that were intact; no reconstructive measurements were made.

Other Artifact Classes

Prehistoric ceramic attributes included the sherd form (base sherd, body sherd, or rim sherd) and ware (if determinable). The two diagnostic categories were Doss Redware and Leon Plainware, while the nondiagnostic categories included incised ware, other plainware, and unknown ware.

Because of the scattered nature of the shovel tests on any given site, it was not expected that detailed faunal analysis, such as the Minimum Number of Individuals (MNI), would be meaningful. As a result, a bare-bones recording scheme was used for faunal specimens which would allow a rough index of assemblage diversity. Skeletal elements were recorded using a collapsed typology (long bone, mandible, skull, scapula, pelvis, rib, unknown). Taxon was recorded by size class only, based on bone wall thickness and general robusticity. Portion was recorded as whole, nearly whole, or fragment, and weight of the specimen was recorded in grams. The presence of burning or cultural modifications including cutmarks were noted.

For mussel shell, only the identifiable umbos (or hinge portions) were recorded. Nonhinge fragments were noted on field form 10 but were not entered into the database. Symmetry (right, left, unknown) was recorded for each umbo to permit calculation of total numbers present. Snail shells were not recorded.

Because all sites were a priori defined as prehistoric (historic components had been previously assigned separate trinomial site numbers), historic artifacts were not of interest except as indicating subsurface disturbances. Accordingly, the only attribute recorded for historic and/or recent artifacts specified the type of material such as glass, brick, ceramic, ferrous metal, nonferrous metal, and plastic.

Finally, a very few artifacts did not fit into the above classes. These included some lumps of hematite and a few nonlocal minerals such as schist which may or may not be cultural manuports. For these items, only the material was recorded.

4.2.2.4 Curation

All artifacts and samples recovered from archeological sites located on the Ford Hood Military Reservation remain the property of the U.S Government. Permanent curation of all archeological materials will be provided at Fort Hood. All materials used in curation preparations were of archival quality. Artifacts and specimen were contained in poly zip bags or poly vials. Original field forms, bag identification tags, field catalogs, specimen printouts, and inventory sheets were produced on acid-free, cotton-based paper.

4.3 QUALITY CONTROL PROCEDURES

From the outset, it was clear that a site evaluation project of this magnitude needed an active program of quality assurance. The sheer number of sites underscored the importance for rigor in methods, replicability of observations, and consistency of conclusions to ensure that each site would be evaluated according to the same set of rules. Directly related to the large number of sites was the fact that the project was necessarily a long-term field endeavor involving many different persons. Field work began in December 1991 and was not completed until July 1993, some 20 months later. (Field work on the final two sites was delayed until December 1993.) Moreover, more than 30 different persons worked in the field, with nearly a complete turnover of field personnel between the first site and the last site.

Accordingly, a program of Total Quality Management (TQM) was designed from the outset and implemented for all aspects of the project. The TQM program consisted of several closely related operations. These included development of standard operating procedure manuals, development of custom data recording sheets, a pilot study, training seminars, double-blind checks of data comparability, review of 100 percent of all data sheets, and appointment of an independent quality officer.

4.3.1 Procedures Manual

First, a standard operating procedures manual was developed and distributed to all field personnel (Mariah Associates, Inc., 1992). Closely based on the contractual scope of work, this manual summarizes the purpose of the project, discusses broad strategies, specifies the data collection tactics, and defines terms. In essence, it was the "bible" for field work. When the specialized evaluation procedures were developed for the LRPA sites (see Chapter 5.0), a supplementary manual was developed and issued (Mariah Associates, Inc., 1993). Both manuals were discussed in workshop fashion with crew members before beginning field work.

Provided in the manual were examples of the standardized data recording sheets developed for the project (see Appendix B). In addition to fairly generic formats for recording data from shovel tests and test pits (Forms 7 and 8), custom data sheets were developed for reconnaissance-level archeological (Forms 3 and 5) and geomorphological (Forms 4 and 6) observations. Additional forms were developed for the field inventory (Form 10), preliminary analysis (Form 11), for LRPA evaluation (Forms 14, 15, and 16), and for LRPA resurvey (Form 17). All forms went through an evolution of content and structure, beginning with a rough idea and ending with an optimal design. As problems were identified, each form was revised, but in general, the data on each new version was backwardly compatible. As new versions of a form were developed, existing stocks of the old form were discarded. Beginning with version 2.1 of each form, the version number was printed at the lower left to easily identify outdated versions.

The initial versions (1.1) were tested during a two-week pilot study conducted in December 1991. The pilot study visited a sample of site types and land forms and assessed utility of the forms as well as general data collection strategies. Based on this pilot study field work, version 1.2 was developed and used beginning in January 1992. Approximately 35 percent of the 571 sites were recorded using versions 1.2. In August 1992, version 2.1 was developed for many forms, which were again revised into version 2.2 in September 1992. A few forms further developed into version 2.3, especially to accommodate the LRPA evaluation procedures.

4.3.2 Training and Comparison Exercises

Despite the standardized data sheets, it was recognized that different observers could interpret the same phenomena differently. Indeed, as claimed by Indiana Jones, "Archeology is not an exact science." Accordingly, onsite training was conducted for the geomorphologists and archeologists who would be making the reconnaissance-level site evaluations. Each question of each form was discussed, again in workshop fashion, in an attempt to identify and resolve differences of professional opinion as well as subtle ambiguities in the scoring system. Only after everyone had a close agreement as to the meaning of the questions and prompts did field reconnaissance begin. As new reconnaissance staff were added to the project, they were matched for several field days with an experienced team before attempting their own sites. Even after such training, new observations, site types, and contexts continually stimulated an ongoing dialog between the several archeologists and geomorphologists.

In an attempt to verify that different teams were in fact evaluating sites similarly, a sample of sites was independently visited by different teams and the resulting scores were compared. This exercise was designed to measure the degree of data comparability between observers and compare the quantitative scores only. Of 11 sites and 15 subareas which were visited by two or more teams, the coefficient of variation for archeological scores ranged from 0 to 19 percent and averaged 6.8 percent (Table 4.5). For the geomorphological scores, the coefficient of variation for archeological scores ranged from 0 to 27 percent and averaged only 1.5 percent. Analysis of the raw field data on forms 3 through 6 for each site suggested that a coefficient of variation of more than about 8 to 10 percent was a result of different interpretations between the field personnel. For example, the differences in archeological scores on site 41BL140 resulted from a disagreement as to whether or not the observed burned rock constituted a feature. Two of the four archeologists assigned higher scores because they claimed that the burned rock present was sufficiently clustered to be designated as a feature. Similarly, the differences in archeological scores on site 41BL516 resulted from a disagreement as to the total area containing potentially in situ deposits; the higher scores included the entire land form while the lower scores were more conservative. Even so, and despite the high coefficients of variation on several sites, *in every case the ultimate assessment of integrity and corresponding management recommendation was identical for all teams.* These exercises and resulting discussions were very helpful in assuring data comparability. The overall quality assurance exercise concluded that sites were being evaluated comparably by different teams.

4.3.3 Quality Control Checkpoints

Despite this system set up to encourage quality, it was recognized that human error creeps into all endeavors and that this project would unfortunately be no exception. Human error was seen to possibly result in incomplete, contradictory, or missing data sheets, both from survey and shovel testing. Accordingly, a program was conducted under which every single page of field data was systematically reviewed for completeness and consistency. This task was conducted by an archeological technician generally within seven days of completion of field work for each site. Data sheets with incomplete or unclear information and those which contradicted other data sheets for the same site were returned to the crew chief for correction. This process was facilitated by a Quality Control checklist (Form 13). Typical errors included missing north arrows on site sketch maps, math errors on the quantitative forms, and conflicting provenience data on Form 10 and artifact bags.

Because of the complex logistical scheduling involved in coordinating multiple phases of work, more often than not, the crew chief who conducted the reconnaissance was not the same one who directed shovel testing. This situation called for clear communication between crew chiefs. Mistakenly shovel testing a site which had been recommended for no further work would have been a serious error, but even worse would have been *not* shovel testing a site with potential deposits.

Table 4.5 Comparability Analysis of Reconnaissance Team Data.

	Archeological Scores							Geomorphological Scores				
Site Subarea	#1	#2	#3	#4	Mean	Std. Dev.	Coef. Var.	#1	#2	Mean	Std. Dev.	Coef. Var.
41BL140	30	30	35	35	32.5	2.9	8.9%	25	23	24.0	1.4	5.9%
41BL203	13	17	--	--	15.0	2.8	18.9%	10.5	14.5	12.5	2.8	22.6%
41BL213	20	20	--	--	20.0	0.0	0.0%	10	10.5	10.3	0.4	3.4%
41BL516A	13	13	17	17	15.0	2.3	15.4%	9	10	9.5	0.7	7.4%
41CV594	35	36	37	40	37.0	2.2	5.8%	12	12	12.0	0.0	0.0%
41CV1010	14	15	17	--	15.3	1.5	10.0%	7.5	11	9.3	2.5	26.8%
41CV1114	12	13	--	--	12.5	0.7	5.7%	--	--	n/a	n/a	n/a
41CV1135	30	30	--	--	30.0	0.0	0.0%	17.5	17.5	17.5	0.0	0.0%
41CV1137A	19	19	19	--	19.0	0.0	0.0%	14	14	14.0	0.0	0.0%
41CV1137B	27	27	29	--	27.7	1.2	4.2%	23	25	24.0	1.4	5.9%
41CV1137C	27	28	29	--	28.0	1.0	3.6%	18	21	19.5	2.1	10.9%
41CV1186A	16	16	13	--	15.0	1.7	11.5%	--	--	n/a	n/a	n/a
41CV1186B	25	29	29	--	27.7	2.3	8.3%	--	--	n/a	n/a	n/a
41CV1186C	37	37	39	--	37.7	1.2	3.1%	--	--	n/a	n/a	n/a
41CV1385	--	--	--	--	n/a	n/a	n/a	19	15	17.0	2.8	16.6%
Average Coefficient of Variation							6.8%					1.5%

Communication between the 11 crew chiefs over the 20 month period was facilitated by means of an analog bulletin board in the field office which physically represented every site by a colored tag, according to its status. Further, each reconnaissance team completed a written set of treatment instructions for the shovel testing crew (Form 12). This form did not include primary site data but was essential in assuring complete follow through on each site.

Following completion of all field work, including the preliminary analysis discussed above in section 4.1.3, all original field forms and the draft site reports were reviewed by the Principal Investigator (PI) for concurrence on site interpretation. If the PI had any questions regarding the primary data or their interpretation, these were discussed with the crew chief and/or geomorphologist. If warranted, the PI made changes in the suggested recommendations, or even directed that additional shovel testing be conducted on the site. Once satisfied that (1) the site had been adequately investigated according to the scope-of-work, and (2) the conclusions and management recommendations were well-founded and defensible, the PI submitted the site report to Fort Hood DEH.

Nevertheless, over the 20 month period, some inconsistencies in final recommendations were bound to occur among the 571 sites and 896 site subareas. After all site data had been tabulated in the DBMS (see Section 4.2.2.3), numerous cross checks were run in order to spot possible outliers and/or problematic contexts. For example, some site subareas were not shovel tested because the upper 40 cm was completely disturbed but were nonetheless located on T1 terraces; all of such areas should have been recommended for deep testing. Cross checking the data base identified a small number of such cases which were erroneously recommended for no further management in the preliminary site reports. Accordingly, the original data for these sites was reevaluated and if appropriate, new recommendations were made. The 11 site subareas which were originally recommended for no further management, but which are now recommended for percent testing are: 41CV484, CV668B, CV913B, CV960B, CV1023C, CV1097, CV1099, CV1137B, CV1218, CV1378B, and CV1551. New recommendations appear in complete form in Appendix A and in summary form in Appendix F.

During laboratory recordation of artifact attributes, quality control was greatly facilitated by the automatic error trapping routines of the DBMS. For each attribute, a specific value type and format was assigned prior to beginning artifact recordation. Value types were numeric, logical, value list, and alphanumeric. For numeric values (e.g., artifact weight), upper and lower limits were set along with a decimal format. Logical values recorded presence or absence (e.g., basal grinding or none). For those attributes with value lists (e.g., lithic material), a predefined list of acceptable entries was created from which to select. Values not on the list or outside the accepted numeric range could still be entered into the DBMS, but these were flagged as "out of condition." The laboratory supervisor would periodically print a list of "out of condition" artifacts for double checking.

4.3.4 Quality Control Officer

Lastly, the program of TQM included appointment of a formal Quality Control Officer (QCO) not directly associated with the project. The QCO made periodic field inspections and compared the ongoing work against the contract, the scope of work, and the procedures manuals. Because the QCO was an archeological PI in another Mariah office, he was often able to spot potential problems before they became serious and offer suggestions and solutions based on similar project experience. The findings of each inspection were reported first to Mariah upper management, then to the project PI. On occasion, the QCO also reported his findings to Fort Hood DEH. If problems were diagnosed, the PI and project team were directed to solve the problem.

Most of the comments made by the QCO dealt with archeological matters. For example, one inspection questioned whether or not sufficient shovel tests were being dug to satisfy the contractual one per 900 m^2 guideline. On the basis of this comment, an analysis of completed sites showed that virtually all sites were tested with an appropriate number of shovel tests. However, crews were also directed to return to three sites and dig additional shovel tests. Other comments made by the QCO dealt with project logistics. For example, on one occasion, the periodic QC inspection was interrupted by a stuck vehicle, resulting in significant delay and loss of efficiency. As a result, and at the suggestion of the QCO, cellular telephones were soon provided to each field crew to allow quick and efficient communication between the PI and the field crews.

4.4 RESULTS

Archeological findings resulting from the site evaluation program are variously discussed in Chapters 6.0, 7.0, 8.0, and 9.0, and conclusions of research potential and site significance are detailed in Chapter 10.0. The following section briefly summarizes some basic data regarding overall site distributions and, for the project as a whole, artifact frequency, ubiquity, and vertical distribution.

4.4.1 Site Distribution

For the 571 trinomial sites, the reconnaissance distinguished more than 800 geomorphic subareas. When supplemented by the additional analyses of LRPA resurvey data (see Chapter 5.0), a total of

897 distinct management areas were defined (Table 4.6). All areas were assessed for geomorphic and archeological potential and 468 areas (52%) were determined to have no potential for intact buried deposits and were not shovel tested. (However, some of these were subsequently evaluated by LRPA-specific tactics --see Chapter 5.0). Of the 429 remaining areas, two could not be fully assessed because of access problems, and 427 areas (48%) were determined to have the potential for intact deposits. Of these, shovel testing was conducted on 414 areas (97%). The remaining 13 areas were not tested for a variety of reasons. Some areas had been previously tested; on others, the upper 40 cm was clearly disturbed but intact deeper deposits were possible; on several very small rockshelters or features, the shovel testing tactics would have been overly destructive of potentially NRHP eligible deposits. While many of the trinomial sites were wholly within a single land form, the majority of sites were in fact subdivided into as many as eight distinct management areas, with an overall average of more than 1.5 areas per site. As shown in Table 4.7, of the 897 site subareas, 273 areas (30%) are situated in stable upland land forms. An additional 341 areas (38%) are on other land forms with minimal depositional potential, including 147 slopes (16%), 60 Pleistocene terraces (7%), and 134 areas with multiple land forms (15%). The inventory is rounded out with 117 rockshelters (13%), and 166 areas (19%) in highly depositional land forms.

A total of 5,814 subsurface tests were excavated in those subareas with depositional potential. As demonstrated in Table 4.7, the decision of whether or not to excavate shovel tests was always made on the merits of the individual site subarea, and not on the basis of a single criterion such as gross land form. While upland land forms in general had negligible subsurface potential, a total of 129 tests were excavated on 26 upland site subareas which were determined in fact to have some potential. Some of these reflect cases of accumulated sediment deeper than 20 cm, and others are burned rock features on otherwise contextless surfaces. Similarly, 637 tests were excavated on 45 slope land forms where potential deposits were suspected. Nevertheless, the majority of the 5,814 tests were dug in highly depositional contexts, including 2,956 tests (51%) in T1 terraces, 500 tests (9%) in colluvial deposits, 220 tests (4%) in rockshelters, and 110 tests (2%) in T0 terrace floodplains.

4.4.2 Artifact Frequency, Ubiquity and Vertical Distribution

The 5,814 subsurface tests recovered a total of 29,612 buried artifacts. Another 307 artifacts were collected from the surface, for a total of 29,919 recovered artifacts. With a diameter of 35 cm and an average depth of 40 cm, the 5,716 shovel tests totaled about 220 m^3. The 98 additional quad tests and test pits totaled about 15 m^3, for a total excavated volume of 235 m^3. Thus, overall average artifact frequency can be calculated as 5.1 artifacts per test and 127.3 artifacts per m^3.

Overall artifact ubiquity is somewhat more difficult to calculate. Of the 897 total possible subareas, 414 subareas (46%) were shovel tested; the remaining areas were mostly deflated upland surfaces and were not tested (see Chapter 10.0 for a detailed breakdown). This calculates to an average of 14 tests per site subarea. At a rate of one test per 900 m^2 of area with the potential for intact deposits, the majority of site subareas received fewer than 10 tests (i.e., were smaller than 9,000 m^2, or 2.2 acres) but 26 areas received more than 50 tests each (were greater than 45,000 m^2, or 11 acres) and one area received 250 tests (was at least 225,000 m^2, or 56 acres). The 29,919 artifacts were distributed at an average rate of 72 artifacts per site subarea and 5.14 artifacts per test.

Table 4.6 Frequency of Site Subareas by Tactic.

	Subsurface Investigation	Total Site Subareas
No Potential for Intact buried deposits	Not Shovel Tested	468
Potential for Intact Deposits	Not Assessed (access problems)	2
	Shovel Tested	414
	Not Shovel Tested (disturbed upper 40 cm, restricted deposits, etc.)	13
TOTAL		897

Table 4.7 Distribution of Shovel Tests by Landform.

Landform	Total Areas	Areas Tested	Pct. of Areas Tested	Total Tests	Pct. of Tests	Tests per Area
T0 Terrace	17	15	88.2%	110	1.9%	7.3
Colluvial	30	28	93.3%	500	8.6%	17.9
T2 Terrace	60	12	20.0%	308	5.3%	25.7
Rockshelter	117	102	87.2%	220	3.8%	2.2
T1 Terrace	119	113	95.0%	2,956	50.8%	26.2
Multiple	134	73	54.5%	954	16.4%	13.1
Slope	147	45	30.6%	637	11.0%	14.2
Upland	273	26	9.5%	129	2.2%	5.0
TOTAL	897	414	46.2%	5,814	100.0%	14.0

However, empirical distribution was far from uniform; while 75 percent of all site subareas had *some* positive tests, only about one-third of all *tests* were positive. Table 4.8 nicely illustrates the effect of sample size on ubiquity. This table summarizes overall ubiquity of positive tests, cross-tabulated by ordinal groupings of number of tests per area and by positive tests as a percentage of total tests per area. Values shown are the numbers of site subareas having a given number of tests (rows) and a given overall ubiquity of positive tests (columns). For the sites with fewer than 10 tests, a bimodal distribution is evident, with frequency peaks at 0 percent ubiquity and 76 to 100 percent ubiquity. This reflects the fact that as the sample size decreases and approaches a single test, ubiquity is either zero or 100 percent. For the next three groupings of number tests per area, ubiquity becomes more and more strongly unimodal between 1 and 25 percent; for those site subareas with more than 50 tests (an adequate sample), more than 65 percent have a ubiquity between 1 and 25 percent.

The overall vertical distribution of artifacts is strongly one-tailed and unimodal in the upper 10 cm; fully 84 percent of all artifacts were recovered from the upper 40 cm, with less than 0.2 percent recovered from below 100 cm (Table 4.9).

Table 4.8 Frequency of Tested Site Subareas by Ubiquity of Positive Tests and Numbers of Tests per Subarea.

	Positive Tests as a Percentage of Total Tests						
	0%	1-25%	26-50%	51-75%	76-100%	Total	Column %
Sites with 1-10 tests	86	20	47	25	104	282	68%
row %	30%	7%	17%	9%	37%	--	--
Sites with 11-20 tests	9	22	9	6	2	48	12%
row %	19%	46%	19%	13%	4%	--	--
Sites with 21-50 tests	7	31	11	5	4	58	14%
row %	12%	53%	19%	9%	7%	--	--
Sites with > 50 tests	2	17	5	1	1	26	6%
row %	8%	65%	19%	4%	4%	--	--
TOTAL SITE SUBAREAS	104	90	72	37	111	414	--
row %	25%	22%	17%	9%	27%	--	--

Table 4.9 Overall Distribution of Artifacts by Class and Depth Below Surface.

	Lithics												
Depth (cmbs)	Debitage	Core	Tool	Point	GS	Ceramic	Bone	Shell	Sample	Historic	Other	Total	Percent
Surface	1	2	31	263	1	1	6	0	1	0	1	307	1.0%
0-10	6,693	20	80	21	3	1	454	129	9	368	3	7,781	26.0%
10-20	6,334	11	0	12	1	1	579	41	8	135	1	7,123	23.8%
20-30	5,129	12	0	9	0	0	660	41	13	60	1	5,925	19.8%
30-40	3,473	5	0	10	1	0	456	19	6	25	0	3,995	13.4%
40-50	1,774	4	0	9	1	0	335	9	2	9	2	2,145	7.2%
50-60	839	4	0	5	0	0	51	2	2	0	0	903	3.0%
60-70	707	1	0	4	0	0	128	6	2	0	0	848	2.8%
70-80	639	1	0	2	0	0	41	4	1	0	0	688	2.3%
80-90	118	1	0	0	0	0	4	0	0	0	0	123	0.4%
90-100	34	0	0	0	0	0	3	0	0	0	0	37	0.1%
100-110	3	0	0	0	0	0	0	0	0	0	0	3	0.0%
110-120	5	0	0	0	0	0	0	0	0	0	0	5	0.0%
120-130	6	0	0	0	0	0	0	0	0	0	0	6	0.0%
130-140	16	0	0	0	0	0	0	0	0	0	0	16	0.0%
140-150	10	0	0	1	0	0	0	0	0	0	0	11	0.0%
150-160	3	0	0	0	0	0	0	0	0	0	0	3	0.0%
Total	25,784	61	111	336	7	3	2,717	251	44	597	8	29,919	100.0%
Percent	86.2%	0.2%	0.6%	1.1%	0.0%	0.0%	9.1%	0.8%	0.1%	2.0%	0.0%	100%	--

However, this distribution is very strongly affected by the fact that few shovel tests were dug much deeper than 50 cm. By normalizing the upper 50 cm, the frequency distribution may be extrapolated to approach zero around 100 cm, which in fact matches the empirical results. The reason for the convergence is that while relatively few tests were dug to 100 cm or below, these were typically in culturally rich deposits such as rockshelters or burned rock mounds.

Examination of cutbank exposures during reconnaissance demonstrated stratified cultural material buried up to 300 cm below surface in Holocene terrace deposits. No tests were dug deeply enough to investigate these deeply buried occupations, but artifact distribution with depth in these terrace deposits is strongly suspected to be multimodal.

Over 86 percent of all artifacts recovered were lithic debitage, followed by about 9 percent bone, 2 percent historic and recent, 1.1 percent projectile points, and less than 1 percent each of lithic cores, tools, groundstone, shell, ceramics, and other. The relatively high proportion of projectile points reflects the fact that no other artifact class was routinely collected from the surface. In fact, more than 68 percent of all points were collected from the surface. When surface artifacts are excluded, points slip to less than 0.3 percent of the total subsurface assemblage.

5.0 LITHIC-RESOURCE SITES: SPECIAL CONSIDERATIONS

G. Lain Ellis

As noted in Section 3.3.3, Shafer (1992) made a series of recommendations for handling lithic-resource sites in a CRM framework. His chapter is notable because it represents the first serious attempt to specify how one might manage and exploit such sites. As an initial attempt, Shafer's work is a good and useful document, especially with respect to making a case for the value of lithic-resource sites and for the general means by which one might pragmatically extract useable data. However, as with most early forays into unexplored territory, his effort suffers from having little cumulative standard wisdom on which to draw. Furthermore, as an introductory work, it is necessarily general and therefore provides insufficient concrete guidance for implementing a CRM program to evaluate and manage LRPAs at Fort Hood.

Chapter 3.0 outlines the limits within which a real-world solution to the LRPA problem must be worked out because these limits realistically reflect the conflicts inherent in the various contexts. The present chapter delineates the process by which Mariah evaluated 94 LRPAs. This process was itself developed in an attempt to flesh out many of Shafer's proposals in a form that could be effectively implemented at Fort Hood and, perhaps, other places where similar sites occur. The chapter begins (Section 5.1) with a discussion of the LRPA-specific significance standards (Section 5.1) Mariah developed as a basis for site assessment. This discussion includes arguments for the effectiveness of the standards vis a vis the above parameters and the background for the LRPA problem. The discussion then shifts (Section 5.2) to the field and analytical procedures Mariah developed in order to implement the significance standards. Next comes a discussion (Section 5.3) of the decision-making structure used to divide LRPAs into smaller units. Since the subdivision process was oriented toward the eventual NRHP eligibility status that would apply to an LRPA or a subdivided unit, the discussion also covers the nature of the recommendations we have made for LRPAs.

5.1 SIGNIFICANCE STANDARDS FOR LRPAS

The main issue to be addressed by LRPA-specific significance standards is the conditions under which a contextless assemblage can be judged to have sufficient research potential to warrant NRHP nomination. Since such assemblages are not stratigraphically discrete and cannot be assumed in most cases to be behaviorally or culturally related, they automatically fail any integrity-driven standards (see Section 3.1.3). Since current analytical capacity allows for the eventual integration of LRPA assemblages into models of prehistoric adaptation, LRPA-specific standards, therefore, will be a special case within the problem-driven standards that apply to prehistoric sites according to the Fort Hood HPP and Mariah's scope of work (see Section 3.1.3). More precisely, since LRPAs may contain any combination of ancient or Holocene depositional contexts and may or may not be associated with any naturally occurring chert resources, the LRPA-specific significance standards must supply the criteria for judging the NRHP eligibility status of contextless assemblages at LRPAs in order to *supplement* integrity-driven standards, and not to replace them.

For a contextless LRPA assemblage to contribute to problem-oriented research into lithic-procurement behavior, a contractual LRPA (i.e., a large site) also must be a functional LRPA (i.e., be a locus of lithic-procurement activities). A palimpsest surface at a large site without chert has extremely poor prospects to contribute to research issues because currently available and reasonably anticipatable analytical capacity cannot translate such assemblages into interpretable behavioral units that are discrete enough to relate to other such units at other sites. Indeed, there is no special reason to attempt to protect large, contextless, chertless sites because the grossness of the empirical results would not be worth either the direct monetary costs of data collection and analysis or the social costs of interfering with the Army's training mandate, especially since the latter can be an important political influence on the future course of CRM activities at Fort Hood (see Sections 3.1.4 and 3.3.4). On the other hand, lithic-procurement data is important enough to the goals of the research design for Fort Hood that the difficulty of using contextless assemblages from functional LRPAs is not by itself sufficient reason to abandon them, especially since technical advances may reduce the degree of difficulty (see Section 3.3.3). Therefore, the first LRPA-specific significance standard is that a contractual LRPA must have enough naturally occurring chert either onsite or nearby to warrant a judgment that it could have been a functional LRPA.

It is not enough that a large site also be a functional LRPA because the potential presence of an assemblage does not automatically translate into a capacity to contribute data to lithic-procurement research. This follows from the fact that cultivation and, especially, widespread traffic by heavy vehicles are recent human impacts that can substantially alter the nature of an artifact assemblage (see Section 3.3.3). In the event that such widespread human impacts have occurred, a functional LRPA assemblage contains an unknown proportion of historically modified artifacts and pseudoartifacts. In such cases, it would be necessary not only to cull apparent natural chert objects from apparent cultural ones, it also would be necessary to determine which of the apparent cultural artifacts actually are prehistoric artifacts. However, mechanically damaged chert objects frequently have the attributes of chert objects created by tool makers. Thus, the scientific reliability of an assemblage collected from a very heavily damaged functional LRPA would be subject to extreme doubt. This element of doubt would imply that the resulting data base is not worth the monetary cost of acquiring the data and the additional monetary cost of winnowing out the damage-induced chaff. Hence, the artifacts in a contextless assemblage from a functional LRPA must have sufficient physical integrity to be interpretable without introducing undue additional ambiguity and difficulty into an already difficult process. Thus, the second LRPA-specific significance standard is that a functional LRPA surface must not be damaged to the extent that the physical integrity of the artifacts in any potential assemblage has been compromised to the point of untrustworthiness. Most functional LRPAs that fail this standard will be in locations where the Army has historically concentrated some of its training exercises. Not coincidentally, therefore, this significance standard directly addresses at least some of the conflict between archeological and land-use goals.

The first two significance standards are applicable only to the in-principle potential of a large site's relevance to lithic-procurement research. As such, they do not provide a sufficient basis for determining whether or not a contextless, functional LRPA actually has the potential to contribute to research. In order to use lithic-procurement data to advance research, there actually must be enough of it present at a functional LRPA to provide a data base large enough to analyze with respect to the net long-term results of lithic-procurement activities. Otherwise, there is no realistic likelihood of having a data base that is robust enough to serve as a basis for distinguishing the general procurement patterns in one time period from the patterns in another as complementary data become available. In other words, a functional LRPA surface characterized by very few, very widely spread lithic scatters is not particularly valuable as a source of data because not enough data is present to do much with.

Hence, another significance standard should be that the distribution of artifacts within a functional LRPA must be sufficiently widespread to allow for random and opportunistic sampling strategies in which there is a relatively high probability of finding data almost anywhere one goes. This standard helps to assure that a decision to protect a functional LRPA is accompanied by a realistic probability of yielding data in mitigation programs that are cost-effective in the sense that a minimum amount of field effort will be spent examining areas that have little potential to yield useable data. This standard also avoids as yet undemonstrated assumptions about what kind of behaviors took place. For example, using something like the two-tool rule as a threshold for significance (depending on what counts as a tool) could automatically rule out any functional LRPA for which raw-material bulk-reduction was the only major activity that took place. In fact, the standard does not assume that any of the artifacts located at a functional LRPA had to be made from materials acquired there because it is an empirical issue to determine whether the mere presence of chert was a sufficient reason for anyone to procure any of it. In general, establishing any specific taxonomic content as a threshold for significance would be inappropriate because it would presuppose that we have a detailed empirical knowledge of the history of lithic procurement patterns at Fort Hood. If we currently had this kind of knowledge, it would not be necessary to assess *any* functional, contextless LRPA because the data there would be applicable only to trivial and resolved issues, and the sites would be automatically insignificant because they fail both integrity- and problem-driven significance standards expressed in the HPP (see Sections 3.1.3 and 3.3.2).

The three LRPA-specific significance standards should be sufficient to assure that a site which fails them is not worth protecting, and that a site which meets them is worth going to bat for. Together, the standards identify large sites or parts of large sites as significant for lithic-procurement research only if they have a realistic chance of contributing data using currently available analytical capacity. It also appears that these standards do not unduly discriminate against sites that would become more valuable in the future as a result of development of reasonably anticipatable technologies. The reasons for this optimism are that future technologies: (1) cannot realistically be expected to provide the degree of temporal resolution that would make assemblages at large, contextless, chertless sites valuable; (2) will not transform large chertless sites into functional LRPAs; and (3) cannot realistically be expected to change the need for large, undamaged data bases that accurately represent the net results of lithic-procurement activities that could span the entire Holocene period at very large sites.

5.2 PROCEDURES FOR EVALUATING CONTRACTUAL LRPAS

The reader will note that the LRPA-specific significance standards, although they focus only on a particular class of site, are not particularly detailed. This follows from the fact that a significance standard is something apart from the procedures used to implement it, and one of the tasks of developing implementation procedures is to show how they operationalize the content of the standards. This section discusses the evaluation procedures for contractual LRPAs by describing the individual steps in the evaluation process. Where relevant, the descriptions include a discussion of its contribution to the operationalization of the significance standards.

As noted in Section 3.1.3, no research design was in place when Mariah began the process of evaluating LRPAs. As a result, the evaluation process began by applying procedures for evaluating small sites with respect to the nature of depositional context. Thus, the evaluation of LRPAs began by dividing them into geomorphic subareas and performing shovel tests on any subareas that had the potential to contain intact cultural assemblages in stratified depositional contexts. These procedures were implemented under the assumption that evaluating LRPAs according to integrity-driven significance standards would be useful and necessary regardless of the eventual content of LRPA-specific significance standards and procedures.

Upon submission and acceptance of Mariah's general research design for Fort Hood, we immediately began attempting to construct an LRPA-specific research design so that we could complete the evaluation process. As we grappled with this research design, it became apparent that attempts to characterize the content of assemblages at functional LRPAs would be hampered by several variables. The first variable is the difficulty (noted by Ensor 1991) of distinguishing cultural lithic objects from natural ones, which is a task that only well qualified, experienced lithic analysts should undertake. This implied that our options were (1) to field crews of experienced lithic specialists; (2) to collect massive amounts of materials for in-lab analysis; or (3) to make a small number of random collections for in-lab analysis. Option (1) would be beyond the call of duty according to widely used staffing standards in the archeological community and would be fiscally irresponsible from the company's perspective. Option (2) would violate a contractual clause prohibiting collection of large amounts of noncultural materials. Option (3) would have a high probability of producing an unrepresentative data base. Furthermore, options (2) and (3) would be equivalent to mitigation-level activities (per Shafer 1992) which appear to be beyond the scope of assessment-phase CRM requirements: it borders on the nonsensical to believe that a mitigation-level assessment procedure should be used as a basis to determine whether a site must be protected for possible future mitigation. Indeed, assemblage characterization would be undesirable because basing significance judgments on assemblage content would run the risk of biasing significance against assemblages that did not happen to meet our a priori expectations of what a procurement locale should contain.

This implied that our only realistic options were (4) to focus on lithic evidence that any experienced field technician could be expected to identify reliably; (5) to emphasize *distributions* of lithic artifacts rather than *kinds* of lithic artifacts; and (6) to rely on survey observations rather than collection analysis. The task, therefore, was to design procedures for sites that had been previously surveyed for their boundaries, but not evaluated for their depositional characteristics or surveyed for their suitability as sources of lithic-procurement data. The procedures developed to assess NRHP eligibility of large sites (contractual LRPAs) include six distinct tasks:

1. Preparing a baseline map;
2. Reconnaissance;
3. Shovel testing of areas with stratified deposits, if applicable;
4. Establishing resurvey parameters, if applicable;
5. Resurvey, if applicable; and
6. Defining and assessing management units.

These tasks establish the framework within which to perform evaluation according to a fatal flaw analysis (Trierweiler 1994b). The tasks are represented in schematic form in Figure 5.1.

5.2.1 Baseline Map

Evaluation activities were based and recorded on a large-scale aerial photograph (about 1 cm:30 m) that provided a large format for mapping features, resurveys, and other aspects of the site assessment process. One of the objectives to be achieved with the use of these maps was to identify, in advance, areas with low and high probabilities of damage by training activities prior to reconnaissance so that the reconnaissance team could concentrate its field time on more problematic areas of the site. Another primary purpose of the map was to provide a cumulative visual record of information on which to base each step of the assessment process, from reconnaissance to definition and assessment of management units. Acetate overlays were attached to the photograph to record more or less separate phases of the evaluation on separate layers. As a practical matter, the large scale of the photographs also proved to be highly valuable for navigational and locational purposes.

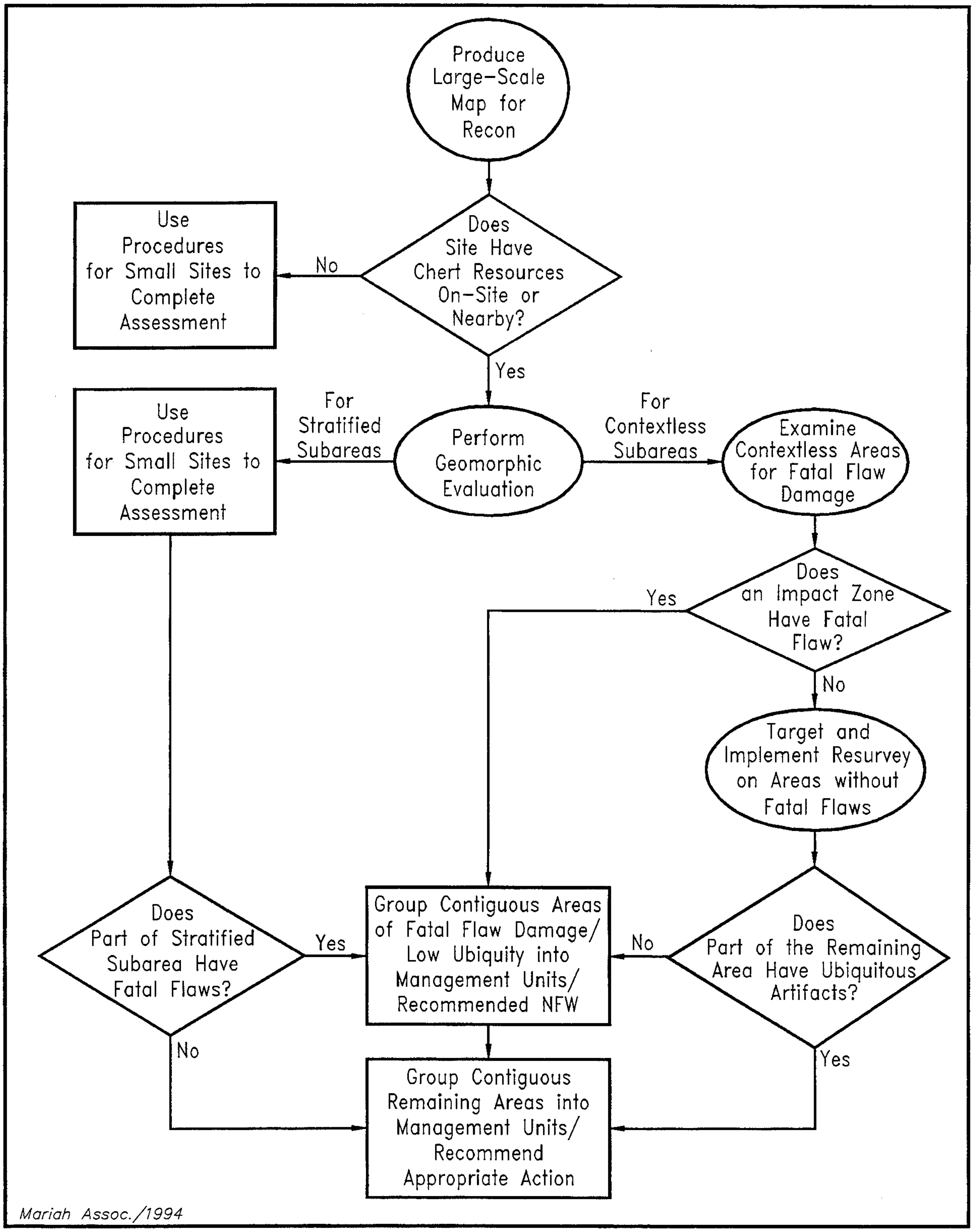


Figure 5.1 Large Site Evaluation Procedures.

5.2.2 Reconnaissance

As with small sites (see Chapter 4.0), evaluation of contractual LRPAs involved assessing archeological potential according to the depositional nature of archeological context. The LRPA-specific procedures added to the other procedures a series of steps for determining whether a large site is a functional LRPA and, if so, whether it contains any contextless areas that might contain lithic-procurement assemblages. Reconnaissance therefore functioned as a preliminary three-step filter within which to identify the extent to which a large site is potentially significant or fatally flawed under integrity-driven standards and LRPA-specific standards.

As with small sites, if reconnaissance showed that a large site contains different landforms with different potentials to contain intact cultural deposits in discrete stratigraphic context, the site was divided into subareas on geomorphic grounds. The subareas were mapped on an overlay to the aerial photograph. If a subarea was observed to have potentially significant stratified contexts, it was scheduled for shovel-testing. (Shovel testing procedures are discussed in detail in Chapter 4.0 and will not be discussed here.) By the end of this step of reconnaissance, all large sites were divided into geomorphic subareas. Hence, this step of reconnaissance provided the first filter for dividing large sites into more manageable units if there were geomorphic grounds for doing so. Note that as a matter of having started the evaluation process prior to development of LRPA-specific procedures, this portion of the reconnaissance was complete before LRPA-specific reconnaissance began.

The reconnaissance crew then examined the site to determine whether chert occurs naturally within site boundaries or nearby. "Nearby" was defined as within about 100 m of site boundaries. This definition was established for two basic reasons. First, site boundaries frequently follow the banks of creeks that can contain high concentrations of chert nodules in their bed-load components. In such cases, a chert resource is technically outside a site's boundaries, but only as a result of arbitrary site-definition procedures. Second, having acknowledged that boundaries may be arbitrary with respect to a site's status as a functional LRPA, it was necessary to draw a line somewhere without the benefit of any knowledge of patterns of lithic-procurement behavior. The 100 m rule was adopted arbitrarily in an attempt to apply a reasonably conservative and conservationist approach to dealing with ignorance.

Having determined that chert occurs naturally onsite or nearby, the reconnaissance crew judged whether or not chert occurs abundantly enough to have been a significant resource. This judgment process was admittedly intuitive because scattered chert nodules or cobbles occur as residual and reworked background clutter on many surfaces at Fort Hood. Although it is possible that extremely sparse chert distributions were features on the cognitive maps of prehistoric people (cf. Binford 1983b), it would not be useful to define a functional LRPA on a such a minimalist presence/absence basis because doing so would transform much of Fort Hood into a functional mega-LRPA. In other words, for purposes of identifying a functional LRPA, a judgment that chert is present as a potential resource should involve a density threshold. However, we found no readily apparent way, short of a detailed geological data-recovery effort, for defining this threshold on nonintuitive grounds.

The judgement that a site has significant chert resources is equivalent to the judgment that it was (or, more precisely, *probably* was) a functional LRPA in systemic context. Having judged that a site was a functional LRPA, the reconnaissance crew defined "chert zones" (see Form 14, Appendix B). Observations were made about the nature of the source (e.g., bedrock outcrop, colluvial lag), the form of the chert (e.g., tabular, cobbles), the overall diversity of the chert (homogenous vs. heterogenous), the general distribution (e.g., dense pavement, patchy scatters), and the apparent overall range of attributes represented (e.g., color, texture, hardness). These characterizations were intended to be highly preliminary assessments of gross characteristics. Chert zones were defined according to their gross characteristics and recorded on an overlay to the aerial photograph. In many cases, more than one chert zone was defined because there were two or more chert distributions with different gross characteristics. In other cases, a single chert zone was defined as consisting of two or more spatially separate areas with very similar chert assemblages.

If reconnaissance showed that there were no lithic resources, then the subareas were evaluated solely according to integrity-driven standards that focused on identifying the potential to preserve intact deposits in stratigraphic context. Thus, the net outcome of reconnaissance at chertless large sites is identical to the outcome of reconnaissance at small sites, and the outcome of assessment is based on the nature of archeological context. However, if reconnaissance showed that a large site had enough chert onsite or nearby to warrant defining a chert zone, then the evaluation proceeded to the other LRPA-specific steps. The remainder of the discussion of reconnaissance procedures applies only to functional LRPAs.

Since the first step of the reconnaissance procedures has already identified areas in which archeological materials may be buried in intact stratified deposits, it also by default has identified areas at functional LRPAs which, if they have lithic-procurement-related evidence, may be significant according to integrity-driven standards. Having defined chert zones, the third reconnaissance step is to record areas of damage that would affect the physical integrity of the artifact assemblage in contextless areas. Damage assessment is the second filter in the LRPA-specific significance standards, and reconnaissance activities attempted to identify contextless areas in which the artifact base would be unreliable as a result of damage, and to distinguish them from areas in which the potential for damage is low. The third reconnaissance step, therefore, is to define impact zones that are fatally flawed with respect to addressing lithic-procurement issues as a result of damage to the artifact base.

The reconnaissance crew examined contextless surfaces in order to determine the extent and nature of damage (see Form 15, Appendix B). Damage from training activities frequently is patently obvious in the form of spatially extensive surfaces of rutted, devegetated land and dense networks of large and small rutted trails among small "islands" of trees. Where upland soils are patchy and bedrock is visible, it is easy to see evidence of rock crushed or scarred by tracked vehicles. In some places, small networked trails are much more widely spaced or more confined to the peripheries of large trails or roads, especially around large mudholes that form after rains. Widespread evidence of cultivation occurs in the form of contour terraces, water-control features, and, on rare occasions, evidence of recent plowing and reseeding by military personnel attempting to control erosion. Evidence of forest clearing (especially cedar harvesting) also is widespread, sometimes in the form of isolated manual-cutting with axes and chain saws, and sometimes in the form of clear-cutting and bulldozing. Somewhat more localized impacts occur in the form of borrow pits, bulldozing for berms and other purposes, and excavations of foxholes and "hull downs" (i.e., earthen emplacements for armored vehicles). Most of these smaller impacts predate the CRM program, but others may have resulted from occasional breakdowns of the permitting process, including mistaken locations of persons during training and other activities. Many of the more recent localized impacts appear to be at least several years old and therefore predate the recent institution of controls on earthworks.

Impacts from natural processes also affect the scientific potential of LRPAs. At many sites, bluffs or steep slopes have led to formation of colluvial deposits. In many cases, chert objects in these colluvial deposits cannot be reliably identified as natural or cultural because impacts from rolling or falling downhill can create pseudoartifacts that closely resemble tested cobbles or flakes. Furthermore, culturally produced flakes rolling downhill can be damaged enough to be indistinguishable from informal tools. At one large site (41BL467), a major impact was extensive wave action from high water during inundation by Belton Lake. Wave action was intense enough to create a series of beach berms and flotsam lines, and culturally produced flakes appear to have been damaged so that they now resemble informal tools. Thus, natural impacts must be considered along with anthropogenically induced damage.

"Impact zones" were defined on the basis of the extent and kind of damage distributed across a contextless area. Any area of upland surface characterized by similar kinds and extent of damage was included in an impact zone. In many cases, more than one impact zone was defined for an upland geomorphic subarea because there were two or more areas with different damage characteristics. Sometimes, these differences were differences in kind, other times, they were differences in extent. In other cases, a single impact zone was defined as consisting of two or more spatially separate areas with very similar damage characteristics. Impact zones were mapped on a separate overlay attached to the aerial photograph.

Thus, in general, by completion of reconnaissance, a functional LRPA: (1) was divided on geomorphic grounds into subareas subject to assessment by integrity-driven criteria; (2) had its chert resources mapped and described; and (3) had its contextless surface divided into impact zones.

5.2.3 Establishing Resurvey Parameters

Resurvey was prescribed for upland surfaces if they were not judged to have excessive damage. In general, an area of contextless surface would be regarded as excessively damaged if more than 75 percent of it was damaged or if lesser degrees of damage were distributed so that establishing a systematic resurvey grid (below) would lead to making resurvey observations at a large proportion of impacted places. For example, some upland areas are so densely crisscrossed by vehicle trails that the unimpacted portions of the surface are islands of trees only a few meters across. In such cases, the actual amount of damaged surface could be less than 75 percent, but virtually all of the unimpacted surface is so close to traffic that creates pseudoartifacts that separating compromised from uncompromised assemblages would not be reliable or feasible. In many cases, steep colluvial slopes also were judged to be excessively damaged because of the difficulty of distinguishing between bona fide artifacts and pseudoartifacts created or modified by slope processes.

The only major exception is for excessively damaged areas that have intact features in them. If archeological features were found in such contextless LRPAs, the surface immediately adjacent to features (i.e., within 30 to 50 m) would be treated as a separate subarea according to evaluation procedures for areas with potentially intact Holocene deposits. An intact feature in an LRPA would warrant protection in its own right according to integrity-driven significance standards. The object of assessment in this case was to evaluate the feature and to demarcate an area around the feature which might have the potential to contain lithic-procurement information relevant to the data contained in the feature. The area around the feature also could serve as a protective buffer zone in the event that the feature was eventually found to be significant, but the surface around it was not.

5.2.4 Resurvey

The absence of excessive damage to a contextless surface is insufficient to establish a functional LRPA's potential significance. In addition to being undamaged, a contextless LRPA surface must also have an artifact base that makes preserving it worthwhile. Hence, the next task is to determine whether the distribution of artifacts is sufficient to provide a data base for addressing issues of lithic-procurement behavior. The resurvey procedures were developed in order to use artifact ubiquity as the third filter for determining significance for functional LRPAs.

Ubiquity was chosen for several reasons. One of the major goals of the LRPA-specific evaluations was to determine whether or not a large site could be divided into smaller units for management purposes. One of the salient characteristics of functional LRPA surfaces is that artifact distributions can be extremely patchy at both large and small scales. A major problem, therefore, is to distinguish relatively large patches of surface with plentiful evidence from other large patches with scant evidence. However, within any given large patch, it is possible to find any combination of large and small, dense and thin artifact distributions. A ubiquity measure, therefore, would provide an indication of whether or not there were large-scale lacunae at a functional LRPA. Second, although artifact density would be an appropriate scale for identifying data potential in terms of the raw quantity of artifacts, it also would entail a massive data-recovery program in order to derive a representative characterization of the differential spatial distributions of different densities of artifacts. On the other hand, if a series of closely spaced observations shows that artifacts are present at most locations in a given area, it would show that one has a high probability of finding relevant data in that area. Third, ubiquity has an advantage over density in the sense that density imposes a more severe bias against less intensely exploited chert resources than does ubiquity. Hence, although ubiquity discriminates against very small artifact bases, it draws the line in a more conservative and conservationist direction than density. Thus, although ubiquity is an imperfect index of data potential, it is a reasonable proxy indicator that achieves a workable compromise.

Impact zones that were not excessively damaged were resurveyed at 30 m intervals on transects placed 30 m apart. Observations were made at each 30 m stop on the transects. The basic resurvey procedure, therefore, is the functional equivalent of the shovel-test program used for stratified contexts (see Chapter 4.0). At each stop, the surveyor made a record of surface visibility characteristics and the presence or absence of artifacts (Form 17, Appendix B). In addition, each surveyor recorded whether or not he or she observed an artifact while in transit from the previous grid point. Features newly discovered during resurvey were examined, described, recorded, and scheduled for shovel testing, if warranted. Diagnostic artifacts were collected and the location of collection was recorded.

Artifact observations at resurvey grid points included tested cobbles, cores, morphologically diagnostic flakes, tools, and "other" prehistoric artifacts. A special notation was made if the resurveyor could identify a "knapping station" composed of the debris from a single, apparent, lithic-reduction episode. The "flake" designation specifically excluded shatter debris and flakes without diagnostic attributes (e.g., striking platforms) so as to reduce the probability of recording naturally produced objects as artifacts. If the resurveyor could not confidently judge that (1) an artifact had a cultural origin or (2) an artifact was not the product of damage from recent impacts, he or she assumed that it was not a relevant object and did not record it as a positive observation. In general, then, the observations that were recorded were conservative in the sense that they were biased against borderline judgments.

As a matter of the general distribution of impacts, most of the resurveyed impact zones involved forested surfaces because such surfaces generally coincide with low training impacts. In cases where resurvey involved unforested impact zones, it usually involved low visibility grassy surfaces. Note, therefore, that stationary observations were likely to be conservative in the sense that observations were likely to underestimate ubiquity as a result of surface visibility limitations. Furthermore, resurvey emphasized stationary observations over in-transit observations. In forested impact zones, surface litter and the physical demands of moving from stop to stop on transects through thick understory growth and branches interfered substantially with the possibility of making in-transit observations. In unforested zones, grassy surface vegetation also inhibited in-transit observations. In almost all cases, therefore, surface visibility and/or thick brush virtually guaranteed that in-transit observations would be an unreliable record of artifact ubiquity. However, they would be unreliable in an interpretively interesting way: since typical resurvey conditions weighed against the possibility of making any observation in transit, positive in-transit observations may be regarded as a *very* conservative indicator of artifact ubiquity.

During resurvey, transects and stationary observation points were mapped on the same overlay as impact zones. After resurvey, stationary and in-transit observations were recorded on the overlay to provide a visual spatial record of the distribution of positive observations (i.e., the presence of artifacts) and negative observations (i.e., artifacts not observed).

5.3 DEFINING AND ASSESSING LRPA MANAGEMENT AREAS

By the time reconnaissance, shovel testing, and resurvey were completed, the aerial photograph and overlays contained a record of: (1) the distribution of surfaces which have and do not have potential for intact assemblages in stratified deposits; (2) the distribution of significant chert resources, if any; (3) the distribution of fatally flawed impact zones, if relevant and if any; (4) the distribution of resurveyed areas, if relevant and if any; and (5) the distribution of positive and negative observations within resurveyed impact zones, if any. Documentation on forms included the details of recovery of cultural materials from shovel tests and resurvey observations. At this point, it was necessary to evaluate the field evidence, divide the site into units with approximately identical potential to meet significance standards, and to provide recommendations with respect to NRHP eligibility. The site-division process could proceed in two basic directions. One would be to divide a large site into smaller sites and then assign new site numbers to each division. This process is apparently what Ensor (1991) had in mind when he described the problem with large sites. However, this option generally would not succeed in establishing behaviorally and/or culturally significant site boundaries and, therefore, would result in a proliferation of scientifically meaningless CRM entities that still would not address Ensor's concerns. Furthermore, the mere largeness and geomorphic variability of contractual LRPAs would entail that in many cases, NRHP eligibility status might be resolved for some parts of a site, but not for others.

Thus, the other direction to take in dividing sites would be to identify internal boundaries on the basis of their current and ongoing management characteristics. By identifying such "management units," sites could be divided into smaller parts so that ongoing CRM activities could be pursued rationally and in ways that would take into account the fact that large sites often contain areas within their boundaries that are subject to assessment under different significance standards. This entails that the eventual outcome of assessment should be built into the management-unit definition process because assessment criteria implicitly inform the process anyway. It also means that a primary dimension for defining management units is to avoid lumping together parcels of land that currently have different eligibility statuses. It also would be useful to account for the fact that different areas in large sites may be subject to eventual mitigation procedures of radically different kinds because of differences in the depositional nature of archeological context. Indeed, differences in the nature of archeological context can be a major factor in how well a given assemblage can be protected. For example, assemblages buried deeply in alluvial settings would not be vulnerable to the same kinds of impacts as assemblages in relatively shallow colluvial deposits, rockshelters, or contextless LRPA settings.

Thus, accounting for the nature of archeological context in the unit-definition process would provide a basis for managing archeological resources according to their protectability and their potential mitigation requirements. This is especially relevant in cases where eligibility status is uncertain. For example, if eligibility status is uncertain for adjacent alluvial and upland contexts, it is possible that one later will be found to be significant and the other insignificant. However, even if both turn out to be significant, one may be threatened with damage and the other not. In this case, managing these units together as a single entity would require a much larger eventual mitigation budget than managing them separately. This would impose on the CRM program an unnecessary loss of flexibility with respect to allocating scarce CRM funds where they are most needed to protect significant resources. Therefore, management-unit definition was pursued in the form of a fatal-flaw analysis conjoined with a filtering process that included the nature of archeological context and archeological potential.

Integrity-driven considerations served as the first filter in management-unit definition. Geomorphic subareas (e.g., alluvial terraces, colluvial slopes, rockshelters, upland surfaces) and isolated features (e.g., burned rock mound on an upland surface) were assessed according to fatal-flaw procedures for small sites (see Chapter 4.0) in order to identify their archeological potential as high, low, or uncertain. This filter identified portions of sites that might be candidates for management units. For a site that happened to be composed entirely of geomorphic subareas with the potential to contain assemblages in intact stratified context, subarea boundaries would serve to define management-unit boundaries, and shovel-test results would be used to assign an assessment of high, low, or uncertain archeological potential.

However, no contractual LRPAs actually met these conditions because all had at least some contextless surface within their boundaries. For chertless sites with both stratified and upland geomorphic subareas or for chertless sites that included only upland surfaces, the absence of stratified context was regarded as a fatal flaw for the contextless area(s) of the site. These areas were therefore regarded as having low archeological potential. Given that the LRPA-specific procedures do not apply to these cases, it was possible to go directly to definition of management units (see below).

Definition of management units at functional LRPAs was more complex. Although management units can be defined as above for stratified subareas (if any), using LRPA-specific considerations to evaluate the archeological potential of contextless subareas introduces several other filtering layers.

The easier filter to accommodate is excessive damage. In cases where the entire upland component of a functional LRPA has been excessively damaged, the only effective difference between the damaged impact zones and upland surfaces at chertless sites is that the former may have nonartifactual value (i.e., naturally occurring cherts) that the latter do not have. However, since further impacts to the natural chert resource are *very* unlikely to make any difference with respect to the site's data potential, the presence of the chert is largely irrelevant with respect to NRHP nomination. Thus, damaged impact zones at functional LRPAs are equivalent to, and were treated the same as, contextless surfaces at chertless sites in the unit-definition process.

The harder filter to accommodate is the artifact-ubiquity standard. The identification of an impact zone that is not excessively damaged does not automatically translate into a management unit with high archeological potential. Therefore, it is necessary to examine impact zones to see if they may be valuable either in whole or in part. The procedures for this level of filtering involve a multi-stage analysis of the distribution of positive resurvey observations adjusted for surface-visibility conditions. These procedures involve statistical, visual, and conservationist elements.

As noted above (Section 5.2.4), resurvey observations were recorded on field forms and on an overlay to the aerial photograph. In general, stationary and in-transit observations were entered in a spreadsheet file for each impact zone (Form 17, Appendix B). Sometimes, when impact zones were relatively small and/or contiguous, they were combined for a joint analysis. Observations were summarized for each transect to reflect total stationary observations, positive stationary observations under high- and low-visibility conditions (i.e., surface visibility higher or lower than 50 percent), negative stationary observations under high- and low-visibility conditions, total number of point-to-point transits, and positive and negative in-transit observations. Summary totals of these values were calculated for the impact zone as a whole. A series of binomial hypothesis tests (cf. Thomas 1986) was run to determine whether the summary totals were consistent with a ubiquitous spatial distribution in the impact zone as a whole.

The first hypothesis test asks: Is the number of positive stationary and in-transit observations consistent with a judgment that the probability of finding data at any given place is higher than the probability of not finding data? This translates into a statistical test hypothesis that:

$p(\text{positive observation}) > p(\text{negative observation})$,

and a null hypothesis that;

$p(\text{positive observation}) \leq p(\text{negative observation})$.

This and all subsequent hypotheses were tested at a .05 significance level. To fail the null hypothesis and support the test hypothesis, the proportion of total positive observations must be sufficiently greater than 50 percent to allow for a high degree of intuitive confidence that a slight horizontal shift of the resurvey grid still would have resulted in more than 50 percent positive observations. Intuitive confidence in turn assumes that artifacts occur in patches of varying sizes and densities, and that a widely dispersed assemblage of isolated artifacts is very unlikely to show up in the form of a high percentage of positive observations. Furthermore, note that the hypothesis test is conservative in several senses. By incorporating the number of point-to-point transits into the number of total observations, the hypothesis is biased against identifying ubiquity because the number of total observations assumed by the test is larger than the number of total observations actually made, and low surface-visibility typical of resurvey conditions predisposes observations toward a high number of false negative in-transit observations. Any impact zone that fails the null hypothesis has done so despite a test structure that is biased heavily against failure. Hence, any impact zone for which observations are consistent with the test hypothesis can reasonably be assumed to have a ubiquitous artifact distribution and, thus, a data base with high potential to address lithic-procurement issues.

Note, however, that an impact zone may not fail the null hypothesis even if positive observations are greater than 50 percent. If an impact zone does not fail the null hypothesis, it is necessary to perform cross-checks given that stationary and in-transit observations are different in kind. The most obvious and plausible possibility is that the physical limitations to making in-transit observations have unduly biased the first test. Hence, the second test asks: Is the number of positive stationary observations consistent with a judgment that the probability of finding data at any given place is higher than the probability of not finding data? This translates into test and null hypotheses that are analogous in structure to the first test, but involve only stationary observations.

As in the first test, the proportion of positive stationary observations must be sufficiently greater than 50 percent to allow for a high degree of intuitive confidence that a slight shift of the resurvey grid still would have resulted in more than 50 percent positive observations. This hypothesis test also is conservative because it assumes that surface visibility is not a factor that influences the probability of a positive observation. To the extent that surface visibility is less than 100 percent, it is likely that visibility conditions lead to underrepresentation of positive observations and, hence, that the test structure weighs against failing the null hypothesis. Thus, any impact zone for which stationary observations are consistent with the test hypothesis can reasonably be assumed to have a ubiquitous artifact distribution and, thus, a data base with high potential to address lithic-procurement issues. Again, it is still possible that an impact zone with positive observations greater than 50 percent can fail the test hypothesis.

If an impact zone is not consistent with the first two tests, it is possible (albeit not very likely) that the systematic resurvey grid positioned stationary observations amidst a patchily distributed assemblage in which most resurvey stops were located in small-scale lacunae. In this case, the second test would have been unfairly biased by a relatively low rate of positive stationary observations when in-transit observations would be a more appropriate index of ubiquity. Hence, the third test should focus only on in-transit observations. However, given the physical limitations of in-transit observation, it would be too severe to demand a demonstration that positive observations are more likely than negative observations. Therefore, the third test asks: Is the frequency of positive in-transit observations consistent with a judgment that the probability of observing an artifact while walking across the surface is equal to the probability of not observing one? The third test translates into a statistical test hypothesis that:

p(positive in-transit observation) $\geq$ p(negative in-transit observation),

and a null hypothesis that;

p(positive observation) $<$ p(negative observation).

The third test intuitively compensates for an expected underrepresentation of positive observations, but still requires that positive observations be consistent with at least an even chance of observing artifacts while walking a systematic resurvey grid. Unlike the previous tests, this one does not require that an impact zone have greater than 50 percent positive observations because it is possible for less than 50 percent to be consistent with a .5 probability of observing artifacts. However, even after weakening the hypothesis structure, the test is still conservative. During resurvey, the in-transit observations distinguished between no artifacts observed and artifacts observed in at least one place between stops. Therefore, the total number of positive in-transit observations recorded undercounts the total number of positive in-transit observations made whenever artifacts were observed in more than one place between stops, and the test assumes that no multiple in-transit observations occurred. Hence, the third test is heavily biased against failing the null hypothesis, and it can be reasonably assumed that an impact zone which has more than the minimum expected number of positive observations has a ubiquitous assemblage that has high potential to provide data for lithic-procurement issues.

Failing any one of the first three null hypotheses was regarded as sufficient ground for judging that an impact zone has a ubiquitously distributed assemblage. This means that positive observations were distributed so that there were no artifactless lacunae large enough to lower the overall probability of observing an artifact below .5. Given the conservative definition of what counted as an artifact and the conservative biases built into the tests, this intuitively implies that the probability of observing relevant artifacts at any given place is probably substantially higher than .5 for any impact zone that is consistent with the first three test hypotheses. As a result, consistency with any one of the first three test hypotheses was regarded as a sufficient basis for assigning high archeological value to an impact zone.

If an impact zone did not fail one of the first three null hypotheses, it was necessary to consider the possible role of surface visibility as a factor influencing the percentage of positive observations. In this case, two additional tests were performed to determine whether positive stationary observations were nonrandomly associated with observations at high visibility surfaces (i.e., test hypothesis that probability of positive observation with >50 percent visibility is greater than probability of positive with <50 percent visibility) and negative observations were nonrandomly associated with observations at low-visibility surfaces (i.e., test hypothesis that probability of negative observation with <50 percent visibility is greater than probability of negative with >50 percent visibility). If both of these conditions occurred, there was extremely good reason to believe that positive observations are grossly underrepresented. In fact, any circumstance where negative observations were nonrandomly associated with low visibility appears to warrant a judgment that positive observations were underrepresented. On the other hand, for any circumstance under which negative observations were not associated with low visibility, there was little reasonable ground for inferring that visibility has much to do with the frequency of positive observations. As it turned out, there were no cases where negative observations were not associated with low visibility.

For any impact zone that required examination beyond the first three tests, it was necessary to define the threshold of positive stationary observations (1) above which to regard a distribution as being inconclusive but potentially ubiquitous, and (2) below which to regard it as being inconclusive but unlikely to be ubiquitous. In case (1), exceeding the threshold would imply that although the impact zone's archeological potential is uncertain, it may be high. In case (2), falling below the threshold would imply that although the zone's potential is uncertain, it is *very* unlikely to be high. For an impact zone with an association between negative observations and low visibility, this threshold would be relatively low because of the realistic possibility that positive observations were grossly underrepresented. For an impact zone with no such association, this threshold would have to be fairly close to 50 percent, especially if positive observations were not associated with high visibility. Any such thresholds would be arbitrary, and in any event would be subject to evaluation according to mitigating circumstances such as the presence of intact features, intact rockshelters, or other similar considerations that affect the long- and short-term interpretive utility of the lithic-procurement data.

A 20 percent threshold was chosen for impact zones that had (1) insufficient positive observations to meet the requirement of the first three tests, and (2) an apparent influence of low surface visibility. Relative to a minimum ubiquity threshold of 51 percent, the 20 percent threshold allows for underrepresentation of positive observations by as much as two-thirds, which is not wholly unrealistic for low-visibility surfaces on Fort Hood. Furthermore, the 20 percent threshold provides a conservationist safety net. In practice, the relationship between positive observations and high visibility played a role when making judgments about borderline cases (i.e., observed ubiquity from about 19-23%) because the absence of an association with high visibility would weaken the likelihood that a marginal percentage of positive observations was consistent with very gross underrepresentation. In general, if total observations, total stationary observations, and/or total in-transit observations were at least 20 percent positive, an impact zone was judged to have a "substantial" data base with uncertain, but possibly high archeological potential.

However, if the impact zone did not reach the 20 percent threshold, the assessment process was repeated in an attempt to identify smaller areas within the impact zone. In such cases, the overlay with resurvey transects was examined to see if there were apparent concentrations of positive observations on a series of contiguous transects or parts of contiguous transects. In cases where the apparent concentrations straddled impact-zone boundaries, the relevant transects would be grouped without regard for impact zone. This procedure sometimes also was followed in order to show whether an impact zone with an acceptable but borderline distribution was characterized by a "hot spot" that would provide additional support for a judgment of uncertain but possibly high potential.

Having identified possible concentrations, the test procedure was applied again. If a concentration met the first three tests, it was assigned high archeological value. If it did not meet the first three tests but met the 20 percent threshold, it was assigned uncertain but possibly high archeological value. If it did not meet the 20 percent threshold, then additional attempts were made to identify concentrations. Assessment for ubiquity stopped when it was apparent that further attempts would not identify areas meeting at least the 20 percent threshold. An area which did not meet the 20 percent threshold was judged to have low archeological potential.

It would be useful at this point to illustrate the assessment process for a functional LRPA so as to lay a foundation for discussing the process for defining management units. Since not even the most complex functional LRPA examined by Mariah had all of the elements that can complicate the management-unit definition process, we will use a hypothetical example that contains elements we actually encountered in real LRPAs at Fort Hood.

Figure 5.2 is a map of a hypothetical LRPA that includes a variety of geomorphic contexts. Most of the site is an ancient upland surface with shallow residual soils. Deep, Holocene-age alluvial deposits occur along the south side of the site. A steep colluvial slope occurs between the upland scarp and the alluvial deposits. Two rockshelters are located near the head of a small tributary that runs from the uplands to the creek that forms the southern boundary of the site. As a result of reconnaissance to evaluate the site on integrity-driven standards, five subareas were defined. The upland surface was designated Subarea A, the colluvial deposits were designated Subarea B, and the alluvial deposits were designated Subarea C. The rockshelters were designated Subarea D to distinguish them from the adjacent colluvial slopes. An apparently intact burned rock midden on the upland surface was designated Subarea E to distinguish it as an area with the possibility of stratified cultural assemblages amidst a much larger, depositionally contextless area.

As a result of the hypothetical reconnaissance, Subareas A and B were judged to have very low potential to contain cultural materials in stratified context. Hence, these subareas have low archeological potential relative to integrity-driven standards. Subareas C, D, and E were recommended for shovel testing because they have the potential to contain intact assemblages in stratified context. Shovel test results showed that a few artifacts were present in the upper portion of the alluvial deposits. Because the shovel tests did not reach the bottom of the alluvial deposits, it was not known whether cultural deposits were present at greater depths. Rockshelter 1 in Subarea D was shown to have very shallow deposits with historic artifacts occurring in all levels. Rockshelter 2, although partially vandalized, had prehistoric artifacts in all levels and appeared to be stratigraphically intact, although this judgment was uncertain. The midden in Subarea E, although also partially vandalized, was shown to contain large, undisturbed pockets. Hence, according to integrity-driven standards, Rockshelter 1 was judged to have low archeological potential, Subarea E was judged to have high archeological potential, and Subarea C and Rockshelter 2 were judged to have uncertain archeological potential.

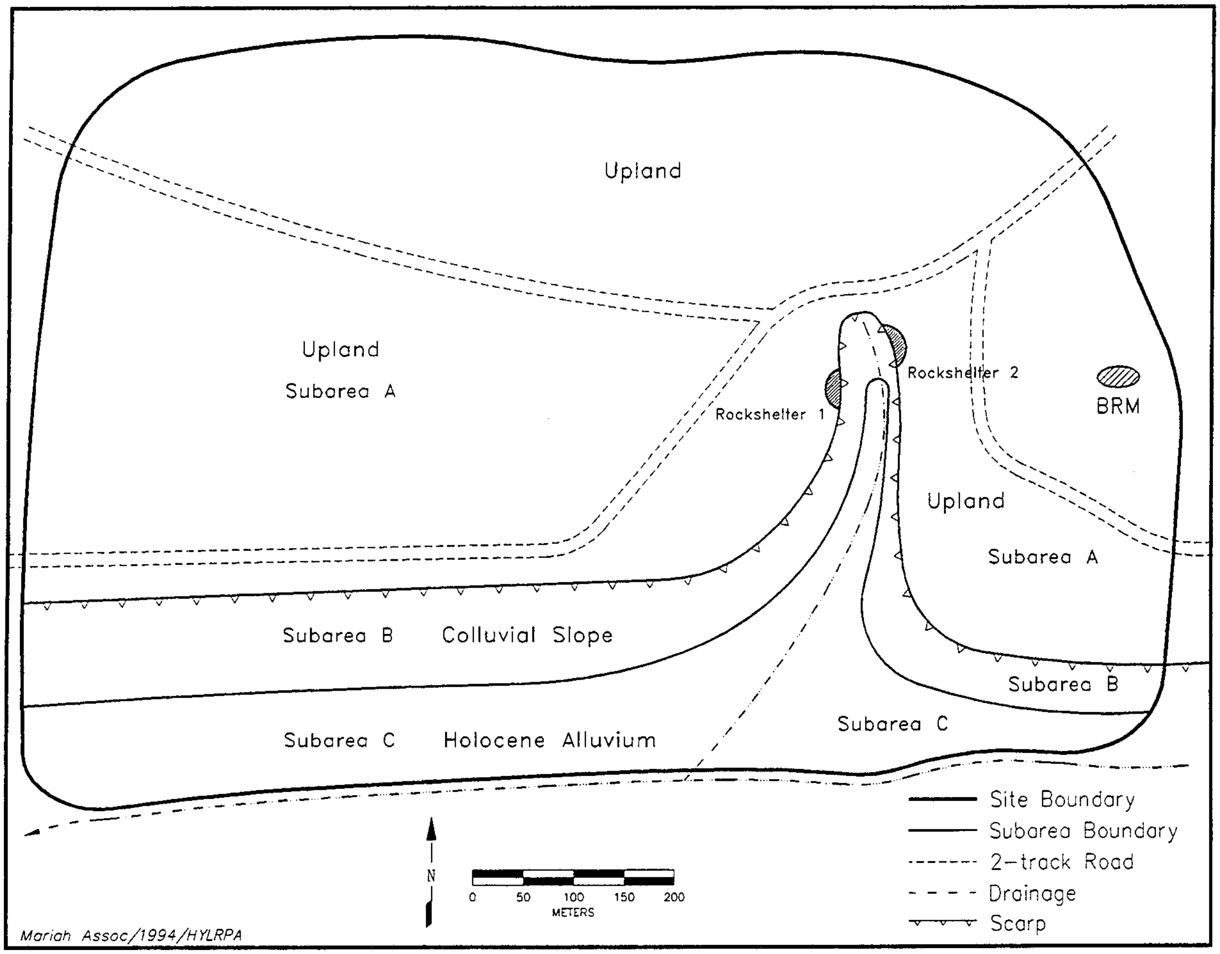


Figure 5.2 Geomorphic Subareas at a Hypothetical LRPA.

Although Subarea A has low archeological potential according to integrity-driven standards, it was shown to be a source of naturally occurring chert. During reconnaissance, two chert zones were defined (Figure 5.3). Chert Zone 1 consists of the entire upland surface, characterized by a patchy pavement of large chert nodules. Chert Zone 2 consists of colluvially derived nodules on the colluvial slope and in the tributary. Substantial amounts of chert also occur in the bed load component of the creek at the site's southern edge.

Given that the site has the potential to have been a functional LRPA, impact zones were defined for the contextless subareas (Figure 5.4). Subarea B was defined as Impact Zone 1 and was judged to be fatally flawed because the steepness of the slope implied that potential for collecting reliable data has been compromised. The eastern portion of the upland was extensively damaged by traffic in a network of trails which were spaced widely enough to judge that less than 75 percent of the area was damaged. This area was designated Impact Zone 2, and was judged not to be fatally flawed. The portion of the site north of the major roads was heavily forested and minimally impacted. This area was designated Impact Zone 3, and also was judged not to be fatally flawed. The remainder of the uplands has suffered virtually complete damage by unconfined traffic. This area was designated Impact Zone 4, and was judged to be fatally flawed. Impact Zones 2 and 3 were not fatally flawed by impacts and were scheduled for resurvey.

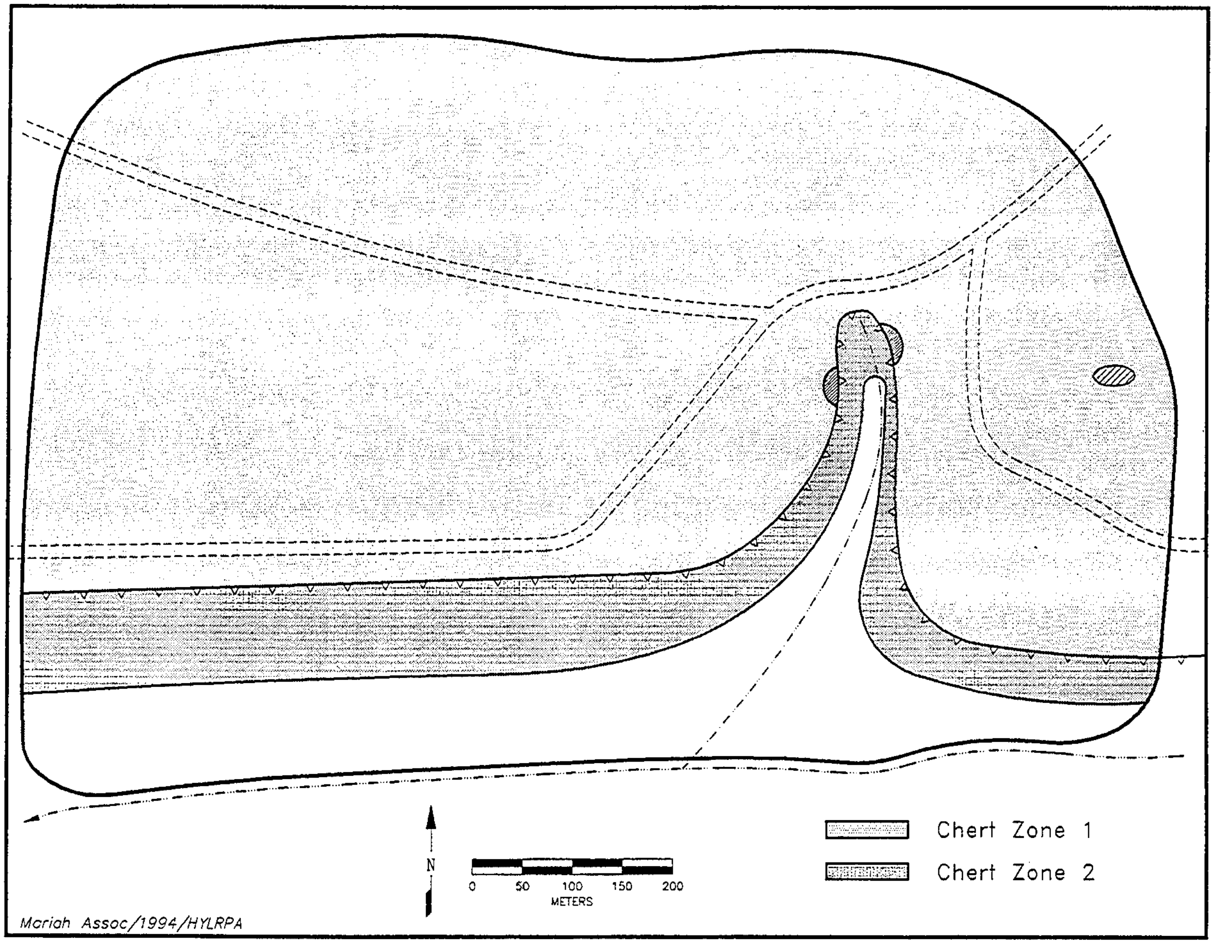


Figure 5.3 Chert Zones at a Hypothetical LRPA.

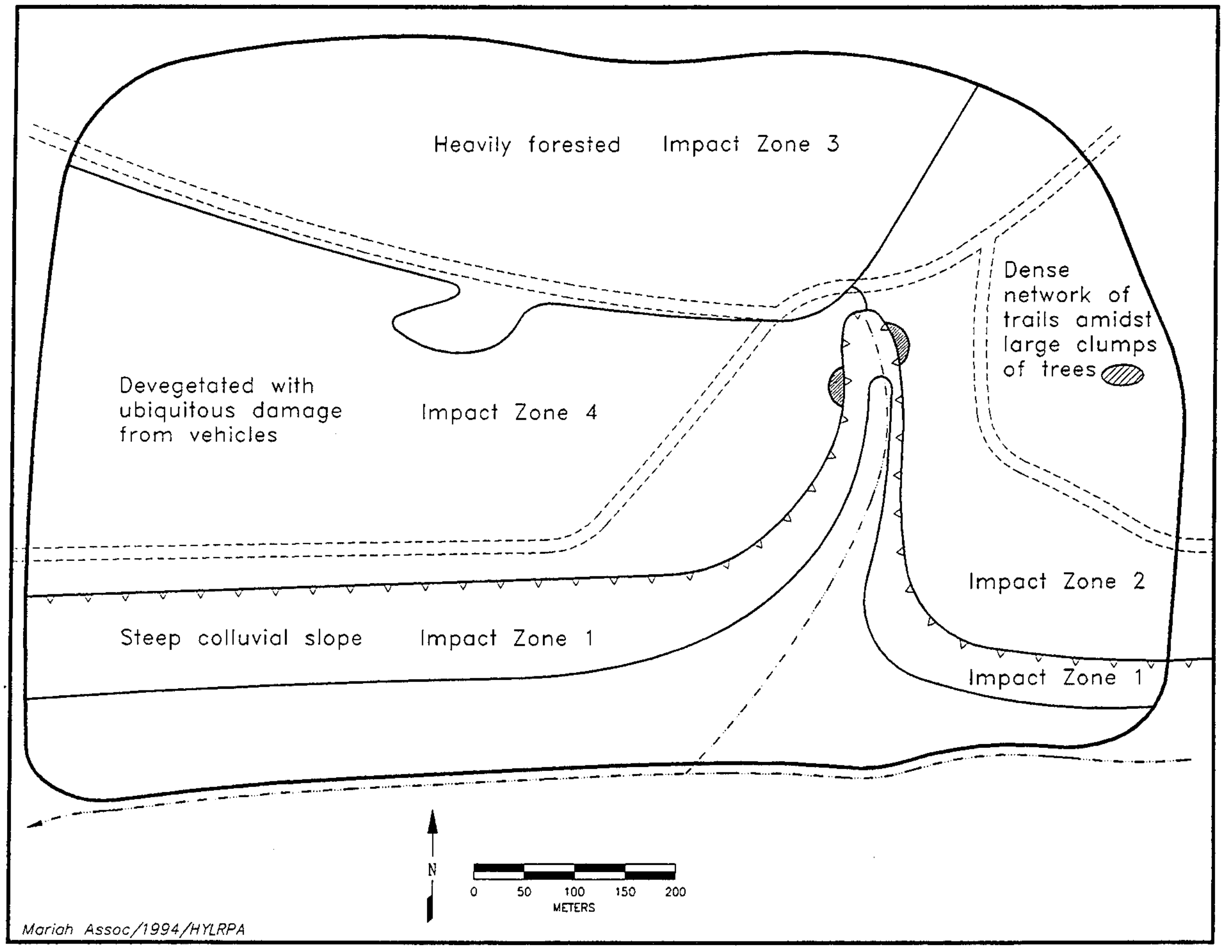


Figure 5.4 Impact Zones at a Hypothetical LRPA.

In Impact Zone 2, positive observations did not exceed 15 percent for stationary, in-transit, or total observations. Hence, positive observations were not high enough to be consistent with a ubiquitous distribution. Moreover, no hot spots exceeding the 20 percent threshold could be identified. Thus, even though low surface visibility probably led to underrepresentation of positive observations, the assemblage in Impact Zone 2 is unlikely to be particularly widespread or dense. Impact Zone 2 therefore was judged to have low archeological potential. In Impact Zone 3, positive observations exceeded 30 percent for stationary, in-transit, and total observations. As in Impact Zone 2, low surface visibility probably led to underrepresentation of positive observations. No hot spots or low-ubiquity lacunae could be identified in Impact Zone 3, implying that the assemblage is more or less evenly distributed. Because positive observations were substantial under conditions of probable underrepresentation, Impact Zone 3 was judged to have uncertain but possibly high archeological potential to contribute to lithic-procurement research.

Analyses such as the foregoing make it possible to divide any large site into management units based on integrity-driven standards for chertless sites, and integrity- and LRPA-specific standards for functional LRPAs. Basic divisions of management units were achieved as follows:

(1) If an entire chertless site consisted of contextless surface, no management units were

defined because the whole site was characterized as having low potential according to both integrity- and problem-driven standards. Further division of the site would serve no useful purpose because the site boundary itself demarcates the smallest unit of interest with respect to long-term management needs. Several contractual LRPAs met these conditions.

(2) If an intact or potentially intact feature was located in an otherwise contextless, chertless site, a boundary was demarcated around the feature to define a management unit with high or uncertain potential, and the remainder of the site was defined as a management unit with low archeological potential. If intact and/or potentially intact features were widely spaced across an otherwise contextless site, several management units with high or uncertain potential were defined. A small buffer zone was built into such management units to ameliorate the probability of inadvertent intrusion by armored and other vehicles during training exercises.

(3) For a chertless site that contains both stratified and contextless geomorphic subareas, all subareas were retained as distinct management units. In many cases, this resulted in defining a mix of stratified subareas with uncertain or high potential and at least one contextless subarea with low potential. The potential of stratified subareas is based on integrity-driven standards. Contextless subareas would have low archeological potential according to both integrity- and LRPA-specific standards. If all geomorphic subareas at a chertless site had low potential, the geomorphic subareas were retained as distinct management units in order to be consistent with site divisions made on small sites. In principle, this treatment creates a series of management units that all will be ineligible for NRHP nomination, albeit for different reasons. In practice, however, such a site can be treated as a single management unit since no part will require special treatment relative to the other parts.

(4) For a functional LRPA in which all contextless surfaces were fatally flawed either by damage or by low ubiquity (i.e., did not meet at least the 20 percent threshold), the contextless surfaces were treated like similar surfaces at chertless sites, and management units were defined as in (1) scenarios through (3) above.

(5) For a functional LRPA in which some contextless surfaces were fatally flawed either by damage or by low ubiquity but other contextless surfaces were not (i.e., met at least the 20 percent threshold), adjacent fatally flawed contextless surfaces were lumped into a contiguous unit, and adjacent unflawed contextless surfaces were lumped into another contiguous unit. In principle, this procedure could produce more than two contextless units. If a fatally flawed contextless unit were adjacent to a fatally flawed depositional subarea, they sometimes were further lumped into a single low-potential management unit. This further lumping typically involved rockshelters lacking Holocene-age deposits or burned rock features that were damaged beyond utility. In all cases, lumping unflawed contextless surfaces with unflawed depositional subareas was avoided to prevent creation of management units internally characterized by (a) radically different archeological contexts; (b) radically different mitigation requirements; and (c) susceptibility to radically different kinds of damage or other protection needs.

In all cases, the process of defining management units divided large sites into the smallest possible areas that could be defined without using mitigation-level tactics while simultaneously being characterized by more or less uniform geomorphic characteristics, management needs, and archeological utility. In practice, however, there were several deviations from the basic pattern when they involved functional LRPAs. For example, a small fatally flawed impact zone might intrude into, or lie entirely within, a large unflawed impact zone. Alternatively, the boundary between flawed and unflawed surfaces might be highly irregular so that narrow spurs or very small islands of unflawed surface extended into an otherwise useless area. In such cases, drawing a management unit boundary to very accurately reflect areas of high and low potential would result in creating a gerrymandered border that is largely unenforceable because armored-vehicle drivers and other personnel probably would have a difficult time respecting it even if they were so inclined.

Thus, final definition of management unit boundaries was tailored to the characteristics of particular sites to increase manageability by reducing unnecessary gerrymandering. Indeed, in many cases, current Army regulations governing landscape impacts (Department of the Army 1993) are likely to be effective for preventing damage at irregularly shaped borders or isolated pockets because personnel on training missions will avoid those areas for nonarcheological reasons. Gerrymandered CRM boundaries are very unlikely to protect anything that other environmental regulations cannot protect, and using gerrymandered boundaries in cases where it is not critical will undermine their value in cases where it is crucial. In other words, the more simply boundaries are drawn around management units where a few square meters makes no practical difference, the more reasonable it will be to hold personnel responsible if they violate the boundaries of a small unit such as an isolated burned rock midden. Hence, identification of management units at LRPAs emphasized practical judgment as well as quantitative and visual procedures to assure as much as possible that any significant management units emerging from the process would be manageable in addition to being significant.

To illustrate this, let us return to the hypothetical LRPA for which management units would be defined as follows (Figure 5.5), given the nature of results from the assessment procedures. Subarea A, the Holocene alluvium, and Rockshelter 1 would be respectively defined as Management Units 1 and 2 to reflect the fact that (1) they have uncertain archeological potential according to integrity-driven standards; (2) they face different levels and kinds of threats; and (3) if both are eventually found to be eligible for NRHP nomination, they will require vastly different strategies if mitigation is ever necessary.

Impact Zones 1 and 4 and Rockshelter 1 have low archeological potential as a result of impacts, and Impact Zone 2 has low potential as a result of low artifact ubiquity. These areas are contiguous with each other, and nothing would be gained by maintaining them as separate entities for CRM purposes. These areas therefore would be lumped into Management Unit 3 to reflect a widespread area within which a variety of conditions lead to more or less uniformly low archeological potential according to integrity- and problem-driven standards. However, the burned rock midden at the east side of the site has high archeological potential according to integrity-driven standards. Hence, Management Unit 4 would be defined to include the midden and a protective buffer zone.

Although Impact Zone 3 fails integrity-driven standards, it has uncertain but possibly high potential according to problem-driven standards. Hence, Impact Zone 3 is defined as Management Unit 5 to (1) distinguish it from adjacent, archeologically useless units; (2) accommodate the fact that it is spatially separated from other units with uncertain potential; and (3) recognize that it has different management and potential mitigation requirements compared to the other uncertain- or high-potential units at the site. Note (in Figure 5.4) that a very small portion of Impact Zone 3 protrudes into the area of Management Unit 3 (in Figure 5.5). Including this area in Management Unit 3 instead of Management Unit 5 recognizes the fact that it is closely surrounded by a heavily traveled road and a heavily used surface. If the forested nature of this enclave cannot protect it under environmental regulations, a CRM boundary also will not protect it. Hence, it is better to make

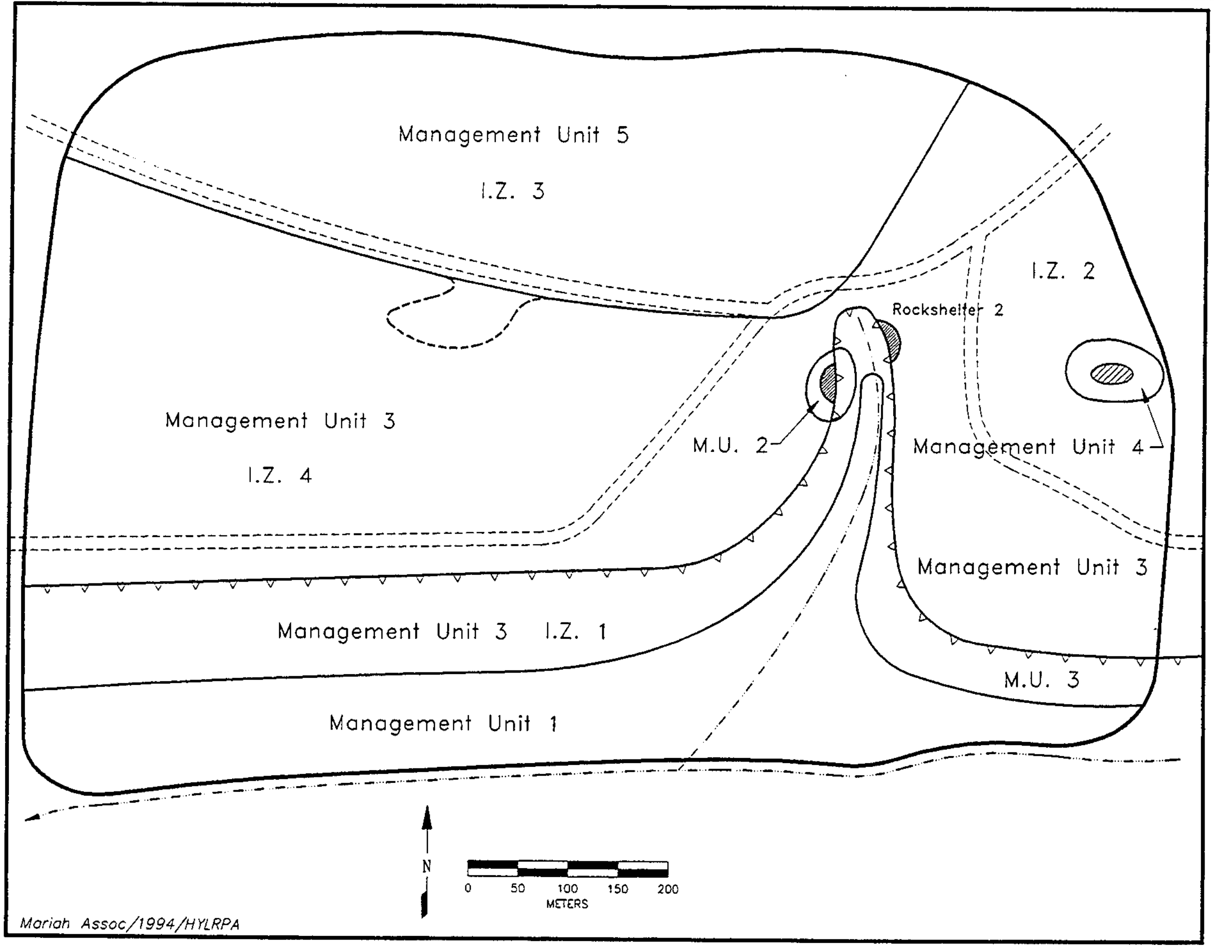


Figure 5.5 Management Units at a Hypothetical LRPA.

the road the southern boundary of Management Unit 5 to eliminate complicated navigational problems as a potential excuse for ignoring the hard-to-detect boundary around Management Unit 4.

As a result of building archeological potential into the definitions, judgments of the NRHP eligibility status of any given management unit followed automatically from the definition process itself. Thus, any management unit defined on the basis of high archeological potential according to integrity- *or* problem-driven standards would automatically be judged eligible for nomination. Any unit defined on the basis of low archeological potential according to integrity- *and* problem-driven standards would automatically be judged ineligible for nomination. The eligibility of any unit defined on the basis of uncertain but possibly high archeological potential according to integrity- *or* problem-driven standards would automatically be judged unknown.

In all cases, it was recommended that eligible management units be protected and that units with unknown eligibility be avoided if possible. An avoidance recommendation was accompanied by a recommendation to perform formal eligibility testing if avoidance was not possible. No further management was recommended for units judged to be ineligible. For stratified management units, the recommendations were identical in scope and rationale to those for small sites (see Chapter 4.0). However, there also were additional recommendations that were based on different rationales.

For all large sites, recommendations included a proviso that management units be treated as if they were individual sites. If a management unit is not significant, it can be removed from protected inventory, thereby freeing up a parcel of land that could have valuable uses. If a management unit is assessed as being significant or having uncertain significance, it can be managed as a separate site with respect to protection or further work to determine significance. For example, if land-use requirements at a large site would impact only one of several protected management units, it would make sense to mitigate only the unit that will be impacted.

Note that treating management units as individual sites is no more arbitrary and no less justified than routinely retaining the whole site as the unit to be managed: since the original boundaries of large sites were established without regard to discrete culturally or behaviorally identifiable phenomena, defining management units on the basis of their general archeological potential and manageability does not violate the original site-definition rationale in any significant way. Indeed, the management-unit concept recognizes (1) that the boundaries of most large sites at Fort Hood are arbitrary; (2) that there is little to be gained by managing large sites as whole, single properties; and (3) that treating management units as single sites makes a realistic contribution to providing flexibility to the CRM program while simultaneously and justifiably easing constraints on the Army's land-use needs.

In the case of management units consisting wholly of contextless, fatally flawed areas at functional LRPAs, no further management was recommended. However, the recommendation recognized that such management units would still have value for chert-source characterization or other studies pertaining to the nature of lithic raw materials, and that such value will endure regardless of whether or not the site is protected. The recommendation therefore included an explicit proviso that access be available to the unit in the event that chert studies become relevant to research elsewhere.

In the case of units with unknown significance, there is nothing magical about the 20 percent cutoff which assures that a unit with (say) 23 percent positive observations represents a high-potential assemblage. Rather, the 20 percent threshold assures the protection of significant assemblages for which positive observations are substantially to grossly underrepresented. Hence, in cases where there is uncertainty resulting from the influence of surface visibility, a recommendation to avoid the unit is based on a conservative judgment biased toward error in favor of preservation. As a result of this bias, it is likely that at least some marginal impact zones will be incorporated into management units for which there is a recommendation for avoidance.

This implies that further work is required to distinguish between low-ubiquity/low-visibility and high-ubiquity/low-visibility distributions. Note, however, that the results of resurvey are functionally equivalent to the results of shovel testing in areas of stratified depositional context. The assessment process for stratified units would continue with formal test excavations and/or backhoe trenches whenever significance is ambiguous after shovel testing. Because any LRPA surface that has been resurveyed is by definition stratigraphically contextless, similar formal test excavations and trenches are inappropriate. Moreover, it would be prohibitively expensive to establish a formal test-excavation program fine-grained enough to verify or falsify ubiquity of artifact distribution. A possible alternative, of course, would be to resurvey one more time. However, because uncertainty emerged as a result of low visibility, this procedure could be a waste of resources because the conditions that produced uncertainty guarantee that yet another round of resurvey will be tainted by the same source of uncertainty.

Thus, in addition to a recommendation to avoid functional LRPA units with unknown eligibility, an additional recommendation was made to withhold formal eligibility testing until such time as a potential need to mitigate was imminent. This recommendation, if followed, would allow time for the possibility of making research advances relevant to functional LRPAs, including accumulation of data that hints at what specifically to look for at particular chert sources. Since formal testing will involve near-mitigation-level data collection, it should be used as the functional equivalent of the first stage of an impending mitigation program in which field efforts not only determine whether a possibly significant assemblage is significant; they also determine how far to carry data recovery in order to acquire a data base with scientifically suitable characteristics.

5.4 CONCLUSIONS

The LRPA-specific evaluation procedures and recommendations provide a realistic approach to dividing very large sites according to parameters that achieve appropriate compromises between short- and long-term scientific utility, CRM needs and resources, and the Army's land-use needs. Mariah's application of these procedures for large-site evaluations achieved the following general results with respect to assessing the archeological potential of contextless surfaces at large sites. More detailed results are reported in Chapter 9.0.

Twenty-eight contractual LRPAs did not have sufficient chert resources onsite or nearby to warrant classifying them as functional LRPAs. As a result, these sites were evaluated according to procedures for small sites. All of these sites had at least one contextless subarea, and four sites consisted entirely of a single contextless subarea. In all cases, contextless subareas had low archeological potential according to integrity-driven standards. By virtue of having no chert resources, they also had low archeological potential according to LRPA-specific standards.

Sixty-six contractual LRPAs had sufficient chert resources on site or nearby to warrant classifying them as functional LRPAs to be evaluated according to integrity-driven and LRPA-specific procedures. The evaluation process defined the 163 management units in upland or other ancient contexts. Of these, 16 were assigned low archeological potential as a result of damage, 16 were assigned low potential as a result of low artifact ubiquity, and 41 were assigned low potential as a result of a combination of damage and low ubiquity. Among these management units were nine whole sites. In general, these low-potential management units were larger than units with uncertain or high potential at the same site. Much of the high frequency and large area covered by low-potential units on ancient surfaces attests to the widespread damage that has occurred over decades of armored maneuvers. However, high visibility and the presence of psuedoartifacts resulting from these same maneuvers (see Chapters 2.0 and 3.0) are major reasons why large boundaries were drawn around many functional LRPAs in the first place. Hence, it is not surprising that large areas of many functional LRPAs are damaged beyond any possible utility.

In contrast, 12 contextless management units were assigned a high archeological value that reflects, in some cases, a amazing surface distribution of tools, debitage, and cores. Another 42 contextless units, including one whole site, were assigned an uncertain archeological potential. Some of these units are probably marginal in terms of their potential to provide substantial data bases, but most others are probably valuable. Indeed, it is highly likely that a worthwhile sample of lithic data that fairly represents what occurred within the original site boundaries remains among the units with high or uncertain potential. Despite the fact that the low-potential units generally were larger than high-/uncertain-potential units, the latter units nevertheless cover a great deal of territory distributed widely around chert outcrops. Thus, the procedures used to evaluate functional LRPAs are likely to be successful at providing a basis for protecting major lithic-procurement data sources.

6.0 LITHIC RESOURCES AT FORT HOOD: FURTHER INVESTIGATIONS

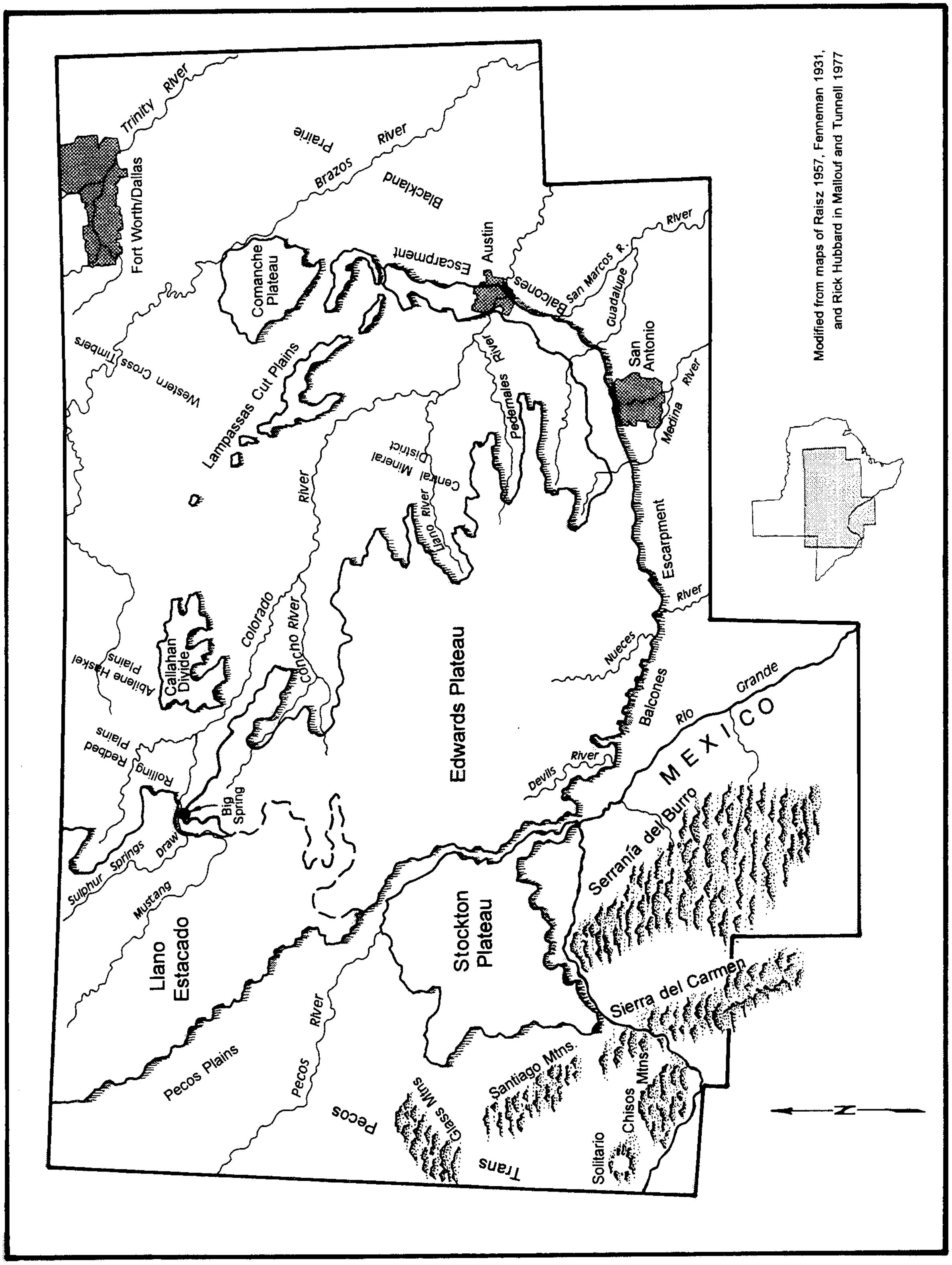
Charles D. Frederick and Chris Ringstaff

Chert within the lower Cretaceous Edwards Group constitutes one of the largest and most variable lithic sources on the High Plains of the United States and northern Mexico. Unfortunately, the vast size of the outcrop, and the apparent variability in the appearance of this material have been poorly documented, leading to significant distortion of reality in the archeological literature regarding both attributes. The first part of this chapter will provide a review of the distribution and the physical appearance of chert occurring in the lower Cretaceous Edwards Group and correlative strata of Central, West, and the Trans-Pecos regions of Texas and the northern half of the state of Coahuila, Mexico. This is achieved through a review of the geologic and archeological literature and subsequently by examination of hand samples obtained from bedrock outcrops. This regional background provides information necessary for understanding the occurrence and morphology of chert at Fort Hood, which lies on the eastern edge of the Edwards outcrop. A very basic chert outcrop map for Fort Hood is presented and serves as a point of discussion regarding chert distribution on Base.

The second part of this chapter describes the physical attributes of Edwards chert at Fort Hood, located in Bell and Coryell counties, Texas, and a select sample of Edwards chert from across the outcrop. A brief review of previous studies is followed by an itemized taxonomy of cherts currently known to occur on or near Fort Hood, and the range of physical appearance of this material is described. The taxonomy builds on Dickens' (1993a, 1993b; 1994) research and expands both the geographic and morphologic bounds of his studies. The third section constitutes a functional analysis of the Fort Hood taxonomy and documents the physical properties of these cherts pertinent to their use as raw material for the manufacture of stone tools.

6.1 INTRODUCTION

Chert or flint within the Edwards limestone, often simply referred to as "Edwards chert," is easily the most areally extensive bedrock lithic resource in Texas and perhaps on the Great Plains. The outcrop of the chert bearing Lower Cretaceous limestones is extensive and spans seven major physiographic regions, including the Edwards, Comanche, and Stockton Plateaus, the Callahan Divide, the Lampasas Cut Plains, and part of the Trans-Pecos (Figure 6.1). Prehistoric use of this material was extensive, an attribute which is widely noted in the archeological literature of Texas. It is widely believed that this lithic source is of high quality and was "was traded in antiquity over hundreds of kilometers" (Black 1989a), in part due to the identification of similar material in collections well outside Texas (e.g. Hofman et al. 1991; Boldurian 1991) and inside the state but outside the outcrop area (e.g. Largent et al. 1991, Table 6; Tunnell; 1978). Unfortunately, the term "Edwards chert" has fallen from use as a specific reference for chert occurring in the Edwards Limestone, to a generic catchall term that is "applied in a wide area of West Texas and the Southern Plains to any good quality chert of gray or tan colors" (Tunnell 1978:7; see also Hofman et al. 1991:297). It is true that a wide variety of potential lithic resources are available from sedimentary rocks in the area depicted on Figure 6.1, and a brief itemization of these deposits is provided on Table 6.1. However, there is very little information regarding the appearance or quality of most of these deposits beyond that summarized on this table and discussed in Banks (1990). Undoubtedly, some of the cherts commonly lumped with Edwards chert are among those listed, but in this chapter, the term is applied literally and refers to chert contained in the Edwards and correlative limestones which crop out in Central and West Texas and northern Mexico.



Modified from maps of Raisz 1957, Fenneman 1931, and Rick Hubbard in Mallouf and Tunnell 1977

Figure 6.1 Physiographic Features of the Region Discussed in the Text.

Table 6.1 Sedimentary Deposits Containing Lithic Resources in the Study Area (excluding Quaternary Alluvium).

Era	Series	Group	Formation	Member	Map	Comments
Pliocene			Goliad		16	some black and red chert
Miocene-Pliocene			Ogallala		9, 2, 6, 1	gravels, occasionally silicified or opalized
Miocene			Oakville		12, 16	quartz and chert pebbles
Eocene			Manning		15, 12, 16	silicified wood, fused glass
			Wellborn		12, 16	locally silica cemented
			Caddell		12, 16	some black chert
			Yegua		15, 16	some chert
		Midway	Kincaid	Pisgah	8, 4	locally cherty
Eocene-Oligocene			Whitsett		12	locally silica cemented
Cretaceous						
Upper Cretaceous						
			Javelina		13	petrified wood common
			Aguja		13	petrified wood common
Lower Cretaceous						
			Buda LS		13	grayish white, porcelaneous, and has conchoidal fracture
	Fredericksburg	Edwards	ns	ns	2, 6, 8, 1, 7, 15, 12, 16, 11	
			Segovia		5, 9, 6, 14, 15, 11, 10	chert
			Fort Terrett		5, 9, 6, 14, 7, 15, 11, 10,	chert
			Santa Elena		9, 14, 13, 17	
			Del Carmen		9, 13, 17	
			Antlers Sand		2, 6, 7, 1	quartzite, and quartzite pebbles
			Olmos		14	silicified wood
			Devils River		14, 15, 17	
			Salmon Peak		14, 15, 17	abundant large chert masses
			McKnight		14, 15, 17	thin chert layers
			Sue Peaks		17	
			West Nueces		17	
			Travis Peak		7, 11	pebbles to boulders of chert
			Twin Mountains		4	pebbles of chert

Table 6.1 (Continued).

Era	Series	Group	Formation	Member	Map	Comments
			Yucca		13	rounded pebbles and cobbles of variously colored chert
			Shafter		13	petrified wood in some sandstone beds
Triassic		Dockum			5, 2, 6	siliceous pebbles
Permian			San Angelo		2	siliceous pebbles
			Cathedral Mountain			
			Caballos Novaculite		9	
			Maravillas chert		9	
	Guadalupe		Ross Mine		13	thin interbeds of sandstone and chert
	Guadalupe-Leonard		Pinto Canyon		13	cherty with nodules and bedded forms present
	Leonard		Cibolo		13	chert layers common
	Leonard	Wichita-Albany	Elm Creek		7	locally cherty
	Wolfcamp	Wichita-Albany	Admiral	Overall limestone	7	locally cherty
		Cisco	Moran	ss1	3, 7	
		Cisco	Pueblo	Stockweather	3, 7	abundant light colored chert
				ss2	3	
Pennsylvanian		Cisco	Harpersville		3	chert pebbles
		Cisco	Thrifty/Graham	numerous	3	chert pebbles
		Cisco	Thrifty/Graham	Upper Gunsight LS	7	partly silicified
		Canyon	ns	ns	11	
		Canyon	Home Creek Limestone		7	locally abundant rounded chert nodules
		Canyon	Ranger Limestone		3, 7	dark brown chert nodules with white fossil fragments
		Canyon	Winchell Limestone		3	black chert nodules with white fossil fragments
		Strawn	Palo Pinto	Fambro SS	3	pebbles of chert
		Strawn	Palo Pinto-Mineral Wells	Turkey Creek SS	3	locally a chert conglomerate
		Strawn	Brazos River	ns sandstones	3, 4	angular pebbles of chert
		Strawn	Grindstone Creek	Brannon Bridge LS	4	dark chert lenses
	Atoka	Strawn	Ricker Station Limestone		7	locally subrounded chert
		Strawn		ss37 to ss1	7	pebbles mostly chert
	Morrow		Marble Falls		7, 11	locally cherty and siliceous
			Dimple Limestone		13	limestone with black chert pebbles

Table 6.1 (Concluded).

Era	Series	Group	Formation	Member	Map	Comments
			Tensus		13	massive white quartzite intervals in upper part
Mississippian-Devonian						
			Caballos Novaculite	multiple	13	novaculite, chert
			Maravillas		13	nodular to bedded chert
		ns	Barnett		11	bedded chert along Doublehorn Creek
			Houy		11	coarse angular chert breccia and fractured chert
			Zesch		11	angular fragments of chert, leached silica rock
			Bear Spring		11	chert bearing limestone
			Stribling		11	chert
Ordovician		Ellenburger	Honeycut		7	cherty
		Ellenburger	Gorman		7, 11	cherty
		Ellenburger	Tanyard	Staendebach	11	fossils (gastropods, cephalopods, and trilobites) in chert
				Threadgill	11	sparingly cherty
Cambrian		Moore Hollow	Wilberns	San Saba	7, 11	sparingly cherty

Note: Data derived from the Geologic Atlas of Texas, published by the Bureau of Economic Geology, The University of Texas at Austin. The individual sheets referenced are as follows: 1) Hobbs, 2) Big Spring, 3) Abilene, 4) Dallas, 5) Pecos, 6) San Angelo, 7) Brownwood, 8) Waco, 9) Fort Stockton, 10) Sonora, 11) Llano, 12) Austin, 13) Emory Peak-Presidio, 14) Del Rio, 15) San Antonio, and 16) Seguin. Information on the Lower Cretaceous of northern Mexico derived from Smith 1970 and is identified as map number 17.

Questions concerning the origin and distribution of Edwards chert in Texas raised by Banks (1990) serve as partial impetus for this discussion and stimulated this attempt to provide a more extensive descriptive data set for this material. We draw attention to the fact that major sources of knappable, or workable, stone often receive considerable attention by archeologists, in part because once the distribution of a source has been documented, this information may be used to demonstrate trade and/or mobility by prehistoric populations. Alibates agate and Tecovas jaspar are two lithic sources in Texas which have been repeatedly documented in the archeological literature (e.g. Shelley 1984; Green and Kelly 1960; Tunnell 1978). Perhaps it is the immense size and internal complexity that account for the few studies of Edwards chert that adequately address the distribution and appearance of this material. Until Banks' (1990) book on lithic resources of the Trans-Mississippi South, the southern Plains, and the adjacent parts of the Southwest, no detailed descriptions of Edwards chert were available in the archeological literature. Although Banks' work is the most comprehensive to date, it left many questions regarding the distribution and appearance of Edwards chert unresolved, especially regarding the distribution of chert in the western part of the Edwards Plateau and in the Trans-Pecos region. Secondly, Banks' work described 15 samples of chert, the majority of which were obtained from a few, often geographically concentrated, regions, namely Fort Hood, an area in the vicinity of Junction, Texas, and near Georgetown, Texas. Since a major portion of the work in this volume is focused on Fort Hood, an effort was made to gather samples of Edwards chert from across the outcrop to obtain a more representative sample of this material and to address specific questions regarding the occurrence of chert in West Texas.

6.1.1 Formation of Edwards Chert

The processes responsible for chert formation continue to be the subject of some debate in the geologic community. Since many cherts occur in carbonate depositional environments that typically lack abundant sources of silica, identification of the source of the silica which formed the chert is often of critical importance in understanding the process. Some theories consider chert to be of a primary origin and composed of the remains of siliceous micro-fossils that accumulated on the ocean floor, or a direct precipitate from seawater. Others favor a secondary origin in which chert forms in situ from the molecular level replacement of carbonate minerals by silica during diagenesis (Pittman 1959).

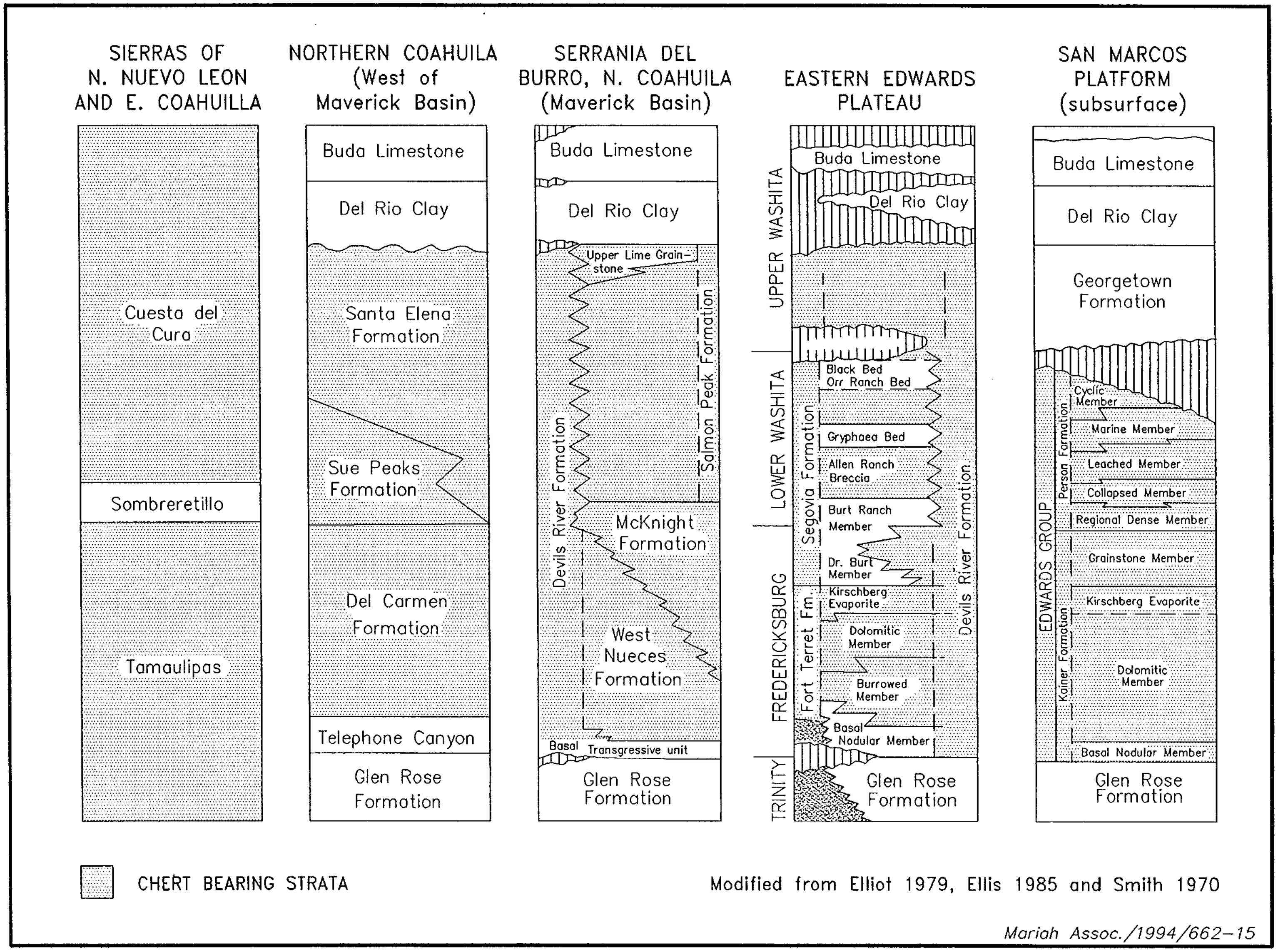
The nodular chert of the Edwards Group is generally thought to be of secondary origin. Evidence corroborating this conclusion is the inclusion and replacement of fossils and the preservation of bedding structures within many chert nodules. The apparent regional scale co-occurrence of chert and dolomite, a carbonate mineral which forms as a result of digenesis, has led some to speculate that the two processes are interrelated (Fisher and Rodda 1969; Mueller 1975) although more recent geochemical evidence cited by Ellis (1985) is conflicting. In a recent reevaluation of the origin of Edwards chert, Ellis (1985) concluded that the silica comprising the chert was locally derived and that silicification occurred early in the digenetic history of the rocks, perhaps penecontemporaneous with deposition (Ellis 1985). Ellis (1985) speculates that the source of the silica comprising nodular Edwards chert may have been either sponge spicules, or clay minerals in the immediate vicinity of the nodules which, in the presence of aluminum, release silica. The fact that many specimens of Edwards chert contain dolomite or pseudomorphs of dolomite (crystals which bear the appearance of dolomite but have in fact been replaced by silica in the form of microcrystalline quartz) indicate that the chert formed after dolomitization but prior to lithification. Unfortunately, the impression that dolomitization and chert formation occurred together (e.g. Fisher and Rodda 1969) has led to a distorted impression of the distribution of chert in Edwards strata in the geological literature.

6.1.2 Stratigraphy

Stratigraphic nomenclature regarding the Edwards Group varies across Central Texas and northern Chihuahua. Stratigraphic units in the lower Cretaceous Series correlative to the Edwards Group are illustrated in Figure 6.2. The Edwards Group in Texas consist of 300 to 1,000 ft of limestone, dolomite, and evaporates deposited on a broad, shallowly submerged carbonate platform during the early Cretaceous. At that time, the platform, known now as the Comanche shelf, was a mostly submerged plain which possessed environments ranging from shallow open marine waters to intermittently exposed, hot and arid, supratidal flats (Ellis 1986; Rose 1968). This shelf was bounded on the southeast and east by a ridge of reefs, small islands, and other shallow water features known as the Stuart City Reef Trend which separated the Comanche shelf from the deeper water of the Gulf of Mexico Basin. Two pronounced lagoons occupied portions of the Comanche Platform in what is now Central Texas and Northern Mexico: the Kirschberg Lagoon and the McKnight Lagoon (also known as the Maverick Basin).

Detailed discussion of the stratigraphy of the Edwards Group and associated strata throughout the Central Texas study area may be found in Rose (1968). Smith (1970) and Elliott (1979) have described correlative strata in northern Mexico (Nuevo Leon and Coahuila). The stratigraphic nomenclature of the Edwards is different in outcrop and subsurface, and it is the outcrop units that are primarily employed in this chapter. Details of subsurface stratigraphic nomenclature are not elaborated upon here but may be found in Rose (1968), and are illustrated on Figure 6.2 under the heading of the San Marcos Platform.

Chert occurs in several Edwards Group Formations and correlative strata, which are shaded on Figure 6.2. In general, the chert-bearing formations in Texas are: the Fort Terrett, Segovia, Devils River, Salmon Peak, McKnight, West Nueces, and Santa Elena. On the Edwards Plateau, Rose (1968) subdivided the Fort Terrett and the Segovia into several beds. In the Fort Terrett, Rose (1968:225-276) recorded the presence of chert in Kirschberg Evaporite, the Dolomitic Bed, and the Burrowed Bed, but not within the Basal Nodular Bed. Chert was reportedly abundant in the undivided portions of the Segovia, common in the Allen Ranch Breccia, sparse in the Doctor Burt Bed, and not identified in outcrop exposures of the Gryphaea Bed, Orr Ranch Bed, or the Black Bed. The Orr Ranch Bed is believed to be a shallow water, near coast deposit, and is known to yield petrified wood. The Bureau of Economic Geology (1977, 1982) records the Devils River Formation as chert bearing but Smith (1970) does not indicate chert is present in this formation in northern Coahuila. In northern Mexico, formations associated with the Comanche shelf that are chert bearing include the Santa Elena, Sue Peaks, and the Del Carmen. Smith (1970, Plate 5, measured section 15) also records the presence of a single chert zone near the top of the Glen Rose Formation. In northern Mexico, chert is also known to occur in deeper water deposits of the Gulf of Mexico basin in addition to the shallow water carbonates associated with the Comanche shelf. Elliott's (1979) work in northern Nuevo Leon and eastern Coahuila demonstrated that, in the deeper water lower Cretaceous sediments chert is largely restricted to the basinal facies, whereas chalcedony is more common in slope facies. Figure 6.3, adapted from the Geologic Atlas of Texas (Bureau of Economic Geology 1976a, 1974a, 1972a, 1972b, 1975, 1975, 1976b, 1990, 1982, 1981a, 1981b, 1974b, 1979a, 1977, 1982, 1979b) and Smith (1970), illustrates the outcrop of potentially chert-bearing strata of the Edwards Group and correlative strata in Central-West Texas and part of northern Mexico.



Modified from Elliot 1979, Ellis 1985 and Smith 1970

Mariah Assoc./1994/662–15

Figure 6.2 Stratigraphic Illustration of the Edwards Group and Correlative Strata for the Study Area.

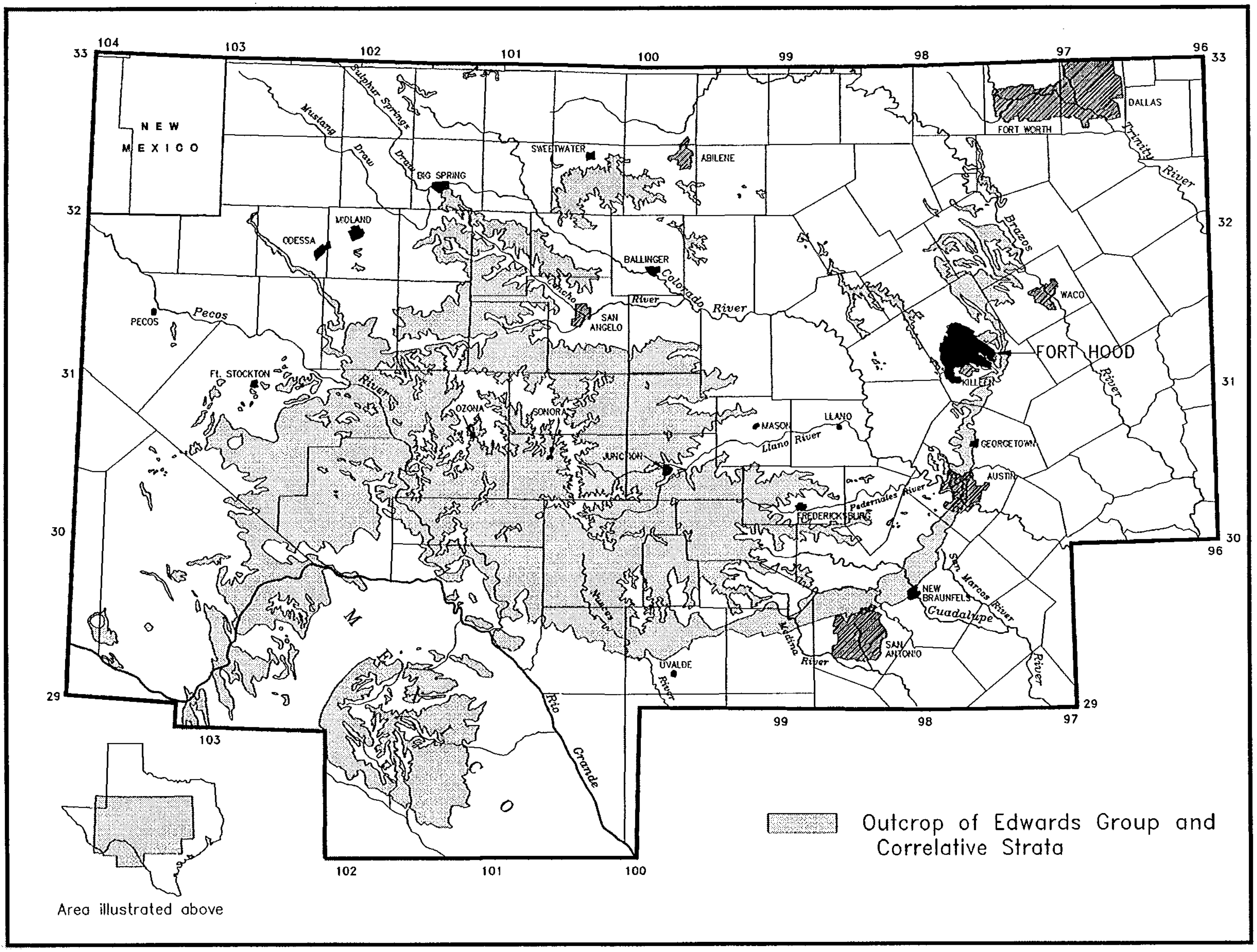


Figure 6.3 Map Illustrating the Outcrop of Edwards Group and Correlative Strata.

6.2 SPATIAL DISTRIBUTION OF EDWARDS CHERT

From this discussion, it is clear that "Edwards chert" is not restricted to the Central Texas region, but is actually a common component of lower Cretaceous rocks throughout Central and West Texas and northern Mexico. Unfortunately, however, for some time the distribution of Edwards chert has been the subject of confusion in the archeological and geological literature. In the archeological literature, published maps depicting the areal extent of Edwards chert often fall very short of reality; a mistake which may have significant implications for those interested in the trade of lithic material by or the mobility of past cultures (e.g. Tunnell 1978; Banks 1990; Boldurian 1991). The source of some of this confusion may be attributed to an article by Fisher and Rodda (1969) which depicts the distribution of chert to be closely tied to the location of the Kirschberg lagoon. In their article "Edwards Formation (lower Cretaceous), Texas: Dolomitization in a Carbonate Platform System," Fisher and Rodda provide a map (Figure 13) which depicts a decrease in the frequency of chert toward the center of the lagoon, with the greatest frequency of chert in a ring-like zone surrounding the center of the lagoon, and in a few isolated outcrops within and occasionally, outside of, the ring (see Figure 6.4 for location of Kirschberg Lagoon). The zone outside the lagoon is reported to contain "little or no chert." Despite the fact that the southwest margin of this map is drawn with a dotted line, and significant chert exposures are situated outside the most areal extensive chert-bearing zone (labeled as "one chert horizon per 15 to 30 ft of section") on the northeast, the distribution portrayed has been literally interpreted by some archeologist as the extent of Edwards chert in Texas.

Examples of cartographic misrepresentation of the distribution of "Edwards chert" in the archaeological literature begin with a map in Hester (1972:94, Figure 86), that depicts the source of this material to be a narrow arc-shaped region lying immediately east of, but separated from, the Llano Estacado. In this map the outcrop is illustrated to be approximately 100 miles long, less than ten miles wide, and roughly 10 to 70 miles distant from the edge of the Llano Estacado. A very similar map is later reproduced by Shelley (1984) and referred to as the "traditionally recognized source for Edwards Plateau chert." In 1978 Tunnel published a map that places the Edwards outcrop entirely north of 31.5N latitude, in the vicinity of the Callahan Divide. Tunnell (1978: Figure 30) does not cite Fisher and Rodda (1969) for the distribution of "Cretaceous chert" portrayed on his map, and may in fact be attempting to illustrate the nearest outcrops of Edwards chert to the lithic caches he describes in this report. However, this map was later reproduced, in a slightly modified form and without citation, by Boldurian (1991), in order to illustrate a source area for Edwards chert. In the same region, Shelley (1984) provides a map illustrating the "traditionally recognized sources for Edwards Plateau chert" that bears little relationship to the outcrop of the lower Cretaceous chert-bearing strata.

Later authors, specifically Banks (1990) and Hillsman (1992) reproduced simplified versions of the Fisher and Rodda (1969) map, while others refer to this work as the definitive statement on distribution (e.g. Shafer 1992). Some authors, such as Banks (1990), do not accept the model on faith and correctly observed that the Geologic Atlas of Texas describes many of the Edwards Group strata as chert bearing outside of the Kirschberg Lagoon, which he uses as evidence to suggest that the Fisher and Rodda (1969) model of chert occurrence should be tested and possibly revised. Perhaps the most accurate but least detailed portrayal of the distribution of Edwards chert is that of Hofman et al. (1991) which, in a very general fashion, shows the region within which the lower Cretaceous chert-bearing limestones crop out in Texas. The significant variability present in the previous description of Edwards chert distribution are compared in Figure 6.4.

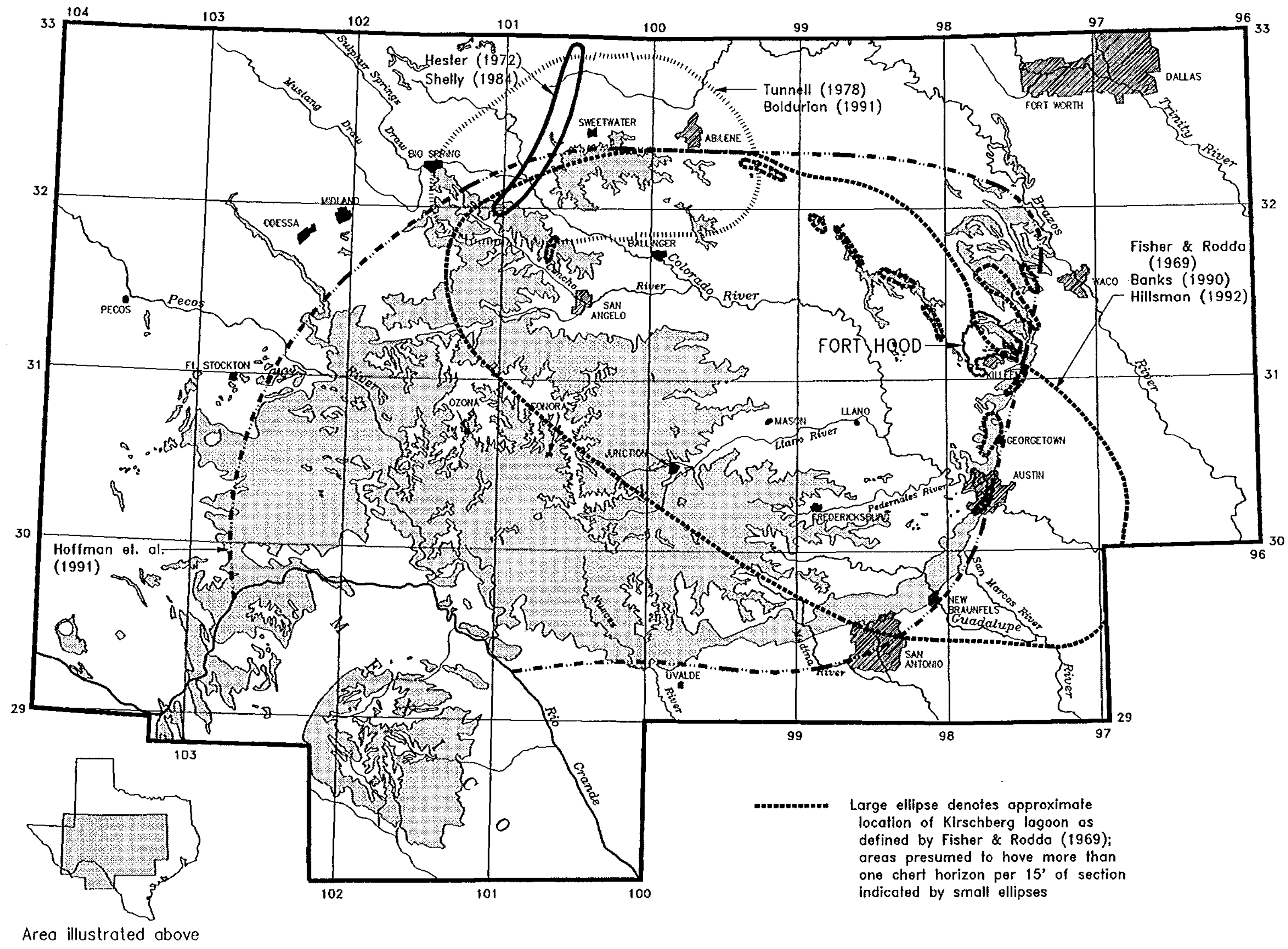


Figure 6.4 Map Comparing the Outcrop of Edwards Group and Areas Identified in the Archaeological and Geological Literature as Sources of Edwards Chert.

Note that the two widely reproduced depictions, namely Tunnell (1978) and Fisher and Rodda (1969), include large areas lacking primary outcrops and exclude approximately one-half or more of the outcrop, implying that these areas lack chert.

To test these models, two approaches are employed: (1) a review of the archeological and geological literature for the regions depicted as lacking chert, and (2) a field excursion designed to search out and sample chert outcrops in Edwards and equivalent strata in the southwestern Edwards Plateau and the Stockton Plateau.

6.2.1 Literature Search

In the geological literature, there are several references bearing on the presence of chert in lower Cretaceous strata correlative to the Edwards Group which lie outside of the Kirschberg lagoon. Some evidence actually predates the publication of the Fisher and Rodda (1969) article. The stratigraphic revision of the Edwards Formation completed by Rose (1968) includes several measured sections outside the area defined later by Fisher and Rodda as the Kirschberg lagoon, all of which contain significant quantities of chert. The location of Rose's chert bearing measured sections are illustrated on Figure 6.5. Additional evidence surfaced in 1975 when Deal (1975:15) argued that the pattern of chert distribution advanced by Fisher and Rodda (1969) "is more apparent than real." As supporting evidence Deal cites the lower frequency of chert in some measured sections near the carbonate platform (that presumably contain more chert), and higher frequencies of chert occurrence in measured sections to the west, off the platform and in the vicinity of West Frio and Vanderpool. Almost concurrently, Mueller (1975) demonstrates a pattern of chert distribution diametrically opposed to the Fisher and Rodda model, namely that chert frequency increases toward the center of the lagoon (deeper water facies), and is less frequent where evaporite sedimentation was most common (e.g. structural highs). A similar trend was later observed by Ellis (1986:164) in a study of the Edwards in the vicinity of the Balcones Fault Zone. By examining cores taken from the vicinity of San Antonio, Ellis noted that chert occurs less frequently in areas that were structural highs during the early Cretaceous and that by coincidence are structural highs today, and that chert frequency increases basinward (to the south, southwest, and east of the study area).

These studies suggest that the association of chert and shallow water environments suggested by Fisher and Rodda may be in error, and that the opposite may in fact be true. That is to say that Edwards chert may occur more frequently in deeper water deposits.

Another source of information on the distribution of Edwards chert are the numerous maps in the Geologic Atlas of Texas (e.g. Fort Stockton, Sonora, Del Rio, and Emory Peak-Presidio; Bureau of Economic Geology 1981, 1982, 1977, 1979) which identify several lower Cretaceous stratigraphic units beyond the periphery of the Kirschberg lagoon as chert bearing (e.g. the Segovia, Fort Terrett, Santa Elena, Devils River, Salmon Peak, and McKnight Formations). Likewise, several site-specific studies in the region outside the Kirschberg lagoon note the occurrence of chert. For instance, Deal (1975, 1976a, 1976b) describes several chert-bearing strata in Fresno Canyon and the Solitario, in Presidio and Brewster counties, north and west of Big Bend National Park, and in the vicinity of Devil's Sinkhole in Edwards and Real counties. Further to the south, Smith (1970) describes the Lower Cretaceous stratigraphy of northern Coahuila and identifies seven chert-bearing formations, four of which are correlative with the Edwards Group of Central Texas. Smith provides numerous measured sections (refer to Figure 6.5) in the Serrania del Burro and Sierra del Carmen which effectively demonstrate the presence of chert in those areas, although the suitability of this material for archeological purposes is unknown.

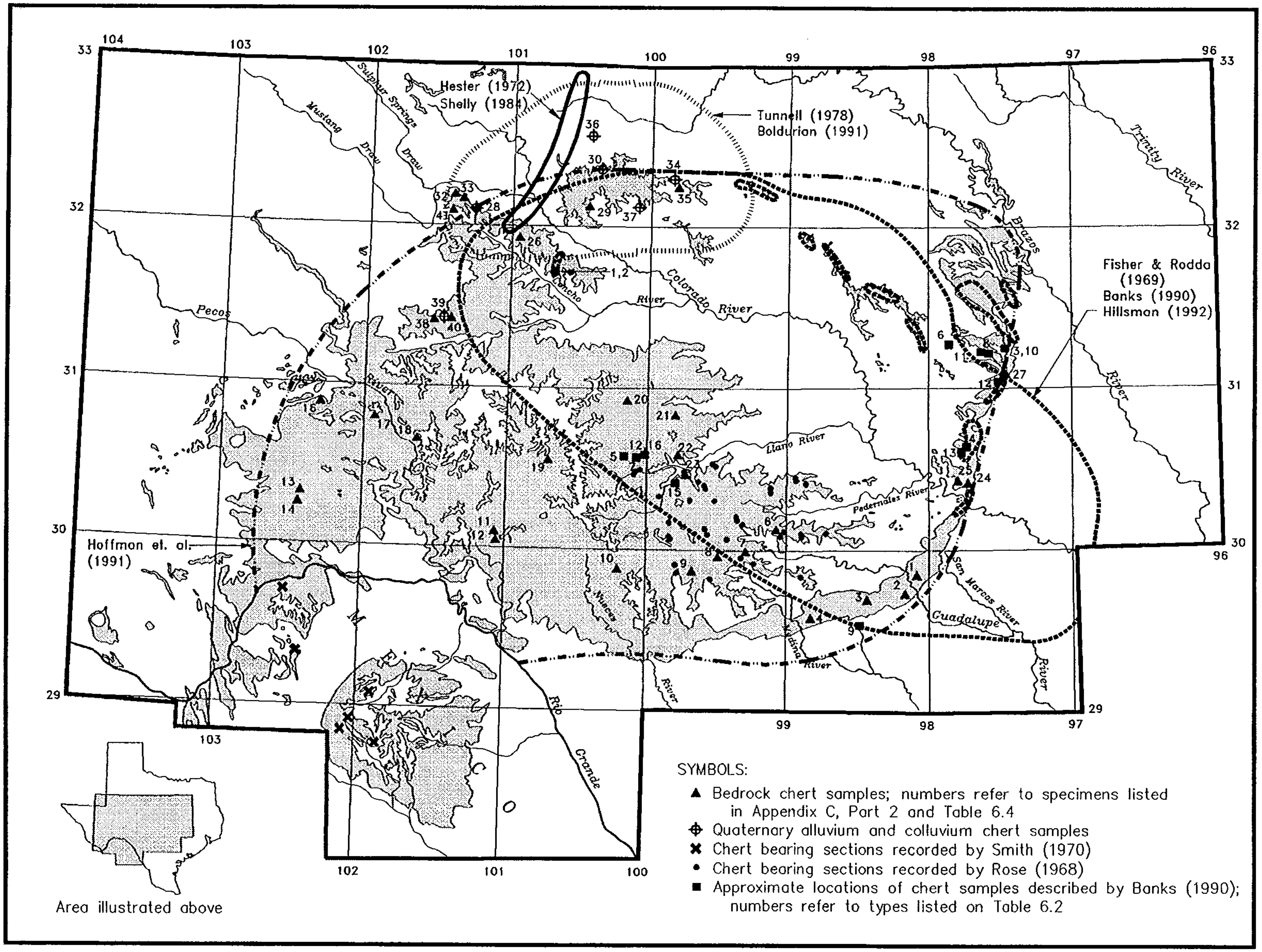


Figure 6.5 Map Comparing the Location of Bedrock Chert Sample Localities Identified in Appendix C with Previously Described Chert Bearing Sections, the Edwards Group Outcrop, and Areas Identified Sources of Edwards Chert.

Obviously, there is ample evidence in the geological literature to suggest that chert occurs in Edwards Group deposits outside of the Kirshberg lagoon.

Archeological records of chert outcrops outside of the lagoon are widely scattered in the cultural resource management literature. For instance, Peter et al. (1990:98-101) recorded 41VV1007 on the Cauthorn Ranch in Val Verde County, Texas as a procurement site and noted the presence of significant quantities of nodular and lenticular chert (multiple lenses) upon the slopes throughout the Trail Canyon drainage. Another record from Val Verde county is provided by McNatt (1981:142-143), who describes three "prominent layers of chert nodules" occurring in the back wall and adjacent cliff at site 41VV232, and two other sites where chert outcrops were observed (e.g. 41VV240, 41VV546). More recently Turpin and Davis (1993) have noted the existence of Cretaceous bedrock chert exposures and prehistoric quarry, lithic procurement and lithic reduction sites in the Devils River State Natural Area in Val Verde County. Three lithic sources are described, two of which are alluvial deposits. The bedrock exposures are described as "cobbles and pieces of tabular chert that litter the ground along specific contour lines" and "extensive, linear erosional exposures of chert." The local bedrock derived cherts are described as abundant and of caramel brown color and tabular morphology. Marmaduke and Whitsett (1975) observed chert outcrops in the vicinity of the Devil's Sinkhole, located in Edwards and Real counties. Outcrops of chert and quarry sites were recorded at several localities (e.g. 41ED41, 41ED46, 41ED54, 41ED77, 41ED82, 41RE41, and Figure 6.8 in Marmaduke and Whitsett [1975]), and demonstrate the presence of a brown chert in the lower Cretaceous strata in both counties. Likewise, Keller (1976) noted a substantial chert outcrop in the vicinity of the Strickleaf site (41ED8) which is also located in the headwaters of the Nueces River in Edwards County. Other outcrops and associated prehistoric quarry sites have also been recorded in Pecos County. For instance, Young (1981) reports on work performed at the Squaw Teat Peak site (41PC14) which contains a quarry. Coincidentally, this locality was also sampled during the brief West Texas field excursion performed as background research for this chapter (locality 16 of Appendix C). Young (1982) also describes another quarry/lithic procurement site chert outcrop from eastern Pecos County at site 41PC35. Further west, Hudson (1976a:139) noted that "quality flint nodules" could be obtained in at least one locality in the Solitario, where a prehistoric quarry site was recorded (41PS48), and that light gray, "brownish and yellowish" type cherts were also available from the local outcrops of lower Cretaceous limestone in Fresno Canyon (Hudson 1976b:133).

6.2.2 Field Reconnaissance

Clear evidence of chert outcrops outside the Kirschberg lagoon are present in both the archeological and geological literature, and demonstrate that this material was used by prehistoric populations. However, in order to obtain hand samples with precise geographic provenience from which detailed description could be compiled, a brief field reconnaissance was undertaken in January 1994. During this four day trip, 23 bedrock localities were sampled from the Edwards outcrop, approximately one-half of which (n=13) were situated outside the area Fisher and Rodda depict as the Kirschberg lagoon. Another 18 samples derived from both bedrock and Quaternary alluvium proximal to Cretaceous outcrops from places outside of Fort Hood were contributed by Mr. Doug Boyd and Dr. Steve Tomka (Prewitt and Associates, Inc.) and Mr. Chris Turnbow (Mariah, Albuquerque, New Mexico) and provide good areal coverage of the Edwards outcrop. These samples, together with previously published detailed descriptions of Edwards chert (e.g. Banks 1990), serve as a base from which the morphologic variability of Edwards chert may be examined and are discussed later (Section 6.3.4). The locations of these samples, as well as the locations of samples described by Banks (1990), and measured sections containing chert described by Rose (1968) and Smith (1970), are illustrated on Figure 6.5 with respect to previous impressions of where Edwards chert occurred, as well as with respect to the limit of chert-bearing, lower Cretaceous outcrops. Detailed descriptions of the hand samples are located in Appendix C.

6.2.3 Summary of Chert Occurrence Outside of Fort Hood

The results of this fieldwork conclusively demonstrate that significant outcrops of Edwards chert occur beyond the margins of the Kirschberg lagoon, and that many of these sources have been used during the prehistoric period. Although Fisher and Rodda (1969) argue that these areas may have little to no chert, several of the outcrops in Terrell County were in excess of 4 m thick and at least one of these contained more than 10 m of dense, cherty limestone. However, it was also noted that chert distribution in the western outcrop extent of the Edwards is highly spatially patterned. Although a highway survey such as this is considered to be a poor data set upon which to evaluate chert outcrop frequency, some observations based on the abundance of chert in stream bedload clearly reflect the frequency or density of chert in the surrounding basin. On the basis of this type of observation, the frequency of chert appears to decrease significantly in Val Verde and Pecos counties. Chert outcrops observed in roadcuts were uncommon and chert comprised much less than one percent of the bedload of most streams examined in this region. If this impression is true, then alluvial gravels may have provided the prehistoric inhabitants of this region with a more reliable source of lithic raw material for purposes not requiring large pieces. The possibility that the lithic resources within the Edwards are spatially heterogeneous is an important consideration when evaluating the prehistoric use of this stone, but the preceding information demonstrates that the most often cited model of chert occurrence is in need of revision and may be of poor utility in archeological studies.

6.2.4 Distribution of Edwards Chert at Fort Hood

The preceding discussion demonstrates that the understanding of chert occurrence within the Edwards and correlative strata is not currently adequate enough to be used as a predictive model for archeological purposes. At this point in time, it is probably best to consider all strata associated with the Edwards Group to be potentially chert bearing, until more detailed regional information is compiled.

The implication of this conclusion for Fort Hood is that chert distribution should be spatially patterned due to heterogeneous digenesis, in addition to differential erosion of the Edwards strata. In the particular case of Fort Hood, the latter may be more important than the former. This is in part due to the fact that Fort Hood is situated within the Lampasas Cut Plains, a physiographic region defined by dissection of the Edwards Plateau. Nordt (1992) has named the two major surfaces associated with the Lampasas Cut Plain at Fort Hood the Manning surface and the Killeen surface. The Manning surface refers to the highest portions of the landscape and is primarily underlain by the undifferentiated Edwards and Kiamichi Limestones and the Comanche Peak Limestone. This surface is widely considered to be an eastern extension of the Callahan Divide (Hayward et al. 1990; Nordt 1992), and because the latter stands above projections of the Llano Estacado surface, it is believed to predate deposition of the Ogallala, making it at least Miocene in age. The lower, more dissected Killeen surface is largely underlain by the Walnut Clay and the Comanche Peak limestone, and is believed to be of early to middle Pleistocene age (Hayward et al. 1990; Nordt 1992). Figure 2.5 illustrates a general cross section of the Lampasas Cut Plain at Fort Hood. According to this model, all of the primary, bedrock-derived chert at Fort Hood should be confined to the surface or margins of the Manning surface and the outcrop of the Edwards Group strata.

In order to test this model of chert occurrence at Fort Hood, we have compiled a map (Figure 6.6) of chert outcrops from the systematic archeological surveys of the base and the LRPA resurveys performed by Mariah during 1992. Obvious secondary deposits, such as the second terrace of Cowhouse Creek, were not included on this map because more accurate sources of this information are available in Nordt (1992). Since most of the surveys from which this data has been compiled were not intended to serve in this capacity, it is necessary to consider this map a first approximation of actual chert outcrops. Early surveys of the base, which did not include field information compiled on aerial photos, often failed to comment on chert outcrops and are one of the most serious biases inherent to this data. The location of the older survey units, more recent quads with aerial photo base maps, and quads for which no data was available are illustrated on Figure 6.7. Comparison of the two figures demonstrates that few chert outcrops are presently known in the parts of the base covered by older survey quads, and in quads for which no survey maps could be found, even though Edwards Group limestones are known to crop out in some of these localities. The principal areas affected by this bias are the Manning Surfaces on the south side of the Owl Creek valley (south of the Henson Mountains) including Robinette Point, Rambo Point, Wolf Point and McBride Point, and Smith Mountain in the Permanent Dudded area. In addition to this bias, a very limited ground truthing of this map demonstrated to us that it underestimates the number and areal extent of chert outcrops. Nevertheless, it provides an interesting first approximation of chert distribution and clearly demonstrates that the majority of the known chert outcrops are associated with the Manning surface.

The remaining occurrences may be explained by secondary chert deposits or possibly the existence of a chert zone in the Glen Rose Formation. The number of small chert outcrops depicted adjacent to House Creek, for instance, were field checked and found to be diffuse scatters of secondary chert cropping out on the margin of the incised House Creek valley. These lag gravels contain the two types of chert that occur on Anderson Mountain and Seven Mile Mountain in the southwest part of Fort Hood.

The general pattern of chert outcrops does, however, reflect the reality of chert distribution on the surface in different parts of the base and is the result of the manner in which the geometry of the present land surface intersects the generally flat-lying chert zones. For instance, a comparison of the areas north and south of Cowhouse Creek in the vicinity of Belton Reservoir in East Range illustrates how chert occurrence is affected by dissection of the landscape. Gentle dissection of the Edwards strata by North Nolan Creek has exposed vast areas of individual nodular chert zones resulting in very extensive chert outcrops. However, the relatively undissected Manning surface north of Belton Reservoir exhibits few chert outcrops, and where source areas are present, they mostly occur around the margins of the surface where they are exposed by the escarpment or gentle beveling of the Edwards adjacent to the escarpment. The other factor that influences the outcrop pattern of chert on this map is the heterogeneous distribution of chert within the Edwards strata. There is little information on this aspect of chert occurrence in either the geological or archeological literature, but it is apparent that these chert beds are not necessarily spatially continuous. In fact, the heterogeneous nature of chert within the Edwards Group, together with the fragmentary preservation of these strata owing to erosion during formation of the Lampassas Cut Plains, results in distinctly different lithic resource opportunities across the base. Not only is chert not available everywhere as some people today seem to believe, but the quality, diversity and ubiquity all vary spatially to form a complex mosaic of potential lithic resources.

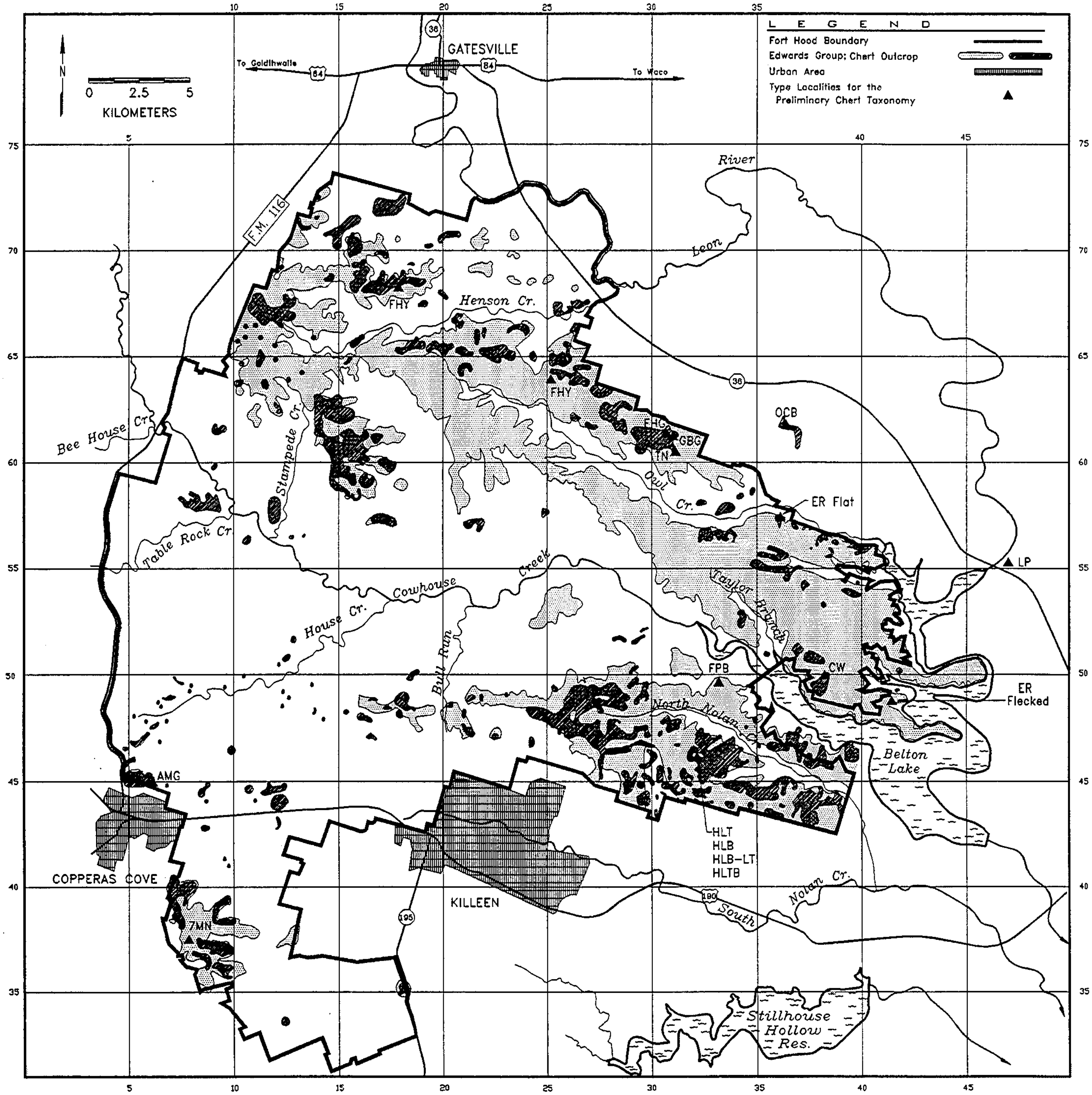


Figure 6.6 Map Comparing Known Chert Outcrops at Fort Hood with the Approximate Outcrop of the Edwards Group Strata.

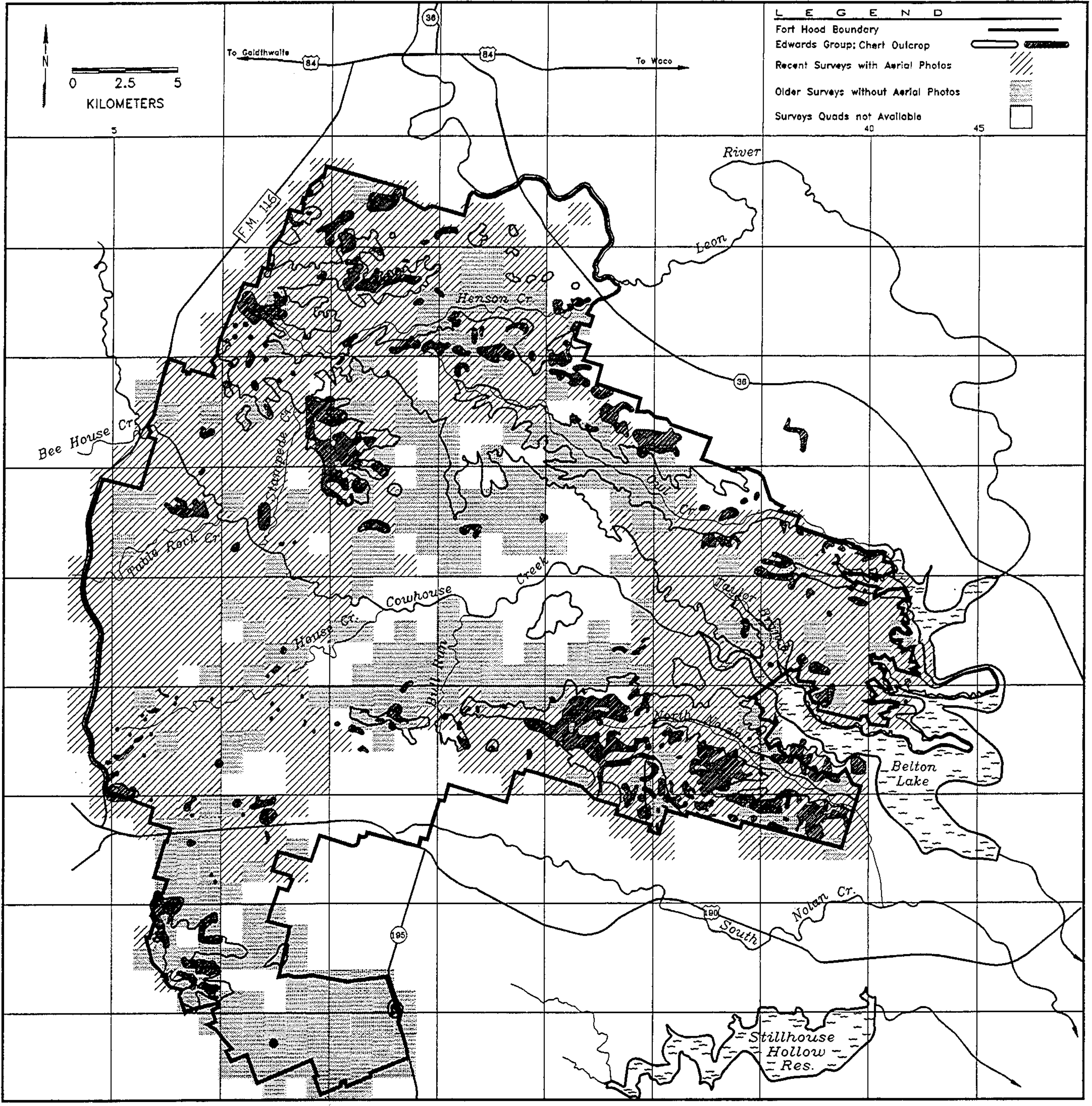


Figure 6.7 Location of Old, New and Unavailable Survey Quads Used in Compiling the Chert Outcrop Map (Figure 6.6).

Note the lack of chert outcrops in the areas covered by older and unavailable survey quads, especially immediately south of Owl Creek in the central portion of the base.

It is also important to remember that a large variety of chert may also be obtained from the bedload deposits of Cowhouse Creek and the Leon River, both of which drain Edwards Group deposits off base to the west. A cursory examination of the bedload of Table Rock Creek, the only other significant drainage which flows onto Fort Hood from the west, failed to find significant quantity or diversity of chert. No systematic collection of these deposits was performed as part of this study, but such a collection should be considered as a necessary prerequisite to understanding the full range of lithic material available to prehistoric groups that once occupied the Fort Hood region.

6.3 APPEARANCE AND COMPOSITION OF EDWARDS GROUP CHERT

Edwards chert is known to occur in three forms: (1) relatively flat, disc-shaped nodules that form parallel to bedding planes; (2) irregular nodules which are often complex three dimensional shapes that cut across bedding; and (3) continuous beds which may be up to 50 cm or more thick. Of the three, the first category appears to be most common, followed closely by the second. Bedded chert is relatively uncommon in the Edwards, but several examples have been recorded (Rose 1968; Banks 1990). The flat, disc-shaped nodular cherts often exhibit radical differences in appearance from one bed to the next, whereas irregular nodules often are remarkably similar through 5 or more meters of section. Banded cherts are nearly almost always found to be flat, disc-shaped nodules, whereas mottled cherts may occur as any morphologic type.

Although no widely accepted classification of Edwards chert exists, Rose (1968) suggests that Edwards chert may be classified into five categories on the basis of field examination:

(1) dark grayish-brown, flat, regular, smooth nodules: this type of chert commonly occurs in thin bedded limestone but is also found in dolomite. Nodules are always oriented with their long axis parallel to bedding. Depositional textures are not commonly preserved.

(2) Light grayish-brown, very irregular, smooth nodules: this variety shows a strong preference for dolomite and recrystallized limestone and is somewhat more coarsely-crystalline than the first variety. Depositional textures are not preserved, but secondary layering may be. It commonly weathers out of covered slopes as loose reddish-brown nodules.

(3) Dark grayish-brown, regular, flat nodules with preserved depositional textures: this type of chert is most common in the Dolomitic Bed and Kirschberg horizons. Some has been found interbedded with gypsum.

(4) Reddish-brown, porous, coarse-shelly rudist rock: this silica ranges widely from nearly chalcedonic to fine quartz druse. Large shells are replaced, but the rock is quite porus -- apparently some interstitial material escaped complete silicification. This type occurs widely at two levels, just below the Kirschberg and just below the Allen Ranch Breccia horizons.

(5) Botryoidal, clear to banded chalcedony to very fine, pure chert: this is fairly rare, but seems to be limited to the Kirschberg Evaporite and Allen Ranch Breccia horizons" (Rose 1968:172-173).

Archeological descriptions of chert often record considerably different information than that typically provided by geological studies designed to elucidate the environment of deposition, or processes of, diagenesis. Descriptions of this type generally examine properties such as color, translucency, hardness, grain size and structure of the chert which may be unique to the material being examined and which may have influenced cultural selection. Although there is considerable variation in the literature with respect to the pertinent type of observations, a recent book by

Luedtke (1992) provides a standardized format for archeological description of cherts and this scheme is employed here.

Because there has been so little formal description of Edwards chert, understanding in the archeological community of what comprises this resource is very general, simplified, and highly contingent upon personal experience. The widely published folk taxonomy that describes Edwards chert as simply gray or tan and of high quality (e.g. Hofman et al. 1991; Tunnell 1978) fails to convey extremes of appearance that were described as early as 1931 (Sayles 1931:18) which included colors such as black, blue, and white. It is also interesting to note that the chert derived from the Edwards that is most widely preferred by modern knappers in the vicinity of Fort Hood is black, a color not included in most published descriptions. The color diversity of Edwards chert may be appreciated by a detailed perusal of the measured outcrop sections of Rose (1968), who uses approximately 16 color combinations to describe the chert he observed in the field (e.g. brown, dark brown, light brown, brownish gray, reddish brown, light brownish gray, pinkish brown, tan, white, medium dark gray, grayish brown, gray, dark gray, bluish gray, reddish gray, and blue).

At this point one may ask the question, "Is there utility in constructing a taxonomy of Edwards chert?" The answer is unequivocally, yes. The results of the present study will demonstrate that, although there may be some overlap in the appearance of different cherts within the Edwards group, there is strong spatial and morphological variation present within these deposits that may be described on a regional scale and that may be of use in regional archeological studies. To provide a comprehensive description of Edwards chert clearly would be as Johnson (1991:77) described it, "an herculean task," but regional taxonomies, such as the one described below, are another matter altogether and relatively easily established. The pronounced spatial patterning of chert resources at Fort Hood actually make a typological analysis of debitage an interesting and potentially rewarding endeavor. However, the inherent variability of this lithic resource limits the confidence of many identifications, even when quite familiar with the chert, so that a greater than 50 percent accuracy of identification should not be expected.

6.3.1 Previous Archeological Descriptions

One of the first archeological descriptions of Edwards chert was a very brief, but precocious, study by Escobedo (1977), performed in association with the University of Texas at San Antonio excavations at Hop Hill, in Gillespie County. Escobedo established a six-member taxonomy of chert for material occurring at Hop Hill and classified these samples on the basis of color, texture, structure, cortex character, and mode of occurrence (Table 6.2). The majority of these specimens were shades of brown or gray, but reddish brown, and black colors were also present. One third of the specimens were banded, another third mottled and the remainder were either vuggy or "contained high amounts of clay."

Banks (1990) provided the most comprehensive descriptions of Edwards chert to date. Sixteen samples were described in detail (see also Table 6.2 and Figure 6.5 for locations) and supplemented with color photographs. Most of the samples were obtained from four areas: Fort Hood and immediate environs (Bell and Coryell counties); near Georgetown, Texas in Williamson County; Kimble County in the vicinity of Junction, Texas; and from northwest of San Angelo, Texas. The dominant hues of the described samples are 5Y, 10YR, and achromatic colors (white or gray). Less frequent hues include 10R, 5YR, 7.5YR, 2.5Y, 5PB, and 5RP. The majority of the specimens are mottled or homogenous, with few exhibiting banding.

Table 6.2 Previous Description of Edward's Group Chert.

Source	County	Type or Internal Reference	Color	Texture	Structure	Translucence	Luster	Occurrence	Cortex
Escobedo 1977	Gillespie	1	black, dark brown, dark gray	very fine	banded	translucent	na	cobble size pieces	thin limestone
		2	light gray, reddish brown, light brown fine	fine	banded	translucent	na	cobble size pieces	thin limestone
		2a	brown, light brown	medium	white spots	translucent	na	cobblesize pieces	thick limestone
		3	brown, brown yellow	medium	high amounts of clay	opaque	na	cobble size pieces	thin limestone
		4	light brown, yellow brown, gray	medium to coarse	vuggy	edge translucent to opaque	na	cobble size pieces	thin, rough limestone
		5	light gray, reddish white, reddish brown	fine to medium	white spots	opaque	na	chunks	thin, rough limestone
Banks 1990	Tom Green (?)	1 (Fig.5a)	Dark grayish brown (5Y 4/1) to medium gray (5YR 5/1)	Aphanic	Excellent conchoidal fracture	Opaque except on thin edges	Very slight	ns	ns
	Tom Green (?)	2 (Fig.5b)	Medium gray (10YR 5/1) to dusky yellowish brown (10YR 4/2). Splotches are light yellowish gray (5Y 8/1)	Aphanic	Excellent conchoidal fracture	Opaque on thin edges	Dull to very slight	ns	ns
	Bell	3 (Fig.5c)	Mottled light gray (5Y 6/1), light olive gray (5Y 6/2) to white (5Y 8/1)	Aphanic	Mottled, excellent conchoidal fracture	Opaque except on thin edges	Dull to very slight	ns	ns
	Williamson	4 (Fig.5d)	Alternating bands of light gray (N7) to medium gray (N5) and dark gray (N4)	Cryptocrystalline	Banded, excellent conchoidal fracture	Translucent on thin edges	Dull to slight Luster	ns	snow white
	Kimble	5 (Fig.5e)	Light olive gray (5Y 6/1), pale yellowish brown (10YR 6/2), grayish red (5RP 7/2) to very pale yellowish white (10YR 8/2)	Aphanic	Horizontally banded (striated) fossiliferious	Opaque	Dull to slightly vitreous	ns	ns

Table 6.2 (Continued).

Source	County	Type or Internal Reference	Color	Texture	Structure	Translucence	Luster	Occurrence	Cortex
	Coryell/Bell	6 (Fig.5f)	Medium gray (N5) with alternating bands of very light gray (N8), light gray (N7), and light brownish gray (5YR 6/1). Some white (N9) inclusions in light brownish gray colors	Cryptocrystalline	Banded, excellent conchoidal fracture	Opaque	Dull	ns	ns
	Sutton	7 (Fig.6a)	Light gray (2.5Y 7/2) Weathers to a grayish brown (2.5Y 7/2) with light brownish yellow (2.5Y 7/4) staining	Aphanic	ns	Opaque	Dull	ns	ns
	Coryell-Bell	8(Fig.6b)	Medium gray (5Y 6/1), to light brownish gray (5YR 6/1)	Aphanic	ns	Opaque	Slightly vitreous	ns	Weathers to a pinkish gray (5YR 8/1)
		9(Fig.6c)	Mottled Light Brownish gray (5YR 6/1) to brownish gray (5YR 4/1), very light gray (N8), light brown (5YR 5/6), moderate yellowish brown (10YR 5/4), and pale blue (5PB 7/2)	Aphanic	ns	Opaque but gives illusion of being translucent	slightly vitreous	ns	ns
	Bell	10(Fig.6d)	Basic color light gray (7.5YR 7/0) to white (7.5YR 8/0). Splotching is orange (10YR 7/4). Weathers to very pale orange (10YR 8/2) and pinkish gray (5YR 8/1)	Densely aphanic	Mottled, vugs with mega quartz fillings, and is fossiliferous	Opaque	Dull to slightly vitreous	ns	ns
	Bell-Coryell	11(Fig.6e)	White (10YR 8/1)	Cryptocrystalline, excellent	Banded	Translucent on thin edges	Slight	ns	ns
	Kimble	12(Fig.6f)	Mottled moderate yellowish brown (10YR 5/4) and light brown (?YR 5/6) [sic]	Aphanic, excellent fracture	Mottled	Opaque	Dull	ns	ns

Table 6.2 (Concluded).

Source	County	Type or Internal Reference	Color	Texture	Structure	Translucence	Luster	Occurrence	Cortex
	Williamson	13(Fig.6g)	Brownish gray (5YR 4/1) to medium dark gray (N4), medium light gray (N6) to white (N9)	Cryptocrystalline, excellent	Banded	Translucent on thin edges	Slight	ns	ns
	Bell	14(Fig.6h)	Medium dark gray (N4) to very light gray (N8). Pale Yellowish brown staining (10YR 6/2)	Aphanic, fossiliferous	ns	Generally opaque, but darker colors tend towards being more translucent	Slight luster in darker colored areas	ns	Thin white (N9) cortex
	Kimble (?)	15(Fig.6i)	Pale red (10YR 6/2) to grayish red (10YR 4/2). Weathers to pinkish gray (5R 8/2)	Cryptocrystal line, excellent conchoidal fracture	ns	Opaque but weathered edges are semi-translucent	Dull to slightly vitreous	Thin lenses	ns
	Kimble	16(Fig.6j)	Light olive gray (5Y 6.1), splotches of brownish gray (5YR 4/1), and red (2.5YR 4/6)	Aphanic, excellent conchoidal fracture	Mottled	Opaque	Dull to slight sheen	ns	ns

The only other detailed descriptions of Edwards chert are found in Dickens' (1993a; 1993b, 1992) work at Fort Hood. In these three publications, Dickens eventually describes seven chert types occurring on or in the vicinity of Fort Hood. Dickens comments specifically on the occurrence and workability in raw and heated states. Unfortunately, no detailed analytically based descriptions of the color, texture, or translucency are presented, nor are type localities, making the taxonomy difficult to evaluate without hand samples or first hand field directions.

6.3.2 The Results of the Work at Fort Hood

The work in this volume adopts Dickens' taxonomy in its entirety and builds upon it. Where possible, we obtained samples from localities identified in the field by Dickens, and subsequently included a number of additional chert types that were clearly different in morphology from the existing types. Dickens' work appears to have identified the most easily worked cherts (and therefore preferred) on or in the vicinity of Fort Hood and stands as a good introduction to the lithic materials of this region. However, the previous taxonomy is of limited geographic extent and fails to include several distinct types of chert which appear to be of lower grade. Where possible, we have incorporated all of the cherts we observed, regardless of grade, because we consider it necessary to document the full range of material grades in order to evaluate prehistoric selection processes. While it may be true than many of the chert types we have added to the inventory may have been infrequently used, that alone is important information when evaluating a lithic assemblage.

While we find the geographic coverage of the existing taxonomy lacking, we find the same fault with this study. All of the work contained in this chapter is a rather opportunistic foray into a subject that could easily entail several months of survey, collection, and analysis. Unfortunately, we did not have that luxury. Therefore, the results of survey, collection, and analysis. Unfortunately, we did not have that luxury. Therefore, the results of this chapter should be viewed as what it really is: a first (although arguably a second) approximation that expands the preexisting taxonomy but fails to provide a sound, geographically or stratigraphically based data set. This is in part due to the manner in which the taxonomy was established. The methods employed were less than systematic, and relied upon personal experience obtained during reconnaissance on base, and a suite of systematic samples obtained from resurvey of LRPAs. No consistent, systematic field observations were made regarding the diversity and occurrence of chert except on LRP areas. To the contrary, this work results from subjective impressions of chert occurrence obtained during ongoing fieldwork in 1991 and 1992 and should be considered a model of chert morphology and occurrence in need of testing by more detailed field examination.

6.3.2.1 The Taxonomy

Sixteen morphologically distinct chert types are currently recognized at Fort Hood. A brief description of each type is provided on Table 6.3, and detailed descriptions are provided in Appendix C. In brief, the types listed in order from lightest to darkest color are: Heiner Lake Blue-Light, Cowhouse White, Anderson Mountain Gray, Seven Mile Mountain Novaculite, Texas Novaculite, Heiner Lake Tan, Fossiliferous Pale Brown, Fort Hood Yellow, Heiner Lake Translucent Brown, Heiner Lake Blue, East Range Flat, East Range Flecked, Fort Hood Gray, Gray-Brown-Green, Leona Park, and Owl Creek Black. The last two types are not known to crop out on Fort Hood, but rather, exist in the immediate vicinity of the base and were therefore included in this study. A photograph of each of these cherts is provided in Appendix C, Plates 1 and 2.

Heiner Lake Blue-Light

This material is one of two distinctly different cherts that occur within large (often >1 m diameter) disc-shaped nodules. It is homogeneous to very faintly banded, opaque, emits a tremendous ring upon being struck, and is generally white to yellowish gray in color. It has a medium to coarse texture and freshly broken surfaces often feel rather chalky. This material occurs around the outside of the nodules; the chert comprising the core of the nodules is darker in color, has a finer texture, and is recorded in the taxonomy as Heiner Lake Blue. The type locality for this material is the pipeline that runs roughly east-west immediately north of Heiner Lake in quad 32/45. The areal extent of this material in unknown.

Cowhouse White

This is a white, very light gray to bluish white, fine- to coarse-grained chert that occurs on the Manning surface in the vicinity of Union Hill (quad 38/45), north of the Cowhouse Creek arm of Belton Reservoir. The outcrop of this chert appears to be restricted to the immediate vicinity of Union Hill, but similar material has been observed in quad 16/59, cropping out from the upper slopes of the Manning surface on the south side of the Clabber Creek valley. It is the only prominently banded chert in the existing taxonomy, and grades to a mottled structure in the interior of large nodules. It occurs as large, flat, disc shaped nodules that in the outcrop are most often found fractured into broken, blocky fragments, with long axes in excess of 20 cm. Complete nodules are uncommon, but may be in excess of a meter in diameter and 20 to 30 cm thick. This material is relatively flawless, opaque, and does not have the chalky surface texture of the previous material. It was previously described by Dickens (1993a).

Table 6.3 The Fort Hood Chert Taxonomy.

Type	Name/Quad	Color	Texture	Structure	Translucence	Luster	Occurrence	Cortex
1	Heiner Lake Blue- light 32/45	White to yellowish gray (N9 to 5Y 8/1). Some bands near the cortex are occasionally pale yellowish brown (10YR 6/2).	medium to coarse, fresh fracture surfaces have chalky feel	homogenous to very faintly banded	<1 mm	dull	very large disc shaped nodules (often >1m)	reddish brown (5YR 4/4 to 4/4)
2	Cowhouse White 38/49	Predominantly white (N8/0, 10YR 8/1) and very light gray (N8), but may include gray -light gray (N7/0, N6/0), bluish white (5B 9/1), light gray, gray and light brownish gray (10YR 7/2, 10YR 6/2, and 10YR 5/1).	fine to coarse, often appears porcellaneous	prominently banded near cortex, mottled in center	1 - 3.4 mm	dull	large nodules	white
3	Anderson Mountain Gray 5/45	white (N9 to 10YR 8/1) at the cortex, to pale yellowish brown (10YR 6/2), light gray (10YR 7/1, 7/2), very pale brown (10YR7/4); medium dark gray (N4), olive gray (5Y 4/1) and brownish gray (5YR 6/1).	fine to medium	mottled, commonly exhibits many fine (<1mm) darker mottles (inclusions) which are most prominent at edges of nodules; larger mottles (5+ mm diameter) are also common. Occasionally to frequently fossiliferous	1 - 3	dull	irregularly shaped nodules	white and slightly rough, but may be stained light reddish brown (5YR 6/4).
4	Seven Mile Mountain Novaculite 7/38	White to light gray (N7/0, N8/0) bluish gray (5B 6/1), and pale blue (5PB 7/2) with irregular veiniform very pale brown (10YR 7/4) inclusions which appear as yellow, somewhat linear mottles (10YR 7/6) in some samples. Often grades to a yellow or orange color at margins of nodules.	coarse to fine; fresh fractures often have a sugary appearance	homogenous, although there are often vein-like inclusions and megaquartz filled vugs	>15 mm	dull, but may have specular highlights	Very large (often >1m diameter), irregular very hard nodules	porous megaquartz cortex, often colored red due to adherence of old argillic horizon
5	Texas Novaculite 31/59	Light bluish gray (5B 5/1 to 7/1), pale yellowish brown (10YR 6/2), and white (10YR 8/1).	medium to fine	Common coarse (>10 mottles which exhibit sharp boundaries, are often composed of slightly coarser textured material.cm diameter)	4 - 6 mm	dull	Large nodules or unknown shape but in excess of 30 cm in diameter.	
6	Heiner Lake Tan 32/45	light gray to light brownish gray (10YR 7/2 to (creamy) white (10YR 8/2), and grayish orange (10YR 7/4). Common, prominent round white to very pale orange (10YR 8/2-8/1) sharp edged mottles which are often slightly coarser textured than surrounding matrix.	medium to fine, often a little chalky feeling	Mottled; common small (<1-5 mm), round white to very pale orange mottles	1 - 5 mm	dull	Very disjointed nodular beds ranging between 10 and 20 cm thickness, occasionally very large nodules (>50 cm in diameter)	moderate orange pink (5YR 8/4)
7	Fossiliferous Pale Brown 33/48	Very pale brown (10YR 6/4 to 7/4) , light gray to white (10YR 7/2 to 10YR 8/2), and mottled to gray-light gray (10YR 6/1). Pale blue (5PB 7/2; 5B 9/1) flecks and veins are common in some specimens.	fine to medium	Mottled, and commonly fossiliferous	<2 mm	dull	irregularly shaped nodules	white (N9) but often stained dark brown (7.5YR 4/2) or reddish brown (5YR 4/4)

Table 6.3 (Continued).

Type	Name/Quad	Color	Texture	Structure	Translucence	Luster	Occurrence	Cortex
8	Fort Hood Yellow 25/63 & 17/67-68	Very pale brown to (10YR 6/2 to 10YR 7/3) varies to light gray, light gray (10YR 7/1, 10YR 5/1, the latter of which most commonly occur as mottles or bands that are coarser textured than the brown parts	fine to medium	Mottled with few to common sharp edged, often very irregular shapes (often look like burrows) which are up to 1 cm diameter.	<1.5 mm	medium to dull	Large irregular nodules, often in excess of 30 cm in diameter	white to moderate yellowish brown (10YR 5/4)
9	Heiner Lake Translucent Brown 32/44	Dark gray to dark grayish brown (10YR 4/1, 10YR 3/1, 10YR 3/2), pale yellowish brown (10YR 6/2), and occasionally grayish brown (10YR 5/2). Light bluish gray and brown (10YR 4/4) laminae occasionally present	fine	laminated to striated. Some laminae act as cleavage planes.	9 - 12 mm	medium to dull	Tabular to squatty disc-shaped nodules, often with t	white and generally thin to light yellowish brown (10YR 6/6, thin laminae weather into bas-relief striations on nodule surface
10	Heiner Lake Blue 32/45	Medium gray (N5) to medium bluish gray (5B 5/1). Common white (10YR 8/1) to light gray (10YR 7/2) gray 0.5 to >2cm mottles, and few to many <1mm bluish white (5B 9/1) flecks.	fine	mottled to brecciated	3 - 5 mm	dull to medium	Large disc shaped nodules	formed by Type 1
11	East Range Flat 36/56	Gray-light gray (N6 - N7) to light (olive) gray (2.5Y 7/2 to 5Y 7/2); colors often shade from one into another. It is commonly gray outside and shades to olive gray inside nodules.	medium	streaked and mottled; few 1-2 cm diameter mottles of coarser textured sediment. Some specimens have many, <1mm dark gray mottles (or flecks)	<1 mm	dull	irregular nodules	Cortex is white, yellowish brown (10YR 5/4) and very pale orange (10YR 8/2)
13	East Range Flecked 41/48	Dark gray (N4) to light gray (N7 to 10YR 5/1) and the colors shade from light gray at outside of nodules to dark gray in interiors. Many fine (<1mm) white to bluish white (inclusions) are present.	fine to medium	Mottled to shaded. Many to common small (<1mm) white flecks which exhibit some preferred orientation (fabric), some of which are fossils; occasionally mottled with coarser textured	<1 mm	dull to medium	thin tabular nodules	white (N9) and chalky
14	Fort Hood Gray 30/60	Variable, light gray to dark gray (N7 to N4), and occasionally medium bluish gray (5B 5/1). Some fracture surfaces and burrow traces within chert are stained dark brown to strong brown (7.5YR 4/4 to 5/6).	fine	Mottled with few to common irregular approximately 1 cm diameter tubular mottles of slightly different color and/or textured material, larger scale color mottling also apparent.	<3 mm	dull to medium	irregular nodules	white to very light gray (N8-N9) and occasionally varies to grayish brown (2.5Y 5/2).
15	Gray-Brown-Green 31/60	Light brownish gray - grayish brown (2.5Y 6/2 - 5/2), light olive gray (5Y 5/2), gray (10YR 6/1) to very dark gray (N3).	fine	Mottled with medium to coarse (2 - 20+ mm) inclusions of variable colored and textured material. Mottles are often slightly coarser textured than the surrounding matrix. A few vugs filled with mega quartz are present.	<1 mm	medium to dull	irregular nodules	white (N9) to yellowish gray (5Y 8/1) and chalky

Table 6.3 (Concluded).

Type	Name/Quad	Color	Texture	Structure	Translucence	Luster	Occurrence	Cortex
16	Leona Park	Irregularly mottled with dark gray (N3), medium gray (N5), very light gray (N8), and light brownish gray (5YR 6/1). Joint faces are stained dark yellowish brown (10YR 6/6)	fine to medium	Difficult to describe. There is a definite fabric present that is roughly parallel to bed boundaries, and the mottles (alternating, mixed gray and light gray colors) are horizontally elongated. Very reminiscent of lenticular bedding.	<1 mm	medium to dull	massive bed	no cortex
17	Owl Creek Black 36/60	Black (N1) to dark gray (N4 to N2). Some specimens have <2 cm diameter, elongate medium light gray (N6) sharp edged mottles. Many tiny (usually <0.5mm) white flecks with a preferred orientation are present.	fine	Mottled to homogeneous. The tiny white inclusions express a horizontal fabric (parallel to long axes of the nodule)	<1 mm	medium to shiny	Thin (<6 cm) tabular nodules	white (N9) to yellowish gray (5Y 8/1) and chalky.

Anderson Mountain Gray

Named for one of the Manning surface remnants in the southwestern part of the base, this chert seems to occur in disc-shaped nodules and ranges widely in color from white, pale yellowish brown, and light gray around the exteriors, to medium dark gray, olive gray, and brownish gray in the interior. It is often fossiliferous, is fine to medium textured, and can best be described as having a mottled structure. It is relatively opaque and has a dull luster. It is believed to occur as far north as Henson Lake, and as far south as Seven Mile Mountain. Artifacts made of this material, especially those found near the type locality, Anderson Mountain which is located in quad 5/45, appear to have a brown or purple patina.

Seven Mile Mountain Novaculite

This chert is found in rather large (often >1m diameter and >40 cm thick), rounded to tabular nodules and commonly displays a light gray, bluish gray, or pale blue color. It is one of the most translucent cherts in the taxonomy and often has vugs partially filled with megaquartz. Typically, the texture of this chert is coarsest on the outside, fines immediately beneath the cortex, and then coarsens again toward the center of nodule. The useable portions are found in the fine textured zone between the cortex and the nodule centers. The latter often exhibit a sugary fracture surface, probably due to the presence of megaquartz, whereas the finer textured portions have a smooth to slightly rough fracture surface and are characterized by thin, irregular yellow to orange veins. The cortex is very unusual: a porus, megaquartz rich material often possessing a pronounced tubular fabric, and is stained brownish red by the surrounding soil. In the raw state this chert is very hard, but the finer textured portions experience a radical metamorphosis after heating, and often become almost vitreous in character. The type locality for this chert is quad 7/38 on Seven Mile Mountain, but it has also been observed south of Heiner Lake. Secondary deposits of this chert are common along the valley walls of House and Clear Creeks.

Texas Novaculite

This material occurs in large nodules of unknown shape, but fragments found in fields often are in excess of 30 cm in diameter. It is commonly light bluish gray, white, or pale yellowish brown, medium to fine textured, coarsely mottled, and moderately translucent. It has been previously described by Dickens (1993a) and is known from only a small area around East Range Road in quad 31/59. It is also hard in its natural state and reportedly improves upon heating.

Heiner Lake Tan

This chert was originally described by Dickens (1993a) and occurs in dense nodular zones that are often >20 cm thick and in nodules in excess of 50 cm in diameter. It commonly breaks into blocky fragments in the outcrop. It is light gray, light brownish gray, white, and grayish orange in color, and typically has numerous, 1 to 5 mm, round, white mottles. The texture is medium to fine, and it is opaque to moderately translucent. It has been observed in the immediate vicinity of Heiner Lake (quad 32/45) but the areal extent is unknown.

Fossiliferous Pale Brown

This is probably the most ill-defined material in the taxonomy. We decided to include it as a distinct type when similar material was observed at several "lithic resource procurement localities" examined by Mariah during 1992. It occurs as large, irregularly shaped but bedding parallel, disc-like nodules, and ranges in color from very pale brown, light yellow, light gray, brownish gray, to white. It occasionally has pale blue, chalcedonic, vein-like inclusions and small (<5 mm) vugs filled with megaquartz. Macro-fossils often replaced by megaquartz are common, and many small (<1mm) pale bluish white fossils may impart a speckled appearance. It is mottled on a coarse scale with the color changing abruptly from white to light yellowish brown near the nodule exterior, to a brownish gray near the interior. The type locality for this chert is 33/48, where it crops out at the margin of the Manning surface overlooking the Cowhouse Creek valley. It is known to exist in quads 16/51, 31/50 and 34/51, but the occurrence outside of these general areas is unknown.

Fort Hood Yellow

This chert occurs in large, irregular nodules and is found across much of the northern half of Fort Hood. It was previously described by Dickens (1993) and is very pale brown to yellow in color and often has light gray mottles which are slightly coarser textured than the matrix. It is opaque, has a medium to dull luster, and is generally fine textured. It occasionally has voids or chalky mottles in the nodule interiors.

This chert is typical of irregularly shaped nodular cherts in that it occurs throughout about 6 m of section and is relatively homogeneous throughout. We believe that Dickens' type locality for this chert is Henson Mountain near the headwaters of Owl Creek inside the Live Fire Area, but we have observed similar material adjacent to East Range Road in quad 25/63, and north of Royalty Ridge Road in quads 17/67 and 17/68. We propose that these two outcrops may serve as accessible type localities for this chert, which is the most ubiquitous material in the taxonomy.

Heiner Lake Translucent Brown

This chert occurs in rounded blocky to tabular nodules, and is dark gray, dark grayish brown to pale yellowish brown in color. It is striated, and the striations are often etched in bas-relief forms on nodule exteriors, and may act as cleavage planes. It is fine textured, commonly has opaque white to light yellowish brown rectangular mottles, is fairly translucent, and exhibits a dull luster which changes significantly upon heating. It occurs in quad 32/44 around Heiner Lake and is known to occur as much as 5 km west of there. Its actual areal extent is unknown. This is the only really root beer brown colored chert in the Fort Hood taxonomy.

Heiner Lake Blue

This chert is named after a type of chert reportedly present in the vicinity of Heiner Lake by J.B. Sollberger (cf. Dickens 1993a), but cannot be confirmed as the chert to which Sollberger referred. It is one of two cherts in this area that appears to be at all blue, the other being the Seven Mile Mountain Novaculite. It forms the bottoms and cores of the large nodules in which Heiner Lake Blue-light occurs and is medium gray to medium bluish gray in color, minimally translucent, and has a mottled to brecciated appearance. It occurs north of Heiner lake in quad 32/45 but its areal extent is otherwise unknown.

East Range Flat

This chert occurs as irregularly shaped nodules that often have voids or chalky inclusions. It is opaque, finely to coarsely mottled, and ranges in color from gray light-gray, to light olive gray, becoming olive toward the center. It has a chalky feel, medium texture, and a very dull appearance, from which the name is partially derived. It occurs in several canyons cut into the Owl Creek Mountains that form the southern valley wall of the Owl Creek basin, near the former confluence of Owl Creek and the Leon River. The type locality for this chert is located on the north and east facing slopes of the Manning surface, southeast of the confluence of Preachers Creek and Owl Creek, in quad 36/56.

East Range Flecked

This chert occurs in a relatively small outcrop located in East Range overlooking the Leon River portion of Belton Reservoir in quad 41/48. It consists of thin, often fractured nodules that are composed of a dark gray to light gray chert that contains numerous small, white flecks. It grades to darker colors in nodule interiors. It is medium to fine textured, opaque, and has a medium to dull luster. The darkest colors of this material overlap with Owl Creek Black, but the flecking is much more pronounced than in that material.

Fort Hood Gray

This chert was initially described by Dickens (1993a) and is known to occur as irregular nodules. It ranges in color from light to dark gray, and occasionally bluish gray, and is minimally translucent, fine textured, and mottled in appearance. A dull to medium luster is present, and it occasionally has chalky mottles or voids. It is known to crop out stratigraphically above Gray-Brown-Green (GBG), and grades, often very gradually, with that material. Its occurrence beyond quad 30/60 is unknown.

Gray-Brown-Green (GBG)

This chert crops out stratigraphically below Fort Hood Gray and is also composed of irregularly shaped nodules, often in excess of 50 cm in diameter. It is light brownish gray, light olive gray to very dark gray in color, has a fine texture, and mottled structure. It is opaque, and exhibits a medium to dull luster. Like Fort Hood Gray, it is known to occur in quad 30/60, but beyond that its distribution is unknown. It was originally described by Dickens (1993).

Leona Park

This chert occurs outside of Fort Hood, on the east side of the Leon River arm of Belton Reservoir, and north of State Highway 36. It is a bedded chert, with a thickness in excess of 50 cm thick in some places. It is mottled dark gray to very light gray, and has a pronounced horizontal fabric, which is reminiscent of lenticular bedding. It is opaque, has a dull luster, and a fine to medium texture. There is no significant cortex, and this chert emits a strong petroleum odor upon breakage after heating.

Owl Creek Black

This chert occurs as thin, tabular, disc-shaped nodules in the Flint Creek and Preacher's Creek drainages immediately northeast of Fort Hood. It ranges in color from black to dark gray and occasionally has elongated light gray mottles. It often has many, very fine flecks that express a preferred orientation parallel to the long axis of the nodule. It is opaque, has a medium to shiny luster, fine texture, and a white cortex. It is currently one of the more widely preferred cherts in the region, and may have been so in the prehistoric past as well. It too has been previously described by Dickens (1993a). The name of this chert suggests that it occurs in the Owl Creek basin, and Dickens (personal communication 1993) noted that it is a common constituent of Preachers Creek bedload. We located a bedrock source for this material in the Preachers Creek drainage basin, north of Fort Hood in quad 36/60, and suspect that it also crops out on base as well. If it occurs on base the most likely outcrop areas would be in the divide between Owl and Henson Creeks, in training areas 63 and 64 in the Live Fire Area.

6.3.2.2 Geographic Trends in Chert Occurrence.

At the regional level, some very interesting trends in chert occurrence are present. One of the most significant is the west northwest to east southeast trend in outcrop occurrence of different types within the taxonomy. Many of the cherts described above appear to have outcrops that are relatively narrow north to south and elongate northwest-southeast. Cherts which exhibit this trend are Fort Hood Yellow, Heiner Lake Translucent Brown, Seven Mile Mountain Novaculite, and possibly Cowhouse White. At a regional level, this appears to represent some sort of zonation of chert morphology within the Edwards Group. The cause of these patterns is unknown at this time, but their existence aids examination of chert use and mobility by prehistoric groups and facilitates the construction and use of taxonomies such as this.

At a simplified level, it is possible to view Fort Hood as having three bedrock chert or lithic provinces: North Fort, South East Range, and West Fort (refer to Figure 6.8). The diversity of chert types in each of these provinces is different, in part a function of the mode of occurrence and the geometry of the outcrop.

North Fort refers to the outcrop that occurs north of Owl Creek and includes the Henson Mountains and Royalty Ridge. At least five and maybe six chert types occur in this province: Fort Hood Yellow, Gray-Brown-Green, Texas Novaculite, Fort Hood Gray, East Range Flat, and probably Owl Creek Black. The last type is known from the bedload component of the stream whose name it bears, but the only bedrock source known to us is off base at the southeast end of this general province. Reports that this black chert occurs in the bedload of the stream where it is crossed by East Range Road suggest that it may also occur on base but inside the live fire area. The most extensive material in this region is Fort Hood Yellow, which extends from somewhere around easting grid 27 to the western edge of the base along a northwest trend. This massive outcrop may be typical for irregular shaped nodular cherts, whose outcrops are often vertically and horizontally extensive.

South East Range includes the chert outcrops immediately northeast of the cantonment area and extends a little north of the point where Cowhouse Creek flows into Belton Reservoir (approximately northing 42 to 53), and is bounded on the west by easting grid line 25 and on the east by easting 43. This is one of the more diverse chert terrains on the Fort and at least six chert types are known to occur in this area: Heiner Lake Blue, Heiner Lake Blue-light, Heiner Lake Tan, Heiner Lake Translucent Brown, Seven Mile Mountain Novaculite, East Range Flecked, Fossiliferous Pale Brown, and Cowhouse White. Other, yet to be described materials undoubtedly occur in this region. Unlike the North Fort region where extensive outcrops of similar material are present, the cherts in this province are often stratigraphically superimposed with little or no transition between types, an occurrence that seems to be typical of disc-shaped nodular cherts. Some of these cherts are known to occur over 10 km laterally, but are very restricted in elevation.

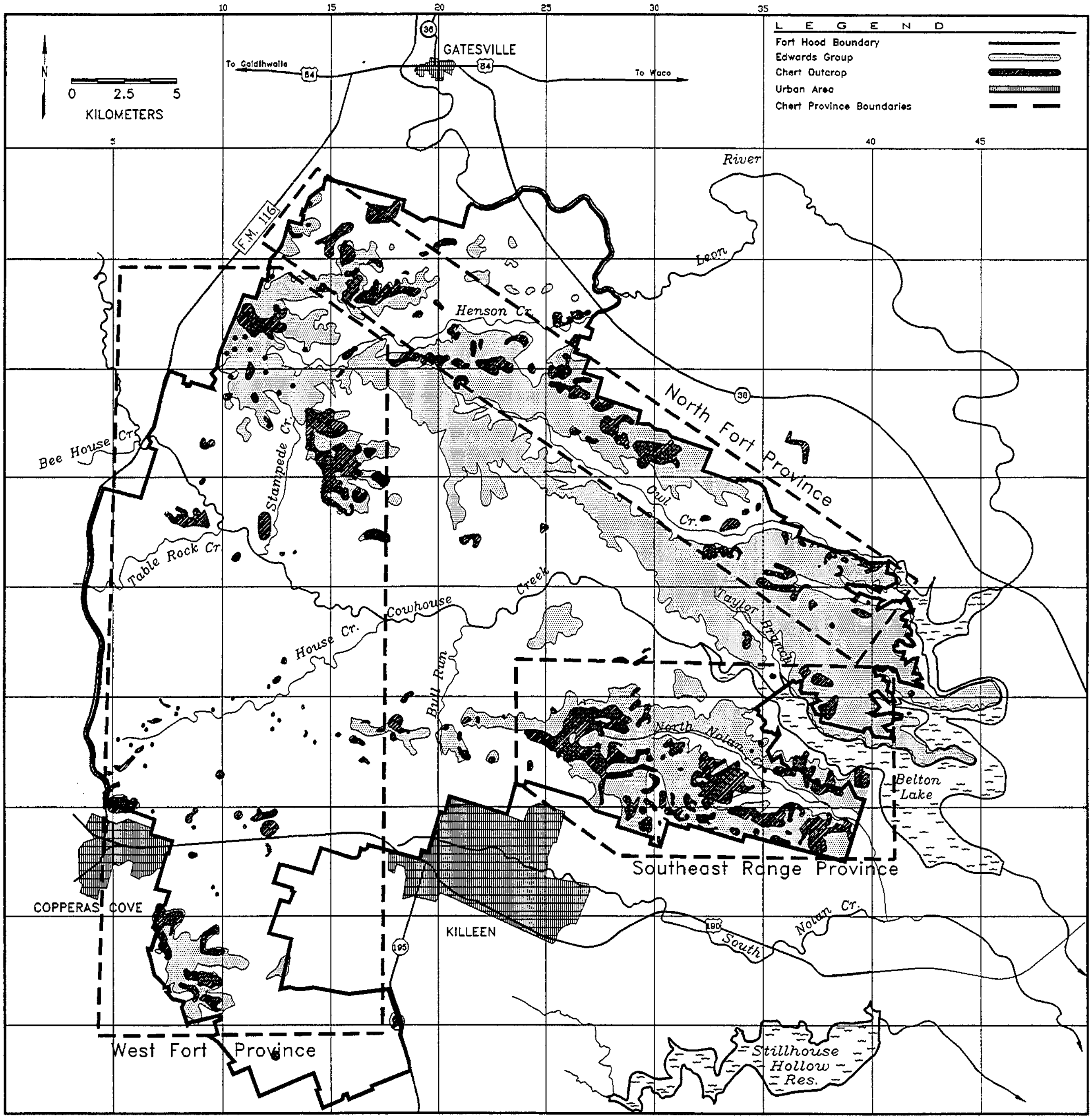


Figure 6.8 Chert Outcrops at Fort Hood, and the Location of the Taxonomy Type Localities.

West Fort is best illustrated by cherts that occur on the southernmost Manning surface remnant, namely Seven Mile Mountain. Two chert types occur on this landform: Anderson Mountain Gray and Seven Mile Mountain Novaculite. Bedrock outcrops of the two types are somewhat different. Anderson Mountain Gray may extend as far north as northing grid line 68, but Seven Mile Mountain Novaculite has not been observed in primary context north of Seven Mile Mountain, although secondary deposits are present adjacent to House Creek. Neither of these materials is especially attractive in their raw state and the Seven Mile Mountain Novaculite is especially hard and difficult to reduce. Hence, the choice of materials is severely limited in the south and western parts of the base.

6.3.3 Edwards Chert Off Base

Samples obtained from Edwards outcrops outside of Fort Hood are described and illustrated in Appendix C (Plates 3, 4, and 5). Provenience information for these samples is listed on Table 6.4. No attempt is made at establishing a taxonomy as this is clearly beyond the scope of this study, and premature considering the present understanding of this resource. Integration and summary of this information is difficult considering the variability present, but some general observations can be made regarding the morphology and distribution of Edwards chert elsewhere in the outcrop. More than a third of the samples in this group were mottled, and approximately a quarter exhibited banding. Several specimens exhibited characteristics of both of the structure groups and were banded near the cortex and mottled in the interior. Laminated/striated and homogeneous structures were less common, but small flakes of many samples could qualify as the latter. Disc-shaped nodules appear to be more common than any other mode of occurrence, accounting for more than 80 percent of the cherts sampled. No bedded cherts were observed, and this occurrence appears to be very uncommon. The majority of cherts sampled in the central and southwestern parts of the Edwards Plateau and Stockton Plateau exhibit 10YR hues, although significant numbers of sampled material possessed achromatic and blue (5B) colors. A few specimens exhibited red hues (5YR and 5R) and a small number of samples were dominantly red or pink in color. The central part of the outcrop (in the vicinity of Schleicher, Menard, Kimble, Medina, and Kerr counties) appear to have a disproportionate amount of brown colors (brownish gray, grayish brown, brown) whereas the area around the Callahan Divide are more often achromatic (gray) and light blue (5B).

Unfortunately, there is not a record of chert occurrence comparable to that of Fort Hood elsewhere in Texas, so it is impossible to comment on whether the Fort Hood assemblage is representative in terms of diversity. It is clear that a roadcut survey is not by any stretch of the imagination representative of the diversity in any given area, and it cannot be expected to reflect accurately on the outcrop as a whole, either. However, compared to the samples obtained elsewhere, the Fort Hood assemblage appears to be biased toward mottled structures, away from banded cherts, and toward more yellow hues (2.5Y and 5Y). The sample described by Banks (1990) exhibited a similar trend in terms of color. Conversely, the outcrop sample obtained from off base appears to be less diverse than the Fort Hood assemblage.

6.3.4 Results of Heat Treatment Upon Edwards Chert

Nearly two-thirds of the samples described in Appendix C were subjected to experimental heating in order to evaluate the influence of this process on chert morphology and workability, the latter of which is discussed in Section 6.4. For these experiments, the procedure outlined by Dickens (1993a) was employed.

Table 6.4 Sample Provenience for Samples Plotted on Figure 6.5 and Described in Appendix B.

Sample Number on Figure 5	Latitude	Longitude	County	Location
1	29°50.99’	98°08.13’	Comal	6.4 miles west of New Braunfels City limit on highway 306; 7.1 miles west of Oak Knot Road.
2	29°43.74’	98°07.19	Comal	North side of Bleiders Creek on highway 46, just outside of Gruene, Texas.
3	29°41.13’	98°27.07’	Bexar	Roadcut on highway 281 about 5.6 miles north of its intersection with FM1604.
4	29°31.94’	98°48.57’	Medina	Roadcut on highway 211 about 1 mile north of its intersection with highway 471, and 6.6 miles south of its intersection with highway 168.
6	30°04.03’	99°04.47’	Kerr	IH-10 roadcut located about 2.1 miles east of intersection of IH-10 and highway 16 in Kerrville, Texas.
7	29°58.79’	99°26.15’	Kerr	11.2 miles southwest of the post office in Hunt, Texas, on highway 39 immediately adjacent to the South Fork of the Guadelupe River.
8	29°56.93’	99°31.16’	Kerr	On highway 39 approximately 2.2 miles northeast of intersection with highway 187 (road to Lost Maples State Park).
9	29°51.46’	99°40.95’	Real	10.8 miles north of point where highway 83 crosses the West Frio River, just north of Leakey, Texas.
10	29°52.20’	100°06.48’	Edwards	Roadcut located about 13.5 miles north of Nueces River (in Barksdale, Texas) on highway 55.
11	30°01.65’	101°10.15’	Val Verde	Roadcut along highway 163 on east side of Devils River Valley approximately 26.2 miles north of Comstock Texas, and intersection of highway 90 and 163.
12	29°58.86’	101°10.04’	Val Verde	Roadcut along highway 163 on east side of Devils River Valley approximately 22.2 miles north of Comstock Texas, and intersection of highway 90 and 163. Sample 11 is located 3.6 miles north along same highway.
13	30°19.63’	102°26.18’	Pecos	Roadcut along highway 285 about 1 mile south of intersection with RR2400.
14	30°15.43’	102°26.81’	Terrell	Roadcut adjacent to highway 285 located about 8.2 miles north of intersection with highway 90.
16	30°53.48’	102°19.72’	Pecos	Roadcut adjacent to IH-10 about 31.8 miles east of intersection of highway 285 and IH-10 on the east side of Fort Stockton, Texas. Locality is immediately southwest of Squaw Teat Peak.
17	30°48.93’	102°00.06’	Pecos	Roadcut on IH-10 about 15.9 miles west of Sheffield, Texas.
18	30°39.93’	101°41.01’	Crockett	Roadcut adjacent to highway 290 along east wall of Pecos River Valley located 10 miles from intersection of IH-10 and highway 290 and about 1 mile east of Fort Lancaster.
19	30°35.31’	100°40.38’	Sutton	IH-10 roadcut located 0.8 miles west of exit 399 at Sonora, Texas.
20	30°52.72’	100°11.83’	Schleicher	Roadcut located on highway 190 about 5.8 miles west of intersection with FM2873.
21	30°51.00’	99°45.85’	Menard	Roadcut on highway 83 located 5.5 miles south of intersection with highway 190 in Menard, Texas.
22	30°35.86’	99°47.17’	Kimble	Roadcut adjacent to highway 83 located 23.4 miles south of intersection with highway 190 in Menard, Texas.
23	30°27.95’	99°43.83’	Kimble	Roadcut adjacent to eastbound lanes of IH-10 2.1 miles east of mile marker 458 near Junction, Texas.
24	30°15.69’	97°46.80’	Travis	Approximately 0.5 mile from start of Barton Creek Greenbelt walking trail west of Barton Springs pool, and situated immediately behind the Barton Oaks Plaza Two office building (which is located off of MoPac highway at intersection with Bee Caves Road).
25	30°16.83’	97°48.47’	Travis	3939 Bee Caves Road, behind Building C; Travis County, Texas.
26	na	na	Sterling	Sample collected from Sterling County, Texas, from a roadcut adjacent to highway 158 approximately 5.8 miles from its intersection with highway 87.

Table 6.4 (Concluded).

Sample Number on Figure 5	Latitude	Longitude	County	Location
27	na	na	Bell	Roadcut on Highway 190 east of Nolanville, Texas.
28	na	na	Howard	Sample collected in Howard County, from channel of Bull Creek, at crossing by highway 2182, about 2-3 miles east of its intersection with highway 821. Bull Creek drains the Fort Terrett Formation.
29	na	na	Nolan	North of Oak Creek Reservoir, off of highway 70; Boyd et al (1993:20-21) sample No. 1
30	na	na	Nolan	South of Sweetwater, off of highway 70; Boyd et al (1993:20-21) sample No. 2
32	na	na	Howard	South of Big Spring; Boyd et al (1993:20-21) sample No. 19.
33	na	na	Howard	South of Big Spring; Boyd et al (1993:20-21) sample No. 20.
34	na	na	Taylor	Buffalo Gap/Lake Abilene; Boyd et al (1993:20-21) sample No. 21.
35	na	na	Taylor	Buffalo Gap/Lake Abilene; Boyd et al (1993:20-21) sample No. 22.
36	na	na	Fisher	Adjacent to FM2744/U.S. Highway 70 intersection; Boyd et al (1993:20-21) sample No. 23.
37	na	na	Nolan	2.1 miles north of FM153/U.S. Highway 277 intersection; Boyd et al (1993:20-21) sample No.
38	na	na	Reagan	Sample collected by Mr. Chris Turnbow, Mariah Associates, Inc., Albuquerque, New Mexico.
39	na	na	Howard	Sample collected by Mr. Chris Turnbow, Mariah Associates, Inc., Albuquerque, New Mexico.
40	na	na	Reagan	Sample collected by Mr. Chris Turnbow, Mariah Associates, Inc., Albuquerque, New Mexico.
41	na	na	Reagan	Sample collected by Mr. Chris Turnbow, Mariah Associates, Inc., Albuquerque, New Mexico.

Cherts to be heated were placed in a baking pan, put into a standard residential oven, and heated to 200°F. The temperature was increased 50° each hour until 550°F was obtained. This temperature was held for two hours and then was decreased at the same rate until 200°F was reached, an hour after which the oven was turned off and allowed to cool for a minimum of 3 hours. Detailed results for each chert are provided in Appendix C.

Almost all of the cherts we heated experienced substantial changes in luster and fracture surface roughness. Of the Fort Hood samples exposed to heat treatment, 93 percent experienced significant luster changes, and the one that did not was medium to coarse textured and chalky feeling (Heiner Lake Blue-Light). Color changes were more complex. Approximately 20 percent failed to exhibit any significant discoloration (primarily the dark cherts: Owl Creek Black, Leona Park, and East Range Flecked), whereas nearly half (40%) changed in a pronounced manner to various shades of red. The remainder only exhibited a minor blush (red shift) or no color change at all.

The specimens from Edwards outcrops away from Fort Hood behaved similarly. All of the 27 specimens subjected to heat treatment experienced increases in luster, and in some cases radical changes occurred. Color changes were variable with 25 percent experiencing no discoloration, and about 37 percent changing to reddish hues. Conversely, the remaining 37 percent experienced color changes not commonly mentioned as a side effect of thermal alteration, such as grays changing to light blue, and dark grays or browns becoming lighter grays and browns. A few examples of changes incurred upon heating are illustrated in Appendix C, Plate 6.

6.4 RELATIVE WORKABILITY OF FORT HOOD CHERTS

As noted above (Section 6.3.2), the taxonomy of Fort Hood cherts includes low-grade materials that were not included in Dickens (1993a) original taxonomy. However, Mariah's experience on Fort Hood has demonstrated that even low-grade materials were used by prehistoric inhabitants, and Dickens (Dickens and Dockall 1992; see Section 3.3.1 above) has demonstrated that they at least occasionally adapted their chert procurement procedures to accommodate the nature of suboptimal raw materials. Given that raw materials have different geographic distributions and uneven qualities, the workability of chert may have had an impact on chert procurement practices.

This section attempts to provide a general understanding of the relative workability of 15 different bedrock sources of Edwards Chert found in and around the Fort Hood military reservation. This understanding was gained through experimental means in which the author (Ringstaff) worked with Fort Hood cherts by chipping samples collected from all 15 sources. Over 600 experiments were performed to become familiar with the materials and their individual chipping properties, and to assess overall workability throughout a full range of reduction.

The determination of a material's workability was based on the overall success of reductive events resulting in the achievement of a viable reduction goal. The subjective nature of these determinations has led to the use of generalized reduction categories that allow a wide range of techniques to be employed. Only by taking each of the materials through a full range of reductive techniques can a determination of workability then be assessed. The results of experimental reduction provide an initial baseline description of the variation in quality of chert materials on Fort Hood. Through an examination of the results of these workability experiments and comparison with representative debitage samples from archeological sites in and around Fort Hood, an understanding may be reached of the influence of workability on possible raw-material preferences and lithic-procurement practices.

The remainder of this section begins with a discussion of the process by which raw materials were selected for experimental use. Next comes a discussion of the reduction techniques used to assess workability. Replication of diagnostic artifacts, which often deals with specific sequential reduction templates, is beyond the immediate scope of this study. The discussion of reduction methods is followed by a discussion of heat and water treatments that were applied to the raw materials to see how they might influence workability. After addressing these preliminary matters, the section turns to descriptions of the workability of the various chert raw materials. The section concludes with a summary discussion of the outcome of the experiments.

6.4.1 Procurement Methods

The acquisition of the raw materials for this study involved selection criteria not intended to parallel procurement strategies of aboriginal peoples. As these strategies are not yet fully understood, these workability studies may prove to be useful in gaining some insight into this aspect of material economy once a larger data base from a number of LRPAs is obtained. Instead, the study's strategy simply aimed at obtaining a variety of raw material textures and forms from each source that allowed the greatest range of reductive techniques to be performed. The criteria for material collection included:

(1) materials with few or no visible (or audible) fracture flaws;

(2) homogeneous materials with few or no abrupt changes in texture or fossil inclusions; and

(3) nodule/cobble morphology best suited for specific reductive techniques.

Over 800 kg of materials were collected to perform the experiments conducted in the study. This considerable amount of material was collected to allow for familiarization with the material and accommodation of unforeseen problems, especially problems that might emerge from heat-treatment experiments.

6.4.2 Reduction Methods

The methods used in these workability experiments were derived from a number of sources in the lithic technological literature (Crabtree 1972; Callahan 1979; Reeves 1970; Collins 1974). Drawing from these sources and the knapping experience of the author, a research design for the workability experiments was constructed that employed diverse knapping techniques requiring a number of different tools.

Four general techniques were used: flake production from prepared and unprepared cores, early-stage biface production, secondary biface thinning, and pressure removal. These techniques allow a wide range of observations to be recorded while generating a range of correlated activity-specific/morphologically distinct debitage.

The tool kit used in the lithic experiments to determine workability was comprised of quartzite and limestone hammerstones, two antler billets, and antler tine pressure tools. These "natural" tools were used in an attempt to roughly duplicate an aboriginal tool kit. Copper or other metals were not used in any of the experiments so that later comparative studies may yield more insight into the thought processes involved in material procurement and reduction. The tool kit used in these experiments included:

(a) 2,230 g quartzite hammerstone;
(b) 2,144 g quartzite hammerstone;
(c) 510 g pink quartzite hammerstone;
(d) 318 g pink quartzite hammerstone;
(e) 324 g quartzite hammerstone;
(f) 639 g limestone hammerstone;
(g) 375 g antler billet (elk);
(h) 231 g antler billet (white-tail deer); and
(i) various antler tines (elk and white-tail deer).

Core-flake production was accomplished by direct percussion using the quartzite and limestone hammerstones. The particular hammerstone employed was dependent upon the size, hardness, and texture of the raw material. Cores were either prepared or unprepared and were variable in form (i.e., bifacial, tabular, block, discoidal). The flakes produced displayed large bulbs of percussion, a fair percentage of erailures, and compression rings. Several of the flakes produced were bifacially edged for primary/early-stage which, in turn, would be taken to secondary/late-stage biface thinning. The rest were left unmodified for representative samples and heat-treating experiments.

Early-stage bifaces were made from either unmodified raw materials (cobbles, nodules, or tabular pieces), macroflakes, or both when variation in material morphology allowed. This early-stage (i.e., primary) biface reduction involved direct percussion using the 510 g, 639 g, 324 g, and 318 g hammerstones. The debitage produced from these experiments had nearly parallel to expanding lateral edges and had large ovate platforms with overall more acute angles (approximately 40 to 70 degrees) than the core-produced flakes (approximately 50 to 90 degrees), pronounced bulbs of percussion, and compression rings.

Secondary biface thinning was accomplished using the 639 g, 510 g, 324 g, and 318 g hammerstones, the 375 g billet, and the 231 g billet. The combination of these tools used to perform secondary thinning varied depending on the raw material's hardness and texture. This technique requires considerable attention to platform preparation with the flakes produced having expanding edges and "lipped" platforms with more acute angles (approximately 25 to 45 degrees) than primary bifacial reduction debitage. The bulbs of percussion on these flakes were generally more diffuse as were the compression rings.

Most of the pressure thinning/flaking was performed with a 110 g elk tine. Two white-tail deer tines weighing 72 and 49 g were also used. The debitage produced by pressure removal most often displayed parallel to slightly expanding lateral edges, diffuse bulbs of percussion and compression rings, and ovate, lipped, or often crushed platforms.

The tools used in these experiments were made of materials that would have been available to aboriginal knappers of Central Texas (with the exception of the medium elk billet and the elk antler pressure tool, although closely comparable tools could be acquired from a large white-tail deer). Native hardwoods are not included as billets in this study though these materials are definitely worthy of consideration. By using materials similar to those that would have been available to aboriginals, the attributes of the debitage produced by these experiments might more closely parallel the attributes of archeological debitage than those produced by metal tools. Reductive problems inherent to using "natural" tools on a specific source material are more likely to be recognized and have greater comparative validity. In the future, this experimentally generated debitage might be compared to debitage from archeological sites in and around the Fort Hood military reservation and may give some insight into the reductive problems and strategies of aboriginal knappers.

6.4.3 Thermal and Water Immersion Alteration of Raw Material

Samples of all 15 types of raw material were subjected to heat treating and water immersion experiments to determine whether or not an improvement in workability could be attained. After each alteration experiment, the different materials were reduced, the debitage collected, and results recorded so workability descriptions could be compiled.

Heat treating was accomplished through six different experiments. Each of these experiments subjected the materials to different temperatures and durations of exposure. These experiments will be referred to as heat treating experiments (HTEs) 1 through 6. The temperatures to which the materials were exposed and the duration of exposure were recorded and thermal curves plotted (Figure 6.9).

The first two heat-treating experiments (HTE 1 and 2) were conducted in a conventional oven. This allowed a good deal of control while providing "a feel" for the way a specific material might react to heat alteration. Cores, flakes, and early-stage bifaces of each material type were placed on cookie sheets and then warmed to 200°F and left at that temperature for one hour. Every hour the temperature was raised 50° until a maximum of 450°F for HTE 1 and 550°F for HTE 2, was reached. Once the maximum temperature was attained, it was held for two hours and then taken back down in 50° increments half hour until 200°F was reached. The specimens were left at 200°F for an hour, the oven was turned off, and the specimens were left to cool for four hours. This procedure was aimed at preventing thermal shock of the materials.

Four other heat treating experiments were performed (HTE 3 through 6) using heat-treating pits. Two pits, which would each be used twice, were constructed as roughly square holes excavated approximately 1 x 1 x 0.5 m deep. The sediment was set aside and a fire was built and sustained for several hours until nothing but a bed of coals remained. The coals were spread out evenly, then buried with 3 to 4 cm of sand (HTE 3) or silty clay loam (HTE 4, 5, and 6) as an insulator. The flakes and early-stage bifaces prepared for the heat-treatment experiments were placed on top of the layer of insulation material along with a *Fluke* thermocouple, and then buried with 3 to 4 cm of the same insulating material. A fire was then built on top of the buried materials and maintained until only coals remained. The coals were then spread out uniformly and temperatures monitored for a 36-hour period.

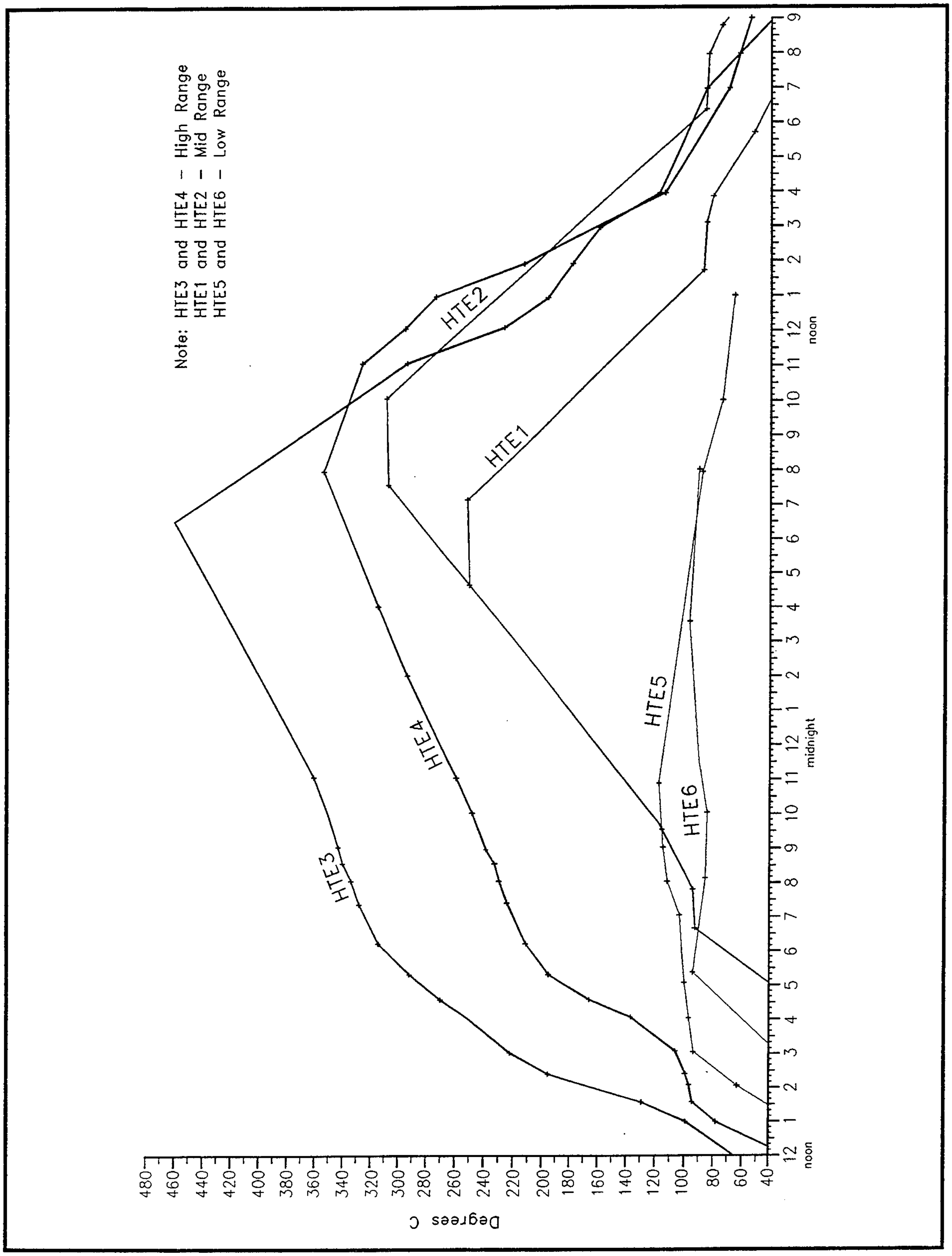


Figure 6.9 Temperature Curves for Heat Treatment Experiments.

Each of the four heat-treating pit experiments (HTE 3 through 6) was performed with slight variation in order to achieve different temperatures and durations. This was accomplished by altering the amount of wood fuel and insulation used. After heat treating was completed, the materials were excavated and labeled by material type and HTE number. The treated materials were later reduced, the debitage collected, and the results recorded. The results are discussed in the individual workability descriptions. The changes in color, texture, and luster experienced by the materials after heat treatment are described in Appendix C and will only be mentioned when relevant to workability.

All six experiments were grouped into three ranges:

HTE 3 and 4: high-temperature range (330 to 460°C);

HTE 1 and 2: mid-temperature range (232 to 288°C);

HTE 5 and 6: low-temperature range (96 to 118° C).

The workability descriptions will focus primarily on these three ranges and refer to specific experiments only when necessary.

The water immersion treatment of the raw materials was accomplished by soaking each type of material in ordinary tap water, outdoors, for a period of one month. Afterwards, the materials were then pulled from the containers in which they had been soaking and immediately reduced. As with the heat-treating experiments, the debitage was collected and results recorded and incorporated into the workability descriptions.

6.4.4 Workability Descriptions

The following workability descriptions have been compiled from over 120 chipping hours and over 600 different reductive experiments. For each of the reduction categories (i.e., core-flakes, early-stage biface, secondary thinning, and pressure removal), the workability of different materials was assessed and assigned a rating of *good, fair,* or *poor.* These ratings were based on success/failure criteria that differ slightly in each of the reduction categories. The results of these descriptions are in abbreviated form in Table 6.5.

6.4.4.1 Workability Ratings for Core-Flake Production

Core-flake production ratings were based on the following criteria.

Good workability in flake production was defined as being able to easily remove a number of usable or modifiable flakes from a given core type (i.e., unifacial tabular, bifacial, block).

Fair workability suggested that some problems were encountered in flake production including difficulty in core preparation caused by raw material morphology, difficulty in core preparation caused by material hardness or flaws, difficulty in flake removal caused by material hardness or flaws, production of flakes difficult to modify due to form or symmetry, and unusual attrition to the tool kit caused by material hardness or flaws.

Poor workability suggested considerable problems in flake production of the nature of those listed in the *fair* rating. Often, these problems were so extreme that few or no viable flakes could be produced.

6.4.4.2 Workability Ratings for Early-Stage Biface Reduction

The primary/early-stage biface production workability ratings were based on the following criteria.

Table 6.5 Results of Workability Experiments.

Material	Treatment	Core Flake	Early-Stage Biface	Secondary Thinning	Pressure Flaking
HLB-LT					
	unaltered	good	good	fair	fair
	low-range heat	good	good	fair	fair
	mid-range heat	good	good	fair/good	fair/good
	high-range heat	good	good	fair/good	fair/good
	water-soaked	good	good	fair	fair
CW					
	unaltered	good	good	good	fair
	low-range heat	good	good	good	good
	mid-range heat	good	good	good	good
	high-range heat	good	good	good	good
	water-soaked	good	good	good	fair
AMG					
	unaltered	fair	good	fair	fair/poor
	low-range heat	fair	good	fair	fair/poor
	mid-range heat	good	good	good	good/fair
	high-range heat	good	good	good	good
	water-soaked	fair	good	good	fair
7MN					
	unaltered	poor	poor	poor	poor
	low-range heat	poor	fair/poor	poor	poor
	mid-range heat	fair/poor	fair	fair	fair/poor
	high-range heat	fair	fair/good	fair/good	fair
	water-soaked	poor	poor	poor	poor
TN					
	unaltered	poor/fair	fair	fair/poor	fair/poor
	low-range heat	fair	fair	fair/poor	fair/poor
	mid-range heat	fair/good	fair/good	fair/good	fair/good
	high-range heat	good	good	good	good
	water-soaked	poor/fair	fair	fair	fair/poor
HLT					
	unaltered	good	good	fair	fair
	low-range heat	good	good	fair	fair
	mid-range heat	good	good	good	good
	high-range heat	good	good	good	good
	water-soaked	good	good	fair	fair
FHY					
	unaltered	good	good	good	good
	low-range heat	good	good	good	good
	mid-range heat	good	good	good	good
	high-range heat	good	good	good	good
	water-soaked	good	good	good	good
HLTB					
	unaltered	poor	fair	fair	fair
	low-range heat	poor	fair	fair	fair
	mid-range heat	fair	fair/good	fair/good	fair/good

Table 6.5 (Concluded).

Material	Treatment	Core Flake	Early-Stage Biface	Secondary Thinning	Pressure Flaking
	high-range heat	fair/good	good	good	good
	water-soaked	poor	fair	fair/good	fair/good
HLB					
	unaltered	poor/fair	fair	poor/fair	poor
	low-range heat	fair	fair/good	fair	fair/poor
	mid-range heat	good	good	fair/good	fair/good
	high-range heat	good	good	good	good
	water-soaked	poor/fair	fair	poor/fair	poor
ER Flat					
	unaltered	fair	fair/good	fair	fair
	low-range heat	fair	fair/good	fair	fair
	mid-range heat	good	good	good	good
	high-range heat	good	good	good	good
	water-soaked	fair	fair/good	fair	fair
ER Flecked					
	unaltered	fair/good	fair/good	fair	fair/poor
	low-range heat	good	good	fair	fair
	mid-range heat	good	good	good	fair/good
	high-range heat	good	good	good	good
	water-soaked	fair/good	fair/good	fair	fair/poor
FHG					
	unaltered	good	good	good	good
	low-range heat	good	good	good	good
	mid-range heat	good	good	good	good
	high-range heat	good	good	good	good
	water-soaked	good	good	good	good
GBG					
	unaltered	good	good	good	good
	low-range heat	good	good	good	good
	mid-range heat	good	good	good	good
	high-range heat	good	good	good	good
	water-soaked	good	good	good	good
LEONA					
	unaltered	good	fair	fair/poor	fair/poor
	low-range heat	N/A	fair/good	fair	fair
	mid-range heat	N/A	good	fair/good	fair/good
	high-range heat	N/A	good	good	good
	water-soaked	N/A	fair	fair/poor	fair/poor
OCB					
	unaltered	good	good	good	good
	low-range heat	good	good	good	good
	mid-range heat	good	good	good	good
	high-range heat	poor	poor	poor	poor
	water-soaked	good	good	good	good

Good workability in primary biface production from nodules and tabular pieces was based on the successful removal of cortex and initial bifacial flake removals by direct percussion. Primary biface production from a core flake would require successful bifacial edging and initial direct percussion bifacial thinning for a *good* workability rating. The viable biface being produced should have a roughly lenticular cross-section with few or no step and/or hinge terminations to complicate later secondary thinning.

Fair workability applied when some difficulties in the production of early-stage bifaces were encountered. These difficulties included step and hinge terminations during initial bifacial thinning (caused by abrupt changes in material texture, hardness, or material flaws), excessive attrition to tool kit caused by material texture or hardness, and end-shock failure from overly brittle materials (especially those heat-treated to high temperatures).

Poor workability was assigned when viable early-stage biface production was either exceedingly difficult or unattainable because of the difficulties often encountered in early-stage reduction previously mentioned.

6.4.4.3 Workability Ratings for Secondary Thinning

Workability ratings for secondary thinning are based on slightly different criteria than primary biface thinning.

Good workability ratings were given to materials in which secondary thinning was easily and successfully accomplished resulting in a biface with a thin lenticular cross section. These thin cross sections were attained by driving the biface thinning flakes transmedially (across the medial line of the biface). The resulting flakes produced from successful secondary thinning exhibited "lipped" platforms, expanding lateral edges, feather terminations, and diffuse bulbs of percussion.

Fair workability ratings in secondary thinning imply that some problems were encountered, although a viable late-stage biface could usually be produced. The problems encountered in thinning generally included step and hinge terminations caused by extreme material hardness, abrupt changes in texture, material flaws, and excessively high median ridges caused by thinning flakes not travelling trans-medially. End-shock failure was a common problem encountered with material altered by high temperature heat-treatment.

Poor workability ratings in secondary thinning were given when problems in thinning were so common that a successful end-product was either difficult or impossible to achieve.

6.4.4.4 Workability Ratings for Pressure Removal

The rating of pressure flaking was based on the following criteria.

Good workability ratings were given when pressure flakes were easily removed, travelled well (in the case of lateral removals, near or beyond the medial line), and feather terminated. The flakes produced from successful pressure flaking usually had small, ovate, sometimes lipped and often crushed platforms, and parallel to slightly expanding lateral edges.

Fair ratings imply that some difficulties were experienced in pressure flaking which included step and hinge terminations, and/or unusually extreme tool attrition due to overly hard or coarse-grained material.

Poor ratings indicate that pressure flaking was difficult to perform with many failed removals occurring.

In addition to the workability ratings above, it is necessary to impress upon the reader the role of "knapper error" in rating workability. Clearly, any knapper sometimes makes mistakes, and mistakes occurred during this study. However, extensive practice and familiarization with all the materials before the workability experiments were performed allowed minimization and better recognition of errors in technique, and the ability to distinguish them from reduction difficulties caused by the material. Moreover, since the major source of variation from experiment to experiment was the raw material itself, it can be assumed that a relative increase in failures is at least partly a result of raw-material characteristics so that a great deal of knapper error boils down to insufficient experience in adapting the knapper's skill level to the available supply of raw materials. For example, if a particular raw material has a high failure rate for early-stage biface reduction as compared to another raw material, at least some of the failure must result from either the nature of the raw material itself or from the knapper's inexperience with that material. In either event, it shows that the material's workability is such that it requires a higher level of skill to be used successfully if in fact it can be used at all.

Thus, the workability descriptions below are based on experiments that hold knapper skills and tools as approximate constants achieved after an initial familiarization with raw materials. Although some changes probably occurred in knapper skill relative to each particular raw material as the experiments progressed, the major variables were restricted to characteristics of unaltered and experimentally treated cherts. Furthermore, no claims are expressed or implied that all knappers would agree with the workability ratings assigned below. Rather, the reader should interpret the ratings as an initial indication of the range of variability that a knapper can expect to encounter with Fort Hood cherts.

6.4.4.5 Workability of Heiner Lake Blue-Light Variety

The Heiner Lake Blue, Light Variety (HLB-LT), was found to be an unusually workable material considering its grainy texture. The homogeneity of the unusually large, "flattish-ovate" nodules obtained from the Heiner Lake area seemed to compensate for the grainy texture, which usually makes workability more difficult. In selecting the material, a quartzite hammerstone was gently rapped against the nodule which would make it "ring." Any internal fracture flaws in the stone were usually audible as a "clinking" sound rather than a ringing one.

The reduction of the HLB-LT material was surprisingly easy given the appearance of this massive, grainy chert. Flakes within the range of 10 to 20 cm were easily produced from a large bifacial core (made from an approximately 20 kg nodule) with a 2,144 g hammerstone. The flakes themselves were nicely expanding and would either feather or mildly hinge terminate. Several of the flakes were bifacially edged and early-stage biface reduction was accomplished with the 510 g and 318 g hammerstones. This was easily performed, thus giving a good relative workability rating for both the core-flake and early-stage biface reduction categories.

Secondary thinning and pressure flaking were slightly more difficult. The 318 g hammer and the 375 g billet were both used in the secondary thinning, although the billet was predominantly used. In the secondary thinning experiments, the overall thinning goals were reached, although a higher incidence of step fracturing was encountered in comparison to the early-stage thinning, giving this category a fair workability rating.

Pressure-flake removal was performed on a thin biface with the 110 g and 72 g antler tines. The execution of the pressure removals as mostly successful, although many of the flakes did not travel very far and some step fracturing occurred (probably caused by the grainy texture). In light of this, the relative workability of pressure flaking was ranked as fair.

Thermally altered HLB-LT demonstrated an improvement in workability in the mid- and high-temperature ranges. The low-temperature experiments showed little change in comparison to the unaltered material throughout all reduction categories. Although the material retained a fairly grainy texture, the secondary thinning and pressure improved in the mid- and high-temperature ranges, thus giving those categories fair to good workability ratings. The water-treated materials showed no noticeable change in workability from the unaltered material and, hence, have the same workability ratings.

6.4.4.6 Workability of Cowhouse White

Cowhouse White (CW) is somewhat similar to Heiner Lake Blue-Light in regard to material texture and nodule size. The CW chert does however, have an overall finer-grained texture. The nodules, like Heiner Lake Blue-Light, ring nicely when lightly tapped, which aided in procuring nodules without hidden internal fractures. The majority of the nodules procured were large (>30 cm), flat-ovate to more rounded (subspherical).

The similarities in nodule size and shape between Heiner Lake Blue-Light and CW facilitated a similar bifacial core strategy in the production of large flakes (8 to 18 cm). These were removed by the 2,144 g hammerstone. Several of the flakes produced were reduced further into early-stage bifaces with the 510 g and 318 g hammerstones. Flake and early-stage biface production was easily accomplished with expanding flakes with pronounced bulbs being produced. These bifaces were later reduced by secondary thinning using the 375 g and 231 g billets. The flakes produced by the secondary thinning experiments were mostly expanding with "lipped" platforms and diffuse bulbs of percussion. The pressure reduction was performed on a thin biface with the 110 g pressure tool. The removals proved to be slightly difficult with most flakes having a length less than 1 cm. The overall workability of unaltered CW is rated as good with the exception of pressure reduction, which is rated as fair.

The heat-treated CW showed improved workability in all temperature ranges. Both direct percussion and pressure removals were detached more easily and traveled farther than those of the unaltered material. In the mid- and high-temperature ranges, CW became more brittle, and extra care had to be taken in supporting pieces being reduced. Although primary and secondary thinning was more easily accomplished, the especially brittle high-temperature range for CW produced a higher rate of end-shock failure than low- and mid-temperature range for CW. All reduction categories of heat-treated (low, mid, and high range) were given good workability ratings.

The water-soaked CW showed what appeared to be slight improvement in overall workability in comparison to the unaltered CW. Secondary-thinning flakes and pressure flakes seemed to be more easily removed. However, the improvement in workability was a subtle one that did not warrant changing the workability rating relative to the unaltered material.

6.4.4.7 Workability of Anderson Mountain Gray

The Anderson Mountain Gray (AMG) material initially thought to be a poorly workable material when it was being acquired at the bedrock source. The nodules were quite variable in their form, so a variety of shapes and sizes was collected. The hardness of this material made the initial preparation of the flake-cores difficult to fair at best. Once the preparation was accomplished with the 510 g hammerstone, subsequent flake removal was less difficult to perform, with most flakes ranging from 8 to 14 cm in length. Most of the flakes produced exhibited large bulbs of percussion with erailures, and many experienced longitudinal splitting. Given the initial difficulty, core-flake production is rated as fair.

Early-stage bifaces were produced from both nodules and core-flakes with the 510 g, 324 g, and 318 g hammerstones. The nodules used for early-stage biface production were flatter and more ovate than the more rounded and amorphous nodules collected. The removal of the cortex, like the preparation of the flake-cores, was difficult, and caused noticeable attrition to the 510 g hammerstone. Reduction became easier after the cortex was removed. The majority of the early-stage biface flakes, produced from both nodules and core-flakes, had fairly prominent bulbs of percussion with fewer erailures and less splitting than the core-flakes. Overall, primary biface reduction is rated from good to fair.

The secondary thinning of AMG early-stage bifaces was rated as fair to poor. The hardness of the material made thinning a bit difficult, although the majority of the thinning flake removals were successful and travelled trans-medially. Attrition to the 375 g billet after a short time was excessive.

Pressure flaking with the unaltered AMG was also difficult because of the hardness of the material. The flakes did not travel very far (usually <1 cm) and there was considerable attrition to the 110 g and 72 g antler tine pressure tools. The workability rating for this category ranged from fair to poor.

The heat-treated AMG showed improvement in workability in all temperature ranges. The mid- and high temperature range materials showed the greatest improvement while the low-range heat-treated materials exhibited only slight improvement. In all categories (especially secondary thinning and pressure flaking), flakes were more easily removed, travelled farther, and caused less attrition to the tools used. Improvement observed indicates an overall rating of good.

The water-treated materials exhibited noticeable improvement in workability in secondary thinning and pressure flaking, giving those categories ratings of good and fair respectively.

6.4.4.8 Workability of Seven Mile Mountain Novaculite

In its unaltered state, Seven Mile Mountain Novaculite (7MN) is undoubtedly, in terms of workability, the worst material of all 15 types included in this study. The nodules acquired from the bedrock source were medium to large (approximately 15 to 40 cm) in size. The majority of these nodules were so hard and coarse grained that it was difficult to even initially test the material (e.g., by knocking off a piece of cortex to examine material quality) to determine which ones would be collected.

Core-flake production with unaltered 7MN was difficult, especially the cortex removal and preparation of the cores. Although flake removal could be accomplished using the 510 and 324 g hammerstones, tool attrition was excessive. The flakes produced usually exhibited a very coarse-grained (sugar-like), ventral surface, large ovate striking platforms, and unusually diffuse bulbs of percussion, especially with the coarser-grained material. It is interesting to note, however, that the nodules procured displayed some consistency in having a fairly fine-grained outer layer near the cortex. If care was taken in preparation, viable flakes from this outer rind could sometimes be obtained. Despite this, the workability of 7MN is rated as poor.

Early-stage biface production was also rated as poor. Reduction was so difficult that only a few early-stage bifaces could even be produced. Bifaces were made exclusively from flakes for two reasons. First, the better quality material that would lend itself to early-stage biface production (the outer rind material) could only be acquired in flake form. Second, the subspherical form of the nodules collected made this kind of reductive technique virtually impossible. The most common difficulties encountered in reduction were step fracturing and edge thickening caused by repeated failure to achieve flake removal. Hinge terminations were less common and was seen more with the finer-grained material.

Secondary thinning on unaltered 7MN was, by any practical sense of the word, impossible. Only a few decent flakes could even be detached, and attrition to the 375 g billet was extreme. Similar difficulties were experienced during pressure flaking using the 110 g tine, thus giving both these categories poor workability ratings.

Heat-treatment of 7MN showed some surprising changes in workability with mid- and high-temperature heat treatment. The low-range treated materials showed little improvement except in the early-stage biface category, which showed enough improvement to rate the category fair to poor. The improvement in the mid-temperature range material was seen in all categories, especially early-stage biface and secondary thinning, which both rated as fair. The high-temperature range material exhibited the greatest change, with all categories improving. The most notable improvements occurred in the early-stage reduction and secondary biface thinning, which were both given fair to good ratings.

The water-treated 7MN material demonstrated no noticeable improvement in workability and, like the unaltered material, was given poor ratings in all categories.

6.4.4.9 Workability of Texas Novaculite

Texas Novaculite (TN) is very hard and, like Anderson Mountain Gray, was thought to be difficult to work when samples of the material were being acquired from the bedrock source. A variety of nodules were collected, although most tended to be large (15 to 30 cm) and subspherical. Like the Seven Mile Mountain Novaculite, the nodules were difficult to test and hammerstone attrition was considerable.

Core-flake production with unaltered TN was somewhat successful using the 2,230 g, 510 g, and 318 g hammerstones. Initial core preparation was not only difficult due to the generally rounded edges of the nodules, but crucial to achieve a viable removal. The flakes produced were mostly large (8 to 14 cm) and expanding with large ovate platforms and pronounced bulbs of percussion. Most of the flakes exhibited erailures, while a lesser number experienced longitudinal splitting. The overall workability rating of this reduction category was poor to fair.

Several core-flakes from the previous experiment were reduced into early-stage bifaces using the 318 g hammerstone. Edging and initial reduction went fairly well considering the hardness of the material. Problems encountered in reduction included the occurrence of step and hinge terminations caused by fossil inclusions and abrupt changes in texture. Despite these problems, several viable early-stage bifaces were produced. In this category, the workability of TN is rated as fair.

Secondary thinning proved to be more difficult than the initial primary thinning. Success in this reduction category was highly variable and could be ranked overall poor to fair. Secondary thinning was accomplished with the 375 g and 231 g billets and the 318 g hammerstone. Attrition to the tools (especially the billets) was high. Fossil inclusions and abrupt changes in texture caused some difficulties in thinning which included primarily step and hinge terminations and, on occasion, edge thickening, which was experienced mostly in the coarser grained materials.

Pressure flaking success, like secondary thinning, was variable, although difficulties in removal, especially step fractures, were often experienced. The hardness of the material restricted most flakes to short travel distances and caused excessive attrition to the 110 g antler tine pressure tool. Overall, this category rated as poor to fair.

Heat treatment of TN improved workability considerably, especially in the mid- and high-temperature ranges. The low-range materials showed little improvement in workability from the unaltered TN. The mid-range heat-treated materials, however, exhibited better workability in all categories. Flake removal was noticeably less difficult, especially secondary thinning and pressure flaking, and attrition to tools was less than that experienced with unaltered TN. The greatest improvement in overall workability was seen in the high-range materials which improved so radically it was hard to believe it was the same material. All reduction categories of the high-range materials were rated as good.

The water-soaked TN demonstrated little or no change in workability from the unaltered material and was given the same workability ratings. Like the unaltered TN, the water-soaked material exhibited longitudinal splitting in core-flake production, difficulties with secondary thinning and pressure flaking, and excessive tool attrition.

6.4.4.10 Workability of Heiner Lake Tan

Heiner Lake Tan (HLT), like Heiner Lake Blue-Light and Cowhouse White, produces a nice ringing sound when tapped with a hammerstone. This aided in selecting the material by revealing any hidden internal fracture flaws. The nodules were variable in form but tended to be large (15 to 60 cm), and ovate to subspherical. Nodules that had experienced weathering were often fractured into blocky fragments. Both complete nodules and blocky fragments were collected for the study.

Core-flake production with the unaltered HLT was accomplished using different core types, including large bifacial cores (made mostly from large nodules), and variable blocky to cylindrical styles (made from blocky fragments). Three 510 g, 318 g, and 639 g hammerstones were used to accomplish flake production. It should be noted that the 639 g limestone hammerstone was used only after initial cortex removal and preparation with the quartzite hammerstones. The flakes produced with the limestone hammer exhibited more diffuse bulbs of percussion and few erailures. The workability of this reduction category was rated as good.

Early stage-biface production was executed with the 510 g and 318 g hammerstones. This category of reduction was easily accomplished and given a workability rating of good. Early-stage bifaces were made from both nodules and core-flakes. Although the HLT material is fairly hard, its fine-grained texture and homogeneity allowed for a high success rate in the primary thinning.

The hardness of the HLT caused some difficulties in the secondary thinning category. These mostly consisted of step and hinge fracturing. The tools used for this category were the 639 g and 318 g hammerstones, and the 375 g and 231 g billets. Attrition to the limestone hammer and the billets was considerable.

The hardness of HLT also caused problems with pressure flaking. The pressure removals were restricted to short travel distances, and step fractures were not uncommon. Excessive wear on the 110 g antler tine was encountered during the pressure experiments.

The HLT material responded somewhat differently to heat-treatment than the previous materials described. Workability improved in the low- and mid-temperature ranges, with the latter showing the most marked improvement; all reductive categories were rated as good. Secondary-thinning and pressure flakes were more easily removed with less attrition to the tools. The high-range heat-treated materials experienced thermal damage including transverse fractures and potlids. Most of the high-range material was too damaged for any further experiments to be performed. The materials that withstood the high temperatures were found to have good overall workability, but were quite brittle and the failure rate from end-shock was high.

The water-treated materials showed no apparent improvement in workability. The workability ratings given are therefore unchanged from the rating of good given the unaltered HLT.

6.4.4.11 Workability of Fort Hood Yellow

Fort Hood Yellow (FHY) is certainly one of the most workable materials of the 15 material types collected. The nodules collected were quite variable in size (10 to 40 cm) and form (flat to subrounded to amorphous). The variability in size and shape allowed for a number of different core types to be produced in the core-flake reduction category. The various core types produced included semiconical unidirectional, large bifacial, and multidirectional amorphous cores. Core preparation and flake removal were easily accomplished with minimal tool attrition. The only problems presented by this material were the presence of chalky voids which were often not detectable through visual examination and abrupt texture changes which were most often gray in color. The overall workability of this category was rated as good.

Both flat nodules and large flakes were used for the primary reduction experiments. This proved to be easily performed using the limestone or the quartzite hammerstones. The flakes produced by the limestone hammer differed slightly from those produced by quartzite. The most notable difference was in bulb size which produced more diffuse flakes than did the limestone hammer. Attrition to tools was, again, minimal although the limestone hammer, because of its softness, exhibited more wear than the quartzite hammers. The early-stage biface category was rated as good.

Secondary thinning experiments with unaltered FHY were successfully executed with minimal problems occurring, giving this category a good rating. This was accomplished using the elk and white-tail deer billets. The removals generally tended to traverse the medial ridge and the flakes produced tended to have expanding lateral edges and lipped platforms.

Pressure flaking with the FHY is also rated as good. The flakes removed travelled nicely with little attrition to the 110 g and 72 g antler tine tools. The flakes produced exhibited parallel to slightly expanding lateral edges with either crushed, ovate, or lipped platforms.

Heat treatment of FHY improved an already highly workable material. It was surprising that the material, given its luster and fine-grained texture, held up well to the high-range heat treating. In HTE 3, which achieved the highest estimated temperature (Figure 6.5), the FHY material did, however, display moderate potlidding, while the cores, bifaces, and flakes used in HTE 4 displayed none. These high-range materials, although workable, were more brittle than the low- and mid-range treated FHY. All reduction categories of heat-treated materials (in all temperature ranges) were rated as good.

The water-treated FHY demonstrated no apparent change in workability from the unaltered material. All reduction categories were rated as good.

6.4.4.12 Workability of Heiner Lake Translucent Brown

Heiner Lake Translucent Brown (HLTB) proved to be a challenging material to work with, and familiarization with the material proved to be important in the subsequent assessment of the workability. Procurement of this material yielded "tabular to squatty disc-shaped nodules." This material, unlike any of the other 14 materials, was not isotropic. Many of the thicker, white striations in the HLTB acted much like cleavage planes which interrupt fracture travel. After extensive experimentation, a strategy was discovered to effectively work around the problems caused by the striations. By extracting material from between the striations, an isotropic section (which varied in thickness from 1 to 6 cm) was obtainable. This approach was used in core-flake production. The cores were most often produced by first identifying a usable section within a given nodule by removing one end of the nodule with a quartzite hammerstone of considerable mass (which included the 2,230 g, 2,144 g, and 510 g hammers) and exposing a "cleavage profile." Once this was accomplished and a desirable section identified, the overlying striae were removed along their striation planes, sometimes with a single strike. At this point, when a face of the targeted section was exposed, platform surfaces were prepared and flakes removed using the 510 g and 318 g hammerstones. These flakes generally displayed pronounced bulbs of percussion and compression rings. The resulting cores were most often unifacial and unidirectional. Given all the core-preparation complications and the low to moderate success rate (at best) of producing viable flakes, material workability in this category was rated as poor.

The early-stage biface experiments were accomplished by using isolated isotropic sections and core-flakes. The 510 g, 324 g, and 318 g hammerstones were used for the experiments for this reduction category. When viable products were attained in the previous reduction category, the resulting sections or flakes were fine grained and relatively easy to reduce by the direct percussion methods employed. Reduction problems that occurred were most often caused by striations and coarse-grained inclusions which resulted in step and hinge fractures. Tool attrition was minimal to moderate. Overall, this category was given a fair workability rating.

Secondary thinning was performed with the 231 g and 375 g billets, and the 318 g hammerstone. The material's workability in this reduction category was, like the previous category, rated as fair. The problems encountered were also similar, mostly the result of inclusions and striations. However, the fine-grained material allowed numerous successful thinning flakes to be removed, often travelling past the median ridge of the biface. Tool attrition was slight on the hammerstone and moderate on the antler billets.

Pressure flaking with HLTB was accomplished with the 110 g and 72 g antler tine pressure tools. Attrition to these tools was moderate. The flakes produced exhibited parallel to slightly expanding lateral edges and lipped to oval platforms. Flake travel distances were short to moderate with some step fracturing occurring, giving this material a rating of fair.

Heat-treatment of the HLTB improved workability in all temperature ranges. Although the materials utilized in HTE 3 were completely unusable due to severe potlidding, the high-range heat-treated materials from HTE 4 proved to be the best in overall workability and were rated as good in all categories except core-flake production, which was given a fair to good rating. The mid-range materials proved to be slightly more difficult to reduce, with all executed categories rated as fair to good. Flakes produced from materials treated at both mid- and high-temperature ranges were more easily removed and travelled farther. The low-range material improved only slightly over the unaltered HLTB.

The water-treated HLTB appeared to show some improvement from the unaltered material. Although very subtle, the workability improvement in the categories of secondary thinning and pressure flaking were noticeable and rated slightly better than the rating of poor assigned to the unaltered HLTB.

6.4.4.13 Workability of Heiner Lake Blue

Heiner Lake Blue (HLB) was procured along with the Heiner Lake Blue, Light Variety (HLB-LT), since both were often found together in the same nodules. Unlike the HLB-LT, the HLB is a fine-grained material with greater hardness. Large disk-shaped nodules (30 to 60 cm in diameter) and fractured blocky nodule fragments were collected at the bedrock source. These raw material shapes most easily facilitated large bifacial and blocky multidirectional cores. Unless the HLB chert was specifically isolated, core-flakes often travelled across the margin of both materials resulting in flakes composed of two distinctly different colors and textures, usually divided by a sharply linear border. Flake removal was accomplished by using the 2,214 g and the 510 g hammerstones, causing moderate to heavy attrition. Difficulties in flake removal were caused by fossil inclusions, abrupt changes in texture, and material hardness. The flakes produced exhibited large bulbs of percussion (often exhibiting erailures) and pronounced compression rings. Given the texture and hardness problems, this reduction category was rated poor to fair.

In the early-stage biface experiments, core-flakes were used almost exclusively. The flakes were edged and primary reduction performed with the 510 g, 324 g, and 318 g hammerstones. Material hardness and texture changes caused some problems in reduction, including step and hinge terminations.

Secondary thinning with HLB proved to be slightly more difficult than the initial primary biface reduction. Attrition to the 375 g and 231 g billets was moderate to excessive. In this stage of reduction, where thinness is achieved by transmedial thinning flake removals, these removals were difficult to attain, resulting in bifaces with thick biconvex cross sections. Step terminations were more common than hinge terminations, although both were encountered. Several thin bifaces were produced, but these represented less than half of the secondary thinning experiments attempted. The workability rating given to this category was poor to fair.

The pressure flaking of unaltered HLB proved to be difficult. This technique was performed on thin bifaces and prepared flakes. The hardness of the material and the abrupt texture changes caused problems which included short travel distances of flakes, step terminations, and excessive attrition to the 110 g and 72 g pressure tools. Given these problems, workability was assessed as poor.

The heat treatment of HLB proved to be significant in improving the workability of the material. The greatest improvement was observed in the high-range heat treated materials of HTE 4, although HTE 3 produced severe potlidding to the point that the materials were unusable. All categories of reduction for the material from HTE 4 were given good workability ratings. It is also notable that these materials still retained a fair amount of elasticity, and few end-shock failures occurred. The mid-range heat treatment also improved the material significantly, and HLB was given good workability ratings for all reduction categories with the exception of pressure, which was given fair to good. In both mid- and high-range heat treatment, tool attrition was markedly less than the unaltered material, with higher occurrences of transmedial thinning flake removals resulting in thinner bifaces and greater pressure flake travel distances. It was also noted that the secondary thinning flakes produced from the mid- and high-range materials exhibited more defined lipped platforms and diffuse bulbs of percussion than the unaltered HLB. The low-range heat-treated materials showed improvement in all reduction categories as compared to unaltered HLB, although this improvement was less dramatic than in the higher temperature ranges.

The water treatment of the HLB chert showed little (if any) improvement from the unaltered material. However, at times there seemed to be a slight overall improvement, but this change was so subtle that changing the workability ratings from the unaltered materials seemed inappropriate. The workability ratings for all reduction categories of water-soaked materials are unchanged from the poor to fair rating assigned to the unaltered HLB.

6.4.4.14 Workability of East Range Flat

The initial selection of East Range Flat (FLAT) materials was a bit difficult due to the irregularity of the nodules and the frequent occurrence of voids. These factors caused some difficulties in core-flake production with FLAT. Although flakes were easily detached, many of the flakes removed from the irregular multidirectional cores exhibited a "swiss cheese-like" appearance. Tool attrition was minimal. The flakes were removed with the 510 g and 318 g hammerstones and displayed pronounced bulbs and compression rings. In this reduction category, the workability of this material was rated as fair.

Early-stage biface reduction was performed on the larger flakes from the previous experiments with few or no visible voids. This was easily accomplished with the 324 g and 318 g hammerstones. Most of the experiments produced early-stage bifaces well suited for further reduction. Some problems did arise, however, from hidden voids, some of which had a chalky texture. Overall, this category was given a fair to good workability rating.

Secondary thinning of the unaltered FLAT was slightly more difficult than the primary reduction. The chalky, medium-grained texture was probably the cause of some reduction problems. These problems were mostly step and hinge terminations. Wear was low to moderate on the 231 g billet used in the thinning experiments. The workability of this category was rated as fair.

Pressure-flaking experiments were performed with the 110 g pressure tool, which experienced moderate wear. The flakes produced in these experiments ranged from expanding to parallel sided. Given the texture of the unaltered FLAT, a surprisingly low incidence of step fractures was encountered, although flake travel distances were fairly short. The workability of this reduction category was rated as fair.

Heat treatment of FLAT provided an interesting observation only noted with one other material (Leona Park) out of the 15 described. A strong petroleum odor was noticed after the reduction of several core-flakes retrieved from HTE 3 and 4. This observation is not noted in Section 6.3.2.1. The high-range heat-treated cherts and the mid-range materials demonstrated the greatest improvement in workability and were rated as good in all reductive categories. Texture and luster also were distinctly improved in the mid- and high-range materials. The low-range materials showed little to no improvement in workability. As a result, the overall same fair rating given to the unaltered FLAT apply to the low-range heat treated materials.

Water-soaked FLAT, like the low-range heat-treated material, showed no improvement in workability. The workability ratings are the same fair rating as those given to unaltered FLAT.

6.4.4.15 Workability of East Range Flecked

East Range Flecked (FLECKED) material was procured in tabular pieces varying in thickness from 1 to 10 cm. This somewhat restricted the types of flake-cores to bifacial and unifacial tabular forms. Flake production was easily performed with the 510 g and 318 g hammerstone. The flakes exhibited large bulbs of percussion with several displaying some degree of curvature. Problems experienced in flake production consisted mostly of hidden internal fractures, which were encountered quite frequently. Workability of the core-flake production category was rated as good.

Early-stage biface production was performed on both tabular pieces and core-flakes with the 324 g and 318 g hammerstones. Complications due to material flaws were not uncommon, however, the tabular pieces initially procured were quite weathered and the less weathered material caused fewer problems. Overall this reduction category was rated as fair to good.

Secondary thinning of the unaltered FLECKED proved to be slightly more difficult. Attrition to the 375 g and 231 g billets was moderate. Difficulty in flake removal was caused by material hardness and resulted in a number of hinge terminations. Given these difficulties, the workability rating of this category was assessed as fair.

The unaltered FLECKED, because of material hardness, proved to be difficult to pressure flake. Problems encountered consisted mostly of short fracture travel distances and tool attrition. Pressure flaking was rated as fair to poor.

The heat-treated FLECKED showed marked improvement in workability, especially in the mid- and high-range temperatures. Although the materials from HTE 3 were potlidded beyond usable, the high-range materials from HTE 4 not only demonstrated the greatest improvement in workability, but still retained a fair amount of hardness. The workability for the high-range heat-treated materials was ranked as good for all reduction categories. The mid-range materials also showed marked improvement, with all reduction categories rated as good except for pressure flaking, which was rated as fair to good. The low-range materials exhibited somewhat less improvement, with workability rated as good in core-flake and early-stage biface categories. The secondary thinning and pressure flaking categories were rated as fair for low-range heat-treated FLECKED.

FLECKED immersed in water showed no noticeable improvement in workability. Ratings for all reduction categories were the same good rating as those given to the unaltered materials.

6.4.4.16 Workability of Fort Hood Gray

The Fort Hood Gray (FHG) nodules procured for the workability assessment often graded in color to the Gray-Brown-Green material. Materials judged strictly to be FHG (i.e., having no olive or brownish grey mottles) were used for the workability experiments. The large, irregular nodules were well suited for production of a number of core types, including bi- and unidirectional cylindrical cores, multidirectional amorphous cores, and unidirectional semiconical cores. Core-flakes produced with the 510 g and 318 g hammerstones had pronounced bulbs of percussion and compression rings. Only a few difficulties were experienced in flake production, most of which were caused by hidden internal chalky voids. The workability of this reduction category was ranked as good.

Early-stage bifaces were made from both core flakes and nodules. This was accomplished with the 510 g, 324 g, and 318 g hammerstones. Few problems were experienced in reduction, giving this category a workability rating of good.

Secondary thinning also went well with few complications. The flakes produced exhibited near parallel to expanding lateral edges. The platforms of the secondary thinning flakes were lipped with diffuse bulbs of percussion and compression rings. The workability of this category was also rated as good.

Pressure flaking of unaltered FHG went well with only a few problems encountered. Occasional, coarser-grained mottles that retarded fracture travel were sometimes encountered. Nonetheless, FHG was rated as good for pressure removal.

Heat-treatment of FHG showed improvement in all reduction categories. The high-range materials recovered from HTE 4 (HTE 3 materials experienced potlidding) exhibited the greatest improvement in fracture distances, especially in secondary thinning and pressure removal. These materials were brittle, however, and care had to be taken to support the bifaces to prevent end shock. Like Fort Hood Yellow, all reduction categories in all temperature ranges were rated as good.

Water-treatment showed no noticeable improvement in workability. All categories were rated as good.

6.4.4.17 Workability of Gray-Brown-Green

Gray-Brown-Green (GBG) material shows color gradation to both Fort Hood Yellow and Fort Hood Gray. The GBG material also is similar to these sibling materials in texture, chalky voids, and workability. Nodules collected for workability experiments were very similar in form to the FHG material since they were collected at the same time at the same locality.

The core-flake production category was performed with the 510 g, 324 g and 318 g hammerstones. The core types from which these flakes were removed were similar in form to those produced with the Fort Hood Gray. Few problems were encountered except for hidden chalky voids which caused flake removal complications. The overall workability of this reduction category was assessed as good.

Early-stage biface reduction, also given a good workability rating, was performed on flakes and nodules (primarily the flatter ones). The 324 g and 318 g hammerstones were employed in this reduction category.

Secondary thinning, which was accomplished with the 375 g and 231 g billets, was given a good workability rating. The flakes produced were very similar in morphology to those produced in the Fort Hood Gray secondary thinning experiments.

Pressure flaking with the unaltered GBG also displayed parallels with the Fort Hood Yellow and Fort Hood Gray. Mottles of different texture caused a few difficulties in successful flake removal by diminishing flake fracture distances. However, the majority of the removals were detached without complication, giving the category a good rating.

GBG reacts to heat treatment much like Fort Hood Yellow and Fort Hood Gray, and demonstrated a dynamic tolerance to a wide range of temperatures. The high-range increased ease of fracture initiation and travel while at the same time making the material more brittle. Mid- and low-range temperatures did not show as great an improvement in fracture characteristics, but remained more elastic. Heat-treated GBG was rated as good for all reduction categories in all heat ranges.

Water-soaked materials were rated as good, although there was no noticeable improvement in workability.

6.4.4.18 Workability of Leona Park

Leona Park (LEONA) material and its bedrock source have long been known to Central Texas lithic technologists. This material is definitely one of the most unusual of the 15 examined in this study. The texture of the large blocky fragments is highly variable. A single tabular fragment, approximately 25 cm thick and weighing 30 kg, produced an incredible blocky core which yielded core flakes of 10 to 25 cm in length and 15 to 20 cm in to width using the 2,210 g hammerstone. A number of core flakes were removed from a prepared unidirectional blocky core. This reduction category was given a good workability rating.

Early-stage biface production was accomplished by using large core-flakes produced in the previous experiment. Edging and primary reduction were performed with the 324 g and 318 g hammerstones. The hardness and texture of the unaltered LEONA made this reduction activity slightly difficult. Edging was easily accomplished, however, primary bifacial-reduction flakes were not easily detached, and as a result, some step and hinge terminations were encountered. The workability of LEONA for this reduction category was rated as fair.

Secondary thinning proved to be slightly more difficult than primary thinning. Material hardness and texture were mostly the cause of failed executions in billet thinning, resulting in step and hinge terminations. Tool attrition to the 375 g and 231 g billets used was moderate. Overall, this reduction category for unaltered LEONA was rated as having fair to poor workability.

Pressure flaking was accomplished with the 110 g and 72 g antler tines. Again, the material's hardness and variable texture caused problems with fracture initiation and travel. The workability of this category was rated as fair to poor.

Heat-treatment of LEONA demonstrated improvement in workability in all temperature ranges. In the high-temperature range, LEONA materials not only withstood even the highest temperatures of HTE 3, but achieved good workability ratings in all reduction categories. (Because the amount of material procured was limited, core-flake production was not performed for heat-treated LEONA). During reduction of high-range LEONA, a distinctive strong petroleum odor was noted. The mid-range LEONA showed slightly better improvement than the low-range materials which, in turn, were slightly improved from the unaltered material.

The water-soaked material showed little or no improvement in workability from the unaltered material.

6.4.4.19 Workability of Owl Creek Black

Owl Creek Black (OCB) material is prized by area knappers for its exceptional workability. After experiencing all the other materials in their altered and unaltered states, it seems that the area knappers are strangely focused on a material which is rather brittle in its unaltered state and only found in fairly thin tabular pieces that restrict the size range of objects that can be produced. However, after the experiments, it was apparent that OCB is preferred because its natural texture and form are best suited for the easy manufacture of bifaces. Indeed, during procurement of OCB, it was apparent that the outcrop had been heavily and recently exploited, and it was difficult to find a large sample of useable materials.

The flake cores produced with the tabular pieces procured for the workability experiments were for the most part bifacial and unifacial tabular cores. Flake removal was surprisingly easy, however, the brittleness of the material which facilitates ease of fracture initiation and travel can also cause overshot terminations and end shock if the knapper does not adjust his or her technique accordingly. Given the mean length and width of the pieces procured for the workability assessment (12 cm x 9 cm), core-flake production and early-stage biface reduction were performed in the same experiments. OCB was rated as good for both reduction categories.

Secondary thinning of the unaltered OCB material proved to be quite easily accomplished, with many flakes travelling completely across the nucleus. A fair percentage of overshot terminations were encountered with the 375 g billet, and a bit less with the 231 g billet. The resulting flakes had defined lipped platforms and exhibited mostly expanding lateral edges. Workability in this category was assessed as good.

Pressure flaking proved to be quite easily performed with the 110 g, 72 g, and 49 g pressure tools. Attrition to these tools, or any of the others used, was minimal. Pressure flakes were often parallel sided to slightly expanding and travelled nicely. The workability rating for this reduction category was good.

Of the 15 materials used in this study, OCB was the least tolerant of heat treatment, as previously noted by Dickens (1993a). The materials exposed to low-range temperatures demonstrated slight improvement in flake initiation and travel. Mid-range materials increased in brittleness at 450°F and began potlidding at 550°F. The high-range materials were essentially reduced to a pile of useless shattered potlids. Workability for heat-treated OCB in the low- and mid-range was rated as good for all reduction categories. OCB heat treated in the high range was rated as poor.

Water-soaked OCB showed little improvement in an already highly workable material, and warranted no rating change with respect to ratings for unaltered materials.

6.4.5 Discussion of Workability Results

The initial goal of gaining an understanding of the relative workability of these 15 materials was met and an initial knowledge of the properties of the materials has been derived. Although the results of this study reflect the observations of a single knapper, a series of preliminary observations can be made about the range of materials available to prehistoric inhabitants of the Fort Hood area.

Among the materials used in this study, four (Fort Hood Yellow, Fort Hood Gray, Gray-Brown-Green, and Owl Creek Black) appear to be of high enough quality to be used consistently in an unaltered state. Interestingly, all of these appear to occur widely in the North Fort province (Section 6.3.3.2). Even the relatively poorer materials in

North Fort (Texas Novaculite, Leona Park, and East Range Flat) respond well to heat treating by inexpertly implemented means. Thus, depending on the actual distribution of outcrops and the pattern of transportation in stream bed loads, it is apparent that persons in the northern third of Fort Hood were never very far from easily worked materials.

Three of the cherts in the South East Range province (Cowhouse White, Heiner Lake Tan, and Heiner Lake Blue-Light) are noticeably harder to work with than the better North Fort cherts, although they are quite useable materials in their unaltered states. Other South East Range cherts (East Range Flecked, Heiner Lake Translucent Brown) are mediocre materials, while unaltered Heiner Lake Blue is not very good at all. Even these cherts improve considerably under one or more levels of heat treatment.

In contrast, the two cherts of the West Fort province (Seven Mile Mountain Novaculite and Anderson Mountain Gray) are relatively poor materials in their unaltered state, although unaltered AMG is still a decent material for many applications. However, heat treatment improves these materials substantially. Indeed, fairly good projectile point replicates were produced with heated 7MN, which is easily the worst material in the batch in its unaltered state.

Thus, heat treatment appears to at least partly ameliorate the necessity of travelling from the West Fort and South East Range provinces to the North Fort province to obtain chert for tasks that require relatively high workability. Interestingly, although it is unlikely that soaking was an aboriginal treatment procedure, the results of reducing soaked materials implies that procurement of materials from bed-load components probably would not involve a change in workability. This further implies that to the extent aboriginal knappers were able to recognize favored materials in stream channels downstream from outcrops, they would not sacrifice workability by procuring materials from channels instead of bedrock sources.

Another variable--form--may strongly influence workability with respect to particular tool-production needs. The thin, tabular nature of Owl Creek Black and East Range Flecked and the internal structure of Heiner Lake Translucent Brown may have imposed thickness-related size limitations on prehistoric knappers. The generally subspherical form of the Texas and Seven Mile Mountain Novaculites make them difficult materials to prepare as cores. Variability in hardness, texture, and the extent and nature of internal flaws in all materials also may have been a limiting factor in their use for particular applications.

The workability of chert and the geographic distribution of sources with different properties, therefore, may have had a bearing on the processes by which prehistoric people at Fort Hood integrated stone tools into their technological base (see Ellis 1994a). How is workability and distribution actually affected economic decisions is, of course, an open question to be resolved in ongoing research (see sections 3.3.3 and 9.1).

6.5 INTEGRATION AND SYNTHESIS

This study has attempted to provide a new and useful body of information on the appearance and occurrence of Edwards chert. It has demonstrated that previous models of chert distribution cited in the archaeological and geological literature are in need of revision and may be poor predictors of chert occurrence within the outcrop. Chert appears to be present throughout the outcrop of Edwards and correlative strata in Texas, and in parts of Mexico, where the chert bearing facies are not restricted to shallow water deposits as has been previously argued for Texas outcrops. In the most general terms, Edwards chert ranges in color from brown and gray, to black, white, yellow, orange, reddish brown, olive gray, pink and pale blue or bluish gray. Various shades of violet and maroon have also been reported (Glen Goode, personal communication 1994). The majority of these cherts occur as flattened, disc-shaped nodules, but irregularly shaped, complex three dimensional forms are also common. Bedded chert is infrequent but occasionally present. The appearance of Edwards chert may change significantly from bed-to-bed, or be remarkably similar through 10 or more meters of section, depending upon the type of nodules that are present. Although some variants are locally restricted in outcrop, others are remarkably similar across large areas, often in excess of 10 to 15 km. Mottled and banded forms are most common, but laminated, striated, and homogeneous structures occur as well. Most of the cherts are relatively opaque, but a few may be quite translucent. The majority of the specimens examined during this study have a dull surface luster in the unaltered state, although some variants reported elsewhere may have a significant luster; nearly all Edwards chert experiences an increase in luster upon heating. Discoloration associated with annealing is highly variable and difficult to generalize. It is significant to note that the workability of most types of Edwards chert improves upon heating. Finer textured, clearly cryptocrystalline cherts do not react favorably to high temperature heating and often respond by fracturing, whereas coarser textured cherts generally tolerate greater temperature extremes and occasionally experience substantial transformations through heat treating. In general, it should suffice to say that Edwards Group chert is a highly heterogeneous material in appearance, quality, and occurrence.

A chert outcrop map, compiled from the base wide archaeological surveys, demonstrates the basic correspondence between primary chert outcrops and the Manning surface, and illustrates that the ubiquity of chert is often related to the fashion in which the modern, dissected surface intersects the relatively flat lying chert zones. The pre-existing Fort Hood chert taxonomy is expanded upon and a total of 16 chert types are now recognized from on or immediately around the base. Detailed, standardized descriptions of these bedrock sources illustrate the range of appearance of these cherts and the changes they incur upon heating. Information on the relative physical properties is compiled and a basic description of the strengths, weaknesses and limitations of form impose upon those interested in knapping the material. Three preliminary and highly subjective chert provinces are identified in order to facilitate intra-regional comparison at Fort Hood. Unfortunately, the piecemeal fashion in which this taxonomy was put together leads us to believe that there is considerable room for improvement, especially in terms of documenting in a more formal fashion, what types of chert occur in the outcrops identified on the outcrop map. It is also crucial to identify the range of variability of cherts brought into Fort Hood by Cowhouse Creek, the Leon River, and Table Rock Creek, because these streams provide a ready source of lithic material that may bear little resemblance to cherts cropping out on base. The physical characteristics of the chert available on base is compared with Edwards chert sampled from localities off base and used to draw conclusions regarding the overall character of Edwards chert.

Contrary to popular perception, chert cannot be found everywhere at Fort Hood, but rather is a highly patterned resource. The results of this study demonstrate that the lithic resources associated with Edwards Group outcrops vary in quality, diversity and ubiquity to form a mosaic of resource potential. Some parts of Fort Hood have immense amounts of fine quality chert, such as the North Fort Province, which contains all four chert types in the taxonomy that were classified as good in the unaltered state. Other areas, such as the West Fort Province, have limited diversity, a generally lower quality and often lower ubiquity. Nearly all types of Edwards chert examined in this study are improved upon by heating, and this process may in part compensate for the low quality of some variants. This process takes on increased importance in regions where diversity and quality choices are both low, as in the West Fort Province. The diversity of raw materials may change on a local or regional basis and is contingent upon the nature of the cherts present. Although the North Fort Province in its entirety is relatively diverse, the range of material choices in any one locality is usually limited to one or two types in the taxonomy. Elsewhere, such as Southeast Range, chert diversity may be very high even within a single site, providing many more options at any one locality. It is not clear if the Fort Hood taxonomy as it currently exists accurately reflects the diversity of Edwards Group chert across the entire outcrop. Examination of the non-Fort Hood sample described here (Appendix C, Part 2) suggests that this taxonomy may be more diverse than some regions, but others familiar with this resource suggest that the variation described here is at least representative, or perhaps, less diverse than other portions of the outcrop. Specifically, Glen Goode (personal communication) has suggested that the region between Kerrville, Fredericksburg, and Junction may be more heterogeneous than the current Fort Hood taxonomy. Unfortunately, the fact that the majority of Edwards Group chert crops out on private land means that few archaeologists will ever have an opportunity to examine chert variability on a scale similar to Fort Hood.

Although considerable progress is made in understanding the occurrence and appearance of this resource, there is ample room for improvement. The heterogeneous nature of the material continues to hinder easy identification, and no doubt has stimulated others to find a rapid and expedient means to discriminate Edwards chert from other, often similar cryptocrystalline silicates such as Knife River Flint. The most widely discussed method, ultraviolet stimulated fluorescence (e.g. Hofman et al. 1991), should be employed with caution at present until a better provenienced study has been published. Although nearly all of the Fort Hood taxonomy and the bedrock specimens collected from across the outcrop fluoresce in a manner consistent with previously examined Edwards chert (Personal communication, Pam Headrick, Marilyn Masson, and Susan Dial, 1994), but at least one type identified at Fort Hood, Owl Creek Black, failed to fluoresce, and it exhibits a plain light color many people would not consider typical of Edwards chert. Further research with this method should select other cherts that crop out in central Texas (besides Edwards chert) and test their fluorescence properties. Analytical techniques useful in discriminating Edwards chert from other sources should be pursued but were beyond the basic scope of this chapter. Trace element characterization of Edwards Group chert by means of instrumental neutron activation analysis is in progress and should provide an independent, and more reliable means of discriminating it from similar materials that crop out in the midcontinent United States. Elliot (1979) noted a significant difference between the oxygen isotopes contained within shallow water Edwards Group cherts and deeper water, basinal facies cherts correlative with the Edwards Group. The application of stable isotopic ratio analysis, specifically with respect to oxygen isotopes, may provide an inexpensive means of discriminating shallow from deep water facies cherts in regions where both occur, such as west Texas and northern Mexico. Furthermore, it is clear that much more needs to be done to explore the relationship between workability and procurement, especially studies that relate the performance properties of cherts to their actual use by aboriginal inhabitants of Fort Hood.

7.0 CHRONOMETRIC AND SITE-FORMATION STUDIES USING LAND SNAIL SHELLS: PRELIMINARY RESULTS

G. Lain Ellis and Glenn A. Goodfriend

This chapter discusses the results of a pilot study conducted to explore the use of land snail shells for dating archeological deposits at Fort Hood. The purpose of the study was to determine whether it is feasible to use land snail shells as a reliable medium for obtaining radiocarbon dates and for using amino acid epimerization analysis for chronometric and site-formation applications. The study was conducted in conjunction with a formal eligibility testing program (to be reported in a future volume) and with the burned rock midden study (Chapter 8.0, this volume). Preliminary results show that all three uses are likely to be useful for archeological research.

The chapter begins with a general overview of problems with chronometric dating in Central Texas (Section 7.1). Next comes a discussion (Section 7.2) of the use of radiocarbon and amino acid epimerization analyses to date the shells of Holocene-age land snails. The discussion outlines the general methods for dating shells and the relative merits of the radiocarbon and epimerization procedures. A preliminary case study (Section 7.3) applies the epimerization method to site-formation studies and shows how land snail shells can be used to provide evidence relevant to the integrity of archeological assemblages, depositional conditions, and correlation of archeological deposits. Another preliminary case study (Section 7.4) shows that *Rabdotus* snail shells are likely to be a suitable medium for radiocarbon dating and for chronometric applications using epimerization analyses.

7.1 CHRONOMETRIC PROBLEMS IN CENTRAL TEXAS

The prehistoric cultural sequence in Central Texas is generally poorly understood (Ellis 1994a; Black 1989), partly because it is poorly dated (Black et al. 1992). Radiocarbon dating is the principal means for chronometric dating in Central Texas because other common methods are either unavailable or only rarely available. Unfortunately, some aspects of radiocarbon dating limit its utility: rarity of accurately datable materials and/or high costs. Charcoal large enough for conventional radiocarbon analysis is rare in Central Texas, so archeologists generally must rely on accelerator mass spectrometry (AMS) radiocarbon procedures to accurately date archeological contexts. Although charcoal suitable for AMS dates is more common,it too is relatively rare in ephemeral sites, which comprise the best sources of data for studying hunter-gatherer adaptations in Central Texas (cf. Ellis 1994a; Binford 1980, 1982). A major consequence of reliance on radiocarbon dating in Central Texas is that many sites cannot be dated because suitable materials are unavailable. A further consequence is that the paleoenvironmental record frequently cannot be placed in a chronological framework that is precise enough to apply to problems of adaptive change (Ellis 1994a).

Even in sites with suitable materials, economic factors limit detailed chronometric analysis. Typical costs for radiocarbon assays range from $225 for conventional dates, to $550 for AMS dates. Thus, relying on AMS assays more than doubles the cost of a date or, alternatively, reduces the number of dates available under a given budget by about 60 percent. The economic limitations of radiocarbon dating are multiplied by the fact that rigorous archeology typically requires duplicate or replicate dates. In many cases (e.g., burned rock middens), very large numbers of dates are needed to study site formation (cf. Black et al. 1992; Collins 1991). Hence, although AMS dates can provide the precision and accuracy needed for site-formation studies, using them is extremely expensive. The high cost of AMS dates also limits the use of chronometric data bases for assessing the contextual integrity of sites during significance testing. Having access to alternative dating methods would be a major boon to Central Texas archeology.

One such alternative involves the amino acid epimerization analysis of land snails shells. Epimerization assays cost about $75 per sample, so more chronometric data can be obtained for less money in comparison to radiocarbon dating. Development of this method would permit much more detailed studies of site formation and chronostratigraphy than would be possible by radiocarbon. Hence, establishing amino acid epimerization as a cost-effective dating technique for Central Texas would have empirical and economic utility. Another alternative involves determining the extent to which snail shells can be used for reliable radiocarbon dating. Development of either technique will extend the possibility of obtaining accurate chronometric dates to many sites that otherwise would not be reliably datable: land snails are more ubiquitous and abundant than charcoal in Central Texas sites.

7.2 DATING HOLOCENE LAND SNAIL SHELLS

In general, there are two methods available for dating land snail shells of Holocene age (the last 10,000 years): amino acid epimerization and radiocarbon analyses. Each of these methods has its own advantages and disadvantages.

7.2.1 Radiocarbon Methods

Radiocarbon dates on land snail shells have been regarded with suspicion because of questions about the sources of carbon in the shell carbonate (e.g., Leighton 1960). Goodfriend and Stipp (1983) showed that modern land snails from limestone areas (such as Central Texas) have radiocarbon age anomalies (up to 3,000 years too old), whereas snails from nonlimestone areas show no age anomalies. Radiocarbon age anomalies result from ingestion of ancient carbonates, the carbon from which is subsequently incorporated into the shell during growth. However, the age anomaly is smaller in some species than in others, and may show low variability among some populations (± 200 years in *Trochoidea seetzeni* from the Negev; Goodfriend 1987a). The implications of this are two-fold. First, in order to radiocarbon date fossil land snail shells reliably, it is necessary to determine the age anomaly correction (usually from radiocarbon analysis of modern shells). Secondly, variability of the age anomaly may limit the precision of radiocarbon dating of land snails.

Once the amount and variability of the age anomaly have been determined, radiocarbon dates on land snails can be used with known levels of precision relative to radiocarbon dates on charcoal. However, establishing age anomaly corrections does not lead automatically to high utility of radiocarbon dates from snail shells. Conventional radiocarbon analysis requires about 10 to 35 g of shell material, so bulk samples comprising many individuals would need to be used in cases where snails are small, as in Central Texas. This eliminates the possibility of determining whether the shell assemblage contains redeposited or intruded individuals. Conventional radiocarbon analysis of land snails is, thus, not very useful for studies of site-formation or fluvial sequences and could lead to wrong conclusions about the age of the stratum containing the shells (Goodfriend 1989). AMS analysis eliminates this problem: it requires much smaller samples (10 to 30 mg), so individual shells can be analyzed in order to detect nonuniformity of the ages of shells within a deposit. However, because of high cost, it often is not practical to use AMS analysis for detailed site-formation studies, which may require dozens, even hundreds, of analyses. Its main use with land snails would be to provide a limited number of dates on sites lacking charcoal.

7.2.2 Amino Acid Epimerization

Amino acid epimerization analysis involves the measurement of the ratio of the amino acidy epimers D-alloisoleucine/L-isoleucine (or A/I ratio) in the organic matrix of the snail shells. In modern material, essentially all of the amino acids are in the L-form, but over time they convert (i.e., epimerize) gradually to the D-form. Thus, measurement of the A/I value gives an indication of relative age and can be used to estimate absolute age once the rate of epimerization is established from calibration against radiocarbon or another chronometric method. Epimerization rates vary among species and among different regions, according to the temperature regime. Although the method has traditionally been used for dating late or middle Pleistocene deposits, in recent years it has been used for dating snails in a wide variety of Holocene deposits: fluvial sediments (Goodfriend 1987b), colluvium (Goodfriend 1987b, 1992, n.d.; Goodfriend et al. n.d.), cave sediments (Goodfriend and Mitterer 1988, 1993), and eolian sands (Cook et al. 1993; Tsoar and Goodfriend n.d.).

This method has several advantages over radiocarbon dating. Only small sample sizes are required (20 to 60 mg), similar to the amount required for AMS radiocarbon, so that variation among individual shells can be analyzed. But the analyses are much easier than AMS, and costs are therefore substantially lower (about $75 per sample), permitting much larger numbers of samples to be analyzed for a given budget. It is thus possible to examine site stratigraphy at levels of detail and thoroughness not typically possible with radiocarbon dating. A disadvantage of the method is that it requires an initial investment to establish a precise calibration against radiocarbon. However, once the calibration is established at a suitable level of precision, further radiocarbon work is not needed.

Epimerization dating may provide greater precision than radiocarbon dating of land snails or even of charcoal in relatively young samples, but it will be less precise than radiocarbon in older samples. In radiocarbon dating of Holocene samples, the precision (i.e., error) of the age estimates does not vary much with age--depending on sample size and measurement technique, precision typically will be around ± 60 to 100 years for charcoal samples. For snail shells, error may be larger (perhaps about ± 200 years) as a result of the variability of the age anomaly, but the overall level of precision still varies with sample size and measurement technique rather than with age. In amino acid epimerization analysis, error results from analytical precision (typically around ± 5 percent of the ratio, but lower if replicate analyses are carried out) and from variability in the rate of epimerization of samples from different contexts, such as deeply or shallowly buried proveniences. This additional component averages about 10 percent among sites in the Negev, but has not been quantified elsewhere. The overall error thus is within the range of about 5 to 15 percent of the age for Negev samples, but is unknown for Central Texas.

For the latest Holocene, epimerization would therefore provide better precision (i.e., smaller error) than radiocarbon analysis of charcoal. Indeed, epimerization can be used for sites that are too recent to date by radiocarbon methods (i.e., sites from the last 350 years), and epimerization would be more precise than radiocarbon dating of land snails for even older samples, up to perhaps 2,000 yr old. In early Holocene samples, radiocarbon analysis of either charcoal or snails would be more precise than epimerization. These estimates assume that the average rate of epimerization is known with a high enough precision (2 to 3 percent) that this does not significantly affect the overall error of epimerization dates. While determination of this rate depends on radiocarbon analysis and therefore on its inherent errors, the rate can be determined with high precision by (1) calibrating against a *series* of radiocarbon-dated samples (the error in the slope estimate is thus much smaller than the error for any particular individual point); and (2) using calibration samples that are not too young (>1,000 to 2,000 years) and whose percent-wise radiocarbon errors are therefore small.

Amino acid epimerization will therefore provide not only a cost-effective alternative to radiocarbon dating for archeological sites in Central Texas, but also may provide better precision than radiocarbon for young samples. The relative imprecision of epimerization for older samples is more than compensated for by the fact that charcoal is not available for many old sites. Thus, the ability to use epimerization to provide dates and to accurately characterize site integrity would represent a major advance for Central Texas archeology by making it possible to obtain chronometric and site-formation data in cases where no such data would otherwise be available.

7.3 THE EPIMERIZATION METHOD AND SITE-FORMATION STUDIES

As part of a separate project, the authors conducted a pilot study in the use of amino acid epimerization. The results of the pilot study will be reported in detail in a separate report, but a preliminary analysis of results will be useful for showing how A/I ratios can be used for site-formation studies. This section starts with a general discussion of the interpretive parameters for using A/I ratios to examine rates of site formation, integrity of depositional context, and temporal correlation of archeological deposits. Next comes a site-formation analysis that serves as an example of one way in which A/I ratio data can be used to interpret integrity of depositional contexts and correlation of proveniences within a given site. The section concludes with a discussion of ways to improve the robustness of results.

7.3.1 Background for Site Formation

Use of the epimerization method for correlation has direct applications to site-formation studies in archeology. If land snails live on a surface, an assemblage of shells should be buried when that surface is buried. In principle, therefore, the A/I ratios in a shell assemblage from a given provenience should be equal, reflecting the contemporaneity of the snails that were buried. Hence, in principle, the portions of an archeological site that are buried at the same time should have snail shells with equal A/I ratios. However, several variables lead to deviations from in-principle expectations.

The first major variable is deposition rate. Even under relatively rapid depositional conditions, any given 5- or 10-cm-thick deposit may contain shells representing at least several decades of time, so at least some variation in A/I ratio is introduced. Additional variation can be introduced because land snail shells may accumulate on a stable surface. Thus, A/I ratios from an assemblage of land snails in an archeological deposit can be expected to contain some variation, at least some of which is diagnostic of variation in rate of burial and, therefore, is also diagnostic of potential to yield archeological materials in behaviorally significant stratified contexts.

The second major variable is redeposition of old shells. Many of the geomorphic processes that mobilize and transport mineral sediments also can mobilize and transport snail shells. As a result, the sediments that bury an in situ snail assemblage can contain older shells transported from the sediment source area. Indeed, redeposition of older shells can be expected to happen routinely, creating an additional source of variability in the A/I ratios of shells from archeological deposits.

The key for interpreting site formation is the vertical and horizontal distribution of equal and unequal A/I ratios (cf. Goodfriend 1987b). In principle, the shell(s) with the lowest ratio(s) corresponds with the date of burial. If most of the shells in a provenience have ratios approximately equal to the youngest shell, this clustering pattern strongly implies rapid burial. In these cases, older shells will appear as outliers. If burial is very rapid over an extended period of time, a vertical sequence of nearly identical ratio clusters should appear. As deposition rate slows, the difference between ratios in vertically spaced clusters should increase, and more of the assemblage in each horizontal provenience should be composed of unequal outliers. Under gradually cumulic depositional conditions, shells with a wide range of ratio values should be present, and ratios should not cluster prominently around the youngest shell. Adjacent, vertically spaced proveniences within a cumulic horizon should show the same pattern, although the youngest shells in the top and bottom proveniences could show an increase in ratio with an increase in depth if net cumulic deposits are very thick. A cumulic surface sandwiched between relatively rapidly aggraded deposits should show up as a horizontal distribution of widely spaced, unclustered ratios over- and underlain by horizontal distributions of clustered ratios in which the over- and underlying clusters reflect substantial elapsed time.

Clearly, however, interpreting site formation is not likely to be straightforward because much can happen to cause further deviations from the idealized patterns above. For example, postdepositional disturbance can lead to assemblage mixture. The absence of clustering around the youngest shell in a provenience may be indicative of postdepositional disturbance, with localized disturbance occurring as random patterns of A/I ratios amidst adjacent proveniences with different patterns. If data collection is not horizontally and/or vertically extensive enough to cross the boundaries between disturbed and undisturbed proveniences, a distribution of A/I ratios resulting from disturbance might be very similar to a pattern resulting from cumulic deposition. Furthermore, if most of the shells in a provenience are redeposited, the pattern may appear to be cumulic or disturbed even if deposition was very rapid. Still further, low levels of disturbance can introduce isolated outliers that are newer than the date of burial, which would lead to assignment of an anomalously recent correlation if one simply used the newest ratio in a provenience to assign a relative date. Finally, excavation errors can lead to sample contamination if, for example, a snail is inadvertently knocked out of a profile during excavation of lower portions of a unit.

Another complication arises for using snails in archeological contexts because the epimerization process is temperature-dependent. It is possible that snails served as a food source for prehistoric peoples or that natural prehistoric fires have had an impact. Cooking processes can increase A/I ratio by an amount that depends on both the temperature and duration of cooking. This effect can occur at temperature/duration levels that do not visibly alter the shell's appearance. For example, boiling snails would subject them to temperatures of 100°C and would not cause them to appear charred. If boiling took place for several hours, the effect on A/I ratio would be unmeasurable because the time/temperature function is not severe enough to accelerate epimerization. Although it is extremely unlikely that culinary snails would be boiled for hours, other cooking processes such as roasting and baking involve higher temperatures that can realistically be expected to have a measurable impact in exposure times too short to char the shell itself. Furthermore, fires in hearths or other cooking features can affect the ratios of nonculinary shells previously deposited in adjacent sediments, especially under conditions of repetitive, long-duration, and/or high-temperature cooking episodes. Grass or forest fires also could have an impact on shells on or just below the surface.

The temperature-dependence of the epimerization process also implies that the burial history of individual snails influences the distribution of ratios in a given assemblage. Mean and maximum temperature within a stratigraphic column are higher at the surface, but fall off with depth (Brady 1990). Thus, snails nearer the surface are exposed to higher temperatures than deeper snails, and over long periods of time, snails near a stable surface theoretically should epimerize at a faster rate than more deeply buried snails (Wehmiller 1977). Interestingly, however, A/I ratios for snails from a variety of depositional contexts in the Negev Desert in Israel did not meet this expectation, even for snails which should have been most susceptible to accelerated epimerization because they were recovered in the upper 50 cm of deposits (Goodfriend 1987b). Hence, the most serious sources of temperature-related, naturally-induced A/I variation appear to be from heating by extended exposure to direct sunlight prior to burial and from the cumulative impact of long-term temperature change.

In addition to being temperature-dependent, the epimerization rate is species-dependent. As a result, the ratios from different species of snails must be calibrated to reflect differences in epimerization rate before they can be used as a single sample for correlation of stratigraphic deposits. Without interspecific calibration, correlation is limited to comparisons among single species unless a large enough sample of each species is available so that each sample by itself is robust enough to identify patterns of equal and unequal ratios. Indeed, A/I ratios from two or more species from the same proveniences can provide a supplementary basis for assessing the significance of A/I ratios because the patterns of ratios from multiple species can be mutually informative cross-check when interpreting the pattern of any one species.

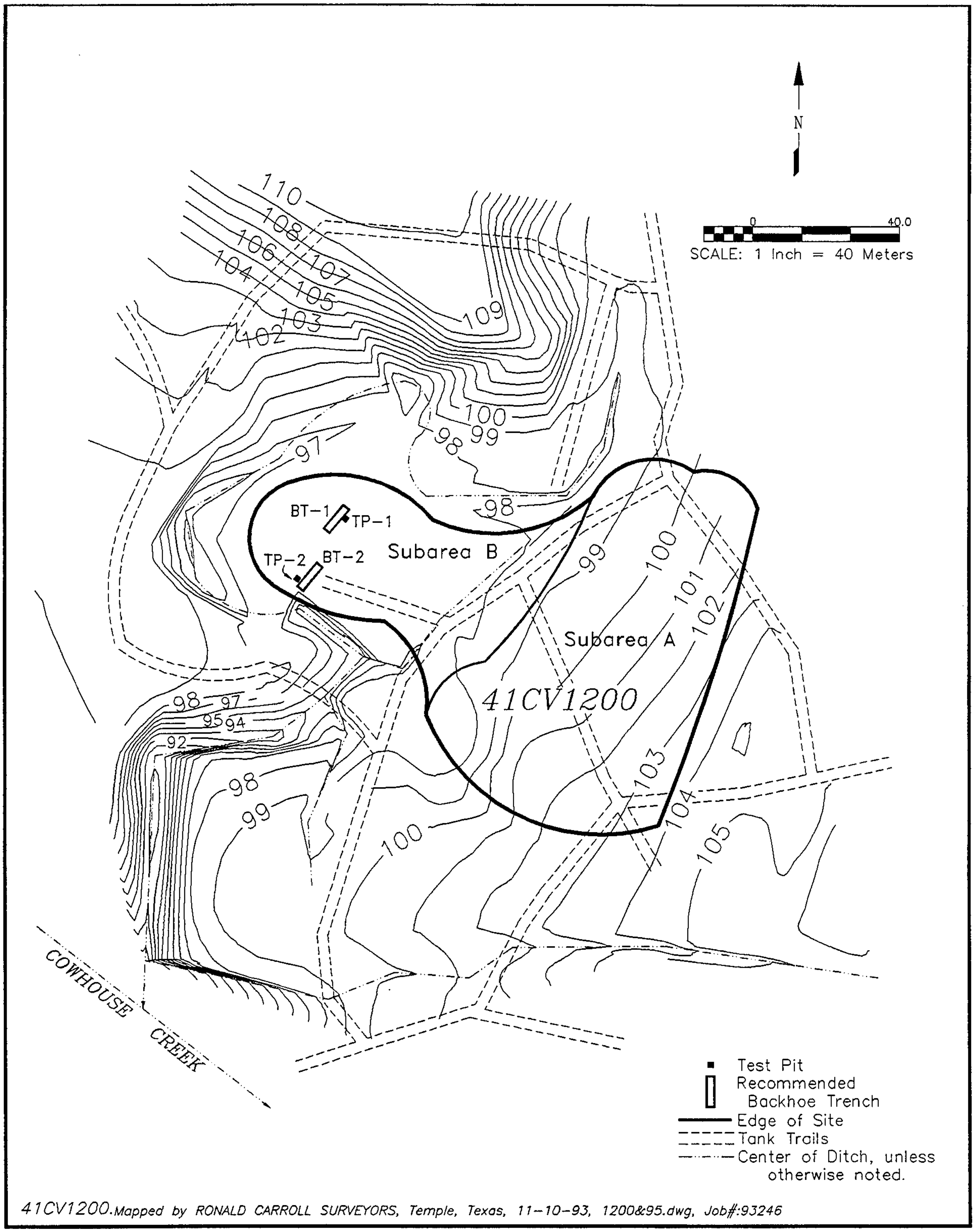
Note, therefore, that A/I ratios have interpretive constraints that are analogous to limitations imposed on obsidian hydration and radiocarbon assays. As with obsidian hydration, some variation in A/I ratios can be introduced by influences from artificial sources of heat, depth of burial, and the cumulative effects of long-term temperature change. Epimerization rate also varies by species, which is similar to the impact of source variation for obsidian. Variation that results from the above effects induces anomalously high A/I ratios that are interpretively equivalent to radiocarbon age anomalies that result from incorporation of "dead" carbon into a dated sample. Furthermore, the fact that old shells may be redeposited into new contexts produces interpretive problems analogous to the "old wood" problem in radiocarbon dating (Schiffer 1972). Still further, analyses of site formation should not be based on very small numbers of shells. Just as correlating archeological sites on the basis of isolated single radiocarbon dates does not provide a robust chronometric data base (Dean 1978), small numbers of A/I ratios do not provide a robust basis for correlating deposits within a site. In other words, as with all other forms of chronometric dating that might be used to study site formation, the use of A/I ratios requires an evaluation of the natural and behavioral variables that can affect the link between dated events (i.e., the age of an object) and target events (i.e., the age of the cultural or natural event putatively associated with the dated event; Dean 1978).

Given the above difficulties, it is apparent that using the epimerization method as a means for studying site-formation rates, depositional integrity, and site-formation/transformation processes is dependent on sampling strategy and interpretive rigor. Shell samples should be relatively large to provide a sufficiently large set of A/I ratios that represents the distribution of relatively old and new shells to maximize the possibility of identifying outliers and central tendencies. An ideal sampling strategy would involve a point-provenienced collection so that horizontal and vertical distance from hearths and other similar features could be used to assess the possibility of influences by fire. Independent evidence also should be incorporated. For example, pedological evidence would be useful for distinguishing between cumulic and mixed deposits, and lithostratigraphy or evidence of depositional conditions would be useful for corroborating rapid deposition (e.g., Ferring 1986) prior to using A/I ratios to determine the correlation between different archeological deposits at a site or suite of sites.

7.3.2 A Preliminary Case Study of Site Formation

41CV1200 is a prehistoric site located on Fort Hood just west of West Range Road and north of Cowhouse Creek (Figure 7.1). An unnamed tributary of Cowhouse Creek forms the western and northern boundary of the site. The shape of the site is irregular, consisting roughly of a large north-south oriented oval with a peninsula at the west-central side next to the unnamed tributary.

The peninsula consists of a T0 terrace located in a meander of the tributary.



41CV1200.Mapped by RONALD CARROLL SURVEYORS, Temple, Texas, 11–10–93, 1200&95.dwg, Job#:93246

Figure 7.1 Site Plan, 41CV1200.

Two backhoe trenches (BT) were excavated in order to examine the deposits in the T0 terrace (Figure 7.1). The first trench was situated in the center of the meander and targeted the most stable portion of the landform. The second trench was placed on the south side of the meander at a cutbank. Both of the trenches penetrated the same alluvial fill, but the sequence and volume of facies present in each trench was variable.

The first trench (BT 1) exhibits an A-AB-Bw-Bk-BC-C soil profile formed in the tributary alluvium (Figure 7.2). The basal unconformity between this alluvial fill and an older fill of Cowhouse Creek was uncovered at 270 cm below surface (cmbs). The top 140 cm of the fill consisted of medial to distal overbank sediments (massive silt loam, loam and silty clay loam). The sediments between 140 and 240 cmbs consist of thin to medium beds (5 to 30 cm thick) of alternating coarse (sand and muddy sand) and fine (silt loam) deposits which are interpreted as representative of a channel proximal overbank environment. A medium bed of muddy gravel rests immediately on the unconformity between the tributary fill and the Cowhouse Creek deposits into which the tributary alluvium is inset.

The second trench (BT 2) exhibited a similar horizon sequence (A-AB-Bk-BC) but exposed a thicker sequence of overbank facies deposits (Figure 7.2). The top 190 cm of the profile consisted of massive fine-grained alluvium (silt loam, silty clay loam and loam). Deposits representative of a channel proximal depositional environment were observed in this trench between 190 and 260 cmbs.

A 1 x 1 m test pit (TP) was placed next to each of the trenches and excavated in arbitrary 10 cm levels in order to explore the nature of cultural materials visible in the trench profiles. Test Pit 1 was placed next to BT 1, and TP 2 was placed next to BT 2, about 20 m from TP 1. *Rabdotus dealbatus* shells were recovered from level 11 (100 to 110 cmbs) in TP 2 and from level 21 (200 to 210 cmbs) in TP 1. Level 11 was excavated in loamy to silty loamy deposits in the Bk horizon of the BT 2 profile, about 3 m from the south cutbank of the tributary meander. Level 21 included portions of at least two interbedded strata in channel proximal deposits in the BC horizon of the BT 1 profile. These channel proximal deposits appear to correlate at least grossly with similar deposits in levels 20 through 26 in the BT 2 profile.

A/I ratios (Table 7.1) were measured from *Rabdotus* shells recovered from level 11, TP 2, and level 21, TP 1. Nine shells were assayed from each level. Figure 7.3 shows the distribution of A/I values. Note that the left-hand symbol in the array for level 11, TP 2, consists of four ratios that are too close to be distinguishable on the plot. Similarly, the third symbol from the left for level 11, TP 2 and the third symbol from the left for level 21, TP 1, each consist of two very close values.

A cluster analysis was performed on the A/I ratios in order to identify within-level and between-level clusters of statistically identical assays (Figure 7.3). Statistical identity was determined only on the basis of measurement error, which was estimated at 4 percent on the basis of measurements on samples from laboratory standards with well known, repeatedly measured A/I characteristics. The cluster analysis was performed by adapting Ward and Wilson's (1978) Case I procedure for identifying clusters of identical radiocarbon assays from replicate analyses of a single sample. The Case I procedure is used when measurement error is the only source of error that needs to be considered because other sources of error are irrelevant. Since the basic research necessary to quantify other sources of imprecision has not yet been done for the epimerization method, quantitative analysis of A/I ratios can incorporate only measurement error because it is the only quantified error as yet available.

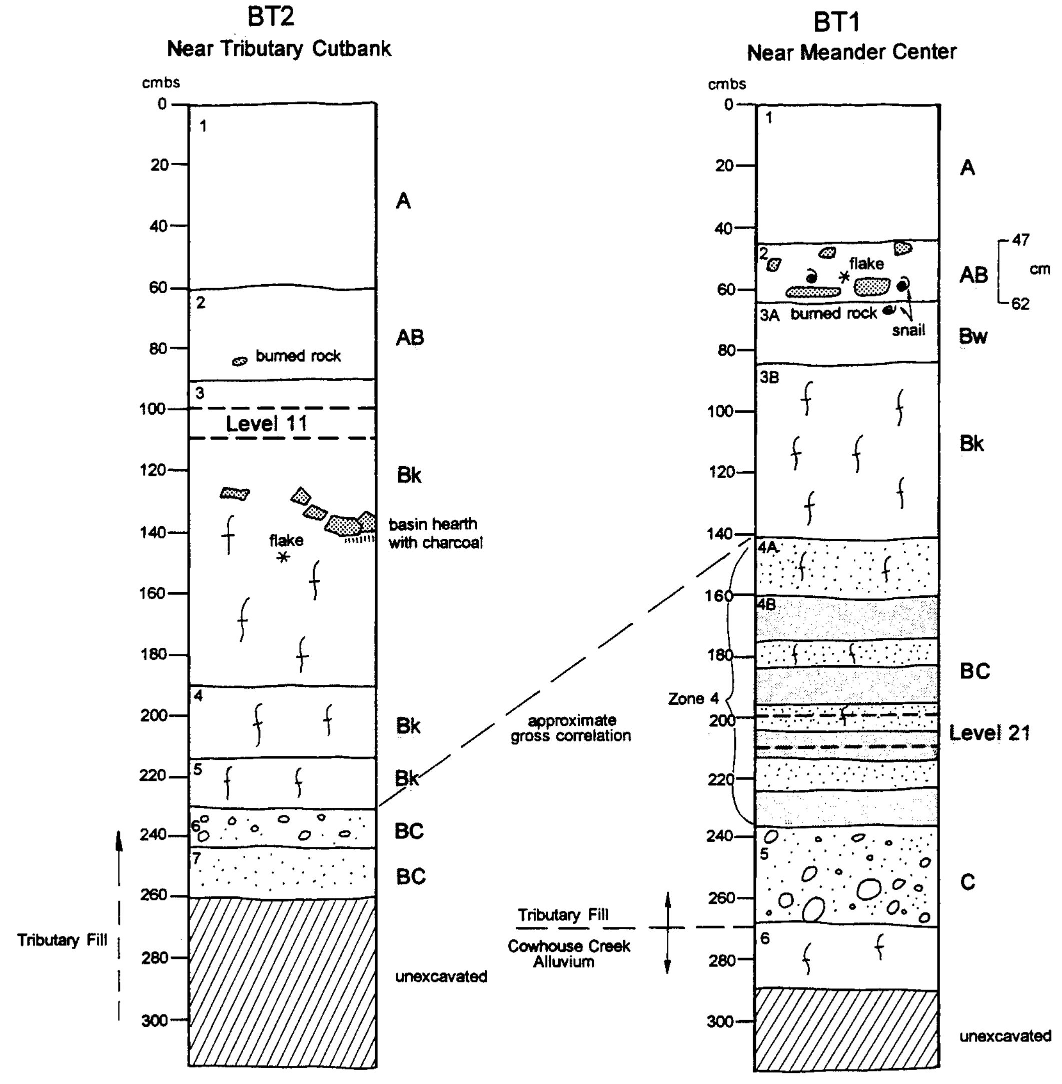


Figure 7.2 Profiles from 41CV1200.

Table 7.1 A/I Ratios from 41CV1200.

Sample ID	Test Pit	Level	A/I Ratio	Error[1]	Within Level Cluster[2]	Between Level Cluster[3]
CB156	2	11	0.0406	0.00162	1	3
CB154	2	11	0.0408	0.00163	1	3
CB171	2	11	0.0408	0.00163	1	3
CB157	2	11	0.0409	0.00164	1	3
CB158	2	11	0.0446	0.00174	1	3
CB155	2	11	0.0473	0.00189	None	None
CB160	2	11	0.0474	0.00190	None	None
CB172	2	11	0.0748	0.00299	None	None
CB159	2	11	0.1020	0.00408	None	None
CB169	1	21	0.0288	0.00152	None	None
CB161	1	21	0.0429	0.00172	2	3
CB166	1	21	0.0473	0.00190	2	3
CB167	1	21	0.0480	0.00192	2	None
CB168	1	21	0.0527	0.00211	None	None
CB164	1	21	0.0557	0.00223	None	None
CB165	1	21	0.0615	0.00246	None	None
CB162	1	21	0.0683	0.00273	None	None
CB163	1	21	0.0748	0.00300	None	None

[1] 1 sigma, conservatively estimated at 4 percent of A/I on the basis of measurements on standard samples with known properties.

[2] Statistically identical at 0.05 significance using procedure in Ward and Wilson (1978). Clusters identified by level starting with the lowest A/I ratio that is equal to at least one other ratio, and proceeding until the addition of a new ratio yields a statistically unequal cluster.

[3] Statistically identical at 0.05 significance using procedure in Ward and Wilson (1978). Clusters identified irrespective of level by starting with the lowest A/I ratio that is equal to at least one other ratio in the whole data set, and proceeding until the addition of a new ratio yields a statistically unequal cluster.

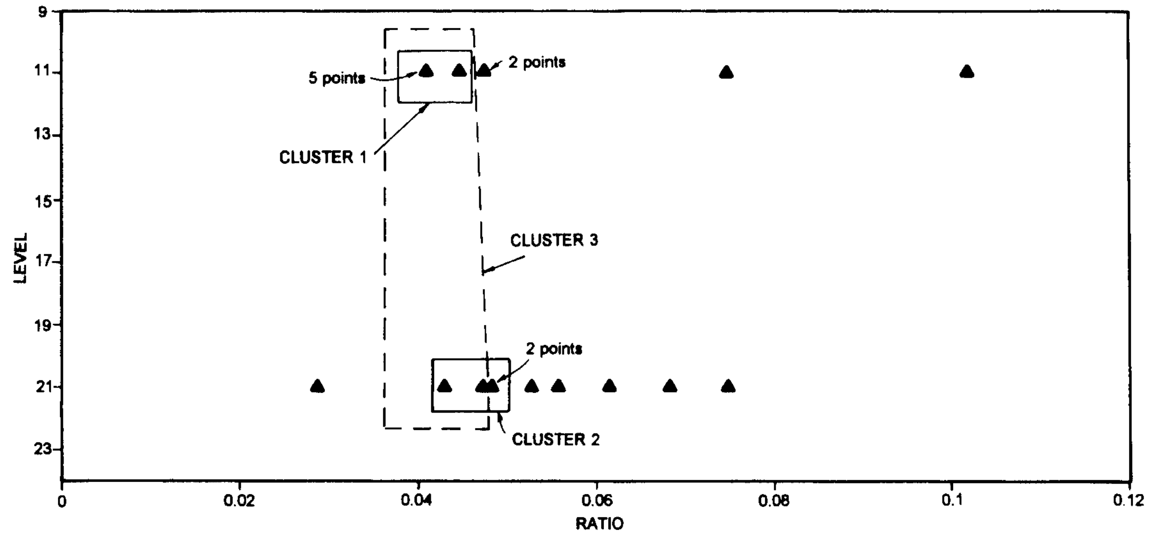


Figure 7.3 A/I Ratios from 41CV1200.

As other sources of A/I error are quantified, an analog of the Case II procedure (for assays from different samples that warrant clustering on stratigraphic or other grounds) can be adapted to reflect them.

Since the difference between the Case I and Case II procedures is that the latter includes additional sources of error, using the Case I procedure here is equivalent to using the Case II procedure under conditions where additional sources of error are negligible. Thus, in the discussion below, the statistical analyses should not be taken too seriously as hard indicators of empirical realities because they may not accommodate all of the relevant sources of errors. Nonetheless, the statistical analyses can be taken seriously as a quantitative point of departure for qualitative analyses and for illustrating how one can use A/I data in site-formation studies.

Analysis to identify within-level clusters began with the lowest ratio under the assumption that the newest shell in a level putatively reflects the date of deposition. The newest two shells were tested for identity at a .05 significance level. If the test was successful, the next highest ratio was added and the test was repeated until adding a ratio to the cluster resulted in statistical difference. If the initial test was unsuccessful, the process was begun again with the second-lowest ratio and repeated until adding a new ratio resulted in statistical difference. This procedure identified the largest and newest possible clusters that included at least two ratios. A between-level clustering procedure was performed as above, but ignoring differences in provenience.

The level 11 ratios largely conform to the idealized pattern for an assemblage from a rapidly aggrading context. Measurements for the five lowest ratios are statistically indistinguishable, which implies that the snail shells were contemporary. These ratios therefore appear to coincide with the date of deposition of level 11, and strongly imply that burial was rapid. The four highest ratios are consistent with outliers resulting from redeposition of older materials, although the third- and fourth-highest ratios might actually be equal to the clustered values if other sources of possible error were currently quantifiable.

The level 21 ratios on the other hand, are more problematic to interpret. There is a wide range of A/I values, and cluster analysis shows that only the second- through fourth-lowest ratios (samples

CB161, CB166, and CB167) are statistically identical measurements. The next highest ratios (CB168 and CB164) might join the cluster if other sources of error could be accounted for in quantified terms.

The lowest ratio in level 21 (CB169) putatively reflects the date of deposition. If so, then level 21 of TP 1 was deposited substantially later than level 11 of TP 2, only 20 m away. The spread of the other values also implies that level 21 may be either cumulic or disturbed if CB169 reflects the earliest date of burial or deposition. However, there was no visible evidence of paleosol development, and depositional beds were well preserved in and around level 21, which suggests that deposition and burial were relatively rapid and that gross disturbance was minimal. At least some of the higher ratios in level 21 therefore appear to reflect redeposition of older materials.

However, CB169 is a statistical outlier which as such should be ignored on statistical grounds. Furthermore, the value for CB169 represents an effectively modern ratio and comes from the approximate center of the tributary meander deposits in T0. If CB169 corresponds to a deposition date, it would strongly imply that low-elevation deposition at the center of the meander took place substantially later than high-elevation deposition at the bank of the meander. This conclusion is counterintuitive since deposits in both trenches appear to contain facies of the same depositional sequence, and level 21 is in a stratigraphically lower depositional unit than level 11. On the other hand, the depth of level 21 implies that CB169 was not introduced by modern rodents, and the preservation of interbedded depositional units implies that extensive postdepositional vertical reworking has not taken place. It is therefore likely that CB169 represents postdepositional contamination (probably excavation error). Hence, there is empirical evidence that supports rejecting CB169 as a statistical outlier. This judgment is weakly supported by the fact that two of the three clustered ratios in level 21 also belong to a between-level cluster that includes all of the clustered ratios in level 11. This between-level cluster implies that if CB169 is a postdepositional outlier (which is plausible on geomorphic grounds), then the two levels were deposited relatively closely in time. A judgment that the two levels are approximately contemporary also is weakly supported by the fact that level 21, despite its 2 m depth below surface, is not a meter lower in absolute elevation than level 11 because the ground surface at TP 1 is slightly higher than the ground surface at TP 2. And even so, deposition of level 21 may not have been as rapid as deposition of level 11, judging from the spread of ratios in level 21.

However, the judgment that the two levels are approximately contemporary is weakened by the fact that level 21 is in a stratigraphically earlier position than level 11. Indeed, this stratigraphic relationship negates the basis for using the between-level cluster as a legitimate basis for anything more than an exploratory exercise. Because the stratigraphic relationship shows that there are good reasons to believe that the elements of the between-level cluster are not contemporary, it violates the assumptions that warrant using the cluster procedure (Ward and Wilson 1978).

Determining if the levels are approximately contemporary therefore requires a comparison of the relative dates of each level. In order to show further how one might use A/I ratios for correlation in archeological deposits, let us assume that site geomorphology provides compelling reasons to regard CB169 as a postdepositional contaminant. Let us also assume that sources of imprecision other than measurement error are negligible, and that the snails in the within-level clusters are contemporary. In this case, the within-level clusters contain shells that provide the best available evidence for relative dates of deposition under the assumption that the most recent material in a provenience provides the best estimate of the deposition date.

Under these circumstances, the mean A/I ratio of each within-level cluster identifies the newest shells as precisely as measurement allows and serves as an estimate of the relative date of deposition. Pooling the ratios and errors for each within-level cluster yields mean ratios of 0.0458 (±0.00106) for level 21 and 0.0414 (±00074) for level 11. The mean ratios are unequal at .05 significance. This implies that level 21 was deposited before level 11, which is consistent with elevational and stratigraphic data. However, the difference between these means is not great, and is not likely to represent a long time. Note that even if more realistic error estimates were available, the level 21 mean still would be weighted so that it is higher (i.e., earlier) than the level 11 mean if the boundaries of the within-level clusters expanded to include additional ratios in each level.

7.3.3 Summary and Additional Observations

Thus, the A/I data appear to show that level 11 in TP 2 was rapidly deposited and buried, which implies that nearby archeological assemblages have a very good chance of containing discrete archeological assemblages. Level 21 in TP 1 appears to slightly predate level 11 in TP 2. Given the spread of A/I ratios, deposition of level 21 may not have been particularly rapid or may involve redeposited snails or both. As a result, the behavioral integrity of the archeological materials may be at least slightly compromised.

The analysis above also shows that the ability to use epimerization effectively for site-formation studies is affected by data collection methods. For example, the spread of ratios in level 21 may be affected by sampling from an arbitrary 10 cm level that cuts across depositionally distinct strata. Although additional assays might show that there is or is not a strong clustering pattern, it would be interesting to have separate snail assemblages from the distinct strata in order to compare patterns of clusters and outliers for evidence of differential degrees of depositional reworking and for different relative ages of deposition. Availability of such samples would make it possible to determine whether the potential for contextual integrity for finer, lower-velocity depositional strata is different from that of coarser, higher-velocity strata. Hence, if collecting point-provenienced data is not possible, collection from identifiable natural strata whenever possible can help reduce interpretive ambiguity. Indeed, if CB169 is a postdepositional contaminant, point-provenienced collection would at least eliminate excavation error as a source of interpretive ambiguity.

The analysis also shows the value of using relatively large samples for assessing contextual integrity and correlating archeological deposits. Random selection of a single shell from each level clearly could have produced widely divergent results about the correlation of the levels. Furthermore, in the absence of any capacity to use ratios from other shells, there would be no basis for assessing the possibility of assemblage mixture or for discussing the rate of deposition or burial. If a vertical sequence of shell samples from each test pit had been used, each vertically spaced provenience would provide data for assessing the significance of other proveniences by making it possible to incorporate the law of superposition into the analysis. Thus, the example shows that even with samples collected from relatively gross proveniences, it is possible to narrow the range of plausible interpretations, especially if additional lines of evidence are incorporated.

The main limitations for using the epimerization method for site-formation studies therefore follow from the relatively early stage of development of the basic research needed to adapt the method to the Fort Hood area. A primary limitation is the impact of error from sources other than measurement. Until these sources of error are quantified, use of the method will remain largely qualitative, as in the analysis above. Furthermore, until epimerization rates have been calibrated to a chronometric standard such as radiocarbon, it will not be possible to assert whether the difference between mean A/I ratios of different proveniences is actually slight or large. Since quantifying the impact of additional sources of error is partly a matter of determining how much elapsed time is reflected by a given change in A/I ratio, the key element for increasing the rigor of the epimerization method for site-formation studies is research that would transform the method into a chronometric rather than merely correlational technique.

7.4 PRELIMINARY RADIOCARBON CALIBRATION RESULTS

As part of a study to explore dating burned rock middens (reported in Chapter 8.0), AMS radiocarbon dates were obtained from shells for which A/I ratios were also measured. These data were used to explore the relationship between elapsed radiocarbon years and A/I ratio. Preliminary results show that there are extremely good reasons to be optimistic about the prospects for using land snails for dating by both radiocarbon and epimerization methods.

7.4.1 Methods

Ten *Rabdotus dealbatus* shells were obtained from test excavations in a burned rock midden at site 41BL598. Two criteria were used to select snails for radiocarbon dating. First, we wanted to see if snails with approximately equal A/I ratios also had approximately equal radiocarbon ages. Hence, samples CB86 and CB100 were selected as shells with approximately equal low ratios, and CB87, CB93, CB108, CB128, and CB132 were selected as shells with approximately equal high ratios. We also wanted to see if different A/I ratios yielded different radiocarbon ages. Hence, the other samples (CB101, CB92, and CB133) were selected as shells with varying ratios that might be useful for extending the data set to approximately unequal A/I ratios.

Table 7.2 presents the AMS and A/I results for these snails. A regression analysis using radiocarbon years B.P. (RYBP) as the independent variable was performed according to procedures outlined in Section 7.2. The regression (Figure 7.4) shows that there is a correlation ($r^2 = 0.844$) between RYBP and A/I. Judging from a good fit between nine RYBP-A/I pairs, one pair (CB133) appears to be a statistical outlier. Given the potential influence of heat from cooking fires in burned rock middens, this anomaly could be explained as an artificially high A/I value. If the CB133 pair is eliminated as a potential outlier (Figure 7.5), the strength of the correlation increases (to $r^2 = 0.937$). Still, even including CB133, the linear relationship between RYBP and A/I is quite strong. As a result of the strength of the regression correlation, several preliminary conclusions can be drawn about using *Rabdotus* shells for chronometric purposes.

7.4.2 Radiocarbon Age Anomaly in *Rabdotus*

Given that A/I ratios are known to increase with age in an approximately linear manner, the strong correlation between RYBP and A/I implies that the regression has substantial capacity to predict A/I values from RYBP values. The *y*-intercepts of both regressions (Figures 7.4 and 7.5) are approximately 0.015 at 0 RYBP (corresponding to 1950). These intercept values are very close to the expected value for a modern snail, which strongly implies that the mean amount of radiocarbon age anomaly for *Rabdotus* is very small (cf. Stafford 1993). However, note that for samples CB87, CB93, CB108, CB128, and CB132, a very small amount of apparent A/I change coincides with a significant amount of apparent change in RYBP. A possible interpretation is that although the *mean amount* of radiocarbon age anomaly is quite small, there may be substantial *variability*. Thus, although shells from a burned rock midden are a less-than-ideal source of A/I data because of possible impacts by fires, preliminary results nonetheless strongly imply that *Rabdotus* is likely to produce accurate radiocarbon dates with a quantifiable age-anomaly-variability error that can be added to measurement error to yield age determinations that have known levels of precision.

Table 7.2 Radiocarbon Ages and A/I Ratios from 41BL598.

Sample ID	^{14}C Lab ID	RYBP[1]	^{14}C Error[2]	A/I Ratio	A/I Error[3]
CB100	Beta 69551 CAMS 10950	1230	60	0.04225	0.00169
CB86	Beta 69547 CAMS 10946	1840	80	0.04915	0.001966
CB101	Beta 69552 CAMS 10951	2130	60	0.0731	0.002924
CB93	Beta 69550 CAMS 10949	5900	80	0.148	0.00592
CB87	Beta 69548 CAMS 10947	6120	70	0.157	0.00628
CB132	Beta 69555 CAMS 10954	6770	60	0.167	0.00668
CB133	Beta 69556 CAMS 10955	6820	50	0.239	0.00956
CB128	Beta 69554 CAMS 10953	7040	80	0.159	0.00636
CB108	Beta 69553 CAMS 10952	7680	60	0.149	0.00596
CB92	Beta 69549 CAMS 10948	8340	60	0.214	0.00856

1 Corrected for ^{13}C fractionation
2 1 sigma, measurement error only
3 1 sigma, conservatively estimated at 4 percent of A/I on the basis of measurements on standard samples with known properties

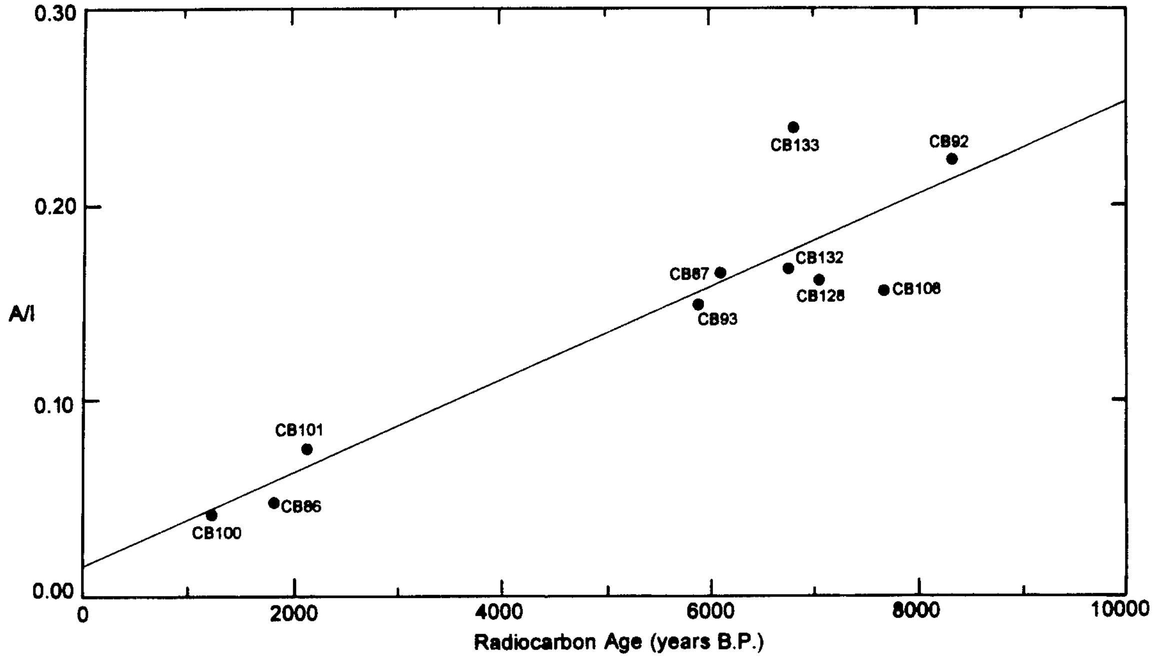


Figure 7.4 Regression of Radiocarbon Age and A/I Ratio.

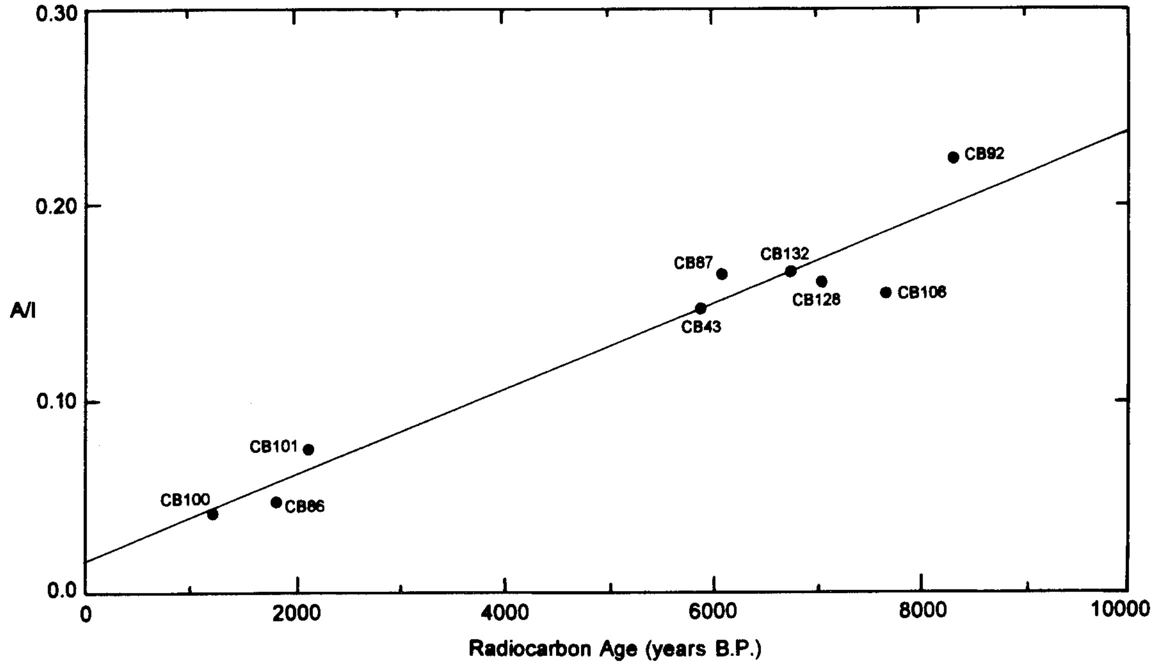


Figure 7.5 Regression of Radiocarbon Age and A/I Ratio After Eliminating Apparent Outlier.

Hence, additional research is needed to assess variability of age anomaly in order to determine the amount of error, if any, that must be added to measurement error. The utility of using *Rabdotus* for radiocarbon dating will depend ultimately on the amount of imprecision, the availability of alternative dating samples, and the archeological problem for which dates are necessary. For example, total imprecision may turn out to be high enough to negate the use of dates on *Rabdotus* for detailed site-formation studies, but it may be low enough to permit using such dates for archeological or chronostratigraphic problems for which maximum precision is not necessary.

7.4.3 Epimerization Dating

If the strength of the regression relationship is indicative of a general level of predictive accuracy, it is now possible to project A/I ratios from other contexts onto the radiocarbon scale. Because fire may have had an unknown effect on the A/I values, it is possible that the regression equation does not predict A/I values with very high accuracy. Because the possible impacts of age-anomaly variability and additional A/I errors are as yet unknown, it is not yet possible to specify the precision of a radiocarbon-equivalent projected from an A/I value. Nonetheless, the regression can be used as an initial approximation of an A/I scale that has been calibrated to the radiocarbon scale. As such, A/I values can be used for rough estimates of radiocarbon age equivalence, and it is possible to show how A/I dating will work when the calibration has been rendered more accurate and sources of error are worked out.

Recall that the within-level A/I clusters from levels 11 and 21 at 41CV1200 yielded means of 0.04584 and 0.04143, respectively. By projecting these values from the y axis to the regression line, the RYBP equivalents of the ratios can be determined (Figure 7.6; calculating RYBP from the regression equation would be spuriously accurate.) The level 11 mean intercepts the regression line at approximately 1000 RYBP, and the level 21 mean intercepts the regression line at approximately 1275 RYBP. On the basis of regression alone, it would be premature at this point to assign a hard date to a level, to assign a level to one of Prewitt's (1981, 1985) phases, or to estimate the elapsed time between the levels. However, it would not be unreasonable to use the regression to claim that these levels were deposited in the Late Prehistoric at about 750 to 1500 RYBP, give or take a little. Although this claim is admittedly loose, it is a definite improvement over no date, and it is probably at least as reliable as what could be obtained from radiocarbon dates on soil organic matter. Clearly, it would be very convenient to have additional AMS-A/I pairs with which to test the strength of the regression and to increase its predictive accuracy and precision. Interestingly, radiocarbon dates from TP 2 provide partial corroboration of the age estimate from the regression. An AMS assay (BETA 70027, CAMS 11202) on charcoal from level 11 (100 to 110 cmbs) yielded a date of 1240 ± 60 B.P. A conventional radiocarbon assay (BETA 70565) on charcoal from a burned rock feature 155 to 180 cmbs yielded a date of 1260 ± 60 B.P. These dates correspond reasonably well with the date yielded by the regression, especially of the charcoal dates are affected by the old wood problem. These results imply that the regression can be used as a fairly accurate dating technique for at least the last 1,500 years, and as a supplementary dating technique in other cases.

7.5 CONCLUSIONS

The results reported in this chapter are preliminary, and the empirical conclusions discussed here should not be taken as either final or unassailable. However, the foregoing analyses do show that land snails have significant promise for archeology at Fort Hood. The 41CV1200 example shows that at the current state of development, the epimerization method can provide useful information for assessing the stratigraphic integrity of archeological deposits.

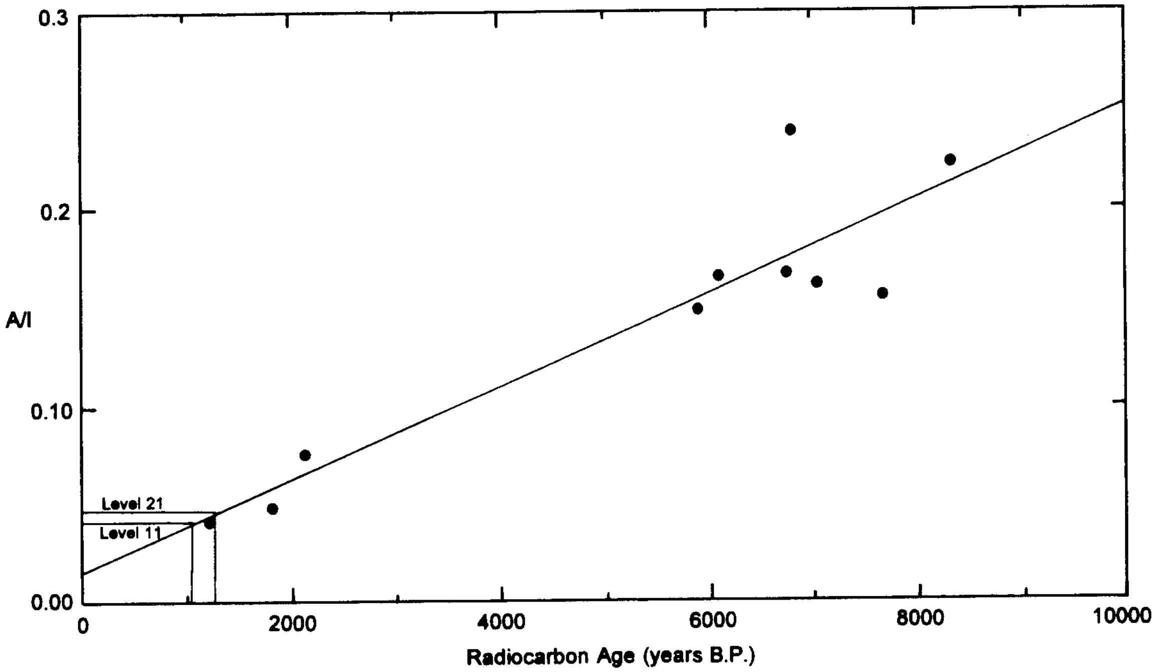


Figure 7.6 Radiocarbon Age of Levels 11 and 21 at 41CV1200. Projected from mean A/I ratio of within level clusters.

It also can be used to provide evidence of the correlation between spatially separated components at a given site. A/I ratios also can be used as a supplementary data set for interpreting the rate of depositional events. Given the strength of the RYBP-A/I regression, A/I ratios can be used as a source of supplementary, approximate chronometric data, even at this early stage of the basic-research process for Central Texas. On the other hand, it is premature to use the regression for assigning hard dates to archeological phenomena on the basis of A/I ratios. It also is premature to use radiocarbon assays on shells because age-anomaly variability is unknown.

However, given that the methods discussed in this chapter have been used productively in chronostratigraphic and paleoclimatic studies in other fields and other regions, there are good reasons for pursuing basic research for the Fort Hood and Central Texas area. A major reason for doing so is that the cost of epimerization analyses is much less than that of AMS dating, which is the only currently available alternative for any problems that require chronometric measurements from small objects. The epimerization analyses for 41CV1200 cost about $1,350. If equivalent numbers of appropriate charcoal samples had been available at 41CV1200, the site-formation analysis would have been impossible using conventional radiocarbon techniques, and would have cost $9,900 using AMS methods. Clearly, applying a conventional- or AMS-level budget to epimerization would yield an extremely dense data set within which a large number of proveniences could be assessed for integrity and relative age. Indeed, an AMS-level budget for epimerization could be cut in half and still produce a very large set of data with which to analyze site-formation processes.

Another major reason is that land snail shells often are the only abundant materials that can be dated at a site, especially when one needs duplicate dates to confirm aspects of site integrity. The ability to use either epimerization or radiocarbon dates from snails also opens up new possibilities for dating natural stratigraphy in cases where charcoal is not conveniently located, and for assigning paleoenvironmental data (e.g., carbon and oxygen isotopes) directly to a chronometric scale. We will return to this issue in Chapter 11.0 with programmatic recommendations for continuing epimerization research.

8.0 BURNED ROCK MOUND CHRONOMETRIC INVESTIGATIONS

J. Michael Quigg and G. Lain Ellis

The purpose of this investigation was to obtain baseline chronometric data from burned rock mounds, both domed and annular middens (Weir 1976:38, Fig. 7), at Fort Hood, Texas. Weir (1976:38) identified four categories of burned rock middens encompassing two fundamental types including the domed (Weir's Type 1) and the annular (Weir's Type 2 and 3) middens based on primary surface expressions. The annular middens are distinguished by some type of central depression or rock-free zone near the middle. To achieve this, limited field investigation at nine burned rock mounds recovered datable materials which subsequently yielded 53 radiocarbon assays. Radiocarbon assays on retrieved organic remains permit initial creation of an absolute chronological framework from which to evaluate Fort Hood mound features with respect to their NRHP eligibility, and facilitate development of an absolute chronology directly applicable to Fort Hood in Bell and Coryell counties. Creation of an absolute regional chronology for burned rock mounds was viewed as a significant step in the site evaluation process, and one of the principal goals established in the HPP for Fort Hood (Jackson 1992). Temporal control is also critical to a number of specific topics in the Fort Hood Research Design including, "cultural-chronology building in Central Texas," and "rethinking burned rock middens" under the theoretical perspective, plus contributes important data toward a number of topics in various research domains (Ellis et al. 1994).

Nine burned rock mounds from eight prehistoric sites at the fort were selected by Mariah staff and targeted for limited hand excavations and mechanical trenching. Data was field collected from March through May 1993. Mariah directed and monitored the mechanical trenching conducted by Fort Hood personnel, followed by Mariah's controlled manual excavations. Matrix from each manually-excavated test pit was collected and floated in the laboratory for maximum recovery of carbon and other organic remains. Multiple organic samples from each individual feature were available for dating.

The following sections include the statement of the problem (Section 8.1); the field investigations and site descriptions (Section 8.2); laboratory methods (Section 8.3); chronometric results (Section 8.4); interpretation and discussion (Section 8.5); and summary (Section 8.6).

8.1 STATEMENT OF THE PROBLEM

Chronology is one of the principal research domains for most archeological studies. An absolute chronological framework is necessary to understand the processual development of cultural systems within a given area. Moreover, a chronological framework is a prerequisite, a building block, for the successful discussion of numerous other research domains including paleoenvironmental reconstruction, changes in technological, and socio-economic adaptations, and so on.

However, there is more to establishing a good usable chronological framework than just obtaining numerous absolute assays. As Dean (1978:223-255) outlines in his general model and associated concepts, numerous influencing factors complicate this process. Factors such as; the physical-chemical and physiological processes that produce the properties that permit the dating of objects by various methods; the structure and relationships of the material products of human behavior (context); the environmental interactions, etc., all serve to make obtaining a useable chronology more arduous.

Over the past 12 to 14 years of archeological investigations at Fort Hood, Texas, most activities have focused on site inventory and site contextual evaluation. Minimal progress has been made toward developing a local absolute chronological framework. Lacking an absolute framework specific to Fort Hood, the obtained data and site evaluation assessments must be viewed within a broad, regional cultural framework for the whole of Central Texas (see Weir 1976; Prewitt 1981, 1985) and beyond.

Briefly, the prehistory of Central Texas as well as much of Texas as a whole, covers ca. 12,000 years. The earliest 3,000 years were marked by a general big game hunting tradition, the Paleoindian period, that lasted to ca. 9,500 years ago. Following that, an extended hunter-gather tradition persisted until ca. A.D. 1100, generally referred to as the Archaic period. Following A.D. 1100, bison hunting dominated throughout a broad region and this period is referred to by various terms such as the Neo-Archaic or Late Prehistoric. Bison dominated the prehistoric subsistence base until the arrival of white settlers in the mid-1800s.

In 1981, Prewitt (1981:65-89) published a synthesis of his perception of the Central Texas chronological sequence, which included Fort Hood. Prewitt (1985:201-238) subsequently published the results of 147 radiocarbon assays to support his 1981 proposed sequence. Johnson (1987) called into question Prewitt's entire temporal sequence for Central Texas because of numerous problems and discrepancies he perceived in the chronology.

In Prewitt's 1981 synthesis, he stated that burned rock features occurred during the Early Archaic (his Oakalla phase) and lasted throughout the Middle Archaic (San Marcos phase). However, most of the 147 radiocarbon assays presented by Prewitt in support of his Central Texas chronology, and thereby the proposed age of the burned rock features, were extracted from organic remains retrieved from rockshelters or deep stratified sites and not from burned rock middens. Most ages assigned to burned rock middens were extrapolated from recovered projectile points. Although over 200 burned rock middens had been excavated in Central Texas by 1990 (Howard 1991:45-69), as recently as 1991, Prewitt stated "the general age range of Central Texas burned rock middens is fairly well established to be middle Archaic, or roughly 5000 to 2250 B.P." however, "*the actual age range is yet to be established*" (Prewitt 1991:26). Recent excavations at burned rock middens along Mustang Branch, south of Buda, Texas (Collins, personal communication 1991), multiple middens at O. H. Ivie Reservoir (Treece, et al. 1993; Treece 1992), and in three counties further south in Central Texas (Goode 1991:71-93) have indicated some burned rock features are much younger than previously proposed by Prewitt (1981:76). As is often the case with many previous burned rock midden excavations, the latter work reported by Goode has not been substantiated by radiocarbon assays and relies on projectile point typology to establish the age of these features. The perception that burned rock middens in Central Texas have been dated is a misnomer, as most have been cross dated using the projectile point typology to postulate an approximate age. Even at sites containing numerous burned rock middens and numerous radiocarbon assays such as Panther Springs, only one of nine charcoal dates reported was actually from a midden context (Black and McGraw 1985:237-239); and at the Greenhaw site where at least nine middens were present, only Midden F was radiocarbon dated (Weir 1979:43). These are just a few examples of how little is known of the absolute chronology of these significant cultural features.

Large and small burned rock features occur in abundance at Fort Hood and throughout Central and West Texas and constitute a significant cultural feature utilized in the prehistoric lifeway (Weir 1976; Prewitt 1981, 1985; Black 1989:17-38; Hester 1991). Since features were readily visible across the landscape, and thus targets for vandalism and professional investigations, they have been an integral part of investigations and discussions concerning Central Texas prehistory.

There are a number of difficulties in applying Prewitt's Central Texas chronology to the burned rock features at Fort Hood. First, the applicability of this general Central Texas sequence to the sites at Fort Hood is unknown without an absolute chronometric assessment. Secondly, the validity of the proposed Middle Archaic ages of burned rock features has been seriously challenged since recently, radiocarbon ages obtained through excavations indicate a much more recent (i.e. Late Prehistoric) association of these features. Finally, the overall validity of the majority of Prewitt's temporal sequence has been questioned (Johnson 1987:1-26). As a result, Prewitt's often cited cultural sequence is of uncertain applicability to the cultural resources at Fort Hood and may not merit use for NRHP evaluation purposes without further investigation.

The burned rock features (mounds and middens) at Fort Hood provides an opportunity to focus attention on these features for the purpose of investigating their specific temporal context as well as contributing to the establishment of an absolute chronological framework for Fort Hood. This would enable one to compare and contrast Fort Hood with other parts of Central Texas and beyond. It was anticipated that these surface features had the potential for preserving organic remains necessary for absolute dating. In order to address the chronometric ages of selected burned rock mounds, charcoal was the primary target material to be utilized, while humates and other organic resources were to be used in pairs to evaluate the various materials from similar contexts. A pilot study of the use of *Rabdotus* snails was to evaluate the applicability of using these to obtain chronmetric results. In obtaining ages for individual features, their context and integrity would also be implicitly evaluated, thus contributing toward the determination of their potential eligibility for listing on the NRHP.

8.2 FIELD INVESTIGATIONS

The primary goal, retrieving organic remains (charcoal, humate, bone, seeds, etc.) within stratified context for radiocarbon dating, was achieved by limited hand excavation at individual mounds. Mechanically trenching each mound served as a cost-effective procedure to help evaluate the mound's content, context, and integrity. Funds were allocated for the investigation of nine mounds and the subsequent running of approximately 50 radiocarbon assays.

The selection of which organic materials were used in the dating process was ultimately a factor of the material types recovered from the various excavated features. In specific instances where multiple types of organic material, i.e. charcoal, seeds, bone, or humates were recovered, it appeared important to gain further understanding of the differences between various materials. It was also important to understand the true context of materials such as seeds and charcoal to one another. Therefore different organic materials from the same level were processed to investigate their apparent association. The identification of modern unburned seeds and their assays would also contribute to our understanding of the movement of fine materials in features.

Presented below are the processes used for the site/mound selection, and general mound documentation and field investigations. This is followed by results from specific site/mound investigations. The laboratory processing techniques and radiocarbon sample selections are also presented.

8.2.1 Site and Mound Selection

The initial task was to select a sample of burned rock mounds (Weir's domed and annular middens) most likely to contain organic remains in stratified contexts. Site/feature selection was accomplished using previous existing Fort Hood site records, supplemented by Mariah's site assessment documents accumulated from field investigation from January 1992 to April 1993. Approximately 107 prehistoric sites with reference to burned rock "mounds" or "middens" were reviewed to identify the most intact and best suited features. Approximately 24 sites containing burned rock features were subsequently identified for preliminary field inspection by Project

Archeologist Mike Quigg. Site selection criteria required the sampling of the two locally prominent geological upland settings (the Paluxy sand and the eastern and western parts of Fort Hood), and the sampling of geographically dispersed areas: the sample of mounds had to be from both sides of the base. Specific target features had to have a measurable height and width, contain intact areas, have open access for the backhoe, and exhibit limited vegetation on the feature so as not to impede or disrupt the trenching. Using these criteria, the initial 24 sites were field inspected and all but seven were eliminated for various reasons. At that time, Mariah's field crews were put on notice to identify more mounds that might qualify. Soon crews encountered suitable sites/features which were inspected and included in this investigation. Eventually, nine mounds (either a domed or annular midden) at eight sites were identified and selected for investigation: 41BL233, 41BL598, 41BL608, 41BL743, 41CV124, 41CV594, 41CV1027, and 41CV1195 (Figure 8.1). All selected sites were located in the maneuver training areas at Fort Hood.

8.2.2 Mound Documentation and Field Investigations

Once target features were selected, field investigation were initiated by the Project Archeologist and Project Geomorphologist. Each feature was initially photographed with black and white and color slide film and a general plan map was drawn. Next, a single 60-cm-wide backhoe trench was excavated across the approximate center of each burned rock mound to expose its horizontal and vertical extent, assess and document its internal structure and integrity, and to identify an optimal location for manual excavations. The location of the manual excavations were selected at the time of the trenching and marked on the ground for the excavation crews. The trench work was supervised by the Project Archeologist and Project Geomorphologist. The location of the mechanically dug trench was plotted on the feature plan map, the trench was profiled, and observed stratigraphic units were recorded by geomorphologist Jim Abbott in consultation with the Project Archeologist.

A two-person crew hand excavated at least one 1 m^2 TP adjacent to the mechanically-dug trench at each mound. A total of 12 TPs were excavated (11.5 m^2 total volume) into the nine mounds at the eight sites. Each TP was excavated in 10 cm arbitrary levels or into the limestone bedrock. Each hand-dug level was documented on a level record. The initial excavation methods proposed that the TP matrix be sieved through nested screens in the field with all fine sediments passing through the screens collected and retained for floating. The largest screen opening, approximately 1 cm (0.5 inch) mesh, was to catch the "coarse matrix" (i.e., the burned rocks). Burned rocks were to be sorted into four size categories, weighed, and counted by level. A burned rock sample of five to 10 rocks was to be collected per level and stored for possible subsequent analyses. The second screen size (8.25 mm; 0.25 inch mesh opening), was to collect the macro artifact assemblage including bone fragments, mussel shell, snails, lithics, groundstone, and ceramics for possible subsequent analysis. Projectile points and other temporally diagnostic artifacts were to be bagged separately for comparison with the radiometric assays. A bottom catch tray would collect the entire fine matrix fraction, including microbiotic and abiotic materials. This fine matrix was to be bagged, labelled, and returned to the laboratory for floating. It was this fine matrix which was postulated to contain the tiny organic remains necessary for dating.

The first few mounds investigated were wet or damp, which hampered the screening process and slowed the screening rate. After the initial three mounds at 41CV124, 41CV1027, and 41CV594 were screened in the manner described above, the process was deemed too slow and thereby altered to speed the screening rate without adversely altering the recovery.

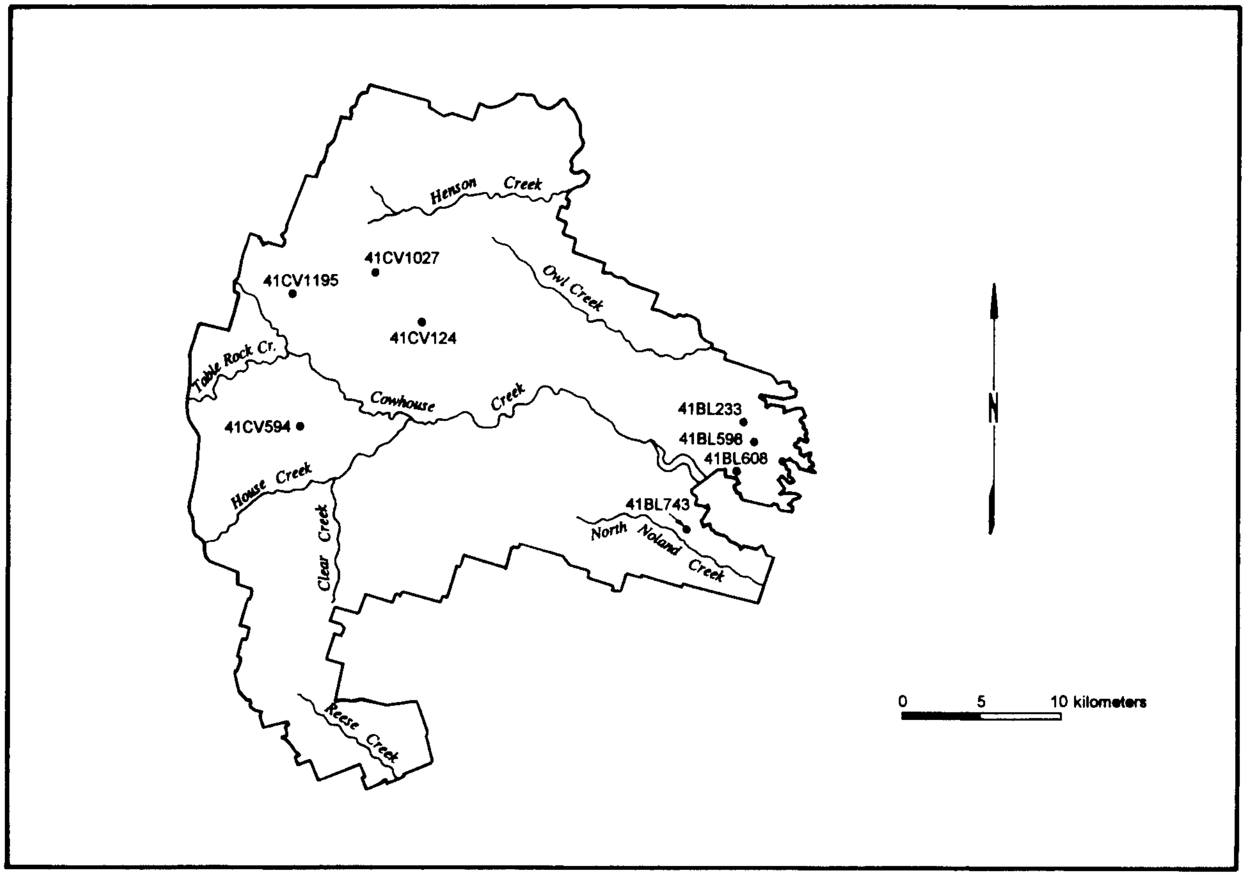


Figure 8.1 General Location of Nine Burned Rock Middens Investigated at Fort Hood in 1992.

One 50 cm quad of each TP was screened through the nested screens to obtain the necessary burned rock data. The rest of the unit matrix was bagged without screening and brought to the laboratory for floating. Burned rock samples were still collected and the fine sediments were floated.

8.2.3 Site Investigations

The eight prehistoric sites, containing the nine investigated burned rock mounds, are briefly described. Each investigated feature is described followed by the specific investigation details. Mound observations, stratigraphy and cultural materials recovered are also presented.

8.2.3.1 Site 41BL233

This large prehistoric open camp with intact features and associated rockshelters lies in training area 6, in East Range (Figure 8.1). This site is situated around the head of a canyon which has incised into the high Manning surface by a tributary of Bull Branch. Site 41BL233 was subdivided into three management subareas, A, B, and C, on the basis of topography and context. Artifacts noted included bifaces, scrapers, point fragments, mussel shell, cores, flakes, and limited quantities of burned rock. The projectile point list is composed of three untyped darts, two untyped arrow points, one Uvalde, three Ensors, two Bulverdes, two Plainviews, one Frio, and three Perdiz indicating Paleoindian through Late Prehistoric site use. Features were originally designated burned rock mounds A through E. The Belton Lake-Gatesville Water Pipeline is installed through the southwest edge.

Subarea A includes areas of upland, backslope, and coarse colluvial toeslope. The upland is mantled with a thin, discontinuous, very dark reddish brown clay soil containing abundant pebbles and cobbles of angular limestone. Large patches of bare limestone are exposed. Vegetation consists of dense juniper/scrub oak forest. A relatively thick mat of leaf litter obscures much of the upland surface. The backslope and colluvial toeslope also are covered with dense juniper and oak and are mantled with a discontinuous lag of coarse colluvium and interstitial dark clay loam. Thick beds of hard Edwards Group limestone crop out on the slope, rendering much of it bare of any sediment cover. A rockshelter (shelter B) and several shallow overhangs which lacked deposits, are considered part of Subarea A. A moderate density of cultural material was observed on the exposed surfaces in Subarea A.

Subarea B designates one rockshelter (shelter A), another small overhang (shelter C), and associated colluvial slopes that possess deposits and cultural material. Shelter A measures approximately 10 m wide by 8 m deep, and is situated on the south side of the valley. Average height of the overhang at the dripline is 1.25 m. Inside the shelter, fine-grained, gray, stony loam containing abundant roof spall appears to be less than 20 cm deep. Deposits on the talus slope in front of the shelter may be considerably thicker. Shelter C is a shallow, 1-m-deep overhang with a well-developed talus slope littered with artifacts. Talus slope matrix is very stony, black clay loam that may exceed 1 m in thickness. Deposition is apparent on the ledge with flakes, burned rock, and bifaces observed on the surface and along the talus slope.

Subarea C includes five relatively large, intact, burned rock mounds across the Manning surface. This surface is bisected north-south by an unnamed drainage. One tributary and three springs are located south of the drainage and empty into the drainage.

Feature 1 (previously designated burned rock mound A) lies at the edge of a clearing 75 m east of the tributary and ca. 100 m south of the drainage, near the southeastern corner of the site. It is approximately 6 by 8 m, and ranges from 75 cm high on the northwestern edge to 20 cm high on the southeastern edge. Feature 1 appears undisturbed, with flakes in association, and was selected for investigation.

Features 2, 3, and 4 are clustered together in the southwestern corner near an active spring. Feature 2 (previously designated burned rock mound B) is situated at the edge of a clearing and is roughly 30 m east of F 3. Feature 2 measures 10 by 8 m and ranges in height from 100 cm (southwest edge) to 30 cm (northeast edge). It appears undisturbed, however, no associated artifacts were observed.

Feature 3 (previously designated burned rock mound C) is located in dense vegetation approximately 30 m west of F 2 and several meters east of the spring head. It measures roughly 6 by 5 m, and is 75 cm high on the eastern edge and 25 cm high on the western edge. It does not appear vandalized.

Feature 4 (previously designated burned rock mound D) is located in dense vegetation several meters north-northeast of F 3. Its dimensions are 6 by 3.5 m and ranges from 50 cm high on the northern edge to 20 cm high on the southern edge. Feature 4 has been minimally disturbed by vandalism. No artifacts were found in association. Trees are now growing in Fs 3 and 4, suggesting that one major potential source of disturbance is from roots.

Feature 5 (previously designated burned rock mound E) is 170 to 180 m north of Fs 3 and 4. It is located at the edge of a clearing in the northwest corner of the site, and is the only mound north (ca. 90 m) of the drainage. The dimensions are 7 by 7.5 m, with heights ranging from 75 cm on the southern edge to 15 cm on the northern edge. It exhibits minimal disturbance, although there is a small, shallow, circular depression near the center. Flakes were found in association. Limestone bedrock is present on the surrounding surface to the south and west of the mound. Feature 5 was also selected for investigation.

Feature 1

Feature 1 was mechanically trenched along a general south to north line (Figure 8.2). The burned rock distribution observed on the surface appears to have been broader than the actual subsurface extent of F 1. The 6 m long west wall was profiled and exhibited a low, shallow burned rock mound with a very dark brown (10YR 2/1) clay loam grading downward to a brown (7.5YR 2/1) clay loam containing burned and unburned rocks (Figure 8.2). This burned rock and mixed matrix zone overlies a disintegrating limestone bedrock with large slabs 15 cm thick and up to 50 cm in diameter with very dark brown (7.5YR 2/1) clay loam. Toward the southern margin, three large slabs were slightly more vertically oriented (22°, 29°, and 50°) than the surrounding burned rocks.

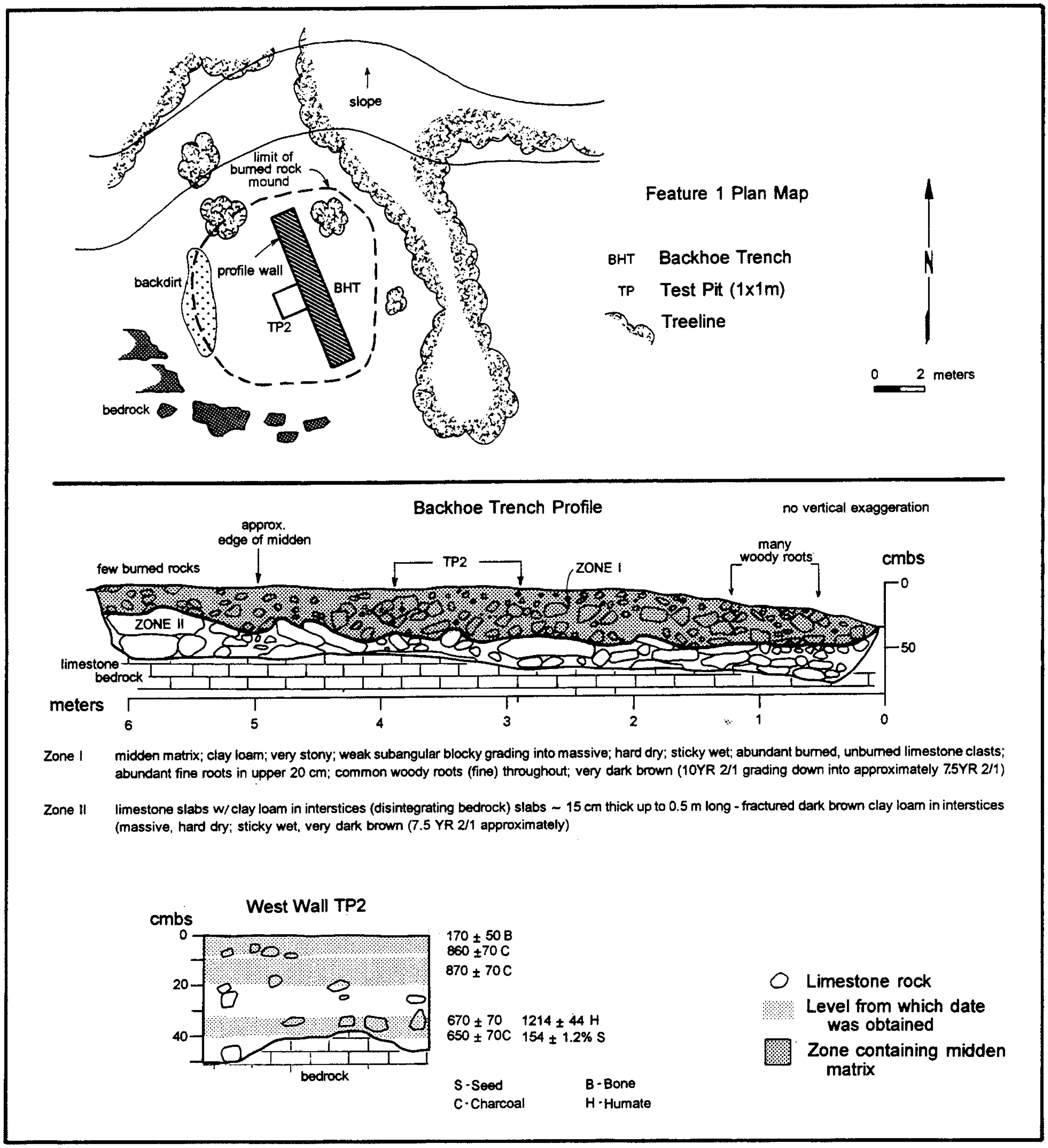
Test pit 2 was positioned on the western side of the trench, near mound center, to investigate the observed vertical burned rocks. The surface of TP 2 appeared undisturbed prior to excavation. Charcoal chunks and a long bone fragment were observed between 10 and 20 cmbs. Numerous large slabs (ca. 10) with small burned rocks in between were detected between 25 and 30 cmbs, but no specific pattern could be discerned. More large slabs were apparent between 30 to 40 cmbs which were in somewhat of an arc pattern across the unit, but no pit or other structure could be defined. Matrix in the latter two levels was unchanged. Large limestone bedrock slabs laid immediately underneath these burned and unburned slabs. Contact between the burned rock and the bedrock was ill defined. The excavation was conducted to 50 cmbs surrounding the bedrock limestone slabs.

The heavy fraction of the floated matrix from all five levels in TP 2 yielded approximately 11.8 g of charcoal with the frequency significantly increasing in the lower three levels (30-50 cm) (Table 8.1). Bone fragments, *Rabdotus* snails, stone tools, three types of seeds, and chert debitage were also recovered (Table 8.1). A proximal half of a Uvalde dart point came from 20 to 30 cmbs (Figure 8.3).

Single pieces of charcoal were selected for AMS dating from depths of 20 to 30 cm and 30 to 40 cm, and two pieces from 40 to 50 cm; single bone fragments from 10 to 20 cm and 40 to 50 cm; and three uncharred seeds submitted from 40 to 50 cm. The matrix from the 40 to 50 cm level remaining in the bottom of the float barrel was also selected for humate dating. The age assessment of F 1 is based on seven radiocarbon ages (4 charcoal, 1 bone, 1 unburned seed sample, and 1 humate sample).

Feature 5

A 9-m-long backhoe trench was excavated (270° from north) across the middle of this low, burned rock feature, but trees on the margins prevented the total width of the mound from being trenched (Figure 8.4). The trench profile revealed a low burned rock mound about 40 cm thick extending at least 9 m across (Figure 8.4). Dense burned rock lay within a very dark brown (10YR 3/2) to black (10YR 2/1) stony clay loam. Near the feature's center, slabs up to 35 cm in diameter, were partially angled between 15 to 25°. This zone overlies a very dark grayish brown (10YR 3/2) to very dark brown (10YR 2/0) stony clay loam with abundant, large limestone cobbles and slabs. This overlies a hard limestone substrate.



Zone I midden matrix; clay loam; very stony; weak subangular blocky grading into massive; hard dry; sticky wet; abundant burned, unburned limestone clasts; abundant fine roots in upper 20 cm; common woody roots (fine) throughout; very dark brown (10YR 2/1 grading down into approximately 7.5YR 2/1)

Zone II limestone slabs w/ clay loam in interstices (disintegrating bedrock) slabs ~ 15 cm thick up to 0.5 m long - fractured dark brown clay loam in interstices (massive, hard dry; sticky wet, very dark brown (7.5 YR 2/1 approximately)

Figure 8.2 Feature 1, 41BL233, Showing Planview with Backhoe Trench and Test Pit, Profile of Backhoe Trench and Test Pit Profile with Radiometric Assays by Level.

Table 8.1 Material Types and Quantities Recovered from Heavy Fractions at Feature 1, 41BL233.

Provenience	Charcoal (g)	Flakes (N)	Tools	Mussel (N)	*Rabdotus* (N)	Bone (N)	Seeds (N)
TP:2, L:1	0.4	327	-	16	1	7	A - 8 B - 300+ C - 18 D - 3
TP:2, L:2	1.0	334	-	10	12	10	A - 0 B - 200+ C - 4 D - 2
TP:2, L:3	2.7	191	1[F]	30	15	7	A - 1 B - 100+ C - 1
TP:2, L:4	4.1	307	-	50	13	22	A - 1 B - 40+ C - 2
TP:2, L:5	3.6	213	-	6	10	5	A - 1 B - 698 C - 31
Totals	11.8[5]	1372	1	112	51	51	A = 10 B = 698+ C = 31 744
Percentages		58.9	0.04	4.9	2.2	2.2	31.7

A = Bluebonnet
B = *Brassica* sp. Seeds
C = Ashei Juniper Seeds
D = Unknown
E = Charcoal not included in totals
F = Base of Uvalde Dart Point (41)

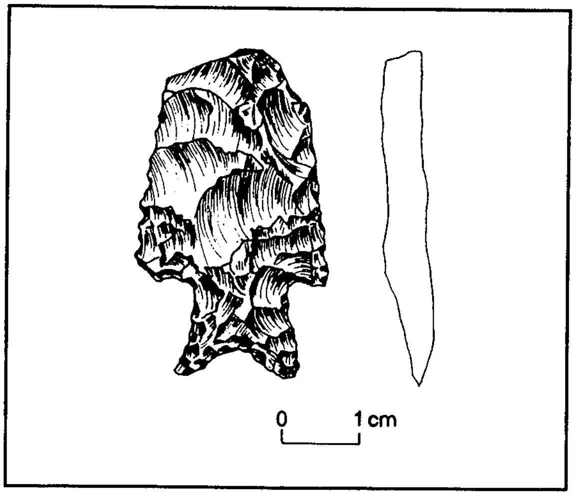
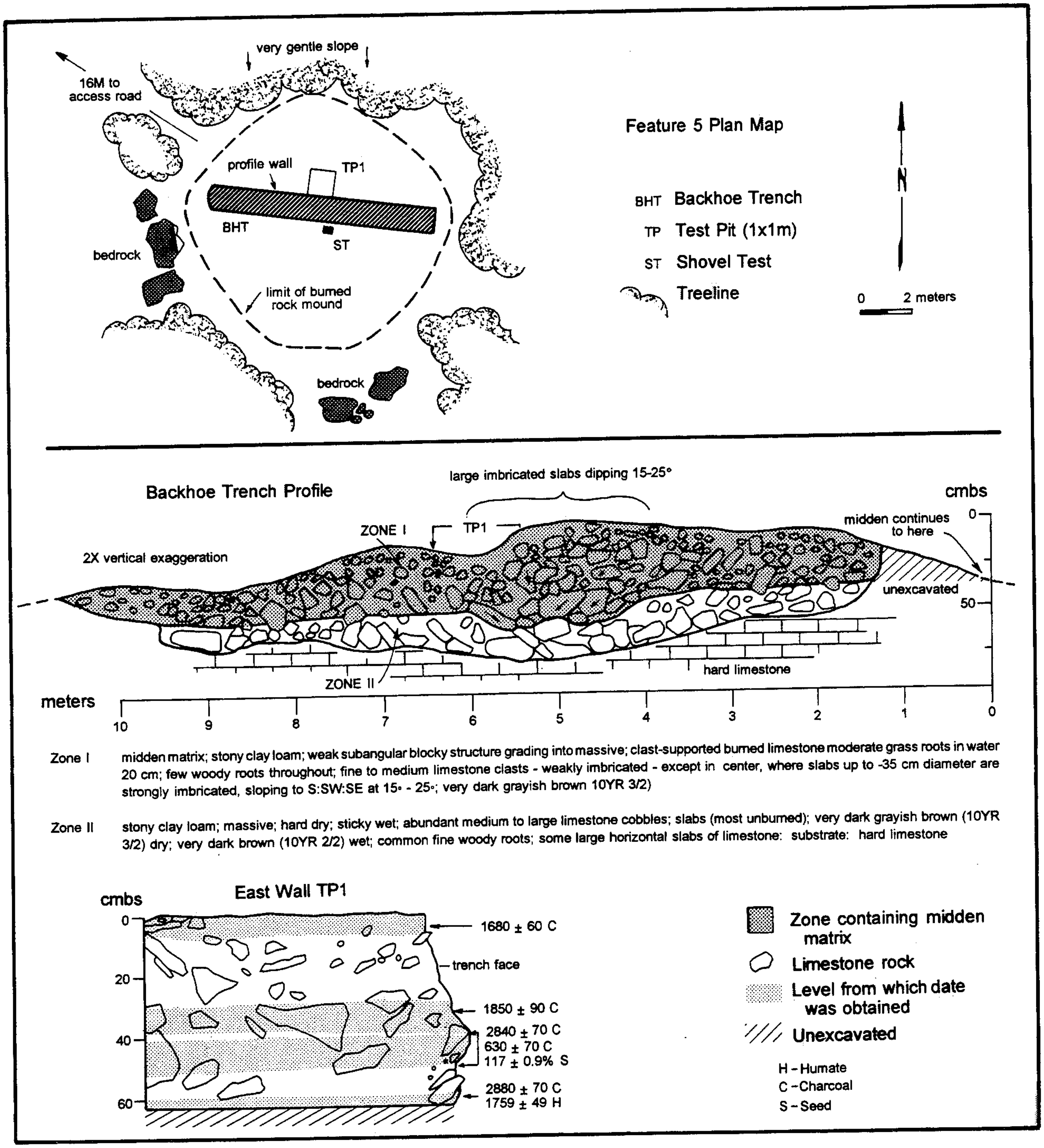


Figure 8.3 Ulvalde Point from Feature 1, 41BL233.



Zone I	midden matrix; stony clay loam; weak subangular blocky structure grading into massive; clast-supported burned limestone moderate grass roots in water 20 cm; few woody roots throughout; fine to medium limestone clasts - weakly imbricated - except in center, where slabs up to -35 cm diameter are strongly imbricated, sloping to S:SW:SE at 15° - 25°; very dark grayish brown 10YR 3/2)
Zone II	stony clay loam; massive; hard dry; sticky wet; abundant medium to large limestone cobbles; slabs (most unburned); very dark grayish brown (10YR 3/2) dry; very dark brown (10YR 2/2) wet; common fine woody roots; some large horizontal slabs of limestone: substrate: hard limestone

Figure 8.4 Feature 5, 41BL233, Showing Planview with Backhoe Trench and Test Pit Location, Profile of Backhoe Trench and Test Pit with Radiometric Assays by Levels.

Test pit 1 (1 x 1 m) was excavated on the northern side of the trench, near the feature's center and over the edge of the observed slanted slabs (Figure 8.4). Starting about 25 cmbs and continuing to nearly 40 cmbs, the southern side of this unit revealed slanted slabs (ca. 9; > 15 cm in diameter) sloping down to the southwest. Slab bases varied from 25 to 36 cmbs; they appeared to represent the structure of an internal feature. Level 5 (40 to 50 cm) was definitely below the majority of burned rocks and had a much higher percentage of matrix to limestone. At 50 to 60 cm, large, flat slabs dominated the unit with limited matrix between the limestone. The lowest level (60 to 70 cmbs) was excavated through fractured bedrock, dark brown clay loam, and the occasional burned rock.

The heavy fraction of the floated matrix yielded 5.6 g of charcoal from the 0 to 70 cmbs sample, with the highest frequency between 40 to 50 cmbs (Table 8.2). A gray chert dart point base came from 38 to 50 cmbs (Figure 8.5). It has a broad, expanding base, with a slightly convex, and lightly ground basal edge. It likely represents a corner notched dart point similar to a Marcos or Lang variety (Turner and Hester 1985:113 and 117). Bone fragments, mussel shell fragments, and *Rabdotus* snails were relatively sparse compared to the plentiful seeds and numerous chert flakes (Table 8.2). The tools, debitage, and *Rabdotus* were most frequent in the same level as the charcoal (40 to 50 cmbs). Although level 7 (60 to 70 cmbs) was mostly represented by unburned limestone, it yielded small quantities of charcoal, debitage, *Rabdotus* and seeds. The latter included three modern *Brassica* sp. seeds.

For radiocarbon assays, a single piece of charcoal was selected from 10 to 20 cmbs, 30 to 40 cmbs, two individual pieces from 40 to 50 cmbs, and one from 60 to 70 cmbs. Unburned *Brassica* sp. seeds were selected from 40 to 50 cmbs for AMS dating while the 60 to 70 cm matrix residue from the bottom of the flotation barrel was used for a humate assay. A total of seven radiocarbon samples (five charcoal, one unburned seed, and one humate) provide the age assessment for F 5. The three samples from 40 to 50 cmbs provide an age estimate for the dart point recovered from that location. The matrix and charcoal from the bottom served as a comparison between two materials and provided the initial age for this mound.

8.2.3.2 Site 41BL598

This large (450 m^2) prehistoric lithic resource procurement area is in training area 5 in the East Range (Figure 8.1). It consists of the dendritic head of a deeply-incised canyon on the margin of the high Manning surface and the gently sloping upland surface surrounding the canyon. Three small streams enter the site from the northeast, east, and southeast, with incisional nickpoints up to 10 m high at the margin of the canyon, which join to flow out of the canyon to the west. The deep canyon is vertically incised into a broader, bowl-shaped notch on the margin of the upland.

A burned rock mound (F 1), four rockshelters, and an extensive lithic scatter are present. A moderate artifact density consists of lithic debitage, points, scrapers, and bifaces. Several dart points represent the Early/Middle through Transitional Archaic time periods, while three arrow points represent the Neo-Archaic/Late Prehistoric. Mussel shell and bone was observed within the rockshelters. The site was estimated to be 12 percent disturbed through erosion, vandalism, and a road.

Site 41BL598 was divided into five distinct management subareas designated A through E based on geomorphic context and potential for intact cultural deposits. Subarea A consists of the gently-to-moderately sloping upland backslope and a relatively level midslope bench that surrounds the vertical scarp of the incised canyon. Subarea B consists of the steep colluvial slopes below the vertical bedrock scarp and the channel of the drainage (no significant alluvial deposits were within the steep slope canyon).

Table 8.2 Material Types and Quantities Recovered from Heavy Fractions at Feature 5, 41BL233.

Provenience	Charcoal (g)	Flakes	Tools	Mussel	*Rabdotus*	Bone	Seeds
TP:1, L:1	0.1	148	-	13	0	1	A - 59 B - 600+1- C - 35
TP:1, L:1 SW Quad	<0.1	89	-	4	6	-	A - 33 B - 225+1- C - 58 D - 5
TP:1, L:2	0.1	187	-	2	10	-	A - 8 B - 82 C - 2
TP:1, L:2 SW Quad	0.1	57	-	8	6	1	A - 7 B - 29 C - 1
TP:1, L:2	0.1	198	-	12	15	-	A - 3 B - 23 C - 0 D - 1
TP:1, L:3	0.7	78	-	22	5	1	A - 2 B - 14 C - 2
TP:1, L:4	0.5	163	-	100	8	2	A - 2 B - 18 C - 0
TP:1, L:4 SW Quad	0.3	78	-	-	3	-	A - 0 B - 5 C - 0
TP:1, L:5	1.6	232^{E}	1^{E}	12	25	1	A - 0 B - 6 C - 0
TP:1, L:5 SW Quad	0.5	175	-	5	8	-	A - 1 B - 6 C - 0
TP:1, L:6	0.6	125	-	-	2	2	A - 0 B - 5 C - 0
TP:1, L:6 SW Quad	0.5	57	-	20	5	0	A - 0 B - 1 C - 0 HB - 1
TP:1, L:7	0.2	50	-	-	3	-	A - 0 B - 1 C - 0
TP:1, L:7 SW Quad	0.2	66	-	-	8	-	A - 1 B - 3 C - 0
							A = 116 B = 3297 C = 98
Totals	5.6^{F}	1703	1	198	104	8	3517
Percentages		30.8	0.02	3.6	1.9	0.2	63.5

A = Bluebonnet Seeds
B = *Brassica* sp. Seeds
C = Ashei Juniper Seeds
D = Unknown
E = Unidentifiable Dart Point Base
F = Charcoal not included in totals
HB = Hackberry Seeds

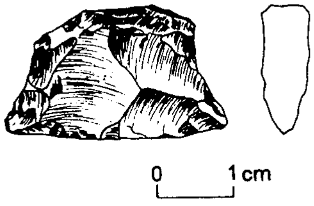


Figure 8.5 Dart Point Base Feature 5, 41BL233.

Subareas C and D consist of two distinct, spatially separate portions of the site, and each contain two rockshelters (shelters A, C, and B, D, respectively). Subarea C has minimal integrity, and Subarea D has substantial deposits. Two additional overhangs/rockshelters are also present along the vertical scarp, but lack deposits, and thus were not assigned to separate subareas. Subarea E is defined as a large burned rock mound situated on the midslope bench.

Subarea A is vegetated with a juniper/oak forest mottled with many grassy clearings and mantled with a thin, discontinuous soil consisting of dark grayish brown to reddish brown stony clay loam (A-R profile). The soil is primarily developed in slopewash deposits and ranges from 0 to approximately 15 cm thick. The thickest profiles in Subarea A are typically at the rear of the bench, where the rate of colluvial accumulation from the backslope is highest, while the backslope and rim surrounding the canyon frequently lack soil except in shallow depressions in the bedrock. A moderate density of debitage and scattered burned rock was observed above Rockshelter A (Subarea C) at the southwestern portion of the site. The burned rock mound of Subarea E is located on this upland surface. An occasional flake, biface, or core was observed on the remainder of the subarea.

Subarea B subsumes the deposits in the canyon, and is separated from the upland by a vertical bedrock scarp 4 to 8 m high. Below the scarp, a colluvial/talus slope dips steeply to the channel of the unnamed tributary. The entire canyon is densely vegetated with a closed, mixed hardwood forest. Deposits on the colluvial walls of the canyon consist primarily of mixed clast and matrix-supported limestone with black clay loam in the interstices. The channel lag is composed of large limestone cobbles and boulders. Very little fine-grained alluvium was observed in the canyon. A low density of debitage was observed, which was probably derived from erosion of the uplands (Subarea A). The slope of the colluvial walls varies from approximately 20 percent to 40 percent, resulting in little potential for preservation of in situ archeological materials.

Subarea C includes two rockshelters that lie below the vertical scarp in the canyon. Shelter A measures approximately 22 m long by 5 m deep, and has a roof roughly 1.5 m high. Shelter C measures roughly 16 x 6 m, and has a roof approximately 4 m high with a steeply dipping floor. Although a coarse limestone lag is preserved, both shelters lack significant fine-grained deposits, suggesting each has been flushed by discharge from seeps in the rear of the shelters, lateral sheet flow along the base of the scarp, or both. A few flakes, which probably have eroded from the uplands, were observed within shelters A and C.

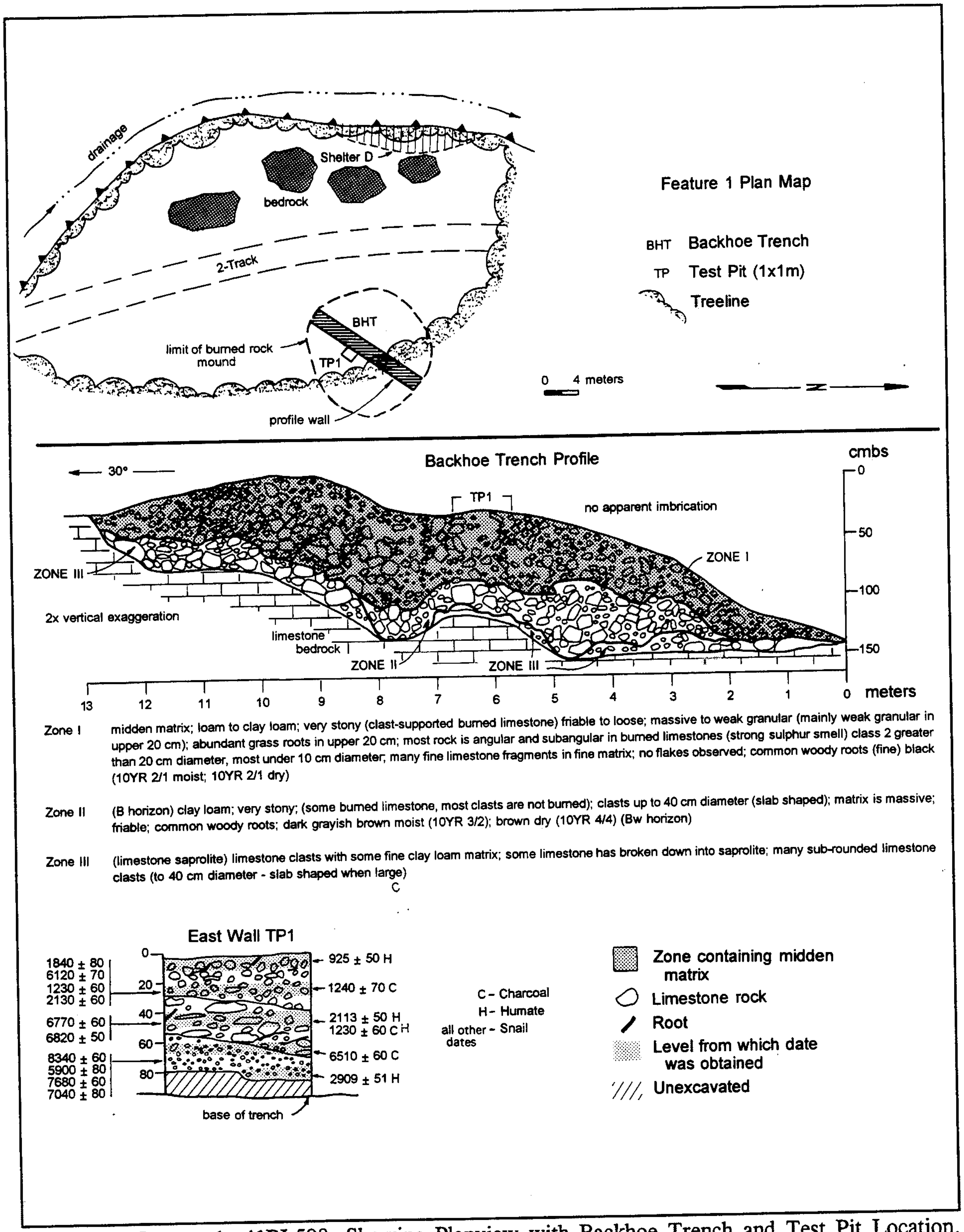
Subarea D also includes two shelters (B and D). Shelter B measures roughly 22 x 8 m, and has a roof roughly 3 m high. The back wall is largely mantled with tufa, and a large tufa formation is present at the southwestern end of the shelter near a metal pipe inserted to capture discharge from the seep. Sediment in shelter B is a dark brown stony clay loam and lacks obvious stratification. Maximum depth is approximately 30 cm. A few burned rocks, flakes, mussel shell fragments, and charcoal from military campfires were observed within Rockshelter B. A Castroville dart point was collected from the talus slope during reconnaissance. This shelter has been moderately to highly disturbed by erosion and camping. One 50 x 50 cm test quad was excavated just inside the dripline and dug to bedrock at 28 cmbs. Recovered materials from this quad included numerous flakes and a burned bone fragment. The quad profile showed that deposit increase in depth toward the talus, with little deposition remaining within the shelter. Shelter D measures roughly 36 x 6 m with a roof roughly 3 m high. The sediment infilling this shelter is similar in thickness and character to that in shelter B. However, some alluvial deposition (and potential flushing) is apparent at the eastern end. A moderate density of debitage, mussel shell fragments, charcoal, and bone fragments (some human skeletal remains) was observed within Rockshelter D. This shelter has been moderately disturbed by vandalism and erosion.

Subarea E consists of a 13 m diameter by 1.5 m high angular burned rock mound on the base of the toeslope (Figure 8.6). A 2.5 to 3 m diameter by 35-to 55-cm-deep depression is present near the center of this well-defined mound. Sparse chert flakes were observed on the mound surface, with a moderate density of chert debitage found adjacent to, and downslope (east) of, the feature. Short grasses and flowers covered the lower half with juniper trees and bushes over the western, upslope, half. An untyped dart was collected 12 m west of the mound during reconnaissance.

One 13-m-long, mechanically-excavated trench was placed through the center of this mound, bisecting the central depression (Figures 8.7 and 8.8). The trench was oriented roughly northeast-southwest and was excavated to approximately 125 cmbs, which was slightly into bedrock. The trench profile revealed a massive, ca. 50-cm-thick black (10YR 2/1), loam to clay loam A horizon with dense, angular, burned rock up to 20 cm in diameter. Most burned rocks were under 10 cm in diameter. This burned rock zone overlies an irregular, 25-cm-thick B horizon with dark grayish brown (10YR 3/2) to brown (10YR 4/4) clay loam containing numerous limestone slabs up to 40 cm in length. The base of the trench exhibits a soft limestone saprolite with limestone slabs up to 40 cm diameter with some fine clay loam between. Discerning burned rock from unmodified bedrock was often difficult. The central depression, observed on the surface, was directly above a depression detected in the limestone bedrock but the latter was a soft part of the formation. It is unclear if this lower bedrock depression was culturally created or naturally caused and if the surface depression was in response to the lower depression, or culturally created. No imbrication was observed in the profile.

Adjacent to the trench's southeastern edge and on the margin of the central depression, TP1 was manually excavated to a depth of 92 cmbs. In general, burned rocks were abundant within the matrix while lithic debitage was scarce. Between 20 and 30 cmbs, a fine gravel lens appears in the northwest corner along with a large (25 cm diameter) slab in the northeast corner. Burned rocks appear to increase in size with depth, from 10 to 50 cmbs. A noticeably lighter colored soil exists over most of the southern half of level 5. Below this depth the burned rock becomes less frequent, with large possibly unburned slabs dominating. By 70 to 80 cm deep, more rounded gravels in a uniform brown matrix are present; this stratum may represent the natural colluvial matrix. No evidence of recent disturbance was noted; the feature appears intact except for obvious material displacement from roots.

Heavy fraction from the unit flotation yielded roughly 1.6 g of tiny charcoal flecks (Table 8.3). Individual charcoal pieces from 10 to 20, 40 to 50, and 80 to 90 cmbs were sent for AMS dating. In addition, matrix samples from 10 to 20, 40 to 50, and 80 to 90 cmbs were sent for humate dating.



Zone I	midden matrix; loam to clay loam; very stony (clast-supported burned limestone) friable to loose; massive to weak granular (mainly weak granular in upper 20 cm); abundant grass roots in upper 20 cm; most rock is angular and subangular in burned limestones (strong sulphur smell) class 2 greater than 20 cm diameter, most under 10 cm diameter; many fine limestone fragments in fine matrix; no flakes observed; common woody roots (fine) black (10YR 2/1 moist; 10YR 2/1 dry)
Zone II	(B horizon) clay loam; very stony; (some burned limestone, most clasts are not burned); clasts up to 40 cm diameter (slab shaped); matrix is massive; friable; common woody roots; dark grayish brown moist (10YR 3/2); brown dry (10YR 4/4) (Bw horizon)
Zone III	(limestone saprolite) limestone clasts with some fine clay loam matrix; some limestone has broken down into saprolite; many sub-rounded limestone clasts (to 40 cm diameter - slab shaped when large)

C

Figure 8.6 Feature 1, 41BL598, Showing Planview with Backhoe Trench and Test Pit Location, Profile of Backhoe Trench and Test Pit Profile with Radiometric Assays by Level.

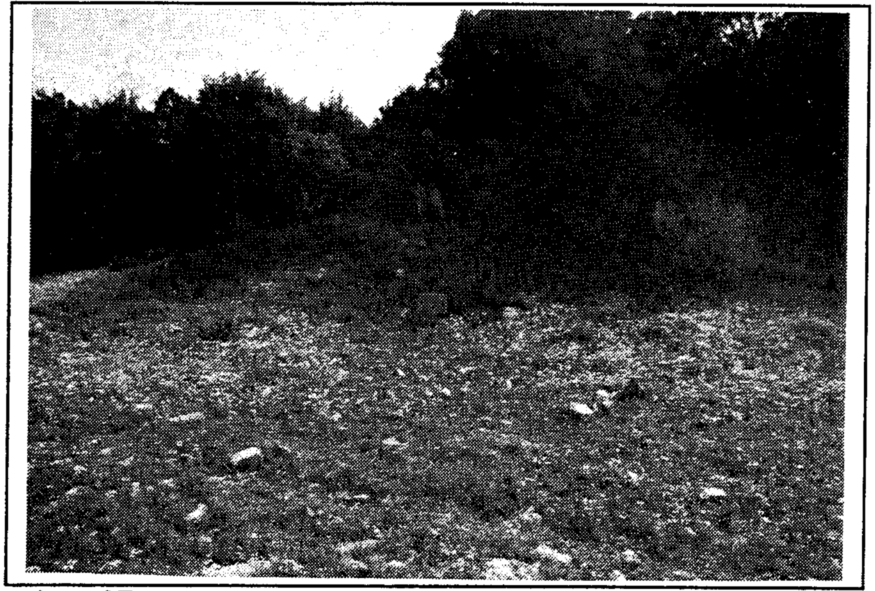


Figure 8.7 Overview of Feature 1, 41BL598, View to Northwest Prior to Excavation in 1992, Individual is Standing on a Backhoe Trench Location.

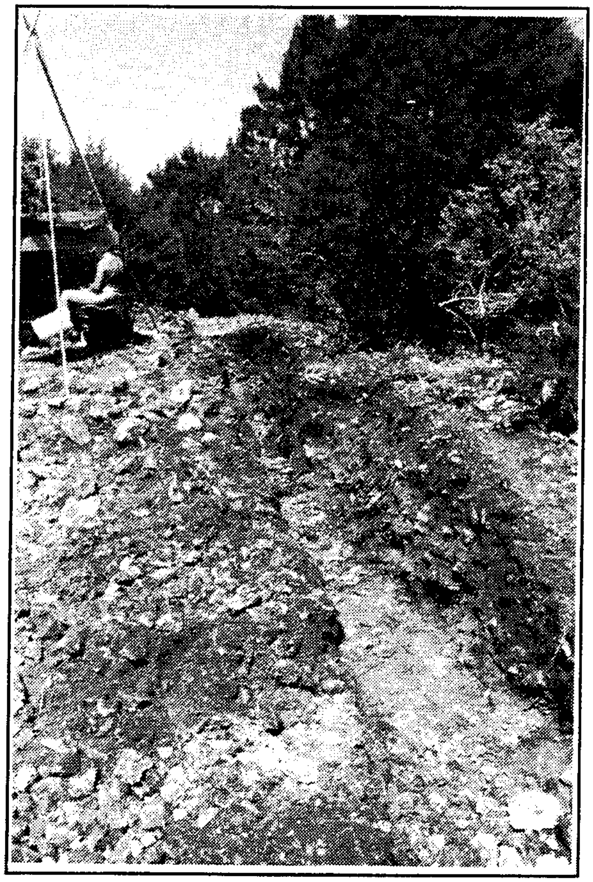


Figure 8.8 Feature 1, 41BL598, Showing Mound Matrix in Backhoe Trench.

Table 8.3 Material Types and Quantities Recovered from Heavy Fractions at Feature 1, 41BL598.

Provenience	P #	Charcoal (g)	Flakes	Tools	Mussel	*Rabdotus*	Bone	Seeds
TP:1, L:1	6	0	93	-	8	0	-	A - 81 B - 40 C - 6 Acorn - 1
TP:1, L:2	7	<0.1	459	1 Biface	12	4	4	A - 160 B - 230+ C - 13 HB - 3
TP:1, L:2 SW Quad	8	<0.1	100	-	4	-	1	A - 32 B - 132 C - 3 HB - 3
TP:1, L:3	9	<0.1	154	-	12	7	-	A - 60 B - 83 C - 2 HB - 2
TP:1, L:3 SW Quad	10	<0.1	70	-	2	-	-	A - 9 B - 95 C - 1 HB - 6
TP:1, L:4	11	0.1	220	-	18	8	3	A - 88 B - 280 C - 2 HB - 13
TP:1, L:4 SW Quad	12	0	45	-	3	-	-	A - 348 B - 7 C - 0 HB - 4
TP:1, L:5	13	0.1	195	-	30	15	1	A - 27 B - 125 C - 1 HB - 37
TP:1, L:5 SW Quad	14	<0.1	61	-	2	-	-	A - 1 B - 11 C - 0 HB - 12
TP:1, L:6	15	<0.1	185	-	135	15+	1	A - 2 B - 15 C - 1 HB - 34
TP:1, L:6 SW Quad	16	<0.1	78	-	1	-	3	B - 5 HB - 11
TP:1, L:7	17	0.1	173	-	26	12	2	B -13 C - 1 HB - 27
TP:1, L7 SW Quad	18	<0.1	65	-	7	-	-	HB - 15

Provenience	P #	Charcoal (g)	Flakes	Tools	Mussel	*Rabdotus*	Bone	Seeds
TP:1, L:8	19	<0.1	98	-	18	15+	7	B - 3 HB - 16
TP:1, L:8 SW Quad	20	<0.1	47	-	9	-	1	HB - 10
TP:1, L:9 SW Quad	21	<0.1	66	-	11	6	1	B - 8 HB - 2
TP:1, L:9 SW Quad	22	<0.1	31	-	8	-	-	B - 4
TP:1, L:10	23	0	11	-	-	3	-	B - 3 HB - 3
TP:1, L:10 SW Quad	24	<0.1	6	-	-	-	1	B - 8 HB - 1
TOTALS		<1.6/g^D	2157	1	306	85+	25	A - 463 B - 1062 C - 20 HB - 198
PERCENTAGES			50.0	0.02	7.1	2.0	0.6	40.4

A = Bluebonnet Seeds
C = Ashei Juniper Seeds
HB - Hackberry Seeds
B = *Brassica* sp. Seeds
D = Charcoal not included in totals

Beta Analytic Laboratory (Beta) encountered problems (see details in Section 8.3) with the original charcoal selected and therefore, three new samples from 20 to 30, 40 to 50, 60 to 70 cmbs were submitted. Six assays (three each charcoal humate) were obtained from this feature. Besides the charcoal, chert debitage, one biface fragment, mussel shell fragments, *Rabdotus* snail shells, bone scraps, and seeds were recovered from the heavy fractions (Table 8.3). Level 2 (10 to 20 cmbs) yielded the highest frequency of lithic debitage and seeds plus the one biface fragment. Although the lithic debris and seeds account for nearly 75 percent of the recovered materials, there were presence of other materials is considered important when discussing feature function and use. Sixty percent of the seeds were identified as a modern type introduced from the Old World (cf. *Brassica* sp.), their presence indicates the short time and the depths that fine materials and sediments moved down through the rock feature. A single modern acorn from 0 to 10 cmbs may reflect how some kinds of organic remains become associated with the burned rock debris.

8.2.3.3 Site 41BL608

This extremely large prehistoric lithic resource procurement area lies in training area 7 in East Range (Figure 8.1). It consists of a vast expanse of the high Manning surface north of Cowhouse Creek valley, overlooking Belton Lake. The western side is marked by two deeply incised tributary valleys, both containing a series of rockshelters and overhangs along the upland margin. An estimated 33 percent of the sites surface is disturbed by roads and historic habitation. Site 41BL608 was subdivided into two Subareas (A and B) on the basis of geomorphic context and archeological potential.

Subarea A consists of the broad upland surface which contains a burned rock mound (F 1). This upland is vegetated with a juniper/oak forest in the northern half, but has been largely cleared of trees across the southern half. Various soils mantle the surface. Across much of the site, particularly adjacent to the upland margin, the soil exhibits a thin, discontinuous stony clay loam (A-R profile) through which much bare bedrock is visible. Elsewhere, a thicker profile, developed primarily in allocthonous sheetwash sediments, exhibits A-R and A-Bw-R horizon sequences. The remainder of the upland is mantled with a relatively thin (generally <25 cm) residual soil consisting of an A-Bt-R or Bt-R profile developed in rubified stony clay loam. Two chert zones were recognized within this site. Chert Zone 1 covers the northern extremity and occurs as a dense-to-relatively patchy pavement of residual nodules in and on the ancient soil and resting on exposed bedrock. Chert Zone 2, which covers roughly the southern quarter, is separated from Chert Zone 1 by almost one kilometer expanse.

Besides the natural chert outcrops, cultural debitage, bifaces, scrapers, burned rock, and mussel shell were observed. One Gower, one Bulverde, two Frio, five untyped dart points, two Scallorn and one Perdiz arrow points, plus one biface and a drill were collected.

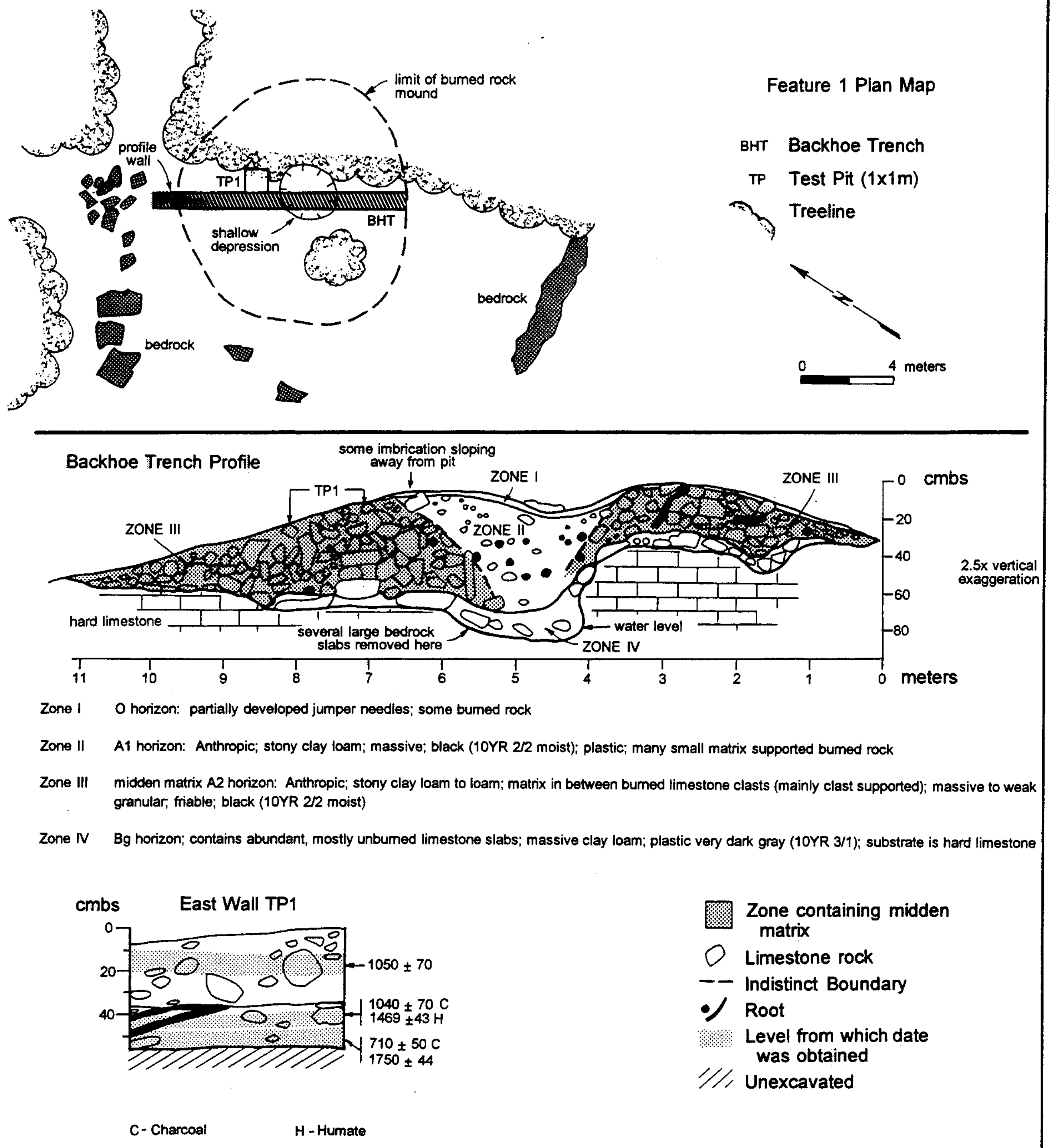
Subarea B consists of a rockshelter that appears to have significant preserved deposits. The other small overhangs and shallow shelters have steeply sloping floors or have been flushed by lateral sheetwash and/or groundwater discharge.

Feature 1 is a burned rock mound on the upland (Subarea A) near the head of the more southerly drainage. It measures 10 m in diameter by 40 to 60 cm in height, and reveals a 2.5 m diameter by 15 cm deep central depression. A few flakes were adjacent to this relatively undisturbed feature. The tree line is encroaching on the eastern half of the feature with a single tree on the western side. Large limestone bedrock slabs are present across the surface surrounding this mound.

A single, 11-m-long, mechanically-excavated trench was dug through the center of this feature, bisecting the central depression (Figure 8.9). The trench was oriented roughly 28° west of north and excavated 50 cm deep, until reaching bedrock. The trench profile revealed uneven limestone bedrock on which Feature 1 was constructed, plus a distinct central pit feature (Figure 8.9). Above the bedrock was a Bg horizon with abundant, mostly unburned limestone slabs in a very dark gray (10YR 3/1), massive clay loam. The lowest portion of this zone revealed several large limestone slabs removed from directly beneath the central depression. This lower zone in the bedrock was water saturated. Immediately on top of this zone was an A2 horizon with a black (10YR 2/2), stony clay loam which contained quantities of burned rock. The central pit area consisted of the A1 horizon with a black (10YR 2/2), stony clay loam. This area had significantly fewer and smaller burned rocks and more numerous roots than the area outside the pit. The contact between the pit and adjacent area was indistinct. This mound is covered in a very thin O horizon and partially decomposing juniper needles with occasional burned rock. No evidence of recent disturbance was recognized.

Adjacent to the northern edge of the trench and north of the central depression, a 1 m^2 TP was manually excavated to 57 cmbs. This TP was purposely placed to penetrate the thick, dense, burned rock, and not the central pit-like area, to obtain information on the rate of mound accumulations. Numerous lithic artifacts and an occasional *Rabdotus* were observed throughout the dense burned rock. Most of the burned rock consisted of pieces less than 10 cm in diameter. No charcoal or unusual rock orientations were observed while excavating the TP. Level 6 (48 to 57 cmbs) appeared to be below the cultural feature, as indicated by the lack of burned rocks and a much lighter brown sediment matrix.

The heavy fraction from the flotation of the TP matrix yielded nearly 2.0 g of charcoal flecks. Individual charcoal flecks were selected from 10 to 20, 40 to 50, and 50 to 60 cmbs for AMS dating in conjunction with matrix samples from 40 to 50 and 50 to 60 cmbs submitted for humate dating.



Zone I	O horizon: partially developed jumper needles; some burned rock
Zone II	A1 horizon: Anthropic; stony clay loam; massive; black (10YR 2/2 moist); plastic; many small matrix supported burned rock
Zone III	midden matrix A2 horizon: Anthropic; stony clay loam to loam; matrix in between burned limestone clasts (mainly clast supported); massive to weak granular; friable; black (10YR 2/2 moist)
Zone IV	Bg horizon; contains abundant, mostly unburned limestone slabs; massive clay loam; plastic very dark gray (10YR 3/1); substrate is hard limestone

Figure 8.9 Feature 1, 41CV608, Showing Planview with Backhoe Trench and Test Pit, Profile of Backhoe Trench and Test Pit with Radiometric Assays by Level.

Five samples (3 charcoal and 2 humate) provided the age assessment of F 1. The floated matrix also yielded chert flakes, mussel shell fragments, *Rabdotus* shells, bones, and seeds from all depths (Table 8.4). Level 3 (20-30 cmbs) yielded the greatest frequency of lithic debitage but other materials were similar to other levels. Although level 6 appeared to be below the mound, it did reveal similar frequencies of material remains as observed in the upper levels.

8.2.3.4 Site 41BL743

This prehistoric site lies in training area 13 in East Range, south of Belton Lake (Figure 8.1). Site 41BL743 lies upon a level upland surface about 50 m south of a steep, north-facing slope extending down to the lake. It possesses extremely shallow (<10 cm) residual soils that exhibit a dark, reddish brown silty clay (A-R horizon sequences) with exposed limestone bedrock in many areas. This is indicative of extensive stripping of the soil mantle during the Holocene. Dense brush with small oak and juniper trees cover about 80 percent of the site.

Near the center of a sparse aerially restricted lithic scatter, lies a burned rock mound measuring nearly 10 m in diameter by 35 cm tall. This low, intact mound was constructed on bedrock. It is partially vegetated with small trees on the northern portion and bush and grass over the remaining areas. An Edgewood and a Bulverde point were previously recovered within 50 m of the mound.

A 50 x 50 cm shovel test near the mound's center penetrated 45 cm yielding 637 burned rocks but no lithics, shell, bone, charcoal, or other cultural material from the dark brown matrix. This mound was selected for the chronological study.

Initially, a north-south backhoe trench was dug from the northern tree margin across the center to beyond the southern mound edge of the feature (Figure 8.10). The 7.5 m long by 50 cm deep trench exposed only the southern two-thirds of F 1. Profiling the trench's west wall revealed a 2 m diameter wide by 30 cm deep (Zone 1) area near the projected middle of the mound that had a few burned rocks, all less than 10 cm in size, mixed with some lithic debitage in loose, black (10YR 2/1) stony clay loam (Figure 8.10). The latter Zone 1 lay above a fine granular, black (10YR 2/1) clay loam with dense, large, burned rocks measuring up to 15 cm in diameter. This feature rested on bedrock, which may have been partially excavated to create an irregular bottom near the middle of the mound and beneath the possible pit-like depression. No matrix lay between the limestone burned rock and the limestone bedrock, making it difficult to define the actual bottom of the feature.

Following trenching, a 1 m^2 test pit (TP 1) was excavated 50 cm deep adjacent to the eastern side of the trench and on the southern margin of the depression. It yielded quantities of burned rock in the top four levels (0-40 cmbs) with some that appeared more vertically oriented on the southwest quad. Besides the vertically oriented rocks, other attributes, such as fewer burned rock or an increase in charcoal typical of a central hearth were observed. Horizontal limestone slabs with matrix in and around them reflected the probable bedrock between 40 to 50 cmbs. Some charcoal flecking was observed between 0 and 20 cmbs.

The heavy fraction obtained from floating TP 1 matrix yielded 1.5 g of charcoal, *Rabdotus* snails, bone fragments, seeds, mussel shell fragments, and chert debitage (Table 8.5). The debitage consisted of 68.1 percent of the recovered heavy fraction material. The next most abundant materials were seeds, dominated (70%) by the ashe juniper (*Juniperus ashei*) species. Single charcoal flecks from 10 to 20, 30 to 40, and 40 to 50 cmbs were submitted for AMS dating and provided the age assessment of F 1.

Table 8.4 Material Types and Quantities Recovered from heavy Fractions at Feature 1, 41BL608.

Provenience	P #	Charcoal (g)	Flakes	Tools	Mussel	*Rabdotus*	Bone	Seeds
TP:1, L:1	9	<0.1	143	-	3	-	-	A - 4 B - 12 C - 58 HB - 1
TP:1, L:1 SE Quad	10	<0.1	117	-	3	-	-	A - 1 B - 23 C - 21 HB - 2
TP:1, L:2	11	0.1	222	-	106	9	2	A - 4 B - 27 C - 33 HB - 2
TP:1, L:2 SE Quad	12	<0.1	204	-	4	-	-	B - 2 C - 6
TP:1, L:3	13	0.2	306	-	109	4	2	A - 3 B - 17 C - 9 HB - 1
TP:1, L:3 SE Quad	14	<0.1	223	-	13	3	-	B - 3 C - 1 HB - 2
TP:1, L:4	15	0.5	229	-	26	6	-	B - 10 C - 3 HB - 4
TP:1, L:4 SW Quad	16	0.2	148	-	16	6	-	B - 1 C - 1 HB - 4
TP:1, L:5	17	0.3	164	-	29	7	1	C - 4 HB - 2
TP:1, L:5 SW Quad	18	0.2	117	-	11	3	-	HB - 9
TP:1, L:6	19	<0.1	85	-	18	3	-	B - 1 HB - 16
TP:1, L:6 SW Quad	20	0.1	133	-	22	6	2	HB - 16
TOTALS = 2808		<2.0[D]	2091	0	360	47	7	A - 12 B - 96 C - 136 HB - 59 303
Percentages			74.5	0	12.8	1.6	0.3	10.8

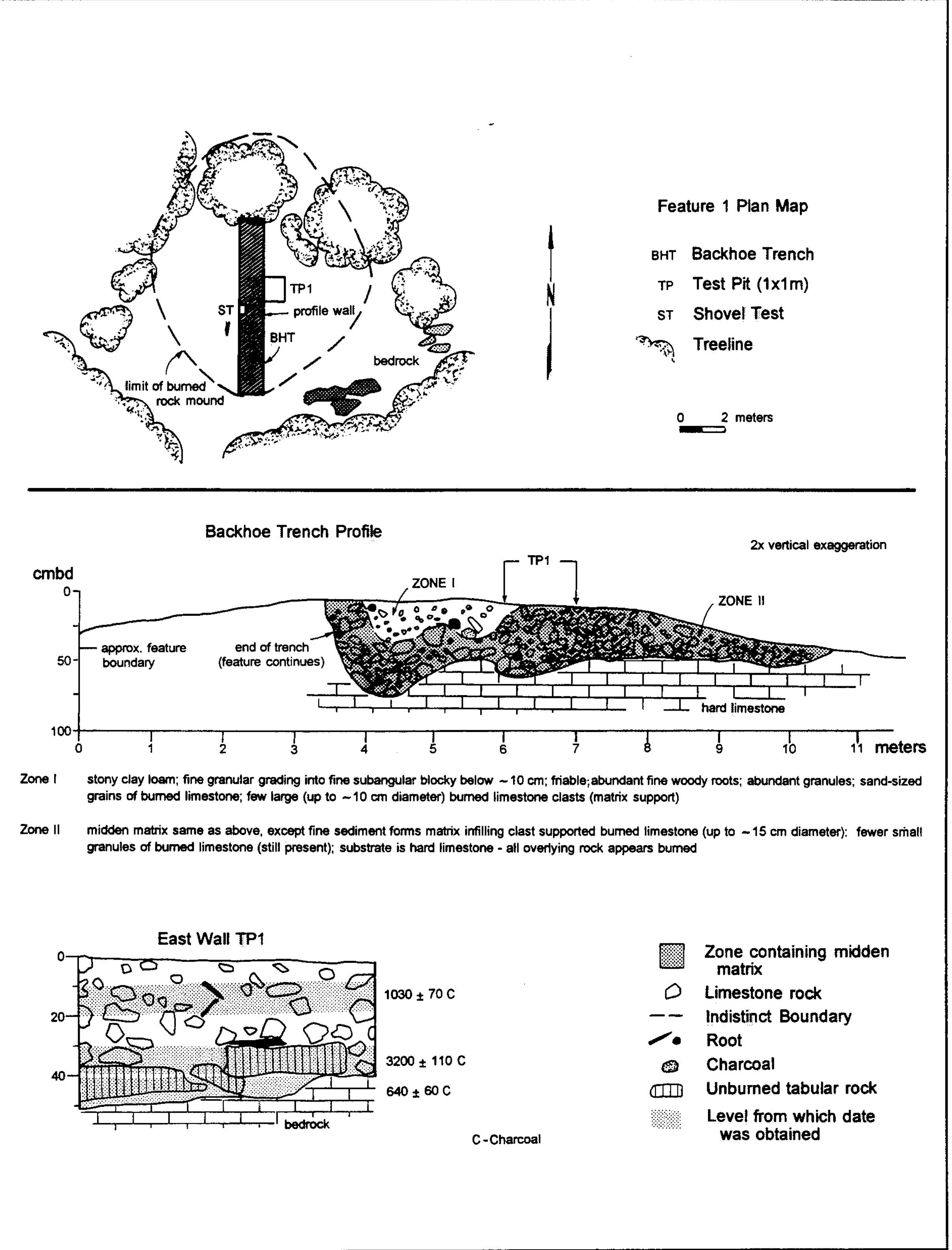
A = Bluebonnet Seeds

B = *Brassica* sp. Seeds

C = Ashei Juniper Seeds

D = Charcoal not included in totals

HB - Hackberry Seeds



Zone I stony clay loam; fine granular grading into fine subangular blocky below ~10 cm; friable; abundant fine woody roots; abundant granules; sand-sized grains of burned limestone; few large (up to ~10 cm diameter) burned limestone clasts (matrix support)

Zone II midden matrix same as above, except fine sediment forms matrix infilling clast supported burned limestone (up to ~15 cm diameter): fewer small granules of burned limestone (still present); substrate is hard limestone - all overlying rock appears burned

Figure 8.10 Feature 1, 41CV743, Showing Planview with Backhoe Trench and Test Pit.

Table 8.5 Material Types and Quantities Recovered from Heavy Fraction at Feature 1, 41BL743.

Provenience	P #	Charcoal (g)	Flakes	Tools	Mussel	*Rabdotus*	Bone	Seeds
TP:1, L:1	4	<0.1	260	-	-	1	45	B - 54 C - 138
TP:1, L:2	5	0.2	308	-	1	14	10	B - 7 C - 21
TP1, L:3	6	0.2	207	-	3	75	15	B - 2 C - 6
TP1, L:4	7	0.5	180	-	27	47	6	B - 3 C - 2 HB - 1
TP1, L:5	8	0.5	138	-	8	18	4	B - 1 HB - 1
TOTALS		1.5^D	1093	0	39	155	80	236
Percentages			68.1		2.4	9.7	5.0	14.7

A = Bluebonnet Seeds
B = *Brassica* sp. Seeds
C = Ashei Juniper Seeds
D = Charcoal not included in totals
E = Hackberry seeds

8.2.3.5 Site 41CV124

This prehistoric site lies in training area 44, in West Range (Figure 8.1). It lies at the eastern end of Manning Mountain at the head of a deeply-incised canyon formed by a tributary of Clabber Creek that drains to the southeast. Site 41CV124 consists exclusively of a moderately-sized, annular burned rock mound on a degrading upland surface characterized by a patchwork of exposed limestone and thin, residual clay soil. The soil is black, stony clay, typically less than 5 cm thick, and contains abundant residual chert. A broad scatter of flakes surrounds the mound, but the surrounding material was assigned a different site number (41CV125) by the previous investigators.

The annular mound (Feature 1) is composed of mostly small, heat fractured, clast-supported limestone in black clay matrix, which appeared to be intact with excellent integrity. The mound is 9 m in diameter and 40 to 50 cm high with a central depression (Feature 1a) measuring about 1 m in diameter and 40 cm deep. The central depression does not appear to represent recent activity such as a fox hole or a pothole. The mound's eastern margin is at the very break in the slope while the majority of the mound is on a relatively flat surface. Juniper trees surround this mound, but none were growing on it. Several flakes, a few biface fragments, an untyped dart point, and a core were observed on the mound while numerous chert flakes, cores, and biface fragments were observed directly south of the feature.

A 50 x 50 cm test quad was excavated from the highest point on the southern side of the burned rock mound and dug to bedrock at 60 cmbs. A low artifact density was detected as each of the five 10-cm- thick levels (0 to 50 cmbs) revealed a single piece of debitage among the small burned rocks.

This mound was selected for the chronological study. An 11-m-long trench was plowed from east to west across Feature 1 and through the margin of the central depression (Figure 8.11). The trench exposed a massive burned rock mound with the deep central pit (F 1a) dug into limestone bedrock (Figure 8.12). The top zone, about 12 cm thick, contains a stony clay loam with abundant fine to medium burned rock clasts up to 10 cm in diameter in a black (10YR 2/1) matrix. Immediately below, Zone 2 consists of nearly 40 cm of a black (10YR 2/1), stony clay loam with abundant burned rock clasts up to 15 cm in diameter which appear layered in some places. This overlies Zone 3, a dark reddish brown (10YR 3/3) clay loam which is classified as a Bt horizon on top of a hard limestone bedrock.

Test pit 1 was excavated adjacent to the northern side of the trench over the central depression (F 1a). This surficial depression was above an intentionally created pit which penetrated through the bedrock starting at 45 cmbs and extending to 103 cmbs. Test pit 1 narrowed in size below 45 cmbs as the bedrock encroached on the pit feature and narrowed to about a 20 to 25 cm diameter circular unit at 103 cmbs. The circular, prehistoric pit was well defined in TP 1, at a depth of 40 to 50 cm, with dark, organic matrix surrounded by light, reddish brown matrix. Although the entire pit was not revealed in TP 1, it is projected to be nearly 1 m in diameter at the top (ca. 45 cmbs) and continually narrowed to 20 to 25 cm in diameter at 103 cmbs.

Test pit 1 yielded numerous pieces of chert debitage and quantities of burned rock (Table 8.6). The internal pit (F 1a) also contained quantities of burned rock and lithic debitage. The lower frequencies documented below 60 cm are influenced by the narrowing of the excavation unit. It is interesting that a few *Rabdotus*, mussel shell fragments and modern *Brassica* sp. seeds were recovered from this narrow pit excavated into the bedrock.

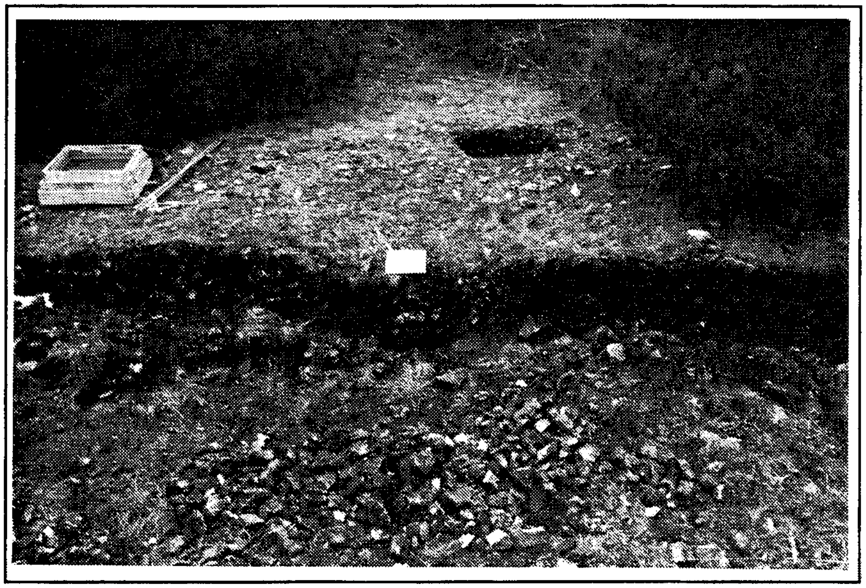
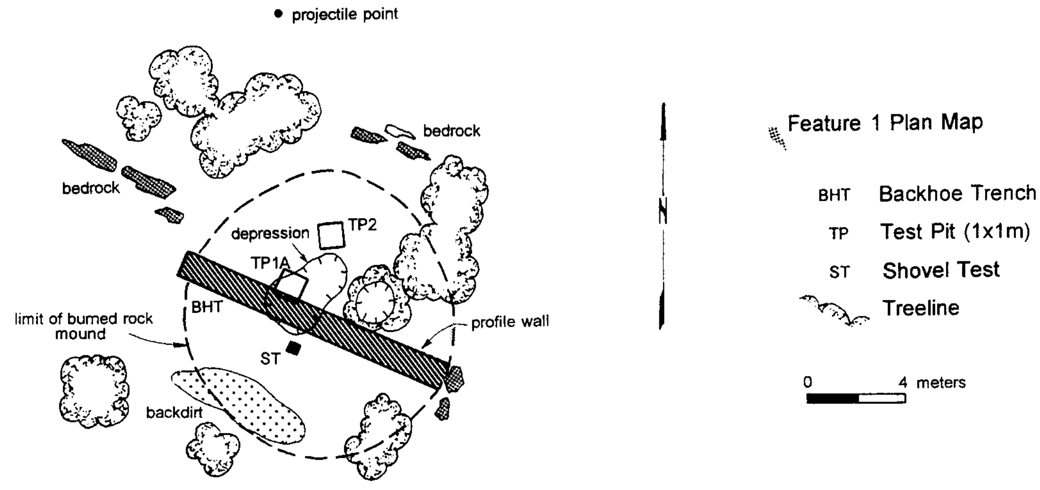
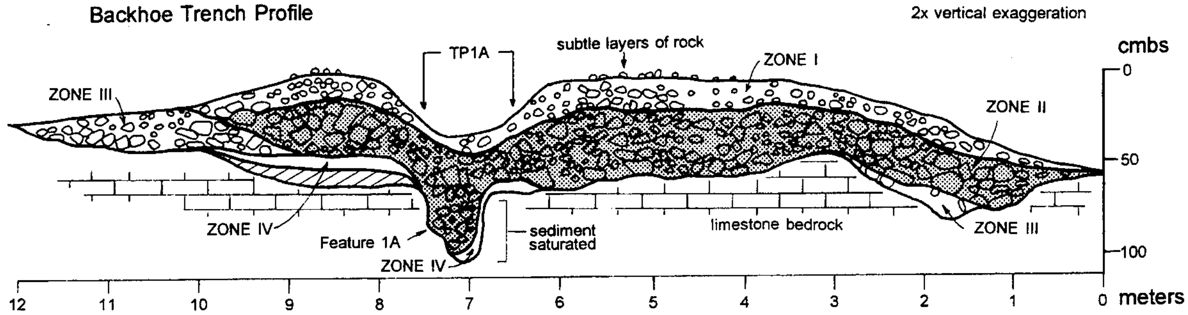


Figure 8.11 Close-up of Feature 1, 41CV124, Showing 1993 Excavations and Central Depression.





Zone I	stony clay loam; weak fine granular to massive; friable to slightly plastic; black (10YR 2/1); abundant fine to medium FCR (clasts to ~10 cm diameter); abundant fine roots (grasses and shrubs) especially in upper 10 cm; some relatively stone-free zones (see sketch); clast; matrix support of FCR
Zone II	stony clay loam; massive; friable to plastic; black (10YR 2/1); abundant clast supported FCR clasts up to 15 cm diameter, some weak imbrication; layering apparent in places; few to common medium roots; few rock-free voids; many areas lack any sign of imbrication
Zone III	stony clay loam; massive; plastic; very dark brown (10YR 2/2); contains abundant burned rock up to ~10 cm diameter (A horizon); common fine to medium roots FSR in upper 10 cm
Zone IV	clay to clay loam; massive; plastic; dark reddish brown (5YR 3/3); common medium roots (typical thin Manning surface Bt horizon); substrate: hard limestone bedrock

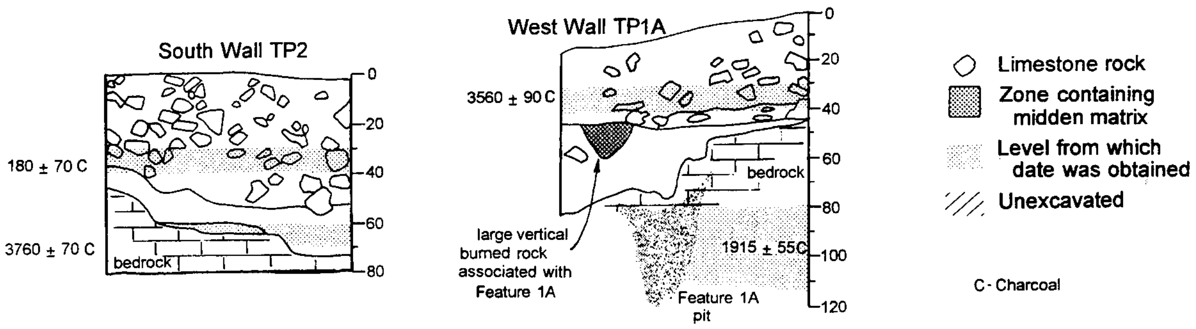


Figure 8.12 Feature 1, 41CV124, Showing Planview with Backhoe Trench and Test Pits, Profile of Backhoe Trench and Test Pits with Radiometric Assays by Level.

Table 8.6 Material Types and Quantities Recovered from Heavy Fractions at Feature 1, 41CV124.

Provenience	P #	Charcoal (g)	Flakes	Tools	Mussel	*Rabdotus*	Bone	Seeds
TP:1A								
TP:1A, L:2	8	0.1	172	-		5	1	A - 47 B - 83 C - 5
TP:1A, L:3	9	0	193	-	-	2	9	A - 6 B - 1
TP:1A, L:4 Black Matrix	10	0.2	193	-	13	22	1	A - 2 B - 9
TP:1A, L:5 Brown Matrix	11	0.2	435	-	2	13	1	A - 2 B - 6
TP:1, L:5	24	0	150	-	8	28	-	-
TP:1A, L:6	12	0.2	118	-	5	6	-	-
TP:1A, L:6 Outside Feature Fill	25	0	230	-	4	20	1	-
TP:1A, L:7	13	0.1	78	-	1	8	-	B - 2
TP:1A, L:7 Outside Feature Fill	26	0	72	-	1	10	-	A - 1
TP:1A, L:8	14	<0.1	22	-	-	-	-	-
TP:1A, L:8 Brown Matrix	27	0	77	-	-	2	-	-
TP:1A, L:9	15	<0.1	104	-	3	15	-	-
TP:1A, L:9 Brown Matrix	28	0	45	-	-	2	-	-
TP:1A, L:10	16	<0.1	52	-	-	7	1	B - 1
Subtotal TP:1A		1.1	1941		37	148	14	A - 58 B - 102 C - 5
TP:2								
TP:2, L:1	11	0	315	-	-	-	-	A - 24 B - 18 C - 3
TP:2, L:2	18	0.1	390	-	1	2	-	-
TP:2, L:3	19	0.2	325	-	-	6	-	A - 3 B - 5
TP:2, L:4	20	0.3	230	-	3	7	10	C - 2
TP:2, L:5	21	0.1	62	-	-	25	-	-
TP:2, L:6	22	0.1	85	-	-	22	-	-
TP:2, L:7	23	0.1	77	-	1	17	-	A - 1 B - 4

Table 8.6 (Concluded).

Provenience	P #	Charcoal (g)	Flakes	Tools	Mussel	*Rabdotus*	Bone	Seeds
SUBTOTAL TP:2		0.9	1484		5	79	10	A = 28 B = 27 C = 5
TOTALS		2.0g^D	3425	0	42	227	24	A = 86 B = 129 C = 10
Percentages			88.1	0	1.1	5.6	0.6	4.6

A = Bluebonnet Seeds
B = *Brassica* sp Seeds
C = Ashei Juniper
D = Charcoal not included in totals

Test pit 2 was 1 m to the north, on the highest point of the mound. It was excavated to a maximum depth of 75 cmbs, although nearly one quarter of this unit was bedrock at a depth of 30 cmbs. Small, weathered cavities in the limestone bedrock continued downward to 75 cmbs and were filled with fine matrix and an occasional lithic. Test pit 2 also yielded quantities of chert debitage and burned rock to about 50 cmbs (Table 8.6).

The first four levels (0 to 40 cm) yielded the greatest material frequencies while there was a significant drop off once bedrock was encountered. In contrast, the number of *Rabdotus* snails had higher frequencies in the lower levels (40 to 70 cm). Nearly 73 percent of the seeds were identified as modern Old World specimens, cf. *Brassica* sp. A relatively few (8 or 4.5%) were identified as bluebonnet seeds which came primarily from the top 10 cm of each test pit.

Charcoal from the heavy fraction from TP 1 yielded just under 1.1 g while heavy fraction from TP 2 yielded about 0.9 g. Individual charcoal pieces from TP 1, 10 to 20, 30 to 40, and 80 to 90 cmbs, and from TP 2, 30 to 40 cmbs were sent for AMS dating, but problems (see details in Section 8.3) with some samples meant resubmission of new samples from TP 1, 70 to 80 cmbs and TP 2, 60 to 70 cmbs. A total of four charcoal assays document the age of this feature. Inspection of this feature following backfilling lead to the discovery of a complete Bulverde projectile point (Figure 8.13) in the fill of the backdirt. Its location in the fill, plus the dark matrix adhering to it, denotes that its original position was from the mound matrix.

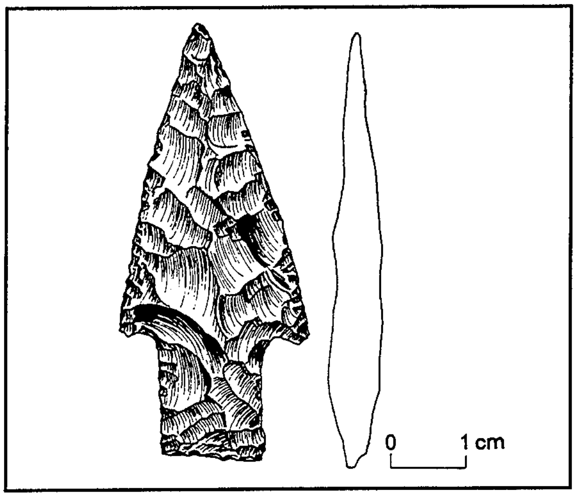


Figure 8.13 Bulverde Point from Backhoe Trench Backdirt, 41CV124.

8.2.3.6 Site 41CV594

This prehistoric site is in training area 36, near the middle of the West Range (Figure 8.1). It occupies high ground on the southern side of Cottonwood Creek which drains into Cowhouse Creek to the north. Site 41CV594 consists of a broad upland bench spanning the outcrop of the Paluxy sand and overlying the Walnut Formation on the intermediate Killeen surface. The site extends from a rounded knoll of exposed nodular Walnut Formation limestone in the southern part, northward across a broad bench underlain by a truncated, disturbed ancient soil (A/E/Bt horizon sequence) developed in the Paluxy sand.

Site 41CV594 is heavily impacted by military activity, with only two (Fs 1 and 2) of the four extant features able to be tested, while the other features have been either erased or disturbed by a variety of maneuver traffic and bulldozing. Bifaces, scrapers, burned rock, debitage, and one mano were scattered across the site. Twelve dart points were collected from the surface revealing a temporal range from Middle Archaic into the Neo-Archaic/Late Prehistoric.

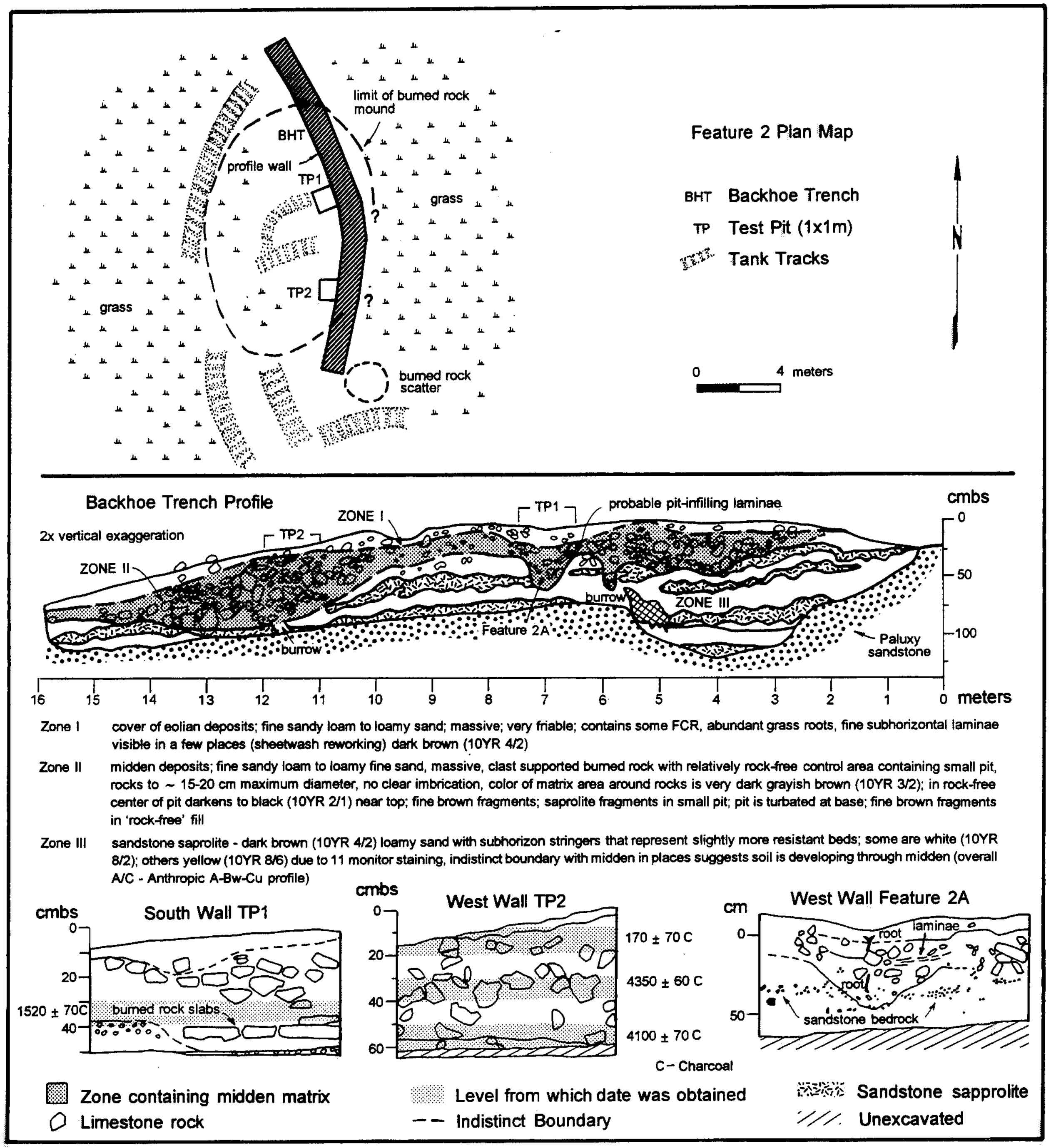
At least three burned rock features are preserved on this bench, including mounds with a relief of up to approximately 1 m. Feature 1 is 15 by 10 m by 30 cm high burned rock mound. Feature 2 is a 12 m long (north-south) by 6.5 m wide by 0.75 m high burned rock mound, although nearly one third of the eastern portion has been totally removed. The feature is definitely a mound, although the top is broad and nearly flat. This spreading may have been caused by heavy military traffic running over it (Figure 8.14). Feature 3 is a 10 x 6 m flattened burned rock mound. Feature 4 is a 9 m diameter area of concentrated burned rock, apparently once a mound now totally destroyed, with only this circular pattern remaining. At these features, very little lithic debitage is mixed in with the burned rock.

Feature 2 was selected for investigation in this chronological study. An arc-shaped, north-south backhoe trench was dug along the disturbed eastern margin, extending some 16 m long and nearly 1 m deep (Figure 8.14). This trench exposed complex stratigraphy above a cemented Paluxy sand. Near the feature's center was exposed a 4-m-wide area nearly void of burned rock except for a few near the surface. This rock-free void was situated between two massive sections of dense burned rock. This central burned rock void may have represented some type of central cooking feature, even though an obvious basin or bottom was not definable and no slab lined pit was observed. A second, more obvious pit (80 x 70 cm deep, designated F 2A), with laminae on the north edge, was located toward the northern end of the 4-m-wide void area (Figure 8.14).

A 5 to 10 cm thin veneer of dark brown (10YR 4/2) eolian sand (fine sandy loam) with very few burned rocks and lots of rootlets is identified as Zone 1. Zone 2 is the midden deposit with clasts up to 20 cm in diameter on either side of the void area, with a very dark, grayish brown (10YR 3/2) sandy loam around the burned rock. The predominately rock-free central area is a black (10YR 2/1) sandy loam. Zone 3 is a sandstone saprolite which varies from white (10YR 8/2) to yellow (10YR 8/6) bands, or zones, of nondecomposed sandstone clasts.

Test pit 1, excavated to 80 cmbs, was situated over the small, well defined pit (F 2A) observed in the trench profile, north of the rock-free void area (Figure 8.14). An obvious outline (plan view) of this pit became apparent between 10 and 20 cmbs as an area of loose, tan, sandy matrix to the northern and eastern side of the test pit, while the southwest corner exhibited dense burned rock in a dark stained matrix. As the excavation continued deeper, the intrusive sand-filled pit was easily distinguished from the intact midden deposits on the sides of the test pit. It continued to narrow with depth going from at least 100 cm in diameter at 20 cmbs to 20 cm in diameter at 80 cmbs. The lighter matrix yielded military cartridges, burlap, and Pearl beer cans. This pit is interpreted as a recent military fox hole that penetrated the mound deposits.

Test pit 2 was slightly more than 3 m south of TP 1 and off the western side of the backhoe trench (Figure 8.14). It was excavated to 60 cmbs with 0 to 10 cm containing mostly disturbed deposits, and 10 to 60 cmbs revealing quantities of burned rocks that ended at 55 cmbs (Table 8.7).



Zone I	cover of eolian deposits; fine sandy loam to loamy sand; massive; very friable; contains some FCR, abundant grass roots, fine subhorizontal laminae visible in a few places (sheetwash reworking) dark brown (10YR 4/2)
Zone II	midden deposits; fine sandy loam to loamy fine sand, massive, clast supported burned rock with relatively rock-free control area containing small pit, rocks to ~ 15-20 cm maximum diameter, no clear imbrication, color of matrix area around rocks is very dark grayish brown (10YR 3/2); in rock-free center of pit darkens to black (10YR 2/1) near top; fine brown fragments; saprolite fragments in small pit; pit is turbated at base; fine brown fragments in 'rock-free' fill
Zone III	sandstone saprolite - dark brown (10YR 4/2) loamy sand with subhorizon stringers that represent slightly more resistant beds; some are white (10YR 8/2); others yellow (10YR 8/6) due to 11 monitor staining, indistinct boundary with midden in places suggests soil is developing through midden (overall A/C - Anthropic A-Bw-Cu profile)

Figure 8.14 Feature 2, 41CV594, Showing Planview with Backhoe Trench and Test Pits, Profiles of Backhoe Trench and Test Pits with Radiometric Assays by Level.

Table 8.7 Material Types and Quantities Recovered from Heavy Fractions at Feature 2, 41CV594.

Provenience	P #	Charcoal (g)	Flakes	Tools	Mussel	*Rabdotus*	Bone	Seeds
TP:1								
TP:1, L:4	24	1.8	1	-	-	-	-	-
TP:1, L:5	25	0.6	1	-	3	6	-	B - 9 HB - 4
Subtotals TP:1		2.4	2	0	3	6	-	13
TP:2								
TP:2, L:1	29	0	4	-	-	5	-	B - 11 C - 1
TP:2, L:2	30	0.1	9	-	13	3	-	B - 173 C - 2
TP:2, L:3	31	0.2	14	-	12	-	-	-
TP:2, L:4	32	0.3	8	-	7	-	-	B - 42
TP:2, L:5	33	0.1	5	-	4	6	-	B - 10
TP:2, L:6	34	0.1	1	-	15	18	-	B - 2
Subtotals TP:2		0.8	41	0	51	32		241
TOTALS		3.2[E]	43	0	54	38	0	254
Percentages	-	-	11.5	0	13.9	9.8	0	65.3

A = Bluebonnet Seeds
B = *Brassica* sp. Seeds
C = Ashei Juniper Seeds
D = Unidentifiable Dart Point Base
E = Charcoal not included in totals
HB = Hackberry Seeds

From 10 to 55 cmbs, quantities of small (10 cm), burned rock was contained within a brown matrix. None of the levels revealed patterned burned rock or evidence of imbrication. Lighter tan matrix was apparent to 30 cmbs and, along with three rifle casings, indicated disturbances.

The heavy fraction of the floated cultural matrix from TP 1 (that matrix from the intact burned rock deposits outside the intrusive pit) yielded 2.4 g of charcoal while the heavy fraction from TP 2 yielded 0.8 g of charcoal. Table 8.7 reveals the type and quantities of various materials recovered from both test pits. A high percentage (65.3%) of seeds was recovered but most were from 10 to 20 cmbs of TP 2 and 97 percent of the total seeds were of a modern *Brassica* sp. This recently introduced Old World species verifies the movement of fine particles and sediments downward through the mound. In general, the lack of lithic tools and the low frequencies of lithic debitage reflect the feature's function. *Rabdotus* snails are present, but in low numbers relative to other materials. Their concentration in the lowest level of TP 2 may contribute to identifying the amount of natural movement or nonvisual destruction of the feature.

Four single pieces of charcoal from TP 2 at 10 to 20, 30 to 40, and 50 to 60 cmbs and TP 1 and 30 to 40 cmbs were selected to assess the age of F 2. Those results may contribute to assessing the horizontal differences and possible use episodes within this feature.

8.2.3.7 Site 41CV1027

This prehistoric site is located in training area 42 near the middle of West Range (Figure 8.1). It straddles a steep slope segment with one gently sloping bench on the eastern side of Stampede Creek, and a tributary flowing southward into Cowhouse Creek. The stepped topography results from differential weathering of the present

Cretaceous deposits which include the Walnut clay, the Paluxy sand, and the Glen Rose limestone. Site 41CV1027 is oriented northeast-southwest and measures approximately 60 by 220 m. It is covered with juniper, oak, greenbriar, and short grasses over some of the impacted areas. A shallow southeast/northwest gully bisects the southern quarter. The majority of the cultural material rests on the upper two benches, formed by the more resistant Glen Rose limestone. The benches are overlain by a thin veneer of Paluxy sand and colluvium. All burned rock features are on the Paluxy sand on the upper bench. Considerable military activity has heavily impacted this site. Feature 1 was selected for the chronological study.

Feature 1, a burned rock mound measuring approximately 11 m north-south by 10 m east-west and 50 cm thick, rests on a slope above the Paluxy sand deposits (Figure 8.15). Measurements are approximate because this feature was extensively altered along the northern and eastern sides by tank trails. Burned rock, apparently washed down from F 1, occurs on the surface downslope from the feature to the edge of the adjacent scarp. A backhoe trench was dug from north to south in the intact portion of the mound immediately west of a tank trail (Figure 8.15). The trench's west wall was profiled with five stratigraphic zones identified (Figure 8.15). The profile revealed that this burned rock feature was constructed slightly above the uneven, weathered yellow-brown sandstone bedrock (Zone 5) with a thin Paluxy sand mantle (Zone 4) between the solid bedrock and the burned rock. Zone 4, a loamy, fine sand parent material with a dark gray (10YR 4/1)-to-grayish brown (10YR 3/2) color contains the lower portion of the midden deposit. Zone 3 is a loamy, fine sand similar in color to the lower material and contains the majority of the burned rock. Zone 2 is a post-mound deposit of brown (10YR 5/3) gravelly fine sand which appears to be road splatter. Overlying this is Zone 1, a recent sandy gravel slopewash that is brown (10YR 5/3). In the wall of the trench near the center of the feature, a large slab, nearly 40 cm across and 25 cm deep set at a north 97° angle, indicates a possible slab-lined central pit feature. This potential pit could not be positively confirmed because of extensive root disturbance. Burned rocks observed near the middle of this feature appeared to be larger than those observed on the northern and southern sides. Snails, burned rocks up to 15 cm in diameter, and mussel shell fragments were observed in the trench profile.

Two test pits (TP 1 and TP 2) were excavated into apparent undisturbed portions of F 1. Test Pit 1 was 1 m^2 in size and was placed near the center of the mound on the eastern side of the trench. Test Pit 2 was 1 by 0.5 m^2 over the observed large, upright slab on the west side, slightly north of TP 1. These two test pits were excavated to 50 cmbs yielding chert debitage, quantities of mussel shell fragments, lots of *Rabdotus* shells, a few seeds, and a complete dart point (Table 8.8 and Figure 8.16). The latter resembles a Yarborough point assigned to the Archaic or possibly later period (Turner and Hester 1993:197). It was recovered in situ from TP 1, level 4, 36 cmbs.

Test Pits 1 and 2 excavations did not encounter any other unambiguous evidence of an internal structure/pit. Howard (1991) believes such features are difficult to detect with vertical excavation strategies. However, the central slab hearth at Mustang Creek (41HY209M) was detected using this excavation technique.

Flotation of matrix from TP 1 yielded roughly 1.5 g of charcoal, with no charcoal from 1 to 20 and 50 to 60 cmbs. Floated matrix from TP 2, half the size of TP 1, yielded slightly less than 0.8 g of charcoal and none from the top 0 to 10 cmbs. "Charcoal" from 10 to 20 cmbs turned out to be tiny black rubber fragments.

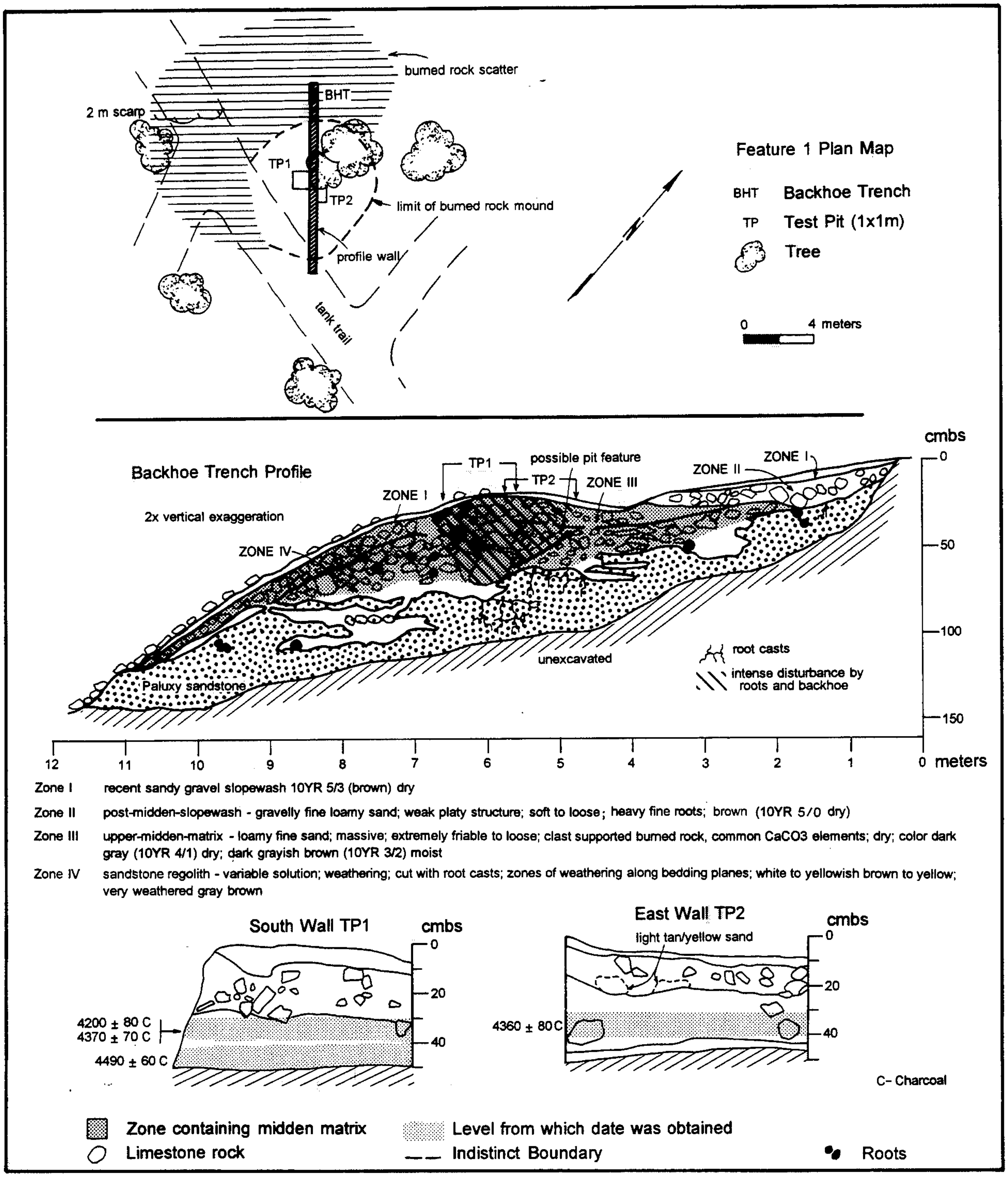


Figure 8.15 Feature 1, 41CV1027, Showing Planview with Backhoe Trench and Test Pits, Profiles of Backhoe Trench and Test Pits with Radiometric Assays by Level.

Table 8.8 Material Types and Quantities Recovered from Heavy Fractions at Feature 1, 41CV1027.

Provenience	P #	Charcoal (g)	Flakes	Tools	Mussel	*Rabdotus*	Bone	Seeds
TP:1, L:3	83	<0.1	16	-	89	29	-	-
TP:1, L:3 NE Quad	84	<0.1	12	-	28	52	-	-
TP:1, L:4	85	0.4	26	1^{E}	350	200	-	-
TP:1, L:5	87	0.7	6	-	49	84	-	HB - 1
TP:1, L:5 NE Quad	88	0.2	1	-	22	25	-	-
Feature 1A								
TP:1, L:2	90	0	5	-	-	3	-	C - 16
TP:1, L:2 SE Quad	91	0	16	-	-	1	-	B - 2 C - 12
TP:1, L:3 SE Quad	92	0	4	-	48	27	-	C - 1
TP:1, L:3	93	0	2	-	14	9	-	-
TP:1, L:4	94	0.1	2	-	27	20	-	C - 1
TP:1, L:4 SE Quad	95	<0.1	5	-	67	43	-	-
TP:1, L:5	96	<0.1	5	-	5	12	-	-
TP:1, L:5 SE Quad	97	0.1	-	-	1	8	-	B - 1
TOTALS		<1.9 g^{D}	100	1^{E}	700	513	0	34
Percentages	-	-	7.4	0	52	38.1	0	2.5

A = Bluebonnet Seeds
B = *Brassica* sp. Seeds
C = Ashei Juniper Seeds
D = Charcoal not included in totals
E = Complete Yarborough Point
HB = Hackberry

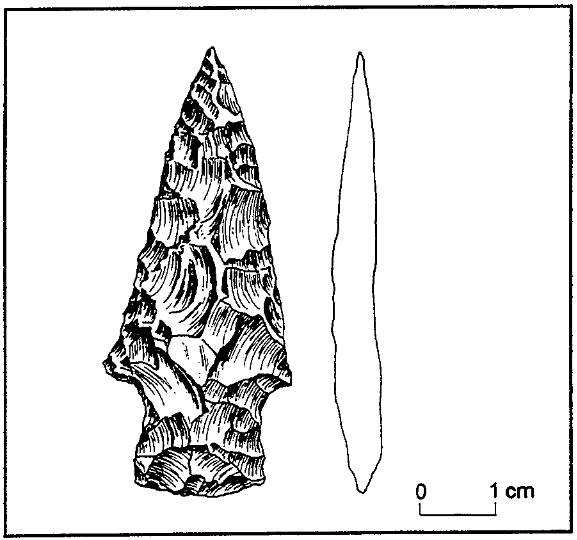


Figure 8.16 Yarbrough Point Recovered from Backhoe Trench, 41CV1027.

Four pieces of charcoal were submitted to Beta for AMS radiocarbon dating. Two individual pieces came from TP 1, 30 to 40 cmbs, the same level as the Yarborough point, a second piece from TP 1, 40 to 50 cmbs, and one from TP 2, 30 to 40 cmbs. These dates will provide an age for the projectile and cross check the differences within one level.

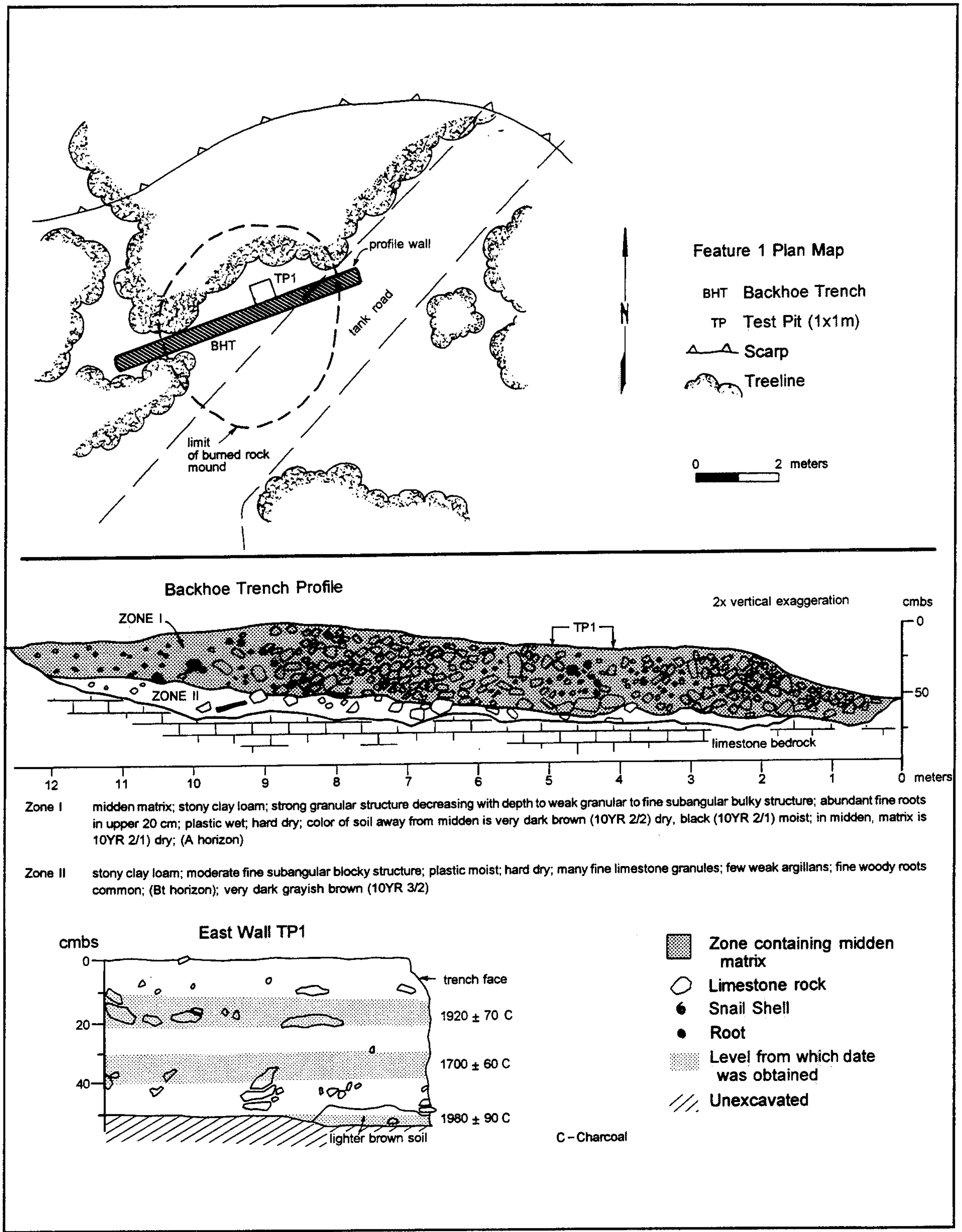
8.2.3.8 Site 41CV1195

This prehistoric site is located in training area 33, near the center of the western side of the West Range (Figure 8.1). The site extends across a broad, gentle, mid-slope bench between two steeper slope segments overlooking Ripstein Creek. One of the steep slopes is present along the northern margin and descends to the floodplain of Ripstein Creek. Upslope, a residual soil consists of an A-Bt-C profile formed through a calcareous sand or sandy marl. The Bt and C soil horizons pinch out downslope, resulting in an A-R profile within the site boundaries. Vehicular disturbance crisscross the site, and, coupled with subsequent sheet and gully erosion of these roads, has denuded much of the site.

Feature 1, a low relief burned rock mound approximately 10 m in diameter by 50 cm thick with a relatively flat surface, was the only definable feature (Figure 8.17). The mound is bisected and exposed by a military dirt trail across the southern half, but retains an estimated 60 to 70 percent integrity. A light scatter of lithic debitage is associated with the mound, but no charcoal, snails, or tools were observed on the feature's surface or the exposed road bed. At least two other burned rock scatters may have been features prior to disturbances. Both are sparse scatters of burned rock on a thin soil profile. A slightly higher density of surface lithics was observed toward the northeast (downslope), and may represent secondary deposits from these features. Feature 1 was selected for the mound chronological study and one backhoe trench and one test pit were excavated into it.

Feature 1 was originally tested by a shovel test (ST 1). At 30 cmbs, the high density of burned rocks terminated the shovel test effort. Thirteen chert flakes (including 2 burned) and 80 burned rocks were recovered from ST 1. Feature 1 was mechanically trenched from the west to east across what appeared to be the middle of the mound (Figure 8.17). This trench exposed a nearly 50-cm-thick burned rock mound just above the nearly flat limestone bedrock that extending over 8 m (Figure 8.17). The burned rock rested on a Bt horizon which exhibited a stony clay loam with moderately fine sorting and many fine limestone gravels. This Bt horizon is a dark, grayish brown (10YR 3/2). The overlying A horizon exhibits the burned rock within a stony clay loam with angular structure that decreases with depth. The color away from the burned rock area is a very dark brown (10YR 2/2) while in the midden area it is black (10YR 2/1). Although not obvious during the initial visual inspection, a poorly-defined basin-shaped area, approximately 2 m across and 60 cm deep near the middle of the trench, appears to have fewer burned rocks than on either side. This may represent some type of central pit.

A single test pit was excavated into the poorly defined central pit area, and extended 55 cm deep to the top of the limestone. The heavy fraction recovered from the flotation, taken from 10 to 50 cmbs, yielded considerable chert debitage, two projectile point fragments (an unidentifiable base and a point tip), a biface fragment, two edge-modified flakes, some mussel shell fragments, some *Rabdotus* snails, a few bone scraps, and very few seeds (Table 8.9). Forty percent of the seeds dispersed throughout the profile were identified as cf. *Brassica* sp., a modern Old World plant species. The high density of chert debitage coupled with the stone tools was unexpected and undoubtedly reflects functional activities. Single pieces of charcoal from 10 to 20, 30 to 40, and 50 to 60 cmbs were submitted for AMS dating.



Zone I	midden matrix; stony clay loam; strong granular structure decreasing with depth to weak granular to fine subangular bulky structure; abundant fine roots in upper 20 cm; plastic wet; hard dry; color of soil away from midden is very dark brown (10YR 2/2) dry, black (10YR 2/1) moist; in midden, matrix is 10YR 2/1) dry; (A horizon)
Zone II	stony clay loam; moderate fine subangular blocky structure; plastic moist; hard dry; many fine limestone granules; few weak argillans; fine woody roots common; (Bt horizon); very dark grayish brown (10YR 3/2)

Figure 8.17 Feature 1, 41CV1195, Showing Planview with Backhoe Trench and Test Pits, Profiles of Backhoe Trench and Test Pits with Radiometric Assays by Level.

Table 8.9 Material Types and Quantities Recovered from Heavy Fractions at Feature 1, 41CV1195.

Provenience	No.	Charcoal (g)	Flakes	Tools	Mussel	*Rabdotus*	Bone	Seeds
TP :1, L:2	5	0.1	590	1 pt. base	-	30+	5	B - 2
TP :1, L:2	6	<0.1	145	-	50	-	11	B - 1
TP :1, L:3	7	0.2	570	1 pt. tip	65	30+	10	B - 1 C - 4
TP :1, L:3 SE Quad	8	0.1	153	-	82	-	1	C - 3
TP :1, L:4	9	0.5	345	1 - Biface 1 - EM	3	25+	5	-
TP :1, L:4 SE Quad	10	0.1	190	1 - EM	6	-	2	C - 1
TP :1, L:5	11	0.5	415	-	10	30+	18	B - 1
TP :1, L:6	13	0.1	155	-	30	25+	4	C - 1
TP :1, L:6 SE Quad	14	<0.1	67	-	4	-	-	B - 1
TOTALS		1.8g^{D}	2630+^{E}	5	250	140+	56	15
Percentage			85	0.2	8.1	4.5	1.8	0.5

A = Bluebonnet Seeds
C = Ashei Juniper Seeds
E = Counts Approximate
B = *Brassica* sp. Seeds
D = Charcoal not included in totals
EM = Edge modified flake

The top three levels (0-30 cmbs) contained very few burned rocks. In the level from 29 to 37 cmbs, a well-defined rock-free semicircle was detected across the southwestern two thirds of the unit. The matrix surrounding this (to the north and east) was packed full of dense burned rock. The subsequent level revealed a similar distribution of burned rock with a slight shift in the rock-free area to the east. Burned rock present along the two margins appeared to be either large or small with no intermediate sizes. There was a noticeable change in matrix color and texture at about 48 to 50 cmbs; the color became lighter brown as the texture became sandier. From 49 to 52 cmbs, there was a thin layer of matrix above the limestone bedrock. A portion of the unit was a dark colored matrix fill directly on bedrock, whereas in the southwestern portion of the unit, the fill was light brown sand.

8.3 LABORATORY METHODS

Following the field excavations, the laboratory processing began with the sorting of bags by level, test pit, feature, and site and the flotation of the matrix samples. Details of the laboratory processing for floating the bulk matrix samples, subsequent sorting of material retrieved, and the selection of the organic material for laboratory dating are presented below.

8.3.1 Floating Procedures

Matrix from each of the 80 hand-dug excavation levels was bagged and returned to Mariah's laboratory in Austin. The bulk of the matrix sample from each level bag was floated to acquire the maximum data return. A 30-gallon plastic barrel flotation system (manufactured by Sandy Enterprises) was set up and tested and a procedure established for separating the heavy and light fractions. The field sample bag was cut open and matrix was carefully poured into the top of the barrel. There a fine, nylon window screen (1.5 mm openings), clothes-pinned to the top rim of the barrel and resting on a metal grill near the top of the barrel, received the matrix. A series of water jets under the matrix created water turbulence to gently move the matrix. In some instances, the matrix was stirred by hand. The fine sediments settled to the bottom, while the heavy fraction stayed on the window screen and the light fraction was suspended in water. The light fraction floated to the top and was gathered into a fine nylon mesh bag (0.125 mm) attached at the overflow spout. After all the matrix was rendered out of the heavy fraction, water jet agitation ceased. The barrel was emptied after processing five to eight sample bags. In 15 selected instances, the fine matrix at the bottom of the barrel was collected and placed into drapery-lined, 6.25-mm mesh screens to air dry. In two other instances, the water in the bottom of the barrel containing suspended fine matrix was also collected and saved. Following careful barrel cleaning, the process was repeated.

Both heavy and light fractions were carefully removed from their respective containers inside the barrel and rinsed to remove excess fine sediments still adhering to the material. The light fractions were transferred into precut chiffon cloth (ca. 0.33 mm), tied up to prevent modern contamination, and hung outside to dry. Once dry, the contents were placed in plastic bags and labeled. The heavy fraction was placed inside a 6.25-mm mesh screen tray and set in the sun to air dry. After drying, these heavy fraction materials were placed in plastic bags and subsequently sorted.

8.3.2 Sorting Process

The heavy fractions were hand sorted on a clean plastic tray under a large magnifying lens. The materials were separated into different categories: burned bone, unburned bone, flakes, seeds, mussel shell, snails, charcoal, and so forth. Individual material classes were weighed and/or counted, recorded, and placed into separate containers and returned to the plastic bags. The tables in Section 8.2 present only the heavy fraction results and only the *Rabdotus* species of snails were tallied. *Helicina* and other snails species are present in the snail assemblage but at this time, they were not counted. In sorting land snails, only the diagnostic whorl sections were collected and counted, although many tiny shell fragments existed. Charcoal was picked by tweezers and placed in foil or small glass vials.

In general, the light fractions consisted of a softball-sized cloth container filled with quantities of tiny rootlets, some seeds, and charcoal. Light fractions were not systematically sorted, although most were inspected for content, with general notes taken on their charcoal frequency. When necessary, charcoal from the light fractions supplemented the charcoal recovered the heavy fraction component. Light fractions generally contained a charcoal frequency similar to that observed in the heavy fraction.

8.3.2.1 Selecting Radiometric Samples

The initial step in selecting the organic samples for dating was to review the charcoal frequencies by level for each feature on the heavy fraction list. The presence of other datable materials (humates, snails, bone, and seeds), from the same context as charcoal also influenced the selection of certain samples. One aspect of the radiometric program was to gather data on the different age results from a number of different substances in comparable context, so as to help guide future radiometric investigations. Very limited numbers of seeds and bone, plus the 15 humate matrix samples collected from the floating process, constituted the primary data base for selection. The funding level for the dating program was limited to 50 samples. Each feature was to be radiometrically assessed by a minimum of three dates on charcoal. Other samples were then carefully selected from similar contexts to provide the comparative results necessary to evaluate radiometric results on unburned seeds, snails, unburned bone, and humate samples.

8.3.2.2 Selection of Snails for Epimerization and Radiometric Analysis

As part of a separate delivery order, Mariah examined the feasibility of using land snail shells for chronometric and site-formation applications (Chapter 7.0). Epimerization analyses focused on a single feature so that feasibility could be assessed on the basis of a relatively robust data set. *Rabdotus* and *Helicina* shells were targeted for selection since they frequently occur in large numbers in archaeological deposits. Feature 1 at site 41BL598 was chosen as a source for snails because it had a relatively deep stratigraphic profile with substantial assemblages of both species in most levels. Levels 3, 5, and 7 were targeted for epimerization sampling because they also had been targeted for at least one radiometric analysis on a charcoal sample. These levels also would provide a basis for identifying matrix integrity and formation rates over relatively a broad vertical span.

Shells of each species were selected from each targeted level. Based on initial results that implied the presence of within-level clustering, additional shells were selected for epimerization. Additional sampling focused on *Rabdotus* because their larger size allows for paired epimerization and radiometric analyses from the same shell. Radiometric samples were selected to determine the extent to which clustering of A/I ratios was reflected by clustering of radiocarbon ages. Thus, selection of shells for radiometric dating concentrated on shells with similar A/I ratios, but also included shells that were outliers in the epimerization data. Chapter 7.0 contains a discussion of the basic chronometric results that underlie the use of epimerization and radiometric assays in the analysis for 41BL598 below.

8.3.3 Accelerator Mass Spectrometer Dating of Organic Samples

Carefully selected charcoal (n=33), seeds (n=2), *Rabdotus* (n=10), and bone (n=1) samples were submitted to Beta for analysis while associated bulk matrix samples (n=7) retrieved from the bottom of the flotation barrel were submitted to The University of Texas, Radiocarbon Dating Laboratory (Tx) for humate dating. Below are the individual laboratory processing techniques, followed by site/feature sample results and discussions.

8.3.3.1 Beta Analytic Laboratory, Inc. Processing

Single pieces of charcoal (with one exception, Beta-65693), bones, seeds, and individual *Rabdotus* parts were submitted to Beta for pretreatment and subsequent dating using the AMS measurements made at the CAMS or Eidgenossische Technische Hochschule (ETH) in Zurich. Carbon 13 and oxygen 18 isotope analyses were also obtained from the conventional mass spectrometry.

The charcoal and seed samples were initially washed in boiling water and intrusive rootlets were removed under magnification. A first acid treatment was used to remove groundwater-derived carbonate and acid-soluble organics. A hot alkali soaking removed leached humic acid contaminants. The final acid soaking removed any atmospheric carbon absorbed by the proceeding alkali treatment. Each application of acid or alkali was followed by soakings in distilled water until chemical neutrality was achieved; this assured removal of the dissolved contaminants introduced by each process. Since the degree and type of preservation and/or contamination was different, the strength, temperature, duration, and number of applications varied for each sample.

The single unburned bone sample was first physically cleaned and any extraneous material removed. It was then crushed and put into dilute cold acid. The acid was periodically renewed over the next few days as the mineral portion (apatite) of the bone dissolved leaving only the organic (collagen) fraction. The resulting collagen was treated with very dilute alkali and thoroughly rinsed to neutrality. Samples were combusted in an enclosed system. The resulting carbon dioxide gas was purified and reacted with hydrogen on cobalt catalysts to produce graphite. The graphite was then sent to CAMS or, in one instance (Beta-65693), ETH, for the actual AMS measurements.

Shell was not pretreated by Beta. Direct acid reactions generated the carbon dioxide used as the carbon source for the radiocarbon content measurement on each sample. The collected carbon dioxide was purified and reacted with hydrogen on cobalt catalysts to obtain the graphite used in dating.

Beta determined that eight of the submitted samples contained insufficient carbon or posed other problems for AMS measurements following their pretreatment. Communication between Beta and Mariah staff resolved these problems in various ways, and these are presented below.

Two samples from 41BL233 had problems. Sample 2-233-011 (Beta-64260), a small (49.3 mg), weathered, unidentifiable, unburned bone fragment from F 1, TP 2, 40 to 50 cmbs, did not yield sufficient collagen to pursue dating. This bone sample was not processed as it was undesirable to combine bone fragments that would result in an average radiocarbon date --especially if multiple bones in the sample were actually of significantly different ages. Charcoal sample 2-233-001 (Beta-64241), from F 5, TP 1, 0 to 10 cmbs, was also determined to have insufficient carbon (0.7 mg) to yield good results. This latter sample was dropped and replaced by a larger single piece of charcoal (2-233-016) from 10 to 20 cmbs of the same TP.

At 41CV124, two samples were determined to be two small for measuring and one sample (1-124-001) turned out to be a tiny piece of black rubber. The latter sample was not replaced. Charcoal sample 1-124-003, weighing 0.6 mg (Beta-62226), and charcoal sample 1-124-004, weighing 0.9 mg (Beta-64227), both from 80 to 90 cmbs, were combined to obtain an average age of the bottom of the deep, central pit (F 1a). This combined charcoal sample was subsequently determined to be still too small and more charcoal pieces (1-124-6) from the bottom of the pit were added to obtain a single averaged date. This was the only composite sample in the entire program. The chemical pretreatment and target material was prepared by Beta, but this sample was AMS measured in triplicate at ETH.

At 41BL598, all three original samples from F 1, TP 1 were inadequate. Charcoal sample 2-598-001, weighing 0.7 mg (Beta-64241), from 10 to 20 cmbs was dropped and replaced by a piece of charcoal (2-598-007) from 20 to 30 cmbs. The uncharred seed husk sample 2-598-002, weighing 0.3 mg, from 40 to 50 cmbs, was dropped and a piece of charcoal (2-598-008) from 40 to 50 cmbs replaced it. Charcoal sample 2-598-003, weighing 0.5 mg, from 80 to 90 cmbs, was dropped and replaced by a charcoal piece (2-598-009) from 60 to 70 cmbs.

At 41CV1027, one piece of charcoal (1-1027-005, weighing 0.7 mg) from TP 2, 40 to 50 cmbs was dropped altogether. A second sample (1-1027-004) from TP 2, 10 to 20 cmbs was dropped because it turned out not to be charcoal.

Isotopic values (depicted as δ13C) were measured directly during the AMS counting procedure. All radiocarbon results from Beta were adjusted for the carbon isotope value which is the ratio of nonradioactive 12C/13C carbon. This isotopic value alters the actual age determination and is thus important for determining the precise age of a sample. In this study, the use of single pieces of dated charred wood (charcoal) or seeds from a single species provides direct carbon isotope information indicative of the specific photosynthetic pathway utilized by the analyzed plant species. None of the pieces of charred wood were large enough for species identification, had they been, they might have added data about the past environmental conditions.

8.3.3.2 Calibration Methods

Radiocarbon dating laboratories have analyzed hundreds of samples obtained from known-age tree rings of oak, sequoia, and fir up to 10,000 B.P. Longer term differences, up to 22,000 B.P., as well as all marine samples, have calibrations that have been inferred from other evidence, but are less certain. The accumulation of individual dates of known age permits the development of calibrated curves which depict the atmospheric carbon content at specific time periods and permits the calibration of radiocarbon to calendrical years.

The calibrations up to 10,000 B.P. assume that the material dated was living for 20 years. This material might be branches, shells, small plants, individual tree rings, etc. For other materials, the "old wood effect" would produce uncertainties; both the maximum and minimum ranges of age possibilities could be overstated by that error source. Also, but less likely, in extreme cases, they might even turn out to be understated.

The difference between radiocarbon years before present (rcybp) and calendar years (A.D./B.C.) is caused by fluctuations in the heliomagnetic modulation of the galactic cosmic radiation and, since the industrial revolution, the advent of large-scale burning of fossil fuels and testing of nuclear devices. Geomagnetic variations are the probable cause of medium-term differences between rcybp and calendrical years, up to 10,000 B.P. In general, the rcybp ages are younger than their calendrically calibrated ages.

Once actual radiocarbon measurements were obtained by the AMS laboratories and returned to Beta, they were calibrated to tree-ring calendrical dates. Beta used the University of Washington, Radiocarbon Calibration Program, Revision 3.0, by Stuiver and Reimer (1993) to calibrate the assays to calendrical ages using the computer program developed by Pearson and Stuiver (1993).

8.3.4 Humate Analysis

Seven matrix samples retrieved from the bottom of the flotation barrel, and measuring roughly 8 l each were selected and submitted to the University of Texas Radiocarbon Laboratory for bulk humate assays. Selection was based on their association with charcoal samples submitted for dating.

Calculations are based on the currently accepted Libby half-life value for C-14 of 5,568 years, a modern reference standard of 74.59 percent NBS oxalic acid, and a measured 12C/13C ratio; to recalculate the date using the NBS half-life value of 5,730 years, multiply the value presented by 1.03. Ages are listed to the nearest year, although the laboratory rounds them to the nearest decade.

8.4 CHRONOMETRIC RESULTS

8.4.1 Site 41BL233

This site contains at least five recognizable burned rock mounds with two, Fs 1 and 5, selected for age determination in this chronological study (see Section 6.3.3.1). One objective of investigating two features at the same site was to obtain chronometeric information on different periods of use of individual features. The chronology of Fs 1 and 5 are discussed below.

8.4.1.1 Feature 1

This mound was assessed through seven chronometric assays from TP 2: four charcoal, one on unburned seeds, one on unburned bone, and one from humates on bulk sediment (Table 8.10). The unburned *Brassica* sp. seeds (Personal communication, Dering, 1993), a species introduced from the Old World, yielded a modern assay of 154 ± 1.2% B.P. These intrusive, modern seeds were recovered from 40 to 50 cmbs and indicate downward movement of fine materials in this mound. Seed age and the depth from which they were retrieved also document how quickly fine materials move to depths of half a meter within burned rock features.

Table 8.10 Radiocarbon Results from Feature 1, Test Pit 2 at 41BL233.

Depth (cm bs)	Fort Hood Catalogue Number	Material Type	Laboratory Number	Unadjusted Date B.P.	C12/C13 Isotope Value	Adjusted Date B.P.	Calibrated Age B.C./A.D.
10 - 20	010	Unburned Bone	Beta 65259 CAMS 7929	130 ±**p1029X50	-22.4	170 ± 50	[1]A.D. 1666 (1680, 1804, 1954) 1954 [2]A.D. 1651 (1680, 1804, 1954) 1955*
10 - 20	006	Charcoal	Beta 64246 CAMS 7919	870 ± 70	-25.9	860 ± 70	A.D. 1052 (1214) 1266 A.D. 1022 (1214) 1289
20 - 30	007	Charcoal	Beta 64247 CAMS 7920	890 ± 70	-26.4	870 ± 70	A.D. 1046 (1195) 1255 A.D. 1019 (1195) 1287
40 - 50	008	Charcoal	Beta 64248 CAMS 7921	680 ± 70	-25.8	670 ± 70	A.D. 1283 (1300) 1396 A.D. 1237 (1300) 1416
40 - 50	009	Charcoal	Beta 64249 CAMS 7922	680 ± 70	-26.7	650 ± 70	A.D. 1288 (1305, 1367, 1373) 1400 A.D. 1260 (1305, 1367, 1373) 1427
40 - 50	015	Humate	TX - 7948	1168 ± 44	-22.1	1214 ± 44	A.D. 776 (816, 847, 853) 886 A.D. 686 (816, 847, 853) 959
40 - 50	012	Unburned Seeds	Beta 64261 CAMS 7930	152.2 ± 1.2% - 28.8	154.3 ± 1.2%		

1. 1 sigma range   2. 2 sigma range   * Bomb influenced

The unburned bone scrap yielded an assay of 170 ± 50 B.P., calibrated to A.D. 1806. Based on the depth from which it was retrieved (10 to 20 cmbs), coupled with its recent age in comparison to most other charcoal ages, the bone appears intrusive into this mound. A cluster analysis revealed that the seed and bone assays (Beta-64261 and Beta-64259 respectively) are statistically the same with a pooled age of 161 ± 65 B.P. (T' 0.01 with 1DF). This modern bone fragment again documents the downward movement of objects from the surface. The intrusive seeds and bone do not reflect cultural use episodes.

The four δ13C-adjusted B.P. charcoal assays visually appear as two distinct groups in Figure 8.18. These four assays were from 10 to 50 cmbs although the two youngest assays (Beta-64246 and Beta-64247) were from 40 to 50 cmbs, while the two oldest assays were from 10 to 30 cmbs. Even though different excavation levels were sampled, a cluster analysis (Carlson n.d.) incorporating these four charcoal assays indicate that they are statistically the same population and form a single age group. Their pooled age is 763 ± 43 B.P. (T' = 5.71, with 3DF), calibrated to A.D. 1279. This combined age is interpreted to represent aboriginal burning event(s) within the Neo-Archaic/Late Prehistoric period, near the Austin and Toyah phase boundary. Without the recovery of diagnostic projectiles, it is uncertain with which phase these assays and mound are associated.

The base of a Uvalde dart point was recovered from 20 to 30 cmbs (Figure 8.3). Based on its shallow position within this mound and the absolute radiocarbon assays retrieved, this projectile appears to have been redeposited in this feature considerably later than the point's presumed manufacture (Early Archaic, 6000-5000 B.P., Prewitt 1981, 1985; Turner and Hester 1985:155).

Nearly 8 liters of matrix from 40 to 50 cmbs and at the very base of this feature yielded a δ13C-adjusted humate age of 1168 ± 44 B.P. (Tx-7948). The 1214 B.P. (calibrated to A.D. 847) humate assay indicates that the clay matrix at the very base of this mound contained older premound carbon in sufficient quantities to add unwarranted antiquity to any carbon associated with the mound. This assay probably represents a period prior to mound construction. It is likely that this mound was used on one or a few short occasions.

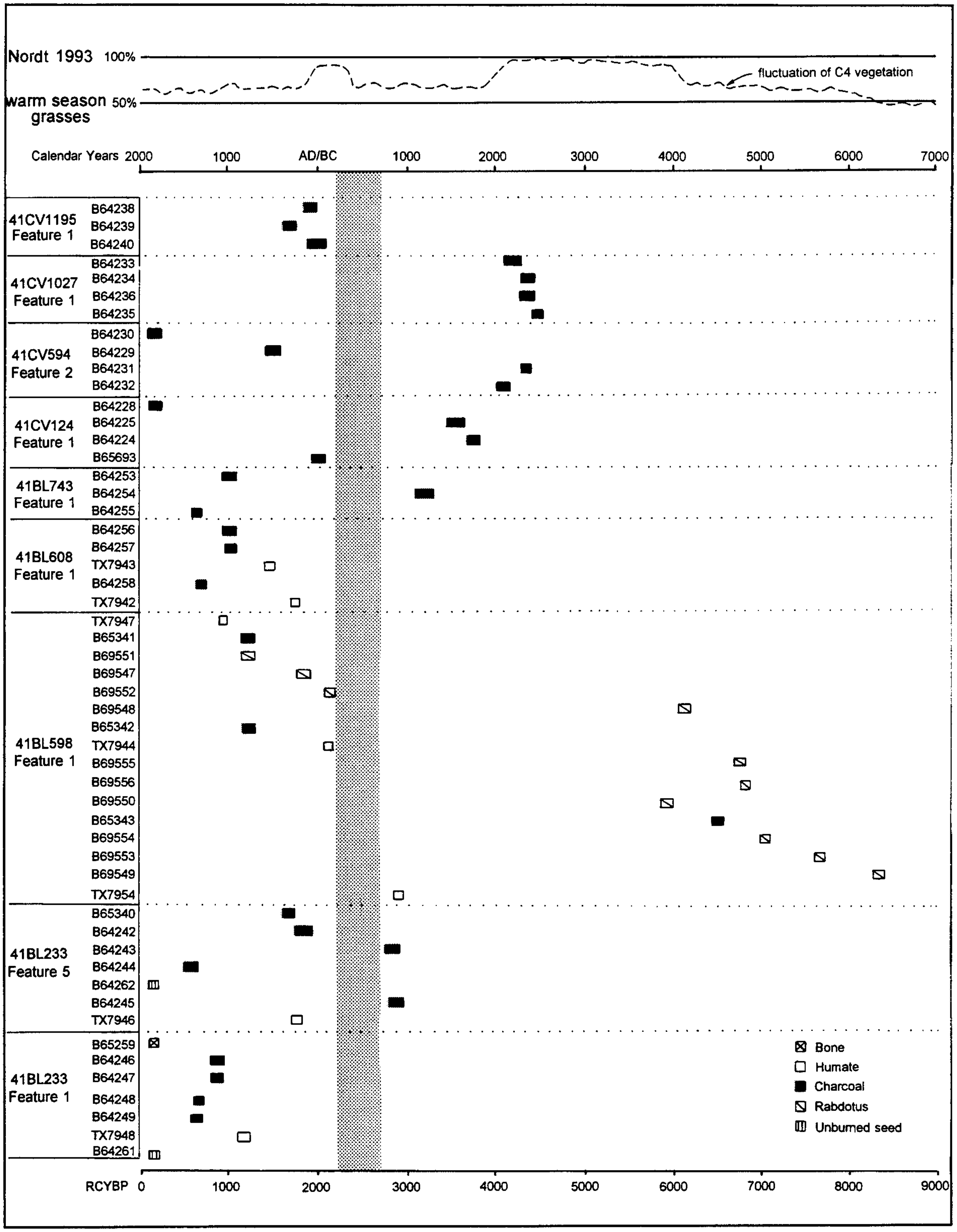


Figure 8.18 Radiometric Assays from Nine Burned Rock Mounds Investigated at Fort Hood in 1992. Shading indicates period with no dates.

The bone, the soil humate, and two charcoal assays (Beta-64248 and Beta-64249) were all retrieved from 40 to 50 cmbs to assess age differences between the various material types from a single level. These four radiocarbon results clearly reveal problems with material association. Objects retrieved from within a single 10 cm level appear vertically associated, but they were not necessarily the same age or culturally associated. The two charcoal assays, calibrated respectively to A.D. 1300 and 1305, appear to reflect one burning event and are ca. 500 years younger than the humate results which were calibrated to A.D. 847. However, the humate assay apparently reflects a premound accumulation of carbon. The seed and bone ages (both modern) appear to represent recent intrusive materials. Over the last 200 years, both the seeds and bone have managed to penetrate 40 to 50 cm into the mound.

8.4.1.2 Feature 5

Five charcoal, one unburned seed, and one humate sediment sample provide seven absolute assays for assessing the age of Feature 5 (Table 8.11). The unburned seed sample retrieved from 40 to 50 cmbs was identified as *Brassica* sp. and yielded a modern assay of 117.1 ± 0.9% B.P. This specimen documents fine matrix moving 40 cm down through the heavy matrix in a little more than 100 years. Since these were modern seeds with a modern age and none of the five charcoal assays were this young, this assay does not reflect a cultural use episode at this feature.

A cluster analysis (Carlson n.d.), on the five charcoal assays revealed Beta-65245 and Beta-64243 were not significantly different and had a pooled radiocarbon age of 2863 ± 70 B.P. (T' = 0.08 with 1DF) calibrated to B.C. 1006. This age appears to represent the initial burning event which occurred during the middle of the Round Rock phase of the Late Archaic period (Prewitt 1985).

Two other charcoal assays, Beta-64242 and Beta-65340, were not significantly different and provided a pooled radiocarbon age of 1742 ± 62 B.P. (T' = 1.73 with 1DF), calibrated to A.D. 283. This second burning event was during the Twin Sisters phase of the Late Archaic period (Prewitt 1981, 1985). This date also represents a new period of midden use according to Prewitt's Central Texas cultural chronology.

Beta-64244, not associated with the previous samples, yielded a more recent radiocarbon age of 630 ± 70 B.P., calibrated to A.D. 1353 and appears to represent the most recent event. This cultural event is near the very end of the Austin phase or beginning of the Toyah phase (Prewitt 1985). Without the recovery of associated diagnostic projectile points in this midden, it is unclear as to which cultural group last used the F 5 mound.

Two charcoal pieces, from the same 40 to 50 cmbs level as the unburned seeds, yielded assays of 630 ± 70 B.P. (Beta-64244) (calibrated to A.D. 1353) and 2840 ± 70 B.P. (Beta-64243), calibrated to 994 B.C. The modern seed penetrated at least 40 cmbs in less than 200 years, and the differences in the two charcoal dates indicate internal mixing as well.

The humate sample (Tx-7946) yielded a radiocarbon age of 1759 ± 50 B.P., calibrated to A.D. 295, which is in the range of the middle pooled assay group. This sample, retrieved from 60 to 70 cmbs, was not as old as anticipated, as it was projected to have revealed an age similar to the oldest assays. However, it obviously contained more younger humates from the upper half of the level than older charcoal from the lower portion. It may indicate a period of stability of the mound at that time.

Table 8.11 Radiocarbon Results from Feature 5, Test Pit 1, 41BL233.

Depth (cm bs)	Fort Hood Catalogue Number	Material Type	Laboratory Number	Unadjusted Date B.P.	C12/C13 Isotope Value	Adjusted Age B.P.	Calibrated Age BC/A.D.
10 - 20	016	Charcoal	Beta 65340 CAMS 8565	1680 ± 60	-22.5	1680 ± 60	[1]A.D. 264 (397) 428
30 - 40	002	Charcoal	Beta 64242 CAMS 7915	1870 ± 90	-26.3	1850 ± 90	[1]A.D. 75 (146, 190) 319 [2]A.D. 32 (146, 190) 407
40 - 50	003	Charcoal	Beta 64243 CAMS 7916	2840 ± 70	-25.1	2840 ± 70	B.C. 1112 (994) 906 B.C. 1251 (994) 826
40 - 50	004	Charcoal	Beta 64244 CAMS 7917	640 ± 70	-25.8	630 ± 70	A.D. 1292 (1310, 1353, 1385) 1405 A.D. 1276 (1310, 1353, 1385) 1434
40 - 50	013	Unburned Seeds	Beta 64262 CAMS 7931	115.9 ± 0.9%	-31.2	117.1 ± 0.9%	
60 - 70	005	Charcoal	Beta 64245 CAMS 7918	2870 ± 70	-24.4	2880 ± 70	B.C. 1153 (1022) 927 B.C. 1263 (1022) 847
60 - 70	014	Humate	TX - 7946	1714 ± 49	-22.2	1759 ± 49	A.D. 235 (257, 295, 319) 375 A.D. 141 (257, 295, 319) 413

1. 1 sigma range 2. 2 sigma range

The two assays which represented the middle burning event, with a pooled age of 1742 ± 62 B.P. and calibrated to A.D. 283, were from the upper half of the mound deposit (from 20 to 30 and 30 to 40 cmbs). The two oldest assays, with their pooled age of 2863 ± 70 B.P. (calibrated to 1006 B.C.), were from 40 to 50 and 60 to 70 cmbs in the lower half of the mound. In general, these results are internally and stratigraphically consistent.

The base and stem portion of a probable Lange dart point (Figure 8.5), considered representative of the Middle Archaic San Marcos phase (Prewitt 1981, 1985) or part of the Late Archaic period (Turner and Hester 1985:113), was recovered from 40 to 50 cmbs. Based on the present assays from this mound, this Lange base would probably best fit with the Late Archaic period of the pooled age of 1742 ± 62 B.P., calibrated to A.D. 283. However, since some internal disturbance within F 5 was recognized, it is possible that the point originally was associated with the assays of the earlier portion of the Middle Archaic period with the pooled age of 2863 ± 70 B.P., calibrated to 1006 B.C. The context of the point does not provide sufficient indication of which, if any, date is associated with this style of projectile point.

The youngest cultural assay of 630 ± 86 B.P. (calibrated to A.D. 1353) reflects charcoal that had moved down through the profile in a manner similar to the modern seeds. So the matrix retrieved from near the mound's surface contained a higher potential for being mixed with recent materials. Apparently, F 5 was used at least three times over a 3,000-year period.

8.4.2 Site 41BL598

Three charcoal, three humate and 10 *Rabdotus* snail assays from F 1 are used to date it (Table 8.12). Charcoal assays represent specific points in time while the humate assays reflect mean residence times (MRT), the average age of organic material within the matrix.

Table 8.12 Radiocarbon Results from Feature 1, Test Pit 1, 41BL598.

Depth (cm bs)	Fort Hood Catalogue Number	Material Type	Laboratory Number	Unadjusted Date B.P.	C12/C13 Isotope Value	Adjusted Age B.P.	Calibrated Age B.C./A.D.
10 - 20	004	Humate	TX - 7947	886 ± 49	-22.5	925 ± 50	[1]A.D. 1029 (1058, 1080, 1124, 1136, 1157) 1187 [2]A.D. 1015 (1058, 1080, 1124, 1136, 1157) 1228
20 - 30	007	Charcoal	Beta 65341 CAMS 8566	1270 ± 70	-26.7	1240 ± 70	A.D. 684 (782) 886 A.D. 659 (782) 974
40 - 50	005	Humate	TX - 7944	2064 ± 50	-22.0	2113 ± 50	B.C. 191 (151, 148, 117) 46 B.C. 351 (151, 148, 117) A.D. 4
40 - 50	008	Charcoal	Beta 65342 CAMS 8567	1240 ± 70	-25.5	1230 ± 60	B.C. 710 (786) 886 A.D. 667 (786) 968
60 - 70	009	Charcoal	Beta 65343 CAMS 8568	6530 ± 60	-26.0	6510 ± 60	B.C. 5447 (5437) 5433 B.C. 5566 (5437) 5311
80 - 90	006	Humate	Tx - 7945	2856 ± 51	-21.7	2909 ± 51	B.C. 1160 (1112, 1103, 1061) 1003 B.C. 1260 (1112, 1103, 1061) 924
20 - 30		*Rabdotus* CB 86	Beta 69547 CAMS 10946	1590 ± 80	-9.9	1840 ± 80	A.D. 11 (215) 399
20 - 30		*Rabdotus* CB 87	Beta 69548 CAMS 10947	5870 ± 70	-9.8	6120 ± 70	B.C. 5227 (5051) 4846
20 - 30		*Rabdotus* CB 100	Beta 69551 CAMS 10950	960 ± 60	-8.7	1230 ± 60	A.D. 667 (786) 968
20 - 30		*Rabdotus* CB 101	Beta 69552 CAMS 10951	1850 ± 60	-8.1	2130 ± 60	B.C. 365 (165) A.D. 6
40 - 50		*Rabdotus* CB 132	Beta 69555 CAMS 10954	6530 ± 60	-10.4	6770 ± 60	B.C. 5712 (5611) 5526
40 - 50		*Rabdotus* CB-133	Beta 69556 CAMS 10955		-6.4	6820 ± 50	B.C. 5735 (5667) 5590
60 - 70		*Rabdotus* CB-92	Beta 69549 CAMS 10948		-8.6	8340 ± 60	B.C. 7500 (7423) 7103
60 - 70		*Rabdotus* CB-93	Beta 69550 CAMS 10949		-8.9	5900 ± 80	B.C. 4942 (4783) 4549
60 - 70		*Rabdotus* CB-108	Beta 69553 CAMS 10952		-8.2	7680 ± 60	B.C. 6600 (6463) 6386
60 - 70		*Rabdotus* CB-128	Beta 69554 CAMS 10953		-7.9	7040 ± 80	B.C. 6005 (5935, 5914, 5871) 5703

1. 1 sigma range
2. 2 sigma range

Amino acid epimerization assays were performed on the shells of 13 *Helicina orbiculata* and 24 *Rabdotus dealbatus* snails to provide data for analyzing the integrity of the feature and interpreting the significance of the radiocarbon assays. This additional data makes it possible to analyze feature dating and formation to a degree not possible for the other sites in this study. As a result, the following is an extended analysis.

8.4.2.1 Charcoal and Humate Assays

Two charcoal assays (Beta-65341 and Beta-65342) are statistically similar in age as revealed by a cluster analysis (Carlson n.d.) which provided a pooled age of 1235 ± 58 B.P. (T' = 0.01 with 1DF), calibrated to about A.D. 784. These charcoal assays came from 20 to 30 cmbs and 40 to 50 cmbs, respectively. These assays imply that the upper 50 cm of the feature correspond to an event within Prewitt's (1981, 1985) Driftwood phase of the Late Archaic period.

A third charcoal (Beta-65343) assay of 6510 ± 60 B.P., calibrated to 5437 B.C., from 60 to 70 cmbs was stratigraphically beneath the previous two charcoal assays. The early age of Beta-65343 and its stratigraphic position within a B horizon containing many unburned clasts (see Figure 8.18) imply that the sample came from below the actual midden matrix, which is confined largely to the upper 50 cm of the stratigraphy. This charcoal assay may still date a cultural event since it may have moved down the profile from the midden zone. Furthermore, the presence of burned rocks and other artifacts in the lower levels may reflect the accumulation of cultural materials prior to the formation of the stratigraphically higher midden deposits dated by Beta-65341 and Beta-65342. If Beta-65343 is from culturally derived material, this age is within Prewitt's (1981, 1985) San Geronimo phase of the Early Archaic period.

Three humate assays provide minimal support for the charcoal ages since they reflect MRT rather than discrete objects. The humate results of 925 ± 50 B.P. (calibrated to A.D. 1124; Tx-7947) from 10 to 20 cmbs is younger than the charcoal assay (1235 ± 58 B.P.) that comes from the 20 to 30 cmbs. This comparison is not surprising since the humates dated by Tx-7947 are close to the surface and in the active root zone where contributions of modern carbon and decomposition of old carbon can be expected to weight MRT toward an anomalously recent date (Matthews 1985).

Sample Tx-7944, from 40 to 50 cmbs, dates to 2113 ± 50 B.P. (calibrated to 148 B.C.), is older than the previous humate date, but nearly 875 years older than the age of a charcoal piece from the same level. The stratigraphic relation between the humate dates is reasonable. However, the difference between the humate and charcoal dates from 40 to 50 cmbs is unexpected if the charcoal and the matrix were deposited at the same time: if anything, the humate date should be newer than the charcoal date as a result of rejuvenation of carbon in the humate sample. This comparison implies either that the charcoal has moved down the profile from its original position, or that it burned in place after the matrix was deposited, or that it was redeposited along with older matrix in a provenience that now contains both relatively old and new materials.

The lowest humate assay (Tx-7945, from 80 to 90 cmbs) is the oldest of the humate dates. At 2909 ± 51 B.P., calibrated to 1103 B.C., Tx-7945 is stratigraphically consistent with the other humate dates, but it is not nearly as old as the charcoal assay of 6510 B.P. from higher in the profile (60 to 70 cmbs). However, there is no necessary conflict between the old charcoal date and the stratigraphically lower humate date. Even if the old charcoal assay represents incorporation of preexisting charcoal into a midden matrix, it is to be expected that carbon rejuvenation and/or decomposition would weight humates from contemporaneous or earlier sedimentary matrix toward a postdepositional date, especially in shallow surface contexts where humate samples are obtained from an active root zone. It is not unreasonable to expect that rejuvenation and/or decomposition could be enough to produce an apparent stratigraphic reversal between the humate and charcoal dates.

At most, then, the uppermost humate date implies that the midden formed before approximately 925 B.P., which is consistent with all of the charcoal and humate dates. However, the lower humate dates imply that the matrix below 40 cmbs was in place before about 2100 B.P., because these two samples can be assumed to contain at least some carbon of postdepositional age. Although the 6510 B.P. charcoal date does not conflict with the humates, both of the younger charcoal dates do. Together, therefore, the charcoal and humate dates appear to support only the following general claims about the age of Feature 1:

(1) On the basis of the humate date from 20 to 30 cmbs, the upper part of the midden can be assumed to predate about 925 B.P.;

(2) On the basis of the humate dates from 40 to 50 and 80 to 90 cmbs, the middle and lower part of the midden may predate about 2100 B.P.;

(3) On the basis of the upper two charcoal dates, there appears to have been a burst of midden formation or modification at about 1230 B.P.; and

(4) On the basis of the lowest charcoal date, the portion of the feature where unburned rock is more common was formed at or after about 6500 B.P.

8.4.2.2 Land Snail Carbon Assays

Radiocarbon data from *Rabdotus* shells may help clarify the date of F 1. The 10 *Rabdotus* snails selected for radiocarbon analysis provided δ13C-adjusted assays as shown in Table 8.12. As noted in section 7.4.2, although the average age anomaly for *Rabdotus* is likely to be small, it is also likely that an unknown amount of variability of anomaly occurs. In a study of age anomalies in land snails, Goodfriend (1987) found that variability of age anomaly can add as much as 1,180 years to measurement error (at 1 sigma), although additional uncertainties for three species in his study added 230 to 500 years to measurement error (at 1 sigma), and additional uncertainty was unmeasurable for another species. Furthermore, δ13C adjustments do not reflect additional adjustments that must be made to compensate for the effects of ingesting 14C-depleted carbonates, although the differences between the corrected ages used here and the appropriate correction, whatever it may be, probably are not major (Goodfriend and Hood 1983; Goodfriend, personal communication to Ellis). Therefore, the radiocarbon ages from *Rabdotus* are generally treated as approximations, although some effort will be made to show the impact of a worst-case-scenario interpretation.

One assay (Beta-69551) on a snail shell from 20 to 30 cmbs yielded a date of 1230 ± 60 B.P. This assay is consistent with the likelihood that the upper portion of the feature underwent a formation or modification episode at about 1230 B.P., as indicated by the two charcoal dates. Two other assays (Beta-69547 and Beta-69552) from the same level, however, yielded dates of 1840 ± 70 and 2130 ± 60 B.P. These two assays conflict with the charcoal dates unless variability of age anomaly adds no more than about 450 years to measurement error. However, given the current state of knowledge about age-anomaly variability, these three assays are not inconsistent with an episodic midden formation event at about 1230 B.P.

However, a fourth sample (Beta-69648) from 20 to 30 cmbs yielded a date of 6120 ± 70 B.P. Since the *total* amount of age anomaly apparently never exceeds 3,000 years (Goodfriend and Stipp 1983), *variability* apparently cannot add more than 1,500 years to the measurement error (at 1 sigma) of dates on *Rabdotus* shells. Thus, even a worst-case interpretation of Beta-69648 is inconsistent with the charcoal dates. Even if the sample has maximum age anomaly and even if the true date for Beta-69648 is at the upper tail of a 95 percent confidence interval, the date still would be about 1,800 to 1,900 years too old to be contemporary with a use-event at 1230 B.P. As a result, although it appears to be highly likely that formation or modification of the upper portion of the feature took place about 1,230 years ago, the upper portions of the stratigraphy almost certainly contain materials redeposited from an earlier context. Indeed, an analysis of the remainder of the snail shell dates implies that formation of the feature and the underlying stratum took place in at least two major stages.

Assays were performed on two *Rabdotus* shells (Beta-69555 and Beta-69556) from 40 to 50 cmbs, yielding statistically identical dates of 6770 ± 60 B.P. and 6820 ± 50 B.P. These dates occur well within the stratigraphic limits of midden fill and in the same level as one of the more recent charcoal dates and a 2,100-year-old humate date. Again, even if variability of age anomaly is at worst-case levels, the snail assays are 2,500 to 2,600 years too old to be consistent with formation at approximately 1230 B.P. Note, therefore, that the combination of humate and snail dates from 40 to 50 cmbs implies that a substantial portion of the midden fill in this level predates a 1230 B.P. use-event at the feature. The humate date, because it is probably weighted by rejuvenated carbon, implies that much of the fill is older than 2,100 years. The snail dates imply that the fill is not older than about 6,800 years.

Assays also were performed on four *Rabdotus* shells (Beta-69549, Beta-69550, Beta-69553, and Beta-69554) from 60 to 70 cmbs, yielding dates ranging from 5900 ± 80 B.P. and 8340 ± 60 B.P. These shells came from the upper limit of the underlying stratum in which substantial numbers of unburned rocks co-occur with burned rocks. Together with the humate date from 80 to 90 cmbs, the snail dates imply that formation of the underlying stratum took place before about 3,000 years ago, but after about 8,300 years ago.

An interesting feature of the F 1 dates is that all of the newer snail dates occur in or above levels with recent charcoal dates so that the preponderance of chronometric evidence in the upper portion of the stratigraphy comes from materials with relatively young ages, whereas the preponderance of chronometric evidence in the lower portion of the stratigraphy (including the lowest two levels of the feature itself) comes from materials with relatively old ages. An especially interesting aspect of the range of charcoal and snail dates is the 3,800-year gap that occurs between the six oldest snail dates and the newer charcoal and snail dates. Given the relatively large number of assays involved, it appears to be very unlikely that the dates come from a stratigraphic matrix that reflects either a single cultural event dating to 1,230 years ago or a more or less continuous accumulation of materials beginning 6,000 to 8,000 years ago, even if a substantial allowance is made for variability of age anomaly in the snail assays. Thus, the dates strongly imply that:

(1) the upper portion of the stratigraphy is dominated by relatively young materials;

(2) the lower portion of the stratigraphy, including the lowest two levels of midden fill, are dominated by old materials; and

(3) the gap between relatively new and relatively old dates represents a hiatus in deposition.

8.4.2.3 Land Snail Epimerization Assays

The interpretation presented above is supported by amino acid epimerization data (Chapter 7.0). Alloicoleucine/isoleucine (A/I) ratios were obtained from 13 *Helicina* and 24 *Rabdotus* shells (Table 8.13), including the 10 *Rabdotus* shells that were dated by radiocarbon methods (see Section 7.4). Figure 8.19 depicts the stratigraphic distribution of A/I ratios from *Rabdotus* shells in F 1, and Figure 8.20 shows the distribution for ratios from *Helicina*. As noted in Section 7.4.1, the A/I ratio for sample CB133 (Figure 8.19) probably has been artificially increased by the influence of heat, perhaps as a result of proximity to fire in the central depression of the feature. In addition, one *Helicina* ratio (CB85, Figure 8.20) is equivalent to a Pleistocene age and also probably reflects the influence of heat from fire. Another *Helicina* ratio (CB90, Figure 8.20) is effectively modern, and probably represents either intrusion or excavation error. The anomalous *Helicina* assays will be ignored hereafter.

Table 8.13 A/I Ratios from Snail Shells, Feature 1, 41BL598.

	Helecina			*Rabdotus*		
Level	ID No.	Ratio	Error	ID No.	Ratio	Error
3	CB105	0.0132	0.0005	CB100	0.0423	0.0017
	CB90	0.0147	0.0006	CB86	0.0492	0.0020
	CB89	0.0770	0.0031	CB101	0.0731	0.0029
	CB91	0.1090	0.0044	CB126	0.0947	0.0038
	CB104	0.1090	0.0044	CB125	0.0992	0.0040
	CB103	0.1590	0.0064	CB102	0.1380	0.0055
				CB88	0.1480	0.0059
				CB87	0.1570	0.00563
5	CB85	0.5370	0.0215	CB132	0.1670	0.0067
				CB135	0.1750	0.0070
				CB130	0.1780	0.0071
				CB134	0.1880	0.0075
				CB131	0.1910	0.0076
				CB133	0.2390	0.0096
7	CB109	0.2050	0.0082	CB127	0.1430	0.0057
	CB111	0.2090	0.0084	CB93	0.1480	0.0057
	CB95	0.2230	0.0089	CB108	0.1490	0.0059
	CB97	0.2250	0.0090	CB106	0.1500	0.0060
	CB110	0.2690	0.0108	CB128	0.1590	0.0064
				CB107	0.1670	0.0067
				CB94	0.1700	0.0068
				CB129	0.1870	0.0075
				CB92	0.2140	0.0086
8				CB84	0.1970	0.0079

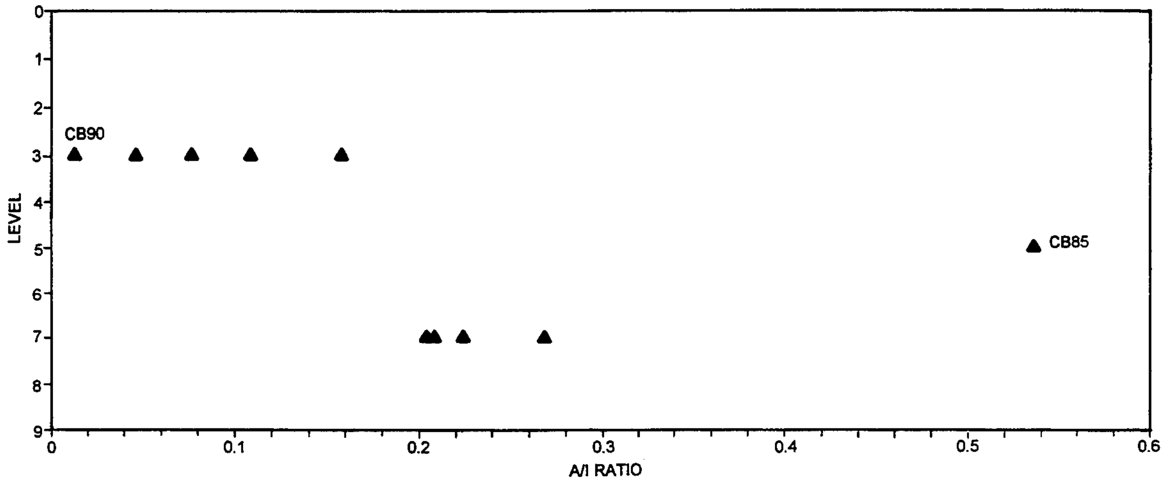


Figure 8.19 Plot of A/I Ratios for the *Helecina* in Feature 1, 41BL598. CB85 is apparently anomalous as a result of heat by fire. CB90 is effectively modern.

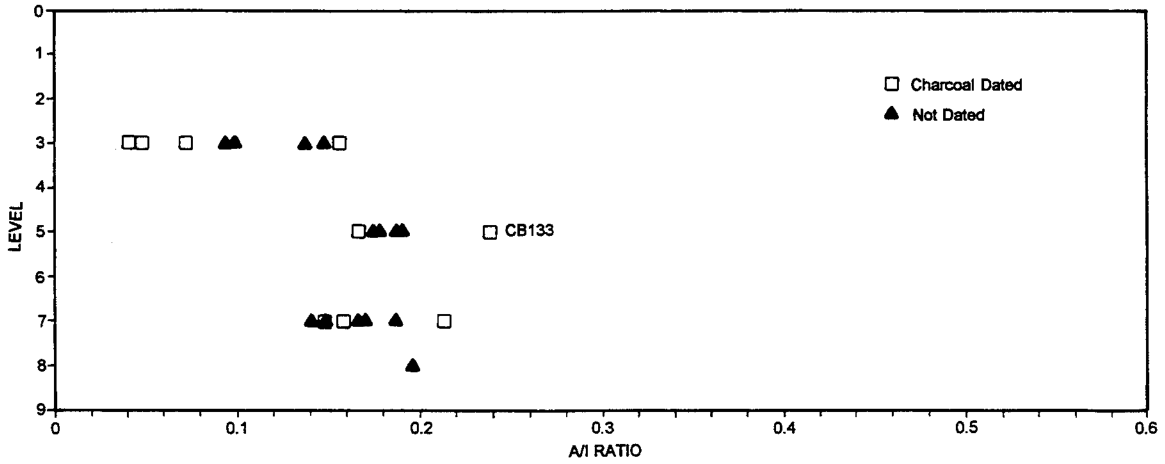


Figure 8.20 Plot of A\I Ratios for the *Rhabdotus* in Feature 1, 41BL598. CB133 apparently has anomalously high ratio as a result of heating by fire (see Section 7.4.1).

Both distributions have similar patterns, with most relatively high ratios concentrated in the lower half of the profile, and all low ratios concentrated from 20 to 30 cmbs. In both distributions, ratios are fairly closely clustered around the ratio of the youngest apparent shell in each of the lower levels. Note that the closely spaced *Helicina* ratios from 60 to 70 cmbs have slightly higher ratios than the closely spaced *Rabdotus* ratios. If the clustering of ratios reflects more or less episodic burial (see Section 7.3.1), it implies that epimerization in *Helicina* occurs at a slightly faster rate than in *Rabdotus,* although there is as yet no empirical data to substantiate this.

The *Rabdotus* distributions show that the shells with old radiocarbon ages in the lower half of the profile are accompanied by another 11 shells with A/I ratios that fall close to the range of ratios from dated shells. Thus, not only is the radiocarbon evidence preponderantly old in the lower half of the unit, the A/I data contains no counter examples. Hence, out of eight charcoal and snail radiocarbon ages and 22 A/I ratios, the recent charcoal date from 40 to 50 cmbs is the only metric datum to imply that the lower midden levels and underlying stratum date to a use-event at about 1200 B.P. The radiocarbon and A/I data therefore strongly imply that the basic content of the matrix in the lower half of the profile was established more than about 5,000 years ago, and that the 1230 B.P date from 40 to 50 cmbs reflects redeposition or translocation. The clustering of *Rabdotus* A/I ratios from 40 to 50 cmbs and 60 to 70 cmbs and *Helicina* ratios from 60 to 70 cmbs supports this judgment by implying that these levels largely are dominated by older materials. Consequently, the 1230 B.P. date from 40 to 50 cmbs appears to be stratigraphically out of place.

However, to say that the charcoal date from 40 to 50 cmbs is out of place is not to explain how it might have come to be so. Note that in both A/I distributions, some relatively high ratios also occur from 20 to 30 cmbs, although this level is dominated by a wide range of ratios for both species. This level also is characterized by a wide range of charcoal and snail radiocarbon dates. The spread of radiocarbon ages and A/I ratios strongly suggests mixed deposits. The contrast in A/I and radiocarbon data between the upper and lower assemblages therefore suggests that something like the scenario presented in the following section led to the formation of the feature and the underlying stratum.

8.4.2.4 Interpretation

Judging from the oldest snail date, the accumulation of burned and unburned rock in the underlying stratum began sometime after 8300 B.P. Given the 6510 B.P. charcoal date and the 5900 B.P. snail date, the underlying stratum was in place by about 6000 B.P., although it may have been subject to stratigraphic mixing through some or all of its accumulation.

Inferring from the snail dates and the clustering of the A/I ratios from 40 to 50 cmbs, formation of the midden itself probably began no later than about 6000 B.P., shortly after the underlying stratum was deposited. Judging from the stratigraphic positions of snail dates and A/I ratios, formation of the lower midden levels could have involved mixture of new materials with old materials from the underlying stratum. However, interpreting from the clustering of the youngest ratios from 40 to 50 and 60 to 70 cmbs and the absence of low ratios in these levels, there probably was not much of a hiatus between the deposition of the underlying stratum and the beginning of midden formation. If the surface of the underlying stratum had been exposed for many centuries before midden formation began, the A/I ratios from 60 to 70 cmbs would be largely unclustered and strung out over a very wide range, which they are not. Moreover, at least some of the A/I ratios from 40 to 50 cmbs would be substantially lower than the some of the ratios from 60 to 70 cmbs. Given the degree to which snails from these levels have been assayed, the absence of low ratios and recent radiocarbon dates in the lower stratigraphy is not likely to result from sampling error.

Given the charcoal and snail radiocarbon dates and the spread of A/I ratios from 20 to 30 cmbs, the upper three levels of the midden fill contain materials of mixed ages. However, the younger charcoal and snail dates in this level are too coincidentally grouped in the 1200 to 2100 B.P. range, especially given that the snail dates are likely to be characterized by some variable amount of age anomaly. Thus, it is likely that the uppermost levels of the midden were deposited more or less episodically around 1,200 years ago. The 20 to 30 cmbs level probably includes materials originally deposited on an old midden surface during a hiatus after about 6000 B.P. -- materials dredged up from lower levels, and materials contemporaneous with the use-event. A model of recent, episodic midden formation from the location of the depression outward is incompatible with both the radiocarbon and A/I data because (1) too little of the chronometric data below 40 cmbs is recent; (2) the radiocarbon and A/I data with the exception of several outliers, are too consistent with each other to imply that fire has severely compromised the A/I data; and (3) the radiocarbon and A/I data overwhelmingly favor deposition of the lower half of the stratigraphy long before deposition of the upper half even if the snail dates are affected by extremely high levels of age-anomaly variability. It is more likely, therefore, that the midden stratigraphy represents two stages of cultural deposition separated by a substantial local hiatus. During the hiatus, cultural deposition may have taken place elsewhere on the site or elsewhere on the feature. The hiatus may represent a period of site abandonment.

It is tempting to speculate that excavation and use of the central depression next to the test pit accounts for the content of the upper levels. Under this scenario, the lower portion of the midden was in place by about 6000 B.P. after which land snails (and perhaps other materials) accumulated on a paleosurface somewhere between 20 to 40 cmbs. Then, at about 1230 B.P., the central depression was dug at least partly into the older deposits. Back dirt was deposited at least partly into the area where the test pit was excavated. As a result, older materials from the lower midden levels and/or the underlying stratum became mixed with materials that had accumulated on the surface since about 6000 B.P., burying an assemblage of in situ and redeposited materials with a wide range of absolute and relative dates. During use, new materials would have been deposited next to the depression, with the net result being that midden use at about 1230 B.P. led to formation of deposits containing materials with ages contemporary to, and older than, the date of formation and use. The spread of radiocarbon ages and *Helicina* and *Rabdotus* ratios from 20 to 30 cmbs supports this contention. Under this scenario, it is possible that the 1230 B.P. date from 40 to 50 cmbs was introduced to the level laterally rather than vertically as a result of activities taking place in the central depression only a few centimeters away.

As a result of this analysis, it is necessary to reconsider the phase assignments made at the beginning of this section according to the charcoal dates. The assignment of a Driftwood date to the upper 30 or 40 cm of the stratigraphy appears to be valid and may coincide with either construction of the central depression or with a shift in the location of cultural deposition from elsewhere on the site (or elsewhere on the feature itself). However, the bulk of the metric data from midden fill below 40 cmbs is much older than the Driftwood date of the charcoal from 40 to 50 cmbs. Hence, assigning a Driftwood age to the lower midden levels does not appear to be valid. On the basis of the snail dates and the lowest charcoal date, the lower midden levels appear to have a San Geronimo to Jarrell-phase date, depending on how much age-anomaly variability goes with the snail dates. The stratum below the midden has late Circleville to Jarrell-phase date, again depending on the age-anomaly variability of the snail dates.

More interesting, however, may be a change in the pattern of cultural deposition, at least in the location of the test pit. There appears to have been a shift from a midden deposit that contains some burned rock in the underlying stratum to a bona fide burned rock midden in the lower levels of F 1 itself. Such a shift may reflect a change in the activities leading to midden formation, or perhaps a change in the location of the pattern of heating and discarding burned rocks. This shift, if it is real, occurred during the Early Archaic. After a period of disuse that may have lasted from the Early to Late Archaic, an extant and otherwise apparently undifferentiated burned rock midden deposit may have been transformed into a locus for activities that involved burning more rocks and depositing them and other materials next to the central depression. In other words, previously formed midden deposits may have been transformed into part of an in situ cooking and heating apparatus. In any event, it is unlikely that the upper and lower feature deposits are contemporary or closely spaced in time.

8.4.3 Site 41BL608

Five radiocarbon assays, three from charcoal and two from humate, provide the age estimate for this annular mound F 1 (Table 8.14). Although there appears to be a central, internal pit feature, none of the obtained assays came from that particular internal feature. All five assays were from the thick, burned rock accumulation adjacent to this potential pit. Three charcoal assays document at least two burning episodes (Table 8.14; Figure 8.18), as a cluster analysis (Carlson n.d.) indicates the 1050 B.P. and 1040 B.P. are statistically similar despite their differences in age. Their pooled age is 1045 ±**p75(4X61D.01, 1DF), calculated to A.D. 1008, and falls within the Austin phase of the Neo-Archaic/Late Prehistoric period of Central Texas (Prewitt 1981, 1985).

The third charcoal assay, from 50 to 60 cmbs, documents another use episode ca. 710 ± 50 B.P., calibrated to A.D. 1290. This most recent charcoal assay (Beta-64258) from the lowest level (40 to 50 cmbs) again documents fine matrix moving down through the profile. The young assay from this provenience could also indicate the amount of turbation following aboriginal abandonment or disruption caused during the more recent cultural episodes. This assay documents the most recent burning event within the Austin phase of the Neo-Archaic/Late Prehistoric period.

Both humate assay results, 1469 ± 43 and 1750 ± 44 B.P., document that earlier organic remains are present since the assays are older than their corresponding charcoal dates. The humate ages are stratigraphically consistent with their depths and do not reflect the mixed displacement that occurred with the corresponding charcoal samples. The mean residue time indicated by the two humate assays place the cultural events in the Twin Sisters phase of the Late Archaic period (Prewitt 1981, 1985). In 1981, this period was not noted for midden use (Prewitt 1981:76).

Feature 1 appears to have been utilized sporadically between 2,000 to 700 years B.P., a time of transition from the Late Archaic to Neo-Archaic periods when dart points were being replaced by arrow points and ceramics were being introduced. Thus, major changes in weaponry and technology were not accompanied by marked changes in the subsistence pattern. Apparently, F 1 formed episodically rather than incrementally.

8.4.4 Site 41BL743

Three charcoal assays from TP 1 identified at least three separate burning events between 640 and 3200 B.P. for F 1 (Table 8.15; Figure 8.18). A cluster analysis revealed each date was statistically distinct from the other, substantiating at least three burning events. The oldest assay (3200 ± 110 B.P., calibrated to 1443 B.C.) falls within Prewitt's (1981, 1985) Round Rock phase of the Middle Archaic period. Another event was ca. 1030 ± 70 B.P. (calibrated to A.D. 1014) and is in the early part the Austin phase in Prewitt's (1981, 1985) Neo-Archaic period. The most recent assay of 640 ± 60 B.P. (calibrated to A.D. 1360) is near the end of the Austin phase and the beginning of the Toyah phase based on Prewitt's Central Texas chronology (1981, 1985).

Table 8.14 Radiocarbon Results from Feature 1, Test Pit 1, 41BL608.

Depth (cm bs)	Fort Hood Catalogue Number	Material Type	Laboratory Number	Unadjusted Date B.P.	C12/C13 Isotope Value	Adjusted Age B.P.	Calibrated Age B.C./A.D.
10 - 20	001	Charcoal	Beta 64256 CAMS 7926	1070 ± 70	-26.5	1050 ± 70	[1]A.D. 898y (1005) 1028 [2]A.D. 880 (1005) 1162
40 - 50	002	Charcoal	Beta 64257 CAMS 7927	1050 ± 70	-25.6	1040 ± 70	A.D. 967 (1011) 1032 A.D. 883 (1011) 1165
40 - 50	004	Humate	TX - 7943	1403 ± 43	-20.9	1469 ± 43	A.D. 559 (610) 644 A.D. 538 (610) 660
50 - 60	003	Charcoal	Beta 64258 CAMS 7928	720 ± 50	-25.8	710 ± 50	A.D. 1279 (1290) 1303 A.D. 1236 (1290) 1393
50 - 60	005	Humate	TX - 7942	1655 ± 44	-19.1	1750 ± 44	A.D. 241 (260, 289, 324) 378 A.D. 213 (260, 289, 324) 412

1. 1 sigma range 2. 2 sigma range based on three absolute charcoal and two humate assays.

Table 8.15 Radiocarbon Results from Feature 1, Test Pit 1, 41BL743.

Depth (cm bs)	Fort Hood Catalogue Number	Material Type	Laboratory Number	Unadjusted Date B.P.	C12/C13 Isotope Value	Adjusted Age B.P.	Calibrated Age B.C./A.D.
10 - 20	001	Charcoal	Beta 64253 CAMS 7923	1050 ± 70	-26.0	1030 ± 70	[1]A.D. 972 (1014) 1037 [2]A.D. 885 (1014) 1204
30 - 40	002	Charcoal	Beta 64254 CAMS 7924	3220 ± 110	-26.2	3200 ± 110	B.C. 1598 (1443) 1324 B.C. 1734 (1443) 1204
40 - 53	003	Charcoal	Beta 64255 CAMS 7925	660 ± 60	-26.1	640 ± 60	A.D. 1292 (1307, 1360, 1379) 1400 A.D. 1278 (1307, 1360, 1379) 1422

1. 1 sigma range 2. 2 sigma range

Stratigraphically, these three assays were in no apparent order according to their depth below surface (Table 8.15). Their internal stratigraphic disruption may have resulted from turbation, specific functional procedures, or multiple use episodes. Recent vandalism of deposits did not appear to account for this disruption as visual inspection of the surface in 1992 revealed the deposits to be intact. Upon backhoe trenching and subsequent trench profiling, the central area of Feature 1 revealed a significantly different concentration of burned rock and chert debitage than that recovered from TP 1 off to the eastern side (Figure 8.10). The central area was filled with sparse burned rocks, more matrix, and a higher frequency of chert debitage in comparison to the rest of the mound. It is unclear what this difference reflects --old vandalism, a filled-in central cooking pit, etc. Test pit 1, from which the radiocarbon assays were retrieved, revealed no obvious sign of internal displacement of burned rock. The cause of the displaced dated charcoal pieces did not leave an obvious visual signature.

8.4.5 Site 41CV124

This distinctive annular burned rock midden (Weir's 1976 Type 2 and 3) was documented by four AMS charcoal assays from TP s 1 and 2 (Table 8.16). The assays appear to document at least three burning episodes (Table 8.16; Figure 8.18). The two oldest assays, Beta-64224 and Beta-64225, were only ca. 200 years apart and clustered together when the Carlson (n.d.) cluster analysis was applied. These two assays yielded a pooled age of 3676 ± 70 B.P. (T' = 1.98, 1DF), calibrated to 2033 B.C. These two pooled assays document an event during the Marshall Ford or Round Rock phase of the Middle Archaic period (Prewitt 1981, 1985). This radiocarbon age represents the earliest burning event for F 1.

The only combined charcoal sample (Beta-65693), consisting of six pieces from the lowest portion of the aboriginal central pit (80 to 110 cmbs in TP 1), revealed an event ca. 2,000 years old (calibrated to A.D. 78). The assay appears to document the use of this deep central pit during Prewitt's (1991, 1985) Uvalde phase of the Late Archaic period.

The 180 ± 70 B.P. (calibrated to A.D. 1801) age for the youngest charcoal sample indicates a "modern" intrusive sample. Since it is less than 200 years old, this charcoal does not appear to represent an aboriginal cultural event.

Two charcoal samples, Beta-64228 and Beta-64225 from 30 to 40 cmbs but different TPs, yielded considerable different assay results (Table 8.16). This significant radiocarbon age difference documents horizontal variation across the mound. Recent intrusion of fine material accounted for Beta-64228 at this depth. However, statistically similar ages retrieved from the two units were separated 20 to 30 cm vertically. In this instance, where there were apparent multiple events and the youngest event utilized a deep central pit, older charcoal from the lower central area may have been removed during the subsequent pit excavation.

8.4.6 Site 41CV594

Table 8.17 lists the provenience and the radiocarbon results on the four charcoal pieces from F 2. Visual examination of the four assays (Figure 8.18) indicates that at least four different burning episodes have occurred over the last ca. 4,500 years. A statistical cluster analysis (Carlson n.d.) verified this interpretation with splits between all pairs of assays. The four dates indicate sporadic burning events beginning at 4350 ± 60 B.P. (calibrated to 2919 B.C.), with events at 4100 ± 70 B.P. (calibrated to 2615 B.C.), 1520 ± 70 B.P. (calibrated to A.D. 553), and 170 ± 70 B.P. (calibrated to A.D. 1753).

The youngest charcoal assays is "modern" and is not likely to represent a Euro-American burning event. The 1520 B.P. assay documents a use episode during the Twin Sisters phase of the Late Archaic period (Prewitt 1981, 1985). The two oldest dates, 4350 B.P. and 4100 B.P. are during the Clear Fork phase of the Middle Archaic period. The latter was noted for burned rock middens and dominated by Nolan and Travis projectile points (Prewitt 1981, 1985). The most likely age range for F 1 at 41CV594 is from 4400 to 1400 B.P., during the entire Middle Archaic and part of the Late Archaic periods. The sporadic nature of these radiometric assays documents long-term periods of nonuse over that time.

The two oldest charcoal assays (Beta-64231 & Beta-64232), both from TP 2, 30 to 40 cmbs and 50 to 60 cmbs respectively, are stratigraphically reversed. The relatively short, 304 year difference between these two assays does not indicate a significant problem. The reversal does document some internal movement of fine materials, as does the modern charcoal assay obtained from 10 to 20 cmbs.

Table 8.16 Radiocarbon Results from Feature 1, 41CV124.

Depth (cm bs)	Fort Hood Catalogue Number	Material Type	Laboratory Number	Unadjusted Number	C12/C13 Isotope Value	Adjusted Age B.P.	Calibrated Age B.C./A.D.
Test Pit 1							
30 - 40	002	Charcoal	Beta 64225 CAMS 7895	3560 ± 90	-25.3	3560 ± 90	[1]B.C. 2019 (1887) 1748 [2]B.C. 2138 (1887) 1676
80 - 110	03, 04, 06	Charcoal	Beta 65693 CAMS 11074	1915 ± 55	-23.7	1915 ± 55	A.D. 18 (78) 130 A.D. 39 (78) 228
Test Pit 2							
30 - 40	005	Charcoal	Beta 64228 CAMS 7903	220 ± 70	-27.5	180 ± 70	[1]A.D. (1678, 801, 1954) 1954 [2]*A.D. 1529 (1678, 1801, 1954) 1955
60 - 70	001	Charcoal	Beta 64224 CAMS 7894	3770 ± 70	-25.5	3760 ± 70	B.C. 2281 (2178, 2166, 2143) 2038 B.C. 2451 (2178, 2166, 2143) 1950

1. 1 sigma range
2. 2 sigma range

* = bomb influence

Table 8.17 Radiocarbon Results from Feature 2, Test Pit 2, 41CV594.

Depth (cm bs)	Fort Hood Catalogue Number	Material Type	Laboratory Number	Unadjusted Date B.P.	C12/C13 Isotope Value	Adjusted Age B.P.	Calibrated Age BC/A.D.
10 - 20	002	Charcoal	Beta 64230 CAMS 7905	210 ± 70	-27.2	170 ± 70	[1]A.D. 1660 (1680, 1753, 1804) 1954 [2]*A.D. 1638 (1680, 1753, 1804) 1955
30 - 40	003	Charcoal	Beta 64231 CAMS 7906	4380 ± 60	-26.7	4350 ± 60	B.C. 3033 (2919) 2891 B.C. 3255 (2919) 2879
30 - 40[3]	001	Charcoal	Beta 64229 CAMS 7904	1530 ± 70	-25.9	1520 ± 70	A.D. 444 (553) 629 A.D. 410 (553) 660
50 - 60	004	Charcoal	Beta 64232 CAMS 7907	4130 ± 70	-26.9	4100 ± 70	B.C. 2866 (2615) 2500 B.C. 2882 (2615) 2463

1 1 sigma range
2 2 sigma range
* = bomb influenced
3 = from TP 1

The two assays (Beta-64229 & Beta-64231) from the same level, (30 to 40 cmbs) of different TPs indicates a difference of some 2,800 years. This horizontal variation across the mound reveals the internal complexities of mound structure. Age differences may result from noncontinuous buildup of material, disruption of deposits in subsequent use episodes, and/or turbation. Only intensive horizontally and vertically dating strategies can begin to document the various processes involved. Extreme care must be employed when sampling a particular feature, as the functional use and reuse are undoubtedly influencing the vertical and horizontal distribution of charcoal.

The documentation of a "recent military pit" during excavations of TP 1 did not affected the charcoal sample (Beta-64229) from TP 1, 20 to 30 cmbs. Even though downward movement of fine materials and some recent vandalism was documented, F 2 does not appear to reflect an extensively mixed mound.

8.4.7 Site 41CV1027

Four radiometric assays were obtained from F 1 and they indicate a narrow time range between 4490-4200 B.P. (calibrated to 3266 to 2798 B.C.) (Table 8.18). The four charcoal assays appear to represent a single event or multiple events very close in time. A statistical cluster analysis (Carlson n.d.) reveals the three youngest assays (Beta-64233, Beta-64234, & Beta-64236) are statistically similar (at .05 significance), with a pooled date of 4367 ± 47 B.P. (T' = 4.90 with 3DF). However, the chi^2 value computed (per Ward and Wilson 1978) for all four dates is too large to conclude that all four dates are statistically identical. However, the dates are close enough in time to conclude that they do represent short-term or episodic formation of F 1 over a 500-hundred-year period. The four charcoal assays, regardless if they represent one or multiple events, document a narrow 200 to 300 year time span during the Clear Fork phase of the Middle Archaic period (Prewitt 1981, 1985). The differences in these four assays could be accounted for by "old wood."

A complete dart point which resembles the Yarborough type (Figure 8.16), from the "Early Archaic period, possibly later" (Turner and Hester 1985:161), was recovered from the same provenience as two charcoal samples dated to 4200 B.P. (Beta-64233) and 4370 B.P.(Beta-64234). This projectile point is completely patinated white and exhibits a heavy carbonate deposit on the bottom side, attributes consistent with long-term stable deposits. It appears to have been in that position for a long period of time. There is no reason, therefore, to believe this point is not directly associated with the two dates obtained from this same level. These two assays provide one of the few absolute dates for this point type, dated here by a pooled date of 4367 B.P. (calibrated to 2923 B.C.), to the Clear Fork phase of the Middle Archaic period (Prewitt 1981, 1985). This point type is common in East Texas (Turner and Hester 1985:160) and its presence at Fort Hood may indicate groups from East Texas traveled to Fort Hood to exploit the Central Texas chert resources.

All assays obtained are in the proper stratigraphic sequence, as the oldest (Beta-64235) assay is from the lowest level (40 to 50 cmbs). The three assays from the same depth (30 to 40 cmbs), but derived from two separate TPs, are the three youngest and document the intact nature of this feature. It is uncertain if younger events followed this 500 year burning period, since organic samples were not processed from upper 30 cmbs. Therefore, this Yarborough point, recovered from intact deposits in F 1, appears to date to the Middle Archaic period of 4367 ± 47 B.P. or earlier.

8.4.8 Site 41CV1195

Table 8.19 presents the provenience information and assay results concerning the three individual charcoal pieces analyzed to determine the age of F 1. Using the Ward and Wilson (1978) statistical package to compare these three assays, a split was found between two groups. Figure 8.18 graphs these three calibrated dates which depict two burning periods. The youngest assay (Beta-64239) created one group, while the two oldest assays created a separate group. Statistically, the youngest sample is less than 200 years younger than the older two samples with their pooled age of 1945 ± 66 years B.P. (T' = 0.20 with 1DF) (calibrated to A.D. 74). A ca. 40-year overlap exists between the two clusters. Statistically, there is a very limited chance that they represent the same event. It is possible that the one event around 1700 B.P. (calibrated to A.D. 382) was the only burning event which incorporated pieces of "old wood" (165 years) which would account for the two earlier ages obtained. However, multiple events cannot be ruled out.

8.18 Radiocarbon Results from Feature 1, Test Pit 1, 41CV1027.

Depth (cm bs)	Fort Hood Catalogue Number	Material Type	Laboratory Number	Unadjusted Date B.P.	C12/C13 Isotope Value	Adjusted Age B.P.	Calibrated Age B.C./A.D.
30 - 40	001	Charcoal	Beta 64233 CAMS 7908	4210 ± 80	-25.9	4200 ±**p1553 80	[1]B.C. 2890 (2873, 2798, 2780) 2621 [2]B.C. 2922 (2873, 2798, 2780) 2621
30 - 40	002	Charcoal	Beta 64234 CAMS 7909	4380 ± 70	-25.7	4370 ± 70	B.C. 3086 (2924) 2905 B.C. 3304 (2924) 2879
30 - 40[3]	004	Charcoal	Beta 64236 CAMS 7911	4370 ± 80	-25.5	4360 ± 80	B.C. 3086 (2921) 2890 B.C. 3310 (2921) 2709
40 - 50	003	Charcoal	Beta 64235 CAMS 7910	4480± 60	-24.3	4490 ± 60	B.C. 3340 (3292, 3283, 3266, 3241) 3039 B.C. 3361 (3292, 3283, 3266, 3241) 2923

1 1 sigma range
2 2 sigma range
3 = From TP 2

8.19 Radiocarbon Results from Feature 1, Test Pit 1, 41CV1195.

Depth (cm bs)	Fort Hood Catalogue	Material Type	Laboratory Number	Unadjusted Number	C12/C13 Isotope Value	Adjusted Age B.P.	Calibrated Age
13 - 20	001	Charcoal	Beta 64238 CAMS 7912	1950 ± 70	-26.9	1920 ± 70	[1]A.D. 18 (84) 197 [2]B.C. 45 (A.D. 8) A.D. 310
30 - 40	002	Charcoal	Beta 64239 CAMS 7913	1720 ± 60	-26.1	1700 ± 60	A.D. 256 (382) 420 A.D. 228 (382) 532
50 - 60	003	Charcoal	Beta 64240	2020 ± 90	-27.4	1980 ± 90	B.C. 50 (A.D. 26, 42, 53) A.D. 125 B.C. 190 (26, 42, 53) A.D. 240

1. 1 sigma range
2. 2 sigma range

The youngest assays (Beta-64239) came from a stratigraphic position between the two older assays. Stratigraphically, Beta-64238 from 13 to 20 cmbs and Beta-64239 from 30 to 40 cmbs are reversed. It is apparent that over time, the fine material, including tiny charcoal pieces, has moved down profile by one mechanism or another such as turbation, roots, animals, and/or water transport. Therefore it should not be unusual to find two assays that are stratigraphically reversed.

No matter if F 1 at 41CV1195 represents one or more closely spaced radiocarbon events, the detected burning event(s) was approximately 1,800 years ago. This documents F 1 in the Uvalde phase (2250 to 1800 B.P.) of the Late Archaic period (Prewitt 1981, 1985).

8.5 INTERPRETATIONS AND DISCUSSIONS

8.5.1 Comparisons Between Dated Materials

In this study, collected organic material utilized to chronometrically assess nine burned rock mounds included humate (n=7), seeds (n=2), bone (n=1), charcoal (n=33), and *Rabdotus* snails (n=10). Their results, visually depicted in Figure 8.21 by mound, contributed to an understanding and appreciation of age variations between different materials and in establishing ages for burned rock features at Fort Hood.

Previously, many investigations of burned rock middens utilized a single class of material to estimate feature ages. Charcoal, although preferred, is often lacking in features in Central Texas, whereas humate in sediment and *Rabdotus* are often more plentiful. Although matrix is present in burned rock features, age estimates from humates are not from targeted events since humates can reflect ongoing rejuvenation by newer carbon. Humates therefore provide minimum age estimates for a dated event that is not necessarily closely tied to a target date of midden use or concentration.

Previously, *Rabdotus* snails have not been utilized for dating purposes in Central Texas. This project has initiated a pilot study into the evaluation of the suitability of *Rabdotus* for dating. Initial results are favorable, though it may require more steps in selecting a suitable sample by using the epimerization analyses. Here, fine material such as tiny seeds, bone fragments, and sometimes charcoal flecks, were demonstrated to be out of context as a result of numerous factors including natural turbation (water percolation), bioturbation, or human interactions. Consequently, it is difficult to say with any degree of certainty, that a single piece of organic material hasn't been moved or displaced, since its original deposit in these features. To establish a greater degree of certainty on a single feature's age, it is necessary to take Collin's (1991) advice and obtain numerous assays to confidently assign a feature to a time period.

Table 8.20 compares five paired humate and charcoal assays obtained from three different burned rock features at Fort Hood. A cluster analysis program (Ward and Wilson 1978) run on each of the pairs revealed no two samples were statistically similar to indicate that these paired assays represent a single event. Comparisons in Table 8.20 were made using the midpoint ages of the calculated assays. Humate assays are older than charcoal assays from the same 10 cm level in all five instances, with differences that range from + 401 years at 41BL608 to + 1,317 years at 41BL233, F 5. This does not mean humate assays are incorrect, but that they represent an average of numerous organic humates which accumulated in the feature to arrive at a mean residence time assay. In contrast, the single charcoal piece, removed from the same humate-dated sediment, represents a single event.

The comparison between charcoal and humate results indicate that the deeper the humate samples were in the profile, the greater the difference in their age, in comparison to the dated charcoal fleck. This may reflect a greater concentration of older humates with depth and/or the presence of younger organic material concentrated higher in the profile. Possibly, the younger charcoal filtered down into the level where older humates are concentrated; thus the two materials were not originally associated and only are perceived to be so by their present position in the profile. As with the "modern" charcoal moving 10 to 30 cm down into the mound, so is older charcoal moving deeper into the lower portion of the feature. Clearly, the movement of fine particles is a major factor inside the mound feature. It is unclear as to what other factors are influencing the age differences.

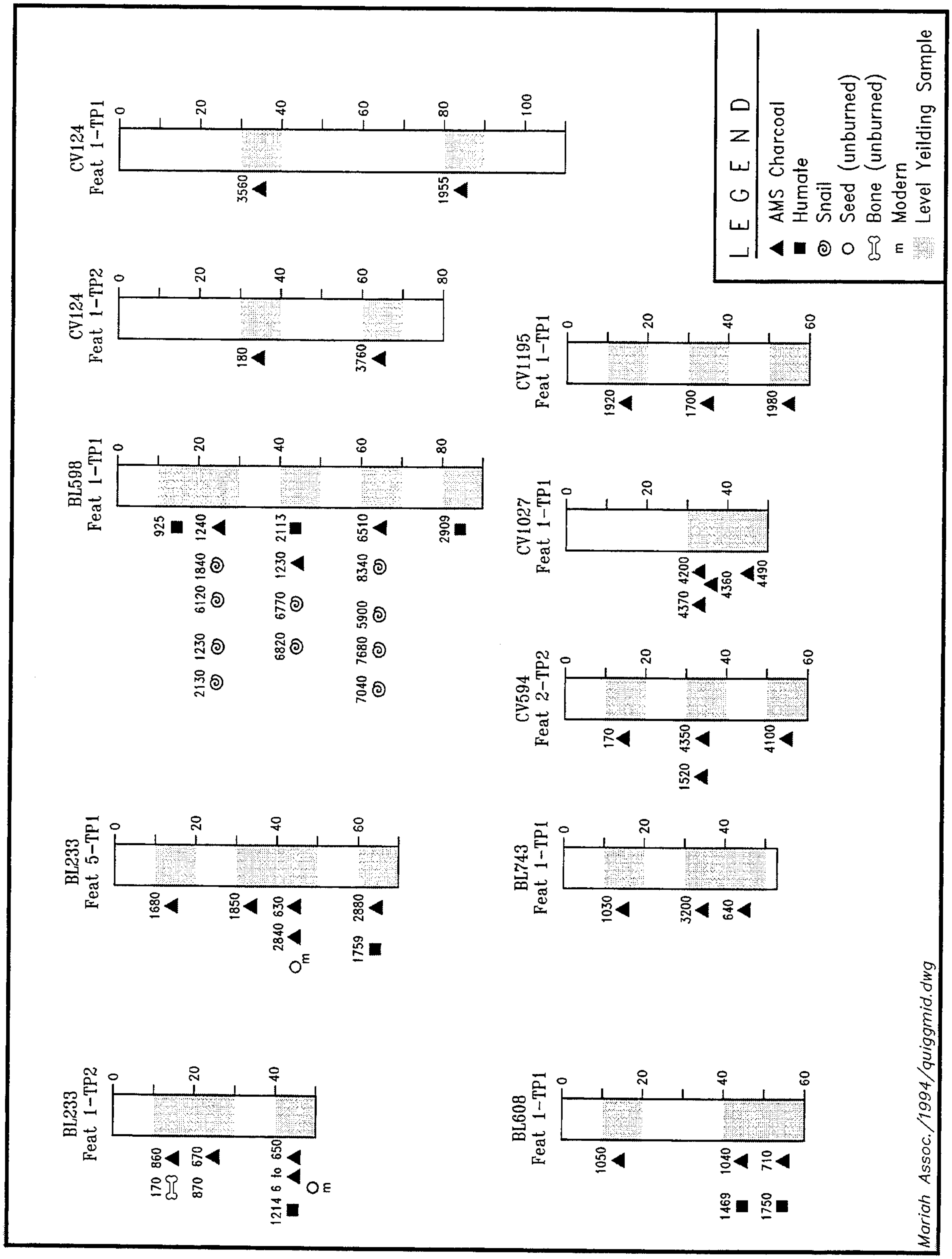


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Figure 8.21 Assay Results from Different Organic Materials at Each Burned Rock Mound.

Table 8.20 Comparison of Humate Assays with Charcoal Assays from the Same Context at Three Mounds at Fort Hood.

Radiocarbon Samples from Sites	Humate Age Difference
41BL233, Feature 1, Test Pit 2, Level 5 (40 - 50 cm bs)	
Charcoal, Beta 64248 2 sigma cal A.D. 1237 (1300) 1416	
Charcoal, Beta 64249 2 sigma cal A.D. 1260 (1305, 1367, 1373) 1427	
Humate, TX-7948 2 sigma cal A.D. 686 (816, 847, 853) 959	520 years
41BL233, Feature 1, Test Pit 1, Level 7 (60 - 70 cm bs)	
Charcoal, Beta 64245 2 sigma cal 1263 (1022) 847 B.C.	
Humate, TX-7946 2 sigma cal A.D. 141 (257, 295, 319) 413	1,317 years
41BL598, Feature 1, Test Pit 1, Level 5 (40 - 50 cm bs)	
Charcoal, Beta 65342 2 sigma cal A.D. 667 (786) 968	
Humate, TX - 7944 2 sigma cal B.C. 351 (151, 148, 117) A.D. 4	934 years
41BL608, Feature 1, Test Pit 1, Level 5 (40 - 50 cm bs)	
Charcoal, Beta 64257 2 sigma cal A.D. 883 (1011) 1165	
Humate, TX-7943 2 sigma cal A.D. 538 (610) 660	401 years
41BL608, Feature 1, Test Pit 1, Level 6 (50 - 60 cm bs)	
Charcoal, Beta 64258 2 sigma cal A.D. 1236 (1290) 1393	
Humate, TX-7942 2 sigma cal A.D. 213 (260, 289, 324) 412	1,001 years

Judging from the regression analysis presented in Section 7.4, the accuracy of radiocarbon dates on *Rabdotus* shells is probably nearly as high as data on charcoal because the average amount of age anomaly appears to be small. As more research is done to quantify average age anomaly, the accuracy of *Rabdotus* dates will closely approximate that of charcoal because a correction factor will be available to adjust the means of snail dates to be equivalent to the means of charcoal dates. However, at present, the precision of dates on *Rabdotus* is unknown because variability of age anomaly can not yet be estimated. The fact that the newer snail dates are relatively close to a charcoal date in the same level implies that variability of age anomaly may not be very high, but more research should be performed to provide a quantified estimate of the uncertainty that should be added to measurement error for *Rabdotus* shells.

8.5.2 Overall Age Range of Nine Burned Rock Mounds

The 1992 chronometric program at Fort Hood consists of 43 radiocarbon assays on 33 charcoal, two seeds, one bone, and seven humate samples that exhibit an absolute age range from modern times back to 6510 B.P. (calibration A.D. 1955 back to calibration 5437 B.C.). However, raw ages oversimplify the complexities involved with dating the mound-use cultural events (cf. Dean 1978:223-255). The spatial and relational complexities of the dates to human behavior requires close scrutiny to fully understand their meaning. Complexities arise from the different kinds of dated materials (sediment, charcoal, bone, seeds, and snails), assumptions concerning material associations, problems deciphering natural and human events, and disturbances both seen and unseen. Each of these factors is examined in relation to the results obtained from this study.

The two modern *Brassica* sp. seed samples (Beta-64261 and Beta-64262) assumed and demonstrated by direct dating, represent nonaboriginal activities at Fs 1 and 5 at 41BL233. The single bone sample (Beta-65259) also yielded a modern collagen date (calibrated to A.D. 1804 with a 2 sigma range that intersects the year 1955). This bone does not appear associated with the cultural use of F 1 at 41BL233 since the youngest charcoal assays are around calibrated A.D. 1367. These three seed and bone specimens are interpreted as intrusive. These modern radiocarbon assays clearly demonstrate mound contamination since modern *Brassica* sp. seeds were recovered from 40 to 50 cmbs in two separate mounds while the modern bone came from 10 to 20 cmbs. Over a period of less than 200 years, organics worked their way down the mound fill. If recognizable fine materials can penetrate 40 cm deep into a mound this quickly, there is a real concern that small charcoal flecks or other organic material used for dating could also have moved around.

Since the *Brassica* sp. seeds clearly demonstrate intrusive organics, the two modern charcoal assays (Beta-64228 and Beta-64230) dated to 180 ± 70 B.P. (calibrated A.D. 1801) and 170 ± 70 B.P. (calibrated to A.D. 1753) may possibly reflect downward movement of charcoal from noncultural events (i.e. range fires) or the continued use of these features by aboriginal groups during the early historic period. The Beta-64228 sample was recovered from 30 to 40 cmbs at 41CV124 and Beta-64230 from 10 to 20 cmbs at 41CV594. These two assays are younger than any absolute charcoal assays obtained for the four large, well-dated middens at O. H. Ivie Reservoir which document nonuse after ca. A.D. 1350 (Treece et al. 1993; Treece 1992). However, the Fort Hood mounds are considerably smaller and might reflect different behaviors or features that were responsible for the massive mounds at the O. H. Ivie Reservoir. The possibility of Protohistoric and aboriginal historic use of rock features is an unresolved issue requiring further study.

The remaining 31 charcoal assays indicate a time span from 630 B.P. (calibrated A.D. 1353) back to 6510 B.P. (cal 5437 B.C.) which possibly represent 6,880 years of sporadic burned rock mound use ending nearly 630 years ago. The earliest assay (Beta-65343) obtained, 6510 B.P. (calibrated to 5437 B.C.) from 41BL598, was from 60 to 70 cmbs and was associated with some burned and unburned limestone in a matrix grading from a dark brown to a brown. It came from below the majority of burned rock in F 1 and most likely represents a premound event. The charcoal may have filtered into lower stratum from the base of the mound, in which case it may then represent a use episode. This date is 2,000 years earlier than the next oldest assay which may also contribute some doubt as to its cultural association with the mound. The second oldest assay (Beta-64235) is 4490 B.P. (calibrated 3283 B.C.) from F 1 at 41CV1027. If the latter assay represents the oldest date associated with mound use, that narrows the nine burned rock mound-use period to some 4,860 years, from calibrated 3283 B.C. to calibrated A.D. 1353. The charcoal assays from 41BL124 indicate that this annular midden dates some 1,000 years earlier than dated annular mounds in adjacent regions (see Collins 1991:2).

Humate date results are often questioned as to their appropriateness because they provide a mean residence time based on accumulated humates within the matrix. Humates within the matrix of these mounds could be from various sources such as decomposing grass and tree matter. Since the percentage of humate contributions from these various sources of different ages are not readily determined, the relationships of the humate date age to the target feature event is unknown. Results from the seven humate samples revealed an age range between 925 B.P. (A.D. 1124) and 2909 B.P. (cal 1103 B.C.) indicating a span of nearly 2,000 years. These dates do not represent the entire age-range of mound use as evident from the charcoal, but humate samples were not intended for that purpose. In general, humate samples were selected for direct comparison with specific charcoal assays from identical context (see discussion above). These seven assays fall within the general time range of 42 percent of the charcoal dates.

The 10 *Rabdotus* assays nominally extend the age of F 1 at 41BL598 back beyond the 6510 B.P. charcoal age. In fact, five of the 10 assays were greater than the 6510 B.P. date and two other snail assays were ca. 500 years younger than that charcoal date (Figure 8.22). Some of these differences may be more apparent than real as a result of the unknown extent of variability of age anomaly. However, even if one assumes that the group of oldest dates on snails is composed of snails that all are individually affected by a very large amount of age anomaly, the snail dates still have a high likelihood of dating to the Early Archaic, which makes the lower levels of the feature unexpectedly early relative to widely accepted beliefs about the timing of burned rock middens. To the extent that age-anomaly variability is less than maximal, an Early Archaic date for portions of F 1 at 41BL598 is hard to deny.

Figure 8.18 depicts 46 chronometric results from the nine mounds investigated. Since the results of the seven humate assays cannot be unambiguously ascribed to the target burned rock mound episodes, they are excluded from the following discussion. With the few exceptions mentioned above (two modern seed, one modern bone, two modern intrusive charcoal assays), the 20 remaining charcoal assays reveal sporadic burning events over a 6,500 year period. The earliest assay (from F 1, 41BL598) is 2,000 years earlier than any other assay, creating some question as to its cultural origin.

The 19 remaining charcoal assays reveal a nearly continuous use of burned rock mound features over the last 4,500 years with one detectable void. This apparent void is a ca. 500 year period between 2050 B.P. to 2650 B.P (50 B.C. to 550 B.C) (Figure 8.18). Although this may be only a sampling error due to the few mounds investigated, this hiatus reflects an important interruption lasting nearly 500 years in a well-established cultural process of making and using burned rock features. The assays from Fort Hood indicate high incidences (65%) of burned rock mound use during the last 2,000 years, relative to the preceding 4,000 year period. Prewitt's (1981:76, Fig. 4) Central Texas chronology acknowledges the common use of burned rock middens during the initial 4000 years, but he did not recognize the common use of burned rock midden during the most recent 2,000 year cultural period.

The relative high incidence (21%) of assays during a 500 year period between 4000 to 4500 B.P. (2000 to 2500 B.C.) generally correlates to the Oakalla cultural period of the Early Archaic (Prewitt 1981, 1985). A significant decrease in dates from these mounds occurs following that period, but this decrease in mound use may be attributed to sampling error.

The discrepancy in the ages of burned rock mounds at Fort Hood and the ages of burned rock midden use proposed by Prewitt (1981, 1985) may be explained in a number of ways. One reconciliation is a sampling error at Fort Hood: the nine features do not reflect the representative or entire range of burned rock mound use periods from across Central Texas. A second possibility is that the actual use periods for burned rock features may differ regionally in various localities within and around Central Texas. A third explanation could be that many previous burned rock middens were erroneously *assigned* relative ages based on unsubstantiated contextual associations of diagnostic projectiles encountered in middens.

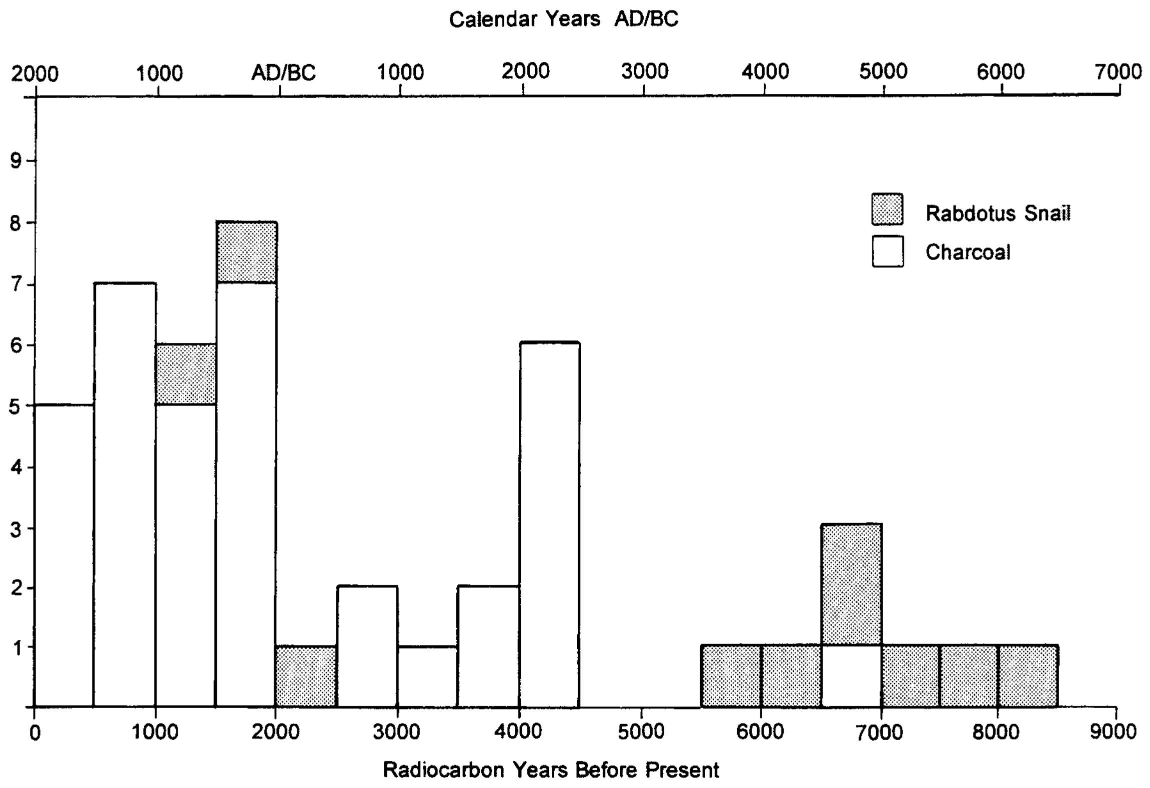

Figure 8.22 Frequency Distribution of Radiocarbon Assays on Charcoal and Rabdotus Grouped by 500 Year Intervals.

If the recovered projectiles do not reflect a true association, their presence may have misled researchers into assigning an improper age estimate to the features (cf. Treece et al. 1993). Pertinent to this latter possibility is the recovery of an Early Archaic-period Uvalde projectile (Prewitt 1981, 1985; Turner and Hester 1985:155) from 20 to 30 cmbs, F 1, at 41BL233. This mound was dated to the Neo-Archaic/Late Prehistoric period based on four AMS charcoal assays of approximately 763 B.P. (A.D. 1279) and one humate assay of 1214 B.P. (A.D. 847). Since the absolute age is based on five radiometric assays, F 1 at 41BL233 is demonstrated to be much younger than would be postulated based only on the cross dating of the recovered projectile point. Absolute charcoal assays provide a more accurate age than a cross date from a projectile point.

The presence and absence of burned rock mounds may be linked to variations in the environment as it relates to the availability of potential plant resources used in the mounds. Nordt (1993) has recently proposed a late Quaternary vegetation and climate history for Central Texas based on carbon isotope work at Fort Hood. That paleoenvironmental sequence is summarized in Figure 8.18 by a line reflecting the fluctuation of warm season C4 grasses relative to the radiocarbon assays from the mounds. In general, the increase in frequencies of burned rock mound dates correlates with periods of increases in cool season C3 vegetation. The roughly 2,000 years

(2000 to 4000 B.P.) Nordt (1993) documents as a cooler/wetter period (60 to 65% warm season grasses) contains nearly 35 percent of the Fort Hood radiocarbon assays. Nordt also indicates that the most recent 2,000 years reflects a similar cooler/wetter period which contains nearly 65 percent of the radiocarbon assays from Fort Hood. The projected periods of warming reflected in the increase of C4 grasses does not appear to have associated radiocarbon dates from these mounds. A 500 year span (2200 to 2700 B.P.) with no occurrences of radiocarbon assays from mounds at Fort Hood is slightly earlier than the warm dry period Nordt (1993) detected about 2,000 years ago. Apparently, there is a higher incident of use of burned rock middens during increased cool/wetter periods in Central Texas. Continued radiocarbon dating of burned rock middens in Central Texas will help evaluate this association.

8.5.3 Dating Cultural Features Using *Rabdotus* Snails

Dating cultural features using only *Rabdotus* snails is currently a risky undertaking. It would be premature to use the radiocarbon calibration for A/I ratios from *Rabdotus* shells (Section 7.4) to assign anything more than ballpark dates because the regression analysis is based on too few points and sources of error which have not been explored fully. It also would be premature to use radiocarbon dates on *Rabdotus* in cases where high precision is necessary because of uncertainties regarding the influence of age anomaly. However, if no other choices are available, radiocarbon assays on *Rabdotus* are much better than nothing, and may in some circumstances be much better than humates because snail shells are not plagued by problems of carbon rejuvenation or decomposition. In such cases, assays on *Rabdotus* shells can be used to provide approximate chronometric dates that can be interpreted conservatively as maximum ages (i.e., minimum dates). In such cases, they can be used to determine temporally diagnostic artifacts are relevant to assigning a date to a provenience and to assign relatively gross phase or period designations.

In conjunction with radiometric assays on other materials in cases where only a few such assays are available, additional radiocarbon dates on *Rabdotus* snails can be used as a cross-check on the stratigraphic consistency of nonsnail dates. In the 41BL598 example, the large number of relatively old snail dates in, below, and above the same level as a relatively new charcoal date and are sufficient enough to cast doubt on the relationship between the charcoal date and formation of the deposit. Furthermore, in conjunction with radiometric dates on charcoal and snails, A/I ratios can provide an inexpensive means for determining whether any of the radiometric dates come from proveniences that can be regarded as mixed or unmixed deposits. Indeed, A/I ratios on snails can be used as a means for assessing depositional integrity prior to selecting charcoal or snail samples for radiometric assays. This allows radiometric assays to be allocated to proveniences that have a relatively high probability of containing discrete assemblages. Thus, as things currently stand, the decision to use *Rabdotus* to date cultural features is mostly a trade-off between the other dating options that are available and the precision that is necessary for the problem at hand. On the other hand, both snail radiometric and epimerization dates currently appear to have very useful applications, and using these techniques at their current state of development can make incremental contributions to the research that is necessary to improve them as rigorous chronometric tools.

8.5.4 Cultural Chronology

The radiocarbon assays are discussed in terms of the Central Texas cultural sequence which Prewitt has presented (1981, 1985). Although the goal of this project was not to revise the cultural chronology, and especially the cultural traits of the various phases, the ages obtained from the mounds contribute to our understanding as to when these features were in use at Fort Hood. Prewitt's scheme presents burned rock middens as one of the "key index markers" in the overall cultural sequence. The 1992 ages from the Fort Hood burned rock mounds can refine the time frame in which this one feature type occurs. As discussed above, the seven humate dates with their mean residence time averages are not sufficiently precise for assigning specific ages to features, and are not incorporated into the following discussion. The 31 charcoal ages believed to be associated with cultural events, are presented here. These are presented from the youngest to the oldest.

There are 10 charcoal dates between 630 ± 70 B.P. (calibrated to A.D. 1353) and 1240 ± 70 (calibrated to A.D. 782) which fall within Prewitt's Austin phase of the Neo-Archaic/Late Prehistoric period for Central Texas (1981, 1985). These assays constitute the highest percentage (26%) for any one time period and were recovered from four separate features: Fs 1 and 5 at 41BL233, F 1 at 41BL743, and F 1 at 41BL608. Prewitt's (1981, 1985) Central Texas chronology does not recognize burned rock middens or mounds within this time period. Recent excavations and intensive dating of four annular middens at the O. H. Ivie Reservoir reflect similar ages (Treece 1992:288). Even though the latter middens are 180 km west of Fort Hood, they support a pattern of widespread use of similar features during the early part of the Late Prehistoric/Neo-Archaic period.

In Williamson County immediately to the south of Fort Hood, a charcoal assay (SMU-1645) from F 1 within Midden 13 at Block House Creek (41WM312) yielded an age of 975 B.P. (A.D. 1040) and was assigned to the Austin phase (Gearhart 1987:117). This latter charcoal sample was collected at 40 to 42 cmbs within a central stone-lined hearth. Diagnostic projectile points from Midden 13 included four Scallorn, four Darl, two Fairland, and five others, of which nine were recovered from the dated central hearth of Feature 1 (Gearhart 1987:78). Still further south in Hays County, Midden F at the Greenhaw site (41HY29) yielded a charcoal assay of 800 B.P. (A.D. 1150) from the upper part of that midden, but it was thought to represent an intrusive date (Weir 1979:43-45). These few examples document other burned rock middens with similar antiquity to those at Fort Hood. Therefore, burned rock middens should now be included as part of the "key index markers" to the Austin phase.

Two charcoal assays from 41BL598 fall within the short duration of the Driftwood phase (ca. 1250 to 1370 B.P.) of the Late Archaic period (Prewitt 1981, 1985). These two assays were statistically similar (pooled age of 1235 B.P.) and appear to represent the same event despite the fact that one of the assays probably was in a redeposited context. They document burned rock mound use at Fort Hood for a period which was not previously recognized by Prewitt (1981, 1985) for Central Texas.

Only three charcoal dates fall between 1370 and 1730 B.P., a period that Prewitt (1981, 1985) referred to as the Twin Sisters phase of the Late Archaic period. These assays were from two sites, 41BL233 F 5 and 41CV594 F 1. Assays for this same period were obtained from 41WM312 (Gearhart 1987:117-119), a charcoal assay of 1678 B.P. (A.D. 341 ± 401; SMU-1644) was from a central hearth in Midden 13, and one date was from a humate sample at 1461 B.P. (A.D. 609 ± 16; SMU-1663) from domed Midden 2. The latter assay was associated with an Ensor and a Darl projectile and thus appear to be consistent with the Twin Sisters phase assignment. The three new dates from Fort Hood and dates from 41WM312 extend the general use of burned rock middens into this phase for Central Texas.

There are four charcoal ages within the 1700 and 2250 B.P. period which is known as the Uvalde phase of the Late Archaic period (Prewitt 1981, 1985). Three of the assays were from F 1, at 41CV1195, and were statistically similar. Since these were the only ages determined for this feature, they may represent a single limited use episode. The other assay date of 1915 ± 55 B.P. (Beta-65693) from the bottom of the central pit feature at 41CV124, is only a few hundred years older than a average of 1678 ± 374 B.P. date (SMU-1644) obtained from charcoal retrieved from the central hearth of Midden 13 at 41WM312 (Gearhart 1978:117). The mixed association of Scallorn, Darl, Fairland, and other unknown projectiles hinder precise phase assessment at the latter site. Feature 1 at 41CV1195 is also only slightly earlier than the annular burned rock middens excavated and dated at the O.H. Ivie Reservoir, which appear to have been primarily used after 1550 B.P. (A.D. 400, Treece 1992:288). Although a substantial suite of radiocarbon age estimates have been obtained for middens at O. H. Ivie Reservoir, their precise phase association based on diagnostic projectile types has not been established since these mounds were mostly built on stable, palimpsest surfaces and the points in these resting areas do not directly reflect the function, age, or cultural affiliation of the features.

Burned rock middens were not a "key index marker" for Prewitt's (1981:Figure 4) Uvalde phase, but burned rock middens were present in the preceding San Marcos phase. Consequently, these four new charcoal results from Fort Hood, coupled with the other charcoal dates from various sites, now document a general use period for burned rock middens throughout the Late Archaic Period which was not previously defined for the Central Texas chronology (Prewitt 1981, 1985).

Three charcoal ages fall within the 2625 and 3500 B.P. period assigned to the Round Rock phase of the Middle Archaic period (Prewitt 1981, 1985). Two assays were from F 5, at 41BL233 and the other was from F 1 at 41BL743. These three assays are within the period of common burned rock midden use for Central Texas (Prewitt 1981, 1985). They are similar in age to three charcoal assays (Tx-451, Tx-453, and Tx-463) that dated to 2650, 2850, and 2900 B.P. (700-950 B.C.), respectively, from Midden F at the Greenhaw site (41HY29, Weir 1979:43-45). Midden F was associated mainly with Pedernales projectiles and a few Bulverde points (Weir 1978:54). The Fort Hood ages are also similar to one charcoal assay (Tx-3852) of 2660 ± 60 B.P. (710 B.C.) obtained from the middle of Midden 2 at the Panther Springs Site, 41BX228 (Black and McGraw 1985:237-239). Midden 2 was a 35-cm-thick, plano-convex burned rock accumulation which was totally buried; it was nearly devoid of any cultural material aside from the burned rock. An apparent pit oven was underneath the main burned rock accumulation (Black and McGraw 1985:296).

Two charcoal dates of 3560 ± 90 B.P. and 3760 ± 70 B.P. from F 1 at 41CV124 fall within the Marshall phase of the Middle Archaic period (Prewitt 1981, 1985). This phase is noted to contain burned rock middens and Bulverde projectile points (Prewitt 1981, 1985). A Bulverde point (Turner and Hester 185:129) with a reworked blade was found at 41CV124 and provides independent confirmation of these projectiles occurring with mounds during this period.

There are six charcoal dates between 4125 to 4625 B.P. from mounds at Fort Hood that occur within the interval of the Clear Fork phase of the Middle Archaic period (Prewitt 1981, 1985). Four of the six dates were obtained from F 1 at 41CV1027 which yielded a Yarbrough point and appeared to represent a very limited-use episode at this feature. The other two dates were from F 2 at 41CV594. The Middle Archaic phase is recognized as having burned rock middens and associated Travis and Nolan projectiles (Prewitt 1981, 1985). Interestingly, both of these sites were located within the Paluxy sand. The sand may have been covering these features for long periods as well, concealing their presence during subsequent periods.

The oldest charcoal date from Fort Hood was 6510 ± 60 B.P. from 41BL598, which falls within the San Geronimo phase (ca. 6125 to 6750 B.P. of the Early Archaic period (Prewitt 1981, 1985). If this date was from a cultural event, then this early charcoal assay demonstrates an extremely early use episode for burned rock mounds at Fort Hood. It would also extend Prewitt's recognized utilization of midden features in Central Texas well into the Early Archaic.

8.5.5 Feature Formation Processes

Although this chronological study does not specially address feature formation processes, some accumulated data does provide insights into the dynamics of feature fill and the rate of mound accumulation. Modern assay results from two seed and one bone sample from Level 5 of Fs 1 and 5 at 41BL233 provide excellent examples of fine matrix, including macrobotanical remains, penetrating through these porous mounds of burned rock. The question of context is very important and cannot be minimized. The recovery of one artifact or one acorn shell does not demonstrate a direct association since numerous other possible explanations exist to account for any one item at any level. Intense rains in Central Texas contribute to the downward movement of fine matrix including the charcoal and seeds. Besides natural causes, numerous turbation influences cause materials to move up and down through sediments of various textures, including rock middens. If middens were repetitively used or accumulated by multiple palimpsest activities, then subsequent events might disrupt the earlier feature context and add new materials to the feature. This could cause mixing that may leave two items of different ages in close proximity to one another without any direct association.

Nine of the 33 charcoal assays were stratigraphically inverted within six of the nine mounds. This reverse chronology does not negate charcoal dating results or procedures, but merely reflects the extremely intricate context of the fine matrix within these kinds of burned rock features. The processes and mechanics accounting for displacement of tiny organic material are uncertain, but the present investigation clearly indicates caution is necessary when interpreting the context of fine particles in burned rock features.

Two of the nine (22%) burned rock mounds (F 1 at 41BL233 and F 1 at 41CV1027) have apparent single periods of use as reflected by short time differences between radiocarbon assays. If these three mounds represent multiple use accumulations, the assays do not reflect considerable time differences between those use events. This limited-use period also may have caused minimal internal disruption, better preserving the structure and evidence of focus of the feature. Since context in mound features is generally complex, it may be appropriate to focus considerable investigations on these apparent single-period-use mounds first to better control the complexities of feature formation processes. In addition, it also may be useful to function on short-term portions of mounds such as the upper levels of F 1 at 41BL598.

Seven (66%) of the mounds exhibited use during two or more periods, based on differences in charcoal and snail assays and A/I ratios. These features probably have considerable internal complexity which would hinder the recognition of specific functions or even changes in function through time. The difficulty in recognizing and interpreting how these multiple-use mounds were used is proportional to the number of distinct events involved in the mound formation.

8.5.6 Feature Functions

Burned rock mounds are presumed to represent some type of cooking event(s). Certainly the extensive amount of burned rock encountered in each excavation testifies to the use of quantities of limestone in a heating process. Although this project was not directed toward addressing feature function, some data gathered allows for limited observation to address this issue.

Specifically, the kinds and frequencies of materials recovered, represented in the heavy fraction component of the flotation process, may indicate other activities and contribute information as to how these features may have formed or functioned. The light fraction components were inspected for charcoal, seeds, and shells, but in general, these fractions revealed limited quantities of these items were recovered. How various materials got into these features remains an open question. The following discussion focuses on the heavy fraction material from individual features, as presented in the tables from Chapter 4.0.

In general, tiny lithic debitage, reflecting stone-chipping behavior, dominates all other categories of material in both percentage by feature and in total numbers. Debitage exceeds 50 percent of the total material recovered in five of the nine mounds, and consists of 41 percent in one other mound. In the features at 41CV594 and 41CV1027, debitage only accounts for 11.5 percent and 7.4 percent respectively. Debitage is not consistent with the direct cooking activities and therefore the chipped stone residues are assumed to reflect processing events that occurred on, or adjacent to, the feature. Chipped stone may have entered the mound in the form of residues contained within the soil matrix that may have been incorporated into the heat-retaining covering utilized during the cooking of plants.

Uncharred "modern" seeds (*Brassica* sp., *Juniperus ashei*, and *Lupinus texensis*) dominate the materials recovered at two mounds (41BL233, F 5, and 41CV594, F 2) with ca. 65 percent. Thus, they are assumed to be intrusive to the features. In most instances, the majority of all three types of uncharred seeds were concentrated in the top 20 cmbs and showed a rapid dropoff in frequencies with increasing depth. *Brassica* sp. dominated the three types and accounted for nearly 80 percent (5,605) of the seeds; followed by *Lupinus texensis* (bluebonnets) at 9.7 percent (687); *Juniperus ashei* (cedar) at 7.3 percent (514); and other seeds at 3.9 percent (276). Nearly 70 percent of the bluebonnet seeds came from F 1 at 41BL598, which was covered in flowers when excavated. The two sites with the fewest seeds were 41CV1027 and 41CV1195 which are both located in the Paluxy sand. This well-drained sandy matrix may have hindered preservation or had a biome of fewer seed plants than elsewhere. The presence of nearly all 7,082 seeds collected most likely reflects "recent" vegetation cover at each feature and subsequent preservation in feature matrix. Other plant parts, besides the seeds, were not recovered or identified during these investigations. It is unclear if the absence of other organic material, such as nut hulls, bulbs, prickly pear, or lechuguilla parts is directly related to preservation, processing, or related to the kinds of products processed in these features.

Mussel shell accounts for 52 percent of the total heavy fraction material recovered from 41CV1027, F 1. All other mound features also have limited shell fragments which ranged from 1 to 23 percent. However, F 5 at 41BL233 had more shell pieces --1197 (22.9% of the total) than any other feature, and this number is nearly double the amount at 41CV1027. Besides these two instances, all other features revealed less than 15 percent of the total material recovered. Mussel shells had to be brought into these features. However, since shells are generally collected from water sources, the transport process mechanism is still unclear. The general feature location relative to rivers and creeks may be a factor influencing the frequencies of mussel shell.

Rabdotus snails ranged from 1 to 10 percent in eight of the nine features; F 1 at 41CV1027 had 38 percent snails. Interestingly, this is the same feature with a high percentage of mussel shells. The context surrounding the presence of *Rabdotus* still requires investigation, but there were surprisingly few snails in the mound fill matrix. However, while examining snail assemblages for samples to submit for epimerization analyses, it was apparent that snails were much less frequent in feature proveniences in Paluxy sand contexts than they were in non-Paluxy features.

Unburned bone fragments were represented in seven of nine features but always in very small size and limited quantities (under 3%). The lack of all bone, including burned or calcined, was unexpected since animal meat was assumed to potentially be a portion of the prehistoric diet. The limited amount of recovered bone coupled with the modern radiocarbon assay from one unburned piece, indicates that preservation may account for the limited return. Some portions of bone may have become burned or calcined incidental to the meat cooking process, and would have been preserved more readily than those unburned portions. The absence of burned bone does not demonstrate that meat cooking did not occur in these features.

The least represented category at each mound is recognizable stone tools, occurring at only five features (41BL233 Fs 1 and 5, 41BL598, 41CV1027, and 41CV1195). The nine stone tools recovered included a base of a Uvalde projectile point, an unidentifiable dart point base, a biface, and a complete Yarborough point respectively, from the first four features; F 1 at 41CV1195 yielded two edge-modified flakes, a biface, and two point fragments. The scarcity of stone tools suggests that they were rarely used in processing the products cooked in these mound features. Their occurrence at the feature may be incidental to the burned rock mounds.

Charcoal was very limited in the heavy fraction component and ranged from 1.5 to 16.4 g per feature. Preservation may be influencing its presence. Floating entire 10 cm levels was anticipated to have yielded significantly more and even larger pieces than what was actually recovered. This effort yielded quantities that limited dating processes to the AMS technique and fragments so small that species identification was not attempted.

8.5.7 Carbon Isotope Data

Carbon isotope values were obtained on all 53 samples submitted for radiocarbon analysis to increase the precision in each assay. In the past, most laboratories did not systematically adjust for δ13C or they used estimates by assuming a standard -27‰ rather than providing the actual measurements for the different materials being dated. Carbon isotope values also contribute information about the type of material being analyzed which adds to a broader understanding of the specific sample and the occurrence of materials within the environment. Materials selected for dating were principally charcoal, but one unburned bone, two modern seeds, 10 *Rabdotus* snails, and seven bulk humate samples were included and dated. The carbon isotopes from each category of material is briefly discussed below.

The tiny unburned bone fragment yielded a carbon isotope value of -22.4‰ which indicate that this animal was consuming high percentages of C3 vegetation. The 2-mm-thick bone represented a medium-sized animal. Since deer from Central Texas have been documented as eating mostly C3 plants (Land et al. 1980), it is likely this fragment represents a deer.

Two dated samples of modern *Brassica* sp. seeds yielded carbon isotope values of -28.8‰ and -31.2‰ which document this plant as having a C3 isotopic pathway. Central Texas, which has been classified as a subtropical subhumid area, contains mostly grasses that follow the C4 pathway (Smith and Brown 1973). The C3 pathway of the *Brassica* sp. reflects its intrusion into the Central Texas region.

The 33 charcoal samples yielded carbon isotope values that ranged from -23.7‰ (one combined charcoal sample, Beta-65693) at 41CV124, to -27.4‰ from Beta-64240 at 41CV1195. The overall mean for charcoal is -25.9‰. All charcoal samples reflect a C3 pathway as expected, which is indicative of the known photosynthetic pathway for trees and flowering bushes. The carbon isotope values reveal that over the last 4,000 years, there was a slight trend for the woody plants to become lighter C3 (more negative) in recent times. The causes underlying this apparent shift, if genuine, are uncertain. Potential explanations might include increases in moisture, changes in temperature, or changes in atmospheric CO2.

The δC13 values from the seven humate samples reflect a range from -19.1‰ to -22.5‰ with a mean of -21.5‰. These values are derived from the average of all decayed organic material from various sources and not a single plant. As expected, the carbon isotope values from the humates are all heavier (less negative) than the δC13 values obtained from the average wood charcoal results (-25.9‰) by about 4.5‰. This reflects the input of an unknown percentage of carbon from C4 species (the grass component of the vegetation community), into the average of the humate results.

Three individual features (41BL233, 41BL598, and 41BL608) have more than one isotope value obtained from humate samples. The differences between these samples reveal very minor changes in the C3/C4 community over time. The results from 41BL598 shows a change of 1.8‰ between two humate samples that were about 280 years apart. There, the youngest sample indicates a higher C3 (trees and bushes) content than the older age.

8.6 SUMMARY

The 1992 chronometric investigation of nine burned rock mounds at Fort Hood yielded assays on 33 charcoal, 10 *Rabdotus* snails, two seeds, one bone, and seven humates. Multiple radiocarbon assays at each feature contributed to an understanding of age range and variations, and an appreciation of differences between dated materials. The 33 charcoal AMS dates reflect possible mound-use events dating from 170 to 4,500 years B.P., except one date of 6,500 years B.P. Over 60 percent of the dates fall within the last 2,000 years and 42 percent fall within the last 1,200 years. As far as cultural chronology is concerned, 10 AMS dates fall within Prewitt's Austin phase of the Neo-Archaic/Late Prehistoric period. Another nine dates fall within the Late Archaic period, while six are in the Middle Archaic, with only one possible Early Archaic date.

The pilot study investigating the possibilities of radiocarbon dating *Rabdotus* snails shows promise. Aided by an initial amino acid epimerization step to identify 10 specific snails to be dated from 41BL598, subsequent AMS dating of *Rabdotus* snails yielded positive results. Seventy percent of the snail dates are greater than 5,500 years B.P. and support the early charcoal date from the same F 1 at 41BL598.

Context is the key to deciphering associations between recovered cultural materials, radiocarbon dates, and interpreting feature function. Nine of the 33 charcoal dates were stratigraphically inverted within six different mounds. Sixty-six percent of the mounds exhibited use during two or more periods based on differences in charcoal assays. Apparent single periods of use at three mounds have the potential to control a number of contextual problems in deciphering feature function.

Function or formation processes have significant impact on interpreting the context of assays. Original function and subsequent actions such as turbation and cultural reuse require careful consideration and in-depth investigations to achieve a complete understanding of each feature. Clearly, our limited excavation (11.5 m^2) in 1992 to assess feature age did not allow for accurate identification of feature function or formation processes. Many complex questions concerning these mounds remain unanswered and can only be addressed through an in-depth research design and intensive investigation strategy.

9.0 ANALYSES AND CONCLUSIONS

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The previous chapters have reported on specialized studies derived as adjunct to the site evaluations. This chapter contains more general results derived from analyses of data acquired during the site evaluations.

The first two analyses address lithic artifacts. Section 9.1 is a discussion of aggregate patterns of chert procurement. This analysis implies that within Fort Hood's boundaries, lithic procurement was relatively localized and that lithic materials may have been largely reduced before leaving the general vicinity of procurement. Section 9.2 is an analysis of projectile points. The analysis focuses on identifying morphological and metric variability within the assemblage collected during site evaluations. It shows that some projectile point types at Fort Hood deviate significantly from the diagnostic characteristics specified in their respective type definitions. This may imply that Fort Hood was home to prehistoric groups who had locally distinctive approaches to producing projectile points.

The next two analyses pertain to major elements of the site evaluation process itself. Section 9.3 examines variability among field personnel during the reconnaissance stage of site evaluations. The analysis demonstrates that the criteria and procedures used to evaluate sites during reconnaissance were consistently applied by all archeologists and geomorphologists, and that the quantitative scoring tactic was an adequate methodological tool for ranking site potential. Section 9.4 discusses the kinds and levels of impacts that have affected the archeological record at Fort Hood. These impacts often had significant effects on site evaluations.

The final two sections describe two classes of archeologically interesting sites at Fort Hood. Section 9.5 describes sites located on outcrops of the Paluxy sand deposit. Paluxy sites generally have low densities of artifacts and have numerous (sometimes large) features composed of burned rock that had to be carried in, often from sources many meters away. The Paluxy sites may, therefore, represent behaviorally distinct occupation loci. Section 9.6 describes rockshelters at Fort Hood. It shows that despite decades of excavations in Central Texas, rockshelters have not been adequately assessed with respect to how and when they formed. Hence, the role of rockshelters in prehistoric land-use patterns is an open question.

9.1 MOVEMENT OF CHERT WITHIN FORT HOOD: PRELIMINARY OBSERVATIONS AND HYPOTHESES

G. Lain Ellis and James T. Abbott

As noted in earlier chapters of this volume, Fort Hood is a prime location for producing information about the procurement and use of lithic raw materials by prehistoric people. In the research design for Fort Hood (Ellis 1994a, 1994b), the procurement of chert is regarded as an element of the various technological systems in which stone tools were used. As such, chert procurement is a major element of the decision-making procedures that lead to production of commodities for which stone tools are used at some stage in the procurement, processing, and consumption sequence. After all, it is obvious that unless steps are taken to replenish the supply of stone tools, commodity production may be grossly hindered.

However, even in a chert-rich area such as Fort Hood, procurement of lithic raw materials must be integrated into other activities in some way. Although Fort Hood as a whole is rich in chert, the distribution of chert resources is not uniform, and the quality of chert apparently varies widely from resource to resource (see Chapter 6.0).

Furthermore, since Fort Hood is approximately the size of the annual range of a !Kung band in the Kalahari Desert (cf. Yellen 1976; Ellis 1994a), it is possible (even likely) that at any given time, members of a group occupying the Fort Hood area may have been pursuing subsistence or other goals in an area of the fort that was locally chert-poor in terms of the quantity and/or quality of chert. Understanding the pattern of chert use within the fort boundaries is therefore directly relevant to understanding human adaptation in the Fort Hood area because the pattern will reflect the extent to which chert procurement was determined by the quality of the chert itself or by other factors, such as location near a regularly exploited subsistence resource.

This section provides an exploration of the movement of chert within Fort Hood in an attempt to provide a preliminary model of aggregate chert procurement behavior. We begin with a discussion (Section 9.1.1) of the limitations that are imposed on the analysis of chert-procurement behavior given the nature of the data base and the state of knowledge about chert resources. The discussion then shifts to a description (Section 9.1.2) of the distribution of artifacts made from identifiable chert resources, with detailed discussion of the distribution of artifacts from selected resources. The section concludes with a summary (Section 9.1.3) of the results and a series of hypotheses that warrant further research with more robust data sets.

9.1.1 Looking at the Movement of Particular Cherts

The analysis of chert-procurement patterns is affected by a series of problems. The first problem is a function of the nature of the project itself. The second two problems relate to current knowledge about chert resources on Fort Hood. The strategy used here to analyze the movement of chert was adopted to meet the limitations imposed by the problems.

9.1.1.1 Problem of Aggregate-Level Data

Because a primary objective of Mariah's work was to assess sites for integrity of archeological context, data recovery was not oriented toward the recovery of artifact assemblages that would be robust enough to support detailed scientific model building (cf. Chapter 3.0; Trierweiler 1994a). Because the primary data-recovery tactic was the 30 cm diameter shovel test, assemblages were small and probably unrepresentative at most individual sites (cf. Chapter 4.0; Trierweiler 1994a). At sites that were not shovel tested, recovery was restricted to surface collection of temporal diagnostics. Hence, the number of lithics recovered from any given site usually was quite small. The only major exceptions were rockshelters and burned rock features, which often had fairly dense assemblages and frequently were tested by excavating 50 x 50 cm units.

Furthermore, since site boundaries were originally established on the basis of surface artifact distributions, the 30 m grid on which shovel testing was arranged at any given site could have straddled subsurface occupations so that the artifacts recovered from any given shovel test might be unrelated to the artifacts from other shovel tests. This aspect of data recovery helps guarantee that noncontemporaneous artifacts will be recovered at any given site. Still further, very little chronometric data was recovered overall, and it was frequently difficult to correlate site sediments with Nordt's (1992) alluvial sequence, particularly in the smaller tributaries. Moreover, since temporally diagnostic artifacts can be and frequently are redeposited, reused, or recycled, they are not particularly useful as time markers in this context. Thus, it typically was not possible to use artifacts or gross chronostratigraphic units as a basis for assigning artifacts to a specific time period.

Table 9.1 Frequencies of Identified and Indeterminate Cherts by Class.

	Cores	Tools	Debitage	Total
	n (%)1n	n (%)1	n (%)1	n (%)1
Indeterminate	23 (44)	287 (60)	11,418 (63)	11,728 (62)
Identified	29 (56)	190 (40)	6,830 (37)	7,049 (38)
Total	52 (100)	477 (100)	18,248 (100)	18,777 (100)

The lithic data base is therefore limited by two major influences that follow from the nature of data recovery. First, data recovery at most sites yielded assemblages far too small to allow for site-level analyses. Second, there is no reliable means for stratifying the lithic data into contemporaneous subassemblages, either within or between sites. As a result, analysis of the movement of chert within Fort Hood is hobbled with respect to site- and component-level analyses, and use of the data is limited to aggregate-level analyses.

9.1.1.2 Problem of Indeterminacy

As noted in Section 4.3.2.2, identification of the source material for chert artifacts is complicated by the fact that color and other attributes of many chert types grade into the range covered by other types. In addition, small artifacts simply may not be large enough to contain a full range of diagnostic features, and the effects of heat treatment or patination can make it very difficult to decide what chert type is represented in many individual cases. The net result of these difficulties is that a large number of indeterminate categories were established in order to minimize the tendency to force artifacts into misidentified chert types. Since artifacts made of indeterminate chert types cannot be assigned to a source, they cannot be used to explore chert movement. Furthermore, the chert typology was developed during the late stages of Mariah's field work, and the ability to diagnose chert types involves a learning curve with respect to recognizing the range of variability of any given chert. It is likely that an analyst's ability to recognize chert types changed during the course of analysis, and it is likely that earlier chert-type identifications are less reliable than later ones. Moreover, since some chert types are generally more easily distinguished from others, it is likely that reliability of identification varies from type to type. Consequently, chert-type identifications are at best provisional, and can only be used as impressionistic data at this stage.

Table 9.1 summarizes the nature of the type-identification problem. For cores, analysts made type identifications more than half of the time. Not coincidentally, cores were generally larger objects which therefore had a high probability of having large enough surface areas to display a wide range of diagnostic attributes. On the other hand, more than 60 percent of debitage and tool artifacts (including projectile points) were placed in indeterminate categories.

9.1.1.3 Problem of Unknown Distribution of Chert Resources

As noted in Chapter 6.0, the physical distribution of chert resources is poorly understood. It is not very likely that the chert typology in Chapter 6.0 is exhaustive with respect to outcrops on Fort Hood, and the typology does not reflect chert types that may occur on Fort Hood as ancient lags (e.g., components of Uvalde gravel deposits) or as channel lags imported to Fort Hood by major streams (e.g., the Leon River, Cowhouse Creek). Indeed, it is possible that many of the artifacts assigned to an indeterminate category were made from chert taken from undocumented sources.

Furthermore, the cherts in the typology are relatively well documented only at their sampling locales. Although Mariah personnel have traveled Fort Hood extensively enough to derive an intuitive sense of the distribution of the documented chert types, there is no systematic, reliable documentation of the distribution of bedrock and lag outcrops within the reservation. Moreover, it is not yet possible to characterize the distribution of the various chert types in the alluvial fills. Consequently, assignment of a location of origin to the chert types is at best provisional, and can only be used as impressionistic data at this stage.

9.1.1.4 Assumptions and Methods

As a result of the above difficulties, an analysis of chert movement within Fort Hood cannot produce a definitive description of chert procurement behavior, even at an aggregate level. These difficulties notwithstanding, it is worthwhile to perform an analysis because it can lead to generation of hypotheses for further research. In an attempt to derive a preliminary model of chert movement, we make the following assumptions.

Since time-stratified analyses of the lithic data base as a whole are largely precluded by the inability to reliably assign assemblages to even gross periods, the time scale adopted below includes the entire range of human occupation at Fort Hood. This scale precludes the possibility of making claims about the nature of stability or change in procurement behavior in much the same way that stratifying data for phase- or stage-level discussions (e.g., Toyah phase, Middle Archaic stage) can preclude the possibility of identifying within-period behavioral patterns (see, e.g., Minnis 1985). However, if any patterns are apparent at this time scale, there would be reason to believe that looking for patterns at smaller time scales would be productive. After all, if movement of chert at the aggregate scale is nonuniform, aggregate nonuniformity is the net result of nonuniformity during a long sequence of shorter time scales. Thus, the main assumption and justification for the following analysis is that if patterns are visible at the aggregate time scale, they also should be visible at smaller time scales. Note, however, that the converse is not necessarily valid. The absence of a nonuniform pattern at the aggregate scale could result from different but highly patterned activities at a series of smaller time scales.

To compensate for the inability to perform site-to-site analyses, we will adopt Fort Hood's PK grid as the spatial matrix for analysis. The PK grid is composed of 1 km^2 squares based on UTM coordinates. As an accident of the high density of archeological sites at Fort Hood and as a side effect of a contractual focus on cultural resources in high-maneuver areas outside the live-fire zone (see Chapter 3.0), typically more than one site was located in the PK squares in which Mariah performed assessment activities. As a result, although data returns generally were small from any single site, total returns in many PK squares were high enough to be treated as samples of what might be expected in a given 1 km^2 area of the base. Indeed, 1 km^2 analytical units are highly appropriate for a preliminary exploration of chert procurement given both the size of the fort and the apparent size of many chert outcrops. Furthermore, since site boundaries at Fort Hood are for the most part not chronologically, culturally, or behaviorally significant (see Chapter 3.0), using PK squares avoids reifying site boundaries for purposes they cannot serve justifiably. Thus, the PK square is adopted as the spatial unit of interest under the methodological assumption that it is large enough to divide the lithic data base into numerically analyzable units, but small enough to reveal relatively local trends, if they exist.

Because the spatial distribution of chert resources is not well known, we assume that the general distribution of outcrops described in Chapter 6.0 is only approximately correct and avoid examining the distribution of artifacts relative to defined outcrop or chert province boundaries. This move not only avoids introducing spurious accuracy it also helps preclude unjustifiable reification of Frederick's chert provinces (Section 6.3.3.2). Frederick has gone to a lot of trouble to ferret out misinformation about the distribution of Edwards chert, and we have no desire to create new chert-resource myths that he or someone else must later correct. However, to provide a point of reference, it is necessary to make a commitment to some natural chert distribution. Figure 9.1 illustrates the locations of chert provinces as they will be referred to in this analysis.

Furthermore, our spatial analyses will be intuitive because the problem of unknown chert-resource boundaries is accompanied by a problem of having acquired data from a suite of sites that is spatially arrayed around the live-fire zone. Using spatial statistics appropriate to the crudeness of the data base would by itself virtually guarantee identification of nonrandom artifact distributions because a large data void exists amidst an already irregularly shaped study area. Avoiding spatial statistics therefore is another means of avoiding spurious accuracy.

Finally, we will deal with the problem of indeterminate chert types by restricting the analysis to artifacts for which a chert-type identification was made. We acknowledge the fact that type identifications are likely to include errors, some of which may be systematic and others of which may be random. We assume for the purposes of this analysis that the error rate is low and that errors were random under the further assumption that most dubious calls were assigned to an indeterminate category. Thus, the following analysis assumes that the data are basically reliable because we believe that it is worthwhile to pursue a source-related analysis, and no such analysis would be possible without this assumption.

Given the above assumptions, the analysis was pursued as follows. Artifacts were divided into three classes: debitage, cores, and tools, including projectile points. The number of artifacts of each chert type was determined for each class for each PK square. Because Heiner Lake Blue-Light chert (Type 1) frequently occurs on the same nodules (and, presumably, in the same outcrops) as Heiner Lake Blue, they were lumped into a single category. Similarly, although Cowhouse White chert (Type 2) was classified according to light and dark specimens reflecting material from the outer and inner portions of natural clasts, the variants were lumped into a single Type 2 category. Type 12 chert was lumped with Fort Hood Gray (Type 14) to reflect the discovery that both are the same material (see Chapter 6.0, Appendix C, and Section 4.3.2.2). Lumping reduced the chert categories to 15 types. The data is presented in Table G.1 in Appendix G.

A map was generated showing the basic frequency distribution of artifacts in each class (Appendix G, Figures G.2, G.3, and G.4). We then generated a map of the frequency of each chert type for tools, including projectile points (Figures G.5 through G.16), and debitage (Figures G.29 through G.43). A set of maps also was generated to show the distribution of projectile points and other tools on a presence/absence basis to illustrate their differential distribution (Figures G.17 through G.28). Each of the type-specific maps includes all of the PK squares in which there was at least one artifact of the class, but for which the frequency of the chert type was zero. For example, Figure G.5 shows the PK square where Cowhouse White flakes were found as well as all of the other squares where flakes of other types were found.

Because the number of recovered cores and tools is very small in most PK squares, we did not perform any statistical analyses. However, a large number of the PK squares had sufficient numbers of debitage artifacts to test whether the number of artifacts was less than, equal to, or greater than the number that would be expected in a random distribution of chert types. For these purposes, the nature of the data recovery process is actually beneficial because sampling on a 30 m grid reduces (but does not minimize or eliminate) the likelihood that representation of a chert type will be skewed as a result of recovering a large number

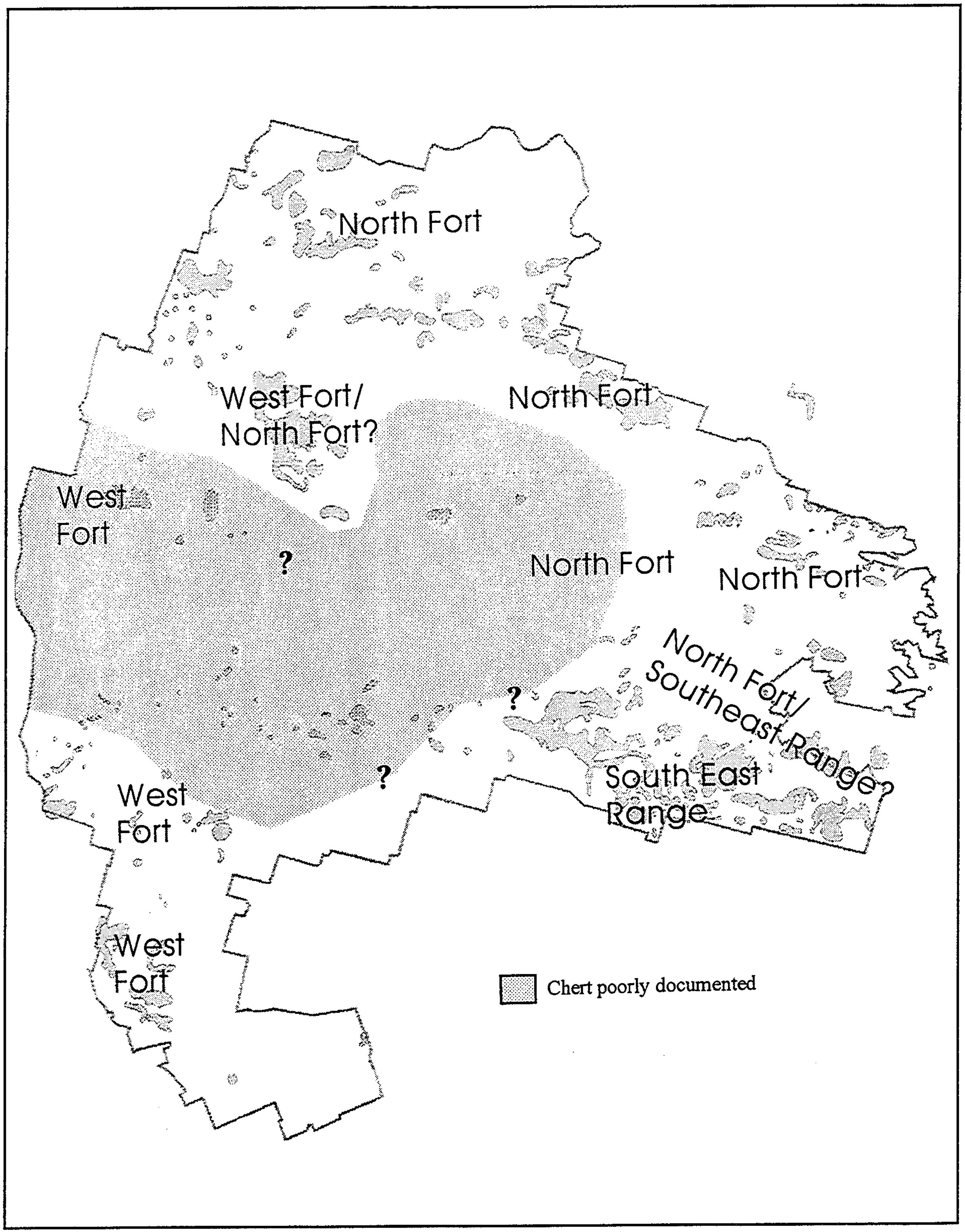


Figure 9.1 Approximate Location of Chert Province in Fort Hood.

of flakes produced in a single knapping episode on a single piece of chert. The possibility of skewing is greatest for PK squares containing rockshelters and burned rock features tested with 50 x 50 cm test pits. However, even in these cases, skewing of one chert type may be at least partially cancelled out as a function of the fact that generally larger assemblages were recovered under these circumstances.

Binomial hypothesis tests (Thomas 1986) were used to determine whether or not the observed frequency for each type in each PK square was within the range expected in a random distribution. Binomial tests apply to phenomena that can be characterized in terms of mutually exclusive, discrete attributes, or states. A chert artifact, for example, belongs to one and only one chert type. Observing the chert type of an artifact constitutes a trial in which the artifact will turn out to have one or another chert attribute. Thus, a sample of *N* artifacts for which chert identifications have been made constitutes a set of *N* trials. Binomial distributions characterize the frequency range that can be expected for each discrete attribute in a random distribution of *N* trials. If the number of artifacts observed for any given chert type$_i$ is less than or greater than the range predicted in the binomial distribution, then the observation is inconsistent with a random selection process for that chert type, which implies that a nonrandom process governs chert selection.

Binomial distributions for each chert type for each PK square were calculated with a computer program (Carlson n.d.b). The number of identified flakes in each square was used as the number of trials. The value for *p* (observing a flake of Type$_i$) was determined by dividing the total number of flakes for each type by the total number of flakes that were recovered and identified by type. *P* was calculated this way because the very low frequency of some cherts in the collection (especially Seven Mile Mountain Novaculite) are so low that cherts obviously do not have the same procurement rates. Thus, the tests determine whether chert types are randomly distributed according to their observed relative frequencies.

Since *p*(observing a flake of Type$_i$) was very low for many of the chert types, it frequently was mathematically possible to identify underrepresentation in samples as small as two artifacts. In all cases, we regarded the sample size as insufficient if the number of flakes in the square was not large enough to provide at least two values outside the expected range. For example, if a square had only four flakes in it, we regarded the sample as too small if the expected range was 0 to 3 or 1 to 4 artifacts, and we regarded it as adequate of the expected range was 0 to 2, 1 to 3, or 2 to 4 artifacts. This arbitrary decision avoided overloading the analysis with results based on extremely small samples while still providing a widespread distribution of squares in which statistical distinctions were mathematically possible.

As a result of small sample sizes and low probabilities of occurrence for many chert types, many PK squares with zero observed frequencies were within the expected range. Interestingly, it was not uncommon to identify PK squares with very small samples for which at least some chert types actually were statistically underrepresented. After running the binomial tests, PK squares were mapped (Figures G.44 through G.58) for each chert type to indicate that the number observed was less than, equal to, or greater than the number expected, or to indicate that there was insufficient data.

9.1.2 Distribution of Source-Identified Chert Artifacts

The following is a discussion of some of the results of the analysis on cores, tools, and debitage. Since many of the chert categories are represented by very small numbers of artifacts, the discussion is not exhaustive, and it has been left to the reader to sort out some of the details using figures and tables in Appendix G. In the interests of reducing redundancy while simultaneously having the relevant figures occur together in the report, most figures referred to in the discussion are located in Appendix G.

9.1.2.1 Cores

Twenty-nine cores were identified according to chert type. Most of these occur in the Heiner Lake area and north of Owl Creek (Figure G.2). Interestingly, most of the cores occur in areas that are close to known outcrops of the natural resource. The only recovered cores made of Heiner Lake Blue and Heiner Lake Translucent Brown occur within several kilometers of the sampling locale from which the type descriptions were obtained. An Anderson Mountain Gray core was found in the far northwest portion of the base near or, perhaps, slightly beyond the northern extreme of its postulated West Fort outcrop province. Cores from Fort Hood Yellow and Fort Hood Gray occur approximately within the North Fort province that includes their known and intuitively likely ranges. Seven out of nine Gray-Brown-Green cores occur within a few kilometers of the sampling locality, but two of them also occur in the far west-central portion of the base. These two cores may reflect transportation a moderate to long distance away from the procurement locality, depending on how extensively the resource crops out in the North Fort province.

The core evidence is interesting for two reasons. First, although the sample of identified cores is not large, no more than two (7%) were recovered a substantial distance from areas in which the resource has a known or high likelihood of natural occurrence. The Anderson Mountain Gray core may or may not be a third example of a core that has been moved beyond its resource area. If the observed distribution of cores begins to reflect the actual aggregate distribution of cores on Fort Hood, it implies that prehistoric people on the base were not particularly inclined to carry cores around with them. Given that the Heiner Lake and Anderson Mountain materials tend to be harder to use, it would not be surprising for them to be left behind near the outcrop (see Dickens and Dockall 1992; Chapter 3.0 of this report). However, this consideration does not apply to Fort Hood Yellow, Fort Hood Gray, or Gray-Brown-Green cherts, which are consistently workable materials (see Chapter 6.0). Thus, the second reason why the core data are interesting is that cores seem to stay close to the source regardless of their workability, although the cores that are most likely to have been transported are from good materials (Chapter 6.0).

9.1.2.2 Tools

Chert type was identified for 190 tools, including 83 projectile points (Table G.2). Figure G.3 shows that tools were recovered from locations widely scattered across the base. Recovered tools were made from each of the materials identified in cores plus six additional chert types. Only tools from two chert types (Heiner Lake Tan, Figure G.7, and Anderson Mountain Gray, Figure G.6) are very widely distributed across the base relative to their known and postulated source areas. Others (e.g., Fort Hood Yellow, Figure G.9, and Gray-Brown-Green, Figure G.14) are distributed widely within and, probably, at least slightly beyond their respective chert provinces, with scattered occurrences on the rest of the base in areas where the resource almost certainly is not available in outcrop sources. In contrast, Heiner Lake Translucent Brown tools (Figure G.10) are narrowly distributed, although about half of them may occur outside the resource province. The distribution of Fort Hood Gray tools (Figure G.13) resembles that of Heiner Lake Translucent Brown with the addition of a few distant occurrences in the far southwestern corner of the base. About half of the Fort Hood Gray tools probably are outside the resource province.

The distribution of projectile points, which on a priori grounds usually would be regarded as mobile tools since their places of manufacture and use are probably seldom the same, does not account for much of the distribution of tools beyond their probable source provinces. For both

Heiner Lake Tan and Anderson Mountain Gray, projectile points and other tools are distributed both within and well beyond known and postulated province boundaries (Figures G.18 and G.19). Projectile points from Fort Hood Gray occur only in the resource area, whereas most other tools occur in other chert provinces (Figure G.25). Heiner Lake Blue tools and points, all of which are made of the harder-to-work interior material, are evenly split between the resource province and locations well beyond the known and postulated limits of natural occurrence (Figure G.23). Hence, it appears that tools in general are fairly mobile, although it also appears that they may be somewhat concentrated in areas relatively near the resource area.

Interestingly, although many modern knappers regard Owl Creek Black as the most desirable chert in the Fort Hood area, neither projectile points nor other tools made of Owl Creek Black (Figure G.28) are either as common or as widely distributed as tools made of Heiner Lake Tan. Fort Hood Yellow tools and points are more numerous than their Owl Creek Black counterparts, but have approximately the same distribution. Tools and points made from some of the less workable cherts (e.g., Anderson Mountain Gray and Heiner Lake Blue) also have wide distributions, although they occur at very low frequencies. This weakly implies that although workability may have some influence on the likelihood of procuring chert for production of a formal or semiformal tool, it may have little influence on the mobility of the tool once it has been made.

9.1.2.3 Debitage

The debitage collection is large enough to warrant reinforcing visual spatial analysis of presence/absence with statistical tests regarding the composition of the samples in many PK squares. However, the statistics do not change the ultimately intuitive nature of the analysis. Rather, they provide additional relevant information to incorporate into the discussion. The debitage analysis begins by characterizing the very general trends in the distribution of squares in which flakes of individual chert types are statistically over- and underrepresented. The discussion then shifts to consideration of the patterns in which multiple chert types occur in the same squares.

Since Leona Park (Type 16) chert is not known to occur naturally on Fort Hood, it will be excluded from the discussion. For simplicity and consistency of usage, squares in a chert province will be referred to as North, South, or West squares. The same descriptors will be assigned to chert types. The zones between provinces will be referred to as the West/North and North/South junctures to reflect the fact that the nature of the boundaries between provinces are completely unknown. Figure 9.1 shows the rough distribution of these areas.

Statistical hypothesis tests were run for each PK square in order to determine whether the observed frequency of flakes of each chert type was less than, equal to, or greater than the expected frequency. Table 9.2 summarizes the results. An examination of the maps showing the distribution of statistical results (Figures G.44 through G.58) shows that for most types, squares with less than expected observed frequencies are widely distributed in general. Squares with greater than expected results also are widely distributed. However, these distributions do not appear to be generally uniform from type to type. For most types, squares with less than and greater than expected values occur both in and outside of their respective provinces.

Table 9.3 provides an impressionistic summary of the distribution of unexpected observations that has been derived from a visual examination of the maps for individual types. Three of the chert types appear to have most of their less than expected observations inside their chert provinces. Two of these, Texas Novaculite (Type 5) and East Range Flat (Type 11) were rated as fair materials in the workability study (Chapter 6.0).

Table 9.2 Summary of Statistical Results for Debitage by Chert Type.

Province	Chert	Insufficient Data	Less Than Expected	Expected	Greater Than Expected
North Fort	Type 5	40	1	101	6
	Type 7	40	2	98	8
	Type 8	67	23	42	16
	Type 11	40	16	91	1
	Type 14	40	11	86	11
	Type 15	53	13	67	15
	Type 17	53	15	77	3
South East Range	Type 2	40	10	84	14
	Type 6	40	7	93	8
	Type 9	40	8	94	6
	Type 10	40	12	84	12
	Type 13	40	14	90	4
West Fort	Type 3	40	6	91	11
	Type 4	40	0	108	0

Table 9.3 General Distribution of Less Than Expected and Greater Than Expected Frequencies of Flakes Relative to Chert Provinces.

	Less Than Expected Values			Greater Than Expected Values		
	Most In	In/Out	Most Out	Most In	In/Out	Most Out
North Fort Province						
	P/F					
Type 5	P/F				P/F	
Type 7		?				?
Type 8		G		G		
Type 11	F			F		
Type 14	G				G	
Type 15		G		G		
Type 17		G		G		
South East Range Province						
Type 2		G		G		
Type 6			G			G
Type 9			P	P		
Type 10			P/F	P/F		
Type 13			F/G	F/G		
West Fort Province						
Type 3			F		F	
Type 4	N	N	N	N	N	N

P = Poor workability in unaltered state
F = Fair workability in unaltered state
G = Good workability in raw state
N = No squares with unexpected results

P/F = Poor to fair workability in unaltered state
F/G = Fair to good workability in unaltered state
? = Unknown workability

Of the remaining types for which a judgement is feasible, half have their unexpectedly low observations split more or less evenly between within- and out-of-province squares. For the rest of the types, squares with less than expected values occur mostly outside the province. Underrepresentation of most of the South and West types occurs outside the province, and relatively little underrepresentation of South types occurs in South squares. Thus, whereas workability may be related to underrepresentation in the North Fort province, it does not appear to be related in the South East Range province.

Conversely, eight cherts have greater than expected values concentrated mostly within their provinces, whereas only two of the cherts appear to have most of their greater than expected observations outside their provinces. Three are split approximately evenly between within- and out-of-province squares. One of the cherts with greater than expected values distributed widely beyond its province (Heiner Lake Tan, Type 6) was rated as good in the workability study. The workability of the other chert is unknown. The distribution of overrepresented values implies that chert reduction was most heavily concentrated near the source at least partly irrespective of its workability.

The distribution of squares with unexpectedly high and unexpectedly low observations suggests that, within aggregate chert procurement, the general trend was for chert to be procured and largely reduced in or near the province where it occurs naturally. Within this trend, there is evidence of ample exceptions. However, given that the time scale assumed here is as much as 10 to 12 thousand years, the fact that a trend is visible at all implies that patterns are likely to exist at smaller time scales. Note, however, that this conclusion follows from an analysis based on a fairly large number of samples that are at best marginally appropriate because they are very small. As a result, it would be useful to see how well the above pattern is reflected in larger samples.

The largest samples have the greatest mathematical likelihood of showing expected or unexpected values that actually represent over- or underrepresented chert types. An examination of the statistical results for the 20 PK squares with the largest samples may help clarify the tendency of chert to be reduced in or near its source province (Table 9.4 and Figure G.59). Of these squares, seven can be fairly confidently assigned to the North Fort province and three to the South East Range province. Another three lie in the North/South zone, and another seven are in the West/North zone.

In the North squares, at least one of the North cherts occurs at a higher than expected frequency, and at least one occurs at a lower than expected frequency. However, the South and West cherts in these squares are for the most part underrepresented. Overrepresentation of South cherts occurs only in North squares no more than 7 or 8 km away from known outcrops. In contrast, at least two local cherts are overrepresented in each of the South squares, whereas the North cherts tend to be underrepresented. Interestingly, the squares in the North/South zone contain a mixture of over- and underrepresented cherts from both provinces. Anderson Mountain Gray, one of the West cherts, is overrepresented in four squares, two of which are in the far east, and two of which are in the West/North zone. Every square in this area has at least two North or West cherts that are overrepresented. Although South cherts tend toward underrepresentation, three squares have unexpectedly high frequencies of a South material.

The distribution of statistically over- and underrepresented types implies that in squares with large samples, lithic reduction appears generally to be dominated by local materials, although there are plenty of exceptions. It would be useful to determine how dependent over- and under-representation are with respect to sample size. In order to do so, we tallied the squares that had more than two observations at greater than expected frequency and the squares with more than

Table 9.4 Statistical Results for 20 Largest Samples.

Statistical Results for Chert Type by Province

			North Fort							South East Range					West Fort		Total
E	N	Chert Province	5	7	8	11	14	15	17	2	6	9	10	13	3	4	
15	69	NF	=	=	>	<	<	<	<	<	=	=	<	<	=	=	102
18	68	NF	=	=	>	<	<	<	<	<	<	<	<	<	<	=	188
26	66	NF	=	=	>	<	<	<	<	<	<	<	<	<	<	=	197
31	56	NF	=	=	<	<	>	=	=	=	=	>	=	<	=	=	174
32	56	NF	=	=	>	<	=	=	=	=	<	<	=	<	=	=	212
35	56	NF	<	<	>	>	<	<	>	<	<	<	<	>	<	=	1,846
36	57	NF	=	=	<	<	<	>	>	<	<	<	<	<	<	=	216
39	50	NF/SER?	=	=	=	=	<	>	=	=	=	=	=	<	=	=	94
39	51	NF/SER?	>	>	<	<	<	<	<	>	>	<	>	=	=	=	181
42	49	NF/SER?	=	=	<	<	=	>	=	<	<	=	<	>	>	=	120
31	47	SER	=	=	<	<	<	<	=	>	=	>	<	<	>	=	167
33	44	SER	=	=	<	<	<	<	<	<	>	>	>	<	=	=	158
34	43	SER	>	<	<	<	>	<	<	<	=	>	>	<	<	=	493
8	60	WF/NF?	=	=	=	=	=	>	=	>	=	=	=	=	=	=	75
9	57	WF/NF?	=	=	<	<	>	=	=	=	=	=	>	<	=	=	112
10	64	WF/NF?	=	=	>	<	=	>	=	=	=	=	<	=	=	=	124
11	63	WF/NF?	>	=	>	=	=	<	<	=	>	=	<	=	>	=	84
11	67	WF/NF?	=	=	<	<	>	>	=	=	=	<	<	<	>	=	464
12	64	WF/NF?	=	=	>	<	<	>	<	<	=	=	<	<	=	=	112
12	65	WF/NF?	=	=	>	<	<	<	<	<	<	<	<	<	<	=	303
		n < expected	1	2	9	16	11	10	9	10	7	8	12	14	6	0	115
		n = expected	16	17	2	3	5	3	9	7	10	8	4	4	10	20	118
		n > expected	3	1	9	1	4	7	2	3	3	4	4	2	4	0	233

two observations at less than the expected frequency. These procedures yielded assortments of PK squares that cross-cut the large and medium sample-size squares in slightly different ways.

The procedure for squares with greater than expected values identified several squares in each of the provinces and in the West/North and the North/South zones (Table 9.5 and Figure G.60). Most of the overrepresented types in the North and South squares are local types, with North types overrepresented more often in the South squares than vice versa. At least one North type is overrepresented in each North square, but one South square has no local types in greater than expected numbers. Anderson Mountain Gray, a West type, is overrepresented twice in each area.

Table 9.5 Squares with More Than Two Greater Than Expected Observations.

Statistical Results for Chert Type by Province

			North Fort							South East Range					West Fort		Total	n >
E	N	Chert Province	5	7	8	11	14	15	17	2	6	9	10	13	3	4		
35	56	NF	<	<	>	>	<	<	>	<	<	<	<	>	<	=	1,846	4
33	53	NF	=	=	<	=	>	=	=	=	=	=	=	=	>	=	17	2
33	56	NF	=	=	=	=	=	>	=	=	=	=	=	=	>	=	25	2
31	56	NF	=	=	<	<	>	=	=	=	=	>	=	<	=	=	174	2
36	57	NF	=	=	<	<	<	>	>	<	<	<	<	<	<	=	216	2
39	51	NF/SER?	>	>	<	<	<	<	<	>	>	<	>	=	=	=	181	5
39	48	NF/SER?	>	=	=	=	=	=	=	>	=	=	=	=	=	=	24	2
42	49	NF/SER?	=	=	<	<	=	>	=	<	<	=	<	>	>	=	120	3
42	47	NF/SER?	=	=	<	=	=	=	<	>	=	=	=	>	=	=	30	2
38	47	NF/SER?	=	=	<	=	=	=	=	>	=	=	>	=	=	=	39	2
32	45	SER	=	=	<	=	=	<	<	>	=	>	>	=	>	=	57	4
34	43	SER	>	<	<	<	>	<	<	<	=	>	>	<	<	=	493	4
33	44	SER	=	=	<	<	<	<	<	<	>	>	>	<	=	=	158	3
31	47	SER	=	=	<	<	<	<	=	>	=	>	<	<	>	=	167	3
34	47	SER	=	>	=	=	>	=	=	=	=	=	=	=	=	=	16	2
30	43	SER	=	=	<	=	=	=	=	=	=	>	>	=	=	=	30	2
38	43	SER	=	=	<	=	=	=	<	>	=	=	>	=	=	=	70	2
6	47	WF	>	>	=	=	=	=	=	=	=	=	=	=	>	=	18	3
7	37	WF	=	>	<	=	=	=	=	=	>	=	=	=	=	=	14	2
5	46	WF	=	=	<	=	=	=	=	>	>	=	=	=	=	=	20	2
5	44	WF	=	>	<	=	=	=	=	=	=	=	>	=	=	=	25	2
11	63	WF/NF?	>	=	>	=	=	<	<	=	>	=	<	=	>	=	84	4
11	67	WF/NF?	=	=	<	<	>	>	=	=	=	<	<	<	>	=	464	3
8	59	WF/NF?	=	>	=	=	=	>	<	=	=	=	=	=	=	=	56	2
11	55	WF/NF?	=	=	=	=	>	=	<	=	=	=	>	=	=	=	61	2
8	60	WF/NF?	=	=	=	=	=	>	=	>	=	=	=	=	=	=	75	2
9	57	WF/NF?	=	=	<	<	>	=	=	=	=	=	>	<	=	=	112	2
10	64	WF/NF?	=	=	>	<	=	>	=	=	=	=	<	=	=	=	124	2
12	64	WF/NF?	=	=	>	<	<	>	<	<	=	=	<	<	=	=	112	2

The pattern in squares in the North/South zone resembles the pattern in the South squares. However, each square has an overrepresented South chert, whereas two do not have any overrepresented North types. One square has greater than expected numbers of a chert from all three provinces.

The pattern for the West squares is not dominated by cherts from any single province. A local chert is overrepresented in only one square. Two squares have both North and South types in greater than expected frequencies, one has only South types, and another has only North types. The West/North zone has overrepresented North types in all eight squares, South types in half of the squares, and West types in two squares. One square has greater than expected values for cherts from all three provinces.

The pattern among squares with at least two overrepresented types suggests that there is a general tendency for flakes from local cherts to occur more frequently in the North Fort and South East Range provinces. The borders between provinces appear to be fairly highly mixed, with the North/South zone perhaps slightly more dominated by South cherts, and the West/North zone perhaps more dominated by North types. The West Range province is dominated by flakes from other provinces. Interestingly, South types appear to occur regularly in high frequencies in the West Fort province and the West North zone.

If this pattern is basically sound, then the pattern of underrepresentation should be the approximate converse. The procedure for underrepresented squares yielded groups of samples in all but the West Fort province (Table 9.6 and Figure G.61). All of the North squares have at least one local type that occurs at greater than expected frequencies. However, there is a high rate of underrepresentation for West and South cherts in these squares. A similar pattern holds for the South squares. The zone between these areas is a mixture in which types from both adjoining provinces have a fairly high rate of underrepresentation, although all South types have expected or greater than expected values in two squares. The West/North zone is also a mixed bag, although there is a relatively low rate of underrepresentation of North types.

Thus, the pattern of underrepresentation is broadly complementary to the pattern of overrepresentation. Within the North Fort and South East Range provinces, less than expected frequencies of local cherts tend to be offset by greater than expected frequencies of other local cherts. In general, nonlocal cherts have higher rates of underrepresentation. This implies that much lithic reduction stays relatively close to the place of procurement. The zones between adjoining provinces tend to have over- and underrepresented cherts from each of the adjoining provinces, which suggests that the cherts may overlap provinces at least slightly and that chert procurement and use blurs the boundaries still further. Interestingly, however, there is a slight but persistent tendency for South cherts to occur in higher than expected numbers near the northwest corner of the reservation, and for a West chert to be overrepresented in the east. Since many of these cherts are not highly workable relative to other, closer materials, the distribution of the resource itself may be reflected in the distant occurrences. In any event, the general pattern is one of domination by local types with apparent diversity among both local and nonlocal types.

If this pattern holds, then diversity of chert and numerical frequency of debitage in a given square should be dominated by local cherts. To explore this possibility, we determined the number of chert types that were present in each square and ranked them from highest to lowest, with 11 types being the highest number occurring in a square. We then arbitrarily identified the upper four ranks (7, 8, 9, and 11 types; roughly the highest tercile) as a sample to examine for diversity (Table 9.7, Figure G.62). This sample contains 11 squares in the South East Range province, 5 in the North Fort province, 6 in the West/North zone, and 5 in the North/South zone. Sample sizes in these squares

Table 9.6 Squares with More Than Two Less Than Expected Observations.

Statistical Results for Chert Type by Province

			North Fort							South East Range					West Fort		Total	n <
E	N	Chert Province	5	7	8	11	14	15	17	2	6	9	10	13	3	4		
18	68	NF	=	=	>	<	<	<	<	<	<	<	<	<	<	=	188	10
26	66	NF	=	=	>	<	<	<	<	<	<	<	<	<	<	=	197	10
36	57	NF	=	=	<	<	<	>	>	<	<	<	<	<	<	=	216	9
35	56	NF	<	<	>	>	<	<	>	<	<	<	<	>	<	=	1,846	9
15	69	NF	=	=	>	<	<	<	<	<	=	=	<	<	=	=	102	7
32	56	NF	=	=	>	<	=	=	=	=	<	<	=	<	=	=	212	4
31	56	NF	=	=	<	<	>	=	=	=	=	>	=	<	=	=	174	3
31	47	NF/SER?	=	=	<	<	<	<	=	>	=	>	<	<	>	=	167	6
39	51	NF/SER?	>	>	<	<	<	<	<	>	>	<	>	=	=	=	181	6
39	50	NF/SER?	=	=	=	=	<	>	=	=	=	=	=	<	=	=	94	2
12	65	NF/WF?	=	=	>	<	<	<	<	<	<	<	<	<	<	=	303	10
42	49	NF/SER?	=	=	<	<	=	>	=	<	<	=	<	>	>	=	120	5
42	47	NF/SER?	=	=	<	=	=	=	<	>	=	=	=	>	=	=	30	2
39	45	NF/SER?	=	=	<	=	>	<	=	=	=	=	=	=	=	=	33	2
34	43	SER	>	<	<	<	>	<	<	<	=	>	>	<	<	=	493	8
33	44	SER	=	=	<	<	<	<	<	<	>	>	>	<	=	=	158	7
32	45	SER	=	=	<	=	=	<	<	>	=	>	>	=	>	=	57	3
38	43	SER	=	=	<	=	=	=	<	>	=	=	>	=	=	=	70	2
11	67	WF/NF?	=	=	<	<	>	>	=	=	=	<	<	<	>	=	464	5
12	64	WF/NF?	=	=	>	<	<	>	<	<	=	=	<	<	=	=	112	6
11	63	WF/NF?	>	=	>	=	=	<	<	=	>	=	<	=	>	=	84	3
9	57	WF/NF?	=	=	<	<	>	=	=	=	=	=	>	<	=	=	112	3
10	64	WF/NF?	=	=	>	<	=	>	=	=	=	=	<	=	=	=	124	2

Table 9.7 Frequencies of Chert Types in Squares with Most Diverse Chert Types.

			North Fort									South East Range							West Fort					
E	N	Chert Province	5	7	8	11	14	15	17	n	%	2	6	9	10	13	n	%	3	4	n	%	Total	n Types
25	66	NF	0	1	11	0	1	4	0	17	85.0	1	0	0	1	0	2	10.0	1	0	1	5.0	20	7
31	56	NF	0	0	55	0	21	24	21	121	69.5	11	4	28	5	0	48	27.6	4	0	4	2.3	174	9
32	56	NF	0	0	118	0	10	24	34	186	87.7	6	1	0	16	0	23	10.8	1	0	1	0.5	212	8
34	53	NF	0	0	25	0	1	9	4	39	79.6	1	0	0	1	0	2	4.1	8	0	8	16.3	49	7
35	56	NF	0	0	705	239	21	159	469	1593	86.3	31	0	0	2	216	249	13.5	1	0	1	0.1	1846	9
38	47	NF?/SER?	0	1	6	0	0	1	1	9	23.1	18	0	0	9	0	27	69.2	3	0	3	7.7	39	7
39	48	NF?/SER?	4	0	6	0	1	6	2	19	79.2	4	0	0	0	1	5	20.8	0	0	0	0.0	24	7
39	50	NF/SER?	0	1	39	0	0	32	6	78	83.0	4	4	0	4	0	12	12.8	4	0	4	4.3	94	8
39	51	NF/SER?	9	6	58	0	0	10	4	87	48.1	35	29	0	17	13	94	51.9	0	0	0	0.0	181	9
42	49	NF?/SER?	3	1	21	0	7	24	11	67	55.8	0	0	0	0	35	35	29.2	18	0	18	15.0	120	8
27	48	SER	7	0	7	0	1	3	1	19	86.4	0	1	1	1	0	3	13.6	0	0	0	0.0	22	8
30	43	SER	0	0	7	0	2	0	1	10	33.3	3	0	8	8	0	19	63.3	1	0	1	3.3	30	7
31	47	SER	2	0	14	0	1	8	13	38	22.8	18	5	92	1	1	117	70.1	12	0	12	7.2	167	11
31	48	SER	0	1	16	0	3	1	3	24	75.0	7	1	0	0	0	8	25.0	0	0	0	0.0	32	7
32	45	SER	1	0	0	1	3	0	0	5	8.8	13	0	12	7	0	32	56.1	20	0	20	35.1	57	7
33	44	SER	0	2	5	0	1	0	0	8	5.1	0	84	10	54	0	148	93.7	1	1	2	1.3	158	8
34	43	SER	23	0	179	0	134	9	22	367	74.4	2	10	32	81	0	125	25.4	0	0	0	0.0	493	9
34	47	SER	0	2	4	0	4	1	1	12	75.0	1	0	0	1	0	2	12.5	1	1	2	12.5	16	9
36	44	SER	0	1	4	0	1	0	1	7	36.8	2	0	0	8	2	12	63.2	0	0	0	0.0	19	7
38	43	SER	0	1	1	0	4	6	1	13	18.6	27	0	1	28	0	56	80.0	1	0	1	1.4	70	9
7	61	WF?/NF?	0	2	6	0	4	3	1	16	57.1	3	6	0	3	0	12	42.9	0	0	0	0.0	28	8
8	60	WF?/NF?	0	1	33	0	1	16	6	57	76.0	12	1	0	1	0	14	18.7	3	0	3	4.0	75	9
10	64	WF?/NF?	0	1	81	0	8	21	8	119	96.0	2	1	0	1	1	5	4.0	0	0	0	0.0	124	9
11	55	WF?/NF?	0	1	29	0	13	5	1	49	80.3	2	0	0	9	0	11	18.0	0	0	0	0.0	61	7
11	63	WF?/NF?	12	0	47	0	1	2	1	63	75.0	1	10	0	0	0	11	13.1	10	0	10	11.9	84	8
11	67	WF?/NF?	0	8	172	1	77	104	50	412	88.8	20	7	0	1	1	29	6.3	22	0	22	4.7	464	11

range from 16 to 1,846 flakes. Judging from the fact that some fairly small samples contain quite diverse arrays of chert types, diversity does not appear to be strongly influenced by sample size beyond the impact of very small samples in which the number of flakes is too small to permit diversity.

In the North squares, local cherts overwhelmingly dominate the sample. In each case, a North chert is the most frequent type. The pattern is different in the South squares. Here, local cherts dominate the sample in six squares, whereas North cherts dominate the sample in four. West cherts constitute a substantial minority in two of the South squares.

In the North/South zone, North cherts are more numerous in three squares. South cherts are more numerous in two squares, although only by a bare majority in one of them. Interestingly, in one square where North cherts are more numerous, a South chert is the most frequent single type. A converse pattern occurs in one of the squares dominated by South types.

In the West/North zone, North cherts dominate the sample in each square. However, South cherts are more numerous than West cherts. In one square, South cherts, one of which is tied with a North chert as the most numerous type, comprise more than 40 percent of the sample. In another, a West type is more numerous than any single South chert. In yet another square, a West type occurs as frequently as the most numerous South type.

In general, in high-diversity samples, chert diversity appears to occur more or less independently of the location of the square and the size of the sample. However, despite wide diversity, there apparently is a fairly strong tendency for North and South squares to be dominated numerically by local cherts, although this trend appears to be weaker for South squares. The North/South zone may be slightly dominated numerically by North cherts. The West North zone appears to be strongly dominated by North cherts.

The above is broadly reinforced by the pattern for squares with samples of greater than 15 flakes, but four or fewer chert types (Table 9.8 and Figure G.63). As with high-diversity samples, low diversity appears to be at least partly independent of sample size. North squares are not only dominated by local cherts, they contain virtually no flakes from other provinces. The North/South zone reflects the pattern in the high-diversity samples, with three squares dominated by North types and one dominated by South types. As with high-diversity squares, the West/North squares also are dominated by North types. Interestingly, the only South square in the sample is dominated by North types, and the only West square is dominated by South types.

9.1.3 Conclusions: Hypotheses for Further Examination

As stated at the outset, this series of analyses was conducted in order to provide a preliminary model of aggregate chert procurement behavior on Fort Hood that could be used to generate hypotheses for subsequent study. It should be emphasized that the data set used in the analyses suffers from a series of relatively serious flaws that necessarily make the results highly provisional. The sample of chert material is smaller than we would like, and the distribution of artifacts in PK squares is fairly badly skewed. The sample cuts across all prehistoric cultural periods, which eliminates the possibility of identifying temporal changes and may blur a series of differing strategies into a composite construct that bears little in common with its parts. The chert taxonomy upon which the analysis is based (Chapter 6.0) is provisional, and the identification of source areas is even more tentative and almost certainly incomplete. Moreover, the individual chert types have been further reduced into three broad chert provinces that take the source identification a step farther away from reality. For example, the only known outcrop of Gray-Brown-Green is in the northeast corner of the reservation, but has been treated as if it has a province-wide distribution. Although there are stratigraphic reasons to believe that this chert has an extensive outcrop, it (and others) may not be nearly as extensive as we have assumed.

Nevertheless, we feel that the results of the study have merit for two reasons. First, they provide a heuristic structure for the analysis of this type of data, and allow identification of data requirements to better address the problem. Second, they serve as a basis for the generation of testable hypotheses about chert distribution, procurement strategies, and the movement of chert on the base. The following develops several of these hypotheses.

Table 9.8 Frequencies of Chert Types in Squares with Least Diverse Chert Types.

			North Fort									South East Range							West Fort					
E	N	Chert Province	5	7	8	11	14	15	17	n	%	2	6	9	10	13	n	%	3	4	n	%	Total	n types
15	69	NF	0	0	102	0	0	0	0	102	100.0	0	0	0	0	0	0	0.0	0	0	0	0.0	102	1
18	68	NF	0	0	188	0	0	0	0	188	100.0	0	0	0	0	0	0	0.0	0	0	0	0.0	188	1
17	68	NF	0	0	16	0	0	0	0	16	88.9	0	1	0	0	0	1	5.6	1	0	1	5.6	18	3
37	55	NF	0	0	6	0	5	17	0	28	100.0	0	0	0	0	0	0	0.0	0	0	0	0.0	28	3
31	51	NF/SER?	0	0	40	0	0	1	0	41	91.1	4	0	0	0	0	4	8.9	0	0	0	0.0	45	3
36	49	NF/SER?	0	0	14	0	1	0	0	15	83.3	3	0	0	0	0	3	16.7	0	0	0	0.0	18	3
39	45	NF/SER?	0	0	0	0	32	0	1	33	100.0	0	0	0	0	0	0	0.0	0	0	0	0.0	33	2
42	47	NF/SER?	0	0	7	0	0	7	0	14	46.7	7	0	0	0	9	16	53.3	0	0	0	0.0	30	4
37	45	SER	1	0	1	0	15	0	0	17	85.0	3	0	0	0	0	3	15.0	0	0	0	0.0	20	4
5	46	WF	0	1	0	0	0	0	0	1	5.0	4	14	0	1	0	19	95.0	0	0	0	0.0	20	4
12	64	NF/WF?	0	0	81	0	0	26	5	112	100.0	0	0	0	0	0	0	0.0	0	0	0	0.0	112	3
12	65	NF/WF?	0	0	296	0	0	0	6	302	99.7	0	0	1	0	0	1	0.3	0	0	0	0.0	303	3
13	61	NF/WF?	0	0	12	0	0	3	0	15	93.8	0	0	0	1	0	1	6.3	0	0	0	0.0	16	3
10	59	NF/WF?	0	0	11	0	0	2	0	13	68.4	2	0	0	0	0	2	10.5	4	0	4	21.1	19	4

The foregoing analyses imply that although people may have moved chert ubiquitously around the reservation, they generally tended to reduce it substantially from its natural form before carrying it well beyond the location of the resource. Cores appear to stay fairly close to their chert provinces. Tools, including projectile points, were moved well beyond the likely resources from which they were made, but even then, there may be a tendency for tools to be slightly concentrated within their home province. Debitage also has a tendency to stay close to home, although it appears that this tendency is accompanied by lots of exceptions.

However, because the collection analyzed above was not collected in a strategy designed to provide a representative sample, the conclusions above should be regarded as strictly provisional, especially since all of the statistics assume that the relative frequency of use of each chert is reflected by its relative frequency of occurrence in the collection. Indeed, if the trends exhibited by the relatively common North Fort cherts are indicative of a general tendency for cores and debitage to stay close to the procurement area, then the fact that relatively few shovel tests were performed in the southwest portion of the base can be expected to underrepresent the frequency of both Anderson Mountain Gray and Seven Mile Mountain Novaculite. Our experience at Seven Mile Mountain indicates that the poor Novaculite which occurs there has been heavily exploited over the course of centuries. Since this material in its raw state is easily the worst known material on Fort Hood, it is clear that the low quality of material (at least according to modern sensibilities) did not prevent prehistoric people from using it for some purposes.

The general observations above can be summarized in the following formal hypothesis:

Hypothesis: Chert generally was procured in the areas where people were pursuing other activities.

> Corollary: Long-distance logistical missions to procure chert were not a major component of chert procurement.

Workability judgements summarized in Table 9.3 indicate that there is a greater tendency for moderate to poor quality cherts to be underrepresented (i.e., show less than expected values) in their home provinces when a variety of high quality cherts is available in comparison to areas where the range of readily available materials includes a relatively high proportion of moderate to poor quality types. For example, less workable Texas Novaculite and East Range Flat cherts are two out three North Fort types that are highly underrepresented in the North Fort province where there are four highly workable local alternatives. However, the poorer South East Range cherts are not highly underrepresented in their home province where there are only a couple of good local alternatives. We can formalize this as follows:

Hypothesis: Highly workable materials were used for a wider range of applications in areas dominated by high-quality local resources, whereas highly workable materials were reserved for limited applications in areas where the quality of many of the readily available outcrop resources is moderate to low.

> Corollary: Short-distance logistical missions to procure chert were not a significant component of chert procurement when people occupied areas with a variety of high-quality resources.
>
> Corollary: Short-distance logistical missions to procure chert were a significant but minor element component of chert procurement when people occupied areas with resources of varying quality.
>
> Corollary: Improvements from heat treatment negated the need for logistical procurement when people occupied areas with resources of varying quality.

In addition, the distribution of overrepresented material, together with the workability judgements, leads to another hypothesis:

Hypothesis: Cherts with better workability characteristics show a higher degree of mobility.

Several other interesting points arise from examination of the raw count distribution maps. One apparent characteristic is the lack of influence exerted by chert ubiquity on frequency of occurrence of cherts with high availability (e.g., Fort Hood Yellow, Heiner Lake Tan) and cherts that were only available from limited outcrops (e.g., East Range Flecked, Owl Creek Black). This can be formalized into the following hypothesis:

Hypothesis: Chert ubiquity was not an important selection criterion.

> Corollary: Localized sources of high quality chert were known and preferentially exploited to some degree, but not to the exclusion of more ubiquitous materials.

Two additional hypotheses can be advanced on the basis of overrepresented outliers in locales distant from known resource distributions:

Hypothesis: There are outcrops or lags of South East Range cherts in the northwest corner of the reservation or these cherts occur as bed-load components of streams entering the northwest side of Fort Hood.

Hypothesis: There are outcrops or lags of Anderson Mountain Gray chert in or near the northwest corner of the reservation.

The foregoing hypotheses do not begin to exhaust the possibilities. However, they do represent a generalized starting point from which to begin to distinguish short-term patterns within the aggregate temporal pattern and spatially restricted patterns among the overall spatial distribution of sites and chert resources. Clearly, much remains to be done before genuinely robust models of chert-procurement can be established. Section 11.1 discusses some steps that should be taken in this direction.

9.2 ANALYSIS OF AND VARIATION IN FORT HOOD PROJECTILE POINTS

Kathleen Callister, Jay Peck, and Michael Quigg

This section examines the relationship between the macro-typologies commonly used to classify projectile points within the state of Texas and community- and area- based projectile point variation represented at Fort Hood. The projectile point classification that follows serves two purposes, first it documents the 335 projectile points recovered during site evaluations at Fort Hood during 1992 and 1993 (previously collected points are not analyzed). Second, it brings attention to the morphological differences and similarities inherent in projectile point types represented in the collection. The analysis does not discuss site-specific context for individual points. Rather, the 335 projectile points are used as a sample population without regard to specific provenience. Presumably, the sample is representative of the overall population of Fort Hood projectile points. Further, the analysis does not evaluate the existing chronological assignments of the various point types, although the conclusions have some bearing on the degree of confidence which Central Texas archeologists rely on relative dates from projectile point typologies.

Prior to the actual analysis, it was determined that the number of points present was sufficient to establish a foundation for examining the relationship between actual morphological traits and the commonly accepted projectile point types established for the project region (Suhm and Jelks 1962, Turner and Hester 1985). During the course of the research, it became apparent that the Fort Hood specimens showed variations and were oftentimes not completely consistent with the typological definitions. The following section explains the methods employed in classifying and quantifying the points. It is followed by a detailed description of each dart and arrow point type. The final sections address problems encountered and conclusions reached.

9.2.1 Methods

Analysis of the points consisted of two sequential tasks performed independently and by different analysts. First, author Quigg, who is familiar with the regional typologies, assigned a typological classification to each of the points based on the descriptions and illustrations in Suhm and Jelks (1962) and Turner and Hester (1985). Following this, author Callister, who at the time was unfamiliar with the point classifications, recorded the morphological attributes and metrics for each of the points. Finally, tables were produced summarizing the data for each of the point types, and a comparison was made to determine if similarities or differences occurred within the point types. Critical analyses were performed by Callister and Peck. Full data for each of the points are presented by site in Appendix A, and examples of point types are illustrated in Appendix D.

The first step in the analysis process was determining what attributes were to be recorded. A list of 15 different attribute categories was established using Crabtree (1972), Lintz and Anderson (1989), Turner and Hester (1985), and Mallouf (1987). These traits and their possible attributes are presented in Table 9.9. Figure 9.2 is a graphic representation of selected attributes. Once this step was completed, a list of the diagnostic characteristics identified in Suhm and Jelks (1962) and Turner and Hester (1985) was made for comparison purposes. This list is presented in Appendix H.

Dimensional values for the points were taken using electronic calipers to the nearest 0.1 cm. Measurements were made only if the needed point elements were intact; no reconstruction of dimensions were made. Figure 9.3 is a graphic representation showing the location of the measurements.

Table 9.9 List of Traits and Attributes Used in the Morphological Analysis of Projectile Points.

A. Intactness
  1. Complete
  2. Blade only
  3. Stem only
  4. Longitudinal segment
  5. Barb
  6. All others
  7. Tip missing
  8. Medial fragment

B. Breakage
  1. None
  2. Shear Fracture
  3. Snap Fracture
  4. Impact Fracture
  5. Other
  6. Indeterminate
  7. Burinated

C. Symmetry
  1. Symmetrical
  2. Non-symmetrical
  3. Asymmetrical

D. Reworking
  1. Minor
  2. Intermediate
  3. Significant
  4. Indeterminate
  5. None

E. Flaking
  1. Minimal
  2. Parallel
  3. Parallel Diagonal
  4. Collateral
  5. Random
  6. Alternately Beveled
  7. Other
  8. Indeterminate

F. Serration of Edges
  1. Yes
  2. No

G. Shape
  1. Triangular
  2. Oval
  3. Lanceolate
  4. Parallel
  5. Unknown

H. Cross Section
  1. Diamond
  2. Beveled
  3. Bi-planar
  4. Bi-convex
  5. Plano-Convex
  6. Concave-Convex

I. Basal Thinning
  1. Yes
  2. No

J. Basal Grinding
  1. Yes
  2. No

K. Notching
  1. Basal Notched
  2. Basal & Side-Notched
  3. Side-Notched
  4. Corner-Notched
  5. No Notching
  6. Basal, Corner-notched
  7. Indeterminate

L. Stem Shape
  1. Expanding
  2. Straight
  3. Contracting
  4. None
  5. Indeterminate

M. Base Shape
  1. Straight
  2. Convex
  3. Concave
  4. Pointed
  5. Indented
  6. Other
  7. Indeterminate

N. Shoulder Shape
  1. Sloping
  2. Rounded
  3. Abrupt
  4. Barbed
  5. Extremely Barbed
  6. Indeterminate
  7. Non applicable

O. Tang Shape
  1. Rounded
  2. Pointed
  3. Indeterminate
  4. Unknown

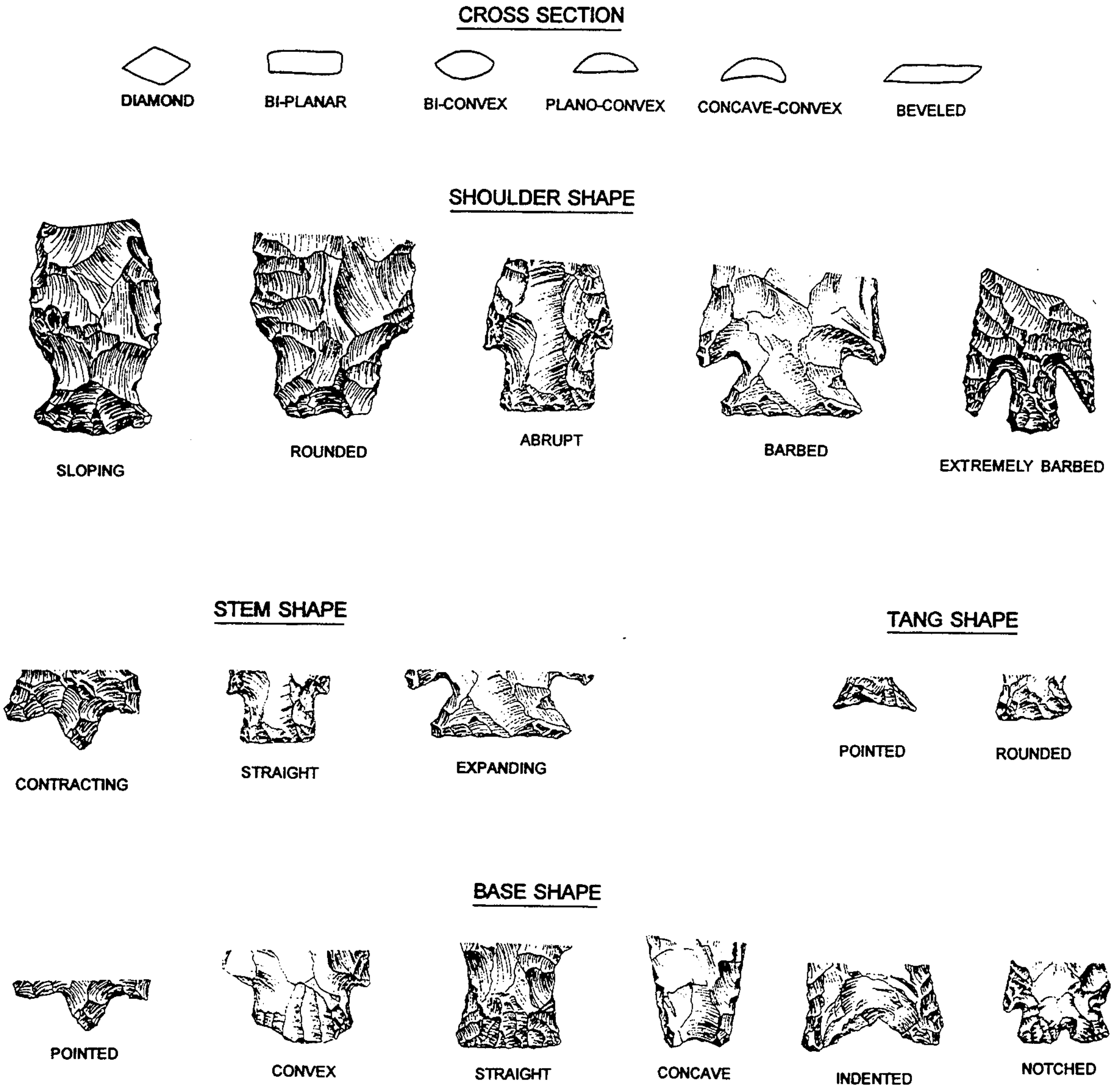


Figure 9.2 Graphic Representation of Select Projectile Point Attributes.

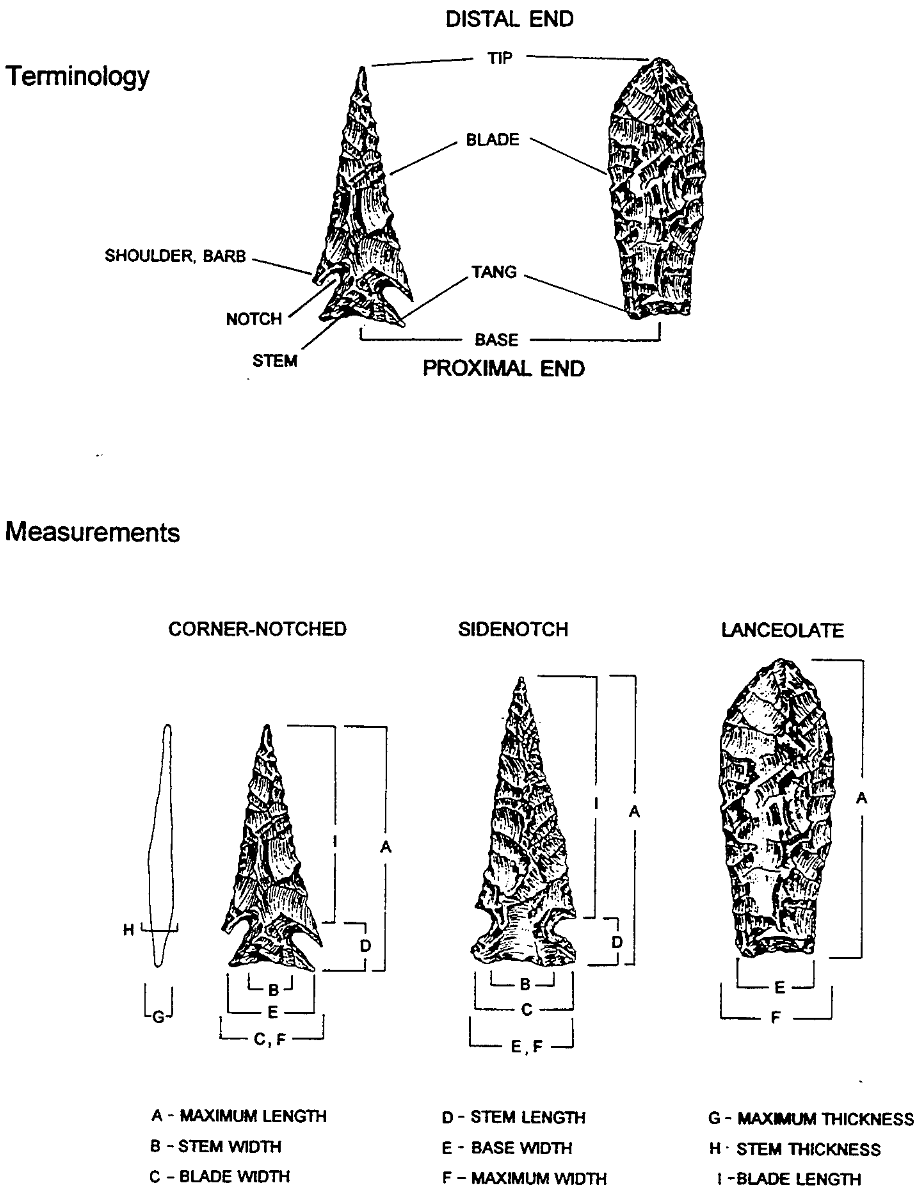


Figure 9.3 Measurement Locations used in Projectile Point Analysis.

The first two measurements taken were maximum length and width. These measurements were based on the greatest distance created by the longitudinal and horizontal plane of the point. Next, the thickest part of the point was measured to determine maximum thickness. This was followed by measuring the thickness of the stem. If possible, dimensions for length and width of the blade were taken, as were length and width of the stem. Base width was measured at the point's widest horizontal distance. If the point was complete, its weight in grams was also noted. When allowed by sample size, standard deviation and coefficient of variation were figured. As stated by Thomas (1986), "coefficient of variation can be used to express group variability in terms relative to the central tendency of that group." It is a "pure measure" because the result is expressed in percentages rather than in the absolute units, like standard deviation. Very low coefficients of variation indicate very small levels of variation.

The analysis also focused on examining morphological variability within the assemblage. The analysis was based on the assumption that if an attribute is diagnostic for a point, then the degree to which it is diagnostic reflects a probability of occurrence. For example, if the standard type definition in Suhm and Jelks (1962) and Turner and Hester (1985) says that an expanding stem is "always" or "usually" diagnostic, the definition reflects a high probability of observing an expanding base on points of that type and a low probability of observing other attributes. However, many type definitions allow for a range of diagnostic attributes. Thus, a type definition may say that stems are "usually" straight and "sometimes" expanding. In such cases, the definition reflects a high probability of observing a straight base and a lower, but not negligible, probability of observing an expanding base.

Hence, the utility of a type definition is a function of how well it represents the probability of occurrence of diagnostic attributes, including how well it describes the relative frequency of exceptions to the diagnostic rule. Furthermore, areal variants of regional types are cases of deviations from general definitional criteria. As such, areal variants are cases where the probability of one or more diagnostic attributes differs from that of the type as a whole. Indeed, it is always possible that a type definition for a region is based on a series of distinctive areal variants, in which case, the regional type definition may mask small-scale phenomena.

Where sample sizes were large enough, binomial hypothesis tests (Thomas 1986) were used (1) to assess the fit between points collected on Fort Hood and the compilation of diagnostic traits in Appendix H, and (2) to assess the relative frequency ranges within which mutually exclusive attributes (e.g., straight, expanding, or contracting stems) appear to occur on typologically distinct points from Fort Hood. In a relatively unusual application, binomial hypothesis tests also were used to explore the meaning of terms such as "sometimes" or "usually" that occur on lists of diagnostic attributes for many types. Binomial hypothesis tests were used as follows.

At any given probability (p) and level of significance, a binomial distribution for a sample of size (n) is characterized by a range of values that constitute the number of expected observations n for a given attribute or other discrete state. In cases where a definitional attribute "always" or "usually" occurs, p should be very high, and where an attribute "rarely" occurs, p should be very low. Where an attribute applies "sometimes," p should be a low to intermediate value. Unfortunately, no one has operationalized terms such as these in the form of probabilities. Consequently, in order to characterize the projectile points, a series of hypothesis tests were run at arbitrarily selected probabilities ranging from .95 down to .05 in .05 increments and at a .05 significance level. Each individual test yielded the range within which a given attribute would be expected if the actual probability of occurrence just happens to be one or more of the arbitrarily selected values for p. The series of tests produced a tool for determining the approximate range of values that p could have while still being consistent with actual observations.

Using this tool, it was possible to look at the range of probabilities that in principle could have produced the observed results. For example, consider a sample of 12 points of a given type, nine of which have expanding stems, two of which have contracting stems, and one of which has a straight stem. In this sample, values of p ranging from .90 to .45 would successfully predict the occurrence of nine expanding stems. Values of p higher than .95 and lower than .40 do not predict the observed results. Values below .45 would predict two contracting stems, and values less than .35 would predict one straight stem. Values higher than .50 and .40, respectively, do not predict the observed results. In this case, the range of expected variability of these stem shapes is described by their respective probability ranges, yielding a mathematical expression of the variation that can be included in the type category if the sample is representative of the population.

Suppose, however, that the type definition specifies that expanding stems "usually" occur. If so, then the term "usually" means "less than about 95 percent of the time, but more than about 40 percent of the time." Further suppose that contracting bases are described as occurring "sometimes." In this case, "sometimes" means "not more than about 45 percent of the time." If straight bases are not mentioned at all in the definition, the test shows that they can occur as much as about 35 percent of the time without deserving any special mention. However, suppose that concave bases are diagnostic in the type definition. If so, then the diagnostic characteristic applies no more than 45 percent of the time, which means that the definition does not accurately describe what can be expected if the sample is representative. This may imply that the sample reflects a local variant or some other influence that leads to a breakdown of the type definition's utility for the assemblage. Note, however, that it does not show that the definition is faulty. Rather, it shows that there may be a some additional variable that bears investigating in terms of comparison with other assemblages from other areas.

Once all the attributes and dimensions were entered into the computer, a summary table for each of the projectile point types identified was made. This data, organized alphabetically by dart points and arrow points, is summarized below. A brief description of the unidentifiable dart points and arrow points is also included, as are brief descriptions of specimens that could not be identified as anything but projectile points.

9.2.1.1 Dart Points

In all, 266 specimens were identified as dart points. As shown in Table 9.10, 220 (83%) were classified into 36 type categories. An additional 46 specimens could not reliably typed and are grouped together in an indeterminate category.

Andice

Only one point was identified as an Andice. It is broken in several places and shows evidence of reworking. The base of the point is wedged and double beveled on one side. Measurements are given in Appendix H, Table H.8.

Angostura

A total of six points were identified as Angostura in the collection; three of these came from a single site, 41CV900. Out of the six, one is complete, two are broken in multiple places, and one is a longitudinal fragment formed by burination. The remaining two are missing distal tips. By definition (Turner and Hester, 1985 and Suhm and Jelks, 1962), these points should display parallel flaking. Out of the five points complete enough to determine flaking, two display stylization which can be characterized as collateral. This may be consistent with the above definitions depending on what the definition of parallel implies. Other distinguishing features of this point type are concave bases and basal grinding, All the points present with bases display these traits.

Table 9.10. Summary of Dart Points (n=266).

Number Identified	Type	Number Identified	Type
1	Andice	4	Lange
6	Angostura	7	Marcos
2	Barber	12	Marshall
1	Bell	6	Martindale
7	Bulverde	3	Montell
2	Carrollton	1	Morhiss
21	Castroville	1	Morrill
14	Darl	1	Nolan
4	Edgewood	2	Palmillas
10	Ellis	1	Pandale
23	Ensor	42	Pedernales
8	Fairland	1	Plainview
6	Frio	1	Travis
1	Gary	4	Uvalde
1	Godley	5	Wells
1	Golondrina	4	Williams
6	Gower	5	Yarbrough
5	Hoxie	46	Indeterminate Dart
1	La Jita	266	TOTAL

Base width is measurable on all four points and averages 1.3 cm. Coefficient of variation worked out to be over 14 percent, indicating that there is a significant amount of variation among the points, although small sample size may account for relatively high coefficients of variation (see Appendix H, Table H.9). Dimensional measurements are within the limits presented in Suhm and Jelks (1962).

Barber

Only two points in the Fort Hood collection are identified as Barber. Both points are fragmentary and so a determination of attributes is limited. Diagnostic attributes established for this type include indented bases, parallel flaking, and basal grinding. The base of both specimens is concave, and one specimen displays parallel diagonal flaking as well as basal grinding. Flaking and the presence or absence of basal grinding could not be determined on the other point. Only two measurements were possible on one of the points (see Appendix H, Table H.10).

Bell

One small point fragment is classified as Bell. This fragment consists of the terminal segment of a barb. The barb expands at its termination and its shape is consistent with those presented in Turner and Hester (1985). All other attributes are impossible to determine, as are all measurements.

Bulverde

All but one of the seven points from Fort Hood identified as Bulverde display basal grinding. The single point without basal thinning is missing much of its base. Based on Turner and Hester (1985) and Suhm and Jelks (1962), the most distinguishing attribute of Bulverde points is basal thinning. The condition of these points varies and includes one complete point, two longitudinal segments, three points with missing tips, and one point with multiple breaks. Of the six broken points, four display snap fractures, indicating that they were possibly broken during manufacture. Reworking is also evident of five of the seven points, four of which are significantly modified. A single point in this type group is alternately beveled on its blade edges. Stem shapes vary from straight to convex to concave with 71 percent being straight.

Most measurements were possible on the majority of the points (see Appendix H, Table H.11). Maximum stem width, thickness, stem thickness, and blade width are fairly consistent with a coefficient of variation less than nine percent. Coefficients of variation for stem width, stem length, and base width are all higher than should be expected in uniform populations.

Carrollton

Two proximal point fragments were classified as Carrollton. Both were probably broken during manufacture as evidenced by snap fractures on the blades. Turner and Hester (1985) indicate that basal thinning is a diagnostic trait for this point type "some of the time." Both of the specimens exhibit basal thinning. Other than that, very little comparison data is possible due to the small number of specimens present. Measurements are given in Appendix H, Table H.12.

Castroville

Over seven percent of the entire Fort Hood assemblage was classified as this type. Of the 21 points, one is complete, eight have multiple breaks, and six are missing their distal tips. Four of the remaining points are stem fragments and two points are medial and longitudinal fragments. Of the 20 broken points, eight have snap fractures and one bears an impact fracture. Reworking is evident on 17 of the points, or 81 percent. Eight of these have been significantly reworked.

One of the diagnostic attributes as defined by Turner and Hester (1985) and Suhm and Jelks (1962) for this type is a "generally" straight or "usually" expanding stem, respectively. Eighteen of the Castroville points from the Fort Hood collection are identified as having expanding stems. This is in line with Suhm and Jelks (1962). Using a binomial distribution, this can be interpreted to mean that for the Fort Hood Castroville points, there is a no less than 80 percent probability that this is a diagnostic attribute. In this instance, an expanding stem appears to be the rule rather than "the sometimes condition." This "sometimes condition" may be attributed to among other things, regional variation.

Another diagnostic attribute identified for this point type is extremely barbed shoulders. The Fort Hood Collection contains two Castroville points with abrupt shoulders, nine with barbed shoulders, and seven with extremely barbed shoulders. The rest are indeterminate. A binomial distribution indicates that for this collection, barbed shoulders have a probability of occurring no less than 25 percent and no more than 65 percent of the time, while extremely barbed points have a probability of occurring no more than 60 percent and no less than 15 percent of the time. This suggests that extremely barbed shoulders may not be diagnostic of the type within the Fort Hood area or that they may have limited diagnostic value.

Measurements taken on the Castroville point indicate that there is greater variability in range within this collection than presented in Suhm and Jelks (1962). As indicated in Appendix H, Table H.13, the coefficient of variation is greater than 11 percent among all parameters except weight. This implies that a refinement of attribute definitions within this category may be needed for the Fort Hood area.

Darl

A total of 14 points are classified as Darl, four of which are complete. The remaining nine are missing their distal tips and one has multiple breaks. Of the broken points, five display breakage, possibly resulting from the manufacturing process, and at least one may have been broken during impact. Reworking is evident on 86 percent of the points.

Over half of the Darl points in the Fort Hood collection have been alternately beveled along the blade. According the Suhm and Jelks (1962) and Turner and Hester (1985), this trait occurs "commonly" or "sometimes," respectively. If these points are representative for the area, a binomial distribution of this attribute indicates that alternate beveling has a probability of occurring no less than 25 percent and no more than 80 percent of the time. This can be interpreted to mean that for the Fort Hood Darls, "commonly" may mean as little as 25 percent, but no more than 80 percent of the time. Conversely, "sometimes" may mean as much as 80 percent, but no less than 25 percent of the time. An additional distinguishing feature for Darl points is either a straight or expanding stem. Out of the 11 points with identifiable stems, seven have straight stems and four have expanding.

The bases of 13 of the 14 Darl points are concave. If the sample is representative of the project area, then there is a probability of no less than 65 percent that a concave base is a diagnostic attribute. Suhm and Jelks (1962) mention that Darl points "usually" have concave bases. Usually, therefore, means no less than 65 percent of the time.

The coefficient of variation for most attributes demonstrates that there is broad range among the points. Differences among measurements of maximum length, maximum width, blade length, blade width, and weight are perhaps the result of reworking.

The coefficient of variation for length, blade length, and weight is over 25 percent. This indicates extremely high diversity. Thickness measurements and stem length (see Appendix H, Table H.14) are all over 12 percent, indicating substantial variability. For this point type, maximum width and blade width represent the same measurement. Variation within this dimension is relatively minor. However, the points in this assemblage have a greater maximum width on average than the 1 to 1.5 cm range indicated in Suhm and Jelks (1962).

Edgewood

This point type, which consists of four specimens, makes up a relatively small percentage (<2%) of the dart points collected during the project. One of the four points has multiple breaks, one is a longitudinal segment, and two are missing distal ends. Three of the four points have been reworked. All four points are triangular in shape and have expanding stems and barbed shoulders. These are diagnostic attributes recognized by Suhm and Jelks (1962) and Turner and Hester (1985). Three of the points also have concave bases and one is indeterminate.

Measurements for all dimensions fall within the ranges given by Suhm and Jelks (1962) (Appendix H, Table H.15). Stem width for all four points shows very little variation, while stem length shows substantial variability.

Ellis

In all, ten points from the Fort Hood collection fall within the Ellis point type. Two of the points are complete, while the remaining points show varying degrees of breakage. Half of the points were broken by a snapping action and over 50 percent show evidence of reworking. In concordance with Turner and Hester (1985), all ten of the points are corner notched and have expanding stems. Among the points in this collection, there is a probability of no less than 65 percent that these are diagnostic attributes. It is unlikely that the Ellis points from Fort Hood deviate substantially from the type definition. Eighty percent of the points have barbed shoulders. Base shape is more variable among the points; six of these are straight, three concave, and one convex. The three points with concave bases may be Edgewoods. The distinction between the two types is somewhat slim.

Excluding stem thickness, base width, stem length, and weight, there is negligible variation among the Ellis points. There is a significant amount of variation among their weights, which may be indicative of reworking. The variation among base width is also quite high. Stem thickness and stem length also show substantial diversity (see Appendix H, Table H.16).

A scattergram showing the relationship between stem length and stem width for Ellis points demonstrates a tight correlation between the two attributes, (Figure 9.4).

Ensor

This type accounts for close to nine percent of the dart points in the collection. Only two of the 23 points are complete, while 10 have breaks in multiple locations and 10 have missing distal tips. The remaining specimens consist of only the stem portion. Snap fractures are present on 11, or 48 percent, of the sample. Reworking is present on over 86 percent, with substantial reworking on 74 percent. If this sample is representative, then a binomial distribution indicates reworking should be expected to occur no less than 75 percent of the time. Three specimens exhibit alternate beveling along the blade edges. Interestingly, basal grinding was noted on five of the 23 specimens. Assuming that this is representative for the area, this attribute should occur between five and 45 percent of the time.

For Ensor points, side notching is defined as a diagnostic attribute by Suhm and Jelks (1962) and Turner and Hester (1985). In the Fort Hood assemblage, side notching is present on all the points except for two indeterminates. This indicates that the probability of this being a diagnostic attribute for the Fort Hood area is no less than 95 percent of the time. Another diagnostic attribute for Ensor points is an expanding stem. This occurs on all specimens within this assemblage. This can also be interpreted to mean that there is more than a 95 percent probability that this is a diagnostic trait for the Fort Hood area.

Base shape for Ensors, as defined by Suhm and Jelks (1962) is "commonly straight but may be concave or convex." There are 13 straight-based points, eight concave, and two convex in the sample. Using this data as a base, a binomial distribution indicates that for the Fort Hood area, straight bases have a probability of occurring no less than 30 percent and no more than 75 percent of the time, while concave bases can occur no less than 15 percent and no more than 55 percent of the time. Convex bases occur no more than 25 percent of the time. Using Suhm and Jelks (1962), "commonly straight bases" can be interpreted to mean that they will occur no less than 30 percent of the time. Along the same lines, "may be concave" means no more than 55 percent of the time and "may be convex" means no more than 25 percent of the time.

Measurements taken for maximum length, maximum width, and stem length are consistent with those presented in Suhm and Jelks (1962) for Ensor (see Appendix H, Table H.17). High coefficients of variation in length, blade length, and weight are probably not representative because there are three or less specimens represented in this assemblage. The variation among stem lengths is substantial even though they fall within the limits of the definition as presented by Suhm and Jelks (1962).

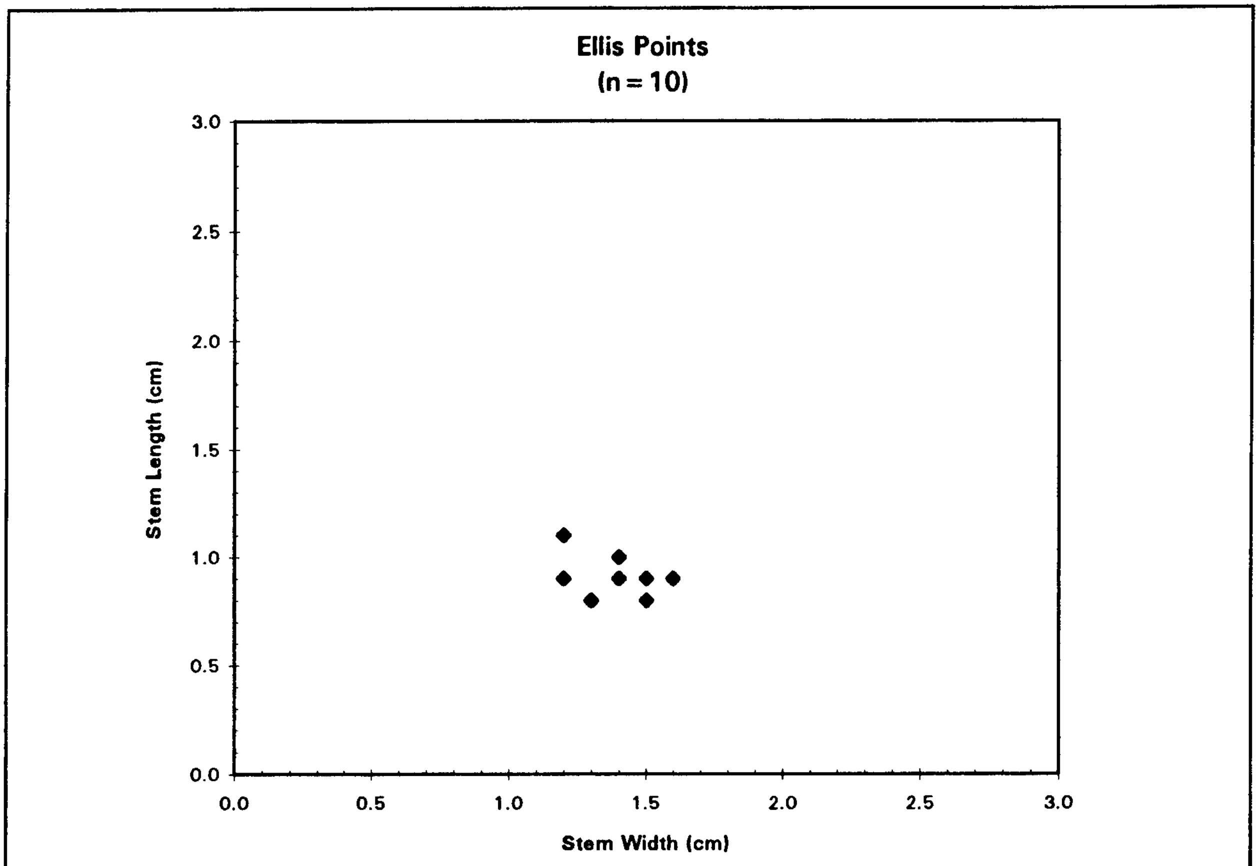


Figure 9.4 Scattergram Showing the Relationship Between Stem Length and Stem Width for Ellis Points.

Fairland

A total of eight points are identified as Fairlands, five (63%) of which are complete. Of the incomplete points, one is missing its distal tip, one is a stem fragment, and the third has multiple breaks. Two of the broken points were probably broken during manufacture as evidenced by the presence of snap fractures. Six of the eight points show definite indications of reworking. Also present on two of the points is alternate beveling of the blade edges. This has been documented by Suhm and Jelks (1962) as a "rarely" occurring phenomena. One of the most distinguishing attributes of Fairland points is the base (expanding and usually as wide or wider than the shoulders). They also have concave bases with fine chipping along the edges (Suhm and Jelks 1962; Turner and Hester 1985). In the case of six of the points, it is possible to make a comparison between base and shoulder width. In every instance, the base is wider than the shoulders. All eight of the points have an expanding base with definite concavity. Although the Fairlands in this collection meet most definitional criteria, the fact that two of eight have alternate beveling implies that "rarely" may mean "fairly often" in the Fort Hood area.

Measurements of maximum thickness were possible on seven of the eight points and the coefficient of variation indicates that there is very little variation among the points (see Appendix H, Table H.18). The rest of the measurements show substantial to extreme degrees of variability. Again, many of these variations may in fact be the result of reworking.

Frio

A total of six points were identified as Frios. By definition (Suhm and Jelks 1962; Turner and Hester 1985), Frio points can be either side or corner notched. Four of the six points recovered during this project are side notched and two are corner notched. The most diagnostic attribute for Frio points, however, is their base. This base is in many cases recurved due to a deep U-shaped notch in the center. Out of the six points identified as Frio in this collection, four have concave bases while two display basal notching.

Measurements of maximum length, blade length, and weight were not possible on any of the points. Other dimensions were measurable on three or more of the points (see Appendix H, Table H.19). The coefficient of variation on maximum width, stem width, stem length, and base width is very consistent, and falls within acceptable boundaries. The coefficient of variation for both thickness measurements, however, is higher than anticipated.

Gary

A single Gary point was identified in the Fort Hood collection. This point probably lost its distal tip during manufacture, as evidenced by a snap fracture. The point has the characteristic contracting stem and barbed shoulders. Width measurements (see Appendix H, Table H.20) of the specimen are within the range given in Suhm and Jelks (1962).

Godley

This type is very similar to Ensor points, but is differentiated by a convex base. The one point identified in the Fort Hood collection is intact except for a missing distal tip. The point has the characteristic expanding stem and convex base. The point also exhibits crazing and potlidding, the result of heat damage. No comparison data is presented for measurements in Suhm and Jelks (1962). See Appendix H, Table H.21 for actual measurements.

Golondrina

Only one point was identified as a Golondrina. It consists of only the diagnostic, proximal end of the point. The base is deeply indented with widely flaring "ears" and both the lower lateral edges and basal cavity are well ground. The only measurement possible on the point was base width (see Appendix H, Table H.22).

Gower

Out of the six points present in this category, only one is complete. Of the remaining five points, two are missing distal tips, one is a longitudinal fragment, and two are broken in multiple places. Two of the points display snapping at the point of breakage and all six points have substantial reworking. Turner and Hester (1985) discuss only two attributes that are diagnostic for this point type. These are parallel-edged stems and "markedly" concave bases. The points from Fort Hood exhibit relatively parallel stems that expand slightly and have definite concave bases. The blade of one point has been alternatively beveled, possibly the result of reworking.

No standards of measurement were available for this point type, but, with the exception of stem length, dimensions for points in this collection are internally consistent as evidenced by relatively low coefficients of variation (see Appendix H, Table H.23). Of note, especially, is stem width which has a coefficient just over four percent.

Hoxie

Five points in the collection fall into this category, none of which are complete. Two of the points are missing distal tips, two are stem fragments, and one is a longitudinal fragment. The longitudinal fragment has been burinated along both lateral edges. This may be intentional, or accidental due to breakage. Reworking is most likely present on all the points, although the degree to which it occurs could not be determined. Diagnostic attributes mentioned by Turner and Hester (1985) include "exaggerated" stems and basal grinding. Stem shape on the points in this collection range from straight to expanding and basal grinding is identifiable on four of the five points. Concave bases on the Fort Hood specimens are consistent with those pictured in Turner and Hester (1985), although this is not mentioned.

Although measurements on the majority of attributes were limited, all but maximum width display minor variability (see Appendix H, Table H.24).

La Jita

One point in the collection was classified as a La Jita and consists of a stem and partial blade. The point exhibits a snap fracture where breakage occurred. The only diagnostic attributes presented in Turner and Hester (1985) are expanding stems with rounded tangs. This point exhibits both of these attributes. Metrics were taken when possible (see Appendix H, Table H.25), but no comparison material was available.

Lange

A total of four Lange points are present, two of which are complete. The other two are a stem fragment and a longitudinal fragment. Various degrees of reworking are evident on three of the four points. Diagnostic attributes include triangular shape, expanding stem, and prominent to barbed shoulders (Suhm and Jelks 1962; Turner and Hester 1985). Base shape is "usually" straight, and "rarely" convex or concave. A triangular shape is evident on three of the points, while all exhibit expanding stems. Shoulder shape on the four points is either barbed or abrupt. Three of the four specimens have straight bases, while the fourth is concave. All four points also are corner notched, although this was not noted in either Suhm and Jelks (1962) or Turner and Hester (1985).

A comparison of metrics with Suhm and Jelks (1962) indicates that the Fort Hood point measurements (see Appendix H, Table H.26) fall at the low end in maximum length and maximum width, while base width is slightly higher than the maximum. Stem length, however, falls well within their parameters. The coefficient of variation for stem thickness, stem width, and base width are all substantially high. Whereas, maximum length, stem length, and blade length are very low.

Marcos

There are seven Marcos points identified in the Fort Hood assemblage. None are complete; three are missing distal tips, two are stem fragments, and two have multiple breaks. Four specimens exhibit snap fractures and one an impact fracture. Reworking is evident on 71 percent of the points. Suhm and Jelks (1962) and Turner and Hester (1985) define triangular shape, corner notches, barbs, and expanding stems as characteristic attributes. Suhm and Jelks (1962) note as well that straight to convex bases are characteristic. Out of the seven points in this set, six are triangular and corner notched. All seven are barbed and have expanding stems. Base shape varies from straight to convex.

A comparison of measurements between the Fort Hood points and those given in Suhm and Jelks (1962) indicates that the average maximum width, and stem width is somewhat smaller for the Fort Hood points (see Appendix H, Table H.27). The average base width, however, is slightly higher. The average stem length for the points from this assemblage is within the range given in Suhm and Jelks (1962). Variation among base measurements is considerably broad, while maximum thickness and stem thickness are within expected ranges for uniform populations.

Marshall

The 12 specimens identified as Marshall points account for 4.5 percent of the Fort Hood dart points. Of these, two are complete, two are missing distal tips, one is a stem, and seven are broken in multiple places. Nine of the points show definite evidence of reworking. Important diagnostic features for Marshall points, as indicated by Turner and Hester (1985), include triangular shape, expanding stem, strong shoulders to barbs, and concave bases. Shape for the Fort Hood specimens could be determined on nine of the points; seven are triangular in shape and two are Lanceolate. Expanding stems occur on all 12 of the points. Using a binomial distribution and assuming that this sample is representative, this can be interpreted to mean that there is more than a 70 percent probability of this being a diagnostic feature in the Fort Hood area. The shoulder shapes of the Fort Hood points are dominated by barbed varieties with one abrupt shouldered specimen. The probability of barbed shoulders being a characteristic trait is no less than 65 percent. Base shape is determinable on all the points. Ten are concave and two are straight, indicating that the probability of a concave base being diagnostic among these points is also no less than 65 percent. However, straight bases may occur up to 50 percent of the time. This may signify that it is a major variant within the area.

All the specimens in this collection are corner notched, meaning that within the project area, this trait has no less than a 70 percent probability of being a characteristic attribute. Turner and Hester (1985) do not state that this is a diagnostic trait. Suhm and Jelks (1962), however, state that "notches may have removed most of the corners ... but usually they were cut up into the blade from the base." Pictures accompanying Suhm and Jelk's (1962) definition show both corner and basal notched points, whereas Turner and Hester (1985) show only corner notched points. This may be an oversight or the result of subsequent, additional data.

When compared with Suhm and Jelk's (1962) data, the Fort Hood points are smaller in maximum length, maximum width, and stem length (see Appendix H, Table H.28). Stem width, however, falls within their ranges. The degree of variation among the different measurements is quite high as indicated by the coefficient of variation. The one exception is stem length, and that falls within acceptable limits.

Martindale

Six specimens make up the Martindale category. One is complete, three have distal tips missing, and two have multiple breaks. An impact fracture is present on one of the points, while five of the points bear evidence of reworking. Triangular shape, an expanding stem, and barbed shoulders characterize this type (Suhm and Jelks 1962) . Both lanceolate- and triangular-shaped points are present in this collection. All specimens display expanding bases and pronounced shoulders, two of which are definitely barbed. The most distinguishing feature of these points, however, is the base, "which is formed by two convex curves meeting at a depression in the center; this gives the base a 'fish-tail' appearance" (Turner and Hester 1985:120). All the points with intact bases exhibit this characteristic fish-tail base.

Metrics for the points in this category are fairly consistent with those presented in Suhm and Jelks (1962). Of note, though, is the high degree of variation within many of the measurement categories (see Appendix H, Table H.29). Stem length shows a substantially high coefficient of variation, while stem width and base width are within expectable limits.

Montell

Only three Montell points are present; two have missing distal tips, and one is broken in multiple places. Both distal tip fractures resulted from snapping. Reworking is identifiable on two of the points. Diagnostic features included triangular shape, strong shoulders that are "usually" barbed and expanding stems with convex bases which are always split in the center with a deep V-shaped notch (Suhm and Jelks 1962; Turner and Hester 1985). All three points exhibit these characteristics.

Because of the low number of specimens and their state of completeness, comparison of measurements is not feasible. Appendix H, Table H.30 presents these measurements.

Morhiss

A single Morhiss is present in the Fort Hood assemblage. This point is missing its distal tip and is significantly reworked. The point was identified on the basis of stem shape, base, and shoulder shape. Because of the fragmentary nature of the point, only measurements involving the base and stem were possible (see Appendix H, Table H.31).

Morrill

One incomplete Morrill point is present. It has been broken in multiple places, one of which is a burination break. The point bears no indications of reworking. Identification was made on the grounds of base, shoulder, and stem shape. Measurements taken are presented in Appendix H, Table H.32.

Nolan

A single Nolan point is present in the assemblage. The distal tip is missing and its blade edges have been significantly reworked. This point was identified based on its steep, alternatively beveled stem edges (Turner and Hester 1985). It also has the distinctive slanted, or sloping shoulders. The base of the point is straight. Measurements of the intact portions of the point are given in Appendix H, Table H.33.

Palmillas

The most important characteristics of this type are its bulbar stem and convex base. Occasionally, straight bases also occur (Suhm and Jelks 1962). Of the two points recovered, both points in this assemblage exhibit this bulbous stem and both have convex bases. One point is complete and the other has had its distal tip snapped off. Reworking is evident on both specimens. All measurements are given in Appendix H, Table H.34 for the complete point while only selected measurements are given for the incomplete point.

Pandale

A single Pandale point is present in the collection. The point is missing its distal tip due to a snap fracture and exhibits minor reworking. It also has collateral flaking. This point has the distinct "corkscrew" twist that is diagnostic of this type. The twist is formed by alternate beveling of the blade and stem. The stem edges are beveled in the opposite direction of the blade edges. Measurements for the Fort Hood points are presented in Appendix H, Table H.35.

Pedernales

There are 42 Pedernales points in the collection. This is by far the largest category in the Fort Hood assemblage. Only five of the points are complete, however. Sixteen are missing distal tips, 15 have multiple breaks, four are only stems, and two are longitudinal segments. Fifteen of these points exhibit snap fractures, while two bear impact fractures and one is burinated. The other 19 points have indeterminate breaks. Some degree of reworking was noted on all 42 points, and 52 percent exhibit significant rework. Basal grinding was noted on three of the specimens.

Descriptions of characteristic attributes for Pedernales points vary greatly within the literature. Both Suhm and Jelks (1962) and Turner and Hester (1985) describe the points as being primarily triangular in shape. In the Fort Hood assemblage, shape was not determined on all the points because of the amount of reworking. However, on specimens where shape was identified, 14 (54%) were defined as being Lanceolate and 12 (46%) were defined as triangular. If these points are representative, a binomial distribution indicates that there is a no less than 30 percent and no more than 70 percent probability that Lanceolate shape is a diagnostic attribute in the Fort Hood area. On the other hand, triangular shape has a probability of being diagnostic no less than 25 percent of the time and no more than 65 percent of the time. This can be interpreted to mean that there is a high probability that triangular and Lanceolate shape are both diagnostic traits.

Shoulder shape in this data set varies greatly. Suhm and Jelks (1962) indicate that this is common for this point type. Out of the 37 points on which this attribute is identifiable, 18 (49%) have abrupt shoulders, 12 (32%) have barbed shoulders, five (14%) have rounded shoulders, and two (5%) have either a sloping shoulder or no shoulder. Again, assuming that this is a representative sample, binomial distributions indicate that either an abrupt or barbed shoulder is diagnostic for the Fort Hood area no less than 65 percent of the time. Other shoulder types have a probability of being diagnostic no more than 40 percent of the time. Both these percentages indicate that there is a wide range in shoulder types present for Pedernales points under the presently accepted definitions.

Suhm and Jelks (1962) state that the stem shape of this point type is "more or less" rectangular or straight. A total of 24 have straight stems. Other stem shapes are as follows: nine expanding, four contracting, and five indeterminates. Using a binomial distribution, the probability of a straight stem being diagnostic for this area is no less than 45 percent. If we use Suhm and Jelks' (1962) definition, "more or less" can be perceived to mean that straight stems will occur no less than 45 percent of the time. This is in line with the type definition "more or less."

As stated by Suhm and Jelks (1962), Pedernales points can have concave or deeply indented U-shaped bases. Base shape is determinable on 38 of the 42 points. Of these 38 points, 37 have concave or indented bases. This is interpreted to mean that there is no less than a 90 percent probability that this is in fact a characteristic attribute for the Fort Hood area.

A comparison between the measurements for the Fort Hood points and those given in Suhm and Jelks (1962) indicates that some refinement of the diagnostic measurements for the project area may be necessary. Maximum length is indicated in Suhm and Jelks (1962) as generally varying between 6 and 9 cm. The average for measurable lengths in this collection is 4.7 cm. This is considerably less than that indicated by Suhm and Jelks (1962). According to Suhm and Jelks (1962), maximum width for the type is 3 to 5 cm. The Fort Hood point average is 2.59 cm. The average stem width and length for the Pedernales points in this collection coincides with those given in Suhm and Jelks (1962).

For the most part, variability among these points is extreme. Coefficients of variation are above acceptable limits for every measurement except maximum length and base width (see Appendix H, Table H.36).

Plainview

One Plainview was present within the Fort Hood assemblage. This point is missing its distal portion due to an impact fracture. It exhibits parallel flaking, lanceolate shape, concave base, and basal grinding; all diagnostic attributes for this point type. Only one measurement, base width, is possible and that is presented in Appendix H, Table H.37.

Travis

The Travis type is represented by one specimen in this collection. It is missing its distal portion due to a snap fracture and is significantly reworked. It conforms to the rather vague characteristic attributes defined in Suhm and Jelks (1962). It has no notching, a straight stem, and a convex base with very little shoulder. Measurements are presented in Appendix H, Table H.38.

Uvalde

A total of four Uvalde points were identified in the Fort Hood assemblage. These points are all broken, two have missing distal tips due to snap fractures, and two have multiple breaks of an indeterminate nature. All four points have been notably reworked and one has an alternately beveled blade. Diagnostic attributes as defined by Suhm and Jelks (1962) and Turner and Hester (1985) include rounded to barbed shoulders, expanding stem, and concave base. Shoulder shapes for the Fort Hood specimens range from abrupt to extremely barbed which is in line with Suhm and Jelks (1962) and Turner and Hester (1985). Stem and base shape are expanding and concave, respectively. Dimensions for maximum width and stem width (see Appendix H, Table H.39) conform to Suhm and Jelks (1962).

Wells

In all, five points are identified as Wells in the collection, none of which are complete. Three of the points are missing their distal tips, one is a stem fragment, and one is a longitudinal fragment formed by burination. Three of the points exhibit snap fractures and one has an indeterminate break. Reworking is evident on all of the points and two have ground basal edges. The most diagnostic feature for this point type is its long, contracting stem that is "sometimes" roughly parallel-edged (Turner and Hester 1985). Of the five points, three exhibit straight stems and two contracting. Base shape, as defined by Suhm and Jelks (1962), can be "nearly pointed in some cases, rounded in others, or occasionally concave." In this assemblage, one point has a straight base, two concave, and two convex. Although serration of the blade margins is mentioned by both Suhm and Jelks (1962) and Turner and Hester (1985), none of the points exhibits this trait. The Fort Hood Wells points may, therefore, represent a departure from the definitional criteria.

The maximum width of the points here falls within the dimensions given by Suhm and Jelks (1962). Of note as well is the uniformity in stem thickness (see Appendix H, Table H.40).

Williams

Four points in the Fort Hood assemblage were classified into this category. All of the points are incomplete; one is a longitudinal segment, one has multiple breaks, and two are missing their distal tips. Reworking is readily apparent on three of the four points. This point type is defined by Turner and Hester (1985) as having a broad triangular shape and an expanding stem with a rounded, convex base. Two of the Fort Hood specimens are lanceolate, while the other two are indeterminable. All four have expanding stems and concave bases. Tang shape can be determined for three of the points and is well rounded.

Dimensions for the points are given below, and although the sample is relatively small the coefficient of variation is minimal for all but one measurement, thickness (see Appendix H, Table H.41). Maximum width is well within the range given in Suhm and Jelks (1962) and stem width is slightly less.

Yarbrough

Five points in the Fort Hood assemblage were identified as Yarbrough and all exhibit definite signs of reworking. Two of the points are complete and the other three are missing their distal tips. Only one break could be identified on the three broken points and it is a snap fracture. Characteristic attributes include a triangular shape, shoulders that are small to prominent but not barbed, stem edges that are parallel to slightly expanding, and a base that ranges from slightly concave to convex (Suhm and Jelks 1962). All five of the points in the assemblage are triangular in shape and have expanding stems. Four of the five points have abrupt shoulders. The shape of the bases ranges from convex to concave.

The Fort Hood Yarbroughs have a slightly smaller maximum width and stem width on average than that given in Suhm and Jelks (1962), although the two points with a maximum length dimension fall well within their parameters. Variation is quite high among all but one of the width measurements as well as length (see Appendix H, Table H.42). The coefficient of variation for thickness measurements, stem length, and base width are all within acceptable limits.

Indeterminate Dart Points

Of the 266 dart points recovered, 46 points (17%) are not typable. This may in part be attributed to reworking. Many of the points show extensive reworking that may have altered or obliterated their diagnostic attributes. Of the 46 points in this category, four are complete, 14 have missing distal tips, four are stem fragments, six are medial fragments, one is a longitudinal fragment, and 17 have multiple breaks. Snap fractures are identifiable on 17 of the point fragments. Alternate beveling is present on five of the points and serration on two. Shape is indeterminate on 48 percent of the points; the remaining 52 percent are composed of 22 triangular-shaped points and two lanceolate-shaped points. Basal grinding is present on six of the points. Over 73 percent of the points have an expanding stem. Base shape ranges from 30 percent concave, 22 percent convex, 24 percent straight, to 24 percent unidentifiable. Shoulder shape is widely variable, as is notching. As one would expect from a sample that probably includes examples from several different types, variation among the different dimensions is extremely high (see Appendix H, Table H.43). The coefficient of variation for all attributes is well over 18 percent.

9.2.1.2 Arrow Points

A total of 66 specimens were identified as arrow points from the Fort Hood site evaluations project. Fifty-one of these points (77%) were classified into nine point types (Table 9.11). Fifteen arrow points that could not be classified as to type were placed in an indeterminate category.

Alba

Two specimens were identifiable as Alba points in the assemblage. They both exhibit multiple breaks of an indeterminate nature. Both points are triangular in shape, have barbed shoulders, and a straight stem. According both Suhm and Jelks (1962) and Turner and Hester (1985), these attributes are all characteristic of the type. Serration is present on both specimens and is also considered a characteristic trait by Suhm and Jelks (1962). Dimensions recorded are presented in Appendix H, Table H.44.

Bonham

Seven points fall within this category, none of which are complete. The distal ends are missing on four of the specimens due to snap fractures. Of the remaining points, one is a stem fragment and two are broken in multiple locations. Reworking is apparent on four specimens. Characteristic attributes for this type are very similar to the Alba category. The only difference being rounded bases and diminished barbs on the Bonhams. Shape for the points in this collection range from triangular to lanceolate, while stem shape ranges from slightly expanding to straight. Base shapes among the present assemblage include five convex, one straight, and one indeterminate. Five of the seven points have rounded bases, one is pointed, and one is indeterminate.

A comparison with Suhm and Jelks' (1962) data indicates that the average maximum width and stem length of the Fort Hood specimens are greater than the standard they give. The coefficient of variation for stem thickness is exceedingly high as is stem width, stem length, and base width (see Appendix H, Table H.45).

Table 9.11 Summary of Arrow Points.

Number Identified	Type	Number Identified	Type
2	Alba	29	Scallorn
7	Bonham	1	Steiner
4	Cliffton	1	Washita
2	Cuney	1	Young
4	Perdiz	15	Indeterminate Arrow
		66	Total

Cliffton

A total of four points were identified as Clifftons. Three of the points are missing their distal tips and one is a stem fragment. All four points were probably broken during manufacture as evidenced by snap fractures, and all of the points exhibit reworking. One point also exhibits serration. These points are classified based on the crudeness of flaking, broad shoulders, and a roughly triangular shape (Suhm and Jelks 1962). Turner and Hester (1985) argue that this form is actually a Perdiz preform. Flaking on the Fort Hood specimens is crude and shoulder shape is barbed. The shape of two of the points is triangular. Shape could not be determined on the other two points.

Dimensions of maximum width and stem length for these points are well outside the range stated in Suhm and Jelks (1962). See Appendix H, Table H.46 for details of measurements.

Cuney

Two Cuney points were identified in this assemblage. One is complete while the other displays multiple breaks. One point has been reworked and neither are serrated. Both points have most of the characteristics of this point type. Measurements for the Fort Hood specimens (see Appendix H, Table H.47) all fall within the parameters given by Suhm and Jelks (1962).

Perdiz

A total of four Perdiz points were present in the assemblage. One is complete, one is missing its distal tip due to a snap fracture, and two exhibit multiple breaks. All show identifiable reworking and two are serrated. Characteristics of these points include a triangular shape and contracting stem. In the present assemblage, three are triangular, and one is unknown. All four have well-barbed shoulders and contracting, or pointed, stems.

Both Suhm and Jelks (1962) and Turner and Hester (1985) state that there is enormous variation in size among these points. Of note, however, is the total lack of variation among the Fort Hood point's stem thickness despite the very small size of the sample (see Appendix H, Table H.48).

Scallorn

Scallorn points are by far the most frequent arrow point type, with 29 specimens (44%). Present are six complete specimens, nine with missing distal tips, three stem fragments, and 11 with multiple breaks. Snap fractures are present on seven of the points with missing tips, and two points exhibit impact fractures. Some degree of reworking is identifiable on all but five of the points. Almost 21 percent of the points have serrated blades. The most diagnostic feature for Scallorn points are stems that expand as widely as their shoulders (Suhm and Jelks 1962). Base shape for these points can be straight, concave, or convex. Expanding stems were present on all the Fort Hood specimens, as should be expected. Base shape of the points varied greatly, however. A total of 12 points have straight bases, 10 convex, six concave, and one was indeterminate. If this sample is representative, then by using a binomial distribution, the probability of a straight base being a characteristic trait is no less than 20 percent and no greater than 65 percent. For convex bases the probability is no less than 15 percent and no greater than 60 percent. Concave bases have a probability of being characteristic no less than five percent of the time and no greater than 45 percent. Can be therefore means 20 to 65 percent for straight bases, 15 to 60 percent for convex, and 5 to 45 for concave.

A comparison with the dimensions given in Suhm and Jelks (1962) indicates that the Fort Hood specimens are slightly smaller than the standards given for this type. This may be partly due to the amount of reworking noted on most of the points. Variation among the points is quite high in all dimensions as expressed by the coefficient of variation (see Appendix H, Table H.49).

Steiner

A single, incomplete Steiner was identified. This point is missing most of its distal end due to a snap fracture that more than likely occurred during manufacture. The point has barbed shoulders and an expanding base that is very irregular. Dimensions for the point are presented in Appendix H, Table H.50.

Washita

Only one specimen in the collection was identified as this type and it consisted of a very small fragment of the base. It does, however, have a very pronounced side notch, which is determinate for this type (Turner and Hester, 1985). The point was too fragmentary to retrieve any dimensions.

Young

Only one point recovered fell into this category. It is a complete, triangular point with minimal flaking and no reworking. Measurements for the points (see Appendix H, Table H.51) are all within the ranges presented in Suhm and Jelks (1962). However, due to its shape and lack of diagnostic features, this type is in all probability a preform for another arrow point type.

Indeterminate Arrow Points

Slightly less than 23 percent of the points were not classifiable. Of these 15 points, two are complete, two are missing distal tips, three are missing their proximal ends, one is a stem fragment, six are medial fragments, and one has multiple breaks. A total of four snap fractures and one impact fracture was identified. Reworking occurs on 75 percent of the points and serration occurs on 47 percent. Stem shape could not be determined on 10 of the points, while three of the points had expanding stems and two had none. Base shape is also indeterminate on 10 of the points, while two are straight, two are concave, and one is convex. Shoulder shape is highly inconsistent. As one would expect, variation among the different dimensions is extremely high (see Appendix H, Table H.52). The coefficient of variation for all the points is well over 14 percent, which should be expected in a sample that is probably composed of mixed types.

9.2.1.3 Indeterminate Points

Three points were collected that were so fragmentary, they could not be identified as either arrow points or dart points. All have significant reworking present. Stem shape included contracting, expanding, and indeterminate, while shoulder shapes ranged from barbed, to rounded, to missing. Base shape was identifiable on only one point and it was convex.

9.2.2 Discussion

Five specific concerns developed from the present study: (1) type attributes which are too broad; (2) type attributes which overlap; (3) the use of vague terminology in the existing typologies; (4) the question of reworking and its implications; and (5) the meaning of dimensional variation. Each of these topics is discussed separately below.

9.2.2.1 Type Attributes Which Are Too Broad

The coefficients of variation for measurements on Castroville points from the present collection signal that there is clearly little metric agreement among members of this group. A scattergram showing the correlation between stem length and stem width supports this evidence (Figure 9.5). The dimensional ranges provided in Suhm and Jelks (1962), however, are much broader than those represented in the Fort Hood assemblage. These specimens also show more consistency in stem shape than that indicated in the literature. A binomial distribution on stem shape indicated that expanding stems seem to be a diagnostic trait rather than a "sometimes condition" as stated by Turner and Hester (1985).

Darl points in the Fort Hood assemblage constitute another type which does not correspond well with the range of measurements stated in Suhm and Jelks (1962). Only stem length falls within the given boundaries and on whole, the Fort Hood Darls are longer and wider. A scattergram showing the correlation between stem length and stem width indicates a fairly inconsistent relationship between the two (Figure 9.6). Coefficient of variations are within acceptable ranges for all width measurement but are highly variable among the length measurements and thickness measurements. Morphologically, straight or expanding stems, concave bases, alternately beveled blades, and a high percentage of reworking appear to be diagnostic attributes for this type in the Fort Hood area. Prewitt's (1981) separation of Hoxie points into an independent morphological type has helped to streamline the diagnostic attributes indicative of Darl points. This may explain in part the range of measurements stated in Suhm and Jelks (1962) which is probably influenced by at least some Hoxie variants.

Points in the assemblage identified as Marshalls also exhibit wide metric variability. Only one measurement, stem length, has a minor coefficient of variation. Traits that have a high probability of being characteristic within the Fort Hood area include expanding stems, barbed shoulders, corner notching, and concave to straight bases. These are more modal tendencies than those presented in Suhm and Jelks (1962), but seem to be in accord with the rather abbreviated discussion of traits discussed in Turner and Hester (1985).

Pedernales points in the Fort Hood assemblage also exhibit great morphological and metric variability. In this collection, the only redundant characteristic appears to be a concave or deeply indented, U-shaped base. Prominent, abrupt shoulders or barbs have a more negligible probability of being characteristic for the area, which corresponds to the wide range of variability stated in Suhm and Jelks (1962). All other categories are equivocal. The only satisfactory coefficient of variation among all Pedernales measurements is maximum length (though this measurement was only feasible on six specimens due to extensive reworking).

The examples presented above demonstrate instances that may be indicative of local- and community-level variation, the identification of which is an important issue in the research design for Fort Hood (Ellis 1994a). These four were chosen because 10 or more specimens were present within the type categories. A high degree of metric and morphological variability was also noted in other types such as Bulverde, Ellis, Ensor, Fairland, Lange, Marcos, Martindale, Uvalde, and Yarbrough; although not as strong a statistical case is present due to small sample size.

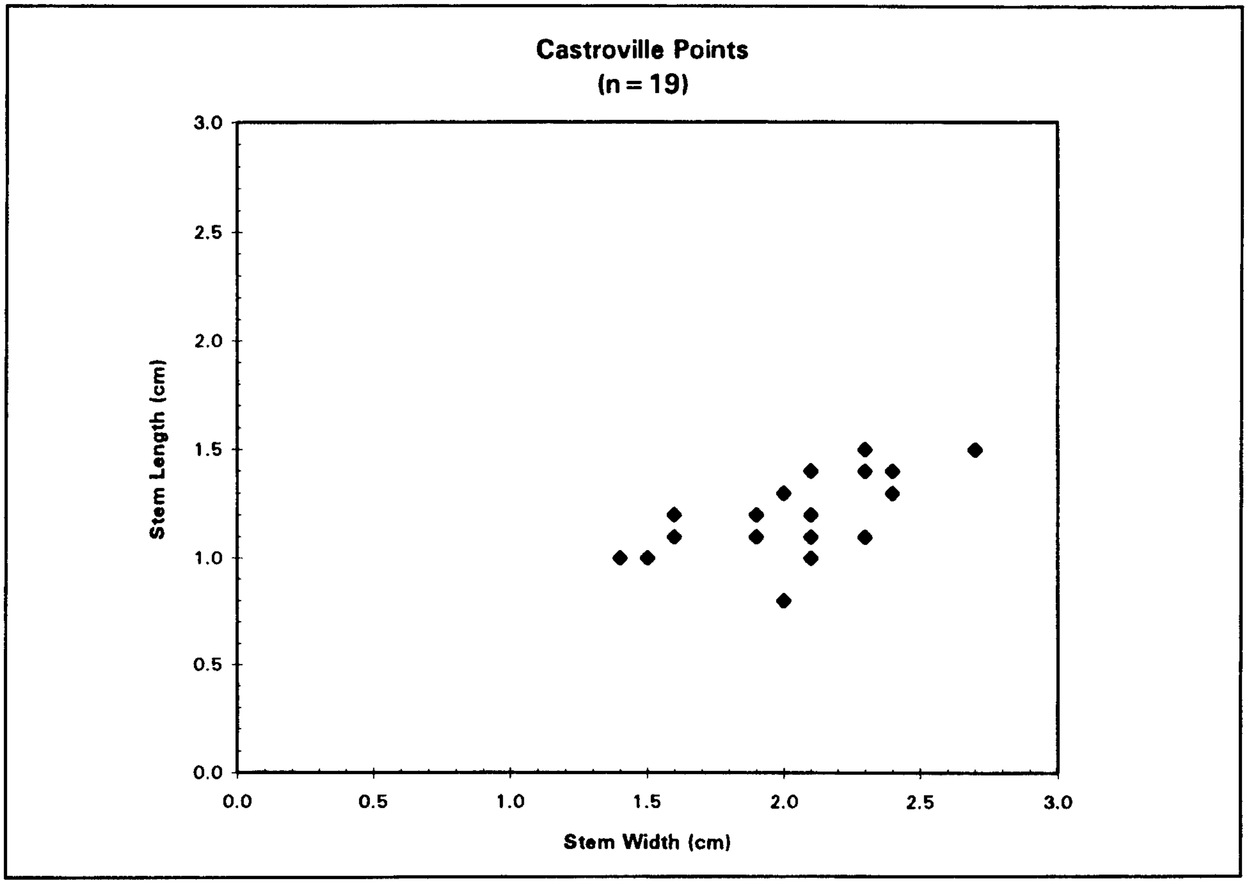


Figure 9.5 Scattergram of Stem Length by Stem Width for Castroville Points.

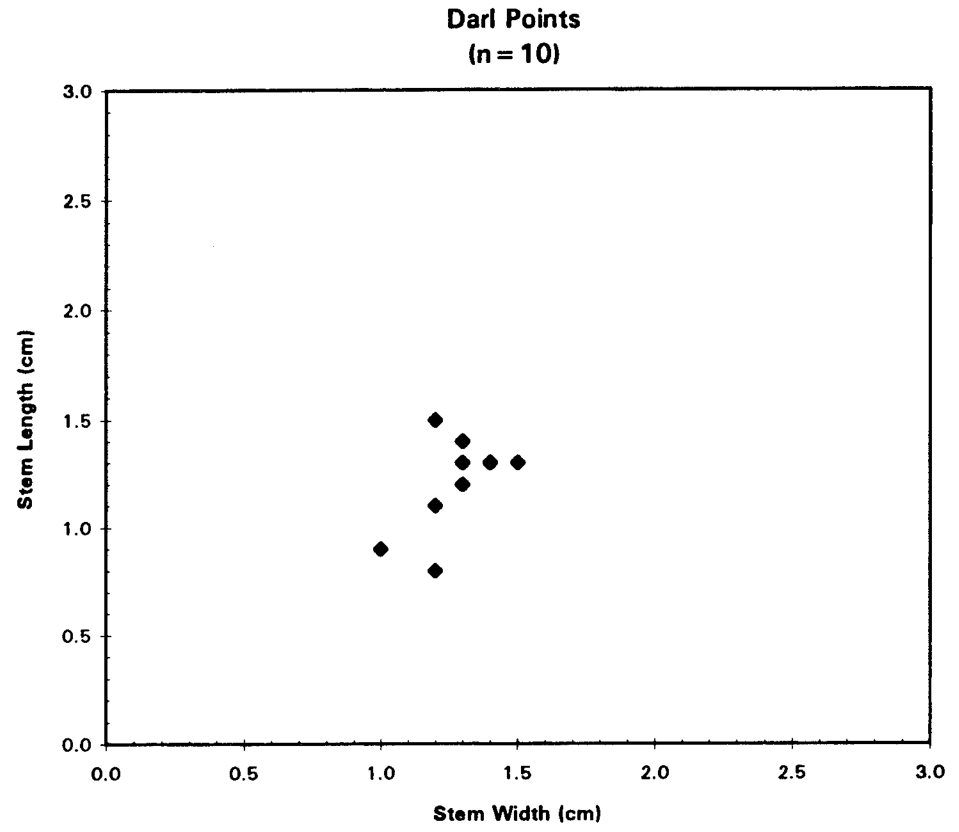


Figure 9.6 Scattergram of Stem Length by Stem Width for Darl Points.

Another important explanation for this variability may be reworking. A significant number of points within each of the above categories showed evidence of reworking. Another explanation may be a lack of concern for metric uniformity on the part of the manufacturers.

9.2.2.2 Type Attributes Which Overlap

Overlapping relationships between point categories may sometimes be concealed by reliance on the identification of select attributes. This is evidenced among the arrow points identified as Alba, Bonham, Cuney, and perhaps Scallorn. They may be better perceived as subtypes within a highly inter-related series. There is very little defined difference between arrow points classified as Alba, Bonham, and Cuney as stated in Suhm and Jelks (1962) and Turner and Hester (1985). Suhm and Jelks (1962) state that Albas have stems which are "usually parallel, occasionally contracted or expanded slightly"; Bonham points have stems that are "very narrow and parallel edged"; Cuneys on the other hand, have stems that are "parallel edged or slightly expanded." Base shape for Albas and Bonhams are defined in Suhm and Jelks (1962) as "straight or slightly convex." Cuneys, however, have bases that are "concave, from shallow curve to deep, U-shaped notch." It is difficult to discriminate between types based on terminology such as "usually," or "sometimes," when types are so morphologically similar. The dimensional ranges overlap significantly as well (Suhm and Jelks 1962), which does little to clarify the differences between the types. All the points from Fort Hood that were classified into these categories demonstrate a high degree of similarity. Scallorn points can be differentiated on the basis of the widely expanding stems, although other attributes for these points are very similar to the Alba, Bonham, and Cuney type definitions.

Other examples of possible typological overlap occur among the dart points. Similar conditions exist among the "M-series" points which consist of the Marcos, Marshall, Montell, Castroville, and perhaps Lange types. All are morphologically similar but are differentiated on the basis of slight variations in stem and base shape. Another series of dart types from the Fort Hood area that are morphologically similar includes Edgewood, Ellis, and Ensor points. These points are differentiated on the grounds of slight variations in base shape and have commonly been referred to as the "E-series." This series may also include Fairland and Godley points but a larger database and additional statistical analysis is required to determine this for certain.

9.2.2.3 Vague Terminology in the Existing Typologies

Because of the broad interregional nature of the present typologies, some of the terms used to describe characteristics are necessarily nonspecific. Terms such as "sometimes," "generally," and "usually" are often used to describe the range of variability within the different point attributes. The use of statistical tools such as binomial distributions make it possible to assign values of probability and percentage to specific differences and similarities. Indeed, such an exploration suggests that in some cases, these terms cannot be applied very well to the Fort Hood area. In all cases it can be used to characterize areal frequencies of multiple diagnostic attributes, expected patterns of variation within assemblages, and, more specifically, point types, both on a regional and community level (See Ellis 1994a, 4.2.4.3).

9.2.2.4 Reworking

Reworking of various degrees and kinds occurs on 93 percent of the projectile points collected during the course of the project. This is an overwhelming figure and presents enormous problems in the metric and morphological analysis of the projectile points, despite efforts to avoid including reworked areas in analysis determinations. Reworking occurs for a number of reasons and can relate to behaviors such as conservation and curation. Reworked areas on blade portions may be attempts to "squeeze" as much use out of the tools as possible. In the Pedernales category, reworking is endemic as witnessed by Turner and Hester (1985:225), when they show a Pedernales point reworked into a drill. Suhm and Jelks (1962:235) may also take it into consideration when they present a highly variable range of dimensions for maximum length within the type.

High incidence of reworking on point blades across all categories has led to the "folkwisdom" in Texas typology that only stems are particularly diagnostic. As with much folkwisdom, there is some element of truth to it; reworking should be a consideration in building a local typology for the Fort Hood area. The concept may be unconsciously built-in to present typologies. The Castroville points pictured in Plate 87 of Suhm and Jelks (1962:174) appear to all have carefully matched bases, while the morphology of the blades is very irregular. Blade length is highly irregular as is the shape of the barbs. These differences more than likely represent the effects of reworking.

9.2.2.5 The Meaning of Dimensional Variation

When confronting a collection of this nature, in which many of the specimens are surface finds, it is difficult to determine the cause and meaning of dimensional variation within projectile point categories. Without the temporal specificity that can be established in controlled excavation, there is little or no method for determining if dimensional variation is a function of time difference, unknown factors, or if it is archaeologically meaningless. After years of meticulously recording dimensional variations, there remains a distinct possibility that the dimensional template exists only in our own minds. We must not forget that the categories of analysis created to help order the archeological continuum are etic products of our own design which are only possibly inherent in the production of the artifacts. In any event, identifying coefficients of variation that are characteristic will help us determine cases where there is a high degree of consistency that may be indicative of culturally influenced processes. The obverse of this is not true, however; wide coefficients of variation may indicate indifference to, or a lack of, control over an array of mutually exclusive attributes. Geographic distributions of different means with low coefficients of variation may indicate territory if other evidence can be brought in to support it. It should be pointed out that as sample size increases, the range used to measure variability will decrease rapidly.

9.2.3 Conclusions

The purpose of this analysis has been to report on the projectile points collected during the Fort Hood site evaluations. A total of 335 projectile points were analyzed and classified into 36 dart point types and nine arrow point types. Specimens that could not be assigned with confidence to specific types were placed into indeterminate dart and arrow point categories. Specimens that could not be classified into either the dart or arrow point categories were placed into a generalized indeterminate category. Independently of this classification, morphological attributes and metrics were recorded for each of the points. After completion of both tasks, summary tables were created for the purpose of clarification and comparison of the data. These comparisons served to identify the similarities and differences adherent within the point types present in the Fort Hood assemblage. Where quantification of the data was necessary, binomial distributions were employed. Binomial distributions were applied to determine presence/absence probabilities for specific morphological traits as recognized by an experienced projectile point analyst unfamiliar with the Texas typology. Variation among the dimensional values was quantified using the coefficient of variation statistic.

One of processes discussed in the research design was the development of community- and area-based typologies and classifications (Ellis 1994a, Section 4.2.4.3). A number of problems were encountered during the course of this analysis that hindered the establishment of a local typology which was in accordance with the interregional structures established by Suhm and Jelks (1962) and Turner and Hester (1985). In macro-aerial typologies such as these, details concerning regional and local variation are often indiscernible in large overviews. Such typologies are sometimes of a necessity so broad that they ultimately function in local analyses as catchalls, masking details which could be of value in tight regional definitions. These problems indicate that the interregional approach may be too broad for accurate regional applications and that the regional approach may be too generalized for use in specific localities and communities, namely the Fort Hood area. A more efficacious approach may be to reconstruct regional typologies based on encompassed local typologies and, from there, expand into broader realms, rather than attempting to apply the more generalized constructions locally. In more circumscribed studies, the use of statistical tools such as binomial distributions will more accurately identify and quantify attributes that may be locally characteristic. The establishment of local typologies that can be interrelated to the broad regional approach to classification may be of more value than the continued use of macro-typologies alone.

9.3 RECONNAISSANCE TEAM COMPARABILITY

W. Nicholas Trierweiler

A central objective of the Quality Control program was to ensure the accuracy, replicability, and comparability of results. To this end, procedures manuals and standardized data forms were developed, onsite workshop discussions were held, and comparability exercises were conducted (see Section 4.3), among other strategies. As part of the comparability exercises, 15 different site subareas were visited and independently assessed by two or more reconnaissance teams. These field exercises and the discussions which resulted were very helpful in resolving different impressions as to how to apply the evaluation criteria procedures. The quality assurance analysis concluded (cf. Section 4.3.2) that sites were being comparably evaluated by different teams. This section continues that analysis and includes all 897 site areas. For the 15 areas visited by more than one team, only the data collected by the senior team is used.

During the reconnaissance phase, each site area was independently scored for its geomorphic potential to contain intact deposits as well as its archeological research potential. Using several different lines of evidence, an aggregate archeological score and an aggregate geomorphological score were obtained for each site area. Details of this process have been presented in Chapter 4.0. The aggregate scores do *not* indicate a calibrated assessment of research value because they were the sum of several individual ordinal rankings. Nevertheless, the aggregate scores suggest relative position along a continuum of research potential. As has been previously illustrated in Figures 4.1 through 4.3, cross plotting the geomorphological and archeological scores yielded a useful heuristic framework for discerning the relative research potential within any subset of sites.

It should be stressed that the ultimate assessment of research potential on each site did not rely on arbitrary cutoff values. Rather, the final evaluation of site potential was a polythetic process drawing on many lines of evidence. Nonetheless, the quantitative scores assigned during the reconnaissance were a useful device which served to focus attention on key site attributes during the assessment. Although not designed as such, the scores also allowed a posthoc methodological evaluation of observational comparability between the several reconnaissance teams.

Over the 20-month span of field work, 11 archeologists and three geomorphologists participated in the reconnaissance. Due to logistical scheduling and availability, four archeologists (Kleinbach, Mehalchick, Quigg, and Turpin) together evaluated more than 80 percent of the sites. Similarly, two of the geomorphologists (Abbott, Frederick) evaluated more than 90 percent of the sites, while the third (Doering) evaluated only 9 percent.

Largely because of these participation differences, only 16 different teams were actually formed, less than half of the 33 possible team pairings. One objective of scheduling was to mix team composition whenever possible, so as to share ideas. Still, a few of the teams accounted for the majority of the 897 site evaluations (Table 9.12). In fact, over 78 percent of all sites were evaluated by five key teams: Abbott-Kleinbach (27%); Abbott-Turpin (15%); Frederick-Mehalchick (14%); Frederick-Quigg (14%); and Abbott-Mehalchick (9%). The remaining 11 teams together accounted for less than 22 percent of the site evaluations, and the bottom eight teams together evaluated less than 11 percent of the sites.

Archeological Scoring

Mean archeological score ranged from a low of 18.9 (Treece) to a high of 31.6 (Lintz) on a scale of 10 to 55 points, with an overall mean of 22.9 points (Table 9.13). However, overall site score is rather meaningless because of the differences in

Table 9.12 Frequency of Site Areas Assessed During Reconnaissance, by Archaeologist and Geomorphologist.

	Geomorphologist				
Archaeologist	Abbott	Doering	Frederick	Total	Percent
Ellis	15	0	0	15	1.7%
Kleinbach	241	0	0	241	26.9%
Lintz	13	0	0	13	1.4%
Mehalchick	81	0	125	206	23.0%
Mires	0	29	2	31	3.5%
Oglesby	12	43	0	55	6.1%
Quigg	8	0	123	131	14.6%
Treece	17	0	0	17	1.9%
Trierweiler	0	0	31	31	3.5%
Truesdale	0	10	0	10	1.1%
Turpin	132	0	15	147	16.4%
TOTAL	519	82	296	897	100%
Percent	57.9%	9.1%	33.0%	100%	--

Table 9.13 Average Archaeological Scores, by Archaeologist and Site Potential.

	Potential deposits?		
Archeologist	no	yes	All Sites
Population			
N	467	427	894*
Range	8-45	10-53	8-53
Mean	15.2	31.4	22.9
Std. Dev.	4.0	6.9	9.9
Sample Means			
Ellis	18.4	25.1	21.5
Kleinbach	15.6	33.9	23.0
Lintz	18.5	37.4	31.6
Mehalchick	14.5	30.4	22.1
Mires	16.4	35.5	25.6
Oglesby	14.9	26.6	22.3
Quigg	15.8	31.6	24.3
Trierweiler	15.4	29.7	24.6
Treece	14.8	32.0	18.9
Truesdale	13.0	27.3	21.6
Turpin	14.3	31.1	21.7

* Does not include two sites not evaluated.

sample size identified above, and because groupings of sites for reconnaissance were nonrandomly assigned to individual archeologists. For logistical considerations, sites were assigned on the basis of proximity; because similar sites tended to be geographically clustered (e.g., rockshelters in the southeast portion of the base), some archeologists evaluated more of one site type than another.

Grouping sites together with similar assessments of depositional potential somewhat controls for this bias. Table 9.13 tabulates mean scores by archeologist for those site areas evaluated as having potential for intact buried deposits separately from those sites evaluated as having no potential for intact buried deposits. The 468 site areas with no potential for intact buried deposits had a mean score of 15.17 points, whereas the 427 areas evaluated as having the potential for intact deposits received a significantly higher mean score of 31.38 points (the remaining two site areas were unscored --see Chapter 10.0).

Mean scores for individual archeologists on sites with *no* potential deposits ranged from a low of 13.0 (Truesdale) to a high of 18.5 (Lintz). Mean scores on sites *with* potentially intact deposits ranged from a low of 25.1 (Ellis) to a high of 37.4 (Lintz). Figure 9.7 crossplots for each archeologist (and geomorphologist) the mean scores for the two classes of sites. For convenience, this illustration also cross plots the mean scores for the three geomorphologists, although archeology was scored along a scale of 10 to 55 and geomorphology was scored along a scale of 7 to 28.

While most of the cross plotted archeological mean scores are clustered around the intersection of the respective population means (x = 15.17, y = 31.38), several outliers are noted. One archeologist assigned scores significantly higher than the overall population mean for both classes of sites. Another archeologist assigned significantly lower scores for both classes of sites. Interestingly, a third archeologist assigned higher than average scores to sites with no potential and lower than average scores to sites with potentially intact deposits. However, all three of these outliers had a total sample size of 15 sites or less (see Table 9.12), and together represent only 4% of the 897 site subareas.

For both classes of sites, all sample means were within one standard deviation of the overall population mean. Assuming random distribution of empirical site potential within each site class, this suggests there was no significant scoring bias between archeologists.

Geomorphic Scoring

Because there were only three geomorphologists, analysis of comparability is somewhat easier for the geomorphic scores. Mean geomorphic score ranged from a low of 15.5 to a high of 16.3 on a scale of 7 to 28 points, with an overall mean of 15.9 points (Table 9.14). Using the same site grouping as above, site areas with no potential for intact buried deposits had a mean geomorphic score of 10.5 points, whereas areas evaluated as having the potential for intact deposits received a significantly higher mean score of 21.8 points.

For both classes, mean scores for the three geomorphologists were clustered to an extraordinary degree around the respective population means (x = 10.48, y = 21.75). Figure 9.7 also crossplots the mean geomorphic scores for the two classes of sites. No outliers are present, and there is no significant scoring bias between the geomorphologists.

Conclusions

Both archeological and geomorphological reconnaissance scores were consistent among the several observers. Despite some variability among the archeological sample means due to small sample sizes, the data strongly suggest that the scoring rules were consistently applied by all archeologists and by all geomorphologists, and that the scoring tactic was an adequate methodological tool for preliminary assessment of site potential.

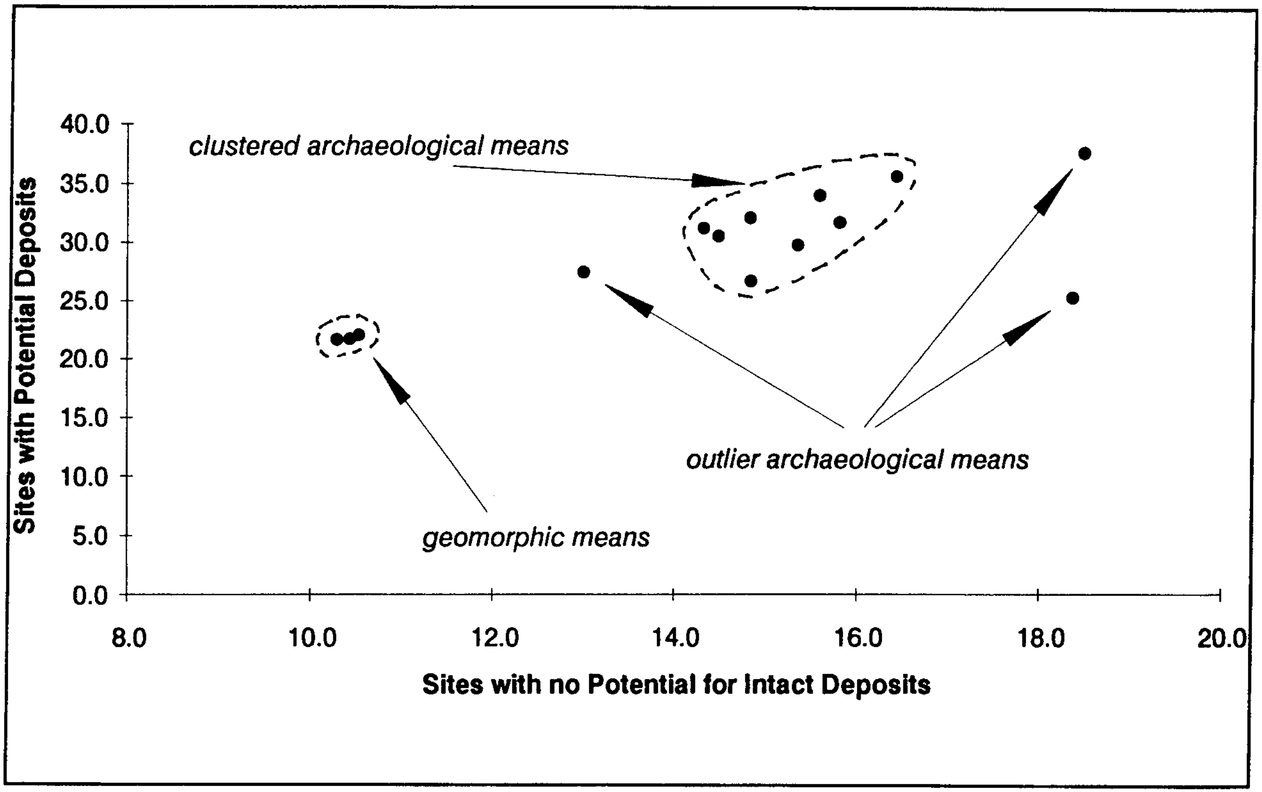


Figure 9.7 Cross Plot of Reconnaissance Scores, by Person.

Table 9.14 Average Geomorphic Scores, by Geomorphologist and Site Potential.

	Potential deposits?		
	no	yes	All Sites
Population			
N	467	427	894*
Range	7-26	7-29	7-29
Mean	10.5	21.8	15.9
Std. Dev.	3.15	3.99	6.67
Sample Means			
Abbott	10.5	22.0	16.3
Doering	10.3	20.6	15.5
Frederick	10.4	21.6	16.0

* Does not include two sites not evaluated.

Nonetheless, it is interesting that the geomorphology scores were significantly more clustered around their means than were the archeological scores. Several explanations may be advanced for this pattern:

(1) All three geomorphologists had an adequate sample size of evaluated sites (n=519, 296, 82), whereas only 7 of the 11 archeologists had an adequate sample size of evaluated sites (n=241, 206, 147, 131, 55, 31, 31, 17, 15, 13, 10). Sampling error within the smaller samples may have biased the sample means, creating the appearance of score divergence.

(2) The forms devised for the geomorphic observations may have been superior to those devised for the archeological observations, allowing for less judgement in scoring.

(3) The three geomorphologists may have had more and better communication among themselves than the archeologists, leading to a clearer understanding and more consistent application of the scoring rules.

9.4 DISTURBING ANALYSES

W. Nicholas Trierweiler

This section consists of a summary and analysis of impacts and disturbances to the prehistoric sites, based on the observations recorded by the reconnaissance teams. The LRPA assessment team also made observations on impacts to sites, but because these data were collected only for the 94 LRPA sites, they are not included in the analysis.

During reconnaissance, three different types of disturbances to cultural deposits were recorded: vandalism, vehicle disturbances, and erosion. Using Form 6 (see Appendix B), each impact was recorded along an ordinal scale from high (>50% of the total area), to medium (20 to 50%), to low (<20%), to none. "Unknown" was also a recording option. These data are cross tabulated against an ordinal scale measuring intensity of land use for military training exercises, as previously characterized by Fort Hood (Jackson, 1990). The 44 maneuver areas had been previously categorized by Fort Hood as receiving heavy, moderate, and light intensities or frequencies of training activities.

9.4.1 Vandalism

Vandalism was most often evidenced by looter's pits, especially in rockshelters and burned rock middens. Some of the pits were as recent as several days old, as indicated by freshly exposed dirt and even boot prints. Many pits may be decades old, as suggested by regrowth of vegetation in the pits. Degree of vandalism varied widely, from a single shallow pit to extensively disturbed "moon scapes" with dozens of pits of all sizes and depths. Vandalism was recorded for 18 percent of all site management areas, including 42 areas (5%) with heavy vandalism, 64 areas (7%) with moderate vandalism, and 39 areas (4%) with low vandalism (Table 9.15). Fifteen site areas (2%) had vandalism recorded as unknown, and 737 areas had no evidence of vandalism.

As Table 9.15 shows, vandalism is not significantly associated with intensity of maneuver training activity. In fact, the overall distribution of vandalism is completely random with respect to training intensity. Of the 737 site areas with no visible vandalism, 187 (25%) are in low-use maneuver areas and 170 (23%) are in high uses areas. Similarly, of the 42 areas with a high degree of vandalism, 12 sites (28%) are in each of the low-use and high-use maneuver classification. This of course is not surprising, given the fact that vandalism is largely committed by collectors and "hobbyists" and is unrelated to formal military activities. By contrast, vandalism is very strongly associated with site type. Rockshelters and burned rock middens in particular are very heavily impacted. Fully 58 of all rockshelters (50%), and 46 of burned rock middens (41%) have some vandalism, whereas only 56 other site types (8%) have any evidence of vandalism (Table 9.16). Of the vandalized shelters, more than 70 percent are moderately or severely vandalized.

Table 9.15 Frequency of Site Management Areas by Degree of Vandalism and Maneuver Area Use.

	Use of Maneuver Area				
Degree of Vandalism	Low	Moderate	Heavy	Total	Percent
None	187	380	170	737	82%
Low	5	20	14	39	4%
Medium	23	24	17	64	7%
High	12	18	12	42	5%
Unknown	7	5	3	15	2%
Total	234	447	216	897	100%
Percent	26%	50%	24%	100%	--

Table 9.16 Frequency of Site Management Areas by Site Type and Presence of Vandalism.

Site Type	Vandalized	Not Vandalized	Total
Rockshelters	58	59	117
Row Percent	49%	51%	100
Burned Rock Middens	46	66	112
Row Percent	41%	59%	100
Other Site Types	56	612	668
Row Percent	8%	92%	100
Total	160	737	897
Percent	18%	82%	100%

9.4.2 Vehicle Impacts

As might be predicted from Fort Hood's primary mission, evidence of vehicular disturbance was observed on the vast majority of open-air sites. Degree of impacts varied from a single two-track path running from one edge of a site to the other, to dense reticular mazes of roads, paths, and trails, to wide expanses of rutted and tracked surfaces covering entire sites. Similarly, severity of impact ranged from relatively recent (and hence, uneroded) wheeled vehicle paths to consistently used and deeply rutted tank trails. Most vehicular impacts, however, appear to be quite old since most of the damage visible today coincides with damage visible on aerial photographs from the early 1980s.

Vehicular impacts were recorded for 73 percent of all site management areas, including 209 areas (23%) heavily impacted, 282 areas (31%) moderately impacted, and 164 areas (18%) lightly impacted (Table 9.17). Twelve site areas (1%) were recorded as unknown. As might be predicted, degree of vehicular disturbance was highly correlated with intensity of training.

Table 9.17 Frequency of Site Management Areas by Degree of Vehicular Impacts and Maneuver Area Use.

Degree of Vehicle Impacts	Use of Maneuver Area Low	Moderate	Heavy	Total	Percent
None	86	100	44	230	26%
Low	37	75	52	164	18%
Medium	66	151	65	282	31%
High	43	114	52	209	23%
Unknown	2	7	3	12	1%
Total	234	447	216	897	100%
Percent	26%	50%	24%	100%	--

Of the 230 sites with no visible vehicular impacts, 86 (37%) are located in the low-use maneuver areas and only 44 (19%) are located in the heavy use areas. By contrast, only 43 (21%) of the 209 sites with high levels of vehicular damage are located in the low-use maneuver areas. Nevertheless, fully 19 percent of the 230 sites with no recorded vehicle impacts are located in the heavy maneuver areas, contrary to what might be expected.

This anomaly is somewhat explained by examining site type. While many rockshelters are located in high-use maneuver areas, due to their topologic setting they have a low (but not zero) probability of being impacted by vehicles. Indeed, of the 117 rockshelters, only three (3%) are recorded as having any impacts by vehicles. Of the 780 nonrockshelter sites, over 85 percent are recorded as having some vehicle impacts (Table 9.18).

9.4.3 Erosion

Erosion was evidenced by a variety of processes including surface sheetwash, gully downcutting, stream bank slumping and cutting, and excessive downslope sedimentation. Degree of erosion varied from mild sheetwash on gently sloping sites to severe erosion caused by multiple agents. As a naturally occurring, long-term geologic process, some degree of erosion was recorded for all sites. However, 378 areas (42%) had heavy erosion, and 285 areas (32%) had moderate erosion, with the remaining 224 areas (25%) having low or unknown erosion (Table 9.19). Interestingly, there is a weak inverse correlation between severity of erosion and intensity of training area uses. Of the 378 highly eroded sites, only 20 percent are in high-use maneuver areas; by contrast, of the 224 sites with low levels of erosion, relatively more (32%) are in high-use maneuver areas. This suggests that intensity of land use by military training maneuvers, as classified by Fort Hood, is not a good predictor of the severity of erosional impacts to sites.

More interestingly, severity of erosion is very strongly associated with depth of deposits (Table 9.20). Of the 590 sites with less than 50 cm of estimated deposits, fully 87 percent are moderately or severely eroded. By contrast, only 49 percent of deep sites (greater than 50 cm) are moderately or severely eroded. This pattern is reinforced when intensity of vehicle disturbance is examined (Table 9.21). Of the 378 sites with severe erosion, 70 percent have been impacted to a moderate or severe degree by vehicles; of the 508 sites with relatively low levels of erosion, only 44 percent have been impacted by vehicles to a moderate or severe degree. Given that the fairly strong

Table 9.18 Frequency of Site Management Areas by Site Type and Presence of Vehicle Impacts.

Site Type	Vehicle Impacts	No Vehicle Impacts	Total	Percent
Rockshelters	3	114	117	13%
Other Site Types	664	116	780	87%
Total	667	230	897	100%
Percent	74%	26%	100%	---

Table 9.19 Frequency of Site Management Areas by Degree of Erosion and Maneuver Area Use.

	Use of Maneuver Area				
Degree of Erosion	Low	Moderate	Heavy	Total	Percent
None to Low	52	101	71	224	25%
Medium	64	156	65	285	31%
High	112	190	76	378	42%
Unknown	6	0	4	10	1%
Total	234	447	216	897	100%
Percent	26%	50%	24%	100%	--

Table 9.20 Frequency of Site Management Areas by Depth of Deposits and Severity of Erosion.

	Severity of Erosion			
Estimated Depth	Low	Moderate to High	Unknown/not Recorded	Total
less than 50 cm	77	510	3	590
Row Percent	13%	87%	-	-
greater than 50 cm	57	57	2	116
Row Percent	49%	49%	-	-
unknown/not recorded	65	71	5	141
Row Percent	46%	50%	4%	100
Total	161	663	10	897
Percent	18%	74%	1%	100%

Table 9.21 Frequency of Site Management Areas by Severity of Erosion and Intensity of Vehicle Impacts.

	Intensity of Vehicle Impacts				
Severity of Erosion	Low	Moderate to High	Unknown/not Recorded	Total	Percent
Low to Moderate	279	224	6	509	57%
High	109	265	4	378	41%
Unknown/not recorded	6	2	2	10	1%
Total	394	491	12	897	100%
Percent	44%	55%	1%	100%	--

association between erosion and intensity of vehicular damage, the probability of further damage from erosion is apparently highest in places with a well-established history of maneuver activity. It is therefore likely that further erosion damage to unimpacted areas will be largely a matter of long-term, natural geologic processes.

9.4.4 Buried Recent/Historic Artifacts

A final line of evidence regarding disturbance is the vertical distribution of buried historic and recent artifacts recovered from the shovel tests. Although historic components were present on many of the prehistoric sites, they were not specifically tested. In fact, the shovel testing procedures intentionally excluded these areas. As a result, those historic artifacts which were recovered from the shovel tests were useful as evidence of intrusion. Suspected disturbance in many cases was confirmed by the recovery at depth of buried beer and tobacco cans, military ration pouches, and rubber tread fragments.

Nearly 600 historic and/or recent artifacts were recovered from all sites, or about 2 percent of the total assemblage. As shown in Table 9.22, the vast majority were glass shards (71%), followed by metal pieces (23%). Most of the artifacts were recovered from the upper 10 cmbs, but fully 229 artifacts (38%) were recovered below this level. Some intrusive artifacts were recovered as deep as 50 cmbs, evidence of significant disturbance to the deposits. As might be expected from the fact that the deepest shovel tests were placed in rockshelters and on burned rock features, most of the historic artifacts were recovered near contexts that have been subjected to vandalism.

9.5 OBSERVATIONS ON PALUXY SITES

James T. Abbott

This section addresses observations made during reconnaissance assessment of sites on Fort Hood underlain by the Paluxy sand. Although it was not considered prior to initiation of fieldwork, the Paluxy emerged as an area of interest gradually throughout the reconnaissance process. Probably the first broad, informal observations made by the reconnaissance team were utilitarian: (1) significant slopewash activity was typically demonstrable in the environment, resulting in a surface mantle that required shovel testing, and (2) shovel tests in the Paluxy were much easier to dig than in most other environments on the fort, which generally made the crew happy. Gradually, however, relatively consistent archeological observations from site to site led us to add the phrase "Paluxy site" to the field lexicon. This section presents an overview of these observations and their bearing on both broader paleoenvironmental and specific behavioral questions.

Table 9.22 Frequency of Historic/Recent Artifacts by Depth and Class.

Depth (cmbs)	Ceramic	Metal	Glass	Other	Total
0-10	14	90	257	5	366
10-20	2	27	104	2	135
20-30	1	17	41	1	60
30-40	3	3	19	0	25
40-50	3	1	4	1	9
Total	23	138	425	9	595
Percent	4%	23%	71%	2%	100%

9.5.1 Composition and Character of the Paluxy Sand

The Paluxy sand is a lower Cretaceous formation at the uppermost part of the Trinity Group (Sellards 1932: 320-321). The formation is widespread to the north and west of Fort Hood, where it attains thicknesses of up to 105 ft (32 m) in areas mapped on the Dallas sheet and 100 ft (30 m) in areas mapped on the Brownwood sheet of the Geologic Atlas of Texas (Barnes 1988, 1976), but thins markedly and finally pinches out to the east and south. The Paluxy represents a near-shore sandstone body deposited on the broad, shallow Cretaceous shelf during an episode of shoreline progradation. The Waco Sheet of the Geologic Atlas of Texas (Barnes 1970) describes the Paluxy Sand as "quartz sand, fine to very fine-grained, friable, in part calcite cemented and hard, some thin interbeds of gray shale and limestone, pyrite nodules and concretions, coal smuts locally, commonly crossbedded and/or laminated, silty limestone beds become more numerous southward, light gray to red; thickness up to 70 feet (21 m)." Fort Hood lies on the southern margin of the formation beyond the extent of the mapped outcrop. Our observations suggest that the unit is discontinuous on the fort, and seldom attains an observed thickness of more than 15 to 20 ft (4.5 to 6 m). Interbedded limestones were observed at several localities, suggesting that the unit interdigitates with calcareous off-shore facies mapped as the upper Glen Rose.

In our experience on Fort Hood, the Paluxy Formation consists of a bleached, fine-grained siliceous sand that is poorly cemented to completely uncemented. It is exposed at the Glen Rose/Walnut Clay contact in the upper valley walls of Cowhouse Creek and its tributaries (primarily Table Rock Creek and House Creek) on the western side of the base. Typically, the landscape position consists of fairly gentle upper valley slopes and benches, and the outcrop is rarely more than 100 m wide, although several localities where an upslope bench has exposed a broader expanse were noted. Both the bedrock and the soils that develop thereon are starkly different than the limestones and calcareous clays that form the vast majority of the landscape. In almost every observed case, the bedrock consists of a densely packed but uncemented very fine sand that has been subjected to extensive burrowing by rodents and insects during the late Quaternary. The outcrop is very susceptible to gully erosion; it is not at all unusual to observe tank trails incised a meter or more below the surrounding surface.

Soils formed in the environment are typically heavily weathered and very red, and contrast markedly with adjacent calcareous soils. Two soil series are typical of the Paluxy: Cisco soils are Alfisols that exhibit a strong argillic horizon, and are typical of more stable parts of the outcrop; Wise soils are more weakly developed Inceptisols typical of more active erosional and depositional loci, including some broad, sandy aprons downslope of the actual outcrop. In most outcrops occurring on slopes, a distinct catena is apparent. Upslope, the surface tends to be relatively eroded and the thick, red Bt horizon is either partially or completely truncated. However, as one moves downslope, the argillic horizon becomes thicker and better preserved, and relatively thin sheets of overlying slopewash/colluvial sands become increasingly prevalent. In some cases, a dark brown loamy sand that represents the original A horizon is preserved near the base of the outcrop; this horizon is almost always mantled with protective sheet sands derived from upslope and underlain by a deep red argillic horizon a meter or more thick. Continuing downslope past the Paluxy outcrop onto the upper Glen Rose, colluvial sheet sands up to half a meter thick represent an additional associated locus of deposition. The colluvial deposits typically exhibit weak to moderate soil development (i.e., an A-C or A-Bw-C soil profile), and lack the well-developed argillic horizon typical of the bedrock outcrop.

9.5.2 Distribution of the Paluxy Sand on Fort Hood

As indicated previously, the Paluxy Sand is a geologic formation of relatively minor areal importance on Fort Hood. The 1:250,000 Waco Sheet of the Geologic Atlas of Texas (Barnes 1970) does not map it at all within the reservation boundary, and no good indication of its distribution on the base is available from any source of which we are aware. Although the broad stratigraphic context limits its distribution to the contact between the Walnut clay and the Glen Rose Limestone, our observations indicate that the Paluxy sands form a thin, spotty mantle on the upper Glen Rose rather than a continuous outcrop. In order to approximate the distribution of the formation, we combined point localities where the formation was noted by the reconnaissance teams with the distribution of characteristic Paluxy soils mapped by the Soil Conservation Service (McCaleb 1985) (Figure 9.8). Although the resulting map provides a fair approximation of the distribution of the formation, the quality of the data used to reconstruct the map does have some problems. First, the soil data used share the relative imprecision typical of most soil surveys, which are not really intended for this type of use. Second, the distribution of soils, even where mapped accurately, probably includes some areas where thin colluvial/slopewash deposits of sheet sand are present downslope of the outcrop and excludes upslope areas where erosion has stripped the soil away. Nevertheless, we feel that the distribution map provides a reasonable indication of the outcrop distribution, which probably does not exceed 1 to 2 percent of the total area of the fort.

9.5.3 Paleoenvironmental Implications

One interesting aspect of the Paluxy sites is an apparent conflict between the degree of Paluxy soil preservation and a postulated period of pronounced upland soil erosion during the early to middle Holocene. Several recent reconstructions of late Pleistocene paleoecology (e.g., Toomey 1993; Graham 1987) suggest that the uplands of Central Texas were mantled with relatively thick, well-developed soils similar to the soil currently preserved on many of the Manning surfaces on the eastern side of the base (e.g., the Speck series). However, as the climate became increasingly warm and dry during the Pleistocene-Holocene transition, severe areal erosion occurred, resulting in the stripping of this thick soil cover in most areas. Evidence cited for this sequence of events includes (1) the relatively rapid extinction of a number of small, burrowing mammals requiring deep soil cover (e.g., *Thomomys*, *Geomys*, and *Blarina* sp.) during the Pleistocene-Holocene transition (e.g., Toomey 1993; Graham 1987); (2) extensive red cave sediments interpreted as soil residuum deposited in traps and sinks as the soil degraded (Toomey 1993); and (3) an increase in the supply of fine-grained, rubified sediment to fluvial systems during the early to middle Holocene (Nordt 1992:64-65; Blum 1987:131-134).

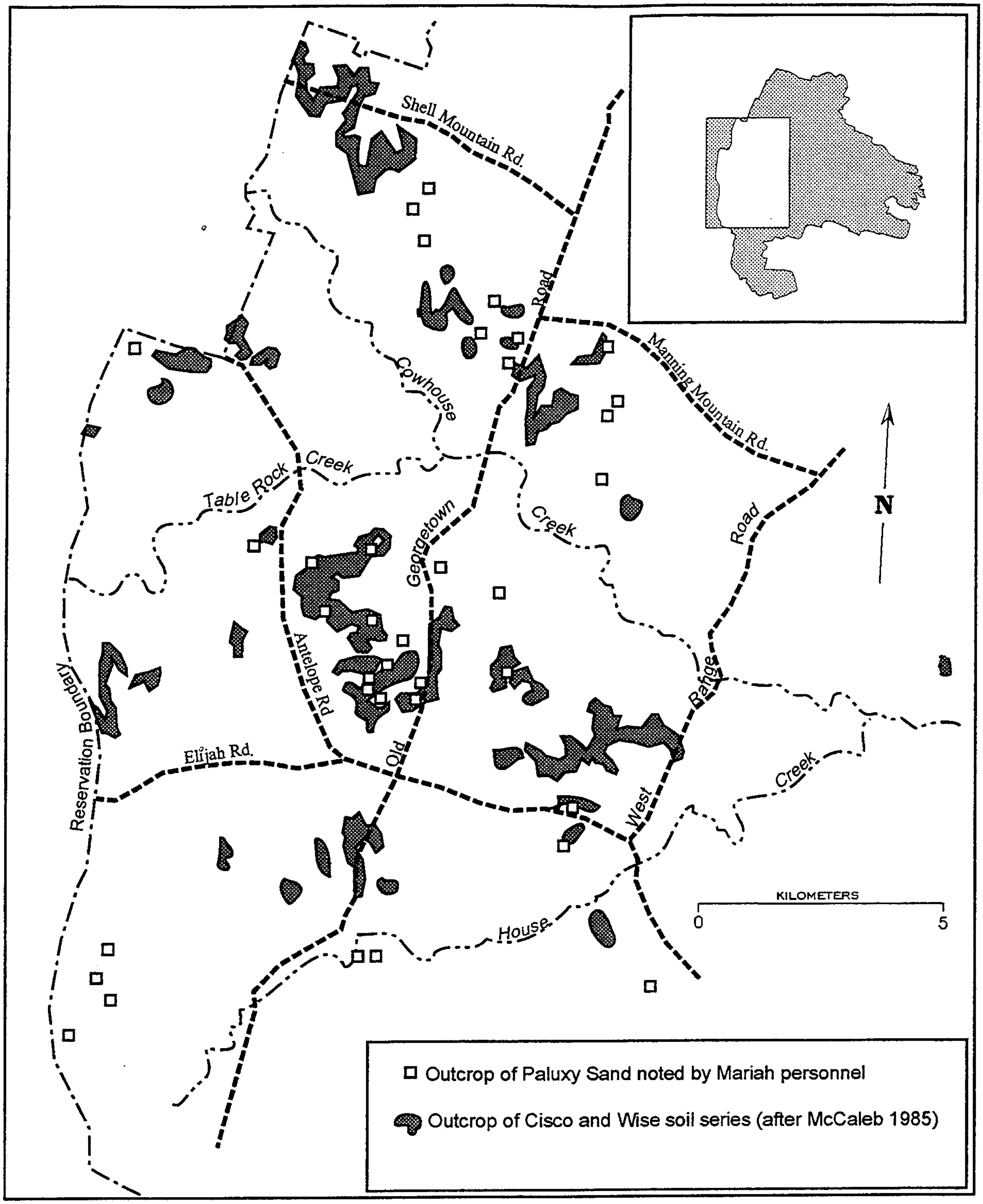


Figure 9.8 Approximate Distribution of the Paluxy Sand on Fort Hood, Based on the Distribution of Characteristic Soils (McCaleb 1985) and Localities Noted By Mariah Personnel.

If this model is accurate, an explanation is necessary for maintenance of a thick soil on the Paluxy substrate. As detailed in Chapter 2.0, the outcrop is typically capped by soils of the Cisco and Wise series. Cisco soils are classified as udic Haplustalfs (McCaleb 1985), which indicates that they are moderately-horizonated Alfisols formed under conditions slightly moister than the present. Typically, Haplustalfs in Texas are developed on deposits or erosion surfaces of late Pleistocene age (Foth and Schafer 1980:168-169). Although undated, the deep red color (typically 2.5YR 5/6 to 5YR 5/6) and thick A-Bt-Bk-C profile of Cisco soils strongly suggests that they pre-date the Holocene. At the same time, their sandy texture makes them particularly prone to sheet erosion and gullying. Therefore, an explanation is required how a thick soil mantle on the surrounding slopes could be completely eroded off, and in many instances transported across the Paluxy outcrop, without also removing the vulnerable Cisco soils.

9.5.4 Cultural Implications

In all, a total of approximately 43 site management areas either partially or totally underlain by the Paluxy substrate were examined during the course of the reconnaissance. This represents 7.3 percent of the total upland sample (583 management area). Although the full extent of the Paluxy outcrop is not known, the available data suggests that it probably does not exceed 2 to 3 percent of the total area of the base. Therefore, it appears that the Paluxy substrate was being preferentially selected by the prehistoric inhabitants. This interpretation is reinforced by the character of the sites themselves, virtually all of which are distinguished by the presence of burned limestone features (or scatters representing destroyed features) in an area where the limestone is not available and therefore had to be carried in. Furthermore, the results of shovel testing of Paluxy features indicate that the associated suite of artifacts is much less concentrated than in burned rock features in other environments. Table 9.23 documents this difference for lithic debitage and tools; patterns of occurrence of bone and mussel shell showed a similar trend. It can be argued, therefore, that the Paluxy sites typically represent a specific type of economic adaptation.

As has been initially discussed in Chapter 2.0, three different hypotheses can be advanced for the apparent preferential selection of the Paluxy substrate:

(1) The prehistoric inhabitants were exploiting biotic resources unique to, or concentrated on, the Paluxy soils. What these resources may have been is unclear, but the neutral to acidic Paluxy does support a slightly different assemblage of vegetation than occurs on surrounding calcareous substrates. If this is the case, it follows that the resources would have been sufficiently concentrated to make it more efficient to carry the rock to the resources than the resources to the rock. Another implication is that the occupation may have been targeting food resources with seasonal availability, and thus represent part of a broader seasonal round. It is also conceivable that the resource was fuel rather than a foodstuff, particularly during dry periods when woody vegetation was relatively scarce. In North-Central Texas, the modern outcrop of the Paluxy substrate coincides with the eastern part of the Western Cross Timbers (Sellards 1932; Johnson 1952), and is typically wooded while the surrounding calcareous rocks support grassy vegetation.

(2) The prehistoric inhabitants were locating on the substrate because its sandy texture and rapid drainage made it a more desirable living surface than the surrounding soils with stony clay epipedons. This implies that occupation coincided with relatively moist intervals, when differences in permeability and drainage would have been significant.

Table 9.23 Comparison of Debitage Return from Burned Rock Features in the Paluxy Sand and in Other Geological Contexts.

Paluxy substrate				Colluvial toeslope and terrace			
Site	Features Tested	Total Shovel Tests	Lithics Recovered	Site	Features Tested	Total Shovel Tests	Lithics Recovered
41CV319	2	2	2	41BL148	2	5	557
41CV478	1	1	2	41BL154	1	7	443
41CV480	1	1	0	41BL155	1	4	130
41CV594	2	2	3	41BL751	1	1	339
41CV595	7	7	62	41CV97	2	2	845
41CV947	1	7	43	41CV99	1	2	145
41CV984	2	2	5	41CV100	2	2	16
41CV988	2	2	14	41CV403	1	6	1601
41CV1027	4	4	0	41CV481	1	3	160
41CV1043	3	3	2	41CV1104	1	1	83
41CV1049	4	4	5	41CV1122A	1	1	9
41CV1050	1	1	0	41CV1167	1	8	485
41CV1093	2	2	11	41CV1244	3	18	38
41CV1106	2	2	15	41CV1423	1	1	3
41CV1135	2	2	1	41CV1430	1	2	0
41CV1141	3	3	78				
41CV1143	1	1	1				
41CV1191	3	3	44				
41CV1194	2	2	6				
41CV1227	2	2	0				
41CV1239	1	1	0				
41CV1391	2	2	0				
41CV1553	1	1	0				
Total	51	57	294	Total	20	63	4854
		average per feature	5.8			average per feature	242.7
		average per shovel test	5.1			average per shovel test	77.04

(3) The prehistoric inhabitants were locating on the substrate because its sandy texture made it easy to excavate pits to concentrate heat or because deep extant gullies could be exploited for the same purpose. There is evidence from several sites that pits or central depressions were commonly associated with burned rock features (see Chapter 8.0), and excavation into the Paluxy is significantly easier than into the thin clays and limestone of adjacent geologic formations.

Although an interesting pattern is emerging, a great many questions remain to be resolved before the role of the Paluxy sites in the prehistoric economy can be determined. First, there is as of yet very little indication of the temporal context of the sites. A few radiocarbon ages are available from large burned rock mounds in the environment (see Chapter 8.0), but it is unclear how these anomalously large features are related to the smaller burned rock clusters typical of the majority of the sites. If the sites tend to cluster around a certain time period, the argument that they represent a specific type of adaptive strategy is strengthened.

Second, there is insufficient economic data available to interpret the role of the sites in the prehistoric economy. Once again, some macrobotanical information has been recovered from the large mounds (Chapter 8.0), but much more is needed to interpret site function. Finally, block excavations are needed to examine the structure of Paluxy sites in a systematic manner.

9.6 ROCKSHELTERS

James T. Abbott

In all, more than 150 shelters and karstic sinkholes were examined on Fort Hood during the reconnaissance process. Some of these features were designated as sites in their own right, while others were included within the boundaries of larger sites. They are particularly numerous in the eastern portion of the base. This section summarizes the aggregate record of Fort Hood shelters and compares it with the body of existing information for this important type of site. The emphasis of the treatment is on the range of information that currently exists and the need for continued investigation within the cultural ecology paradigm.

9.6.1 Summary of Previous Investigations

Rockshelters are an extremely common type of archaeological site in Central Texas, and have a long history of investigation. Table 9.24 lists rockshelters reported in the published literature. Rockshelters from the Trans-Pecos area, including the suite of shelters from Amistad Reservoir, have been deliberately omitted to concentrate on the Central Texas record. A few additional Central Texas shelters have been omitted because the references in question did little more than note their existence. Finally, the two rockshelters excavated on Fort Hood by Texas A&M University field school in the summer of 1990 (Carlson 1993) were omitted because they are included in the present sample and discussed below. The location of the shelters listed in Table 9.24 is illustrated in Figure 9.9.

Rather than present a text discussion of the individual shelters, this review will focus on a synthetic treatment that emphasizes what is and is not known about rockshelters. With one notable exception (Coffman et al. 1986), previous rockshelter investigations have focused on reconstruction of cultural history at the expense of other aspects of the record, although recent investigations (e.g., Carlson 1993a; 1993b; Kotter et al. 1985) have provided a somewhat more balanced treatment.

Size

Examination of the table reveals that the shelters range in size from less than 3 m to more than 70 m long, 1.5 to 12 m deep, and have ceiling heights ranging between a little over 0.5 to 7 m.

Table 9.24 Description of Better Documented Rockshelters in Central Texas.

Site	Name	Location	Maximum Depth of Fill	Age/Culture	14C range (oldest and youngest ages)	Size (length, max. depth, max. height)	References
41BQ63	Five Goat Shelter	Hog Creek, Bosque Co.	approx 1.0 m	Late Prehistoric; Transitional Archaic; Late Archaic	1228±53 B.P. to 1421±58 B.P.	16 m x 4 m x approx 1.5 m	Larson et al. 1975; Henry et al. 1980
41BQ66	Opilionid Shelter	Hog Creek, Bosque Co.	>1.0m; cultural material to 0.7 m	Late Prehistoric	none	14 m x 1.5 m (no height given)	Larson et al. 1975; Henry et al. 1980
41CV69	Windy Shelter	Hog Creek, Coryell Co.	approx 0.9 m	Late Archaic to Late Prehistoric	AD657±60 to AD915±60	60 m x 8 m x 3 m	Larson et al. 1975; Henry et al. 1980
41CV61	Stone Rockshelter	unnamed Hog Creek tributary, Coryell Co.	approx 1.25 m	Transitional Archaic to Late Prehistoric	1448±64 B.P. to 870±60 B.P.	14 m x 6 m x approx. 2 m	Larson et al. 1975; Larson and Kirby 1976; Henry et al. 1980
41CV62	L.E.Robertson Shelter	unnamed Hog Creek tributary, Coryell Co.	approx 1.2 m	Late Prehistoric; Transitional Archaic; Late Archaic	AD775±74 (at base)	42.5 m x 5 m x 2 m	Larson and Kirby 1976; Henry et al. 1980
41HL17	Bear Creek Shelter	Bear Creek near Brazos confluence, Hill Co.	> 4 m	Middle Archaic to Transitional Archaic; Late Prehistoric	2200 B.C. ± 50 to A.D. 1320 ± 50	46 m x 8 m x approx. 2.5 m	Stevenson 1970; Lynott 1978
not given	Kyle Site	Lake Whitney (Brazos River valley) Hill Co.	>3.6 m	Late Prehistoric; some Transitional Archaic material	A.D. 561 ± 150 to A.D. 1561 ± 130	27 m x 12 m x 3.5 m	Jelks 1962
41BQ20	Brawley's Cave (a shelter)	unnamed Bosque River tributary, Bosque Co.	up to 2 m	Late Archaic to Late Prehistoric	none	length not given width 6 m ceiling height not given	Olds 1965; and Simmons report therein
41ME7	Scorpion Cave	Medina River near confluence of Koenig Creek, Medina Co.	not given; at least 1 m based on deepest reported depth	Early Archaic to Late Prehistoric	none	5.5 m x 18 m x 2 m	Highley et al. 1978
41BQ47	Horn Shelter No. 1	Brazos River valley below Lake Whitney, Bosque Co.	> 2.4 m	Paleo-Indian; Middle to Transitional Archaic; Late Prehistoric	10785 ± 500 B.P. to 510 ±30 B.P.	15 m x 6 m (no height given)	Watt 1978
41BQ46	Horn Shelter No. 2	Brazos River valley below Lake Whitney, Bosque Co.	7.6 m	Paleo-Indian; Middle to Transitional Archaic; Late Prehistoric	10310 ± 150 B.P. to 590 ± 60 B.P.	46 m x 7.6 m x 4 m	Watt 1978; Forrester 1985; Redder 1985; Young et al. 1987
41BL28	Aycock Shelter	Kell Branch, Leon River tributary, Bell Co.	0.8 m	Unspecified Archaic; Late Prehistoric (Toyah Focus only)	>10,000 B.P. (questionable context and assay)	33 m x 12 m x 1.5 m	Watt 1936; 1961; 1978; Suhm 1960

Table 9.24 (Continued).

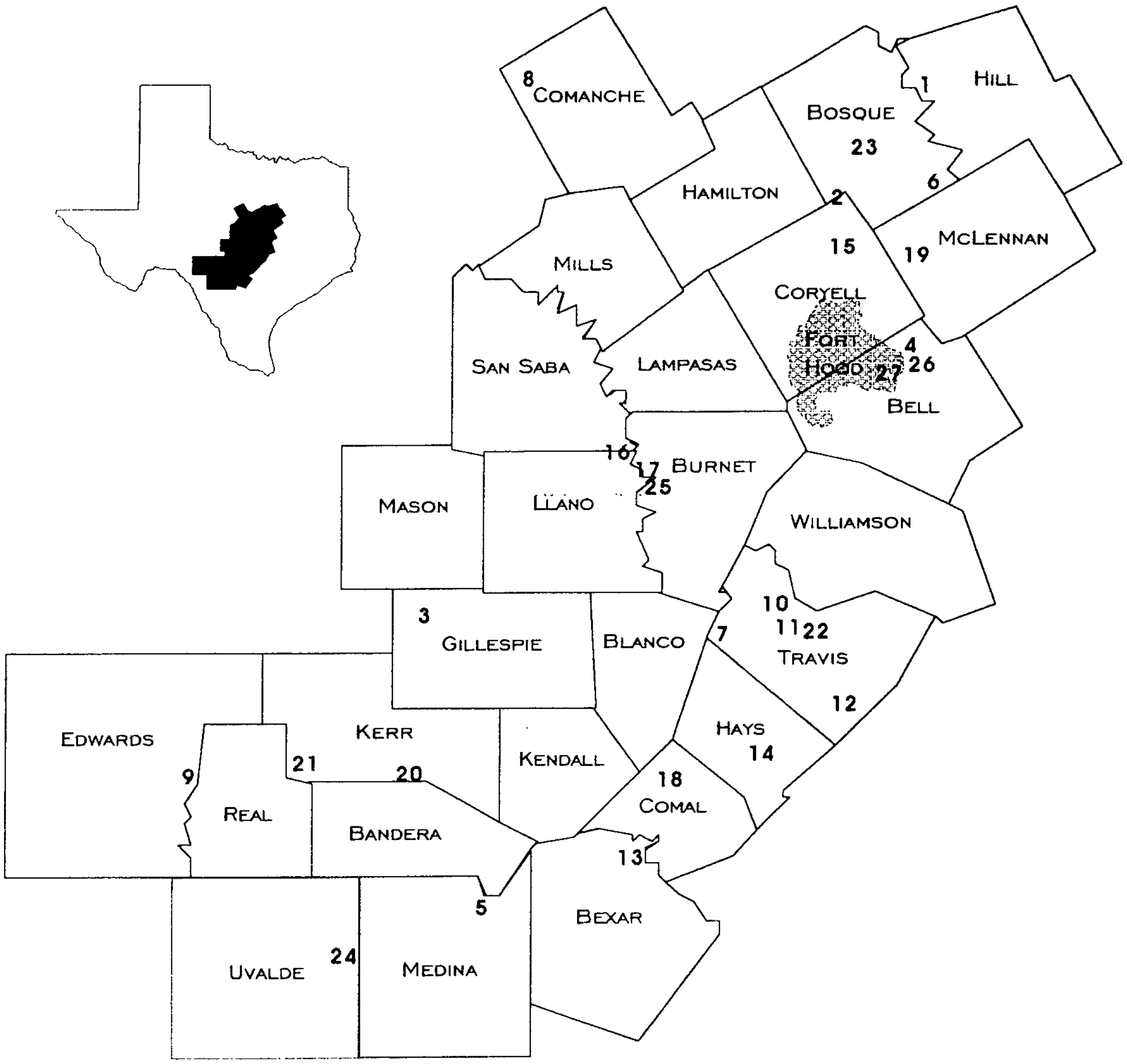
Site	Name	Location	Maximum Depth of Fill	Age/Culture	14C range (oldest and youngest ages)	Size (length, max. depth, max. height)	References
41-26D7-5 (41HI53)	Pictograph Shelter	Lake Whitney (Brazos River valley) Hill Co.	2 m	Late Prehistoric; sparse Late Archaic component	none	16 m x 7 m x 2.1 m	Stephenson 1947; 1970
41-26D7-12	Buzzard Shelter	Lake Whitney (Brazos River valley) Hill Co.	0.9 m	Late Prehistoric (primarily Toyah Focus); sparse Late Archaic component	none	36 m x 7.6 m x 3.6 m	Stephenson 1947; 1970; Long 1961
41-26D7-20	Sheep Shelter	Lake Whitney (Nolands River valley) Hill Co.	1.8 m	Austin Focus, Toyah Focus; sparse Archaic components	none		Stephenson 1947; 1970
41HI8	Blum Rockshelter	Lake Whitney (Nolands River valley) Hill Co.	> 2.9 m	Late Prehistoric	A.D. 551 ± 120	58 m x 4.5 m x 1.5 m	Jelks 1953; 1962
26D7-14	Little Buzzard Shelter	Lake Whitney (Brazos River valley) Hill Co.	unspecified (>0.7 m)	Late Prehistoric	none	22.5 m x 6.7 m (no height given)	Long 1961
26D7-15	Forrester Cave	Lake Whitney (Brazos River valley) Hill Co.	approximately 0.3-0.4 m	Late Prehistoric (Austin Focus)	none	4.2 m x 1.8 m x 1.8 m	Long 1961
41TV49	The Levi Site	Lick Creek (Pedernales River tributary) Travis Co.	2.1 m	Paleo-Indian, Archaic, Late Prehistoric (report concentrates on Paleo component)	10000 ± 175 B.P. to 7350 ± 150 B.P. (one younger date rejected)	36 m x 4.5 m	Alexander 1963
41CJ62	Yellowjacket Shelter	Copperas Creek (Leon River tributary), Comanche Co.	1.3 m	Early to Transitional Archaic; Late Prehistoric	none	8 m x 1.7 m x 0.8 m	Bandy et al. 1981
63B3-13	Fields Shelter	unnamed tributary of Hackberry Creek, Edwards Co.	0.5 m	Archaic (mix of Central Texas and Trans-Pecos attributes); sparse Late Prehistoric	none	15 m x 6 m x 6 m	Campbell 1957; Suhm 1960
53C5-20 (41TV42)	Smith Rockshelter	Onion Creek, Travis Co.	2.6 m	Early to Transitional Archaic; Late Prehistoric	none	40 m x 5.4 m x 3 m	Suhm 1957; 1960
41TV69	Boy Scout Rockshelter	Bull Creek at Colorado River confluence (Lake Austin), Travis Co.	up to 0.75 m	Late Prehistoric	none	2 sections: east 10 m x 3 m (no height given); west 25 m x 4.25 m x 3.5 m	Pollard et al. 1963
41TV742	Kenyon Rockshelter	Bull Creek tributary, Travis Co.	approx 95 cm	Late Archaic; Late Prehistoric	1660 ± 230 B.P. to 750 ± 70 B.P.	6 m x 3.5 m x 0 .65 m	Coffman et al. 1986

Table 9.24 (Continued).

Site	Name	Location	Maximum Depth of Fill	Age/Culture	14C range (oldest and youngest ages)	Size (length, max. depth, max. height)	References
41BX32	Classen Rockshelter	Cibolo Creek valley, Bexar Co.	approx 1.1 m	Middle Archaic to Transitional Archaic	none	25 m x 6 m x 7 m	Fox 1980
41HY95	Timmeron Rockshelter	Lone Man Creek (Blanco River Tributary), Hays Co.	1.2 m	Late to Transitional Archaic; Late Prehistoric	none	approx 30 m x 3 m x 3 m	Harris 1985
none given	Cave Creek shelter	Cave Creek, Coryell Co.	0.9 m	unspecified Archaic	none	none given	Horne 1938
Fall Creek Site 3, Shelter 1	none	Colorado River (Lake Buchanan) Llano Co.	1.8 m	indeterminate Archaic	none	8.2 m x 4.8 m (no height given)	Jackson 1938; Suhm 1960
Fall Creek Site 3, Shelter 2	none	Colorado River (Lake Buchanan) Llano Co.	not given	unknown age	none	2.7 m x 1.5 m x approx 1 m	Jackson 1938; Suhm 1960
Fall Creek Site 3, Shelter 1	none	Colorado River (Lake Buchanan) Llano Co.	0.75 m	indeterminate range; includes Late Prehistoric	none	2.6 m x 1.5 m (no height given)	Jackson 1938; Suhm 1960
Fall Creek Site 2, Cave 1	none	Colorado River (Lake Buchanan) San Saba Co.	0.38 m	indeterminate	none	18.5 m x 11.5 m (no height given)	Jackson 1938; Suhm 1960
Fall Creek Site 2, Cave 2	none	Colorado River (Lake Buchanan) San Saba Co.	1.25 m	indeterminate	none	11 m x 6 m (no height given)	Jackson 1938; Suhm 1960
Fall Creek Site 2, Shelter 2	none	Colorado River (Lake Buchanan) San Saba Co.	0.75 m	indeterminate Archaic	none	3 m x 1.2 m x 1.4 m	Jackson 1938; Suhm 1960
Buchanan Lake Site No. 57	none	Colorado River (Lake Buchanan) Burnet Co.	2.2 m	unspecified Archaic; Late Prehistoric	none	44 m x 4.5 m x approx 2.5 m	Woolsey 1938; Suhm 1960
41CM1	The Oblate Site	Guadalupe River (Canyon Lake) Comal Co.	approx. 0.6 m	Early to Transitional Archaic; Late Prehistoric	none	45 m x 3.6 m x 2.4 m	Tunnell 1962
41GL1	The Lehmann Rock Shelter	Onion Creek, Gillespie Co.	approx 2.4 m	Middle to Late Archaic; Late Prehistoric (Toyah Focus only)	none	73 m x 18 m x 3.6 m	Kelley 1947; Suhm 1960
41TV933	Cherry Tree Shelter	unnamed tributary of Bull Creek Branch, Travis Co.	approx 0.65 m	Middle Archaic to Late Prehistoric	2360 ± 140 B.P. to 1560 ± 80 B.P.	16 m x 8.5 m x 0.95 m	Kotter et al. 1985

Table 9.24 (Concluded).

Site	Name	Location	Maximum Depth of Fill	Age/Culture	14C range (oldest and youngest ages)	Size (length, max. depth, max. height)	References
none given	Tonk Creek Shelter	Tonk Creek (Middle Bosque River tributary), McLennan Co.	not noted	Early Archaic to Late Prehistoric	none	23 m x 6 m x 4.5 m	Mason 1936; Perkins 1956
41KR116	Bushwhack Shelter	Bushwhack Creek (Turtle Creek tributary), Kerr Co.	1.25 m	Middle Archaic to Late Prehistoric	none	44 m x 5.8 m x 1.4 m	Skinner 1979
BT17 (not standard trinomial)	Goodrich Shelter	Colorado River valley Burnet Co.	approx 1.0 m reported	unspecified Archaic Late Prehistoric	none	46 m x 3 m (no height given)	Field 1956; Suhm 1960
41-39D4-17	Grimes-Houy Shelter	Horse Creek (Lake Belton), Coryell Co.	approx 0.6 m	Transitional Archaic Late Prehistoric	none	18 m x 3.6 m x 2.4 m	Miller and Jelks 1952; Suhm 1960
not given	Kincaid Rockshelter	Sabinal River valley Uvalde Co.	not given	Paleo-Indian (Folsom) unspecified Archaic and Late Prehistoric	none	10 m x 10 m (no height given)	no primary report Sellards 1952; Suhm 1960; Hester et al. 1985; Collins et al. 1989
41BL495	none	tributary of Spicewood Creek, Bell Co. (Ft. Hood)	approx 0.6 m	Late Prehistoric	none	24 m x 6 m x approx 2 m	Carlson 1993b
41BL496	none	Spicewood Creek, Bell Co. (Ft. Hood)	approx 0.9 m	Late Prehistoric	580 ± 90 B.P.	13 m x 4 m (no height given)	Carlson 1993b
41BL497	none	Spicewood Creek, Bell Co. (Ft. Hood)	approx 0.7 m	Late Prehistoric	1090 ± 100 B.P. to 1380 ± 110 B.P.	unspecified ("small")	Carlson 1993b
none given	Goat Bluff Shelter	southwestern Kerr Co.	0.75 m	unspecified Archaic; Austin Focus	none	12 m x 3 m (no height given)	Sollberger 1949



1) Kyle Site, Pictogram Shelter, Buzzard Shelter, Sheep Shelter, Bear Creek Shelter, Forrester Cave, Little Buzzard Shelter, Blum Site
2) L.E.Robertson Shelter, Stone Rockshelter, Five Goat Shelter, Opilionoid Shelter, Windy Shelter
3) Lehmann Rockshelter
4) Aycock Shelter
5) Scorpion Cave
6) Horn Shelter No. 1 and Horn Shelter No. 2
7) Levi Site
8) Yellowjacket Shelter
9) Fields Shelter
10) Kenyon Rockshelter
11) Cherry Tree Shelter
12) Smith Rockshelter
13) Classen Rockshelter
14) Timmeron Rockshelter
15) Cave Creek Shelter
16) Fall Creek Site 3, Shelters 1-3; Fall Creek Site 2, Cavel-2, Shelter 2
17) Lake Buchanan Site 57
18) Oblate Site
19) Tonk Creek Shelter
20) Bushwhack Shelter
21) Goat Bluff Shelter
22) Boy Scout Rockshelter
23) Brawley's Cave
24) Kincaid Rockshelter
25) Goodrich Shelter
26) Grimes-Houy Shelter
27) 41BL495, 41BL496,41BL497

Figure 9.9 Location of Investigated Rockshelters in Central Texas.

Sediment Depth and Character

The depth of shelter sediments is not typically reported, but minimum depths can usually be determined from the depths of excavation units published in the reports. Depths reported for Central Texas rockshelters with substantial cultural remains range from less than a meter to almost 8 m, with the majority reported as 3 m or less. Even more difficult to interpret are the terse, nonstandard descriptions of internal fill character typical of reports predating the 1970s. Clearly, however, a variety of sediments derived both from within and outside the shelters are present in many instances.

Processes and Rates of Rockshelter Evolution

This subject has only been breached in a handful of reports. The earliest study to address rockshelter formation is the Blum Rockshelter reported by Jelks (1953), who attributed formation to lateral stream erosion. More recent work to treat the subject includes Cherry Tree Shelter (Kotter et al. 1985) and Kenyon Rockshelter (Coffman et al. 1986), who attributed formation to groundwater sapping and freeze-thaw processes, respectively.

One of the clearest trends evident in the existing data is the tendency for rockshelters to be dominated by Late Prehistoric cultural material (Thomas 1978; Prewitt 1981; Shafer 1977). However, as Table 9.24 demonstrates, material from PaleoIndian on up is represented, and the dominance of Late Prehistoric remains may be an artifact of shelter preservation and evolution rather than an indication of shifting cultural preferences (Coffman et al. 1986). Although it is sometimes difficult to tell, most reports do not suggest that substantial sterile deposits underlie the cultural strata, which suggests that previous deposits may have either been flushed by an increase in groundwater discharge or not present due to shelter development during the late Holocene.

9.6.2 Rockshelter Formation Processes

The rockshelters of Central Texas are commonly developed in beds of softer limestone overlain by harder, more massive beds that have a greater resistance to weathering and erosion. On Fort Hood, most shelters appear to be associated with the transition from the softer, fissile beds of the Comanche Peak limestone to the harder, massive beds of the overlying Edwards limestone. An important point to remember is that all rockshelters are temporary features formed and ultimately destroyed as slopes evolve.

Farrand (1985) recognizes a number of physical processes active in the formation of rockshelters. Cryoclaticism and cryoturbation are processes unique to frost climates, and result in the physical disintegration of rock and mixing of shelter sediments due to the freezing of water. Solifluction is also a process typical of cold climates, and results in the introduction of external sediment. In addition to frost action, shelter walls can be attacked by chemical solution, resulting in hydration spalls, granular disintegration, and precipitation of tufa and travertine. Collapse is a gravity process where weakened rock falls from the roof or wall, enlarging the shelter. Flowing water can introduce external flood and sheetwash sediment, chemical precipitates or sediment from solution pipes within the shelter, or erode existing deposits. Eolian sediments can also be introduced in conducive environments. Pedogenic modification of shelter deposits can result in physical and chemical changes to rockshelter fill. Finally, Farrand recognizes that humans and animals can introduce a variety of materials and can disturb or chemically alter existing deposits. To this list can be added introduction and subsequent decomposition of organic material through overland wash, wind, gravity processes, and in situ growth and decay. Such material can be mixed with mineral matter to form an A horizon, or if rapidly buried, can be maintained as a discrete organic stratum.

Very little work has been done on the geomorphology of rockshelters in Texas, and the relative role of various processes in shelter formation is not clear. Few reports completed before the mid-1970s bother to address formation processes at all, and those that do typically invoke simplistic and possibly erroneous mechanisms. One of the most commonly cited mechanisms (e.g., Jelks 1953; Suhm 1957; Tunnell 1962; Pollard et al. 1963; Harris 1985) is undercutting of bedrock by laterally shifting streams. While such a mechanism may have contributed in some part to the formation of many shelters, channel gravels are rarely reported from shelter excavations, and it is likely that the role of this process is overstated in the literature.

By far the most thorough study of rockshelter sediments and formation processes is that of Coffman et al. (1986), who attacked the geoarchaeological component head on in their investigation of Kenyon Rockshelter in Travis County. One of the most important contributions of this work was the recognition that rockshelters are evolutionary geomorphic features, and excavation strategies that treat them as static entities may bias the record toward recovery of relatively recent material. While it is certainly a giant step in the right direction, the Kenyon study is hampered by a flaw in the theoretical assumptions underpinning the analysis. The model of rockshelter formation adopted by Coffman et al. (1986) is lifted directly from the work of Henri Laville in the French Perigord (e.g., Laville 1976; Laville et al. 1980), and attributes all shelter growth to cryoclastic processes. Although their initial discussion acknowledges that shelter formation is the result of "either freeze-thaw or solution weathering, or both" (Coffman et al. 1986:41), the interpretation of the sediments is based on the more restrictive assumption that "rockshelters form in a less-resistent zone of limestone through cryogenic (freeze-thaw) processes" (Coffman et al. 1986:74). In our opinion, solution weathering is a much more likely mechanism than cryoclasticism during the Holocene in Central Texas. If so, the resulting paleoenvironmental interpretations in the Kenyon study lose their validity.

We feel that variation in temperature is not the primary driving mechanism influencing the rate of shelter formation. Rather, the most likely control is probably variability in the rate of groundwater discharge. Thus, the primary factor influencing the rate of rockshelter development is not variations in temperature, as Coffman et al. (1986) suggest, but rather changes in precipitation patterns.

Shelters contain a wealth of potential for paleoenvironmental research. The ratio of coarse to fine matrix through the various strata gives an index of variability in the rate of shelter development through time. Episodes of deposition of externally derived sediment can give an indication of the degree of broader landscape stability. Faunal and floral material preserved in the fill can supply both paleoenvironmental and paleoeconomic information. Tufa and travertine can encase paleobotanical and faunal remains, and episodes of travertine growth (which can be obtained directly by radiocarbon dating of the precipitate) can give an indication of the timing of elevated groundwater discharge.

Although a fair amount of data is extant concerning the age of cultural deposits contained in Central Texas shelter fill, very little is known about the time range represented by the rockshelters themselves. Examination of this topic, coupled with excavations designed to target older shelter deposits (which may now lie outside the overhang due to shelter evolution), has the potential to either bolster or revise current interpretations of cultural use of Central Texas rockshelters. This is one of the most important potential contributions of the Fort Hood database.

9.6.3 Characteristics of Rockshelters on Fort Hood

More than 150 rockshelters, caves, and karstic sinks were examined during the reconnaissance process. Data from 135 of these shelters is presented in Table 9.25; the remainder were judged during the reconnaissance to lack significant deposits and were not recorded in comparable detail. The shelters ranged from 2 m to 60 m long, 0.75 m to 15 m wide, and 0.4 m to 4.0 m high. This range is similar to the variability of shelters in the existing literature. Depths were recorded based on existing exposures (e.g., in potholes), on the basis of wire probes, and from shovel test data; they should be considered minimum estimates. The majority were estimated to be less than 50 cm deep and based on the reconnaissance, only three had an apparent depth greater than 1 m.

Subsurface diagnostic projectile points were recovered from 25 of these shelters (19%). As in other areas, temporal affiliations of these points tend to cluster around the Transitional Archaic and Late Prehistoric. However, the amount of data afforded by the reconnaissance and shovel testing methodology was limited, and neither the context or representative character of this sample is as yet established.

During the process of geomorphic assessment, a number of different types of rockshelter sediment were observed. Most of the shelters contained a component of coarse roof spall varying in size from coarse granules to multi-ton blocks and slabs. This material was typically contained in a fine matrix composed of a variety of sediments that can be divided into two broad categories: (1) deposits derived internally through the in situ breakdown of the bedrock or chemical precipitation of calcium carbonate from groundwater, and (2) deposits derived from outside the shelter and delivered by a variety of aqueous processes. In all, six broad categories of shelter fill were identified and are described below. Some shelters contained more than one type.

Type 1 Deposits

Type 1 is characteristically light gray, gray brown, yellowish brown or tan silt with variable amounts of coarse limestone spall. This type of fill was observed in a total of 87 shelters (64%), which is greater than any other single type. It is interpreted as a relatively recent internal sediment derived from spalling and granular disintegration of the walls and roof in a relatively dry environment. Color variation appeared to be largely a function of the bedrock; yellowish brown silts, in particular, appeared associated with limestones exhibiting a relatively high degree of limonite staining. Little or no soil development was apparent.

Type 2 Deposits

Type 2 is characteristically stratified, multicolored silts (red, orange, yellow, brown, gray, black, or white) with variable amounts of coarse incorporated spall and organic lenses. The type of fill was only observed in six instances (4% of total), but may have been present in some interpreted as type 1. This type of fill also appears to represent internally derived sediments, but exhibits broader diversity in character and may indicate greater age. Much of the alteration appears to be the result of diagenetic alteration, particularly oxidation-reduction reactions, that is probably associated with periodic groundwater discharge in the shelter. Organic lenses and stained cultural strata are occasionally apparent.

Type 3 Deposits

Type 3 is characteristically dark grayish brown to black clay loam or stony clay loam. This was the second most numerous fill type, occurring in 59 shelters (44%). Most of this type of fill probably represents externally derived material reworked from the A horizon of upland soils, but in a few instances, similar material appeared to have developed in situ as a result of frequent saturation of type 1 sediments. It is also probable that some areas composed almost entirely of partially-decomposed organic matter are included. The material was introduced by sheet flow over the shelter lip, from the shelter margins, or from chimneys in the overhang. Unlike type 4, none was observed issuing from pipes and fissures in the shelter wall, but this origin cannot be ruled out.

Table 9.25 Description of Rockshelters Examined During Reconnaissance Phase Investigation on Fort Hood, 1992-1993.

	Estimated Sediment Depth	Sediment Type (see key)	Length (m)	Width (m)	Ceiling Height (m)	Age/Culture	Remarks
BL0043	50-100 cm	1	30	8	5		
BL0069B	20-50 cm	1	17	1.5	3		
BL0069C	20-50 cm	2	15	3	not noted		
BL0142A	20-50 cm	1, 5	10	3	3		
BL0145A	absent or < 20 cm	1	10	5	not noted	Austin	
BL0154D	20-50 cm	3	4	5	1.25	Toyah	Shelter A
BL0154D	20-50 cm	3	4	2.5	not noted		Shelter B
BL0168B	20-50 cm	3	6	2	not noted		Shelter A
BL0168B	absent or < 20 cm	3	6.5	1	not noted		Shelter B
BL0168B	20-50 cm	3	9	1	not noted		Shelter C
BL0168B	absent or < 20 cm	3	8	1.5	not noted		Shelter D
BL0168B	20-50 cm	3	9	1.5	not noted		Shelter E
BL0181A	50-100 cm	1, 3, 4	15	10	4	Middle Archaic to Late Prehistoric	
BL0188	20-50 cm	1	5	2	1.5		
BL0192A	20-50 cm	1, 3	8	4	1.5		
BL0198B	50-100 cm	1, 5	40	7	3	Late Prehistoric	
BL0231B	20-50 cm	4	8	4	1	Late Archaic / Late Prehistoric	
BL233B	absent or < 20 cm	1, 3	10	8	1.25		Shelter A
BL0233B	50-100	3	6	1	1	Toyah	Shelter B
BL0432	20-50 cm	1, 5	32	5	3		
BL0433	20-50 cm	1, 3	12	3.5	2		
BL0488A	20-50 cm	3	12	3	2.5		Shelter 1
BL0488A	20-50 cm	3	25	6	2		Shelter 2
BL0490	20-50 cm	2, 5	30	8	2	Transitional Archaic	
BL0491	20-50 cm	3	40	5	2.5	Archaic	
BL0504B	20-50 cm	3	15	3	not noted	Late Prehistoric to Historic	
BL0528	absent or < 20 cm	6	8	2.7	1.2		
BL0529	20-50 cm	1, 3	2	1.5	1.5		
BL0531	20-50 cm	1	4	12	1.5		
BL0538	20-50 cm	1	14	3	2		

Table 9.25 (Continued).

	Estimated Sediment Depth	Sediment Type (see key)	Length (m)	Width (m)	Ceiling Height (m)	Age/Culture	Remarks
BL0547	20-50 cm	1	7	2	not noted	Toyah	Shelter 1
BL0560C1	20-50 cm	3, 4	12	1	1-1.5		Shelter D
BL0560C2	20-50 cm	3, 4	10	3	1-1.5		Shelter C
BL0560C2	20-50 cm	3, 4	11	2	1.2		Shelter A
BL0560C3	20-50 cm	3, 4	9	3	1-1.5		Shelter G
BL0563B	20-50 cm	1	13	4	1		Shelter A
BL0563B	20-50 cm	1	8	2	2		Shelter B
BL0564C	50-100 cm	1	7.5	2	1	Late Archaic / Late Prehistoric	
BL0566A	20-50 cm	1	24	3	not noted		
BL0567	20-50 cm	1	30	3	2		
BL0570	20-50 cm	1	22	4	5		
BL0579B	20-50 cm	4	12	2	1.5		Shelter A
BL0579B	20-50 cm	1, 4	25	4	>2		Shelter B
BL0579B	20-50 cm	1	45	6	2.5-4		Shelter C
BL0581A	20-50 cm	1	36	2	not noted		east shelter
BL0581B	20-50 cm	1	28	6	not noted		west shelter
BL0582A	50-100 cm	1	10	3	not noted		Shelter A
BL0582A	20-50 cm	1	6	2	not noted		Shelter B
BL0583	absent or < 20 cm	6	3	1	not noted		
BL0589B	20-50 cm	1, 3	15	1.5	1.8		
BL0590A	20-50 cm	1, 3	2	2	1.5		
BL0592	absent or < 20 cm	1	15	2	1.1		
BL0595	20-50 cm	1	12	2	2.1		
BL0596	20-50 cm	1, 3	10	6	1.5	Transitional Archaic / Late Prehistoric	
BL0597	absent or < 20 cm	1	10	2.5	1		
BL0598C	absent or < 20 cm	6	22	5	1.5		Shelter A
BL0598C	absent or < 20 cm	6	16	6	4		Shelter C
BL0598D	absent or < 20 cm	1, 3, 5	22	8	3	Late Archaic	Shelter B
BL0598D	absent or < 20 cm	1, 3, 5	36	6	3		Shelter D
BL0608B	absent or < 20 cm	2	20	3	3		Shelter B
BL0612	absent or < 20 cm	4	10	1.5	1.5		Shelter A
BL0612	absent or < 20 cm	4	10	3	2.5		Shelter B
BL0613	absent or < 20 cm	3, 4	50	5	2.5		

Table 9.25 (Continued).

	Estimated Sediment Depth	Sediment Type (see key)	Length (m)	Width (m)	Ceiling Height (m)	Age/Culture	Remarks
BL0615	20-50 cm	2	36	15	not noted		
BL0627A	20-50 cm	4	8	3	2	Late Prehistoric	Shelter 1
BL0627A	absent or < 20 cm	6	12	4	3.5		Shelter 2
BL0627A	absent or < 20 cm	1	40	4	5.5		Shelter 3
BL0627A	absent or < 20 cm	3	8	2	2		Shelter 4
BL0628	absent or < 20 cm	1	30	2	2.5		
BL0635	20-50 cm	1, 4	16	6	2		Shelter A
BL0635	50-100 cm	1, 4	20	3.5	1.5		Shelter B
BL0635	50-100 cm	1, 4	12	5	1		Shelter C
BL0636B	absent or < 20 cm	4	25	3	1.7	Transitional Archaic	
BL0667	1- 2 m	1, 3	12	4	2.5	Late Prehistoric	
BL0670C	20-50 cm	1, 4	8	10	1.5	Austin, Toyah	Carlson 1993a
BL0671	1- 2 m	1	40	4	4	Transitional Archaic to Late Prehistoric	Carlson 1993a
BL0674	20-50 cm	1	12	3	4		
BL0681A	absent or < 20 cm	1, 3	12	2.5	1.4		Shelter 1
BL0681A	absent or < 20 cm	1	10	2	1.2		Shelter 2
BL0683	20-50 cm	3	9	0.75	1.25		
BL0686	absent or < 20 cm	1, 3	8	3	1.3		
BL0694	20-50 cm	3, 4	18	7	2		
BL0695	20-50 cm	1, 3, 4	15	1.5	0.4		
BL0699B	20-50 cm	3, 5	10	3	2		Shelter 1
BL0699B	20-50 cm	3, 5	3	1.5	1		Shelter 2
BL0711B	20-50 cm	1, 3	11	2	1		
BL0723B	20-50 cm	1 and/or 3	25	4	1		Shelter A
BL0723B	absent or < 20 cm	1 and/or 3	20	4	1		Shelter B
BL0728A	absent or < 20 cm	1	20	7	3.6	Austin	Shelter 1
BL0728A	20-50 cm	not noted	5	2	1.6		Shelter 2
BL0731	20-50 cm	1, 3	6	5	2.5	Archaic	
BL0744	50-100 cm	1	35	7.5	2.5		
BL0754	20-50 cm	1, 3	13	1.5	2		
BL0759	absent or < 20 cm	1, 3	4	1.5	1		
BL0765	50-100 cm	1, 3, 5	40	18	not noted		
BL0766	absent or < 20 cm	3	10	1	1.2		

Table 9.25 (Continued).

	Estimated Sediment Depth	Sediment Type (see key)	Length (m)	Width (m)	Ceiling Height (m)	Age/Culture	Remarks
BL0773	20-50 cm	1	4.5	1.2	not noted		
BL0800	20-50 cm	1, 3	8	1	1.3		
BL0806	20-50 cm	1, 4, 5	60	5	not noted	Transitional Archaic / Austin	
BL0827	50-100 cm	not noted	20	5	2		
BL0837	absent or < 20 cm	3	10	3	1.6		
BL0844B	20-50 cm	1	13	3	1.75		Shelter A
BL0844B	20-50 cm	2	15	5	1.6	Late Prehistoric	Shelter B
BL0844B	20-50 cm	3	14	1.5	1.5		Shelter C
BL0844B	20-50 cm	2	16.5	3.5	1.5	Early Archaic / Late Prehistoric	Shelter D
BL0868B	20-50 cm	1	13	2.5	1.5		Shelter B
BL0868B	20-50 cm	1	48	8	1.5	Toyah	Shelter C
BL0886	20-50 cm	1, 5	30	5	not noted		Shelter A
BL0886	50-100 cm	1	3	5	not noted		Shelter B
BL0894B	50-100 cm	3	6	4	not noted		
CV0053C1	absent or < 20 cm	1, 3	15	5	2		
CV0053C2	absent or < 20 cm	1, 3	10	3	2	Middle Archaic/ Late Prehistoric / Austin	
CV0115B3	50-100 cm	1	22	8	1.25		
CV0125B	20-50 cm	1	12	3	4		Shelter A
CV0125C	20-50 cm	4	12	4	1.5		Shelter B
CV0739B	20-50 cm	1, 3	8	2	2.5		
CV0757A	50-100 cm	1	25	5	not noted		
CV0901	20-50 cm	1	18	3	2		
CV0905A	50-100 cm	1, 3	10	2.5	1.5		Shelter A
CV0905A	20-50 cm	1, 3	8	2.5	2		Shelter B
CV0935B	20-50 cm	1, 5	50	10	>2	Late Prehistoric	
CV0944C	20-50 cm	1	30	7	1.5-4		Shelter 1
CV0944C	20-50 cm	1	50	10	2.5		Shelter 2
CV1006	20-50 cm	1, 3	18	2.5	2		
CV1008A	50-100 cm	1, 3	45	10	2.5		
CV1085	1- 2 m	1	15	5	2		
CV1163B	absent or < 20 cm	1, 3	5	1.5	1.5		
CV1166A	20-50 cm	1	4	4	not noted		

Table 9.25 (Concluded).

	Estimated Sediment Depth	Sediment Type (see key)	Length (m)	Width (m)	Ceiling Height (m)	Age/Culture	Remarks
CV1169	50-100 cm	1	17	5	1.5	Middle Archaic to Late Prehistoric	
CV1348A	50-100 cm	1, 3	16	8	1.25		Shelter 1
CV1348A	20-50 cm	3	4	4	not noted		Shelter 2
CV1365C	absent or < 20 cm	1	6	2	1.5		Shelter 1
CV1365C	absent or < 20 cm	1	8	3	2		Shelter 2
CV1367	not noted	6	14	9	1		
CV1550	20-50 cm	1, 3, 4	15	3	2		

Key to sediment types: (1)=light gray, gray-brown, yellowish brown or tan silt w/ variable amounts of coarse limestone spall (internally derived); (2)=stratified, multicolored silts (may be reddish, orange, yellow, brown, gray, black, or white) w/ variable amounts of coarse limestone spall and organic lenses (internally derived); (3)= dark grayish brown to black clay loam or stony clay loam (usually externally derived; may be washed in through pipes or chimneys); (4)=reddish brown to red clay loam or stony clay loam (usually externally derived; may be washed in through pipes or chimneys); (5)=tufa or travertine (precipitated in situ); (6)=no deposits or coarse stony lag only.

Type 4 Deposits

Type 4 is characteristically reddish-brown to red clay loam or stony clay loam. This fill type occurred in 22 shelters (16% of total). This material appears to represent external sediment derived from reworking of the rubified upland argillic horizon. The material was introduced by sheet flow over the shelter lip, from the shelter margins, or from chimneys in the overhang. In some instances, considerable volumes of sediment were introduced through karstic pipes in the rear of the shelter, and in at least one case had resulted in a tiny prograding fan spreading out from the source pipe.

Type 5 Deposits

Tufa (a relatively soft, spongy carbonate precipitate) and travertine (a dense, microcrystalline carbonate precipitate) was noted in 11 shelters (8% of total). However, this figure represents only those shelters where relatively spectacular formations have developed. It is likely that some form of active or fossil tufa is present in at least 40 to 50 percent of the shelters, although data do not currently exist to support this guess.

Type 6 Deposits

This type represents shelters than had either been completely flushed of deposits or contained only a coarse lag. Only six (4%) of the recorded shelters fit this description, but many shelters had been partially flushed. Further, 15 shelters were judged during the reconnaissance to lack significant deposits and were not recorded in comparable detail to the sample of 135 discussed above. It is likely that most or all of these might be classified as type 6 deposits.

9.6.4 Conclusion

The rockshelters of Fort Hood pose a unique management problem because they typically contain a high frequency of artifactual material, and are also one of the most common settings for prehistoric burials. This fact is not lost on the vandals of Central Texas; rockshelters are particularly attractive to vandals, and the vast majority probably have suffered the impact of at least one exploratory hole. This vandalism is not a thing of the past; fresh holes were observed in a number of shelters during reconnaissance. In one case, additional vandalism was noted between the reconnaissance visit and the return of the shovel testing crew only two weeks later. Nor is this a new phenomenon, as extensive vandalism has been reported as early as the mid-1930s (Watt 1936). In our opinion, there is no economically feasible method to protect the shelters from continued vandalism, and we recommend that those shelters deemed to have remaining potential be given high priority for mitigation.

10.0 SITE EVALUATIONS AND MANAGEMENT RECOMMENDATIONS

W. Nicholas Trierweiler

The primary goal of the site evaluation and shovel testing program was to evaluate each site with respect to its eligibility for inclusion in the NRHP. At the beginning of the program, it was recognized that three outcomes were possible for any given site. A site could be eligible because it contains significant data which could be used to address important research issues. Such sites would be recommended for avoidance and protection. A site could be ineligible because of a lack of significant data for addressing important research issues. No further management would be warranted on these sites. Finally, a clear determination of eligibility might not be possible on the basis of the shovel testing and resurvey tactics. Such sites would be recommended for avoidance or further testing.

A secondary goal of the program was to assess site boundaries. Many sites had been arbitrarily enlarged by previous survey methodologies. Consequently, Mariah's program was designed from the outset to allow independent evaluation and reporting of discrete portions of sites with different research potentials. Accordingly, in this chapter, assessments of eligibility for nomination to the NRHP and appropriate management recommendations are not made on a site basis, but rather by geomorphic subarea for small sites and by management unit for the LRPA sites. As described in Chapters 4.0 and 5.0, the 571 contractually issued sites were subdivided into a total of 897 management areas (Table 10.1). The 477 small sites were subdivided into 616 management areas on the basis of geomorphology and differing potential for intact buried deposits. Similarly, the 94 LRPA sites were subdivided into 281 different management areas on the basis of geomorphology, supplemented by an assessment of the integrity and ubiquity of their surface assemblages. Because the individual management areas defined within any given trinomial site differ considerably in their research potential, we recommend that each minimally defined management area should be treated and managed as if it were an independent site.

Because of the extremely large number of site areas documented in this report, this chapter does not individually present for each area the linkages between the field observations (e.g., landform, context, shovel test results, artifact ubiquity), the resulting assessments (e.g., research potential, site significance, NRHP eligibility), and the final management recommendations. These linkages are explicitly made for each site in Appendix A, and are presented in tabular form in Appendix F. Rather, this chapter summarizes several major classes of assessment. The major classes are identified in Table 10.2. This 12- cell contingency table identifies the NRHP eligibility determinations for both LRPA and small sites resulting from the tactics of shovel testing and/or surface resurvey. Each class is separately discussed in Section 10.1 and 10.2. Within each class, all appropriate site management areas are individually identified.

Portions of small sites which were *not* shovel tested were determined (1) to have no potential for intact buried deposits; (2) to have been previously tested; or (3) to have deposits which could be destroyed by shovel testing or which would not adequately be investigated by shovel testing. Small sites which *were* shovel tested were determined (4) to lack deposits or have deposits which lack contextual integrity; (5) to have clearly intact deposits; or (6) to have deposits of uncertain integrity and/or deeper than the limits of shovel testing. Portions of LRPA sites which were *not* shovel tested were determined (7) to have damaged, sparse, or missing surface lithic assemblages; (8) to have high surface lithic ubiquity; or (9) to have substantial but uncertain surface lithic ubiquity. Portions of LRPA sites which were shovel tested *were* determined (10) to have deposits lacking contextual integrity; (11) to have clearly intact deposits; or (12) to have deposits of uncertain integrity and/or which were deeper than the limits of shovel testing.

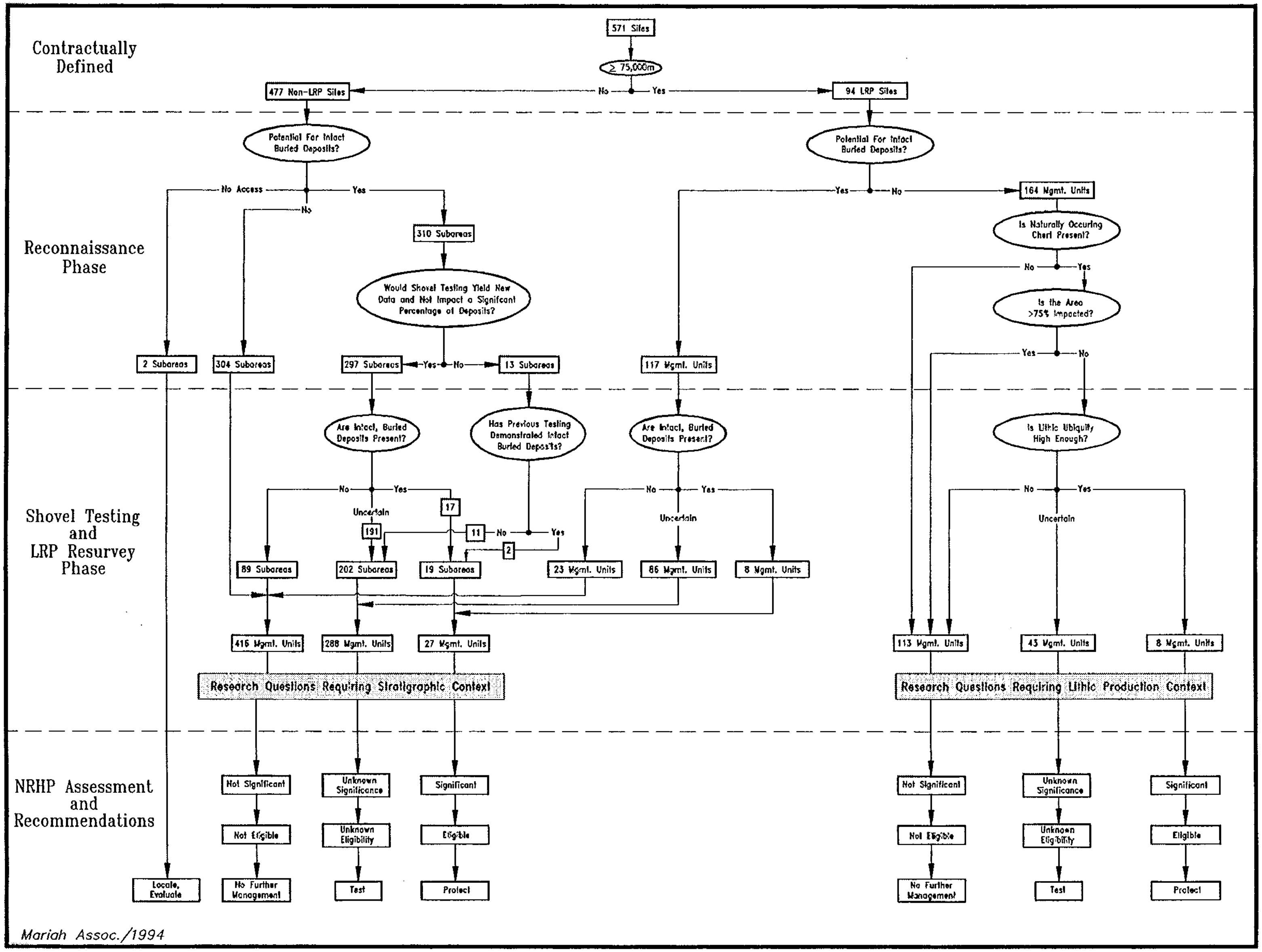
Table 10.1 Frequencies of Sites and Sub-site Management Areas.

	non-LRPAs	LRPAs	Total
Trinomial Sites	477	94	571
Management Areas	616	281	897
Mean areas per site	1.29	2.99	1.57

Table 10.2 Twelve-cell Contingency Table of Possible NRHP Eligibility Determinations.

Status	SHOVEL TESTED?	RE-SURVEYED?	NRHP Eligibility		
			Not Eligible	Eligible	Unknown
Non-LRP	NO	NO	*no potential for intact buried deposits*	*previously tested*	*shovel testing destructive or not productive of new data*
	YES	NO	*deposits lack contextual integrity*	*clearly intact deposits*	*deposits of uncertain integrity and/or deeper than shovel testing*
LRP	NO	YES	*damaged, low ubiquity, or missing lithic assemblage*	*high surface lithic ubiquity*	*substantial but uncertain surface lithic ubiquity*
	YES	NO	*deposits lack contextual integrity*	*clearly intact deposits*	*deposits of uncertain integrity and/or deeper than shovel testing*

This overall process is illustrated in Figure 10.1. The 571 contractually issued sites were divided into 477 small sites and 94 LRPA sites on the basis of size. As is discussed in depth in Chapter 3.0, the arbitrary criterion of 75,000 m^2 was adopted by Fort Hood as a contractual device to identify, *in advance of additional field work*, those sites which had the greatest probability of being true localities of lithic procurement behaviors. All sites were subjected to geomorphic field reconnaissance, at which time the areas having some potential for intact buried deposits were identified. With few exceptions, all areas with such potential were shovel tested, including those within the boundaries of an LRPA site. The exceptions are noted in Figure 10.1 and described below in Sections 10.1.1.2 and 10.1.1.3. Shovel testing data were used to assess whether or not intact deposits were in fact present. These results were then filtered through the set of research questions requiring stratigraphic context to determine research potential and significance. For the areas having no potential for buried deposits, no further work was conducted on the non-LRPA sites. On the LRPA sites, additional reconnaissance was conducted to determine whether the area had naturally occurring chert and whether its surface lithic assemblage was reasonably unimpacted by widespread vehicular traffic. Areas meeting both of these criteria were resurveyed. The resurvey data was then used to assess the degree of ubiquity of the surface assemblage. These results were then filtered through the set of research questions requiring intact lithic assemblages in order to determine research potential and significance.



Mariah Assoc./1994

Figure 10.1 Schematic of Site Evaluation Process.

10.1 SMALL (NON-LRPA) SITES

For the 477 small (i.e., non-LRPA sites), a total of 616 management areas were defined during the reconnaissance on the basis of geomorphology and differing potential for intact deposits. Fully 361 of the sites (76%) were sufficiently uniform in context to warrant no subdivision on geomorphic grounds. The remaining 116 sites were subdivided into two or more areas. For these sites, each landform was delineated as a separate geomorphic area using alphabetical suffixes (e.g., 41BL415A); for two rockshelter areas, individual shelters were further labeled (e.g., 41BL782B1). For these 116 sites, an average of 2.2 management areas was defined per site, with a maximum of four areas defined on two different sites. Overall, an average of 1.3 management areas was defined per site.

10.1.1 Site Management Areas Not Shovel Tested

Of the 616 management areas on small sites, 319 areas were not shovel tested because of 1) a lack of potential for intact buried deposits (304 areas); 2) exposed buried cultural horizons were deeper than the maximum depth of shovel testing or the area was entirely a small feature for which shovel testing would be more destructive than productive of new information (11 areas); 3) the area had been previously tested (two areas); or 4) the area could not be evaluated (two areas). These conditions are described below.

10.1.1.1 No Potential for Intact Buried Deposits

The initial geomorphic reconnaissance determined that 304 management areas had no potential for intact buried deposits, and no shovel testing was conducted on these areas. The vast majority of these management areas are deflated palimpsest lithic scatters on the Killeen or Manning surfaces. Many such sites have exposed bedrock or less than 10 cm of deposit. Others sites with no potential for intact buried deposits are barren rockshelters, those with less than 10 cm of deposits, and those which have been completely disturbed by vandalism. Still other sites with no potential for intact buried deposits are burned rock features which have been completely deflated or disturbed by vehicular traffic. Many of these burned rock features are scatters which may have been mounds at one time, but now have no remaining integrity. These management areas are assessed as not significant and are thus not eligible for nomination to the NRHP. No further management is recommended for these management areas.

A tabular summary of these 304 management areas appears in Appendix F and complete site descriptions are presented in Appendix A. Site areas consists of: BL69A, 142B, 145B, 153, 157, 162, 168A, 178, 181B, 182, 192B, 193, 194, 201, 203, 206, 213, 215, 230, 336, 339C, 347, 348, 357, 358B, 370, 372, 373A, 377, 378, 379, 381, 383, 384, 386, 395, 409, 413, 415C, 415D, 416A, 427A, 430, 439, 444, 448, 451, 455, 472, 482, 488B, 489A, 489B, 500, 504A, 505, 506, 507, 513B, 517, 524, 525, 528, 530, 545, 548, 549, 550, 556, 559, 561, 562, 563A, 566B, 581C, 582B, 583, 589A, 590B, 611, 612, 613, 620, 624, 627B, 628, 634, 636A, 636B, 648, 649, 652, 656, 668, 669, 670A, 673, 681B, 682, 686, 688, 689, 691, 699A, 703, 709, 711A, 716, 717, 718, 721, 722, 723A, 728B, 729, 730, 732, 733, 734, 740A, 742, 748, 749, 750, 751B, 755A, 762, 770, 789, 792, 793, 794, 816B, 837, 840, 853A, 869, 879, 885, 887, 889, 890, 894A, 898B, CV41B, 49, 70A, 82, 84, 85, 90B, 97B, 104, 105B, 109B, 118C, 162, 164A, 203, 204, 205, 206, 208, 227, 271A, 326, 327, 334, 336A, 385, 389A, 390, 395, 478B, 479B, 481C, 493A, 493B, 512, 515, 517, 518B, 520, 560, 578B, 597, 598, 618, 620, 667A, 668A, 677, 679, 687, 721A, 724, 726, 727, 730A, 736, 737, 738, 739A, 741, 744, 745, 747, 748, 750, 751, 754, 755B, 756, 757B, 758, 765, 766B, 771A, 771B, 774, 776, 779, 780, 782, 849A, 855, 905B, 913A, 916, 917A, 929, 936A, 946A, 954, 957A, 967, 983, 988A, 994B, 995A, 998, 999, 1007B, 1008B, 1010, 1012A, 1013, 1023B, 1038B, 1043B, 1049B, 1050B, 1054, 1071, 1077, 1084, 1114, 1123, 1124, 1125, 1137A, 1145, 1161, 1162, 1163A, 1166B, 1184, 1200A, 1216, 1225B, 1229, 1232, 1236, 1237, 1240, 1261, 1262, 1280, 1282B, 1283A, 1291, 1296, 1298, 1300, 1305, 1314, 1316, 1334, 1340, 1352, 1356B, 1364, 1365B, 1367, 1376, 1377, 1383, 1402, 1410A, 1413A, 1425, 1433, 1435, and 1443B.

10.1.1.2 Shovel Testing Destructive or Not Productive of New Information

On the basis of the initial reconnaissance, 11 management areas are suspected to contain intact buried cultural deposits but were not shovel tested. Most of these 11 areas contain buried and intact cultural horizons (exposed in cutbanks for example) but only at depths below the maximum depth of shovel testing. Shovel testing these areas would not have been productive of new information, and further evaluation was deferred. Other management areas are very small features or restricted rockshelters for which shovel testing tactics would actually have been more destructive of the deposits than productive of new information. For all of these 11 management areas, shovel testing was not warranted. On the basis of the initial reconnaissance, these areas are assessed to be of unknown significance and of unknown NRHP eligibility. We recommend that these management areas be avoided. If avoidance is not possible, then formal testing is recommended to determine eligibility.

A tabular summary of these 11 areas appears in Appendix F and complete site descriptions are presented in Appendix A. Site areas consists of: BL69B, 173, 198A, 421, 490, 743, CV45B, 960B, 1097, 1218, and 1235.

10.1.1.3 Previously Tested

Two management areas had been previously tested and did not warrant additional testing. Rockshelters 41BL670C and 41BL671 both contain demonstrated intact cultural deposits and/or intact human burials. On the basis of the published site descriptions and data (Carlson 1993:5-28), as supplemented by the reconnaissance assessment and observations, these areas are both assessed as significant and eligible for nomination to the NRHP. We recommend these areas for immediate avoidance, protection, and preservation. If avoidance and protection is not an option, then adverse impacts to these areas, including ongoing military activity and the threat of vandalism, should be mitigated to avoid loss of significant scientific information. A tabular summary of these two areas appears in Appendix F and complete site descriptions are presented in Appendix A.

10.1.1.4 Not Evaluated

Two management areas could not be evaluated. Site 41BL139 is on file as a rockshelter but it could not be relocated in the reported location despite four different attempts. Management area CV118A is located in the live fire zone. Because of restricted access to this part of Fort Hood, this area was not field checked. These two areas were not assessed for eligibility for nomination to the NRHP. We recommend the first area be deleted from the list of sites. We recommend the second area be geomorphically assessed and shovel tested. A tabular summary of these two areas appears in Appendix F and complete site descriptions are presented in Appendix A.

10.1.2 Shovel Tested Site Management Areas

Of the 616 management areas defined on the small sites, shovel testing was conducted on 297 management areas. The initial geomorphic reconnaissance determined that these management areas had some potential for intact buried deposits. These areas received a total of 2,767 shovel tests and 51 test pits. The number of tests per area ranged from one test in several small rockshelters or rock features to a maximum of 70 tests on a large alluvial terrace area (41CV1549).

10.1.2.1 Deposits Lacking Contextual Integrity

On the basis of shovel testing, 89 management areas were demonstrated to have either no buried deposits or deposits which lack contextual integrity. Many of these areas are portions of terraces which simply lack buried cultural material, or which contain both extremely low ubiquity and extremely low frequency of cultural material. Other management areas contain solely secondarily deposited cultural materials as suggested by their landform (e.g., colluvial slopes) and confirmed by the sediment descriptions from the shovel tests. A third type of area which shovel testing demonstrated to lack intact buried deposits were those for which the entire depth profile had been thoroughly turbated by vehicular traffic. Evidence of disturbance included excessive surface erosion visible in cuts and shovel tests, widespread surface rutting, as well as buried military artifacts at depths up to 70 cmbs. These management areas are assessed as not significant and are thus not eligible for nomination to the NRHP. No further management is recommended for these areas.

A tabular summary of these 89 management areas appears in Appendix F and complete site descriptions are presented in Appendix A. Site areas consists of: BL140, 141, 145A, 188, 339B, 358A, 376, 416B, 416C, 462, 526, 529, 547, 563B, 564B, 564C, 566A, 569, 570, 575, 581A, 592, 683, 728A2, 759, 766, 800, 807, 814, 853B, 894B, 898A, 898C, CV105A, 174A, 175, 333, 336B, 479A, 480, 484A, 721B, 739B, 740, 757A, 761, 766A, 917B, 932, 946B, 946C, 981, 991, 994A, 995B, 1002, 1006, 1024, 1028, 1135, 1137C, 1143B, 1163B, 1227, 1230, 1239, 1245, 1257, 1307, 1315A, 1315B, 1365C, 1378A, 1379, 1382, 1385, 1387, 1389A, 1389B, 1393, 1395A, 1395B, 1410C, 1412, 1413B, 1416, 1423A, 1553, and 1556A.

10.1.2.2 Clearly Intact Deposits

Shovel testing on the small sites demonstrates that 17 management areas contain clearly intact cultural deposits. For the most part, these areas are rockshelters with undisturbed buried deposits and/or human remains. One area is a pristine rock mound feature with undisturbed buried deposits, and three areas consist of alluvial terraces with stratified and buried deposits of high research value. These areas are assessed as significant and eligible for nomination to the NRHP. We recommend that these areas be immediately avoided, protected, and preserved. If avoidance and protection is not an option, then adverse impacts to these areas, including ongoing military activity and the threat of vandalism, should be mitigated to avoid loss of significant scientific information.

A tabular summary of these 17 management areas appears in Appendix F and complete site descriptions are presented in Appendix A. Site areas consist of: BL590A, 596, 670B, 731, 806, 821, CV100, 184, 386, 391, 1132, 1141, 1169, 1244, 1550, and 1552.

10.1.2.3 Deposits with Uncertain Integrity and/or Deeper than Shovel Testing

On the basis of the shovel testing, clearly demonstrating the presence of intact buried deposits could not be done for 191 site management areas. Many of these were shown to contain shallowly buried cultural deposits of possible, but uncertain, significance. Others yielded negative results from the shovel testing but nonetheless had Holocene deposits deeper than the maximum depth of shovel testing. Because the deeper deposits could not be tested adequately by shovel testing, complete assessment of the area was not possible. These 191 management areas are of unknown significance and of unknown eligibility for nomination to the NRHP. We recommend that these areas be avoided. If avoidance is not possible, then formal testing is recommended to determine eligibility.

A tabular summary of these 191 management areas appears in Appendix F and complete site descriptions are presented in Appendix A. Site areas consist of: BL43, 69C, 142A, 148A, 148B, 149, 168B, 181A, 192A, 198B, 339A, 340, 373B, 415A, 415B, 427B, 431, 432, 433, 454, 470, 488A, 489C, 491, 504B, 512, 513A, 531, 532, 538, 564A, 567, 568A, 568B, 581B, 582A, 589B, 595, 597, 615, 627A, 635, 667, 674, 681A, 694, 695, 699B, 711B, 723B, 728A1, 740B, 744, 751A, 754, 755B, 765, 773, 816A, 827, 853C, 886, 888, CV41A, 44, 45A, 46, 47, 48, 50, 70B, 88, 90A, 94A, 94B, 95, 97A, 98, 99, 109A, 118B, 124, 137, 164B, 174B, 271B, 319, 378, 379, 380, 382, 389B, 478A, 481A, 481B, 484B, 493C, 518A, 578A, 582, 587, 595, 667B, 668B, 686, 722, 730B, 755A, 760, 769, 849B, 901, 905AA, 905AB, 913B, 936B, 947, 957B, 960A, 984, 988B, 1007A, 1008A, 1011, 1012B, 1023A, 1023C, 1023D, 1027, 1030, 1038A, 1043A, 1049A, 1050A, 1080, 1085, 1093, 1098, 1099, 1105, 1106, 1116, 1120, 1122A, 1122B, 1133, 1136, 1137B, 1138, 1143A, 1152A, 1152B, 1166A, 1167A, 1167B, 1191, 1194, 1195, 1200B, 1211, 1221A, 1221B, 1222, 1225A, 1269A, 1269B, 1282A, 1283B, 1287A, 1287B, 1287C, 1356A, 1365A, 1375, 1378B, 1400, 1401, 1403, 1410B, 1423B, 1430, 1432A, 1432B, 1441, 1443A, 1549, 1551, 1554, 1555, 1556B, and 1557.

10.2 LRPA SITES

As has been discussed above in Chapters 3.0 and 5.0, the LRPA sites were found to include a variety of contexts. These included not only upland surfaces with no depositional potential, but also depositional contexts such as rockshelters and/or T1 and T0 terraces. Indeed, some LRPA sites consisted exclusively of depositional context areas. Other LRPA sites consisted exclusively of contextless upland surfaces. Most LRPA sites contained a mix of upland surfaces and depositional contexts. Within each site, each landform with differing potential for buried deposits was delineated as a separate geomorphic area using alphabetical suffixes (e.g., 41BL233A). Following the LRPA resurvey of the contextless surfaces, some of the upland geomorphic areas were further subdivided on the basis of integrity and ubiquity of their surface assemblages. These further subdivisions, referred to as management units, were labeled with numeric suffixes (e.g., 41BL233C1).

For the LRPA sites, a total of 281 management units were defined on the basis of geomorphology and differing research potential of the surface assemblage. Most of the LRPA sites (81 of 94) were subdivided into two or more management units, with an average of 3.0 management units defined per site. Only 13 LRPA sites were sufficiently uniform to warrant no subdivision.

10.2.1 Site Management Areas with Potential Stratigraphic Integrity

Shovel testing was conducted on 117 of the management units defined on the LRPA sites. The initial geomorphic reconnaissance determined that these areas had some potential for intact buried deposits, and these areas received a total of 2,949 shovel tests and 47 test pits. The number of tests per area ranged from one test in several small rockshelters or rock features to a maximum of 250 tests on very large alluvial terrace area 41CV1275C5.

10.2.1.1 Deposits Lacking Contextual Integrity

On the basis of shovel testing, 23 of the management units defined on the LRPA sites were demonstrated to have either no buried deposits or deposits which lack contextual integrity. Some of these management units simply lack buried cultural material, or contain an extremely low frequency and/or ubiquity of material. Other management units contain cultural materials in secondary context only (e.g., colluvially redeposited). Still on other LRPA management units, shovel testing showed the entire depth profile to be thoroughly turbated by vehicular traffic as evidenced by excessive surface erosion (visible in cuts and shovel tests), widespread surface rutting, and/or buried military artifacts at depths up to 70 cmbs. These management units are assessed as not significant and are thus not eligible for nomination to the NRHP. No further management is recommended for these management units.

A tabular summary of these 23 management units appears in Appendix F and complete site descriptions are presented in Appendix A. These management units consists of: BL154A, 231C, 233B5, 516BB, 560D5, 844BC, 868B, CV91A, 125B, 397A, 397B, 584B, 1048B, 1165B1, 1206D, 1258C, 1275B2, 1275B3, 1333B, 1333C, 1348A, 1348B, and 1391A.

10.2.1.2 Clearly Intact Deposits

Shovel testing demonstrates that eight of the management units defined on the LRPA sites contain clearly intact cultural deposits. These units consist exclusively of pristine rock mound features on upland surfaces or rockshelters with undisturbed buried deposits and/or human remains. These management units are assessed as significant and eligible for nomination to the NRHP. We recommend these management units for immediate avoidance, protection, and preservation. If avoidance and protection is not an option, then adverse impacts to these areas, including ongoing military activity and the threat of vandalism, should be mitigated to avoid loss of significant scientific information.

A tabular summary of these eight management units appears in Appendix F and complete descriptions are presented in Appendix A. These management units consist of: BL554B1, 554B2, 608A1, CV53C1, 53C2, 408B, 594-1, and 1092A1.

10.2.1.3 Deposits with Uncertain Integrity and/or Deeper than Shovel Testing

On the basis of shovel testing, 86 of the management units defined on LRPA sites were shown to contain shallowly buried cultural deposits of possible, but not demonstrated, significance, and/or Holocene deposits deeper than the maximum depth of shovel testing. These management units are of unknown significance and of unknown eligibility for nomination to the NRHP. We recommend that these management units be avoided. If avoidance is not possible, then formal testing is recommended to determine eligibility.

A tabular summary of these 86 management units appears in Appendix F and complete site descriptions are presented in Appendix A. These management units are: BL154B, 154C, 155B, 208B, 231B, 231D, 233B4, 233C1, 233C2, 233C3, 516BA, 560C1, 560C2, 560C3, 579B, 598DB, 598DD, 600B, 608B, 788B, 834B2, 834B3, 844BA, 844BB, 844BD, 850C, CV71B, 93B, 115B3, 117C, 125A2, 125A3, 125C, 201A, 240B, 240C, 317A, 332B, 394B, 397C, 403B, 403C, 495B, 506B, 601B1, 669B, 900B, 900C, 903A3, 903B4, 903B5, 918B, 927B, 935B, 944C1, 944C2, 1033B, 1048C, 1092A2, 1129B, 1129C, 1165B2, 1186B, 1186C, 1206C, 1219B, 1250B, 1258B, 1275B7, 1275C4, 1275C5, 1286B, 1286C, 1308B, 1310B, 1310C, 1329B3, 1329B4, 1329B5, 1329B6, 1330B3, 1346B, 1348D, 1354B, 1359A, and 1391B.

10.2.2 Site Management Areas Lacking Stratigraphic Integrity

LRPA evaluation procedures were conducted on 164 LRPA management units which the initial geomorphic reconnaissance had determined to have no potential for intact buried deposits. As discussed in detail in Chapter 5.0, these LRPA evaluation procedures consisted of a stepwise process of (1) mapping and describing zones of naturally occurring chert; (2) mapping and assessing zones of surface impacts; (3) systematic surface resurvey of those zones having both naturally occurring chert *and* less than 50 percent surface damage; and (4) statistically estimating the probability of ubiquitous chert artifacts across the surface of the management unit.

10.2.2.1 Damaged, Low Ubiquity, or Missing Lithic Assemblage

Of the 164 LRPA management units with no potential for buried deposits, 113 were demonstrated to lack significant data for lithic-procurement issues. Many of these management units, although located on upland landforms, simply lack any naturally occurring chert source. Other management units were determined to have assemblages with unacceptably high proportions of damaged lithics, as evidenced by widespread vehicular impacts to more than 50 percent of the site surface. Other management units with both naturally occurring chert and low damage levels nonetheless contain very low ubiquities of surface lithics, even taking variable surface visibility into account. The cultural material present at these management units is judged to be too thinly distributed and/or too heavily damaged to provide useful data for lithic-procurement issues. These management units are therefore judged to be insignificant and ineligible for NRHP nomination. We therefore recommend no further management of these units.

A tabular summary of these 113 management units appears in Appendix F and complete site descriptions are presented in Appendix A. These management units consists of: BL154D, 155A1, 155A3, 155A5, 179, 187A1, 208A4, 208A6, 208A8, 231A, 232A, 232B, 233A, 457, 463-2, 466, 467-3, 502A, 502B, 514-2, 516A3, 554A3, 560A5, 560B5, 579A, 598A, 598B, 598C, 599, 600A3, 608A6, 787A3, 834A4, 844A3, 850A, 850B, 868A2, 1039A, CV53A4, 53B, 71A, 73, 78, 91B2, 93A, 114-1, 115A1, 117A, 117B, 125A4, 136, 201B, 240A, 317B, 332A, 337-1, 337-2, 337-3, 394A1, 403A6, 408A, 495A, 506A4, 506A5, 584A, 594-2, 601A2, 603, 669A, 900A, 918A, 927A, 935A, 944A, 944B, 955-1, 955-3, 958-1, 958-2, 1026, 1033A, 1048A, 1092A3, 1101-2, 1101-3, 1129A, 1165A, 1172-2, 1186A1, 1186A2, 1206A, 1206B, 1219A, 1242, 1246, 1250A, 1258A, 1275A6, 1286A, 1308A, 1310A, 1329A1, 1329A2, 1329A7, 1330A1, 1333A, 1342, 1346A, 1348C, 1354A, 1359B, 1422-2, and 1422-3.

10.2.2.2 High Surface Artifact Ubiquity

Eight of the LRPA management units were demonstrated to contain significant data for lithic-procurement issues. All of these management units contain one or more naturally occurring chert sources and have surface assemblages which are not seriously damaged by vehicular traffic. Further, the resurvey demonstrated these management units to contain exceptionally high ubiquities of surface lithics. The assemblages in these units have significant potential to address lithic-procurement issues. Accordingly, these site areas are assessed as significant and eligible for nomination to the NRHP. We recommend these areas for immediate avoidance, protection, and preservation. If avoidance/protection is not an option, then adverse impacts, including ongoing military activity, should be mitigated to avoid loss of significant scientific information. In the event that mitigation eventually is necessary, we further recommend that mitigation be planned according to the state of ongoing development of lithic-procurement research at Fort Hood in order to avoid amassing unnecessarily redundant data.

A tabular summary of these eight management units appears in Appendix F and complete site descriptions are presented in Appendix A. These management units consist of: BL467-1, 467-2, 514-1, 788A, CV394A2, 403A4, 903A1, and 903A2.

10.2.2.3 Substantial but Uncertain Surface Artifact Ubiquity

On 43 of the management units defined on the LRPA sites, a clear determination of assemblage utility could not be achieved on the basis of the resurvey. All of these units are situated within a naturally occurring chert zone, none had surface damage more than about 75 percent, and all were resurveyed. The resulting resurvey data is suggestive, but not conclusive, of an assemblage with potential to provide data relevant to questions of lithic-procurement behavior. In general, these management units have widespread poor surface visibility due to organic surface detritus, and the artifacts which were observed during the resurvey were not ubiquitous enough to extrapolate to the obscured portions. These management units are of unknown significance and of unknown eligibility for nomination to the NRHP. We recommend that these units be avoided. If avoidance is not an option, then these units should be formally tested to determine their eligibility. Because these sites by definition lack any stratigraphic context, testing may involve collection and recording of multiple attributes of a large sample of surface lithics, accompanied by various laboratory assays. Such testing would very possibly require a total effort comparable to a data recovery mitigation.

A tabular summary of these 43 management units appears in Appendix F and complete site descriptions are presented in Appendix A. These management units consist of: BL155A2, 155A4, 187A2, 208A2, 208A3, 208A5, 208A7, 463-1, 516A2, 560A4, 598E, 600A2, 608A2, 608A3, 608A4, 786, 787A2, 787B1, 787B2, 834A1, 844A1, 844A2, 868A1, 1039B, CV53A3, 91B1, 114-2, 114-3, 115A2, 403A2, 403A3, 403A5, 506A2, 506A3, 601A3, 955-2, 958-3, 1101-1, 1172-1, 1186A3, 1275A1, 1330A2, and 1422-1.

10.3 SUMMARY AND CONCLUSIONS

The 571 contractually issued sites were subdivided on the basis of geomorphology and differing data potential into 897 management areas. The final significance assessments and management recommendations for the 897 areas are summarized in Table 10.3 and are tabulated in Appendix F. Because the individual management areas which have been defined within any given trinomial site differ considerably in their research potential, each minimally defined management area should be treated and managed as if it were an independent site.

A majority of site management areas were determined to lack significant data which could be used to address important research issues. These 529 management areas include 112 areas in depositional contexts (regardless of LRPA status) and 417 areas in upland nondepositional contexts. All of these areas are evaluated as not eligible for inclusion in the NRHP and are recommended for no further management.

A small fraction of site management areas were determined to contain significant data which could be used to address important research issues. These 35 management areas include 25 areas in depositional contexts (regardless of LRPA status) and 10 areas in upland nondepositional contexts. These management areas are evaluated as eligible for inclusion in the NRHP and are recommended for immediate avoidance and protection.

Two site management areas were not evaluated because of incorrect locational data or access problems. It is currently unknown whether or not these site units contain significant data which could be used to address important research issues. These site units are evaluated as being of undetermined eligibility for inclusion in the NRHP; these site units should be located, evaluated, and/or deleted as appropriate.

The remaining 331 site management areas could not be fully evaluated using the reconnaissance, shovel testing, and resurvey tactics. These 331 areas include 277 areas in depositional contexts (regardless of LRPA status) and 54 areas in upland nondepositional contexts. It is currently unknown whether or not any of these site areas contain significant data which could be used to address important research issues.

These areas are evaluated as being of undetermined eligibility for nomination to the NRHP and avoidance is recommended for all of these management areas. If avoidance is not possible, then these areas should be formally tested.

Table 10.3 Frequencies of Site Management Units, by NRHP Eligibility Determination and LRP Status.

Status	SHOVEL TESTED?	RE-SURVEYED?	NRHP Eligibility				Total
			Not Eligible	Eligible	Unknown	Other	
Non-LRPA	NO	NO	304	2	11	2	319
	YES	NO	89	17	191	0	297
LRPA	NO	YES	113	8	43	0	164
	YES	NO	23	8	86	0	117
Total	--	--	529	35	331	2	897
Percentage	--	--	59.0%	3.9%	36.9	0.2%	100%

11.0 PROGRAMMATIC RECOMMENDATIONS

James T. Abbott and G. Lain Ellis

Over the course of examining sites for a variety of archeological and geoarcheological evidence and after thousands of shovel tests, Mariah personnel have acquired an intimate familiarity with the archeological resources at Fort Hood. We would be remiss in our duty to the resources and to the Fort Hood CRM program if we did not offer some general suggestions about how to proceed from here. This chapter, therefore, offers a series of programmatic recommendations which we believe would be part of a happy marriage between compliance and science at the base. The recommendations which follow are not exhaustive, but they do address some of the more difficult issues that face Fort Hood.

Section 11.1 discusses issues related to the successful management and scientific exploitation of LRPAs. Pursuing lithic-procurement research and clearing significant and potentially significant LRPAs from protected inventory is likely to be effective only if guided a long-term vision that integrates fundamental research into the nature of chert resources, research at small sites, and research at LRPAs.

Sections 11.2 and 11.3 discuss the issues that pertain to Paluxy sites and rockshelters, respectively. These kinds of sites each appear have unique data potential, which implies that they should be subject to specialized research aims. Furthermore, each is subject to specific forms of degradation that impose different kinds of management requirements.

The final two sections discuss research directions that can help Fort Hood address some of the fundamental research issues that underpin the cultural-ecology focus of the research design. Section 11.4 addresses directions for additional research into the use land snails for chronometric and site-formation purposes. This additional research, if successful, would provide a robust data base with which to resolve paleoenvironmental and paleoclimatic problems. Section 11.5 addresses directions for additional geomorphic research. Although substantial progress is being made in this regard, additional base-line and site-specific data are needed.

11.1 RECOMMENDATIONS FOR LITHIC RESOURCE PROCUREMENT AREAS

Fort Hood's location in a chert-rich area automatically makes it a prime location for studying the place of lithic procurement in the adaptations of Central Texas groups and for studying chert-procurement as a general archeological phenomenon. However, the effective management and scientific use of LRPAs are interrelated and should be pursued as systematically as possible under constraints imposed by land-use needs and funding availability. The following is a discussion of (1) research streams that should be pursued to increase the effectiveness of recovery and interpretation of LRPA data, and (2) management concerns that affect significance judgements under Fort Hood's current HPP.

11.1.1 Lithic Resource Procurement Research

Research relevant to providing a sound basis for scientific exploitation of LRPAs falls into three broad categories: chert distribution, chert characterization, and patterns of procurement and use of chert. The first two categories are points of departure from which to pursue the third more rigorously and effectively.

11.1.1.1 Chert Distribution

The geographic distribution of chert resources described in Chapter 6.0 is provisional at best. As suggested in Section 9.1, this is a major limitation on assessing the degree to which lithic production and tool use are concentrated near the raw material source. At a minimum, it would be extremely useful to determine where individual chert types crop out or occur as lags. It is especially important to begin to fill in the largely undocumented gap in the west-central portion of the base, and it would be helpful to extend the documentation at least a short distance into the live-fire area. From this information, it would be possible to map chert diversity for any given area on the reservation and to provide initial models of the chert types that can be expected in the bed loads of streams that originate within fort boundaries. It also would be useful to identify the chert content of other streams at points where they enter the base in order to assemble an initial model of the extent to which on-base chert resources may be supplemented by materials that originate off base. This research would directly address fundamental questions and research hypotheses posed in Sections 5.1.4.3, 5.2.1.4, and 5.2.2.4 of the research design for Fort Hood (Ellis 1994b).

11.1.1.2 Chert Characterization

Chert characterization is essential for the successful identification of chert types and, therefore, identifying the locations from which raw materials were obtained. The current chert typology (Chapter 6.0 and Appendix C) is based on attributes that provide a means for visual identification. This typology is an initial approximation that (1) is virtually certain to be incomplete for chert sources that outcrop within Fort Hood's boundaries and (2) is unlikely to adequately characterize the range of variability subsumed within some of the types. Furthermore, even within some of the known ranges of variability, there can be substantial overlap of diagnostic traits, especially color. To increase the reliability and, hence, scientific value of chert-source data, the following research directions should be pursued:

(1) Frederick's visual typology should be refined by identifying the range of variability evident from a series of sampling locales for each type. A well-documented, relatively large reference collection should be developed. Studies should be performed to determine the extent to which (a) analysts can consistently correctly identify individual cherts and (b) different analysts produce comparable results. Incorporating these activities into Fort Hood's long-term development of its laboratory and curation facilities would provide an ideal institutional resource for ensuring long-term continuity in lithic-procurement research.

(2) Neutron activation analysis (NAA) and fluorescence studies should be pursued as systematically as possible. These procedures are frequently touted as techniques that can improve the reliability of source identifications. Although there are good reasons to believe that these techniques (especially NAA) can be used effectively (see Section 3.3 above), it remains to be seen how well they can be applied with respect to differentiating between visually similar materials. If one or both of these techniques can be used to reduce the number of erroneous or ambiguous identifications, they could be used to supplement visual typological data. Studies of the application of quantified fluorescence measurements would be especially useful for determining the extent to which fluorescent response is a reliable indicator of chert source because the technique is easy to apply. Results from NAA and fluorescence studies would establish the scientific and fiscal limits within which the techniques are viable characterization tools. This includes determining whether they have (a) no applications that cannot be achieved by other means, or (b) limited but important applications that cannot otherwise be achieved. In the event that both techniques are useful, the extent to which they are reliably interchangeable also should be explored.

(3) Patination research and fluorescence studies should be pursued as a means of determining the relative or absolute ages of artifacts. If successful, such studies could provide a substantial increase in the capacity to reliably

interpret lithic-procurement data from contextless proveniences (see Section 3.3). The results of such studies would establish the scientific and fiscal limits within which the techniques can be used or, perhaps, eliminate them as viable alternatives. Given relatively low costs of necessary equipment, ease of use, and potentially broad applicability, incorporating fluorescence studies into the long-term development of Fort Hood's laboratory and curation program would be highly desirable.

(4) Additional workability studies should be performed. Ringstaff's study (Section 6.4) should be augmented by more extensive explorations of the responses of various raw materials to heat treatment. It also should be backed up by blind tests in which a series of experienced knappers assess the workability of various materials without knowing the materials' sources or degree of heat treatment. Experimental studies on the performance properties of various materials also should be performed to provide a baseline understanding of the possible impact that quality may have had on selection of particular materials for particular kinds of tools. As a side benefit, the performance property studies would produce a reference collection for studying use wear.

11.1.1.3 Chert Procurement and Use

It is standard practice in Central Texas archeology to note that hunter-gatherers here were "highly mobile." However, to claim (probably correctly) that they were highly mobile is not to say anything about the size of the area within which they were mobile at any given time. If the general pattern of chert movement described in Section 9.1 is basically correct, "highly mobile" in the Fort Hood area may mean "highly mobile in relatively small areas at any given time." Indeed, the lithic assemblage left by occupants of Fort Hood is probably the most powerful single basis on which to model mobility. Accordingly, the development of historic contexts for lithic-procurement research should be a high priority in CRM activities based on the Fort Hood research design (Ellis et al. 1994). The hypotheses listed in section 9.1.3 are a starting point for the development of more specific and, hence, more resolvable research issues. These hypotheses should be treated, for the time being, as background conditions within which to pursue technological analyses according to the inferential structure contained in the research design (Ellis 1994a, 1994b).

11.1.2 Identifying Redundancy in the LRPA Inventory

The primary difficulty that currently complicates the management of LRPAs is the issue of assessing redundancy in the inventory of significant and potentially significant management units that have been identified within the boundaries of functional LRPA sites. Out of the 730 ha (2.8 m^2) of contextless LRPA surfaces that have been recommended for protection or testing, at least some must be unnecessary. Unfortunately, as things now stand, so little is known about lithic-procurement behavior that there is no legitimate basis for determining whether or not any particular management unit is redundant. However, it is possible to specify the conditions that ultimately will influence identification of redundancy. These conditions reflect the dimensions along which LRPAs must be stratified to ensure that the inventory of significant management units is representative. Ultimately, the inventory of protected LRPAs should include management units that represent the local resource base.

(1) Outcrops of all local cherts should be represented in a *minimum* of at least one unit if it is possible. For more extensive outcrops (e.g., Fort Hood Yellow, Anderson Mountain Gray), it would be useful to have several widely spaced units on protected inventory in order to accommodate the possibility that procurement of a particular chert type was affected by the nature of nearby activities.

(2) Natural diversity of chert types should be represented. Some areas of the base (e.g., the zone between the North and South East Range provinces), appear to have very diverse chert resources, whereas others (e.g., near Seven Mile Mountain) do not (Chapter 6.0 and Section 9.1). Since diversity of chert type is partly accompanied by diversity of workability, LRPAs with different arrays of chert can provide laboratories to explore the extent to which chert procurement was influenced by workability or performance properties.

(3) Natural diversity of chert density should be represented at two levels: density of chert within a given outcrop, and density of the outcrops themselves. Some outcrops on the reservation have relatively dense pavements of chert materials on the surface, whereas others are fairly patchy. Furthermore, some outcrops are laterally extensive, while others may be spatially restricted to features such as geographically isolated Manning Surface remnants. Since the density and spatial extent of occurrence of chert affect access to suitable materials within and among outcrops, density and spatial extent also establish what may be regarded as the "effective availability" of raw materials for any particular tool-production goal. Thus, distance between LRPAs may be an important variable affecting redundancy.

Given that 54 significant and potentially significant LRPA management units are distributed widely in the maneuver areas around the live-fire zone, it is possible that a relatively small number of units ultimately will be able to supply an appropriate representative sample.

11.1.3 A Systematic Approach to Long-Term LRPA Management

As noted in Chapter 5.0, significance testing at LRPAs is a task that is nearly as complex and large as actually mitigating them because the degree of coverage and data analysis must be substantial even at very low sampling rates. Furthermore, the value of LRPA data depends on the specificity of the problems and hypotheses to be addressed at any given LRPA site. This entails that treating LRPA management units as stand-alone entities divorced from questions and issues in the larger research context will not be effective. Hence, it is useful to discuss ways in which to integrate LRPA management into a framework of wider CRM and scientific goals. The following discussion acknowledges the high likelihood that specific CRM activities will be driven by the need to address land-use concerns rather than by scientific needs. As a result, the recommendations are offered as suggestions to be followed when circumstances permit.

(1) Testing and/or mitigation of an LRPA management unit should serve as a follow up to data recovery from nearby stratified contexts, including such contexts in stratified management units at the same site. It would be especially useful if, given the option, a data recovery program at stratified sites could emphasize those with multicomponent deposits from a wide range of time periods so that testing and/or mitigation at LRPA management units could focus on identifying specific kinds of lithic-procurement data relevant to a broad span of time. Postponing formal eligibility testing of contextless LRPA units until a need for potential mitigation is imminent may allow testing to be at least partly focused on specific data needs if research at other sites has revealed a need for specific classes of data from specific chert sources.

(2) It would be useful to classify the inventory of significant or potentially significant LRPAs with respect to their spatial relationships to significant or potentially significant stratified sites. This information could be used to target CRM activities at LRPAs on the basis of their potential relevance to data that accumulates from previously excavated stratified sites. Furthermore, since sorting out chert-procurement patterns is largely a matter of the distance between particular classes of lithic

artifacts and the location of the raw material, conscious attention to spatial relations between LRPAs and stratified sites may provide an additional scientifically important basis for assigning CRM priorities to the stratified sites.

(3) To the extent that land-use needs permit, it would be useful to postpone identification of redundancy at LRPAs as long as possible. The relative significance of any given LRPA may change according to the distribution of data recovery activities at stratified sites and developments in chert research. Identifying redundant LRPAs on more or less a priori grounds would provide no reliable guarantee that the LRPAs which end up on protected inventory are the ones most relevant to ongoing research developments and eventual data needs.

(4) The state of development of lithic-procurement research should be critically reviewed on a periodic basis, perhaps in conjunction with periodic renegotiation of the HPP. A major element of the review should be to assess how well lithic-procurement behavior has been modeled for various time periods in various parts of the reservation. This review process would identify current data gaps and, as time passes, would provide a framework for reevaluating the current and ongoing significance of sites on protected inventory.

(5) Lithic-procurement research should be pursued at small sites in conjunction with mitigative data recovery programs. Many small stratified sites currently recommended for testing or protection are located in or immediately adjacent to chert sources. These sites can be expected to contain evidence of chert-procurement activities. In some cases, contextless subareas adjacent to these stratified management areas may contain lithic-procurement evidence that can affect the reliability of interpretations from stratified assemblages. As such, the contextless subareas would be amenable to opportunistic, small-scale sampling and analysis of discrete knapping events. However, because of relatively small size, they would not be amenable to large-scale sampling and analysis for aggregate procurement behavior. Therefore, they would not be subject to protection as data bases significant in their own right according to LRPA-specific standards (Chapter 5.0).

Thus, whenever practical, mitigative data recovery at small sites should be accompanied by opportunistic data collection on adjacent contextless surfaces. This would simply be a special case of the standard archeological practice of examining sites in relation to their surroundings. These efforts could provide incremental growth in knowledge of basic patterns of lithic-procurement behavior. As a long-term side benefit, such research at small sites *could effectively negate the significance* of at least some LRPA management units, depending on the state of development of lithic-procurement research. For example, if research at a series of closely spaced small sites yields clear patterns of procurement behavior for a specific array of cherts in a specific area of the reservation, artifact assemblages at a nearby LRPA management unit might have nothing new to add to lithic-procurement models.

(6) Although it would be useful to have a detailed understanding of chert resources at Fort Hood from the outset of serious research, such is not now the case. Since site-evaluation activities to complete the inventory process and maintain Section 106 compliance have a very high priority for funding, chert research may be forced into relatively low-priority categories. Since the various aspects of chert research (Section 11.1.1) have different start-up costs and varying prospects for more or less immediate application, they should be prioritized. An additional issue is whether to pursue chert-related research as large-scale projects or to rely on incremental advancements accumulated during the course of ongoing CRM activities.

(a) The highest priorities should be assigned to fleshing out the chert typology and further documenting the distribution of chert resources because this information can be obtained at relatively low cost and can be used more or less immediately with reasonable reliability for partial characterization of lithic assemblages. Large-scale studies would be desirable because they would lead directly to resolution of fundamental issues in the research design for Fort Hood. However, if large-scale projects cannot be implemented, then chert research should be implemented in an incremental approach guided by long-term vision, planning, and commitment. Such an approach could be effective if applied patiently, consistently, and systematically during the course of other CRM activities.

(b) Feasibility studies of chert fluorescence and NAA techniques should be implemented at the earliest practical opportunity. Quantitative fluorescence studies should be given a relatively high priority. Because fluorescence involves relatively inexpensive and easy-to-use equipment, successful development of this technique would provide a cost-effective means for characterizing and, perhaps, dating chert artifacts. If the technique is effective, it would have a fairly high likelihood of widespread use outside of Fort Hood. Fluorescence and NAA feasibility studies would require substantial, although not enormous, initial investments, after which continued advances could be achieved at incremental rates if large-scale development and application projects cannot be funded. If such an approach must be taken, it would be desirable to plan for the eventual implementation of systematic research on cumulative Fort Hood collections. Such activities could substantially advance results achieved in several domains of the research design by acquiring new data and performing new analyses without the expense of new field work.

11.2 RECOMMENDATIONS FOR PALUXY SITES

As has been detailed in Section 9.5, relatively consistent archeological observations made at a number of sites situated on the Paluxy sand substrate suggest that most of these sites probably represent a different type of resource exploitation strategy than that represented by sites in other environments on the base. Our data suggests that the Paluxy substrate was preferentially selected as an activity locus in the uplands, and that some unknown subsistence activity was conducted that resulted in significant burned rock accumulation without the concomitant accumulation of other types of artifactual material (e.g., lithic debitage and tools, bone) typical of the classic Central Texas midden. At present, this observation remains informal, but it is amenable to formal testing within the constraints of a broader program of site evaluation. Several different hypotheses to explain the selection of the Paluxy substrate were presented previously (see Section 9.5); many more can probably be formulated.

In order to address these types of questions, a number of generalized data requirements can be outlined:

(1) Better microenvironmental data is needed for the Paluxy sites and for other upland and terrace sites. In particular, comparative biotic inventories of the modern Paluxy substrate and surrounding calcareous substrates may give an indication of the types of resources with differing availability. Testing and mitigation of sites situated on the Paluxy substrate should include an aggressive program for

paleobotanical and microfaunal retrieval, particularly in and around features, to aid in the recovery of economic and localized paleoenvironmental data.

(2) Controlled block excavations to determine the structure and comparability of activity loci within the Paluxy environment, and comparative information from similar data recovery efforts in other contexts, are necessary both to confirm the uniqueness of the Paluxy environment sites and to gain insight into their form and function.

(3) Temporal data is needed to provide intersite comparability and to determine how the sites may have fit into a broader adaptive pattern.

(4) Better information on the overall distribution of the substrate and of internal variability of soil development and preservation is needed to predict the distribution of potential resources and of hitherto unidentified sites.

(5) Relatively detailed geoarcheological information is needed to clarify site formation processes and to address the apparent discrepancy between the apparent age of the classic Paluxy soil and the timing of widespread episodes of upland soil loss (see Section 9.5).

Management considerations for the Paluxy sites should focus on preservation; data recovery efforts should concentrate on those sites experiencing active impacts. The Paluxy soils are highly prone to sheetwash and gullying, and tracked vehicles are capable of initiating severe degradation both by mixing the matrix and the subsequent natural erosion of disturbed areas. Due to the low density of flaked stone tools, vandalism is probably not a serious concern.

11.3 RECOMMENDATIONS FOR ROCKSHELTERS

As detailed in Section 9.6, the rockshelter sites on Fort Hood represent a tremendously valuable segment of the overall resource base. Unfortunately, the vast majority of the shelters have already suffered considerable damage by looters. As a result of their typically high artifact concentration, frequently isolated location, and relatively easy excavation, rockshelters represent a particularly attractive target to relic hunters, who can totally destroy the context of deposits in a matter of hours. Thus, rockshelters pose a particularly troublesome management problem. It is our opinion that no protection measures short of building a sturdy locked cage or posting a round-the-clock guard at each of the shelters can dissuade determined looters from continued destruction of the resource. Therefore, we recommend that those shelters still deemed to have remaining potential be given a high priority for mitigation.

Despite a long history of archeological investigation, relatively little is known about the cultural ecology of rockshelters in Central Texas or how the rockshelters fit in to the overall sequence of landscape evolution (see Section 9.6 above). Nevertheless, rockshelter investigations have the potential to shed considerable light on a number of archeological and paleoenvironmental research concerns. The primary requirement necessary to address these question is the need for detailed analysis of rockshelter formation processes and developmental history at a number of different shelters. Reconnaissance evaluation by Mariah geomorphologists suggests that at least five distinct types of shelter fill, including both internally and externally derived sediments, can be distinguished in the shelters on Fort Hood. This suggests that a suite of processes is responsible for rockshelter evolution, and that the magnitude and timing of different types of processes vary between individual shelters.

Previous investigators have noted that rockshelter occupation on Fort Hood and in the rest of Central

Texas appears to increase dramatically during the Late Prehistoric (Thomas 1978; Prewitt 1981; Shafer 1977). We feel that this conclusion is premature; more data is necessary to determine whether the higher incidence of recovered remains reflects a real shift in cultural preference or a geomorphic bias imposed by the rate of shelter evolution.

Generalized data requirements to address these questions include:

(1) Investigation of the character and origin of sediments filling the shelter, including types of sedimentation occurring in both cultural and culturally sterile strata. Episodes of roof fall should be identified, and investigations should be expanded to include external areas that may represent previous stages of shelter evolution. Lines of investigation should include macromorphologic, micromorphologic, and chemical analyses.

(2) Depositional chronology of sediments, both in cultural and noncultural strata.

(3) Investigation of the timing and context of indicators of groundwater discharge, including gleyed sediments and tufa or travertine. Lines of investigation may include identification of stratigraphic context; collection and analysis of radiometric data to bracket the age of activity if this is not possible on stratigraphic grounds; and collection and analysis of oxygen isotope data to address trends in paleotemperature.

(4) Aggressive paleobotanical retrieval, both from unconsolidated and chemically precipitated sediments.

11.4 RECOMMENDATIONS FOR FURTHER LAND SNAIL STUDIES

Results presented in Chapter 7.0 and Section 8.5.2 strongly imply that using amino acid epimerization and radiocarbon techniques on land snail shells can provide additional means for chronometric dating and for assessing the integrity of archeological deposits. The epimerization results are especially encouraging because this technique is extremely cost-effective relative to radiocarbon dating. However, the results are preliminary and several sources of uncertainty must be resolved before the techniques can be regarded as chronometric tools with demonstrated reliability at known levels of precision. The following tasks should be pursued to enable Fort Hood to take advantage of these promising techniques.

(1) Variability of age anomaly on *Rabdotus* should be quantified so that the level of precision of radiocarbon assays can be established. Quantifying age anomaly is a prerequisite to using both radiocarbon and epimerization for chronometric purposes. This research can be performed with snails collected live before 1950. It also can be performed on snails from archeological contexts. For example, five snails from site 41CV1200 have virtually identical A/I ratios. If variability of age anomaly is small, radiocarbon assays on these snails should not be significantly different. Note that even if variability is not small, radiocarbon assays can still be used with known levels of precision. Since many sites do not have datable charcoal, this would constitute a major improvement in the ability to date sites.

(2) Further work should be done to calibrate A/I ratios to the radiocarbon scale. The current calibration is at best an initial approximation because it is possible (even likely) that fire affected some of the shells from which A/I ratios were obtained. Thus, although the strength of the regression implies that the calibration is reasonably accurate, it cannot be relied on in cases where known accuracy is necessary. Furthermore, no basis yet exists for determining the precision of the calibration. Hence, the standard error that accompanies A/I dates is not known. Additional calibration work also would provide a means for quantifying any additional error factors that

must be included when using A/I ratios for site-formation studies. The calibration should be developed using radiocarbon dates from snails for which A/I ratios are available and radiocarbon dates from charcoal stratigraphically associated with snails. As the calibration for *Rabdotus* is developed, other snails (e.g., *Helicina*) should be calibrated to *Rabdotus* by using inexpensive controlled heating experiments.

(3) As calibration efforts proceed, additional paleoclimatic and paleoenvironmental research should be pursued. Because A/I ratios are temperature dependent, a stratigraphic column of snails shells will contain a record of temperature change. Using a well-calibrated A/I scale, it is practical to determine the timing and magnitude of temperature change. As a result, it is possible to directly test hypotheses about the timing and magnitude of the Altithermal if it involved temperature change of as little as 2°C. Carbon and oxygen isotope assays on snail shells can provide additional data relevant to local vegetational change and change in the pattern of sources of precipitation. Therefore, a well-calibrated A/I scale establishes a basis for correlating paleoenvironmental and climatic data directly with a chronometric scale instead of relying on stratigraphic associations with dates from other materials. Thus, a major effort to develop epimerization as a chronometric tool also could contribute substantially to resolution of fundamental research issues in the Fort Hood research design.

11.5 RECOMMENDATIONS FOR GEOMORPHOLOGY

As discussed in Chapter 2.0, although much is known about geomorphic processes and historical landscape evolution on Fort Hood, much more remains to be investigated. At this point, most of the larger streams on the fort have been studied in relative detail, and a broad interpretive model is in place for alluvial deposits in these contexts (Nordt 1992; 1993b). Geomorphic studies have also contributed to broader paleoenvironmental questions (Nordt 1993a; Nordt et al. 1994).

Subsequent geomorphic investigations should be of two basic types:

(1) Additional baseline geomorphic studies. Avenues of particular interest include the historical alluvial sequence of smaller tributaries, particularly on the margins of the Manning surface; the timing, magnitude, and distribution of late Quaternary colluvial episodes in various contexts; and the distribution and availability of chert resources.

(2) Geoarcheological investigations conducted in tandem with testing and mitigation of individual sites. These studies are essential to aid in interpretation of site context and preservation, provide site-specific paleoenvironmental and paleoeconomic data, and refine the broader models.

12.0 REFERENCES CITED

Advisory Council on Historic Preservation
1980 *Treatment of Archaeological Properties: A Handbook.* United States Government Printing Office, Washington, D. C.

Ahler, Stanley A.
1972 Mass Analysis of Flaking Debris. Paper presented at the 30th Annual Plains Anthropological Conference.

1991 U.V. Fluorescence as a Relative Age Indicator in Knife River Flint Artifacts. Paper presented at the 49th Plains Anthropological Conference.

Alexander, H. L.
1963 The Levi Site: A Paleo-Indian Campsite in Central Texas. *American Antiquity* 28(4):510-528.

Allred, B. W., and Homer C. Mitchell
1955 Major Plant Types of Arkansas, Louisiana, Oklahoma and Texas and Their Relation to Climate. *Texas Journal of Science* 7:7-19.

Altschul, Jeffrey H.
1990 Red Flag Models: The Use of Modeling in Management Contexts. In *Interpreting Space: GIS and Archaeology,* edited by K. M. Allen, S. W. Green, and E. B. W. Zubrow, pp. 226-238. Taylor & Francis, London.

Anderson, James N.
1973 Ecological Anthropology and Anthropological Ecology. In *Handbook of Social and Cultural Anthropology*, edited by J. J. Honigmann, pp. 179-239. Rand McNally, Chicago.

Anthropological Conference, Lincoln, Nebraska.
1986 *The Knife River Flint Quarries: Excavations at Site 31DU508.* State Historical Society of North Dakota, Bismarck.

Ashmore, P. E.
1991 How Do Gravel-Bed Rivers Braid? *Canadian Journal of Earth Sciences* 28:326-341.

Aynesworth, K. H.
1936 Biographic Studies of 21 Skulls of the Central Texas Indians. *Bulletin of the Central Texas Archeological Society* 2:30-35.

Bamforth, Douglas B.
1986 Technological Efficiency and Tool Curation. *American Antiquity* 51:38-50.

Bandy, P., S. A. Skinner, A. Faust, T. Turner, and B. Yates
1981 Archaeological Excavations at Yellow Jacket Shelter, Comanche County, Texas. Dallas: Environmental Consultants Inc. 132 p.

Banks, Larry D.

1990 *From Mountain Peaks to Alligator Stomachs: A Review of Lithic Resources in the Trans-Mississippi South, the Southern Plains and Adjacent Southwest.* Oklahoma Anthropological Society, Memoir 4, Oklahoma City.

Barnes, Virgil E.

1970 *Geologic Atlas of Texas, Waco Sheet.* Bureau of Economic Geology, University of Texas at Austin.

1976 *Geologic Atlas of Texas: Brownwood Sheet.* Bureau of Economic Geology, University of Texas at Austin.

Barnes, V. E. (editor)

1972a *Geologic Atlas of Texas, Abilene Sheet*, 1:250,000. University of Texas at Austin.

1972b *Geologic Atlas of Texas, Dallas Sheet*, 1:250,000. University of Texas at Austin.

1974a *Geologic Atlas of Texas, Big Spring Sheet*, 1:250,000. University of Texas at Austin.

1974b *Geologic Atlas of Texas, Austin Sheet*, 1:250,000. University of Texas at Austin.

1975a *Geologic Atlas of Texas, Pecos Sheet*, 1:250,000. University of Texas at Austin.

1975b *Geologic Atlas of Texas, San Angelo Sheet*, 1:250,000. University of Texas at Austin.

1976a *Geologic Atlas of Texas, Hobbs Sheet*, 1:250,000. University of Texas at Austin.

1977 *Geologic Atlas of Texas, Del Rio Sheet*, 1:250,000. University of Texas at Austin.

1979a *Geologic Atlas of Texas, Emory Peak-Presidio Sheet*, 1:250,000. University of Texas at Austin.

1979b *Geologic Atlas of Texas, Seguin Sheet,* Second Printing, revised, 1:250,000. University of Texas at Austin.

1981a *Geologic Atlas of Texas, Sonora Sheet*, 1:250,000. University of Texas at Austin.

1981b *Geologic Atlas of Texas, Llano Sheet*, 1:250,000. University of Texas at Austin.

1982a *Geologic Atlas of Texas, Fort Stockton Sheet*, 1:250,000. University of Texas at Austin.

1982b *Geologic Atlas of Texas, San Antonio Sheet*, 1:250,000. University of Texas at Austin.

1990 *Geologic Atlas of Texas, Waco Sheet*, Third Printing, revised, 1:250,000. University of Texas at Austin.

Barrett, Richard A.

1987 *Culture and Conduct: An Excursion in Anthropology.* Wadsworth, Belmont, California.

Bateson, Gregory
1972 *Steps to an Ecology of Mind.* Ballantine, New York.

Beardsley, R. K., P. Holder, A. Krieger, B. Meggers, J. Rinaldo, and P. Kutsche
1956 Functional and Evolutionary Implications of Community patterning. In *Seminars in Archaeology: 1955,* edited by R. Wauchope, pp. 129-157. Memoirs of the Society for American Archaeology 11, Salt Lake City.

Bement, Leland C.
1989 Lower Pecos Canyonlands. In *From the Gulf to the Rio Grande: Human Adaptation in Central, South, and Lower Pecos Texas,* by T. R. Hester, S. L. Black, D. G. Steele, B. W. Olive, A. A. Fox, K. J. Reinhard, and L. C. Bement, pp. 63-76. Arkansas Archaeological Survey Research Series Number 33. Center for Archaeological Research, University of Texas at San Antonio, Texas A&M University, and Arkansas Archaeological Survey, Fayetteville, Arkansas.

Bennett, J. W.
1967 Comments on the Cultural Ecology of India's Sacred Cattle. *Current Anthropology* 3:251-252.

Binford, Lewis R.
1977 *Olorgesailie* Deserves More Than the Usual Book Review. *Journal of Anthropological Research* 33:493-502.

1978a *Nunamiut Ethnoarchaeology.* Academic Press, New York.

1978b Dimensional Analysis of Behavior and Site Structure: Learning from an Eskimo Hunting Stand. *American Antiquity* 43:330-361.

1979 Organization and Formation Processes: Looking at Curated Technologies. *Journal of Anthropological Research* 35:255-273.

1980 Willow Smoke and Dogs' Tails: Hunter-Gatherer Settlement Systems and Archaeological Site Formation. *American Antiquity* 45:4-20.

1981a *Bones: Ancient Men and Modern Myths.* Academic Press, New York.

1981b Long-Term Land-Use Patterning: Some Implications for Archaeology. Paper presented at the 46th Annual Meeting of the Society for American Archaeology, San Diego, California. Published in 1983 in *Working at Archaeology,* edited by L. R. Binford, pp. 379-386. Academic Press, New York.

1981c Behavioral Archaeology and the Pompeii Premise. *Journal of Anthropological Research* 37(3):195-208.

1982 The Archaeology of Place. *Journal of Anthropological Archaeology* 1(1):5-31.

1983a *In Pursuit of the Past: Decoding the Archaeological Record.* Thames and Hudson, New York.

1983b *Working at Archaeology.* Academic Press, New York.

Binford, Lewis R., and Jeremy A. Sabloff
1982 Paradigms, Systematics, and Archaeology. *Journal of Anthropological Research* 38(2):137-153.

Birdsell, Joseph B.
1968 Some Predictions for the Pleistocene System Among Recent Hunters and Gatherers. In *Man the Hunter,* edited by R. Lee and I. DeVore, pp. 229-240. Aldine, Chicago.

Birkeland, Peter W.
1984 *Soils and Geomorphology.* Oxford University Press, New York.

Black, Stephen L.
1989a Central Texas Plateau Prairie. In *From the Gulf to the Rio Grande: Human Adaptation in Central, South, and Lower Pecos Texas,* by T. R. Hester, S. L. Black, D. G. Steele, B. W. Olive, A. A. Fox, K. J. Reinhard, and L. C. Bement, pp. 17-38. Arkansas Archaeological Survey Research Series Number 33, prepared by the Center for Archaeological Research at the University of Texas at San Antonio, Texas A&M University, and the Arkansas Archaeological Survey, Fayetteville, Arkansas, for the U. S. Army Corps of Engineers, Southwestern Division, Contract DACW63-84-C-0149.

1989b Environmental Setting. In *From the Gulf to the Rio Grande: Human Adaptation in Central, South, and Lower Pecos Texas*, by Thomas R. Hester, Stephen L. Black, D. Gentry Steele, Ben W. Olive, Anne A. Fox, Karl J. Reinhard, and Leland C. Bement, pp. 5-16, Arkansas Archaeological Survey Research Series No. 33, prepared by the Center for Archaeological Research at the University of Texas at San Antonio, Texas A&M University, and the Arkansas Archaeological Survey, for the U. S. Army Corps of Engineers, Southwestern Division, Contract DACW63-84-C-0149.

1993 Nailing the Coffin Shut. Texas Historical Commission *News and Views*, volume 5 #1:16.

Black, S. L., and A. J. McGraw
1985 *The Panther Springs Creek Site: Cultural Change and Continuity Within the Upper Salado Creek Watershed, South-Central Texas.* Archaeological Survey Report Number 100. Center for Archaeological Research, University of Texas at San Antonio.

Black, S. L., J. Guy-Motriuk, L. W. Ellis, D. G. Creel, L. Douglass, K. Miller, and C. Ward
1992 *The Five Burned Rock Midden Sites Project: Progress Report and Research Plan.* Texas Archeological Research Laboratory, University of Texas at Austin.

Black, S., D. Potter, K. Jolly, and J. Karbula
1994 High Tech and Low Life Along Salado Creek: The Wurzbach Parkway Project. Presentation to the South Texas Archeological Society, San Antonio.

Blair, W. Frank
1950 The Biotic Provinces of Texas. *Texas Journal of Science* 2(1):93-117.

Blum, M. D.
1987 Late Quaternary Sedimentation in the Upper Pedernales River, Texas. Unpublished Masters thesis, University of Texas at Austin.

1990 Climatic and Eustatic Controls on Gulf Coastal Plain Fluvial Sedimentation: An Example from the Late Quaternary of the Colorado River, Texas. In *Sequence Stratigraphy as an Exploration Tool: Concepts and Practices in the Gulf Coast*, edited by J. M. Armentrout and B. S. Perkins, pp. 71-83. Proceedings of the 11th Annual Research Conference, Gulf Coast Section of the Society of Economic Paleontology and Minerology Foundation.

1992 *Modern Depositional Environments and Recent Alluvial History of the Lower Colorado River, Gulf Coastal Plain, Texas*. Unpublished Ph.D. dissertation, University of Texas at Austin.

Blum, M. D., and S. Valastro, Jr.
1989 Response of the Pedernales River of Central Texas to Late Holocene Climatic Change. *Annals of the Association of American Geographers* 79:435-456.

Blum, Michael D., James T. Abbott, and Salvatore Valastro, Jr.
1992 Evolution of Landscapes on the Double Mountain Fork of the Brazos River, West Texas: Implications for Preservation and Visibility of the Archaeological Record. *Geoarchaeology* 7:339-370.

Blurton Jones, Nicholas, and Melvin J. Konner
1976 !Kung Knowledge of Animal Behavior (or: The Proper Study of Mankind Is Animals). In *Kalahari Hunter-Gatherers: Studies of the !Kung San and Their Neighbors,* edited by R. B. Lee and I. DeVore, pp. 325-348. Harvard University Press, Cambridge, Massachusetts.

Boldurian, Anthony T.
1991 Folsom Mobility and Organization of Lithic Technology: A View from Blackwater Draw, New Mexico. *Plains Anthropologist* 36(137):281-295.

Bousman, C. Britt
1974 *Archeological Assessment of Alibates National Monument.* Archeology Research Program, Southern Methodist University, Dallas.

1990 Paleoenvironments and Human Diets. In *Prehistoric Archeology and Paleoenvironments in Hidalgo and Willacy Counties, South Texas: Results of the Phase II Excavations,* by C. B. Bousman, S. A. Tomka, and G. L. Bailey, pp. 91-103. Reports of Investigations Number 76. Prewitt and Associates, Austin.

Bousman, C. B., S. A. Tomka, and G. L. Bailey
1990 *Prehistoric Archeology and Paleoenvironments in Hidalgo and Willacy Counties, South Texas: Results of the Phase II Excavations.* Reports of Investigations Number 76. Prewitt and Associates, Austin.

Bradley, R. S.
1985 *Quaternary Paleoclimatology: Methods of Paleoclimatic Reconstruction.* Allen and Unwin, Boston.

Brady, Nyle C.
1990 *The Nature and Properties of Soils.* 10th ed. Macmillan, New York.

Briuer, Frederick L., and George B. Thomas
1986 *Standard Operating Procedure for Field Surveys*. Research Report Number 13. United States Army, Fort Hood Archaeological Resource Management Series.

Bronitsky, Gordon
1986 The Use of Materials-Science Techniques in the Study of Pottery Construction and Use. In *Advances in Archaeological Method and Theory,* volume 9, edited by M. B. Schiffer, pp. 209-276. Academic Press, Orlando, Florida.

Brown, D. A.
1984 Prospects and Limits for a Phytolith Key for Grasses in the Central United States. *Journal of Archaeological Science* 11:345-368.

Brune, Gunnar
1981 *Springs of Texas, Volume I.* Branch-Smith, Fort Worth.

Bryant, Vaughn M.
1974 The Role of Coprolite Analysis in Archeology. *Bulletin of the Texas Archeological Society* 45:1-28.

Bryant, Vaughn M., and Harry J. Shafer
1977 Late Quaternary Paleoenvironment of Texas: A Model for Archaeologists. *Bulletin of the Texas Archeological Society* 48:1-26.

Bryant, V. M. and R. G. Holloway
1985 The Late Quaternary Paleoenvironmental Record of Texas. In: *Pollen Records of Late Quaternary North American Sediments*, edited by V. M. Bryant and R. G. Holloway, pp. 39-70. Dallas: American Association of Stratigraphic Palynologists.

Busch, Lawrence, and William B. Lacy
1983 *Science, Agriculture, and the Politics of Research.* Westview, Boulder, Colorado.

Butzer, Karl W.
1971 Environment and Archaeology: An Ecological Approach to Prehistory. Aldine-Atherton Press, Inc. Chicago.

1980 Holocene Alluvial Sequences: Problems of Dating and Correlation. In *Timescales in Geomorphology*, edited by R. A. Cullingford, D. A. Davidson, and J. Lewin. John Wiley, London. and Sons.

1982 *Archaeology as Human Ecology: Method and Theory for a Contextual Approach.* Cambridge University Press, Cambridge.

Califano, L., P. Dohrn, G. Montalenti, and H. S. Purvi (editors)
1964 *Ostracods as Ecological and Paleoecological Indicators.* Publication of the Naples Zoological Station Volume 33, Supplement. Stazione Zoologica di Napoli, Naples, Italy.

Campbell, D. T.

1965 Variation and Selective Retention in Sociocultural Evolution. In *Social Change in Underdeveloped Areas: A Reinterpretation of Evolutionary Theory,* edited by R. W. Mack, G. I. Blanksten, and H. R. Barringer, pp. 19-48. Schenkman, Cambridge.

Campbell, T. N.

1957 The Fields Shelter: An Archeological Site in Edwards County, Texas. *The Texas Journal of Science* 9(1):7-25.

Carlson, David L.

n.d. Clustering Radiocarbon Dates. Computer program in author's file. Department of Anthropoloy, Texas A&M University, College Station.

1992 Conclusions and Recommendations. In *Archaeological Investigations in Bull Branch: Results of the 1990 Summer Archaeological Field School,* edited by D. L. Carlson, pp.161-163. Archaeological Management Series Research Report Number 19. United States Army, Fort Hood, Texas. Draft submitted for review.

1993a Archaeological Investigations in Bull Branch: Results of the 1990 Summer Archaeological Field School. United States Army Fort Hood Archaeological Resource Management Series Research Report Number 19. 144 p.

1993b Archaeological Investigations in Spicewood Creek: Results of the 1991 Summer Archaeological Field School. United States Army Fort Hood Archaeological Resource Management Series Research Report Number 22. 131 p.

Carlson, David L. (editor)

1993 *Archaeological Investigations in Bull Branch: Results of the 1990 Summer Archaeological Field School.* Archaeological Management Series Research Report Number 19. United States Army, Fort Hood, Texas. Draft submitted for review.

Carlson, David L., and Frederick L. Briuer

1986 *Analysis of Military Training Impacts on Protected Archaeological Sites at West Fort Hood, Texas.* Archaeological Management Series Research Report Number 9. United States Army, Fort Hood, Texas.

Carlson, S. B., H. B. Ensor, D. L. Carlson, E. A. Miller, and D. E. Young

1987 *Archaeological Survey at Fort Hood, Texas, Fiscal Year 1984.* Archaeological Management Series Research Report Number 14. United States Army, Fort Hood, Texas.

Carlson, S. B., D. L. Carlson, H. B. Ensor, E. A. Miller, and D. E. Young

1988 *Archaeological Survey at Fort Hood, Texas, Fiscal Year 1985, the Northwestern Training Area.* Archaeological Management Series Research Report Number 15. United States Army, Fort Hood, Texas.

Carlson, David L., and H. Blaine Ensor
1991 *Significance Standards for Archaeological Sites at Fort Hood,* draft submitted by Archeological Research Laboratory, Texas A & M University, Contract No. DACA63-87-D-0155, Delivery Order #9.

Carr, J. T.
1967 Climate and Physiography of Texas. Report 53, Texas Water Development Board. Austin. 27 pp.

Cerling, T. E., J. Quade, Y. Wang, and J. R. Bowman
1989 Carbon Isotopes in Soils and Paleosols as Ecology and Paleoecology Indicators. *Nature* 341:138-139.

Chorley, R. J., S. A. Schumm, and D. E. Sugden
1984 *Geomorphology.* London, Methuen.

Clark, J. G. D.
1975 *The Earlier Stone Age Settlement of Scandinavia.* Cambridge University Press, Cambridge.

Cleland, Charles E.
1976 The Focal-Diffuse Model: An Evolutionary Perspective on the Prehistoric Cultural Adaptations of the Eastern United States. *Midcontinent Journal of Archaeology* 1(1):59-76.

Coffman, R. J., M. C. Trachte, and M. B. Collins
1986 Cultural Ecology of the Kenyon Rockshelter and the Cunningham Site, Canyon Creek Development, Travis County, Texas. Prewitt and Associates, Inc., *Report of Investigations* 53.

Cohen, Gerald A.
1978 *Karl Marx's Theory of History: A Defence.* Princeton University Press, Princeton, New Jersey.

Collins, Michael B.
1973 The Devil's Hollow Site, A Stratified Archaic Campsite in Central Texas. *Bulletin of the Texas Archeological Society* 43:77-100.

1991 Thoughts on Future Investigations of Burned Rock Middens. In *The Burned Rock Middens of Texas: An Archeological Symposium,* edited by T. R. Hester, pp. 1-24. Studies in Archeology Number 13. Texas Archeological Research Laboratory, University of Texas at Austin.

Collins, M. B., G. L. Evans, T. N. Campbell, M. C. Winans, and C. E. Mears
1989 Clovis Occupation at the Kincaid Shelter, Texas. *Current Research in the Pleistocene* 6:3-4.

Collins, Michael B., Bruce Ellis, and Cathy Dodt-Ellis
1990 Excavations at the Camp Pearl Wheat Site (41KR243): An Early Archaic Campsite on Town Creek, Kerr County, Texas. *Studies in Archeology Number 6.* Texas Archeological Research Laboratory, University of Texas at Austin.

Cook, L. M., G. A. Goodfriend, and R. A. D. Cameron
1993 Changes in the Land Snail Fauna of Eastern Madeira During the Quaternary. *Philosophical Transactions of the Royal Society of London,* 339:83-103.

Cordell, Linda S.
1984 *Prehistory of the Southwest.* Academic Press, New York.

Cotterell, Brian, and Johan Kamminga
1987 The Formation of Flakes. *American Antiquity* 52:675-708.

Courty, M. A., P. Goldberg, and R. MacPhail
1989 *Soils and Micromorphology in Archaeology.* Cambridge University Press, Cambridge.

Crabtree, Don E.
1972 *An Introduction to Flintworking.* Occasional Papers of the Idaho State Museum Number 28. Pocatello.

Creel, Darrell G.
1986 Assessing the Importance of Acorns in Archaic Subsistence: The Distribution of Burned Rock Middens in West Central Texas. Unpublished Ph.D. dissertation, Department of Anthropology, University of Arizona.

1991 Assessing the Relationship Between Burned Rock Midden Distribution and Archaic Subsistence in West-Central Texas. In *The Burned Rock Middens of Texas: An Archeological Symposium,* edited by T. R. Hester, pp. 33-43. Studies in Archeology Number 13. Texas Archeological Research Laboratory, University of Texas at Austin.

Crumley, Carole L., and William H. Marquardt
1990 Landscape: A Unifying Concept in Regional Analysis. In *Interpreting Space: GIS and Archaeology,* edited by K. M. S. Allen, S. W. Green, and E. B. W. Zubrow, pp. 73-79. Taylor and Francis, London.

Deal, Dwight
1975 Geologic Environment of the Devil's Sinkhole--Hackberry Creek Area, Nueces River Headwaters, Edwards and Real Counties, Texas. In *Devil's Sinkhole Area--Headwaters of the Nueces River. A Natural Area Survey, Part VIII of VIII.* Division of Natural Resources and Environment, The University of Texas at Austin, pp. 11-20.

1976a The Geologic Environment of the Solitario, Brewster and Presidio Counties, Texas. In *The Solitario, A Natural Area Survey No. 9,* pp. 17-66. Lyndon B. Johnson School of Public Affairs, The University of Texas at Austin.

1976b The Geologic Environment of Fresno Canyon, Southeastern Presidio County, Texas. In *Fresno Canyon, A Natural Area Survey No. 10,* pp. 17-66. Lyndon B. Johnson School of Public Affairs, The University of Texas at Austin.

Dean, Jeffrey S.
1978 Independent Dating in Archaeological Analysis. In *Advances in Archaeological Method and Theory,* volume 1, edited by M. B. Schiffer, pp. 223-255. Academic Press, New York.

Delorme, L. Denis
1989 Methods in Quaternary Ecology #7. Freshwater Ostracodes. *Geoscience Canada* 16(2):85-90.

DeNiro, Michael J.
1985 Postmortem Preservation and Alteration of *In Vivo* Bone Collagen Isotope Ratios in Relation to Paleodietary Reconstruction. *Nature* 317:806-809.

Dennell, R.
1983 *European Economic Prehistory: A New Approach.* Academic Press, New York.

Department of the Army
1984 Historic Preservation. Army Regulation 420-40.

1991 Archeological Testing and Evaluation, Fort Hood Texas. Contract DAKF48-91-0058. Headquarters, III Corps and Fort Hood. Copy on file at the Directorate of Engineering and Housing, Fort Hood, Texas.

Dering, J. P., and V. M. Bryant
1992 Plant Remains from the Richard Beene Site (41BX831): Implications for Holocene Climatic Change in South-Central Texas. In *Late Cenozoic Alluvial Stratigraphy and Prehistory of the Inner Gulf Coastal Plain, South-Central Texas,* edited by R. D. Mandel and S. C. Caran. Guidebook, 10th Annual Meeting, South-Central Friends of the Pleistocene.

Dibble, David S., and Frederick L. Briuer
1989 *Archaeological Survey at Fort Hood, Texas.* Fort Hood Archaeological Resource Management Series, Research Report Number 3. United States Army, Fort Hood, Texas.

Dickens, William A.
1993a In *Archaeological Investigations in Bull Branch: Results of the 1990 Summer Archaeological Field School,* edited by D. L. Carlson, pp. 79-116. Archaeological Management Series Research Report Number 19. United States Army, Fort Hood, Texas.

1993c Lithic Artifact Analysis. In *Archaeological Investigations In Spicewood Creek: Results of the 1991 Summer Archaeological Field School,* edited by David L. Carlson, pp. 75-111. Archaeological Resource Management Series Research Report Number 22. United States Army, Fort Hood.

Dickens, William A. and John E. Dockall
1992 Lithic Analysis. In *Archaeological Site Testing and Evaluation on the Henson Mountain Helicopter Range AWSS Project Area, Fort Hood, Texas,* edited by David L. Carlson. Research Report Number 25. Archaeological Research Management Series. United States Army, Fort Hood, Texas. In press.

Dillehay, Tom D.
1974 Late Quaternary Bison Population Changes on the Southern Plains. *Plains Anthropologist* 19:180-196.

Dunnell, Robert C.
1971 *Systematics in Prehistory.* Free Press, New York.

Elias, Scott A., and Laurence J. Toolin
1990 Accelerator Dating of a Mixed Assemblage of Late Pleistocene Insect Fossils from the Lamb Spring Site, Colorado. *Quaternary Research* 33:122-126.

Elias, Scott A., and Thomas R. Van Devender
1990 Fossil Insect Evidence for Late Quaternary Climatic Change in the Big Bend Region, Chihuahuan Desert, Texas. *Quaternary Research* 34:249-261.

Elliott, Thomas Lloyd
1979 Deposition and Diagenesis of Carbonate Slope Deposits, Lower Cretaceous, Northeastern Mexico. Unpublished Ph.D. dissertation, The University of Texas at Austin.

Ellis, G. Lain
1994a Archeological Overview Theoretical Perspectives. In *Significance Standards for Prehistoric Cultural Resources: A Case Study from Fort Hood, Texas,* by G. L. Ellis, C. Lintz, W. N. Trierweiler, and J. M. Jackson, pp. 43-104. Tri-Services Research Center Series. United States Army Construction Engineering Research Laboratory, Urbana, Illinois. In press.

1994b Research Domains. In *Significance Standards for Prehistoric Cultural Resources: A Case Study from Fort Hood, Texas,* by G. L. Ellis, C. Lintz, W. N. Trierweiler, and J. M. Jackson, pp. 105-181. Tri-Services Research Center Series. United States Army Construction Engineering Research Laboratory, Urbana, Illinois. In press.

Ellis, G. L., C. Lintz, W. N. Trierweiler, and J. M. Jackson
1994 *Significance Standards for Prehistoric Cultural Resources: A Case Study from Fort Hood, Texas.* Tri-Services Research Center Series. United States Army Construction Engineering Research Laboratory, Urbana, Illinois. In press.

Ellis, Linda W.
1992 Technological Style in Upper Texas Coastal Ceramics: A Case Study from 41HR616, Harris County, Texas. Unpublished Masters thesis, Department of Anthropology, University of Texas at San Antonio.

Ellis, Patricia M.
1986 Post-Miocene Carbonate Diagenesis of the Lower Cretaceous Edwards Group in the Balcones Fault Zone Area, South-Central Texas. In *The Balcones Escarpment, Central Texas,* Patrick L. Abbott and C. M. Woodruff, Jr., eds., The Geological Society of America, pp. 101-114.

Ensor, H. Blaine
1991 *Archaeological Survey at Fort Hood, Texas, Fiscal Year 1987, the MCA Range Construction, Pidcoke Land Exchange, and Phantom Range Projects.* Archaeological Management Series Research Report Number 23. United States Army, Fort Hood, Texas.

Ensor, H. Blaine, and Erwin Roemer, Jr.
1989 Comments on Sullivan and Rozen's Debitage Analysis and Archaeological Interpretation. *American Antiquity* 54:175-178

Ericson, Jonathon E.
1977 Egalitarian Exchange Systems in California: A Preliminary View. In *Exchange Systems in Prehistory,* edited by T. K. Earle and J. E. Ericson, pp. 109-126. Academic Press, New York.

Escabedo, James
1977 Lithic Raw Materials. In *Hop Hill: Culture and Climatic Change in Central Texas*, edited by Joel Gunn and Royce Mahula. Center for Archaeological Research, The University of Texas at San Antonio, Special Report No. 5, pp. 253-255.

Espey Huston and Associates
1979 *Ecological Baseline Report, Fort Hood Texas.* Environmental Impact Statement, Overall Mission, Fort Hood Texas. Submitted to Department of Army Headquarter Forces Command by Espey Huston and Associates, Austin.

Farrand, W. R.
1985 Rockshelter and Cave Sediments. In *Archaeological Sediments in Context*, edited by J. K. Stein and W. R. Farrand, pp. 21-39. Center for the Study of Early Man. University of Maine at Orono.

Fenneman, Nevin M.
1931 *Physiography of the Western United States.* McGraw Hill, New York.

1938 *Physiography of the Eastern United States.* McGraw Hill, New York.

Ferring, Reid C.
1986 Rates of Fluvial Sedimentation: Implications for Archaeological Variability. *Geoarchaeology* 1:259-274.

Feyerabend, Paul
1975 *Against Method.* Verso, London.

Fisher, William L., and P. U. Rodda
1969 Edwards Formation (Lower Cretaceous), Texas: Dolomitization in a Carbonate Platform System. *American Association of Petroleum Geologists Bulletin* 53:55-72.

Flannery, Kent V.
1973 The Origins of Agriculture. *Annual Review of Anthropology* 2:271-310.

Flannery, Kent V. (editor)
1986 *Guilá Naquitz: Archaic Foraging and Early Agriculture in Oaxaca, Mexico.* Academic Press, New York.

Ford, Richard I.
1988 Commentary: Little Things Mean a Lot--Quantification and Qualification in Paleoethnobotany. In *Current Paleoethnobotany: Analytical Methods and Cultural Interpretations of Archaeological Plant Remains,* edited by C. A. Hastorf and V. S. Popper, pp. 215-222. University of Chicago Press, Chicago.

Forrester, R. E.
1985 Horn Shelter Number 2: the North End. *Central Texas Archeologist* 10:21-35.

Forrester, R. E.
1988 Analysis of Non-perishable Remains from two Adjacent Rock Shelters in Northern Bosque County, Texas. *The Record* (Dallas Archaeological Society) 42(3):36-53.

Foth, H. D., and J. W. Schafer
1980 *Soil Geography and Land Use.* John Wiley & Sons, New York.

Fox, D. E.
1980 Test Excavations at the Classen Rockshelter, Northeastern Bexar County, Texas, 1967. *La Tierra* 7(1):16-23.

Franke, Richard, and Barbara Chasin
1980 *Seeds of Famine: Ecological Destruction and the Development Dilemma in the West African Sahel.* Allanheld, Osmun and Co., Montclair, New Jersey.

Frederick, Charles D.
1994 Chert Patination as a Chronometric Indicator. Mariah Associates, Inc. (manuscript in preparation).

Futato, Eugene M.
1977 Toward a Formal Account of Projectile Point Morphology. In *The Belfonte Site, 1J300,* by E. M. Futato, pp. 36-62. Research Series 2. Office of Archaeological Research, University of Alabama.

1983 Appendix A: A Beginning Artifact Geometry. In *Archaeological Investigation in the Cedar Creek and Upper Bear Creek Reservoirs,* by E. M. Futato, pp. 467-486. Reports of Investigation Number 29. Office of Archaeological Research, University of Alabama.

Gearhart, Robert Lewis
1987 Study of Central Texas Burned Rock Middens: Their Formation, Function and Rate of Accumulation. Unpublished Masters thesis, Department of Anthropology, University of Missouri, Columbia.

Gerrard, A. J.
1981 *Soils and Landforms: An Integration of Geomorphology and Pedology.* George Allen & Unwin, London.

Gile, L. H., F. F. Peterson, and R. B. Grossman
1966 Morphological and Genetic Sequences of Carbonate Accumulation in Desert Soils. *Soil Science* 101:347-360.

Goode, Glen T.
1991 Late Prehistoric Burned Rock Middens in Central Texas. In *The Burned Rock Middens of Texas: An Archeological Symposium,* edited by T. R. Hester, pp. 71-93. Studies in Archeology Number 13. Texas Archeological Research Laboratory, University of Texas at Austin.

Goodfriend, Glenn A.
1987a Radiocarbon Age Anomalies in Shell Carbonate of Land Snails from Semi-arid Areas. *Radiocarbon* 29:159-167.

1987b Chronostratigraphic Studies of Sediments in the Negev Desert, Using Amino Acid Epimerization Analysis of Land Snail Shells. *Quaternary Research* 28:374-392.

1989 Complementary Use of Amino Acid Epimerization and Radiocarbon Analysis for Dating of Mixed-age Fossil Assemblages. *Radiocarbon* 31:1041-1047.

1991 Patterns of Racemization and Epimerization of Amino Acids in Land Snail Shells over the Course of the Holocene. *Geochimica et Cosmochimica Acta* 55:293-302.

1992a A New Fossil Land Snail of the Genus Hemitrochus from Bowden, Jamaica. *Nautilus* 106:55-59.

1992b The Use of Land Snail Shells in Paleoenvironmental Reconstruction. *Quaternary Science Reviews* 11:665-685.

n.d. The Fossil Record of Terrestrial Mollusks in Jamaica. In *Biostratigraphy of Jamaica,* edited by R. M. Wright and E. Robinson. *Geological Society of America Memoir* 182, in press.

Goodfriend, G. A., R. A. D. Cameron, and L. M. Cook
n.d. Fossil Evidence of Human Impact on the Land Snail Fauna of Madeira. Ms. submitted to *Journal of Biogeography.*

Goodfriend, G. A., and D. G. Hood
1983 Carbon Isotope Analysis of Land Snail Shells: Implications for Carbon Sources and Radiocarbon Dating. *Radiocarbon* 25:810-830.

Goodfriend, G. A., and V. R. Meyer
1991 A Comparative Study of Amino Acid Racemization/Epimerization Kinetics in Fossil and Modern Mollusk Shells. *Geochimica et Cosmochimica Acta* 55:3355-3367.

Goodfriend, G. A., and R. M. Mitterer
1988 Late Quaternary Land Snails from the North Coast of Jamaica: Local Extinctions and Climatic Change. *Palaeogeography, Palaeoclimatology, Palaeoecology* 63:293-311.

1993 A 45,000-yr Record of a Tropical Lowland Biota: The Land Snail Fauna from Cave Sediments at Coco Ree, Jamaica. *Geological Society of America Bulletin* 105:18-29.

Goodfriend, G. A., and J. J. Stipp
1983 Limestone and the Problem of Radiocarbon Dating of Land-snail Shell Carbonate. *Geology* 11:575-577.

Gore, Albert
1992 *Earth in the Balance: Ecology and the Human Spirit.* Houghton Mifflin, New York.

Gould, F. W.
1975 *Texas Plants--A Checklist and Ecological Summary.* Report MP-585/Revised. Texas Agricultural Experimental Station, Texas A & M University, College Station.

Gould, Richard A., and Sherry Saggers
1985 Lithic Procurement in Central Australia: A Closer Look at Binford's Idea of Embeddedness in Archaeology. *American Antiquity* 50:117-136.

Gould, Stephen J.
1989 *Wonderful Life: The Burgess Shale and the Nature of History.* W. W. Norton and Co., New York.

Gould, S. J., and R. C. Lewontin
1979 The Spandrels of San Marco and the Panglossian Paradigm: A Critique of the Adaptationist Programme. *Proceedings of the Royal Society* 205:581-598.

Graham, R. W.
1987 Late Quaternary Mammalian Faunas and Paleoenvironments of the Southwestern Plains of the United States. In *Late Quaternary Mammalian Biogeography and Environments of the Great Plains and Prairies* edited by R. G. Graham, H. A. Semken, and M. A. Graham, pp. 24-86. Illinois State Museum Scientific Papers 22.

Green, F. E., and J. H. Kelly
1960 Comments on Alibates Flint. *American Antiquity* 25:413-414.

Greer, John W.
1965 A Typology of Midden Circles and Mescal Pits. *Southwestern Lore* 31(3):41-45.

Greiser, Sally T., and Payson D. Sheets
1979 Raw Materials as a Functional Variable in Use-Wear Studies. In *Lithic Use-Wear Analysis,* edited by B. Hayden, pp. 289-296. Academic Press, New York.

Guccione, M. J., R. H. Lafferty III, and L. S. Cummings
1988 Environmental Constraints of Human Settlement in an Evolving Holocene Alluvial System, the Lower Mississippi Valley. *Geoarchaeology* 3:65-84.

Guderjan, Thomas H., George B. Thomas, and Howard R. Cramer
1980 *Final Report: Existing Data Inventory of Cultural Resource and Paleontological Information, Fort Hood, Texas.* Soil Systems, Marietta, Georgia.

Gunn, Joel
n.d. Mobility Patterns in Central Texas. Manuscript in author's files.

Gunn, Joel, and Royce Mahula
1977 *Hop Hill: Culture and Climatic Change in Central Texas.* Special Report Number 5. Center for Archaeological Research, University of Texas at San Antonio.

Guy, Janice A.
1990 Previous Archeological Investigations. In *The Archeology and Bioarcheology of the Gulf Coastal Plain: Volume 1,* by D. A. Story, J. A. Guy, B. A. Burnett, M. D. Freeman, J. C. Rose, D. G. Steele, B. W. Olive, and K. J. Reinhard, pp. 26-130. Arkansas Archaeological Survey Research Series Number 38. Arkansas Archaeological Survey, Fayetteville, Arkansas.

Haas, H., V. T. Holliday, and R. Stuckenrath
1986 Dating of Holocene Stratigraphy with Soluble and Insoluble Organic Fractions at the Lubbock Lake Archaeological Site: An Ideal Case Study. *Radiocarbon* 28:473-485.

Hagstrum, Melissa B., and John A. Hildebrand
1990 The Two-Curvature Method for Reconstructing Ceramic Morphology. *American Antiquity* 55:388-403.

Hall, Grant D.
1981 *Allens Creek: A Study in the Cultural Prehistory of the Lower Brazos Valley.* Research Report Number 51. Texas Archeological Survey, University of Texas at Austin.

Hall, Stephen A.
1988 Environment and Archaeology of the Central Osage Plains. *Plains Anthropologist* 33(120):203-218.

1990 Channel Trenching and Climate Change in the Southern U.S. Great Plains. *Geology* 18:342-345.

Hally, David J.
1983 Use Alteration of Pottery Vessel Surfaces: An Important Source of Evidence for the Identification of Vessel Function. *North American Archaeologist* 4(1):3-26.

Harris, E. S.
1985 An Archaeological Study of the Timmeron Rockshelter (41HY95), Hays County, South Central Texas. *South Texas Archaeological Society Special Publication No. 4.* 54 p.

Harris, Marvin
1966 The Cultural Ecology of India's Sacred Cattle. *Current Anthropology* 7:51-59.

1968 *The Rise of Anthropological Theory.* T. Y. Crowell, New York.

1979 *Cultural Materialism: The Struggle for a Science of Culture.* Vintage, New York.

Hassan, Fekri A.
1981 *Demographic Archaeology.* Academic Press, New York

Hastorf, Christine A., and Virginia S. Popper
1988 *Current Paleoethnobotany: Analytical Methods and Cultural Interpretations of Archaeological Plant Remains.* University of Chicago Press, Chicago.

Hayden, Brian (editor)
1979 *Lithic Use-Wear Analysis.* Academic Press, New York.

Hays, T. R. (compiler and editor)
1982 *Archaeological Investigations at the San Gabriel Reservoir Districts, Central Texas.* 3 volumes. Archaeology Program, Institute of Applied Sciences, North Texas State University, Denton.

Hays, T. R., and Olin McCormick
1982 Archaeological Background. In *Archaeological Investigations at the San Gabriel Reservoir Districts, Central Texas,* volume 1, compiled and edited by T. R. Hays, pp. 4-1-4-6. Archaeology Program, Institute of Applied Sciences, North Texas State University, Denton.

Hayward, O. T., P. M. Allen, and D. L. Amsburg
1990 Lampasas Cut Plain--cyclic Evolution of a Regional Landscape, Central Texas. Geological Society of America *Guidebook* 2, 122 p. Dallas, Texas.

Helm, June
1962 The Ecological Approach in Anthropology. *American Journal of Sociology* 67:630-639.

Henry, D. O., F. E. Kirby, A. B. Justen, and T. R. Hays
1980 *The Prehistory of Hog Creek: An Archaeological Investigation of Bosque and Coryell Counties, Texas.* 3 volumes. Laboratory of Archaeology, Department of Anthropology, University of Tulsa.

Hester, James J.
1972 *Blackwater Locality No. 1: A stratified, Early Man Site in Eastern New Mexico.* Southern Methodist University, Fort Burgwin Research Center.

Hester, Thomas R.
1970 Burned Rock Middens on the Southwestern Edge of the Edwards Plateau, Texas. *Plains Anthropologist* 15(1):237-249.

1971 Archeological Investigations at the La Jita Site, Uvalde County, Texas. *Bulletin of the Texas Archeological Society* 42:51-148.

1973 The Formation of a Burned Rock Midden: A California Example. *The Record* 30(1):4. Dallas Archeological Society, Dallas.

Hester, Thomas R. (editor)
1991 *The Burned Rock Middens of Texas: An Archeological Symposium.* Studies in Archeology Number 13. Texas Archeological Research Laboratory, University of Texas at Austin.

Higgs, E. S., and C. Vita-Finzi
1972 Prehistoric Economies: A Territorial Approach. In *Papers in Economic Prehistory,* edited by E. S. Higgs, pp. 27-36. Cambridge University Press, Cambridge.

Highley, L., C. Graves, C. Land, and G. Judson
1978 Archaeological Investigations at Scorpion Cave (41ME7), Medina County, Texas. *Bulletin of the Texas Archeological Society* 49:139-194

Hill, R. T.
1900 *Physical Geography of the Texas Region, Topographic Atlas of the United States.* Folio 3, U.S. Geological Survey.

Hillsman, Matthew J.
1992 Evaluation of Visible and Ultraviolet-Excited Attributes of Some Texas and Macroscopically Similar New Mexico Cherts. Unpublished Masters thesis, Eastern New Mexico University.

Hodder, Ian
1986 *Reading the Past: Current Approaches to Interpretation in Archaeology.* Cambridge University Press, Cambridge.

1991 Interpretive Archaeology and Its Role. *American Antiquity* 56:7-18.

Hofman, Jack L.
1989 Prehistoric Culture History--Hunters and Gatherers in the Southern Great Plains. In *From Clovis to Comanchero: Archaeological Overview of the Southern Great Plains,* by J. L. Hofman, R. L. Brooks, J. S. Hays, D. W. Owsley, R. L. Jantz, M. K. Marks, and M. H. Manhein, pp. 25-60. Arkansas Archaeological Survey Research Series Number 35. Oklahoma Archeological Survey of the University of Oklahoma, Louisiana State University, and Arkansas Archaeological Survey, Fayetteville, Arkansas.

Hofman, Jack L., Lawrence C. Todd, and Michael B. Collins
1991 Identification of Central Texas Edwards Chert at the Folsom and Lindenmeier Sites. *Plains Anthropologist* 36:297-308.

Hoganson, John W., and Allan C. Ashworth
1992 Fossil Beetle Evidence for Climatic Change 18,000-10,000 Years B. P. in South-Central Chile. *Quaternary Research* 37:101-116.

Hole, Frank, and Robert F. Heizer
1973 *An Introduction to Prehistoric Archaeology.* 3rd ed. Holt, Reinhart and Winston, New York.

Holliday, Vance T.
1985 Holocene Soil-Geomorphological Relations in a Semi-Arid Environment: The Southern High Plains of Texas. In *Soils and Quaternary Landscape Evolution*, edited by J. Boardman, pp. 325-357. John Wiley and Sons, New York.

Holliday, V. T., E. Johnson, H. Hass, and R. Stuckenrath
1983 Radiocarbon Ages from the Lubbock Lake site, 1950-1980: Framework for Cultural and Ecological Change on the Southern High Plains. *Plains Anthropologist* 28:165-182.

Horne, S. N.
1938 Dating Cave Creek Shelter Occupancy. *Central Texas Archeologist* 4:96-97.

Howard, Margaret A.
1991 Burned Rock Midden Excavations, Hearths and Botanical Remains. In *The Burned Rock Middens of Texas: An Archeological Symposium,* edited by T. R. Hester, pp. 45-69. Studies in Archeology Number 13. Texas Archeological Research Laboratory, University of Texas at Austin.

Huckabee, John W., David Thompson, Jim Wyrick, and E. G. Pavlat
1977 *Soil Survey of Bell County, Texas.* Soil Conservation Service, United States Department of Agriculture. Government Printing Office, Washington, D.C.

Hudson, William R., Jr.
1976a A Preliminary Archaeological Reconnaisance of the Solitario. In *The Solitario, A Natural Area Survey No. 9*, Lyndon B. Johnson School of Public Affairs, The University of Texas at Austin, 133-151.

1976b A Preliminary Archaeological Reconnaisance of Upper Fresno Canyon. In *Fresno Canyon, A Natural Area Survey No. 10*, pp. 119-144. Lyndon B. Johnson School of Public Affairs, The University of Texas at Austin.

Huebner, Jeffrey A.
1991 Cactus for Dinner Again! An Isotopic Analysis of Late Archaic Diet in the Lower Pecos Region of Texas. In *Papers on Lower Pecos Prehistory,* edited by S. A. Turpin, pp. 175-190. Studies in Archeology Number 8. Texas Archeological Research Laboratory, University of Texas at Austin.

Huebner, J. A., and T. W. Boutton
1990 The Isotopic Ecology of Bison in Texas. Paper Presented at the 48th Plains Anthropological Conference, Oklahoma City, Oklahoma, Oct 31-Nov 3, 1990.

Huskey, Vane
1935 An Archeological Survey of the Nueces Canyon of Texas. *Bulletin of the Texas Archeological and Paleontological Society* 7:104-114.

Jackson, A. T.
1938 The Fall Creek Sites. In *Annual Report of WPA and the University of Texas Archaeological Research, Lake Buchanan, 1936-1937,* pp. 13-118. Anthropological Papers Vol III, No. 1, Bureau of Research in the Social Sciences Study No. 26, University of Texas Publication No. 3802. Austin.

Jackson, Jack M.

1990 United States Army Historic Preservation Plan for Fort Hood, Texas, Fiscal Years 1990 Through 1994. Document on file at the Directorate of Engineering and Housing, Fort Hood, Texas.

1992 United States Army Historic Preservation Plan for Fort Hood, Texas. Directorate Engineering and Housing, United States Army, Fort Hood, Texas.

1993 Cultural Resource Management. Army Environmental Manager's Handbook Series. Manuscript in author's files, Directorate of Engineering and Housing, Fort Hood, Texas.

1994 History of the Project. In *Significance Standards for Prehistoric Cultural Resources: A Case Study from Fort Hood, Texas.* by G. L. Ellis, C. Lintz, W. N. Trierweiler, and J. M. Jackson, pp. 21-25. Tri-Services Research Center Series. United States Army Construction Engineering Research Laboratory, Urbana, Illinois. In press.

Jackson, Jack M., and Frederick Briuer (editors)

1989 *Historical Research and Remote Sensing: Applications for Archaeological Resource Management at Fort Hood, Texas Fiscal Year 1981.* United States Army, Fort Hood, Texas, Archaeological Resource Management Series, Research Report 5, 6 and 7.

Jelks, Edward B.

1951 Relationships Between Foci of the Edwards Plateau Aspect: A Distributional Analysis of Diagnostic Projectile Point Types from Archaeological Sites in the Marshall Ford Dam Reservoir, Travis County, Texas. Unpublished Masters thesis, Department of Anthropology, University of Texas at Austin.

1962 *The Kyle Site: A Stratified Central Texas Aspect Site in Hill County, Texas.* Archaeology Series Number 5. Department of Anthropology, University of Texas at Austin.

1978 The Diablo Range. In *Chronologies in New World Archeology,* edited by R. E. Taylor and C. W. Meighan, pp. 71-111. Academic Press, New York.

Jenny, H.

1941 *Factors of Soil Formation.* McGraw-Hill, New York.

Jochim, Michael A.

1976 *Hunter-Gatherer Subsistence and Settlement: A Predictive Model.* Academic Press, New York.

Johnson, LeRoy, Jr.

1962 *Survey and Appraisal of the Archeological Resources of Stillhouse Hollow Reservoir on the Lampasas River, Bell County, Texas.* Texas Archeological Salvage Project, University of Texas at Austin.

1967 *Towards a Statistical Overview of the Archaic Cultures of Central and Southwestern Texas.* Texas Memorial Museum Bulletin 12, Austin.

1987 A Plague of Phases: Recent Sociocultural Taxonomy in Texas Archaeology. *Bulletin of the Texas Archeological Society* 57:1-26.

1989 Classification of Stone Projectile Points by a Small Texan Folk Community: A Case Study. *Texas Journal of Science* 41(2):193-203.

1990 *The Life and Times of Toyah-Culture Folk as Seen from the Buckhollow Encampment, Site 41KM16, Kimball County, Texas.* 4 volumes. Draft submitted to Texas State Department of Highways and Public Transportation, Highway Design Division, Texas Antiquities Permit Number 35, Austin.

1991 *Early Archaic Life at the Sleeper Archaeological Site, 41BC65, of the Texas Hill Country, Blanco County Texas.* Publications in Archaeology Report Number 9. Texas State Department of Highways and Public Transportation, Highway Design Division, Austin.

Johnson, L., Jr., D. A. Suhm, and C. D. Tunnell
1962 *Salvage Archeology of Canyon Reservoir: The Wunderlich, Footbridge, and Oblate Sites.* Bulletin Number 5. The Memorial Museum, University of Texas at Austin.

Kant, Immanuel
1787 (1965) *Critique of Pure Reason.* Translated and edited by N. Kemp Smith. Saint Martin's, New York.

Keller, John Esten
1976 *The Strickleaf Site.* Texas State Department of Highways and Public Transportation, Highways Design Division, Publications in Archaeology Report No. 8, Austin, Texas.

Kelley, J. Charles
1940 Report on Excavations in Travis County, Site 52C1-5(412) Work Project 15311. Unpublished manuscript on file. Texas Archeological Research Laboratory, University of Texas at Austin.

1947a The Lehmann Rock Shelter: A Stratified Site of the Toyah, Uvalde, and Round Rock Foci. *Bulletin of the Texas Archaeological and Paleontological Society* 18:115-128.

1947b The Cultural Affiliations and Chronological Position of the Clear Fork Focus. *American Antiquity* 13(2):97-109.

Kelley, J. Charles, and Thomas N. Campbell
1942 What Are the Burned Rock Mounds of Texas? *American Antiquity* 7:319-322.

Kelly, E. F., R. G. Amundson, B. D. Marino, and M. J. DeNiro
1991 Stable Isotope Ratios of Carbon in Phytoliths as a Quantitative Method of Monitoring Vegetation and Climate Change. *Quaternary Research* 35:222-233.

Kennedy, Stephen K, and Wei-Hsiung Lin
1988 A Fractal Techniques for the Classification of Projectile Point Shapes. *Geoarchaeology* 3:297-301.

Knox, J. C.
1983 Responses of River Systems to Holocene Climates. In *Late Quaternary Environments of the United States: Volume 2, The Holocene*, Wright, H. E. and Porter, S. C.,editors. University of Minnesota Press, Minneapolis.

Kornicker, Louis S.
1964 A Seasonal Study of Living Ostracoda in a Texas Bay (Redfish Bay) Adjoining the Gulf of Mexico. In *Ostracods as Ecological and Paleoecological Indicators,* edited by L. Califano, P. Dohrn, G. Montalenti, and H. S. Purvi, pp. 45-60. Publication of the Naples Zoological Station Volume 33, Supplement. Stazione Zoologica di Napoli, Naples, Italy.

Kosso, Peter
1991 Method in Archaeology: Middle-Range Theory as Hermeneutics. *American Antiquity* 56:621-627.

Kotter, S. M., T. M. Byrd, and M. W. Davis
1985 Cherry Tree Shelter: Excavation of a stratified Late Archaic and NeoArchaic rockshelter, Travis County, Texas. Texas Archeological Survey Research Report 92. Austin.

Krieger, Alex D.
1946 *Culture Complexes and Chronology in Northern Texas*. The University of Texas Publication, Number 4640. Austin.

1953 New World Culture History: Anglo-America. In *Anthropology Today*, edited by A. L. Kroeber, pp. 238-264. University of Chicago.

Krueger, H. W., and C. H. Sullivan
1984 Models for Carbon Isotope Fractionation Between Diet and Bone. In *Stable Isotopes and Nutrition,* edited by J. R. Turnland and P. E. Johnson, pp. 205-220. ACS Symposium Series Number 258. American Chemical Society.

Kuchler, A. W.
1964 *Potential Natural Vegetation of the Coterminous United States.* Special Publication 36. American Geographical Society, New York.

Kuhn, Thomas S.
1970 *The Structure of Scientific Revolutions.* 2nd ed., enlarged. University of Chicago Press.

Lakatos, Imre
1978a History of Science and Its Rational Reconstructions. In *The Methodology of Scientific Research Programs.* Philosophical Papers, volume 1, edited by J. Worall and G. Currie, pp. 102-138. Cambridge University Press, London.

1978b Falsification and the Methodology of Scientific Research Programs. In *The Methodology of Scientific Research Programs.* Philosophical Papers, volume 1, edited by J. Worall and G. Currie, pp. 8-101. Cambridge University Press, London.

1978c Changes in the Problem of Inductive Logic. In *Mathematics, Science and Epistemology.* Philosophical Papers, volume 2, edited by J. Worall and G. Currie, pp. 128-200. Cambridge University Press, London.

Lamb, H. H.
1977 *Climatic History and the Future.* Princeton University Press, New Jersey.

Land, L. S., E. L. Lundelius and S. Valastro
1980 Isotopic Ecology of Deer Bones. Palaeogeography, Palaeoclimatology, Palaeoecology 32:143-151.

Larkin, T. J. and Bomar, G. W.
1983 *Climatic Atlas of Texas.* Report LP-192, Texas Department of Water Resources, Austin.

Larson, R., D. Peter, F. Kirby, and S. A. Skinner
1975 An Evaluation of the Cultural Resources at Hog Creek. Southern Methodist University Archeological Research Program Resource Report 84. 126 p., Dallas.

Larson, Richard E., and Foster E. Kirby
1976 *Test Excavations at the L. E. Robertson Shelter and the Stone Rockshelter.* Research Report Number 87. Archaeological Research Program, Southern Methodist University, Dallas.

Latham, T. S., P. A. Sutton, and K. L. Verosub
1992 Non-Destructive XRF Characterization of Basaltic Artifacts from Truckee, California. *Geoarchaeology* 7:81-101.

Lauritzen, S. E, J. E. Haugen, R. Løvlie, and H. Gilje-Nielsen
1994 Geochronological Potential of Isoleucine Epimirization in Calcite Speleothems. *Quaternary Research* 41(1):52-58.

Laville, H.
1976 Deposits in Calcareous Rockshelters: Analytical Methods and Climatic Interpretations. In *Geoarchaeology: Earth Science and the Past.*, edited by D. A. Davidson and M. L. Shackley, pp.137-155. Duckworth, London.

Laville, H., J. P. Rigaud, and J. Sackett
1980 *Rock Shelters of the Perigord: Geological Stratigraphy and Archaeological Succession.* Academic Press, New York.

Lawrence, T. G., Jr., and Albert J. Redder
1985 Frank. H. Watt, the Central Texas Archeologist. *Central Texas Archeologist* 10(Spring):7-10.

LeBlanc, Steven A.
1991 Archaeology as Big Science: Present and Future Prospects. Paper presented at the Plenary Session of the 56th annual meeting of the Society for American Archaeology, New Orleans.

Lechtman, Heather
1977 Style in Technology--Some Early Thoughts. In *Material Culture: Styles, Organization, and Dynamics of Technology,* edited by H. Lechtman and R. S Merrill, pp. 3-20. West Publishing, New York.

Lee, Richard, and Irven DeVore
1968 *Man the Hunter.* Aldine, Chicago.

Leighton, M. M.
1960 The Classification of the Wisconsin Glacial Stage of North Central United States. *Journal of Geology* 68:529-552.

Leudtke, Barbara E.
1992 *An Archaeologist's Guide to Chert and Flint.* Archaeological Research Tools 7, Institute of Archaeology, University of California, Los Angeles, 172 p.

Levine, Frances, and Charles M. Mobley
1976 *Archaeological Resources at Los Esteros Lake, New Mexico.* Southern Methodist University, Institute for the Study of Earth and Man, Department of Anthropology.

Lintz, Christopher
1989 Experimental Thermal Discoloration and Heat Conductivity Studies of Caliche from Eastern New Mexico. *Geoarchaeology* 4:319-346.

Lintz, Christopher
1994 Contextual Considerations. In *Significance Standards for Prehistoric Cultural Resources: A Case Study from Fort Hood, Texas,* by G. L. Ellis, C. Lintz, W. N. Trierweiler, and J. M. Jackson, pp. 26-41. Tri-Services Research Center Series. United States Army Construction Engineering Research Laboratory, Urbana, Illinois. In press.

Lintz, Christopher and Jane L. Anderson (editors)
1989 Temporal Assessment of Diagnostic Materials From the Pinon Canyon Maneuver Site. *Memoirs of the Colorado Archaeological Society Number 4.* Colorado Archaeological Society, Denver.

Lintz, Christopher, and Jack M. Jackson
1994 The Fort Hood Project. In *Significance Standards for Prehistoric Cultural Resources: A Case Study from Fort Hood, Texas,* by G. L. Ellis, C. Lintz, W. N. Trierweiler, and J. M. Jackson, pp. 13-25. Tri-Services Research Center Series. United States Army Construction Engineering Research Laboratory, Urbana, Illinois. In press.

Löffler, Heinz
1986 Ostracod Analysis. In *Handbook of Holocene Palaeoecology and Palaeohydrology,* edited by B. E. Berglund, pp. 693-702. John Wiley and Sons, New York.

Long, J. K., III
1959 Three Central Texas Aspect Sites in Hill County, Texas. *Bulletin of the Texas Archaeological Society* 30:223-252.

Lukowski, P.
1987 *Archaeological Investigations at 41BX1, Bexar County, Texas.* Archaeological Survey Report 135. Center for Archaeological Research, University of Texas at San Antonio.

Lundelius, E. L.
1986 Vertebrate Paleontology of the Balcones Fault Trend. In *The Balcones Escarpment: Geology, Hydrology, Ecology, and Social Development in Central Texas*, edited by P. L. Abbott and C. M. Woodruff, pp. 41-50. Geological Society of America.

Lynott, M. J.
1978 An Archaeological Assessment of the Bear Creek Shelter, Lake Whitney, Texas. Archaeological Research Program, Dept. of Anthropology, Southern Methodist University, Dallas. 109 p.

Mallouf, Robert
1987 Las Haciendas: A Cairn-Burial Assemblage from Northeastern Chihuahua, Mexico. *Office of the State Archeologist Report 35.* Texas Historical Commission, Austin.

Malmer, Nils, and Gösta Regnéll
1986 Mapping Present and Past Vegetation. In *Handbook of Holocene Palaeoecology and Palaeohydrology,* edited by B. E. Berglund, pp. 203-218. John Wiley and Sons, New York.

Mandel, R. D.
1991 Geoarchaeology of a Deeply-Stratified PaleoIndian through Late Prehistoric Site (41BX831) in the Lower Medina River Valley, South Texas. Paper Presented at the 49th Plains Anthropological Conference, November 13-16, 1991, Lawrence, Kansas.

Marchbanks, Michael L.
1989 *Lipid Analysis in Archaeology: An Initial Study of Ceramics and Subsistence at the George C. Davis Site.* Unpublished Masters thesis, Department of Anthropology, University of Texas at Austin.

Mariah Associates, Inc.
1992 Procedures Manual for Archaeological Field Work at Fort Hood, Texas. Unpublished manuscript on file, Austin.

1993 Assessing Research Potential and National Register Eligibility of Large Lithic Resource Procurement Sites at Fort Hood, Texas. Unpublished manuscript on file, Austin.

Marmaduke, William S., and Hayden Whitsett
1975 An Archaeological Reconnaissance in the Vicinity of the Devil's Sinkhole. In *Devil's Sinkhole Area--Headwaters of the Nueces River. A Natural Area Survey, Part VIII of VIII.* Division of Natural Resources and Environment, The University of Texas at Austin, pp. 88-117.

Maruyama, Magoroh
1963 The Second Cybernetics: Deviation Amplifying Mutual Causal Processes. *American Scientist* 51:164-179.

Marx, Karl, and Frederick Engels
1846 *The German Ideology.* In *Collected Works of Marx and Engels,* volume 5, pp. 19-92. International Publishers, New York.

Mason, J. K.
1936 A Central Texas Multiple Metate. *Bulletin of the Central Texas Archaeological Society* 2:80.

Matthews, J. A.
1985 Radiocarbon Dating of Surface and Buried Soils: Principles, Problems, and Prospects. In *Geomorphology and Soils,* edited by K. S. Richards, R. R. Arnett, and S. Ellis, pp. 269-288. Allen and Unwin, London.

McCaleb, N. L.
1985 *Soil Survey of Coryell County, Texas.* United States Department of Agriculture, Soil Conservation Service.

McCullough, Samuel D., Jr.
1986 An Assessment of the Environment and Resources of Central Texas in Terms of Prehistioric Adaptations. Unpublished Masters thesis, Department of Anthropology, University of Texas at Austin.

McGimsey, Charles R., III, and Hester A. Davis
1977 *The Management of Archaeological Resources: The Airlie House Report.* Special Publication of the Society for American Archaeology.

McGinley, Ann Neil
1977 Elemental Analysis of Edwards Formation Flint: A Comparison of Sample areas. M.A. Thesis, Texas A&M University, College Station.

McGinley, Ann Neil, and E. A. Schweikert
1979 Neutron Activation Analysis of Flints from the Edwards Formation. *Journal of Radioanalytical Chemistry* 52(1):101-110.

McKenzie, David R.
1991 Agroethics and Agricultural Research. In *Beyond the Large Farm: Ethics and Rsearch Goals for Agriculture,* edited by P. B. Thompson and B. A. Stout, pp. 33-49. Westview, Boulder, Colorado.

McKern, W. C.
1939 The Midwestern Taxonomic Method as an Aid to Archaeological Culture Study. *American Antiquity* 4:301-313.

McNatt, Logan
1981 An Archaeological Reconnaisance of the Lower Pecos River. In *Five Archaeological Investigations in the Trans-Pecos Region of Texas,* pp. 115-168, Texas Antiquities Committee Permit Series No. 6, Texas Antiquities Committee, Austin, Texas.

Mesrobian, A., R. Merrill, and D. Carlson
1992 Field Investigations. In *Archaeological Site Testing and Evaluation on the Henson Mountain Helicopter Range AWSS Project Area, Fort Hood, Texas,* edited by David L. Carlson. Research Report Number 25. Archaeological Research Management Series. United States Army, Fort Hood, Texas. In press.

Miall, A. D.
1977 Review of the Braided Stream Depositional Environment. *Earth Science Reviews* 13:1-62.

Mill, John Stuart
1859 (1978) *On Liberty.* Edited by E. Rapaport. Hackett, Indianapolis.

1863 (1979) *Utilitarianism.* Edited by G. Sher. Hackett, Indianapolis.

Miller, E. O., and E. B. Jelks
1952 Archaeological Excavations at the Belton Reservoir, Coryell County, Texas. *Bulletin of the Texas Archeological and Paleontological Society* 23:168-217.

Minnis, Paul E.
1985 *Social Adaptation to Food Stress: A Prehistoric Southwestern Example.* University of Chicago.

Moncure, Henry
1989 Impacts Research. In *Archaeological Survey at Fort Hood, Texas Fiscal Year 1980 (Spring).* David Dibble and Frederick Briuer, editors. United States Army, Fort Hood, Texas, Archaeological Resource Management Series, Research Report 3 (not paginated).

Moore, James A.
1981 The Effects of Information Networks in Hunter-Gatherer Societies. In *Hunter-Gatherer Foraging Strategies: Ethnographic and Archeological Analyses,* edited by B. Winterhalder and E, A. Smith, pp. 194-217. University of Chicago Press.

Mueller, H. W., III
1975 *Centrifugal Progradation of Carbonate Banks: A Model for Deposition and Early Diagenesis, Ft. Terrett Formation, Edwards Group, Lower Cretaceous, Central Texas.* Unpublished PhD dissertation, The University of Texas at Austin.

Mueller-Wille, C. S., and David L. Carlson
1990 *Archaeological Survey at Fort Hood, Texas Fiscal Year 1986 Other Training Areas.* United States Army, Fort Hood, Texas, Archaeological Resource Management Series, Research Report 21.

Nanda, Serena
1991 *Cultural Anthropology.* 4th ed. Wadsworth, Belmont, Califronia.

Neck, R. W.
1992 Late Pleistocene and Holocene Environments in the Medina Valley of Texas as Revealed by Nonmarine Molluscs. In *Late Cenozoic Alluvial Stratigraphy and Prehistory of the Inner Gulf Coastal Plain, South-Central Texas* edited by R. D. Mandel and S. C. Caran. Guidebook, 10th Annual Meeting, South-Central Friends of the Pleistocene.

Nordt, Lee C.
1992 *Archaeological Geology of the Fort Hood Military Reservation, Fort Hood, Texas.* Archaeological Resource Management Series, Research Report Number 25. United States Army, Fort Hood, Texas.

1993a Late Quaternary Vegetation and Climatic Changes Based on the Isotopic Composition of Organic Carbon. In *Additional Geoarchaeological Investigations at the Fort Hood Military Reservation, Ft. Hood, Texas.* Archaeological Resource Management Series, Research Report Number 28, Addendum to Research Report Number 25. pp 49-77.

1993b Archaeological Geology of Clear and Browns Creek. In *Additional Geoarchaeological Investigations at the Fort Hood Military Reservation, Ft. Hood, Texas.* Archaeological Resource Management Series, Research Report Number 28, Addendum to Research Report Number 25. pp 79-89.

Nordt, L. C., T. W. Boutton, C. T. Hallmark, and M. R. Waters
1994 Late Quaternary Vegetation and Climate Changes in Central Texas Based on the Isotopic Composition of Organic Carbon. *Quaternary Research* 41(1):109-120.

Nordt, L. C., and C. T. Hallmark
1993 Soil-Geomorphology Guidebook for Cowhouse Creek, Fort Hood, Texas. In *Additional Geoarchaeological Investigations at the Fort Hood Military Reservation, Ft. Hood, Texas.* Archaeological Resource Management Series, Research Report Number 28, Addendum to Research Report Number 25. pp 1-47.

North American Commission on Stratigraphic Nomenclature
1983 North American Stratigraphic Code. *American Association of Petroleum Geologists Bulletin* 67(5):841-875.

Olds, D. L.
1965 Report on Materials from Brawley's Cave, Bosque County, Texas. *Bulletin of the Texas Archaeological Society* 36:111-152. Includes publication of an edited version of a 1919 unpublished report by F. E. Simmons entitled "Report on prehistoric relics and skeletal remains in the Bosque Basin."

Olive, Ben
1992 Botanical Analyses. In *Archaeological Investigations in Bull Branch: Results of the 1990 Summer Archaeological Field School,* edited by D. L. Carlson, pp. 81-89. Archaeological Management Series Research Report Number 19. United States Army, Fort Hood, Texas. Draft submitted for review.

Pearce, J. E.
1919 Indian Mounds and Other Relics of Indian Life in Texas. *American Anthropologist* 21(3):223-234.

1932 The Present Status of Texas Archaeology. *Bulletin of the Texas Archeological and Paleontological Society* 4:44-54.

Pearson, G. W. and M. Stuiver
1993 High Precision Bidecadal Calibration of the Radiocarbon Time Scale 500-2500 BC, Radiocarbon 35:25-33.

Perkins, J. L.
1956 Tonk Creek Shelter. *Central Texas Archeologist* 7:41-47.

Peter, Duane E.
1982 Alternative Perspectives on Burned Rock Middens. In *Archaeological Investigations at the San Gabriel Reservoir Districts, Central Texas,* volume 2, compiled and edited by T. R. Hays, pp. 20-1-20-15. Archaeology Program, Institute of Applied Sciences, North Texas State University, Denton.

Peter, Duane E., and T. R. Hays
1982 Models of Prehistoric Adaptation in the San Gabriel River Valley. In *Archaeological Investigations at the San Gabriel Reservoir Districts, Central Texas,* volume 2, compiled and edited by T. R. Hays, pp. 19-3-19-10. Archaeology Program, Institute of Applied Sciences, North Texas State University, Denton.

Peter, Duane E., T. R. Hays, and Marie-Anne Demuynck
1982 An Evaluation of the "Phase" Concept. In *Archaeological Investigations at the San Gabriel Reservoir Districts, Central Texas,* volume 2, compiled and edited by T. R. Hays, pp. 21-1-21-18. Archaeology Program, Institute of Applied Sciences, North Texas State University, Denton.

Peter, Duane E., William A. Cloud, Cynthia Stiles-Hanson, and Maynard B. Cliff
1990 *Intensive Survey Investigations of the Dughest Project, Val Verde County, Texas.* Geo-Marine, Inc., Miscellaneous Reports of Investigations, No. 6., Plano, Texas.

Phillips, Phillip
1970 *Archaeological Survey in the Lower Yazoo Basin, Mississippi, 1949-1955.* Papers of the Peabody Museum of Archaeology and Ethnology Number 60. Cambridge, Massachusetts.

Piperno, D. R.
1988 Phytolith Analysis: An Archaeological and Geographic Perspective. Academic Press, New York.

Pittman, J. S., Jr.
1959 Silica in Edwards Limestone, Travis County, Texas. In *Silica in Sediments*, Society of Economic Paleontologists and Mineralogists Special Publication 7, H. A. Ireland, ed., 121-134.

Pollard, J. C., J. W. Greer, and H. F. Sturgis

1963 Archeological Excavations at the Boy Scout Rockshelter (41TV69), Travis County, Texas. *Bulletin of the Texas Archeological Society* 34:31-56.

Prewitt, Elton R.

1974 *Archeological Investigations at the Loeve-Fox Site, Williamson County, Texas.* Texas Archeological Survey, Research Report Number 49. University of Texas at Austin.

1981a Archeological Investigations at the Loeve-Fox, Loeve and Tombstone Bluff Sites in the Granger Lake District of Central Texas. Archeological Investigations at the San Gabriel Reservoir Districts, vol. 4. Institute of Applied Sciences, North Texas State University, Denton.

1981b Culture Chronology in Central Texas. *Bulletin of the Texas Archeological Society* 52:65-89.

1985 From Circleville to Toyah: Comments on Central Texas Chronology. *Bulletin of the Texas Archeological Society* 54:201-238.

1991 Burned Rock Middens: A Summary of Previous Investigations and Interpretations. In *The Burned Rock Middens of Texas: An Archeological Symposium,* edited by T. R. Hester, pp. 25-32. Studies in Archeology Number 13. Texas Archeological Research Laboratory, University of Texas at Austin.

n.d. The Rogers Springs Site: 1974 Investigations. Unpublished manuscript on file. Texas Archeological Research Laboratory, University of Texas at Austin.

Prikryl, Daniel.J.

1987 A Synthesis of the Prehistory of the Lower Elm Fork of the Trinity River. Unpublished Masters thesis, Department of Anthropology, University of Texas at Austin.

Putnam, Hilary

1975 Brains and Behavior. In *Mind, Language and Reality,* Philosophical Papers, volume 2, by H. Putnam, pp. 325-341. Cambridge University Press, Cambridge.

1983 Why There Isn't a Ready-Made World. In *Realism and Reason,* Philosophical Papers, vol. 3, by H. Putnam, pp. 205-228. Cambridge University Press, Cambridge.

Quine, W. V.

1953 Two Dogmas of Empiricism. In *From a Logical Point of View,* by W. V. Quine, pp. 20-46. Harvard University Press, Cambridge, Massachusetts.

Quine, W. V., and J. S. Ullian

1970 *The Web of Belief.* 2nd ed. Random House, New York.

Rafferty, Janet E.

1985 The Archaeological Record on Sedentariness: Recognition, Development and Implications. In *Advances in Archaeological Method and Theory,* vol. 8, edited by Michael Schiffer, pp. 113-156. Academic Press, New York.

Ray, Cyrus N.
1929 A Differentiation of the Prehistoric Cultures of the Abilene Region. *Bulletin of the Texas Archeological and Paleontological Society* 1:7-22.

Ray, Cyrus, and E. B. Sayles
1941 An Agreement on Abilene Region Terminology. *Bulletin of the Texas Archeological and Paleontological Society* 13:175-176.

Redder, A. J.
1985 Horn Shelter Number 2: the South End. *Central Texas Archeologist* 10:37-65.

Redder, Albert J.
1985 Bibliography of Frank H. Watt. *Central Texas Archeologist* 10(Spring):12-20.

Reina, Ruben E., and Robert M. Hill, Jr.
1978 *The Traditional Pottery of Guatemala.* University of Texas Press, Austin.

Renfrew, Colin
1977 Alternative Models of Exchange and Spatial Distribution. In *Exchange Systems in Prehistory,* edited by T. K. Earle and J. E. Ericson, pp. 71-90. Academic Press, New York.

Rice, Prudence
1987 *Pottery Analysis: A Source Book.* University of Chicago Press.

Ricklis, Robert A.
1992 The Spread of a Late Prehistoric Bison Hunting Complex: Evidence from the South-Central Coastal Prairie of Texas. *Plains Anthropologist* 37:261-273.

Rindos, David
1984 *The Origins of Agriculture: An Evolutionary Perspective.* Academic Press, New York.

Ritter, Dale F.
1986 *Process Geomorphology.* 2nd ed. Wm. C. Brown, Dubuque, Iowa.

Rose, P. R.
1968 *Edwards Group, Surface and Subsurface, Central Texas.* The University of Texas at Austin, Bureau of Economic Geology, Report of Investigations No. 74, 198 p.

Rosen, S. A., and G. A. Goodfriend
n.d. An Early Date for Gaza Ware from the Northern Negev. *Palestine Exploration Quarterly,* in press.

Rosenberg, Alexander
1988 *Philosophy of Social Science.* Westview, Boulder, Colorado.

Rovner, Irwin

1988 Macro- and Micro-Ecological Reconstruction Using Plant Opal Phytolith Data from Archaeological Sediments. *Geoarchaeology* 3:155-163.

Rye, Owen

1981 *Pottery Technology: Principles and Reconstruction.* Taraxcum, Washington, D.C.

Sackett, James R.

1986 Style, Function, and Assemblage Variation: A Reply to Binford. *American Antiquity* 51:628-634.

Salmon, Merrilee H.

1982 *Philosophy and Archaeology.* Academic Press, New York.

Sanchez, Julia L., and Brian S. Shaffer

1992 Faunal Analysis. In *Archaeological Investigations in Bull Branch: Results of the 1990 Summer Archaeological Field School,* edited by D. L. Carlson, pp. 59-79. Archaeological Management Series Research Report Number 19. United States Army, Fort Hood, Texas. Draft submitted for review.

Savage, Stephen. H.

1990 Modelling the Late Archaic Social Landscape. In *Interpreting Space: GIS and Archaeology,* edited by K. M. S. Allen, S. W. Green, and E. B. W. Zubrow, pp. 73-79. Taylor and Francis, London.

Sayles, E. B.

1931 Some Flint Sources in Central West Texas. *Bulletin of the Texas Archaeological and Paleontological Society* 3:18-23.

Schiffer, Michael B.

1972 Archaeological Context and Systemic Context. *American Antiquity* 37:156-165.

1976 *Behavioral Archaeology.* Academic Press, New York.

1986 Radiocarbon Dates and the "Old Wood" Problem: The Case of the Hohokam Chronology. *Journal of Archaeological Science* 13:13-30.

1987 *Formation Processes of the Archaeological Record.* University of New Mexico Press, Albuquerque.

Schiffer, Michael B., and James Skibo

1987 Theory and Experiment in the Study of Technological Change. *Current Anthropology* 28:595-622.

Schultz, Jack M.

1992 The Use-Wear Generated by Processing Bison Hides. *Plains Anthropologist* 37:333-351.

Schultz, Theodore W.
1974 *Transforming Traditional Agriculture.* Yale University Press, New Haven, Connecticut.

Schumm, S. A.
1969 Geomorphic Implications of Climatic Changes. In *Introduction to Fluvial Processes,* R. J. Chorley, editor. Methuen, London.

1977 *The Fluvial System.* John Wiley & Sons, New York.

Schwarcz, Henry P., and Nicholas Eyles
1991 Laurentide Ice Sheet Extent Inferred from Stable Isotopic Composition (O, C) of Ostracodes at Toronto, Canada. *Quaternary Research* 35:305-320.

Sedlak, Michael A., and Sammy Brown
1992 *Maneuver Activity Damage Assessment Model Applications to Predicting the Effects of the Restationing of the 5th Infantry Division (Mech) to Fort Hood, Texas.* Texas A&M Research Foundation, College Station, Texas.

Shafer, H. J.
1977 Late Prehistory of Central Texas. *Bulletin of the South Plains Archeological Society* 3:18-24.

Shafer, Harry J.
1963 Test Excavations at the Youngsport Site, a Stratified Site in Bell County. *Bulletin of the Texas Archeological Society* 34:57-81.

1986 The Future of Texas Archeology. *Texas Archeology* 30(2):1-6.

1992 Research Potential of Prehistoric Quarry Sites. In *Archaeological Site Testing and Evaluation on the Henson Mountain Helicopter Range AWSS Project Area, Fort Hood, Texas,* edited by David L. Carlson. Research Report Number 25. Archaeological Research Management Series. United States Army, Fort Hood, Texas. In press.

Shafer, Harry J., and Thomas R. Hester
1983 Ancient Maya Workshops in Northern Belize, Central America. *American Antiquity* 48:519-543.

Shafer, H. J., D. A. Suhm, and J. D. Scurlock
1964 *An Investigation and Appraisal of the Archeological Resources of Belton Reservoir, Bell and Coryell Counties, Texas: 1962.* Miscellaneous Papers Number 1. Texas Archeological Salvage Project, University of Texas at Austin.

Shelley, P. H.
1984 PaleoIndian Movement on the Southern High Plains: A Reevaluation of Inferences Based on Lithic Evidence from Blackwater Draw. *Current Research* 1:35-36.

Siegenthaler, Ulrich, and Ulrich Eicher
1986 Stable Oxygen and Carbon Isotope Analyses. In *Handbook of Holocene Palaeoecology and Palaeohydrology,* edited by B. E. Berglund, pp. 407-422. John Wiley and Sons, New York.

Sillen, A., J. C. Sealy, and N. J. van der Merwe
1989 Chemistry and Paleodietary Research: No More Easy Answers. *American Antiquity* 54:504-512.

Skinner, B. F.
1953 *Science and Human Behavior.* Macmillan, New York.

Skinner, S. A.
1979 The Bushwhack Shelter (X41KR116), Kerr County, Texas. *La Tierra* 6(2):3-12.

Skinner, S. Alan
1971 Prehistoric Settlement of the DeCordova Bend Reservoir, Central Texas. *Bulletin of the Texas Archeological Society* 42:149-269.

1974 Prehistoric Settlement of a "Natural Area." Unpublished Ph.D. dissertation, Department of Anthropology Southern Methodist University.

Skinner, S. A., F. L. Briuer, W. A. Meiszner, and I. Show
1984 *Archaeological Survey at Fort Hood, Texas, Fiscal Year 1979.* Archaeological Resource Management Series, Research Report Number 2. United States Army, Fort Hood, Texas.

Skinner, S. A., F. L. Briuer, G. Thomas, and I. Shaw
1981 *Initial Archaeological Survey at Fort Hood, Texas, FY78.* Archaeological Resource Management Series, Research Report Number 1. United States Army, Fort Hood, Texas.

Slade, R. M., Jr.
1986 Large rainstorms along the Balcones Escarpment in Central Texas. In *The Balcones Escarpment: Geology, Hydrology, Ecology, and Social Development in Central Texas*, edited by P. L. Abbott and C.M. Woodruff, pp. 15-19. Santa Fe Springs, California, Comet Reproduction Service.

Smith, Bruce N. and W. V. Brown
1973 The Kranz Syndrome in the Gramineae as Indicated by Carbon Isotope Ratios. *American Journal of Botany* 60:505-513.

Smith, Ralph A.
1962 Apache "Ranching" Below the Gila. *Arizoniana* 3(4):1-17.

Smith, Robert L.
1977 *Elements of Ecology and Field Biology.* Harper and Row, New York.

Soil Survey Staff
1975 *Soil Taxonomy: A Basic System for Making and Interpreting Soil Surveys.* United States Department of Agriculture Handbook, 436. U.S. Government Printing Office, Washington.

Sollberger, J. B.
1978 A Prehistoric Rockshelter in Kerr County, Texas. Originally published in *The Record* 8(3). Reprinted in *La Tierra* 5(4):2-6.

Sollberger, J. B., and Thomas R. Hester
1972 The Strohacker Site: A Review of the Archaic Manifestations in Texas. *Plains Anthropologist* 17:327-344.

Sorrow, William
1969 *Archeological Investigations at the John Ischy Site: A Burnt Rock Midden in Williamson County.* Papers of the Texas Archeological Salvage Project Number 18. University of Texas at Austin.

Sorrow, William, Harry J. Shafer, and Richard Ross
1967 Excavations at Stillhouse Hollow Reservoir. *Papers of the Texas Archaeological Salvage Project* 11. University of Texas at Austin.

Speth, John D.
1983 *Bison Kills and Bone Counts: Decision Making by Ancient Hunters.* University of Chicago Press, Chicago.

Stafford, Thomas W., Jr.
1993 AMS $_{14}$C Dating in Geoarchaeology: Field and Laboratory Controls on Absolute Accuracy and Precision. Paper presented at the Annual Meeting of the Geological Society of America, Boston.

Stephenson, R. L.
1947 Archaeological Survey of Whitney Basin: A preliminary report. *Bulletin of the Texas Archeological and Paleontological Society* 18:129-142.

1970 Archeological investigations in the Whitney Reservoir area, central Texas. *Bulletin of the Texas Archeological Society* 41:37-286.

Stephenson, Robert L.
1985 Frank H. Watt: A Tribute. *Central Texas Archeologist* 10(Spring):1-6.

Steward, Julian
1973 *Theory of Culture Change: The Methodology of Multilinear Evolution.* University of Illinois, Urbana.

Stine, Roy S., and T. Drew Decker
1990 Archaeology Data Integration and GIS. In *Interpreting Space: GIS and Archaeology,* edited by K. M. Allen, S. W. Green, and E. B. W. Zubrow, pp. 134-140. Taylor & Francis, London.

Story, Dee Ann
1990 Cultural History of the Native Americans. In *The Archeology and Bioarcheology of the Gulf Coastal Plain: Volume 1,* by D. A. Story, J. A. Guy, B. A. Burnett, M. D. Freeman, J. C. Rose, D. G. Steele, B. W. Olive, and K. J. Reinhard, pp. 161-366. Arkansas Archaeological Survey Research Series Number 38. Arkansas Archaeological Survey, Fayetteville, Arkansas.

Stuiver, Minze and Paula J. Reimer
1993 Extended 14C Database and Revised CALIB Radiocarbon Calibration Program. *Radiocarbon* 35:215-230.

Stute, M. A., P. Schlosser, J. F. Clark, and W. S. Broeker
1992 Paleotemperatures in the Southwestern United States from Noble Gases in Groundwater. *Science* 256:100-1003.

Suhm, D. A.
1957 Excavations at the Smith Rockshelter, Travis County, Texas. *The Texas Journal of Science* 9(1):26-58.

Suhm, Dee Ann
1960 A Review of Central Texas Archeology. *Bulletin of the Texas Archeological Society* 29:63-107.

Suhm, Dee Ann, and Edward B. Jelks
1962 *Handbook of Texas Archaeology: Type Descriptions* (reprinted 1989). Jointly published by The Texas Archaeological Society, Special Publication Number 1, and The Texas Memorial Museum, Bulletin Number 4.

Suhm, Dee Ann, Alex D. Krieger, and Edward Jelks
1954 An Introductory Handbook of Texas Archaeology. *Bulletin of the Texas Archeological Society* 25:1-582.

Sullivan, Alan P., III, and Keneth C. Rozen
1985 Debitage Analysis and Archaeological Interpretation. *American Antiquity* 50:755-779.

Syms, E. Leigh
1977 Cultural Ecology and Ecological Dynamics of the Ceramic Period in Southwestern Manitoba. Memoir 12, *Plains Anthropologist* 22(76), Part 2.

Taylor, A. J.
1982 The Mammalian Fauna from the Mid-Irvingtonian Fyllan Cave Local Fauna, Travis County, Texas. Unpublished Masters thesis, University of Texas at Austin.

Taylor, Walter W.
1948 *A Study of Archeology.* Memoirs Series of the American Anthropological Association.

1964 Tethered Nomadism and Water Territoriality: An Hypothesis. In *Acts of the 35th International Congress of Americanists*, pp.34-38. Mexico City.

Testart, Alain
1982 The Significance of Food Storage Among Hunters-Gatherers: Residence Patterns, Population Densities, and Social Inequalities. *Current Anthropology* 23:523-537.

Thomas, David Hurst
1986 Refiguring Anthropology: First Principles of Probability and Statistics. Waveland Press, Inc, Prospect Heights, Illinois.

Thomas, George B.
1978 A Survey and Assessment of the Archeological Resources of Fort Hood, Texas. *Bulletin of the Texas Archeological Society* 49:193-240.

Thoms, Alston V.
1989 The Northern Roots of Hunter-Gatherer Intensification: Camas and the Pacific Northwest. Unpublished Ph.D. dissertation, Department of Anthropology, Washington State University, Pullman.

Thompson, P. B., G. L. Ellis, and B. A. Stout
1991 Introduction: Values in the Agricultural Laboratory. In *Beyond the Large Farm: Ethics and Research Goals for Agriculture,* edited by P. B. Thompson and B. A. Stout, pp. 3-31. Westview, Boulder, Colorado.

Todd, Larry
1992 Rethinking Context: A Descriptive or an Analytical Concept? Paper presented at the 50th Plains Anthropological Conference, Lincoln.

Toomey, R. S., III.
1993 Late Pleistocene and Holocene Faunal and Environmental Changes at Hall's Cave, Kerr County, Texas. Unpublished Ph.D. dissertation, University of Texas at Austin.

Torrance, Robin
1983 Time Budgeting and Hunter-Gatherer Technology. In *Pleistocene Hunters and Gatherers in Europe,* edited by G. Bailey, pp. 11-22. Cambridge University Press, Cambridge.

Toynbee, Arnold
1976 *Mankind and Mother Earth.* Oxford University Press, New York.

Treece, Abby
1992 A Study of Five Annular Burned Rock Middens from the O. H. Ivie Reservoir, West Central Texas. Unpublished Masters thesis, Department of Anthropology, University of Texas at Austin.

Treece, Abby C., Christopher Lintz, W. Nicholas Trierweiler, J. Michael Quigg, Kevin A. Miller
1993 Cultural Resource Investigations In The O. H.Ivie Reservoir, Concho, Coleman, and Runnels Counties, Texas. Volume III Data Recovery Results From Non-Ceramic Sites. Mariah Associates, Inc., *Technical Report 346-III,* Austin.

Trierweiler, Nicholas
1994a Managing Cultural Resources on Large Military Reservations. In *Significance Standards for Prehistoric Cultural Resources: A Case Study from Fort Hood, Texas,* by G. L. Ellis, C. Lintz, W. N. Trierweiler, and J. M. Jackson, pp. 1-12. Tri-Services Research Center Series. United States Army Construction Engineering Research Laboratory, Urbana, Illinois. In press.

1994b Implementing the Management Program. In *Significance Standards for Prehistoric Cultural Resources: A Case Study from Fort Hood, Texas,* by G. L. Ellis, C. Lintz, W. N. Trierweiler, and J. M. Jackson, pp. 183-202. Tri-Services Research Center Series. United States Army Construction Engineering Research Laboratory, Urbana, Illinois. In press.

Trigger, Bruce G.
1978 *Time and Traditions: Essays in Archaeological Interpretation.* Columbia University Press, New York.

Tringham, R., G. Cooper, G. Odell, B. Voytek, and A. Whitman
1974 Experimentation in the Formation of Edge Damage: A New Approach to Lithic Analysis. *Journal of Field Archaeology* 1:171-196.

Troike, Rudolph C.
1955 Anthropological Theory and Plains Archeology. *Bulletin of the Texas Archeological Society* 26:113-143.

Tsoar, H., and G. A. Goodfriend
n.d. Chronology and Paleoenvironmental Interpretation of Holocene Eolian Sands at the Inland Edge of the Sinai-Negev Erg. Ms. submitted to *The Holocene.*

Tunnell, C. D.
1962 Oblate: A Rockshelter Site. In *Salvage Archaeology of Canyon Reservoir: the Wunderlich, Footbridge, and Oblate Sites*, edited by L. Johnson, Jr., D. A. Suhm, and C. D. Tunnell. Texas Memorial Museum Bulletin 5. 126 p.

Tunnell, Curtis
1978 *The Gibson Lithic Cache from West Texas.* Office of the State Archaeologist, Texas Historical Commission, Office of the State Archaeologist Report 30, Austin, Texas.

Turner, Ellen S.
1989 Exploring the Possibilities of Acorn Utilization in the Burned Rock Middens of Texas. *Bulletin of the Texas Archeological Society* 59:177-191.

Turner, Ellen S., and Thomas R. Hester
1993 *A Field Guide to Stone Artifacts of Texas Indians.* 2nd ed. Texas Monthly Press, Austin.

Turner, William B., and Walter E. Klippel
1989 Hunter-Gatherers in the Nashville Basin: Archaeological and Geological Evidence for Variability in Prehistoric Land Use. *Geoarchaeology* 4:43-67.

Turpin, Solveig A.
1991 Time Out of Mind: The Radiocarbon Chronology of the Lower Pecos River Region. In *Papers on Lower Pecos Prehistory,* edited by S. A. Turpin, pp. 1-49. Studies in Archeology Number 8. Texas Archeological Research Laboratory, University of Texas at Austin.

Turpin, Solveig A., and Michael W. Davis
1993 The 1989 TAS Field School: Devils River State Natural Area. *Bulletin of the Texas Archeological Society* 61:1-58.

United States Department of the Interior, National Park Service
1977 Recovery of Scientific, Prehistoric, Historic, and Archaeological Data: Methods, Standards and Reporting Requirements. *Federal Register* 42(19, 28 January 1977): 5374-5383.

1983 Archaeology and Historic Preservation; Secretary of the Interior's Standards and Guidelines. *Federal Register* 48(190, 29 September 1983):44716-44742.

van der Leeuw, Sander E.
1981 Ceramic Exchange and Manufacture: A "Flow Structure" Approach. In *Production and Distribution: A Ceramic Viewpoint,* edited by H. Howard and E. L. Morris, pp. 361-386. British Archaeological Reports International Series 120. Oxford.

Vayda, Andrew P, and Roy A. Rappaport
1968 Ecology, Cultural and Noncultural. In *Introduction to Cultural Anthropology*, edited by James Clifton, pp. 447-496. Houghton Mifflin, New York.

Ward, G. K., and S. R. Wilson
1978 Procedures for Comparing and Combining Radiocarbon Age Determinations: A Critique. *Archaeometry* 20(1):19-31.

Warren, Robert E.
1990 Predictive Modeling in Archaeology: A Primer. In *Interpreting Space: GIS and Archaeology,* edited by K. M. Allen, S. W. Green, and E. B. W. Zubrow, pp 90-111. Taylor & Francis, London.

Watt, F. H.
1936 A Prehistoric Rockshelter Burial in Bell County, Texas. *Bulletin of the Central Texas Archaeological Society* 2:5-27.

1961 Two Radiocarbon Dates from the Central Brazos Valley. *Bulletin of the Texas Archeological Society* 31:327-328.

1978 Radiocarbon Chronology of Sites in the Central Brazos Valley. *Bulletin of the Texas Archeological Society* 49:111-138.

Watt, Frank H.
1938 The Waco Sinker. *Bulletin of the Central Texas Archeological Society* 4:21-70

Watt, Frank H. (editor)
1936 *Bulletin of the Central Texas Archeological Society No. 2.* Central Texas Archeological Society, Waco.

Wehmiller, J.
1977 Amino Acid Studies of the Del Mar, California Midden Site: Apparent Rate Constants, Ground Temperature Models, and Chronological Implications. *Earth Planetary Science Newsletter* 37:184-196.

Weir, Frank
1976 The Central Texas Archaic. Unpublished Ph.D. dissertation, Department of Anthropology, Washington State University, Pullman.

1979 Greenhaw: An Archaic Site in Central Texas. *Bulletin of the Texas Archaeological Society* 50:5-67.

Wiessner, Polly
1985 Style or Isochrestic Variation? A Reply to Sackett. *American Antiquity* 50:160-166.

Willey, Gordon R., and Phillip Phillips
1958 *Method and Theory in American Archaeology.* University of Chicago Press.

Willey, Gordon R., and Jeremy A. Sabloff
1980 *A History of American Archaeology.* 2nd ed. W. H. Freeman, San Francisco.

Williams-Thorpe, O., R. S. Thorpe, C. Elliot, and C. Xenophontos
1991 Archaeology, Geochemistry, and Trade of Igneous Rock Millstones in Cyprus During the Late Bronze Age to Roman Periods. *Geoarchaeology* 6:27-60.

Wilmsen, Edwin N., and Frank H. H. Roberts, Jr.
1984 *Lindenmeier, 1934-1974: Concluding Report on Investigations.* Smithsonian Contributions to Anthropology Number 24. Smithsonian Institution, Washington.

Wilson, E. W.
1930 Burned Rock Mounds of Southwest Texas. *Bulletin of the Texas Archeological and Paleontological Society* 2:59-63.

Wilson, L.
1973 Relationships Between Geomorphic Processes and Modern Climates as a Method in Paleoclimatology. In *Climatic Geomorphology*, edited by E. Derbeyshire. MacMillan Press, New York.

Winner, Langdon
1977 *Autonomous Technology: Technics-out-of-Control as a Theme in Political Thought.* MIT Press, Cambridge, Massachusetts.

Winterhalder, Bruce, and Eric A. Smith (editors)
1981 *Hunter-Gatherer Foraging Strategies: Ethnographic and Archeological Analyses.* University of Chicago Press.

Wood, Raymond, and Donald Lee Johnson
1978 A Survey of Disturbance Processes in Archaeological Site Formation. In *Advances in Archaeological Method and Theory*, volume 1, edited by Michael B. Schiffer, pp. 315-381, Academic Press, New York.

Woodruff, C. M., Jr., and P. L. Abbott
1986 Preface. In *The Balcones Escarpment: Geology, Hydrology, Ecology, and Social Development in Central Texas*, edited by P. L. Abbott and C. M. Woodruff. Geological Society of America.

Woolsey, A. M.
1938 Additional Lake Buchanan Sites. In *Annual Report of WPA and the University of Texas Archaeological Research, Lake Buchanan, 1936-1937*, pp. 119-145. Anthropological Papers Vol III, No. 1, Bureau of Research in the Social Sciences Study No. 26, University of Texas Publication No. 3802. Austin.

Yellen, John E.
1976 Settlement Patterns of the !Kung: An Archaeological Perspective. In *Kalahari Hunter-Gatherers: Studies of the !Kung San and Their Neighbors,* edited by R. B. Lee and I. DeVore, pp. 47-72. Harvard University Press, Cambridge, Massachusetts.

Young, D., S. Patrick, and D. G. Steele
1987 An Analysis of the Paleoindian Double Burial from the Horn Shelter No. 2, in Central Texas. *Plains Anthropologist* 32:275-298.

Young, Diane
1988 An Osteological Analysis of the Paleoindian Double Burial from Horm Shelter, Number 2. *Central Texas Archeologist* 11(Spring):13-115.

Young, Wayne C.
1981 *Investigations at the Squawteat Peak Site, Pecos County, Texas.* Texas State Department of Highways and Public Transportation, Highways Design Division, Publications in Archaeology Report No. 20, Austin, Texas.

1982 *Excavations at the Ram's Head Site 41PC35, Pecos County, Texas.* Texas State Department of Highways and Public Transportation, Highways Design Division, Publications in Archaeology Report No. 23, Austin, Texas.

1986 *Archaeological Investigations in Eastern Kimble County, Texas.* Texas State Department of Highways and Public Transportation, Highways Design Division, Publications in Archaeology Report No. 30, Austin, Texas.

Zubrow, Ezra B. W.
1990 The Fantasies of GIS Software. In *Interpreting Space: GIS and Archaeology,* edited by K. M. Allen, S. W. Green, and E. B. W. Zubrow, pp 184-193. Taylor & Francis, London.

APPENDIX A:

DATA COMPENDIUM

(under separate cover)

APPENDIX B:

SAMPLE FIELD FORMS

FORT HOOD SITE EVALUATIONS

Form 1: Site Summary

SITE NO.: ____________

Reconnaissance Date(s): ______________; Crew: ______________________________

Shovel Testing Date(s): __________________; Resurvey Date(s): ______________

Training Area: ________ Airphoto map: ________ UTM East: __________, UTM North __________

SUMMARY OF PREVIOUS INVESTIGATIONS

Date originally recorded: ____________ Recorded by: ________________________

Subsequent visits: ____

Site type/features present: ____

Disturbance extent: __________ Disturbance type: ____________________

Artifacts collected/noted: ____

Assessment of previous information:

SUMMARY OF SITE CHARACTERISTICS (location, geomorphology, archaeology, impacts, conclusions)

SUMMARY OF CURRENT INVESTIGATIONS

total number of subareas: ________

	Area A	Area B	Area C
RECONAISSANCE SUMMARY			
Landform (upland, slope, terrace)			
Context (primary, secondary)			
Integrity (excellent to poor)			
Revised Site Type			
Site Age / Chronolog. stage			
no. surface probes			
New or revised map			
surface collections			
Archaeological Score			
Geomorphic Score			
Recommendation (NFW, ST, Surv)			
SUBSURFACE SUMMARY			
shovel tests (30x30cm)			
quads (50x50cm)			
test pits (1x1m)			
total recovered lithics			
total excavated burned rock			
total recovered bone/other			
distribution/comments			
SURFACE SUMMARY (LRP sites only)			
Chert Zones			
Impact Zones			
Percent Impacted			
Resurvey Transects			
Resurvey Observation Points			
EVALUATION SUMMARY			
Mgmt Unit(s) (LRP sites only)			
NRHP Eligibility (NE, PE, E)			
Mgmt. Recommendation (NFW, T, P)			
Suggested Testing (#m^2, #BHT)			
Other Mgmt (NR District)			

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MARIAH ASSOCIATES, INC.

Fort Hood Evaluation and Shovel Testing
Revised Sketch Map - Form 2
Mariah Associates, Inc. 1992

FORT HOOD SITE EVALUATIONS

Form 3: Descriptive Archaeological Assessment

SITE NO.: __________ Subsection(s): _____________ Training Area: ______

Recorder: ___________________ Date: ____________

Dateable materials (diagnostics, bone, shell, perishables)

Features (for each: type, size, number, preservation, location, disturbance)

Cultural material (for each type: description, location [horizontal, vertical], abundance)

Nature of occupation (number of components, mixing, height of overhang)

Resources available (chert, springs, shelter)

Disturbance (types, locations, intensity)

Preservation of perishable goods (tufa, bog, wet/dry, dry)

FORT HOOD SITE EVALUATIONS

Form 4: Quantitative Archaeological Assessment

SITE NO.: __________ Subsection(s): _____________ Training Area: ______

Recorder: ___________________ Date: ____________

For each, circle ordinal rank; sum rankings at bottom

Potentially Dateable Material

1 = few **3** = unknown **4** = abundant
1 = one type **3** = two/three types **4** = four or more types

Area Function

1 = debitage only **3** = unknown **4** = tools & debitage **6** = features, tools, debitage

Archaeological In-Situ Material

1 = absent **3** = unknown **6** = present

Total Area: **1** = < 20m^2 **2** = 20-50m^2 **3** = 50-200m^2 **4** = 200-1000m^2 **5** = > 1000m^2
Percent of Total Area: **1** = <10% **2** = 10-80% **3** = unknown **5** = 80-100%
Depth of Deposits: **1** = <20 cm **2** = 20-40 cm **3** = unknown **5** = > 40 cm
Features: **3** = intact features on disturbed surfaces

Ecofacts

1 = none **2** = snails **3** = clams **4** = bone **5** = multiple types

Nature of Cultural Occupation(s) either Unknown, Primary, or Secondary

Unknown **4** = unknown whether primary or secondary

Primary context (undisturbed)
2 = unsealed single or multiple (palimpsest) activity surface(s)
4 = multiple activity surfaces, partially or completely sealed
6 = sealed single or multiple activity surface(s)

Secondary context (transported)
1 = unsealed **2** = sealed

Artifact Assemblage Uniques (non-local lithics, unique tools)

1 = none **3** = unknown **6** = unique

TOTAL ARCHAEOLOGICAL SCORE: ☐

FORT HOOD SITE EVALUATIONS

Form 5: Descriptive Geomorphic Assessment

SITE NO.: __________ Subsection(s): _____________ Training Area: ______

Recorder: __________________ Date: ____________

OBSERVATIONS

Exposures (for each: height, location, deposit type, cultural manifestations, features, and depth)

Geomorphic Surfaces (relief, relative height)

Soil or Sediment Profiles (for each: horizon sequence, parent material, age estimate, integrity)

Disturbance (form, extent, location)

Surface or Subsurface Visibility (vegetation type, density, location of visible surfaces, % visible)

Soil Probes (for each: location, depth, profile description, cultural material)

INTERPRETATIONS

Depositional Processes and Events (number, type of process, age)

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FORT HOOD SITE EVALUATIONS
Form 5: Descriptive Geomorphic Assessment, page 2

SITE __________, Subsection(s) ____________

Erosional Events (number, type, extent, age)

Cultural Occupations/Horizons (number, type, extent, features, age)

RECOMMENDATIONS (sketch map and illustrate all locations on site map)

Subsurface Inspection (trenches, number and locations)

Qualitative Evaluation of Site Context (relative area of potential deposits, thickness, number of occupations)

In-situ Archaeological Deposits (present? are they restricted to features?)

COMMENTS

FORT HOOD SITE EVALUATIONS

Form 6: Quantitative Geomorphic Assessment

SITE NO.: __________ Subsection(s): ______________ Training Area: _______

Recorder: ___________________ Date: ____________

CONTEXT

Surface Type (circle one)

1 flat to gently sloping upland surface
2, 2, 1 water spreading slope: low / moderate / steep
3, 2 ,2 water gathering slope: low / moderate / steep
4 colluvial toe slope
5 terrace; 1° 2° 3° 4° 5° order stream
3 floodplain; 1° 2° 3° 4° 5° order stream
3, 5 rock shelter; minimal deposits obvious deposits

Age of Geomorphic Surface (circle one)

1 ancient (>15,000 yrs; Bt, Bk, K)
2 moderate (15,000-2,000 yrs; Bw, weak Bt, no B)
2 young (<2,000 yrs; A-C, no soil development)
1.5 unknown. give reason: ______________________________

Position and Context of Cultural Remains (circle one)

1, 5, 4, 3 surface / buried / buried & surficial / unknown

CONTEXT SUBTOTAL: ________

INTEGRITY

In-situ Deposits of Late Pleistocene/Holocene Age (circle one)

5, 1, 3 present / absent / unknown
discrete / continuous / unknown
thickness: _________. depth: _________

In-situ Cultural Deposits (circle one)

5, 3, 1, 3 present / potentially present / absent / unknown

Pedoturbation (circle one)

1, 2, 3, 1.5 extent: HI (>50%) / MED (20-50%) / LO (<20%) / unknown
Form: argillic / faunal / floral / vehicular / vandalism

Erosion (circle one)

1, 2, 3, 1.5 Extent: HI (>50%) / MED (20-50%) / LO (<20%) / unknown
Form: gully / sheet / road / cutbank
Currently active or remnant
Evidence: (type, extent, location) __________________________

INTEGRITY SUBTOTAL: _________

TOTAL GEOMORPHIC SCORE: ☐

Fort Hood Evaluation and Shovel Testing
Shovel Test Results - Form 7
Mariah Associates, Inc. 1992

Site No.________ Recorder________ Date________

Maneuver Area________ Site Type________ Subsection________ p____of____

On Site Transects				Shovel Hole No.	Diameter (cm)	Depth (cm bs)	Sediment Texture (clay, sandy, rocky) Color (dark, light)	Screen Y/N (6 mm)	Cultural Material	FS No.	Comments
Line No.	Datum	Bearing°	Distance (m)						No., Type (6 flakes, 3 burned rocks)		

field done? Y N : QC checked? Y N

FORT HOOD ARCHAEOLOGICAL PROGRAM
1993-1994 NRHP Testing
Excavation Level Record

Site: ____________ subarea: ____________
Test Pit: ____________ Level: ____________
Recorder: ____________ Date: ____________

PLAN VIEW

PROVENIENCE DESIGNATION

Main PNUM: ________
Other PNUM: ________ describe: ____________
Other PNUM: ________ describe: ____________

ELEVATION cmbd/cmbs	NW	SW	SE	NE
Starting Depth				
Ending Depth				

** Circle pit datum corner above & on plan

SUMMARY OF LEVEL:

TECHNIQUES: arbitrary cultural natural comments: ____________
pick/shovel shovel trowel comments: ____________
1/4" screen 1/8" screen comments: ____________

OBSERVATIONS

Soil Texture: ____________ Color: ____________
Feature: none Fea.# ________ Type: ____________
Charcoal: none flecks chunks // feature non-feature
Disturbance: none root rodent erosion vandal. other: ________

ROCK

Burned Rock: ________ pieces; ________ kg
Other Rock: ________ pieces; ________ kg
comments

ARTIFACTS (type)	Total	Comments (give PNUM if different than level)
lithic tools		ID types:
lithics		material:
bone		ID specimens:
shell		types:

SAMPLES	Feature#	Comments (give PNUM if different than level)

PHOTOGRAPHS (include video)	film	roll #	shot #	direct.	subject

PROFILED? yes / no

FORT HOOD ARCHAEOLOGICAL PROGRAM

1993-1994 NRHP TESTING

Field Catalog

SITE NO.: ________ Recorder: ________ Date: ________

P#	PROVENIENCE HORIZONTAL	PROVENIENCE VERTICAL	CONTENTS	COUNT	COMMENTS

FORT HOOD SITE EVALUATIONS

Summary of Shovel Tests - Form 11

SITE NO.: ____________ **SUBAREA:** ______ **PAGE** ___ **OF** ___ *for this subarea*

Shovel test date: __________ lab date: __________; lab analyst: ________________.
Total number of units: ______ shovel tests, ______ quad tests, and ______ test pits.
Total number of features: _______ surface recorded, _______ subsurface investigated.
Maximum depth of testing: _________; maximum depth of cultural material __________.

KEY: // = bedrock; * = charcoal/ash; **H** = historic/recent; **S** = shell; **B** = bone; **PP** = proj. pt.
+ = item present but not counted; + + = item abundant but not counted.
For ecofacts, distinguish counts for bone, shell, and other.
Note features and diagnostic items under comments (eg., Pedernales pt. @20-30; Feature #1 @ 0-30).

HOLE NO.	item	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	TOTAL	COMMENTS
	lithics												
	ecofacts												
	burned rock												
	lithics												
	ecofacts												
	burned rock												
	lithics												
	ecofacts												
	burned rock												
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	ecofacts												
	burned rock												
TOTAL	lithics												
	ecofacts												
	burned rock												
	TOTAL ITEMS												
	# of holes												
	DENSITY												

FORT HOOD SITE EVALUATIONS

Form 12: Site Treatment Instructions

SITE NO.: ______________ Geomorphic area ________ of ______ areas

Recon Date(s): ________________ Recorder: ____

Training Area: ________ Airphoto map: ________ UTM East: ____________, UTM North ____________

Site Characteristics

Landform: ______________________________
Context: ______________________________
Context: ______________________________
Age: ______________________________
Integrity: ______________________________
Archaeo. score: ______________________________
Geomorph. score: ______________________________

Is Subsurface Testing Necessary ? YES / NO

_______ 1x1 test units are recommended
_______ 50x50 cm quad tests are recommended
_______ 35 cm shovel tests are recommended
_______ Backhoe trenches are recommended (NRHP testing phase)

Is Resurvey Necessary ? YES / NO

Is Other Work Necessary ? YES / NO

Planning Information

Area for ST ________ m2
Projected depth ________ cm
Projected hours ________ hr (at 10 ST/day)
Optimal crew size ____________ persons

Area for Resurvey: ________ m2
Vegetation density: open mixed closed
Transect interval: 20 25 30 35m
Observation interval: 20 25 30 35m

Special Instructions to Shovel Crew/Resurvey Crew (access, vegetation, overhang height):

Shovel Testing / Resurvey Completed

ST Crew Chief: ____________________ Date completed: ________________
________ shovel tests, ________ quad tests, ________ test pits

Resurvey Crew Chief: ____________________ Date completed: ________________
________ transects, ________ stop points

Other work done:

YES / NO: Artifacts checked into Lab?

YES / NO: Field Inventory checked into Lab?
Form 10 total sheets: ________

YES / NO: Field forms filed in office for QA?
Form 7 total sheets: ________ (shovel tests)
Form 8 total sheets: ________ (1x1 tests)
Form 16 total sheets: ________ (features)
Form 17 total sheets: ________ (resurvey)

YES / NO: Tracking tag moved on board?

YES / NO: Did you have fun?

FORT HOOD SITE EVALUATIONS

Form 13

Quality Control Program - Data Consistency Check

Site _____; Subarea(s)___ -or- Impact Zone(s)____ Checked by:____________________ Date:_______

Circle Yes or No; Explain all No

Locational Data Completed by:____________________

Y N Site Number consistent on all forms?
Y N Training Area consistent on all forms?
Y N Subarea/Impact Zone agreement?
Y N UTM E & N correct?

Sketch Map Completed by:____________________

__ Site Number?
__ North Arrow?
__ Scale?
__ BHTs Suggested?
__ STs Plotted?
__ Features Plotted?
__ Artifacts Plotted?
__ Site Boundaries?
__ Subarea Boundaries?
__ Impact/Chert Zone Boundaries?

Archaeological Data Completed by:____________________

Y N Fm 1: Overview summarizes previous work?
Y N Fm 1: Overview summarizes all current work?
Y N Fm 3: All prompts addressed?
Y N Fm 3: Features numbered (on map, too) with sizes/types indicated?
Y N Fm 3: Datable materials agree with Fm 4?
Y N Fm 4: Archaeological score add OK?
Y N Fm 10: Collected artifacts have inventory sheet?
Y N Fms 1,4 & 12: Archaeological scores agree?

Geomorphological Data Completed by:____________________

Y N Fm 5: Are all prompts addressed?
Y N Fms 5&6: context-1 agree?
Y N Fms 5&6: integrity-3 & 4 agree?
Y N Fms 6: Geomorphological score add OK?
Y N Fm 1, 6 & 12: Geomorphological scores agree?

Shovel Testing Data Crew Chief:____________________

Y N Excavation needed? (if no skip)
Y N ST/TP locations plotted on site map?
Y N P#'s on Fms 7,8 (ST/Level) agree with Fm 10 (p#)?
Y N Data on bags agree with Fms 7, 8, 10 (ST/Level/P#)?
Y N Fms 7 & 8 recovered artifacts agree with Fm 1?

LRP Reconnaissance Completed by:____________________

Y N Resurvey needed? (if no, QA is complete)
Y N Form 14 completed for each chert zone?
Y N Form 15 completed for each resurveyed impact zone?
Y N Form 16 section completed for each feature?

Page Over

Reconnaissance/Resurvey Map Completed by: ____________________

___ Site Number
___ North Arrow
___ Scale
___ Site Boundary/Geomorphic Overlay
___ Geomorphic Subareas/Geomorphic Overlay
___ Previously Identified Features/Geo Overlay
___ Chert Zone Overlay
___ Impact Zone Overlay
___ Resurvey Transects/#'s
___ Negative Observations
___ Positive In-transit
___ Management Units/Labelled

LRP Resurvey Crew Chief: ________________________

Y N Resurvey Fm 17 for each transect?
Y N Sheet summary completed for each Resurvey Fm 17?

LRP Evaluation Completed by: _______________________

Y N Summary output for each resurveyed impact zone?
Y N All appropriate questions answered on summary sheet?
Y N Description of management units in site module?
Y N Recommendation made for each management unit?

FORT HOOD SITE EVALUATIONS

Form 14: LRP Chert Resource Description

SITE NO.: ____________ **Recorder:** _________________________ **Date:** ______________

Are multiple resource zones present on this site? YES NO
If yes, this sheet is for CHERT ZONE ______ of ______ zones

Chert Resource Location (Check one and fill in/circle as necessary)
_____ On-site only (including streams within site boundaries)
_____ On-site and extending off-site to: N W S E
_____ Off-site < 100 m meters to: N W S E
_____ Off-site > 100 m meters to: N W S E

Source Kind (circle all that apply)
modern channel terrace ancient lag bedrock colluvium unknown

Chert Morphology (circle all that apply)
nodular bedded/tabular fluvial gravels

Maximum Size Class (circle one)
gravel (1-6 cm) cobble (6-25 cm) boulder (>25 cm)

Chert Density (circle one)
pavement and extensive pavement but patchy
sparse and extensive sparse and patchy

Homogeneity/Heterogeneity of Chert
Color: Homogenously ______________________________
Varies from ________________________ to ______________________________
Texture: Homogenously ______________________________
Varies from ________________________ to ______________________________

Collected Chert Source Samples
Chert Sample #_____ description/comments: ______________________________
Chert Sample #_____ description/comments: ______________________________
Chert Sample #_____ description/comments: ______________________________

Comments/Other Observations:

FORT HOOD SITE EVALUATIONS

Form 15: LRP Site Impacts

SITE NO.: ____________ **Recorder:** ________________________ **Date:** _______________

Are multiple impact zones defined for this site? YES NO
If yes, this sheet is for IMPACT ZONE ______ of ______ zones

Kinds of Damage (all that apply)
- ___ Unconfined heavy vehicle traffic
- ___ Trails/roads
- ___ Large earthworks/Hulldowns
- ___ Foxholes/infantry bunkers
- ___ Contour terraces
- ___ Vandalism/Potting
- ___ Other _________________________

Evidence of Damage (all that apply)
- ___ Crushed rock
- ___ Piles of debris/earth/rock
- ___ Linear ruts
- ___ Holes
- ___ Recent devegetation
- ___ Irregular surfaces (hummocky)
- ___ Other _________________________

Distribution of Damage (most applicable one)
- ___ isolated patches of damage amid undamaged areas
- ___ network of damage amid undamaged areas
- ___ wide areas of damage amid undamaged areas
- ___ ubiquitous damage

Percentage of Damaged Area within Impact Zone
negligible <25% 25-50% 50-75% >75% totally damaged

Confidence of Damage Estimate
- ___ zone is definitely damaged as indicated above
- ___ zone is damaged, above estimates are good indicator
- ___ zone has damage, but not confidant in above estimates

explanation: ____

Net Damage Assessment
- ___ This impact zone has negligible potential because:
- ___ This impact zone has some remaining research potential because:

Comments

FORT HOOD SITE EVALUATIONS

Form 16: LRP Features

SITE NO.: ____________ **Recorder:** ________________________ **Date:** _______________

Feature # _____

Feature Type: BR Mound BR Concen. Hearth Other: ______________________

Dimensions (m): L _____ x W _____ x H _____ **Buried?** YES NO

Integrity: negligible <25% 25-50% 50-75% >75% pristine unknown

Impacts: Vandalism Vehicle Earthmoving Dissection Deflation

Artifacts:

Comments / Plan sketch:

Feature # _____

Feature Type: BR Mound BR Concen. Hearth Other: ______________________

Dimensions (m): L _____ x W _____ x H _____ **Buried?** YES NO

Integrity: negligible <25% 25-50% 50-75% >75% pristine unknown

Impacts: Vandalism Vehicle Earthmoving Dissection Deflation

Artifacts:

Comments / Plan sketch:

Feature # _____

Feature Type: BR Mound BR Concen. Hearth Other: ______________________

Dimensions (m): L _____ x W _____ x H _____ **Buried?** YES NO

Integrity: negligible <25% 25-50% 50-75% >75% pristine unknown

Impacts: Vandalism Vehicle Earthmoving Dissection Deflation

Artifacts:

Comments / Plan sketch:

FORT HOOD SITE EVALUATIONS

Form 17: LRP Resurvey Observations

SITE NO.: ____________ page ______ of ______

Transect No.: ________ Transect interval: ____________ Observation Interval: ________

Recorder: ______________________________ Date: ____________________

Observation Number[1] --->																				
Artifacts seen since last stop?[2]																				
SURFACE VISIBILITY[3] none																				
< 25%																				
25-50%																				
50-75%																				
> 75%																				
complete																				
Is this stop in a chert zone?[4]																				
ARTIFACTS[5] tested cobble/core																				
formal debitage																				
formal tool																				
other artifact																				
NONE OBSERVED																				
Collection[6]																				

NOTES: 1-for this transect; 2-Yes or No; 3-check ONE box; 4-Yes or No; 5-check all applicable boxes; 6-check if a collection is made (diagnostics only)

version 1.3 (3/93)

MARIAH ASSOCIATES, INC.

ANALYST:
DATE:
SITE:
IMPACT ZONE:

DATA ENTRY SHEET --->	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Total
Total Stops:																										0
Pos. Stops, Hi Vis.:																										0
Pos. Stops, Lo Vis.:																										0
Neg. Stops, Hi Vis:																										0
Neg. Stops, Lo Vis.:																										0
Is Total Correct?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	-
Positive Transits:																										0
Negative Transits:																										0
Is Total Correct?	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	-
Total Positive Stops:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Negative Stops:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Transits	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Significance Tests

Is p(all positive observations) > p(all negative observations)?
total stops + transits: 0
number positive: 0 % of total
Highest Predicted: [____]
umber Obs. > Highest Pred.? Yes / No

Is p(positive stops) > p(negative stops)?
total stops: 0
number positive: 0 % of total
Highest Predicted: [____]
umber Obs. > Highest Pred.? Yes / No

Is p(positive transits) >= p(negative transits)?
total transits: 0
number positive: 0 % of total
Lowest Predicted: [____]
mber Obs. >= Lowest Pred.? Yes / No

Is p(positive stops/low visibility) >= p(positive stops/high visibility)?
total positive stops 0
number positive/ low vis: 0
Lowest Predicted: [____]
mber Obs. >= Lowest Pred.? Yes / No

Is p(negative stops/low visibility) >= p(negative stops/high visibility)?
total negative stops 0
number negative/ low vis: 0
Lowest Predicted: [____]
mber Obs. >= Lowest Pred.? Yes / No

FORT HOOD SITE EVALUATIONS

Quality Control Program
Inspection by Quality Control Officer

QC Officer: ________________ Date: ____________

I. COMPLIANCE WITH SOW AND CONTRACT

Y N Is project designed to meet SOW and Contract requirements?
Y N Is the required information being collected?
Y N Is there a project schedule?
Y N Is project on schedule?
Y N Is required contact with COR maintained?
Y N Is required contact with Range Control maintained?
Y N Are communications with COR made in writing; are all verbal agreements followed up with letter to client?
Y N Are safety measures adequate?
Y N Are all project stipulations being followed?
Y N Are evaluations for particular site types justified by data collected or written description?
Y N Are overall types of field observations adequate?

Comments:

II. GEOMORPHOLOGY/ARCHAEOLOGY RECON -- FIELD WORK

SITES VISITED: ____________________________

Y N Are sites being relocated efficiently?
Y N Is the necessary time being spent at each site?
Y N Are sites being checked for correct map location?
Y N Are previous site forms and maps being checked for accuracy?
Y N Are corrections being made to previous information?
Y N Is geomorphology information being collected?
Y N Is archaeological information being collected?
Y N Are the necessary forms being completed for each site?
Y N Is all information being recorded for each site?
Y N Is similar information being collected by different investigtors?
Y N Is the rating system being used consistently?
Y N Are geomorphology evaluations/rankings consistent?
Y N Are archaeology evaluations/rankings consistent?
Y N Are new site maps being completed if necessary?
Y N Are the sites being divided into geomorphic subareas?
Y N Are notes being organized daily?
Y N Can recommendations be justified?

Comments:

III. SHOVEL TESTING STAGE -- FIELD WORK

SITES VISITED:________________________

A. Recording Procedures

Y N Has the site map been revised to reflect new information?
Y N Is each test unit recorded and numbered on the site map?
Y N Is each level recorded as to depth, sediment, and material recovered?
Y N Is information recorded for each shovel test on the forms?
Y N Is shovel test depth recorded on forms?
Y N Are daily field notes completed?
Y N Are all collected artifacts recorded on the artifact inventory forms?
Y N Are artifact bags completely filled out?
Y N Are notes and artifact bags organized on a daily bases?
Y N Are recommendations concerning the site justified?
Y N Are shovel tests being excavated efficiently?
Y N Are shovel tests being excavated on a roughly 30 m grid system?
Y N Are at least two shovel tests excavated on all sites with deposits?
Y N Are shovel tests being excavated to sufficient depth?
Y N Are shovel tests of sufficient size?
Y N Is all sediment being screened through screen of sufficient size?
Y N Are all artifacts being collected?
Y N Are the proper areas of the site being tested?
Y N Is a sample of judgementally placed shovel tests being used?
Y N Are consistent methods being used on each site or site type?

Comments:

IV. DATA SHEETS

Y N Has a schedule been developed for reviewing completeness of field forms.
Y N Are field and lab data sheets being reviewed for completeness and logic before submission to the government?

____ sites have forms completed.
____ sites have forms checked.
____ sites have forms not checked.

V. INDEPENDENT EVALUATIONS

Y N Have independent evaluations of the same site been conducted by different recon teams?
If yes, give date, site no., andd teams

If yes, give results; comment on team comparability.

If no, are independant evaluations scheduled?

VI. SUMMARY OF PROBLEMS AND RECOMMENDED CORRECTIVE ACTIONS

(other than contract violations)

VII. CONTRACTUAL VIOLATIONS

VIII. QUALITY CONTROL REPORTING

Y N Have contractual violations been reported to the PI, to Mariah corporate, and to the government?

Nature of reported deviation:

Date of government notification _________; phone call___; letter___.

Contact person:________________.

Date of corporate notifiation_________; phone call_____; letter___.

Date of PI notification_________; phone call___; letter____.

FORT HOOD DAILY LOG

week beginning ____________________, 1993

DATE	hrs worked	CREW	SITE(s)	small sites recon'd	LRP sites recon'd	shovel tests dug	1x1 m levels dug	total stops surveyed

APPENDIX C:

CHERT TAXONOMY

CHERT TAXOMONY

Fort Hood Chert Taxonomy

Type 1: Heiner Lake Blue - light colored outer part.

Occurrence: Very large (often >1 m) disc-shaped nodules.

Color: White to yellowish gray (N9 to 5Y 8/1). Some bands near the cortex are occasionally pale yellowish brown (10YR 6/2). Cortex is reddish brown (5YR 4/4 to 4/4).

Texture: Medium to coarse. Freshly broken surfaces often have a chalky feel.

Structure: Homogeneous to very faintly banded.

Translucency: <1 mm.

Luster: Dull.

Patination: Unknown.

Results of heating: Fracture surfaces are often smoother after heating, but this process has no apparent effect on luster. At low temperatures (ca. 300°F) no significant color change was observed. At 450°F the surface begins to redden slightly to a pinkish white (7.5YR 8/2), and by 550°F, the color change is more uniformly pink (5YR 7/4). At high temperatures (> 700°F) colors range between pink-pinkish gray (5YR 7/3 to 7/2), very light gray (N8), and light brownish gray (5YR 6/1).

Comments: A relatively uniform but somewhat soft material. It occurs in very large pieces and emits a pronounced ring when struck with hammer or hammerstone. The interiors of the nodules upon which this material occurs are finer textured, occasionally brecciated, and described separately as Heiner Lake Blue (No. 10). As the name suggests, this material is found in the vicinity of Heiner Lake, most notably observed in the spoil of a pipeline which runs roughly east-west about 300 m north of Heiner Lake.

Type 2: Cowhouse White.

Occurrence: Large nodules, probably disc-shaped but most outcrop specimens are broken into smaller pieces (often <30 cm in diameter).

Color: Predominantly white (N9, 10YR 8/1) and very light gray (N8), but may include gray -light gray (N7, N6), bluish white (5B 9/1), light gray, gray and light brownish gray (10YR 7/2, 10YR 6/2, and 10YR 5/1).

Texture: Variable, fine to coarse, often appears porcellaneous.

Structure: Prominently banded near cortex and mottled in center. A few specimens exhibit extensive mottling (ca. 1 cm tubular fills of different textured, usually coarser, pale yellowish orange [10YR 8/5] material) and most samples also exhibit numerous small (<1 mm) white to light gray flecks.

Translucency: 1.0 - 3.4 mm.

Luster: Dull.

Patination: White.

Results of heating: At low temperatures (ca. 300°F) there is no significant color or luster change. At 450°F the luster increases slightly to medium, especially finer-textured material adjacent to the cortex, and a faint blush of grayish orange pink (10R 8/2) occurs on heated surface. By 550°F, a more uniform reddening of occurs and most pieces appear to be grayish pink to moderate pink (5R8/2 to 7/4), and the small flecks discolor more than surrounding matrix. Luster is irregular and ranges between dull and medium. At high temperatures (> 700°F) a more uniform medium luster occurs and the colors are slightly more intense pink than at 550°F.

Comments: This chert does not have the chalky feel of type 1; it is also somewhat harder. It is the only prominently banded chert currently known from Fort Hood. It occurs in East Range, north of Cowhouse Creek, around Union Hill.

Type 3: Anderson Mountain Gray.

Occurrence: Irregularly shaped nodules, commonly < 40 cm in diameter.

Color: In general, this chert becomes darker toward the center of the nodules, and ranges in color from white (N9 to 10YR 8/1) at the cortex, to pale yellowish brown (10YR 6/2), light gray (10YR 7/1, 7/2), very pale brown (10YR7/4), medium dark gray (N4), olive gray (5Y 4/1), and brownish gray (5YR 6/1). Cortex is white and slightly rough, but may be stained light reddish brown (5YR 6/4).

Texture: Fine to medium.

Structure: Mottled, commonly exhibits many fine (<1 mm) darker mottles (inclusions) which are most prominent at edges of nodules; larger mottles (5+ mm diameter) are also common. Occasionally to frequently fossiliferous (gastropods and bivalves), and a few vugs with megaquartz are also present.

Translucency: 1 - 3 mm.

Luster: Dull.

Patination: Often a grayish red purple to brownish gray.

Results of heating: Low temperatures (ca. 300°)) increase the luster slightly to medium, and a very faint pink occurs on the outside surface. At 450°F, there is no significant color change, but the luster is clearly increased to a medium, in excess of lower temperature state. Around 550°F, the exteriors change to a grayish pink (5R 8/2 to 7/2) but interior colors remain unchanged; luster increases to medium or shiny. High temperatures (> 700°F) turn exposed surfaces grayish orange pink (10R 8/2) and a more uniform medium to shiny luster is apparent.

Comments: This material is greatly improved by heating. It occurs in the southwest part of Fort Hood, most notably on Anderson Mountain and Seven Mile Mountain. Some exposures north of Anderson Mountain have been observed, but mostly in secondary contexts adjacent to House Creek.

Type 4: Seven Mile Mountain Novaculite.

Occurrence: Very large (often >1m diameter), irregular very hard nodules with porous megaquartz cortex, often colored red due to adherence of old argillic horizon.

Color: White to light gray (N7, N8) bluish gray (5B 6/1), and pale blue (5PB 7/2) with irregular veiniform very pale brown (10YR 7/4) inclusions which appear as

	yellow, somewhat linear mottles (10YR 7/6) in some samples. Often grades to a yellow or orange color at margins of nodules.
Texture:	Highly variable, fine to coarse, occasionally looks like a quartzite. Surface fractures often have a "sugary" appearance.
Structure:	Vein-like inclusions, occasionally look like mottles; otherwise, rather homogeneous.
Translucency:	>15 mm.
Luster:	Dull, but individual quartz crystals often lend specular highlights.
Patination:	White to pale yellow.
Results of heating:	Low temperatures (ca. 300°F) result in no significant color change but may increase luster to a medium and make fracture surface textures smoother. At 450°F the veins near surface begin to turn reddish yellow (5YR 6/6) and luster increases to medium. Around 550°F, a radical luster change occurs and some specimens change to medium or shiny, the latter of which are almost glassy. Colors are similar to 450°F. High temperatures (> 700°F) cause the veins to turn red (2.5YR 4/8) and same luster changes as 550°F.
Comments:	A very hard material in the raw state. However, finer-grained specimens experience a radical metamorphosis upon heating, especially at high temperatures that are deleterious to finer-grained cherts.

Type 5: Texas Novaculite.

Occurrence:	Large nodules or unknown shape but in excess of 30 cm in diameter.
Color:	Light bluish gray (5B 5/1 to 7/1), pale yellowish brown (10YR 6/2), and white (10YR 8/1).
Texture:	Medium to fine.
Structure:	Common coarse (>10 cm diameter) mottles which exhibit sharp boundaries; often composed of slightly coarser textured material.
Translucency:	4-6 mm.
Luster:	Dull.
Patination:	Unknown.
Results of heating:	Low temperatures (ca. 300°F) cause fracture surfaces to be smoother, but no discernible color-luster change. Slightly higher temperatures (ca. 450°F) evoke a distinct increase in luster to medium. Around 550°F, the surface takes a very minimal blush (light gray to light pinkish gray - 5YR 7/1 to 7/2) and the luster is slightly greater than at 450°F. At temperatures in excess of 700°F, the color changes to gray-pinkish gray (5YR 6/1 to 6/2) and luster increases to medium-shiny.
Comments:	A hard material in the raw state. It crops out north of Owl Creek in East Range, but the extent of this material is unknown.

Type 6: Heiner Lake Tan.

Occurrence:	Very disjointed nodular beds ranging between 10 and 20 cm thickness with occasionally very large nodules (>50 cm in diameter). Typical outcrop exposures have blocky chert fragments scattered in rather high density pavements.

Color:	Light gray to light brownish gray (10YR 7/2 to (creamy) white (10YR 8/2), and grayish orange (10YR 7/4). Common, prominent, round white to very pale orange (10YR 8/2-8/1) sharp-edged mottles which are often slightly coarser textured than surrounding matrix. Cortex is moderate orange pink (5YR 8/4).
Texture:	Medium to fine; cortex is coarser textured and often a little chalky to touch.
Structure:	Mottled; the common small (< 1-5 mm), round white to very pale orange mottles are diagnostic of this type. Some samples are very crudely banded with a few concentric color bands roughly parallel to and within 5 mm of the nodule surface.
Translucency:	1-5 mm.
Luster:	Dull.
Patination:	Unknown.
Results of heating:	Low temperatures (ca. 300°F) evoke a light blush on heated surfaces (grayish pink, something less than 5R 8/2), and a low-end, medium luster. At 450°F, the surface discoloration is more uniform and of the same color as previously mentioned; the luster is also more uniformly increased to medium. Slightly higher temperatures (e.g. 550°F) cause the heated surfaces to become moderate red to red (5R 5/4 to 2.5YR 5/6) but interiors are mostly unchanged in color with a medium to shiny luster. High temperatures (> 700°F) cause thermal fractures (pot lids) to occur and the color to change to medium gray (N5); luster is similar to 550°F.
Comments:	The mottles are a diagnostic attribute of this chert.

Type 7: Fossiliferous Pale Brown.

Occurrence:	Probably irregularly shaped nodules.
Color:	Very pale brown (10YR 6/4 to 7/4) , light gray to white (10YR 7/2 to 10YR 8/2), and mottled to gray-light gray (10YR 6/1). Pale blue (5PB 7/2; 5B 9/1) flecks and veins are common in some specimens. Cortex is white (N9) but often stained dark brown (7.5YR 4/2) or reddish brown (5YR 4/4) by the surrounding soil.
Texture:	Fine to medium.
Structure:	Mottled, and most specimens exhibit numerous fossils, and vein-like, possibly chalcedonic, inclusions.
Luster:	Dull.
Patination:	Unknown.
Results of heating:	Unknown.
Comments:	This material is known from several sites at Fort Hood (e.g. quads 16/51, 31/50 and 34/51), but more field work is necessary to confirm it as a distinctive type of chert.

Type 8: Fort Hood Yellow.

Occurrence:	Large, irregular nodules, often in excess of 30 cm in diameter.
Color:	Very pale brown to (10YR 6/2 to 10YR 7/3) varies to light gray, light gray (10YR 7/1, 10YR 5/1, the latter of which most commonly occur as mottles or

bands that are coarser textured than the brown parts. Cortex is generally white to moderate yellowish brown (10YR 5/4).

Texture: Brown samples are generally fine textured whereas the gray colored mottles and inclusions are often medium or coarse textured.

Structure: Mottled with few to common sharp edged, often very irregular shapes (often look like burrows) which are up to 1 cm diameter. Some mottles have distinctly different color band around mottles, often gray, and the majority of the mottles are a coarser texture than the surrounding matrix.

Translucency: < 1.5 mm.

Luster: Medium to dull.

Patination: Yellow to white.

Results of heating: Low temperatures (ca. 300°F) cause a minimal change in luster and no color change. At 450°F, the outer surfaces become light reddish brown (5YR 6/3) in a thin (< 0.5 mm) rind, and the luster increases to a low end medium. Exposure to temperatures of approximately 550°F turn the surface a pale red (5R 7/2) and the luster turns medium to shiny, whereas exposure to high temperatures (> 700°F) causes pot lids and a significant reddening of the surface, weak red to dark reddish gray (10R 6/3 to 10R 4/1) colors pervade material, and luster becomes medium to shiny.

Comments: The most ubiquitous chert at Fort Hood, the outcrop of which extends across much of the north half of the base. Results of the shovel testing suggest this was the most commonly used material in this region, although not necessarily the most preferred material.

Type 9: Heiner Lake Translucent Brown.

Occurrence: Tabular to squatty disc-shaped nodules, often with thin laminae weathered into bas-relief striations on nodule surface.

Color: Dark gray to dark grayish brown (10YR 4/1, 10YR 3/1, 10YR 3/2), pale yellowish brown (10YR 6/2), and occasionally grayish brown (10YR 5/2). Light bluish gray and brown (10YR 4/4) laminae occasionally present. Cortex is white and generally thin to light yellowish brown (10YR 6/6).

Texture: Fine.

Structure: Laminated to striated, typically exhibits many thin (< 1 mm) laminae parallel to long axes of nodules (horizontal), which occasionally act as cleavage planes. Few to many of these laminae are discontinuous, white, irregular blocks and are often 1-4 mm thick.

Translucency: 9 -12 mm.

Luster: Medium to dull.

Patination: White.

Results of heating: No significant changes occur at low temperatures (ca. 300°F) but at 450°F, a shiny luster appears but no color change is observed. Slightly higher temperatures, (e.g. 550°F) evoke a greater luster, shiny but almost glassy, and a slight reddening with reddish brown (2.5YR 4/4) the dominant color. High temperatures (> 700°F) cause thermal fractures, the colors become darker (very dusky red purple (5RP 2/2) to dark gray (5YR 4/1)) and luster is about the same as 550°F.

Comments: This is a unique chert for the region. The striations are easily diagnostic, but it is also the only translucent brown chert currently known on base. The luster change upon heating is impressive. The tendency of this chert to break upon striations (in a cleavage manner) makes working with it challenging. As the name implies, it occurs around Heiner Lake in the southeastern part of Fort Hood.

Type 10: Heiner Lake Blue.

Occurrence: Found at the center of very large (often >1 m) disc-shaped nodules.

Color: Medium gray (N5) to medium bluish gray (5B 5/1). Common white (10YR 8/1) to light gray (10YR 7/2) gray 0.5 to >2 cm mottles, and few to many <1 mm bluish white (5B 9/1) flecks.

Texture: Fine.

Structure: Mottled to brecciated near margins with type 1 material.

Translucency: 3-5 mm.

Luster: Dull to medium.

Patination: White.

Results of heating: Low temperatures (ca. 300-450°F) cause the luster to increase to medium-shiny, but does not cause a color change. Around 550°F, the surface began to change to a pinkish gray (5R 7/2) but the luster is still a medium-shiny. High temperatures (> 700°F) cause pot lids, but the luster increases to shiny. Discoloration remains a pinkish gray.

Comments: This chert occurs at the centers of nodules which have type 1 on the outside. Although we are not certain that this is what J.B. Sollberger was calling Heiner Lake Blue, we decided to adopt the name because it is some of the only material in this region that could be construed to be of a blue color. It is rather hard and often appears to be brecciated around the margins where it grades into type 1.

Type 11: East Range Flat.

Occurrence: Irregular nodules, often with hollow center voids or chalky burrows.

Color: Gray-light gray (N6 - N7) to light (olive) gray (2.5Y 7/2 to 5Y 7/2); colors often shade from one into another. It is commonly gray outside and shades to olive gray inside nodules. Cortex is white, yellowish brown (10YR 5/4) and very pale orange (10YR 8/2).

Texture: Medium.

Structure: Streaked (elongate mottles) and mottled, few 1-2 cm diameter mottles of coarser textured sediment. Some specimens have many, <1 mm dark gray mottles (or flecks). Surface often feels rather chalky.

Translucency: <1 mm.

Luster: Dull, very flat in appearance.

Patination: Unknown.

Results of heating: At low temperatures (ca. 300-550°F) the surface changes to a pale red (10R 6/3) and the luster increases to medium. High temperatures (> 700°F) change the luster to medium and occasionally shy, and the heated surfaces become pale red

(10R 6/3). High temperature heat treating and subsequent breakage evokes a strong petroleum odor.

Comments: Although some of the colors are similar to GBG and Ft. Hood Gray, this chert has a very dull luster, chalky feel, small flecks, and seems somewhat softer. It occurs along the south Owl Creek valley wall in several small canyons.

Type 13: East Range Flecked.

Occurrence: Thin (< 10 cm) tabular nodules which are often fractured into tabular fragments in the outcrop.

Color: Dark gray (N4) to light gray (N7 to 10YR 5/1) and the colors shade from light gray at outside of nodules to dark gray in interiors. The cortex is white (N9) and there are a few very pale orange (10YR 8/2) mottles. Many fine (< 1 mm) white to bluish white (inclusions) are present.

Texture: Fine to medium.

Structure: Mottled to shaded. Many to common, small (< 1 mm), white flecks which exhibit some preferred orientation (fabric), some of which are fossils; occasionally mottled with coarser textured (medium to coarse, dull, opaque gray material).

Translucency: < 1 mm.

Luster: Mostly dull, although dark, finer-textured material may be medium.

Patination: White.

Results of heating: No visible changes occur at low temperatures (ca. 300°F), but around 450°F, the coarser textured mottles and cortex turn weak red (1010R 5/2) and the luster increases to medium, especially the darker, finer-textured parts. At high temperatures (> 700°F), this chert experiences severe thermal fractures (pot lids) and the luster increases to medium-shiny. No interior color change was noted but the cortex changed to pale red (10R 6/3).

Comments: Darkest colors of this chert overlap with lighter colors of Owl Creek Black but the inclusions associated with this material are much more prominent. The outcrop of this material is currently known to be very limited, located at the eastern end of the Fort in quad 41/48, adjacent to Belton Lake. The size of nodule fragments and the presence of internal fractures is a limiting factor in using this material, but a procurement site in the outcrop belt confirms aboriginal use.

Type 14: Fort Hood Gray.

Occurrence: Irregular nodules that may exceed 50 cm in long axis and 30 cm in thickness.

Color: Variable, light gray to dark gray (N7 to N4), and occasionally medium bluish gray (5B 5/1). The cortex may be white to very light gray (N8-N9) and occasionally varies to grayish brown (2.5Y 5/2). Some fracture surfaces and burrow traces within chert are stained dark brown to strong brown (7.5YR 4/4 to 5/6).

Texture: Fine, but mottles occasionally coarser than matrix.

Structure:	Mottled with few to common irregular tubular mottles approximately 1 cm diameter and of slightly different color and/or textured material; larger-scale color mottling was also apparent.
Translucency:	<3 mm.
Luster:	Usually dull, but infrequently medium.
Patination:	Often a deep purple-brown color (not on Munsell), and occasionally white.
Results of heating:	Low temperatures (ca. 300°F) cause some mottles to turn weak red (5Y 4/2) and the luster increased to medium. Heating to 450-550°F causes a change in luster to medium and in some cases shiny. High temperatures (> 700°F) result in thermal fractures (1-2 cm diameter pot lids), but the luster is shiny to medium. No dramatic color changes were evident in most specimens.
Comments:	Crops out near GBG in the northern part of East Range, has similar mode of occurrence, coloration and structure. Sometimes difficult to distinguish from GBG.

Type 15: Gray-Brown-Green.

Occurrence:	Irregular nodules (40+ cm diameter).
Color:	Light brownish gray-grayish brown (2.5Y 6/2 - 5/2), light olive gray (5Y 5/2), gray (10YR 6/1) to very dark gray (N3). Some light olive gray mottles (5Y 6/1) grade to light gray (N7). The cortex is white (N9) to yellowish gray (5Y 8/1) and chalky.
Texture:	Fine.
Structure:	Mottled with medium to coarse (2-20+ mm) inclusions of variable colored and textured material. Mottles are often slightly coarser textured than the surrounding matrix. A few vugs filled with mega quartz are present.
Translucency:	Usually <1 mm.
Luster:	Medium to dull.
Patination:	Unknown.
Results of heating:	Low temperatures (ca. 300°F) cause no visible changes, but at 450°F, the luster increases to medium and a very light blush occurs on heated surfaces (10R 6/2 - pale red). At 550°F, a similar discoloration occurs, but the luster often becomes shiny.
Comments:	This material occurs in East Range north of Owl Creek and is very closely related to Fort Hood gray and probably Owl Creek Black as well.

Type 16: Leona Park.

Occurrence:	Massive bedded chert, in excess of 50 cm thick in places. Weathers into large rhombohedral blocks along joint planes.
Color:	Irregularly mottled with dark gray (N3), medium gray (N5), very light gray (N8), and light brownish gray (5YR 6/1). Joint faces are stained dark yellowish brown (10YR 6/6). There is no appreciable cortex.
Texture:	Fine to medium.
Structure:	Difficult to describe. There is a definite fabric present that is roughly parallel to bed boundaries, and the mottles (alternating, mixed gray and light gray colors) are horizontally elongated. Very reminiscent of lenticular bedding.

Translucency: <1 mm.
Luster: Dull, but occasionally medium.
Patination: Unknown.
Results of heating: Low temperatures (ca. 300°F) cause a minor luster change and evoke a minor petroleum odor, but exposure to temperatures around 450°F results in a definite increase in luster, and changes the yellow joint planes to a weak red (2.5YR 4/2). Slightly higher temperatures (ca. 550°F) have a similar effect, but the luster is slightly greater. High temperatures (> 700°F) make the freshly broken surface luster shiny, joint planes red (5R 5/4), and broken pieces quite smelly.
Comments: Occurs outside the boundary of Fort Hood in Leona Park, east side of Belton Lake, just north of Highway 36. Freshly broken heated specimens emit an intense petroleum odor (sort of kerogen-like), similar to, but much more intense than, burned limestone.

Type 17: Owl Creek Black.

Occurrence: Thin (<6 cm) tabular nodules.
Color: Black (N1) to dark gray (N4 to N2). Some specimens have <2 cm diameter, elongate medium light gray (N6) sharp-edged mottles. Many tiny (usually <0.5 mm) white flecks with a preferred orientation are present. The cortex is a white (N9) to reddish yellow (7.5YR 7/6) chalky material.
Texture: Fine.
Luster: Medium to shiny.
Structure: Mottled to homogeneous. The tiny white inclusions express a horizontal fabric (parallel to long axes of the nodule).
Translucency: <1 mm.
Patination: white.
Results of heating: Low temperatures (ca. 300°F) result in a minimal luster increase and change the chalky cortex to yellow (10YR 8/6). Slightly higher temperatures (ca. 450°F) evoke a distinct increase in luster to shiny and are still knappable, but all higher temperatures (550° > 700°F) cause extensive thermal fractures (pot lids) which decreased in size with temperature.
Comments: Probably the most preferred chert in the region. In the outcrop a few extreme pieces were observed. One occurred as large, irregular fragments that had a dull luster, medium texture, and were a mottled gray to light gray (10YR 5/1 to 10YR 6/1). The mottles appeared to be irregularly laminated with arc-shaped, discontinuous, and often nested shapes which appear similar to mollusk burrow traces.

APPENDIX C - Part 2: Edwards Chert Outside of Fort Hood.

Locality 1: Sample collected from Comal County, Texas, about 6.4 miles west of New Braunfels city limit on Highway 306; 7.1 miles west of Oak Knot Road. [29° 50.99'N, 98° 08.13'W].
Occurrence: Relatively small disc-shaped nodules, less than 5-10 cm thick and less than 30 cm in diameter, that occur parallel to bedding planes.

Color: Dominant color is a very dark grayish brown (10YR 3/2). Faint red hues (approximately dark reddish gray or 5YR 4/2) are present in a diffuse fashion across most pieces. Mottles are various shades of brown (10YR 5/3), and gray (10YR 5/1) and commonly have rather diffuse boundaries (exhibit shading). Gray mottles are slightly more opaque than browns. Cortex is smooth, thin (2-3 mm) and white (N9).
Texture: Fine.
Structure: Mottled, bordering on shaded. Weathered faces often appear banded but no bands are visible in freshly broken surfaces.
Translucency: 4.8-6.0 mm.
Luster: Dull.
Patination: Unknown.
Effects of heating: Luster increases to medium, but significant thermal spalling occurred during heating.
Comments: Weathered surfaces give illusion that this chert is banded but no bands are visible on fresh break surfaces.

Locality 2a: Sample collected in Comal County, Texas, from a roadcut on Highway 46 immediately north of Bleiders Creek, just outside of Gruene, Texas. Two samples were obtained from this locality, the other is described as locality 2b. [29° 43.74N, 98° 07.19'W].
Occurrence: Nodules 4-8 mm thick and usually less than 50 cm in diameter.
Color: Irregularly mottled with grayish brown-light brownish gray (2.5Y 5/2 - 6/2), and becoming light gray (10YR 7/2) to white (N9) adjacent to the cortex, which is smooth to slightly rough and white. Mottles have sharp boundaries but color may shade within each mottle. Small (< 1 mm) white (N9) to bluish white (5B 9/1) flecks are common throughout, and become bluish white toward center of nodules where they become hard to discern from the matrix.
Texture: Fine.
Structure: Irregularly mottled. A few macro-fossils (bivalves) replaced with megaquartz are present.
Translucency: 0.5-1.4 mm.
Luster: Dull to medium.
Patination: White.
Effects of heating: Luster increases to medium and colors become slightly darker (values decrease) making it appear more gray than brown.
Comments: This material lacks significant flaws and has a nice, even conchoidal fracture in the unaltered state.

Locality 2b: Sample collected in Comal County, Texas, from a roadcut on Highway 46 immediately north of Bleiders Creek, just outside of Gruene, Texas. Two samples were obtained from this locality, the other is described as locality 2a. [29° 43.74N, 98° 07.19'W].
Occurrence: Similar to 2a.
Color: Dark grayish brown to grayish brown (2.5Y 4/2 - 5/2).
Texture: Fine.

Structure: Densely fossiliferous, containing many bivalve fossils and a few vugs. The fossils have all been replaced with macro-quartz and/or chalcedony, the latter of which is bluish white (5B 9/1).

Translucency: 3.4-6.0 mm.

Luster: Medium.

Patination: White.

Effects of heating: Luster increases to medium and/or shiny, and fracture surfaces are smoother. Some spalling occurred while heating.

Comments: One of the most fossiliferous cherts collected. Bivalve fossils are numerous and affect fracture properties more when material is unaltered by heat. Numerous joints and internal fractures are also present in some of this material.

Locality 3: Roadcut on Highway 281 about 5.6 miles north of its intersection with FM 1604, Bexar County, Texas. [29° 41.13'N, 98° 27.07'W].

Occurrence: Irregular nodules, generally <30 cm in diameter.

Color: Interior colors range between dark gray to dark grayish brown (5YR 4/1, 10YR4/2-4/1) and medium bluish gray (5B 5/1), to light gray and gray (10YR 7/1 to 6/1). A few pieces exhibit dark reddish gray (10R 4/1) colors as well.

Texture: Medium.

Structure: Primarily mottled, but a few specimens were irregularly banded where the bands paralleled internal clasts rather than the edges of the nodule.

Translucency: Darker-colored portions range between 4.0-6.8 mm, whereas lighter grays are more opaque and 1.6-2.3 mm.

Luster: Dull.

Patination: White.

Effects of heating: Fracture surfaces are smoother and have a medium to dull luster. Interior colors principally unchanged, but heated surfaces were very pale red (10R 6/2 the closest Munsell color).

Comments: None.

Locality 4a: Roadcut in Medina County, Texas, on Highway 211 about 1 mile north of its intersection with Highway 471, and 6.6 miles south of its intersection with Highway 168. [29° 31.94'N, 98° 48.57'W].

Occurrence: Relatively thin (4-10 cm), 30-50 cm wide nodules which occur parallel to bedding planes.

Color: Cortex is white (N9) and up to 1 cm thick and slightly rough and chalky. It grades into the chert, and around margins appears to be light bluish gray (5B 7/1). The center of nodules are dark gray (5Y 4/1), bluish brown gray (no good Munsell color match) and brown (10YR 5/3). Translucent pieces appear to be a yellowish brown (approximately 10YR 5/6). Joint faces are occasionally faintly stained yellow (10YR 8/6).

Texture: Fine to medium near edges of nodules.

Structure: Faintly banded, most prominent around margins of nodules at edge of cortex. A few mottles of slightly coarser textured material are present and of light gray (N7) color.

Translucency: 15-20 mm.

Luster: Dull to medium.

Patination:	Unknown.
Effects of heating:	Colors shift to brown-pale brown (10YR 5/3 to 6/3) and cortex margins become pale bluish white (5B 9/1). Luster increases uniformly to medium, and banding in center of nodules becomes much more pronounced. Yellow stained joint faces become red (2.5YR 5/8).
Comments:	This material becomes much lighter in color (more brown than gray) upon heating and appears to be significantly improved by this process.
Locality 4b:	Roadcut in Medina County, Texas, on Highway 211 about 1 mile north of its intersection with Highway 471, and 6.6 miles south of its intersection with Highway 168. [29° 31.94'N, 98° 48.57'W].
Occurrence:	Nodules which are generally <10 cm thick and between 30 and 100 cm wide.
Color:	Dark bands are dark grayish brown (10YR 4/2) to a dark bluish brown gray (no Munsell match), and lighter brown bands are pale brown (10YR 6/3) to light gray (10YR 7/1 to 6/1). Gray bands are medium bluish gray (5B 5/1) to medium gray (N5). The cortex is white (N9) and usually <1 cm thick. There are many very fine (<0.5 mm) inclusions or grains throughout this material which enhance the rough appearance of unaltered samples.
Texture:	Medium to coarse, although some bands around margins of nodules are fine textured.
Structure:	Prominently banded various shades of brown and gray.
Translucency:	1.3-6.3 mm; dark gray bands much less translucent than brown material.
Luster:	Dull.
Patination:	Unknown.
Effects of heating:	Luster is slightly increased, occasionally medium, and colors shift from light browns to light grays (10YR 6/3 to 10YR 6/1) and grays become slightly darker (lower values). Fracture surface roughness is greatly decreased after heating. No red colors were observed after heating.
Comments:	This chert appears to be rather marginal prior to heating but is changed to a more attractive knappable material by this process.
Locality 6:	Eastbound IH-10 roadcut located about 2.1 miles east of intersection of IH-10 and Highway 16 in Kerrville, Texas. [30° 04.03'N, 99° 04.47'W].
Occurrence:	Relatively thin (<10 cm) disc-shaped nodules, occurring parallel to bedding planes. Most nodules <50 cm in diameter.
Color:	Finer textured nodules grade from a light gray (10YR 7/1) or light brownish gray (2.5Y 6/2) to a medium gray (N5) near the center of the nodules. Coarser nodules are often uniform medium gray (N5) and grade to a light gray or medium light gray (N6 and N7) near margins. Cortex ranges from very pale brown (10YR 8/3) to light gray (10YR 7/1) and is thin and rough textured.
Texture:	Coarse to fine. Most nodules are in the medium to fine grade but some are quite coarse.
Structure:	Finely mottled, although some pieces appear to be streaked or shaded.
Translucency:	1.0-2.3 mm.
Luster:	Dull.
Patination:	Unknown.

Effects of heating: Minimal color change, although some heated surfaces became reddish gray (5YR 5/2). Luster of coarser textured portions was unchanged but fracture surfaces were less rough, and finer textured material took a medium luster after heating.

Comments: None.

Locality 7: Sample collected in Kerr County, Texas, 11.2 miles southwest of the post office in Hunt, Texas, on Highway 39 immediately adjacent to the South Fork of the Guadalupe River. [29° 58.79'N, 99° 26.15'W].

Occurrence: Thin (< 10 cm), disc-shaped nodules generally less than 50 cm in diameter which occur parallel to bedding planes.

Color: The majority of this material is banded light brownish gray (10YR 6/2), grayish brown (10YR 5/2), and dark gray (10YR4/1). A few pieces are very light gray (N8) to light gray (10YR 7/1). Darker colors are often more pronounced toward the outside of the nodules. Very small white and infrequent red flecks are common throughout brown pieces. Cortex is 2-7 mm thick, smooth to slightly rough, and white (N9).

Texture: Medium to coarse.

Structure: Prominently banded, but a few specimens exhibit very irregular, and finely textured mottling.

Translucency: 1.6-5.8 mm.

Luster: Dull.

Patination: Unknown.

Effects of heating: A very pronounced change in fracture surface texture from rough to smooth, and from flat to medium luster, although some pieces appear almost shiny. The dark gray bands appear to change color to medium light gray or light gray (N7-N6) but appear almost a light bluish gray. Lighter colored bands become slightly lighter colored (light brownish gray 10YR 6/2).

Comments: The change upon heating of this material is extreme and surprising. The observed color changes toward gray and bluish gray rather than red is out of the ordinary.

Locality 8: On Highway 39 approximately 2.2 miles northeast of intersection with Highway 187 (road to Lost Maples State Park). Kerr County, Texas. [29° 56.93'N, 99° 31.16'W].

Occurrence: Very irregularly shaped nodules. Collected from a field in the outcrop and most fragments were 10-30 cm in diameter, although a few larger ones were present.

Color: Highly variable. Smaller nodules ranged from an opaque light gray (10YR 7/1) near the cortex, and changed gradually to gray (10YR 5/1) toward the center, where a more translucent dark gray (10YR 4/1) very dark gray (10YR 3/1) and dark grayish brown (10YR 4/2) occurs. Some of the brown colored portions have small white to pale brown specks which eventually become 2-7 mm wide, slightly coarser textured sharp edged gray (10YR 5/1) mottles. The cortex ranges from about 1.5 cm to 0.5 cm and is white, but occasionally stained by the surrounding soil to a reddish brown (5YR 4/4) and has a slightly rough texture.

Texture: Mostly fine, but a few pieces are medium.

Structure: Mottled to shaded. A few vugs filled with megaquartz are present in gray material.

Translucency: Browns are 5.1-8.4 mm, whereas the grays are more opaque and range between 1.1-2.4 mm.
Luster: Dull.
Patination: White.
Effects of heating: Luster increased to medium but no significant color changes were noted. Significant crazing and thermal fracturing occurred while heating.
Comments: None.

Locality 9: Sample collected from Real County, Texas, about 10.8 miles north of point where Highway 83 crosses the West Frio River, just north of Leakey, Texas. [29° 51.46'N, 99° 40.95'W].
Occurrence: Thin (3-10 cm) and small (<30 cm diameter) nodules.
Color: Pale brown (10YR 6/3) to dark gray and dark grayish brown (10YR 4/1 to 4/2). Cortex is thin (<0.5 cm), white (N9), and chert adjacent to cortex appears to be bluish white to light bluish gray (5B 9/1 to 7/1). Mottles are commonly light gray (10YR 7/1) and have sharp boundaries. More brown pieces have numerous inclusions (<0.5 mm)and a rougher fracture surface.
Texture: Medium to fine.
Structure: Striated grading to mottled with some attributes of both occurring on most pieces.
Translucency: 5.0-10.5 mm.
Luster: Primarily dull, but a few pieces approach medium.
Patination: White.
Effects of heating: Luster increases to medium, and fracture surfaces become much smoother. Some of the light browns become even lighter (10YR 6/3 go to 10YR 7/2) and the light bluish colors adjacent to cortex become more pronounced. Some heat spalls occurred while this material was in the oven, but heating to lower temperature would probably avoid this problem.
Comments: None.

Locality 10: Roadcut in Edwards County, Texas, located about 13.5 miles north of Nueces River (in Barksdale, Texas) on Highway 55. [29° 52.20'N, 100° 06.48'W].
Occurrence: Large, disc-shaped nodules which in outcrop are broken into 10-20 cm diameter fragments.
Color: Cortex is fine textured and white (N9) and up to 7 mm thick. Most material is grayish brown to dark grayish brown (10YR 5/2 to 4/2) and occasionally brownish gray (5YR 4/1). Banding is most prevalent with grayish browns, but occasionally, near the cortex, this material is white with pale brown (10YR 6/3) bands.
Texture: Fine to medium.
Structure: Prominently banded to homogeneous.
Translucency: 2.9-7.1 mm.
Luster: Dull to medium.
Patination: White.
Effects of heating: No color change was observed, but a significant increase in luster accompanied heating. One banded fragment fractured while heating, but a homogeneous piece exhibited no thermal fractures.

Comments: Few internal flaws and a nice conchoidal fracture. This material is improved upon heating but is also easily worked in the unaltered state.

Locality 11: Roadcut along Highway 163 on east side of Devils River Valley, approximately 26.2 miles north of Comstock Texas, and intersection of Highways 90 and 163. [30° 01.65'N, 101° 10.15'W].

Occurrence: Large (< 100 cm wide), thin (< 10 cm thick), disc-shaped nodules occurring parallel to bedding planes.

Color: Interiors of nodules are mottled various shades of brownish gray with cortical pieces exhibiting light gray to light brownish gray (10YR 7/2 to 6/2), and interiors exhibiting dark grayish brown (10YR 4/2) and gray (10YR 4/1). Numerous, very fine (< 0.5 mm) white (N9) to bluish white (5B 9/1) round to elongate flecks are present throughout but most visible in interior fragments. Cortex is smooth and ranges from white (N9) to very light gray (N8), and joint planes are strong brown (7.5YR 5/6) to grayish yellow (5Y 8/4).

Texture: Mostly fine.

Structure: Primarily mottled but with a horizontal fabric resembling striations; a few specimens exhibit banding. The very small mottles (flecks) often have a preferential orientation or fabric parallel with long axis of the nodule.

Translucency: 3.2-4.2 mm.

Luster: Dull.

Patination: White.

Effects of heating: Increases luster to medium and heated surfaces change to pale red (10R 6/3), grayish pink (5R 8/2) and grayish orange pink (10R 8/2). Yellow stained joint planes change to weak red (7.5R 4/4).

Comments: None.

Locality 12: Roadcut along Highway 163 on east side of Devils River Valley, approximately 22.2 miles north of Comstock Texas, and intersection of Highways 90 and 163. Sample 11 is located 3.6 miles north along same highway. Val Verde County, Texas. [29° 58.86'N, 101° 10.04'W].

Occurrence: Disc-shaped nodules approximately 10 cm or less in thickness and often more than 30 cm in diameter.

Color: Very light gray (N8) and grayish pink (5R 8/2) near outside of nodules, becoming darker (light brownish gray, 5YR 6/1) toward center. Mottles in center of nodules range from brownish gray (5YR 4/1) to gray (10YR 4/1). Many nodules have a thin band of dark yellowish brown (10YR 4/6) near cortex, which may be white (N8) or very pale brown (10YR 8/4). Fracture planes or joints are often stained brownish yellow (10YR 6/8).

Texture: Fine.

Structure: Distinctly banded, and occasionally mottled near the center of the nodule. Few joint planes are present and black dendrites emanate from these fractures and are present on the fracture planes.

Translucency: 2.3-2.5 mm.

Luster: Dull.

Patination: Unknown.

Effects of heating: Luster increases to medium or shiny, and dominant color changes to grayish orange pink (10R 8/2), grayish pink (5R 8/2), and occasionally moderate pink (5R 7/4).

Comments: This is one of the few specimens of Edwards chert exhibiting dendrites. The fractured nature of this outcrop, together with the occasional pink color and presence of dendrites suggest that it has experienced hydrothermal alteration.

Locality 13: Roadcut in Pecos County, Texas, adjacent to Highway 285 about 1 mile south of intersection with RR 2400. [30° 19.63'N, 102° 26.18'W].

Occurrence: Irregular-shaped nodules, often oriented vertically to sub vertically. Diameters in excess of 10 cm common, and nodule length occasionally greater than a meter.

Color: Grades from white (10YR8/1 - 8/2) at the cortex to a light gray (10YR 7/2) or light brownish gray around the margins of the nodules. Nearly all of the nodules are larger in the center and range between grayish brown (10YR 5/2) and dark grayish brown (10YR 4/2). Small (<1 mm) dark color specks are common in the lighter colored material near edges of the nodules. Outside of the cortex is yellow (10YR 7/6).

Texture: Fine.

Structure: Mottled. The gradual color change may appear as a mottle, but there are also 0.5-2 cm side, elongate mottles, often with sharp edges, that consist of lighter colors than the nodule centers (generally light grayish brown or white). Some of the mottles appear to be burrows, that often become chalky in the center and eventually become voids, especially common in larger nodules where voids up to 3 cm were occasionally present.

Translucency: 2.6-4.5 mm.

Luster: Primarily dull, although finer-textured portions are occasionally medium.

Patination: White.

Effects of heating: Heated outer pieces change to a pale red (10R 6/2) and reddish gray (10R 5/1 to 6/1). Internal colors remain mostly the same but perhaps more yellow, as pale brown (10YR 6/3) was dominant near the cortex rather than light gray. Luster increased from dull to medium and, in a few cases, shiny. One thermal fracture, a pot lid, occurred while heating in the oven.

Comments: There was about 4 m of chert-bearing section in this roadcut, and pieces of this material were observed and collected from the bedload of Big Creek to the east.

Locality 14: Roadcut adjacent to Highway 285 located about 8.2 miles north of intersection with Highway 90 in Terrell County, Texas. [30° 15.43'N, 102° 26.81'W].

Occurrence: Very irregular globular nodules which occur throughout more than 10 m of limestone in this roadcut. Often vertically to sub vertically oriented, perpendicular to bedding.

Color: Dominantly pale red (5R 6/2 to 7/2), and grayish orange pink (10YR 8/2). Some nodules are very pale brown (7/3) to light brownish gray (10YR 6/2). Bands near outside of nodules are occasionally very dusky purple (5RP 2/2) to dusky brown (5YR 2/2). Cortex is a pinkish gray (5YR 8/1) to very pale brown (10YR 8/4).

Texture: Fine.

Structure: Primarily mottled with few to many, fine (1-5 mm) light brownish gray (10YR 6/2) mottles, although a few larger mottles are present. The outer portions of each nodule (< 1 cm) exhibit faint to prominent banding.

Translucency: 2.9-3.5 mm.

Luster: Mostly dull, but few fractured surfaces are moderately lustrous.

Patination: White (N8) to pinkish gray (5YR 8/1).

Effects of heating: Luster changes to shiny or medium, and colors change to grayish orange pink (10R 8/2), pale red (10R 6/2), and weak red (2.5YR 5/2).

Comments: This is a massive outcrop of chert in a region where, judging by the minimal amount of chert in the bedload component of local streams, it is not very common.

Locality 16a: Roadcut in Pecos County, Texas, adjacent to I-10 about 31.8 miles east of intersection of Highway 285 and IH-10 on the east side of Fort Stockton, Texas. Locality is immediately southwest of Squaw Teat Peak and is part of the Squaw Teat Peak site, 41PC14, described by Young (1981). [30° 53.48'N, 102° 19.72'W]. Three nodular zones were present in this roadcut and are described as separate samples: 16a, 16b, and 16c.

Occurrence: Irregularly shaped nodules < 10 cm thick and < 30 cm wide.

Color: Very light gray and light gray (N8, N7) and occasionally bluish white (5B 9/1) to light bluish gray (5B 7/1). The cortex is strong brown (7.5YR 4/6) or white (N9) in color and smooth to slightly rough.

Texture: Fine.

Structure: Some pieces banded, but most have a granular appearance, which could be construed as very finely mottled. Few macrofossils and megaquartz crystalline filled voids.

Translucency: 0.8-1.5 mm.

Luster: Dull to medium.

Patination: White.

Effects of heating: Luster is slightly increased, but not significantly, but color changed to a pinkish gray (5YR 8/1), and grayish orange pink (10R 8/2). Some of the grains within did not change color and stand out as prominent, and very common, very fine (< 1 mm), white flecks.

Comments: none.

Locality 16b: Roadcut in Pecos County, Texas, adjacent to I-10 about 31.8 miles east of intersection of Highway 285 and IH-10 on the east side of Fort Stockton, Texas. Locality is immediately southwest of Squaw Teat Peak and is part of the Squaw Teat Peak site, 41PC14, described by Young 1981. [30° 53.48'N, 102° 19.72'W].

Occurrence: Thin (< 7 cm), disc-shaped nodules.

Color: Nodules are distinctly two-tone, with the centers being light gray to medium light gray (N7-N6), and the outer parts light yellowish brown (10YR 6/4), to brown-dark brown (10YR 4/3). The gray centers and brown outer parts are separated by sharp boundary, but there is some shading within each color group. The brown portions contain small patches of granular inclusions. The cortex is thin and smooth and ranges from white (N9) to yellow (10YR 8/6).

Texture: Fine.

Structure: Technically mottled, but differently from most other Edwards specimens.

Translucency: 1.5-2.1 mm.

Luster: Dull.

Patination: Unknown.

Effects of heating: Gray colors change to a creamy white (Munsell color of white 10YR 8/1), and the yellowish brown-brown portions become pale red (10R 6/3) to weak red (10R 4/3). The granular inclusions in the latter become a deep red color and are more prominent than in unaltered material.

Comments: This material is physically dissimilar than most of the other material from this source, and does not fluoresce. Colors are profoundly altered by heating.

Locality 16c: Roadcut in Pecos County, Texas, adjacent to I-10 about 31.8 miles east of intersection of Highway 285 and IH-10 on the east side of Fort Stockton, Texas. Locality is immediately southwest of Squaw Teat Peak and is part of the Squaw Teat Peak site, 41PC14, described by Young 1981. [30° 53.48'N, 102° 19.72'W].

Occurrence: Disc-shaped nodules, <10 cm thick and <50 cm wide.

Color: Overall appearance is a very light gray (N8), but in actuality this material is composed of individual grains (most <1 mm) which range in color from white (N9) to light brownish gray (10YR 6/2). Cortex is slightly rough, and white to yellow (10YR 7/6). A thin (<3 mm) band of brown-dark brown (7.5YR 4/4) to gray (N4) is present immediately adjacent to the cortex.

Texture: Fine, although it appears granular upon close inspection.

Structure: Granular.

Translucency: 1.6-2.0 mm.

Luster: Dull.

Patination: Unknown.

Effects of heating: Luster increases to medium, and heated surfaces change to grayish orange pink (10R 8/2). Interiors become more pale brown (Munsell color white, 10YR 8/2). Cortex changes to yellowish red (5YR 4/6).

Comments: Fairly similar to 16a, but much more granular in appearance.

Locality 17: Roadcut in Pecos County on IH-10 about 15.9 miles west of Sheffield, Texas. [30° 48.93'N, 102° 00.06'W].

Occurrence: Thin (5-10 cm), disc-shaped nodules that occur parallel to bedding planes. Typically less than 30 cm in diameter although a few larger nodules were observed.

Color: Very light gray (N8), medium to light bluish gray (5B 5/1 -7/1), to light gray (10YR 7/2). A few fragments are pale pinkish gray closest to, but not well represented by, Munsell color 5R 6/2. Cortex is white (N9) to very pale brown (10YR 8/4), and a few joint planes are brownish yellow (10YR 6/8).

Texture: Predominantly fine, although cortex is occasionally medium to rough textured.

Structure: Faintly to distinctly banded around outer portions of the nodules, and bands cut across the major fabric of this chert, which is composed of numerous, but often discontinuous laminations <1 mm thick. Laminations give way to oriented mottles in places. Few to common small (<1 mm) white flecks throughout.

Translucency: 1.8-3.0 mm.

Luster: Dull.

Patination: Unknown.

Effects of heating: Heated surfaces change to a grayish orange pink (10YR 8/2) and moderate orange pink (10YR 7/4). Luster becomes medium to shiny and interior colors became more yellow, with light gray (10YR 7/2) and light brownish gray predominant.

Comments: This is a nice, fine-grained chert with a good fracture which is significantly improved upon heating.

Locality 18: Roadcut adjacent to Highway 290 along east wall of Pecos River Valley located 10 miles from intersection of IH-10 and Highway 290 and about 1 mile east of Fort Lancaster, in Crockett County, Texas. [30° 39.93' N, 101° 41.01' W].

Occurrence: Disc-shaped nodules approximately 30 cm in diameter and 5-10 cm thick.

Color: Light gray (N7) and medium light gray (N6), and pale yellowish brown (10YR 6/2) comprise the colors of laminations. Lighter grays dominate outer portions of the nodules and darker grays are more common in nodule cores. A thin (5-6 mm), dark yellowish brown (10YR 4/2) band often is present adjacent to cortex, which is very thin, smooth to slightly rough, and very pale brown (10YR 7/4) to yellow (10YR 7/6).

Texture: Fine.

Structure: Large pieces are distinctly laminated, but some mottling occurs as well.

Translucency: 2.6-4.8 mm.

Luster: Mostly dull, but few fractures exhibit medium luster.

Patination: White (N8).

Effects of heating: Luster changes to medium, and occasionally shiny. Colors range from moderate pink (5R 7/4), to pinkish gray (5YR 8/1) near outside of heated surface and gray colors (medium gray [N5] and medium light gray [N6]) in nodule cores become more pronounced. Cortex turns brown (7.5YR 5/4).

Comments: Very uniform grain and easily worked material.

Locality 19: I-10 roadcut located 0.8 miles west of exit 399 at Sonora, Texas. [30° 35.31'N, 100° 40.38'W].

Occurrence: Irregular-shaped nodules, typically less than 30 cm in diameter.

Color: Very pale brown (10YR 7/4) near the cortex, grading to light grayish brown and grayish brown (10YR 6/2 to 5/2) toward the center of the nodules. Some nodules have a thin (3 mm) band of dark grayish brown (10YR 3/2) adjacent to cortex, the latter of which is brownish yellow (10YR 6/6) to brown-dark brown (10YR 4/3). Numerous very fine (< 1 mm) mottles of contrasting colors (light grayish brown against grayish brown or vice versa) throughout. A few diffuse areas of light reddish brown (5YR 6/3) are also present.

Texture: Fine to medium.

Structure: Mottled with large (0.5-3 cm) irregular, sharp to gradual boundaries, as well as common small, contrasting color flecks. A few vugs with megaquartz fillings, and some nodules have interior, coarse-grained, chalky mottles that grade into voids, possibly former burrows.

Translucency: 0.5-1.6 mm.

Luster: Dull.
Patination: White.
Effects of heating: Heated margins change to pale red (10R 6/3), and chalky void/mottles may change to pink (5YR 7/3), but interiors mostly unchanged. Luster increases to medium.
Comments: None.

Locality 20a: Roadcut in Schleicher County, Texas, located on Highway 190 about 5.8 miles west of intersection with FM 2873. This sample is the upper of two nodular cherts which crop out in this locality; the other is identified as 20b [30° 52.72'N, 100° 11.83'W].
Occurrence: Nodules are generally less than 30 cm wide and less than 10 cm thick.
Color: Cortex is very thin (<1 mm) and white, but limestone occasionally adheres to nodules. Interiors are banded grayish brown and light grayish brown (10YR 6/2 to 5/2) and dark gray and very dark gray (10YR 4/1 to 3/1) and a few small, opaque white flecks are widely scattered throughout. Toward the margins of the nodules, the bands become more closely spaced and are primarily light gray, very light gray and white (N7, N8 and N9). A thin (3-4 mm), discontinuous band of medium bluish gray (5B 5/1) is often present immediately adjacent to the cortex.
Texture: Fine.
Structure: Prominently banded, and the bands become thinner toward the cortex.
Translucency: 2.7-8.2 mm.
Luster: Dull, with few pieces medium.
Patination: White.
Effects of heating: No significant color changes observed, but some of the grayish browns appear to become more gray. Luster increases slightly to medium. Some spalling occurred while heating, but lower temperatures may be successful.
Comments: None.

Locality 20b: Roadcut in Schleicher County, Texas, located on Highway 190 about 5.8 miles west of intersection with FM 2873. This sample is the lower of two nodular cherts which crop out in this locality; the upper chert is identified as locality 20a [30° 52.72'N, 100° 11.83'W].
Occurrence: Rather large disc-shaped nodules, often in excess of 10 cm thick and most less than a meter in diameter.
Color: Very dark gray (5YR 3/1), to dark grayish brown (10YR 4/2), but often has a bluish tint. Mottles are irregularly shaped, and range in color from light brownish gray (10YR 6/2) to gray (10YR 5/1). The cortex is up to 1.5 cm thick and ranges in color from white (N9) to light gray (10YR 7/1).
Texture: Mostly fine, but some of the mottles are coarser, medium texture.
Structure: Mottled, and in some cases striated.
Translucency: 9.7-10.2+ mm.
Luster: Medium to dull.
Patination: White.

Effects of heating: Luster increases to shiny and/or medium, and dark grayish browns become slightly more blue (no good Munsell match). Considerable thermal fracturing occurred while in the oven.

Comments: One of the more translucent cherts collected.

Locality 21a: Roadcut in Menard County, on Highway 83 located 5.5 miles south of its intersection with Highway 190 in Menard, Texas. Two samples were collected at this locality, this is the lower chert zone; the upper one is identified as locality 21b. [30° 51.00'N, 99° 45.85'W].

Occurrence: Disc-shaped nodules less than 30 cm in diameter and about 5-10 cm thick.

Color: Highly variable. Almost equal proportions of very dark gray (5YR 3/1), a flecked light gray to light brownish gray (10YR 6/2 to 7/2), and weak red (10R 5/4.) The cortex is white to brownish yellow (10YR 6/4), chalky, slightly rough and generally less than 1 cm thick.

Texture: Fine.

Structure: Intensely mottled with wide range of colors, hence it appears almost variegated. Some voids are present in nodule interiors.

Translucency: 4.9-7.4 mm.

Luster: Medium to dull.

Patination: Unknown.

Effects of heating: Luster increases from medium to mostly shiny. Colors remain mostly the same although the dark grays appear to become somewhat light bluish gray to bluish white (5B 9/1 to 7/1). Significant crazing and thermal fracturing occurred during heating.

Comments: Much of this chert is marred by internal joints and fractures, but some thin homogeneous nodules were found and they were easily workable. This is easily the most variable material collected.

Locality 21b: Roadcut in Menard County, on Highway 83 located 5.5 miles south of its intersection with Highway 190 in Menard, Texas. Two samples were collected at this locality, this is the upper chert zone and the lower one is identified as locality 21b. [30° 51.00'N, 99° 45.85'W].

Occurrence: Irregular disc-shaped nodules which are generally < 10 cm thick and less than a meter in diameter.

Color: Outer portions of nodules are banded and dominantly white (N9, 10YR 8/1 and 8/2) and occasionally have numerous small fossil shell fragments which impart a flecked appearance. The center of the banded material is typically medium dark gray (N4). The latter material expands in thickness in some nodules and is mottled. Dominant colors are medium bluish gray (5B 5/1) to dark gray (N4) to and mottles have sharp boundaries and are gray (10YR 5/1 to 6/1) Cortex is white but occasionally stained by the surrounding soil to a reddish brown (5YR 5/4).

Texture: Medium to fine.

Structure: Faintly to distinctly banded and mottled.

Translucency: Grays are 3.3-7.6 mm and banded whites are opaque and range from 0.5-1.2 mm.

Luster: Dull.

Patination: Unknown.
Effects of heating: Increases luster to medium and makes fracture surfaces much smoother.
Comments: None.

Locality 22: Roadcut adjacent to Highway 83 located 23.4 miles south of intersection with Highway 190 in Menard, Texas. [30° 35.86'N, 99° 47.17W].
Occurrence: Small (<30 cm diameter), thin (<7 cm) disc-shaped nodules which occur parallel to bedding planes.
Color: Cortex is slightly rough and white (N9), but interior colors are highly variable. Dominant colors are very dark gray (5YR 3/1), dark gray (10YR 4/1), dark reddish gray (5YR 4/2) and reddish brown (5YR 4/3). Most specimens have one or more coarser textured gray-light gray (10YR 6/1) to occasionally white, more opaque mottles <1 cm in diameter.
Texture: Fine.
Structure: Primarily mottled in a complex manner, but a few laminations also present.
Translucency: 5.0-7.7 mm.
Luster: Dull, but infrequently medium.
Patination: White.
Effects of heating: Some pieces appeared to take on a light bluish to medium bluish (5B7/1 to 5/1) color, and the luster of fresh fracture planes increased to medium. However, numerous heat spalls occurred while in the oven, and resulting piece was seriously crazed.
Comments: Heating to a lower temperature might be successful with this material, but it is fairly easily worked without thermal alteration.

Locality 23a: Roadcut in Kimble County, adjacent to eastbound lanes of IH-10, 2.1 miles east of mile marker 458 near Junction, Texas. Two samples were collected from this locality, and this is the lower of the two. The other sample is designated Locality 23b. [30° 27.95'N, 99° 43.83'W].
Occurrence: Relatively large nodules, <15 cm thick and typically <50 cm in diameter.
Color: White-light gray (10YR 8/2 to 7/2) inside nodules, and shades to gray and light gray (10YR 5/1 to 6/1) at margins. One side of nodules usually has sharp-edged, 2-3 cm diameter translucent, light gray (N7), light brownish gray (5YR 6/1), light bluish gray (5B 7/1) and bluish white (5B 9/1) mottles that are typically zoned bluish white around the margins and turn gray toward their interiors.
Texture: Medium to fine.
Structure: Mottled.
Translucency: Light browns are generally between 1-3 mm, but the light gray- bluish grays are >10 mm.
Luster: Dull.
Patination: Unknown.
Effects of heating: Heating to 555°F causes the light gray interiors to turn grayish orange pink (10R 8/2), the darker exteriors a grayish brown (10YR 5/2). Only the latter parts show a marked increase in luster, and they definitely increase to medium. Likewise, the more translucent mottles also increase to a medium luster, but do not experience a significant color change.

Comments:	This chert appears to be in part a silicified evaporite, with relict bedding. The more translucent mottled areas exhibit a boxwork-like structure very similar to anhydrite. The more opaque parts are different from most in that the are darker on the outside and become progressively lighter toward the interior.
Locality 23b:	Roadcut in Kimble County, adjacent to eastbound lanes of IH-10, 2.1 miles east of mile marker 458 near Junction, Texas. Two samples were collected from this locality, and this is the upper of the two. The other sample is designated Locality 23a. [30° 27.95'N, 99°**p1319X43.83'W].
Occurrence:	Thin disc-shaped nodules, commonly 4-7 mm thick and less than 30 cm in diameter. Often broken into long, narrow tabular pieces.
Color:	Very dark grayish brown (10YR 3/2) to very dark gray (10YR 3/1). Mottles in nodule interiors are light gray to gray (10YR 6/1 to 5/1) and relatively infrequent. Banding is expressed by thin (< 1 mm) light gray (10YR 7/2 to 6/1), broken streaks parallel to nodule cortex, which is thin (<3 mm) and white to very pale brown (10YR 7/2) in color.
Texture:	Fine.
Structure:	Much of it appears homogeneous, but some nodules are faintly banded, and the centers of larger nodules are mottled.
Translucency:	7.0-7.5 mm.
Luster:	Medium.
Patination:	White to a bluish white (5B 9/1).
Effects of heating:	Experiences extensive thermal fractures during heating to 550°F. Luster increases to shiny.
Comments:	An excellent chert without thermal alteration. A few pieces observed in the outcrop appeared to be crazed, either by tectonic warping of strata, or possibly by prior heating.
Locality 24:	Approximately 0.5 mile from start of Barton Creek Greenbelt walking trail west of Barton Springs pool, and situated immediately behind the Barton Oaks Plaza Two office building (which is located off of MoPac Highway at intersection with Bee Caves Road. [30°15.69'N, 97° 46.80'W].
Occurrence:	Thin (<10 cm) disc-shaped nodules commonly less than 40 cm in diameter, which occur parallel to bedding planes. Nodules often have irregular plan form.
Color:	Gray (10YR 5/1), dark gray to grayish black (N2-N3), the latter colors often appear almost a dark navy blue. The infrequent mottles are light gray (10YR 6/1). Cortex is thin (<3 mm), and white (N9).
Texture:	Fine.
Structure:	Banded, although a few, fine mottles are present in the interior portions of some nodules.
Translucency:	3.3-6.6 mm.
Luster:	Medium.
Patination:	White.
Effects of heating:	Unknown.
Comments:	A nice, fine-grained chert common throughout the Barton Creek valley walls near Barton Springs Pool.

Locality 25: Sample collected from 3939 Bee Caves Road, behind Building C (Mariah Associates Inc., office); Travis County, Texas. [30°16.83'N, 97°48.46'W].

Occurrence: Large (>15 cm thick and >50 cm in diameter) nodules.

Color: Dominant colors are very dark gray (10YR 3/1) dark gray (10YR 4/1) and dark grayish brown (10YR 4/2). Larger mottles (>1cm) are infrequent and range in color from light gray to grayish brown (10YR 7/2 to 5/2). Many macrofossils are present, mostly bivalves, and these shells are white (N9 to 10YR8/2), and occasionally replaced by megaquartz. Small (<1 mm) flecks (possibly microfossils) are common and range in color from white to light bluish gray (5B 7/1). Many specimens have a thick (1-2 cm) band of white (N9) cortex, which is still very much chert.

Texture: Fine.

Structure: Mottled to infrequently banded.

Translucency: 3.7-8.3 mm.

Luster: Medium to dull.

Patination: White.

Effects of heating: Unknown.

Comments: The large number of fossils and the presence of a few internal joints and fractures keep this chert from having excellent working qualities.

Locality 26: Sample collected from Sterling County, Texas, from a roadcut adjacent to Highway 158 approximately 5.8 miles from its intersection with Highway 87.

Occurrence: Nodules.

Color: Very dark gray to dark grayish brown (10YR 3/1 to 4/2) and medium light gray (N6) which often appears to be a light bluish gray (5B 7/1). Some of the mottles are light gray (10YR 7/1 to 7/2). Cortex is slightly rough and white (N9), and relatively recent fracture surfaces often exhibit some corrosion pitting.

Texture: Fine.

Structure: Mottled but some color changes give a crude striated appearance.

Translucency: 7.0-8.3 mm.

Luster: Medium.

Patination: White to light bluish gray (N9 to 5B 7/1).

Effects of heating: Unknown.

Comments: Collected by Mr. Mike Quigg, Mariah Associates, Inc., Austin, Texas.

Locality 27a: Roadcut in Bell County, on Highway 190 east of Nolanville, Texas. This is one of two samples collected from this roadcut. The other is identified as Locality 27b.

Occurrence: Nodular chert.

Color: Very light gray (N8) to light gray (10YR 7/2). Some white (N9-10YR 8/1) sharp-edged mottles are present in this chert. Cortex is very pale brown (10YR 8/4) to yellow(10YR 8/6), slightly rough and chalky.

Texture: Fine.

Structure: Mottled.

Translucency: 0.3-1.1mm.

Luster: Dull.

Patination: Unknown.

Effects of heating: Unknown.
Comments: Collected by Mr. Mike Quigg, Mariah Associates, Inc., Austin, Texas.

Locality 27b: Roadcut in Bell County, on Highway 190 east of Nolanville, Texas.
Occurrence: Nodular chert.
Color: Dark gray to medium gray (N4 - N5), light bluish gray (5B 7/1), and very light gray (N8). Mottles are often coarser textured than surrounding matrix and light gray (10YR 7/1). Cortex is white to yellow (10YR 8/2 to 8/6), slightly rough and chalky.
Texture: Fine.
Structure: Banded, with some mottles.
Translucency: 2.2-5.5 mm.
Luster: Medium to dull.
Patination: Unknown.
Effects of heating: Unknown.
Comments: Collected by Mr. Mike Quigg, Mariah Associates, Inc., Austin, Texas.

Locality 28: Sample collected in Howard County, from channel of Bull Creek, at crossing by Highway 2182, about 2-3 miles east of its intersection with Highway 821. Bull Creek drains the Fort Terrett Formation.
Occurrence: Quaternary alluvium, gravel.
Color: Three dominant colors. Many pieces have a brownish yellow (10YR 6/6) to very pale brown (10YR 7/4) band which is slightly coarser textured (fine to medium) and about 2 cm thick. This material is separated by an abrupt boundary from two other colors of chert. One is very light gray (N8), light gray (N7), and light bluish gray (5B 7/1) and is faintly banded and has a few inclusions of pale blue (5PB 7/2) chalcedony and megaquartz-filled vugs. The other material is mostly dark gray (5YR 4/1) and contains irregular mottles of light gray (N7) and white (10YR 8/2). The cortex of all materials is slightly rough and light brownish gray (10YR 6/2) to brown (7.5YR 5/4).
Texture: Fine to medium.
Structure: Banded, occasionally mottled in center of nodules.
Translucency: White and gray portions are about 6.6-7.8 mm, but band of yellow is much more opaque, around 1-3 mm.
Luster: Medium.
Patination: White.
Effects of heating: Unknown.
Comments: This material is nearly identical to Locality 41, collected by Chris Turnbow in Reagan County, Texas.

Locality 29: North of Oak Creek Reservoir, off of Highway 70; Boyd et al. (1993:20-21) sample No. 1., southern edge of the Callahan Divide.
Occurrence: Not specified.
Color: Medium light gray (N6) to light bluish gray (5B 7/1) are most common, but mottles range into brown and gray, specifically brown (10YR 5/3), grayish brown (10YR 5/2), light gray (10YR 7/1), and dark gray (10YR 4/1). The

cortex ranges from white (N9), very pale brown (10YR 8/4) and light brown (7.5YR 6/4). Relatively recent fracture surfaces exhibit corrosion pits.

Texture: Fine.
Structure: Striated to mottled.
Translucency: 2.4-5.5 mm.
Luster: Medium to dull.
Patination: Unknown.
Effects of heating: Unknown.
Comments: This sample probably represents a single bedrock source although Boyd et al. (1993:20-21) assigned this material 5 color categories.

Locality 30: Collected from Quaternary alluvium south of Sweetwater, off of Highway 70; Boyd et al. (1993:20-21) sample No. 2 from the north edge of the Callahan Divide.

Occurrence: Not specified.
Color: White (10YR 8/1), and light gray (10YR 6/1-5/1) most common, with mottles often light brownish gray (10YR 6/2) and dark gray (10YR 4/1). The cortex is chalky in character and white (N9) to reddish yellow (7.5YR 8/6).
Texture: Medium to fine.
Structure: Banded to mottled.
Translucency: 1.2-1.7 mm.
Luster: Dull.
Patination: Unknown.
Effects of heating: Unknown.
Comments: On the basis of the variability present, this sample appears to represent a single bedrock source. It is a very even textured material that appears to have few internal flaws. Boyd et al. (1993:20-21) assigned this material 2 color categories.

Locality 32: South of Big Spring in Howard County, Texas; Boyd et al. (1993:20-21) sample No. 19. Corner of Oak Glen and Goliad, just south of FM 700.

Occurrence: Not specified.
Color: Light gray (10YR 7/2 to N7), very light gray (N8), and some faint and diffuse areas of light brown (5YR 6/4). Mottles are occasionally coarser textured and are light brownish gray to light gray (10YR 6/2 to 7/2). A few very small (<0.5 mm) light reddish brown (5YR 6/4) flecks are present throughout. The cortex is slightly rough and ranges in color from white N9) to light red (2.5YR 6/6).
Texture: Fine to medium.
Structure: Faintly banded adjacent to cortex, becoming faintly mottled toward the center.
Translucency: 6.0-8.3 mm.
Luster: Mostly dull.
Patination: Unknown.
Effects of heating: Unknown.
Comments: Boyd et al. (1993:20-21) assigned this material 2 color categories, and the variability present suggests a single bedrock source.

Locality 33: South of Big Spring in Howard County, Texas; Boyd et al. (1993:20-21) sample No. 20.
Occurrence: Not specified.
Color: Light brownish gray (5YR 6/1), light gray (N7) and very light gray (N8) are dominant, with some very pale orange (10YR 8/2) and grayish pink (5R 8/2) also present. A few small (< 1 mm) yellowish red (5YR 5/6) flecks are also present. The cortex is thin, white (N9) to light gray (10YR 7/2), and slightly rough. One piece in this assemblage was dark gray (10YR 4/1) with occasional, small (< 3 mm) light gray mottles.
Texture: Fine.
Structure: Faintly banded. Few vugs partially filled with megaquartz.
Translucency: 5.5-7.7 mm.
Luster: Dull. Patinated surfaces appear to have a greater luster.
Patination: White.
Effects of heating: Unknown.
Comments: Boyd et al. (1993:20-21) assigned this material 2 color categories.

Locality 34a: Buffalo Gap/Lake Abilene in Taylor County, Texas; Boyd et al. (1993:20-21) sample No. 21. At least two types of chert appear to be represented by this assemblage and are described separately as samples 34a and 34b.
Occurrence: Not specified.
Color: Medium bluish gray (5B 5/1), medium gray (N5), and light bluish gray (5B 7/1). The cortex may be thick (> 2 cm) and very pale brown (10YR 7/3) or yellowish brown (10YR 5/6).
Texture: Fine.
Structure: Homogeneous.
Translucency: 4.5-7.7 mm.
Luster: Medium.
Patination: White.
Effects of heating: Unknown.
Comments: Together with sample 34b, Boyd et al. (1993:20-21) assigned this material 7 color categories.

Locality 34b: Buffalo Gap/Lake Abilene in Taylor County, Texas; Boyd et al. (1993:20-21) sample No. 21. At least two types of chert appear to be represented by this assemblage and are described separately as samples 34a and 34b.
Occurrence: Not specified.
Color: Light gray (2.5Y 7/2), medium gray (N5), and gray-light gray (10YR 6/1). Mottles are <3 mm in diameter, and light gray (10YR 7/1) to medium gray (N5), and occasionally strong brown (7.5YR 5/6). The cortex is white (N9), very pale brown (10YR 7/4), and occasionally brownish yellow (10YR 6/6), and may be more than 1 cm thick.
Texture: Fine.
Structure: Mottled.
Translucency: 2.0-6.3 mm.
Luster: Dull to medium.
Patination: White.

Effects of heating: Unknown.
Comments: Together with sample 34a, Boyd et al. (1993:20-21) assigned this material 7 color categories.

Locality 35a: Buffalo Gap/Lake Abilene in Taylor County, Texas; Boyd et al. (1993:20-21) sample No. 22. At least two bedrock sources are reflected by this sample and are described separately as 35a and 35b.
Occurrence: Unknown.
Color: Medium gray (N5), medium bluish gray (5B 5/1), and medium light gray (N7). A few, 1-4 mm diameter, light brownish gray (10YR 6/2) mottles are present. Cortex is thin (<2 mm) and yellowish brown (10YR 5/8).
Texture: Fine.
Structure: Homogeneous to mottled.
Translucency: >6 mm.
Luster: Medium.
Patination: Unknown.
Effects of heating: Unknown.
Comments: Boyd et al. (1993:20-21) assigned this material (their sample 22, our sample 35a and 35b) 5 color categories.

Locality 35b: Buffalo Gap/Lake Abilene in Taylor County, Texas; Boyd et al. (1993:20-21) sample No. 22.
Occurrence: Appears to occur as irregularly shaped nodules.
Color: Grayish brown (10YR 5/2), grading to dark gray (10YR 4/2) toward center of nodules. Some specimens have abrupt-edged translucent light bluish gray (5B 7/1) to medium light gray (N6) inclusions up to 3 cm in diameter. Cortex is white (10YR 8/20 to light gray (10YR 6/1) and often banded within a centimeter of the outer part of the nodule. Cortex surface is generally smooth and brownish yellow to strong brown (10YR 5/8 to 7.5YR 5/8).
Texture: Fine.
Structure: Banded immediately adjacent to cortex, and mottled in the interior.
Translucency: Mostly 1-5 mm, but the gray-bluish gray inclusions are much more translucent, usually >11 mm.
Luster: Medium.
Patination: Unknown.
Effects of heating: Unknown.
Comments: Boyd et al. (1993:20-21) assigned this material 5 color categories.

Locality 36: Adjacent to FM 2744/U.S. Highway 70 intersection in Fisher County, Texas; Boyd et al. (1993:20-21) sample No. 23.
Occurrence: Not specified.
Color: Homogeneous light gray (N7) to very light gray (N8), grading to very pale orange (10YR 8/2) near cortex, which is yellowish brown (10YR 5/8) to brownish yellow (10YR 6/6). One piece is medium gray (N5) to medium bluish gray (5B 5/1) and has numerous small (<1 mm) very light gray (N8) mottles. Another piece is mottled with light olive gray (5Y 6/1) and light gray (5YR 6/1).
Texture: Fine.

Structure: Shaded to mottled.
Translucency: 2.2-3.4 mm.
Luster: Medium.
Patination: White to light yellowish brown (10YR 6/4).
Effects of heating: Unknown.
Comments: Boyd et al. (1993:20-21) assigned this material 5 color categories, but the sample we obtained was not that diverse. Although two bedrock materials may be present, all of was described as if it were a single source.

Locality 37a: 2.1 miles north of FM 153/U.S. Highway 277 intersection in Nolan County, Texas; Boyd et al. (1993:20-21) sample No. 24. At least two relatively distinct cherts are present in this sample and are described separately as Localities 37a and 37b. It is possible that this represents a single bedrock source but a continuum of appearance could not be demonstrated in the hand samples obtained.
Occurrence: Not specified.
Color: Medium bluish gray (5B 5/1) and pale blue (5PB7/2) are the dominant colors. The pale blue parts are composed of many, densely packed, small 1-2 mm diameter inclusion, possibly microfossils, in a medium bluish gray matrix. The medium bluish gray portions are more homogeneous, but have occasional, very fine, diffuse veins of strong brown (7.5YR 5/8) colored material. Cortex is generally white (10YR 8/2), thin, and slightly rough.
Texture: Fine.
Structure: Homogeneous to finely mottled.
Translucency: 3.4-8.7 mm.
Luster: Medium to shiny.
Patination: White.
Effects of heating: Unknown.
Comments: Boyd et al. (1993:20-21) assigned this material 7 color categories.

Locality 37b: 2.1 miles north of FM 153/U.S. Highway 277 intersection in Nolan County, Texas; Boyd et al. (1993:20-21) sample No. 24. At least two relatively distinct cherts are present in this sample and are described separately as Localities 37a and 37b. It is possible that this represents a single bedrock source but a continuum of appearance could not be demonstrated in the hand samples obtained.
Occurrence: Not specified.
Color: Light gray (2.5Y 7/2), medium gray (N5) and somewhat medium bluish gray (5B 5/1). A few, small (<3 mm) light gray (10YR 7/2) mottles are present on some samples. Cortex ranges in color from very pale brown (10YR 8/3) and brownish yellow (10YR 6/6) to white (N8), and is slightly rough. A few vugs partially filled with megaquartz are present.
Texture: Fine.
Structure: Shaded to mottled.
Translucency: 3.2-5.2 mm.
Luster: Medium.
Patination: Unknown.

Effects of heating: Unknown.
Comments: Boyd et al. (1993:20-21) assigned this material 7 color categories.

Locality 38: Reagan County, Texas.
Occurrence: Not specified.
Color: White (10YR 8/1 to 8/2). Small inclusions (<3 mm in diameter) are often light gray (N7), light bluish gray (5B 7/1), or very pale brown (10YR 8/4). Internal fracture planes often stained very pale brown (10YR 7/4). Cortex is thin (<2 mm) and white (N9).
Texture: Fine.
Structure: Striated to mottled. Inclusions definitely exhibit a preferred orientation.
Translucency: About 4-5 mm.
Luster: Dull to medium.
Patination: White.
Effects of heating: Unknown.
Comments: Sample collected by Mr. Chris Turnbow, Mariah Associates, Inc., Albuquerque, New Mexico.

Locality 39: Sample collected from Moss Creek, just below a bedrock outcrop in Howard County, Texas.
Occurrence: Not specified.
Color: Light gray to light brownish gray (N7, 10YR 7/2 to 6/2), to almost a light bluish gray (5B 7/1). A few very small (<0.5 mm) yellowish red (5YR 5/8) inclusions are also present. The cortex is thin, smooth and white (N9), but transition to cortex often appears bluish white (5B9/1) to light bluish gray (5B7/1).
Texture: Fine.
Structure: Banded, most prominent near the cortex.
Translucency: 4.4-7.0 mm.
Luster: Mostly dull.
Patination: Pale brown (10YR 6/3) to white (N9).
Effects of heating: Unknown.
Comments: Sample collected by Mr. Chris Turnbow, Mariah Associates, Inc., Albuquerque, New Mexico.

Locality 40: Reagan County, Texas.
Occurrence: Not specified.
Color: Variable. Interiors range from light gray to very light gray (N7-N8), and white (10YR 8/2) to almost a pale reddish brown (10R 5/4) and may contain many small white inclusions which exhibit a preferred orientation. Mottles are light gray (10YR 7/2) and often of a slightly coarser texture than surrounding matrix. Cortex is slightly rough and ranges in color from pale brown (10YR 8/3) to reddish brown (5YR 4/3). Joint planes are often stained yellow or brownish yellow (10YR 7/8 to 6/6). A couple of pieces have a thin (<2 mm) band of grayish red purple or very dusky red purple (5RP 4/2 to 5RP 2/2) adjacent to cortex.
Texture: Fine to medium.
Structure: Mottled.

Translucency:	White and light grays are around 3.0-3.5 mm, whereas the reddish browns are often in excess of 5 mm.
Luster:	Medium to dull.
Patination:	Unknown.
Effects of heating:	Unknown.
Comments:	Sample collected by Mr. Chris Turnbow, Mariah Associates, Inc., Albuquerque, New Mexico.

Locality 41:	Reagan County, Texas.
Occurrence:	Not specified.
Color:	White to very light gray (N9-N8; 10YR 8/2). A few pieces are very pale brown to brownish yellow (10YR 7/4 to 6/8). Cortex is slightly rough and very pale brown (10YR 8/4).
Texture:	Fine.
Structure:	Banded to homogeneous.
Translucency:	About 2.6-4.7 mm.
Luster:	Dull to medium. Patinated surfaces appear to have increased luster (medium).
Patination:	White (N9) to a cream (no good Munsell match).
Effects of heating:	Unknown.
Comments:	Sample collected by Mr. Chris Turnbow, Mariah Associates, Inc., Albuquerque, New Mexico.

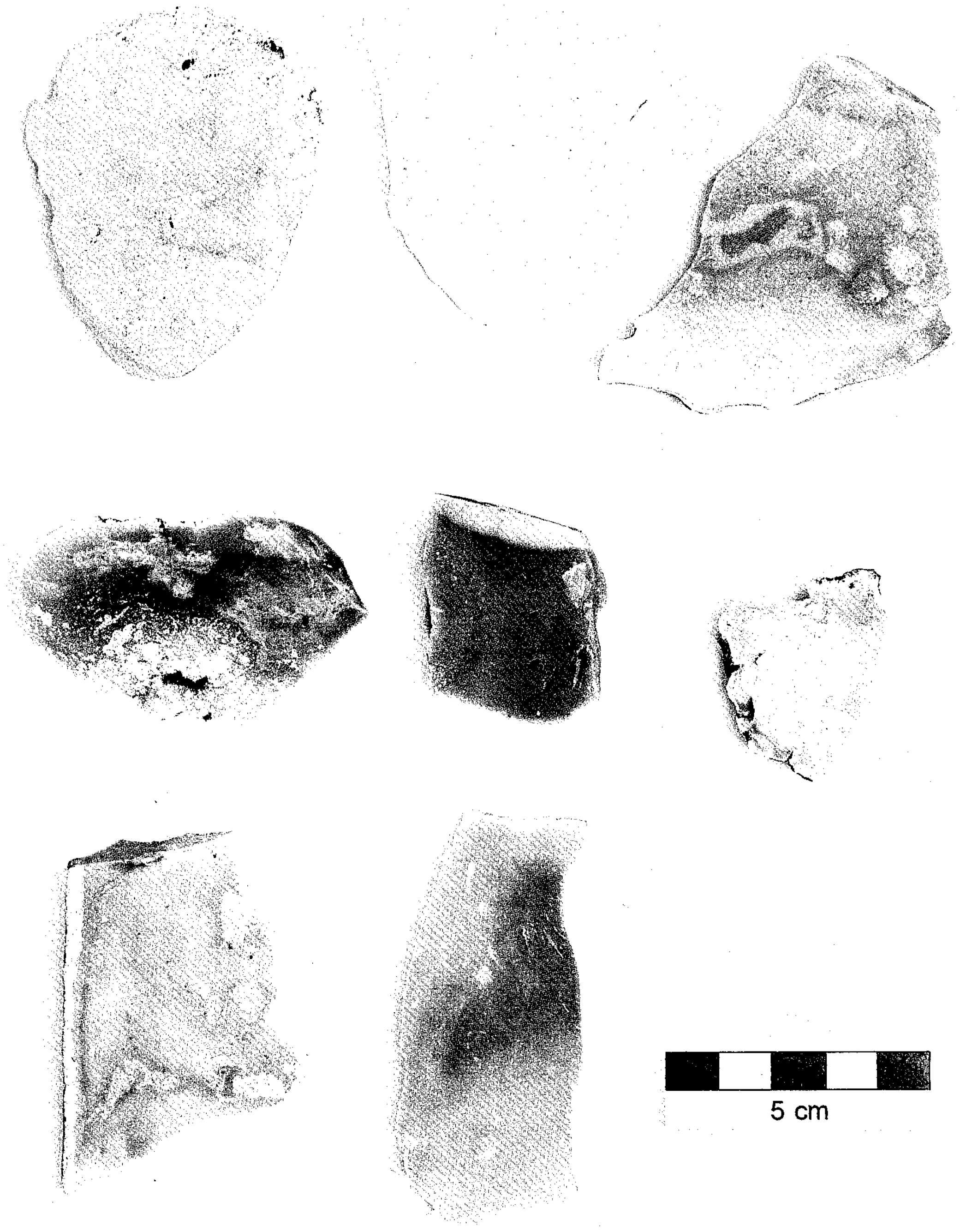


Plate 1 Fort Hood Cherts. Top left across to bottom right: Type 1, Heiner Lake Blue-Light; Type 2, Cowhouse White; Type 3, Anderson Mountain Gray; Type 4, Seven Mile Mountain Novaculite; Type 5, Texas Novaculite; Type 7, Fossiliferous Pale Brown; Type 6, Heiner Lake Tan; Type 8, Fort Hood Yellow.

Plate 2 Fort Hood Cherts. Top left across to bottom right: Type 9, Heiner Lake Translucent Brown; Type 10, Heiner Lake Blue; Type 11, East Range Flat; Type 13, East Range Flecked; Type 14, Fort Hood Gray; Type 15, Gary-Brown-Green; Type 16, Leona Park; Type 17, Owl Creek Black.

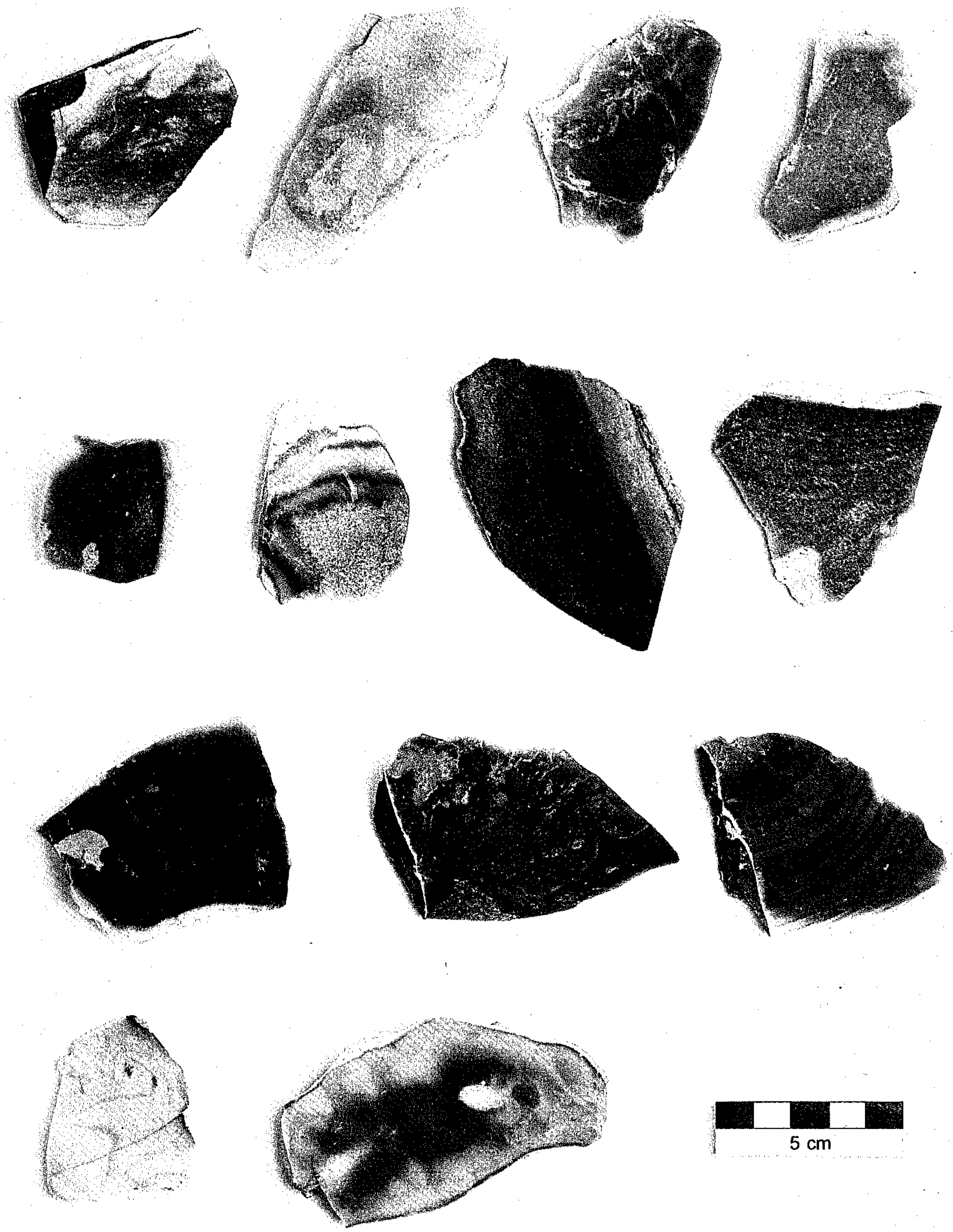


Plate 3 West Texas Cherts. Top left across to bottom right: Localities 1, 2a, 2b, 3, 4a, 4b, 6, 7, 8, 9, 10, 12, 13.

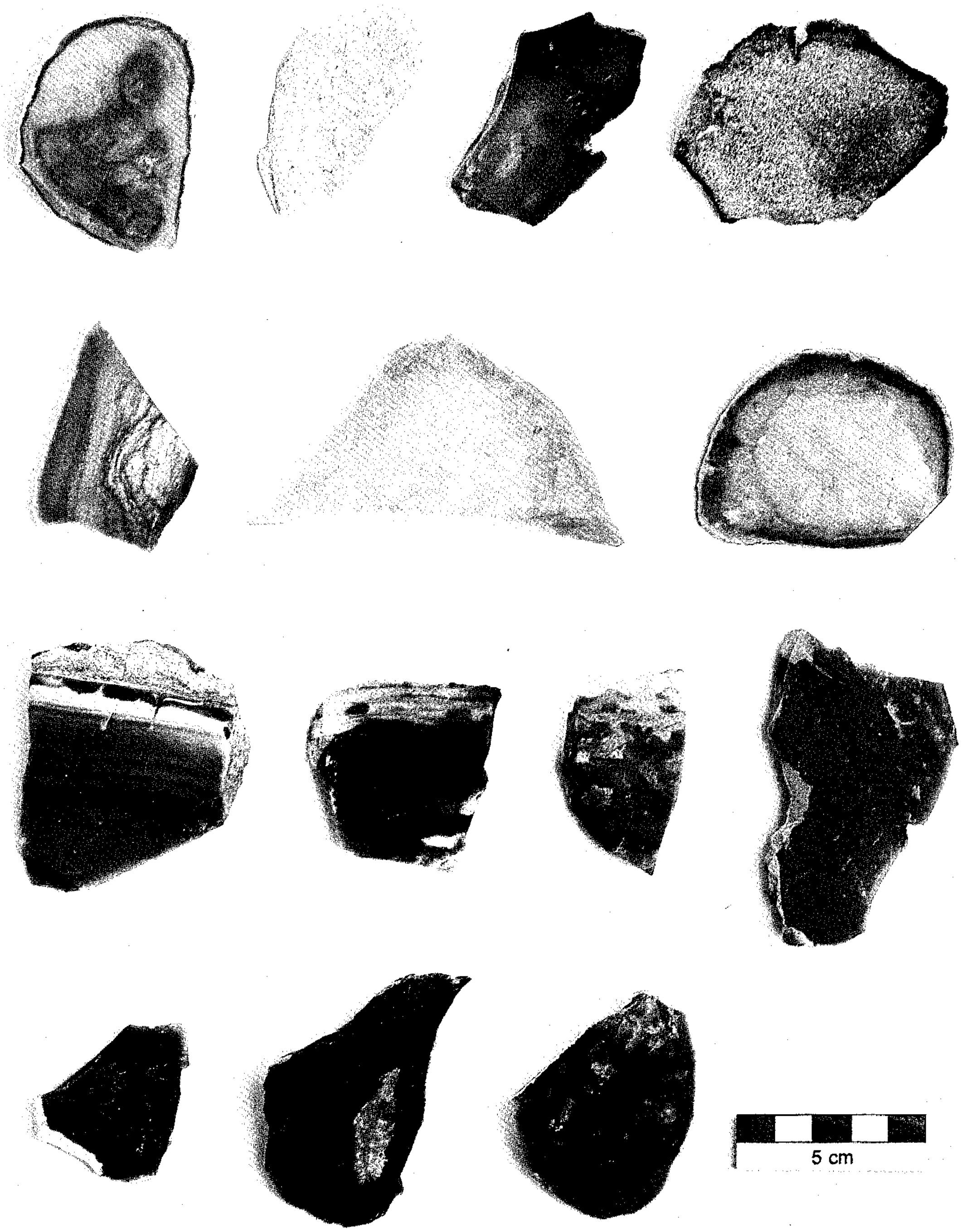


Plate 4 West Texas Cherts. Top left across to bottom right: Localities 14, 16a, 16b, 16c, 17, 18, 19, 20a, 20b, 21a, 21b, 22, 23a, 26.

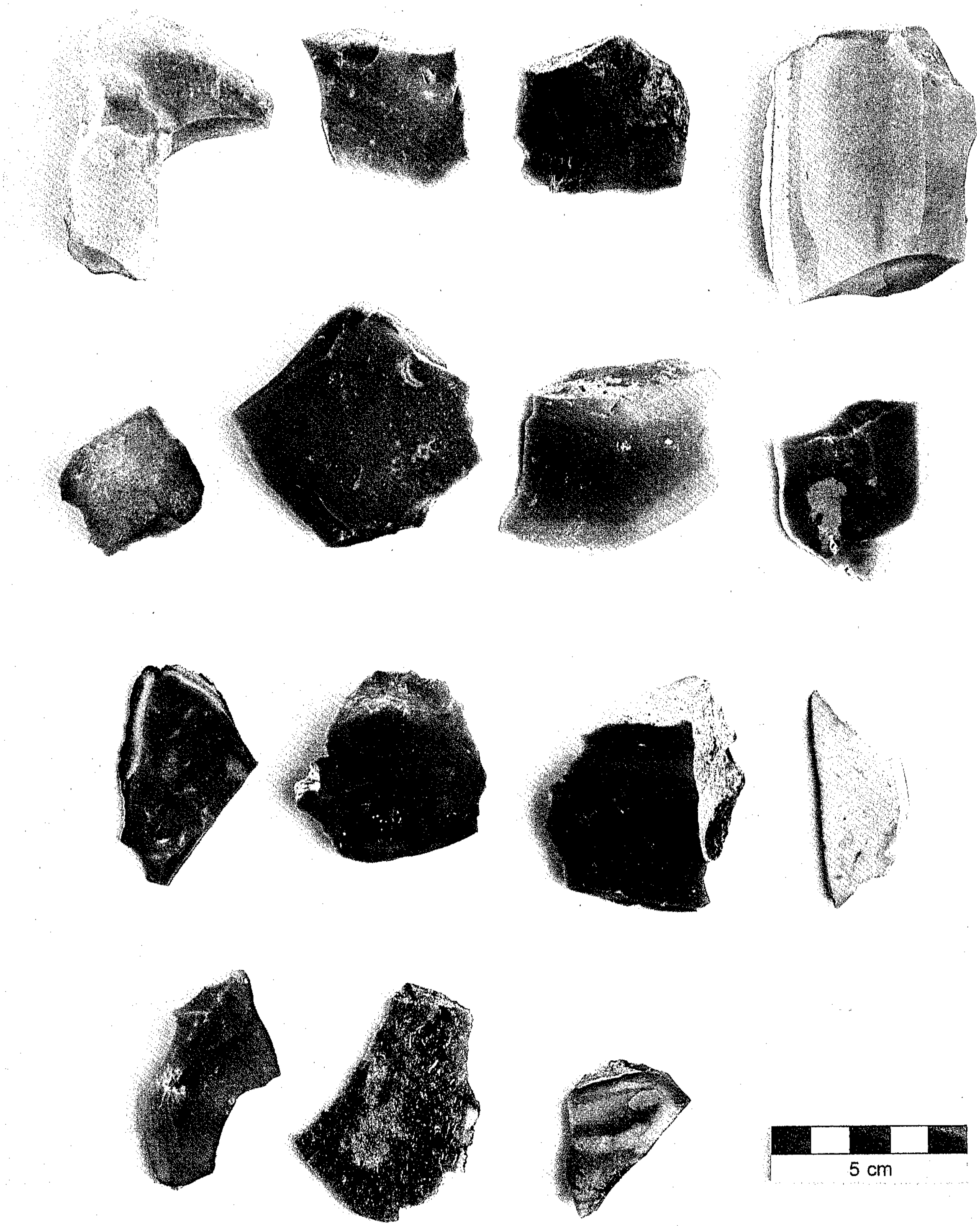


Plate 5 West Texas Cherts. Top left across to bottom right: Localities 27a, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41.

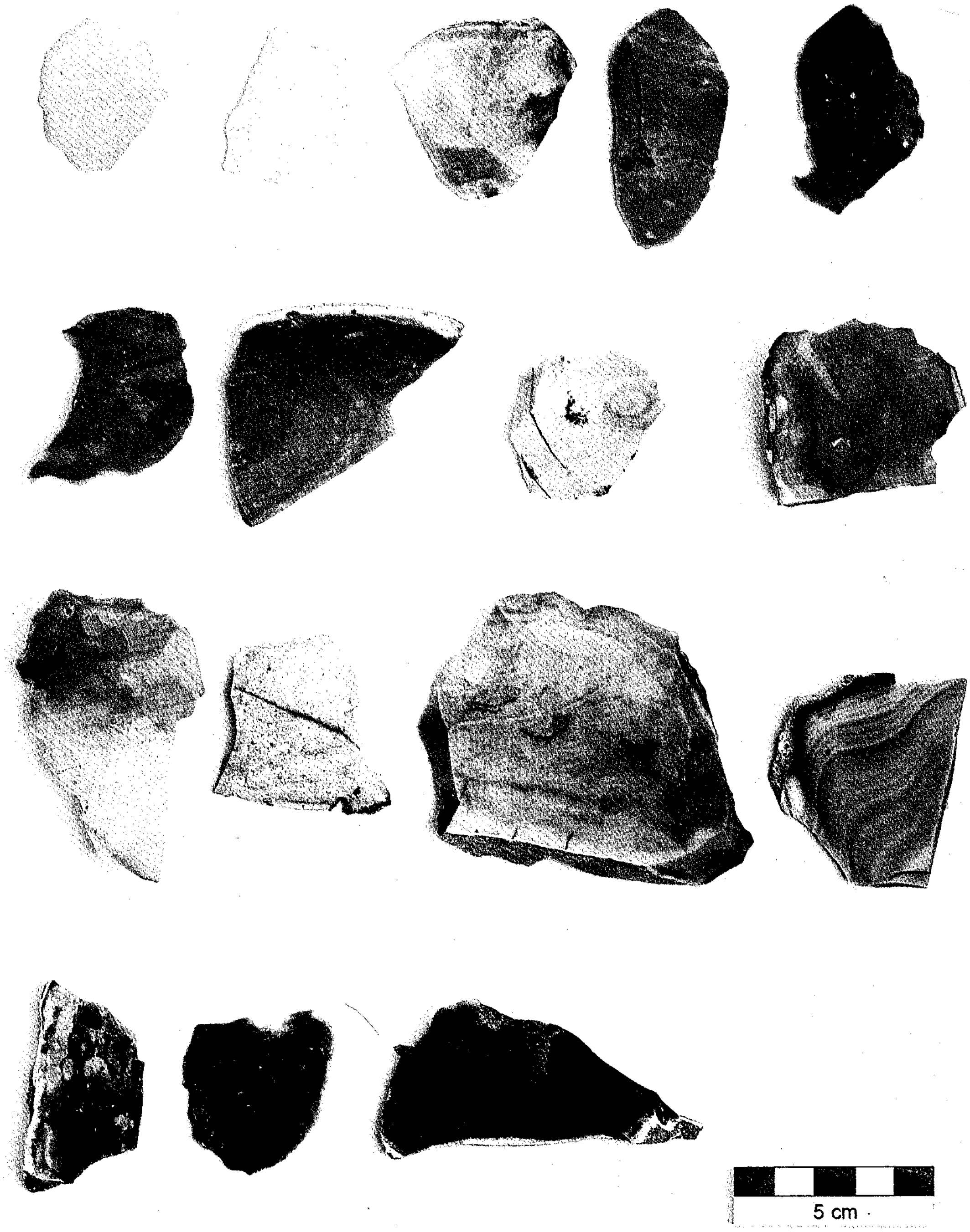


Plate 6 Heat-Treated Cherts. Top left across to bottom right: Heiner Lake Blue-Light; Cowhouse White; Seven Mile Mountain Novaculite; Fort Hood Yellow; Fort Hood Gray; Gray-Brown-Green. West Texas Cherts: Localities 7, 12, 13, 14, 16c, 18, 20, 21a, 21b, 22. All heated to 288 o C (550 o F) except Gray-Brown-Green, 232 o C (450 o F).

APPENDIX D:

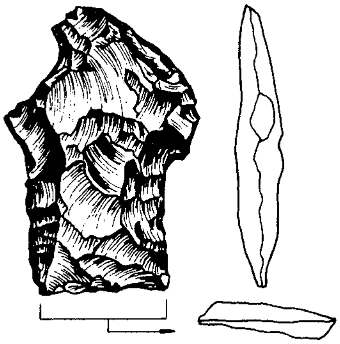
PROJECTILE POINT TYPOLOGY

FORT HOOD POINTS

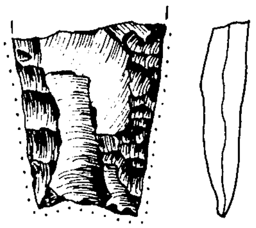
INTRODUCTION

This Appendix contains illustrations for each of the named point types present in the assemblage. Projectile points were classified into generally accepted, pre-established point types. These principally bifacal chipped stone tools were assigned to types according to various individual attributes including general overall form, thickness, blade shape, stem configuration, presence or absence of grinding on the stem, form and location of half element, and reworking. In instances where reworking/resharpening was recognized on a particular point, then that reworked, nonoriginal flaking was not considered for establishing classification. Specimens were generally thought to represent one of the previous named types, therefore the analyst tried to place each specimen into a type. If reworking altered a major portion or a projectile was significantly damaged, then that specimen was labelled as unidentifiable. A distinction was made between dart and arrow points within the unidentifiable group.

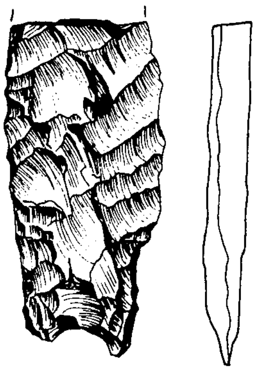
Collected projectile points were compared with verbal and visual attributes in a number of the established references including Turner and Hester (1985), Suhm and Jelks (1962), Bell (1958, 1960), and supplemented by other reports where numerous points of a particular type were illustrated, to observe the range of variation within a type.



Andice 1-1133-001

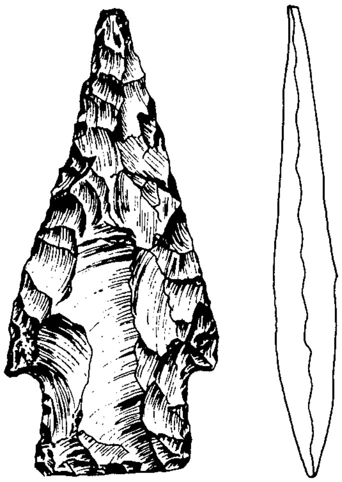


Angostura 1-900-002

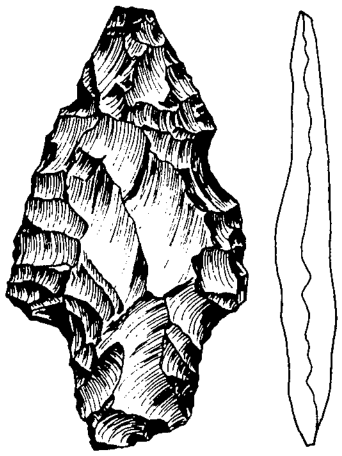


Barber 1-1071-001

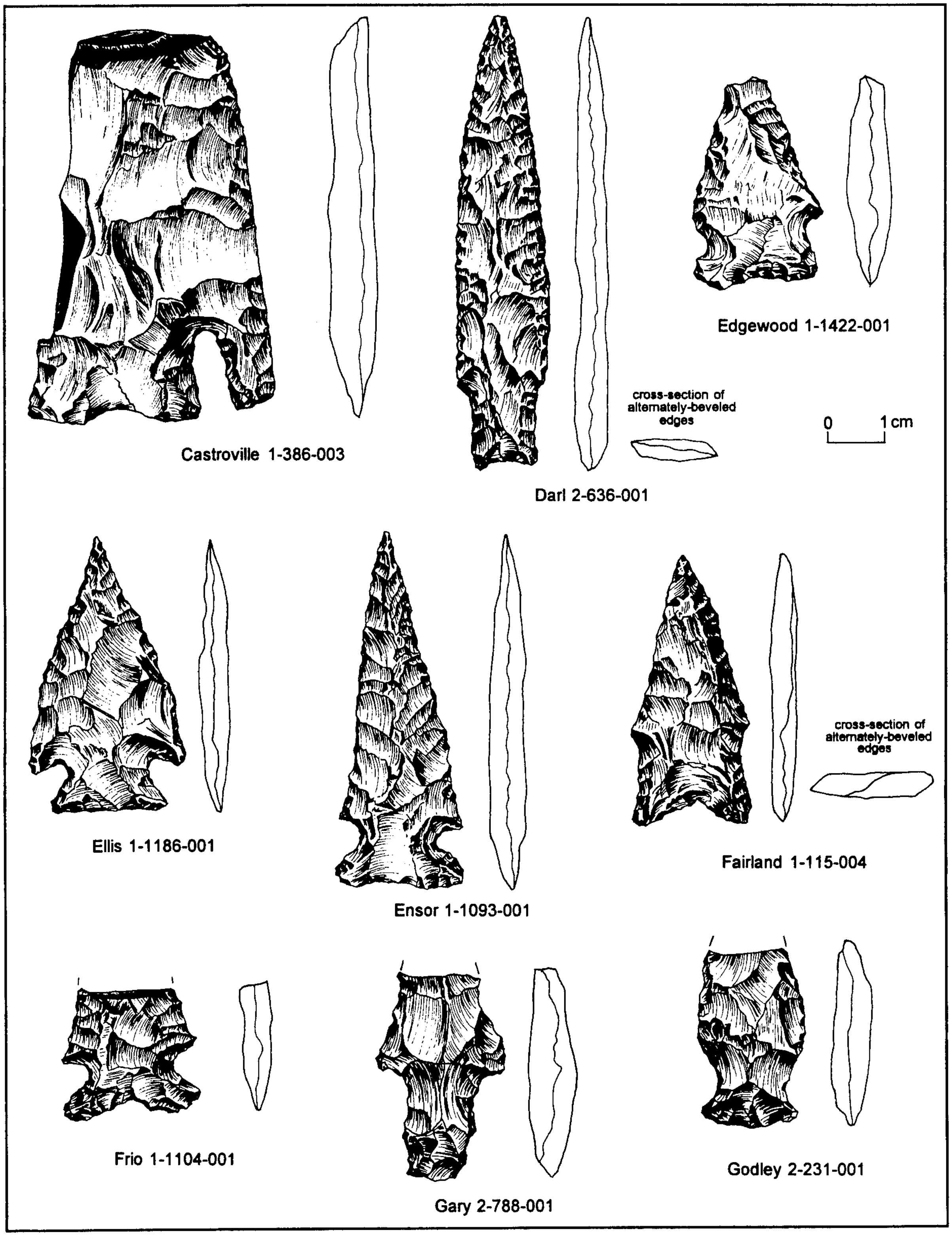
0 1 cm

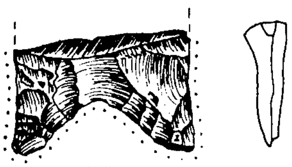


Bulverde 2-554-007

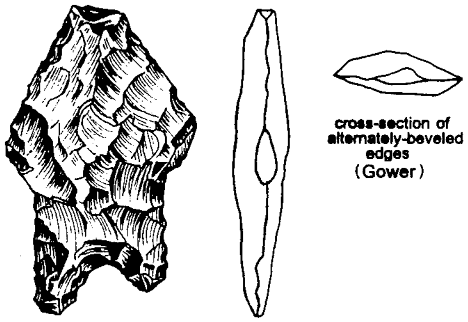


Carrollton 1-1114-001

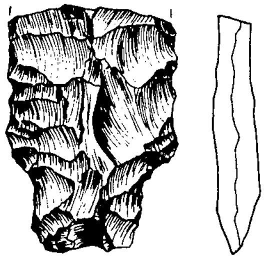

Castroville 1-386-003
Darl 2-636-001
cross-section of alternately-beveled edges
Edgewood 1-1422-001
0 1 cm
Ellis 1-1186-001
Ensor 1-1093-001
Fairland 1-115-004
cross-section of alternately-beveled edges
Frio 1-1104-001
Gary 2-788-001
Godley 2-231-001



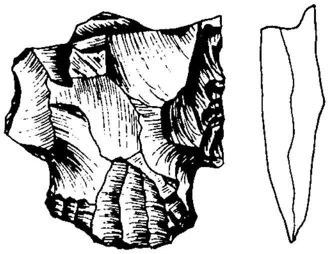
Golondrina 2-500-001



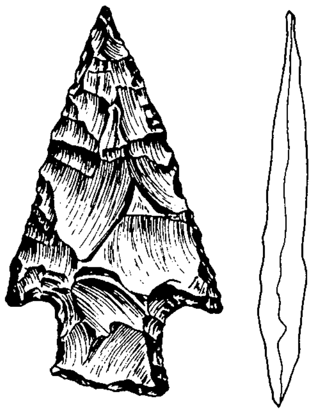
Gower 2-233-001



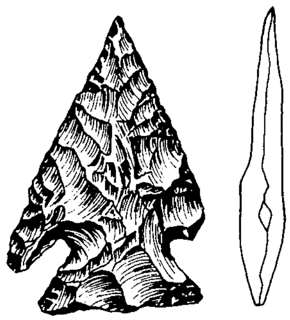
Hoxie 1-1556-002



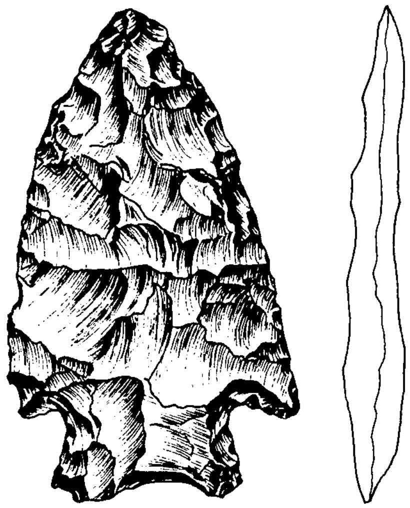
La Jita 1-378-002



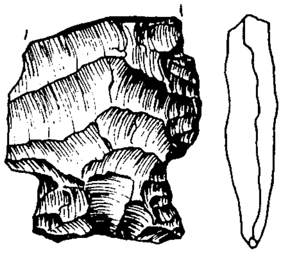
Lange 1-97-002



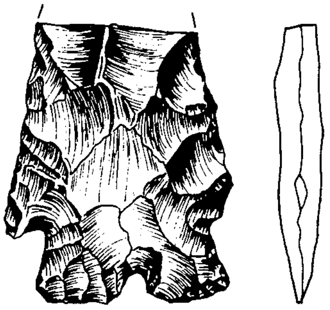
Marcos 2-821-002



Marshall 1-408-001

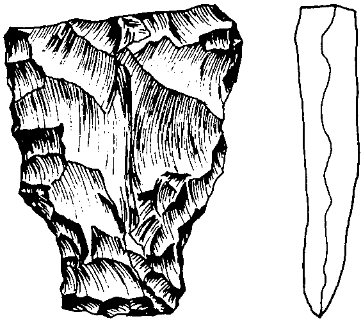


Martindale 1-1329-001

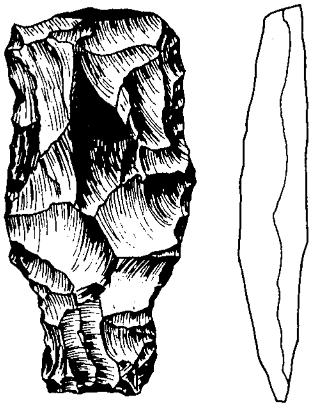


Montell 1-594-006

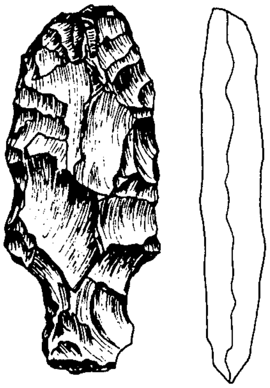
0 1 cm



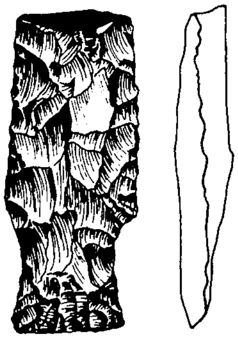
Morhiss 2-381-001



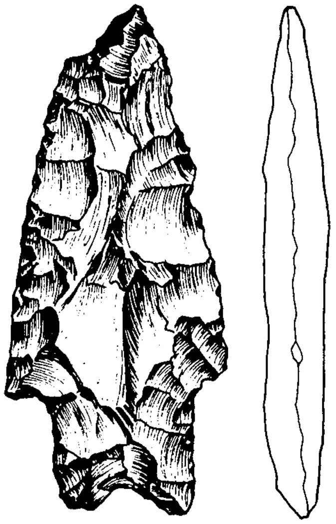
Nolan 1-1186-006



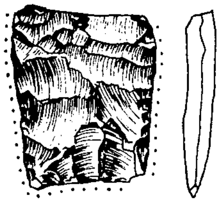
Palmillas 2-561-002



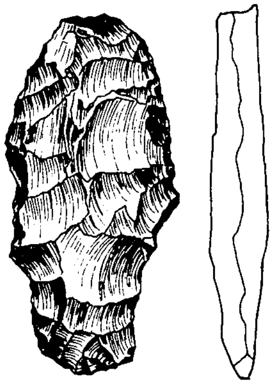
Pandale 1-334-002



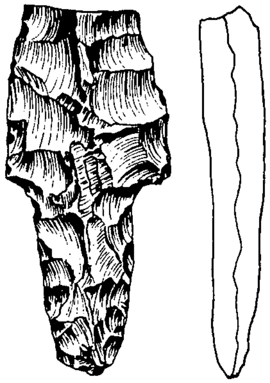
Pedernales 2-198-002



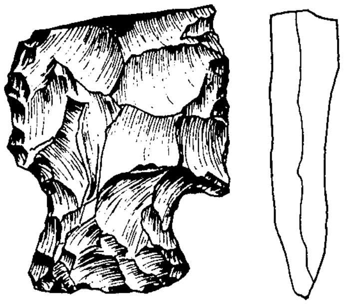
Plainview 2-751-001



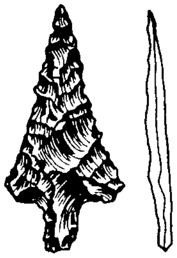
Travis 2-837-002



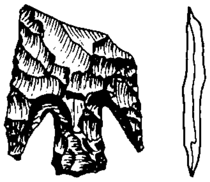
Wells 2-575-001



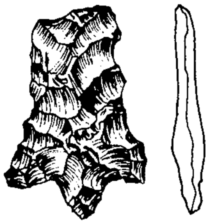
Williams 1-93-001



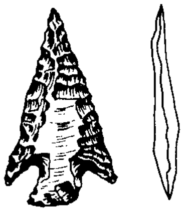
Alba 2-844-003



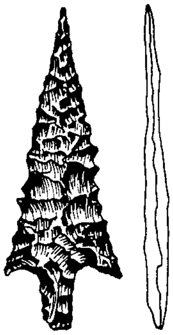
Bonham 1-601-003



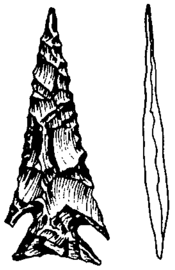
Cliffton 2-868-001



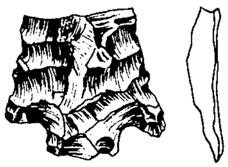
Cuney 2-504-001



Perdiz 2-233-002

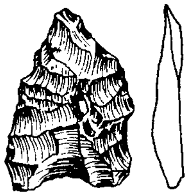


Scallorn 1-1169-006



Steiner 1-936-002

0 1 cm



Young 2-569-001

APPENDIX E:

FEATURE TYPOLOGY

FEATURE TYPOLOGY

Features are nonportable objects, object clusters, or sediment anomalies which are most often attributed to fairly discrete cultural behaviors. Nonportable isolated features can include bedrock mortars, rock art, etc. Object clusters can include tool caches, fire-cracked rock associations or foundation stones from cobble ring walls which derive significance from their spatial patterning or contextual relationships. Sediment anomalies consist of such items as oxidized soils, daub concentrations, or postholes/molds which are distinguished by color, texture or inclusions from the surrounding soil matrices. The following list presents feature typology developed largely prior to fieldwork. The typology should not be assumed to be all inclusive; other feature types are certainly possible, and no all feature types were actually observed.

Burned Rock Scatter

This type of rock feature consists of a diffuse, discontinuous scatter of angular burned rocks across a horizontal surface. These features are one rock thick with no dark ashy matrix associated with the burned rock. The feature is interpreted to represent a deflated hearth or midden, margins of a midden or a discard pile. Contextual relationship is poor to nonexistent. These features occur in surface and subterranean contexts.

Rock Scatter

These features consist of unpatterned distributions of unburned rocks. Generally, these are associated with other cultural debris such as flakes, mussel shell or burned rocks. However, no formal function can be interpreted as they most likely represent an unidentifiable disturbed feature.

Burned Rock Concentrations

This feature type resembles a burned rock scatter or midden, but the rocks tend to be more clustered and less than 10 cm thick, and no dark ashy matrix is associated with the feature. The absence of the dark matrix suggests the feature has been deflated or disturbed, leaving little integrity. These features may represent minimally deflated hearths, storage cysts, incipient rock mounds or even dumping episodes.

Incipient Burned Rock Mound

This feature type is characterized by a central hearth feature (usually a slab-lined hearth) surrounded by a thin layer of discard rock within a 4 m radius of the hearth. Ashy matrix can occur in the central slab hearth and to some extent, among the discard rocks. Most of the discard rocks are scattered and not stacked.

Annular Burned Rock Mound

This is a prominent burned rock feature type characterized by a mound of burned rocks with a central depression. The feature has dense fire-cracked rock and may have a central dark charcoal-laden matrix. The feature can reach a large size (up to 18 m in diameter and 1.5 m tall). Excavations can reveal considerable interior structure including pit features, laminated deposits, a lack of rocks in the interior cone-shaped area, or rock imbrications suggestive of a central pit.

Domed Burned Rock Mound

This prominent burned rock feature type is characterized by an amorphous dome shape. No surficial evidence exists to suggest the presence of a central pit/depression. The plan morphology may be amorphous. Matrices consist of clasts and dark ashy sediments.

Burned Rock Midden

This feature type consists of a thick accumulation (greater than 15 cm) of burned rock, generally with scattered charcoal and dark matrix between rocks. Because the observer lacks a complete view of feature characteristics (i.e., shape, size, extent), this accumulation can not be assigned a specific type (domed or annular mound). No patterning or clustering can be detected. Often, these features have lithic debitage and shell fragments associated. No evidence of a pit or basin is evident.

Hearths with Angular Rock

This feature type is a subterranean feature which contains quantities of angular or blocky stones frequently containing ashy/charcoal matrix.

Slab-lined Hearths

This feature type is lined with tabular limestone slabs on either the outer edges, the base of the feature, and in some instances, the top of the feature. Charcoal, ash, oxidation and/or burned rock may be present within the basin if a basin is present.

Basin-shaped Hearths With No Rock

These features are basin-shaped, excavated into the living surface, and characterized by oxidized earth at the base, or ash, and/or charcoal deposits confined to the basin. These features have none to very few incidental fire-cracked rocks.

Ash Charcoal Stains/Lenses

These features consist of concentrations of a white powdery ash, both circular and amorphous in plan view. These usually lack fire-cracked rock but can have an oxidized base, denoting the difference between a primary firing and a secondary deposition.

Rock Cairns

These features refer to a wide range of piled and stacked rocks which are not shown to be associated with human burial remains. The rocks tend to be tabular and are usually not associated with subsurface pits or dark matrix. They occur on or above the living surface and tend not to be subterranean. Cairns could be confused with slab-lined storage features if they are eroded or disturbed.

Burial Cairns

This is a special subclass of cairn directly associated with human remains. The cairns may consist of a pile of rocks which were used to mark the presence of prehistoric or historic aboriginal remains.

Bone Peg Alignment

These features consist of sets of vertically positioned bison rib fragments which penetrate the occupation surface. The pegs form circular and linear alignments. They resemble bone stakes used for a wide range of activities such as hide processing or tacking down a hide shelter.

Flint Knapping Stations

These features consist of dense concentrations of lithic debitage often directly associated with core implements and/or hammerstones. They are interpreted as discrete stone tool manufacturing areas.

Caches

These features are discrete concentrations of complete and incomplete tools or concretions/cobbles which appear to have been "stashed" together. The complete tools may represent tool kits, whereas the tool fragments may represent reduced and shaped pieces of raw materials readily available from reshaping into a variety of tool forms.

Mussel Shell Accumulations

These features are characterized by dense accumulations of freshwater mussel shell. Lithic debitage, tools, burned rock, and even charcoal may be associated but in less frequency than the shell. These accumulations can occur on the surface or subsurface and in thin lenses or in piles up to 10 cm in thickness.

Occupation Zones

This designation is for massive accumulations of associated cultural debris, burned rock, lithic debitage, tools, etc. in which no specific feature is definable. The material is observable generally through some type of erosion.

Bedrock Mortars

These features are culturally modified conical depressions located on large slabs of limestone. They are usually round or oval in shape and vary in shape and size. Shape may reflect functional differences resulting from the techniques of grinding or the material being ground. Presumably, these result from the preparation of food. Mortar holes are usually much more even and perfect in shape than fossil- or stone-formed holes, which can occur naturally.

Cobble Rings

This feature is characterized by a discontinuous alignment of rocks in a circular formation which may range from 2 to 8 m in diameter. The rocks could have been used to anchor a tipi-like structure.

Rock Alignments

These features are linear or curvilinear alignments of unburned rocks occurring on a living surface.

Historic Features

These include a variety of specific feature types, including, but not limited to buildings, structures, bridges, corrals, windmills, rock walls, fences, berms, stock tanks, dams, fire hearths, wells, roads, trash dumps, mines, spoils piles, impact craters, and other types. Usually, historic features must be greater than 50 years old to be considered "archaeological."

APPENDIX F:

SITE LISTING

APPENDIX F: SITE LISTING

This appendix lists key data for all 897 site subareas on the 571 sites.

COLUMN	KEY
LRPA?	checked if the site was larger than 75,000 m^2 and classified (prior to field work) as a Lithic Resource Procurement Area.
UTM East Grid	1000 meter ("PK" grid)
UTM North Grid	1000 meter ("PK" grid)
Training Area	Fort Hood maneuver area.
Archaeologist	initial reconnaisance evaluation: LE=Lain Ellis; KK=Karl Kleinbach; CL=Chris Lintz; GM=Gemma Mehalchick; PM=Pete Mires; FO=Fred Oglesby; MQ= Mike Quigg; AT=Abby Treece; NT=Nick Trierweiler; JmT=Jim Truesdale; Jft=Jeff Turpin.
Geomorphologist	initial reconnaisance evaluation: CF=Charles Frederick; BD= Bill Doering; and JA=Jim Abbott.
Arch. Score	archaeological total score, rounded to the nearest whole number.
Geomorph. Score	geomorphological total score, rounded to the nearest whole number.
Context	U=unknown; P=primary; S=secondary
Sealed?	U=unknown; NS=not sealed; PS=partially sealed; S=sealed
Landform	Up=upland; C=colluvial; M=mixed; S=slope; RS=rock shelter; T2=T2 terrace; T1=T1 terrace; T0=T0 terrace.
Landsurface	K=Killeen; M=Manning; P=Paluxy; NS= not specified.
Drainage	nearest stream/watercourse
Stream Order	ordinal ranking; n/a=not applicable
Est. Depth (cm)	estimated depth of sediments (not deposits) in cm
Burned Rock	BRM=burned rock mound/midden(s); C=concentration(s); DS=dense scatters(s); TS=thin scatter(s); P=present; N= none recorded.
Archaeological Age	presumed from diagnostic artifacts (if any)

Vandal Disturbance	estimated percent of the subarea with potholes or other evidence of vandalism.
Vehicle Disturbance	estimated percent of the subarea with roads, ruts, tank tracks, or other evidence of vehicular surface disturbance.
Erosion Disturbance	estimated percent of the subarea with downcutting, slumping, sheetwash or other evidence of erosion.
Potential Deposits	on the basis of initial reconnaissance, did the subarea have potential for buried deposits? Y=yes; N=no; U=uncertain
No. Shovel tests	total 30 cm diameter units
No. Test Pits	total 1m2 units or 50 x 50 cm units
Intact Deposits?	on the basis of shovel testing, did the subarea have intact buried deposits? Y=yes; N=no; U=uncertain
Ubiquitous Lithics?	for upland components on LRPA sites only, on the basis of surface resurvey, did the subarea have abundant and ubiquitous surface lithics? Y=yes; N=no; U=uncertain; n/a=not applicable
NRHP Eligibility	NE=not eligible; UE=uncertain eligibility; E=eligible
Mgmt Recom.	N=no further management; T=avoid or test for eligibility; P=preserve and protect, or mitigate

Appendix F: Site Listing

Site subarea	LRPA?	UTM East Grid	UTM North Grid	Training Area	Archeologist	Geomorphologist	Archaeol. Score	Geomorph Score	Context	Sealed?	Landform	Land Surface	Drainage	Stream Order	Est.Depth (cm)	Burned Rock	Archae. Age	Vandal Disturb.	Vehicle Disturb.	Erosion Disturb.	Potential deposits	No. Shovel Tests	No. Test Pits	Intact deposits?	Ubiquitous lithics?	NRHP Eligibility	Mgmt. Recom.
BL0043		38	47	7	GM	JA	42	23	P	S	RS	NS	Cowhouse	n/a	50-100	DS	unkn	20-50%	none	20-50%	Y	2	1	U	N/A	UE	T
BL0069A		42	48	7	KK	JA	13	7	S	NS	Up	M	Cowhouse	n/a	0-20	N	Arch	none	>50%	>50%	N	0	0	N	N/A	NE	N
BL0069B		42	48	7	KK	JA	37	23	U	U	RS	NS	L.Belton	n/a	20-50	N	unkn	>50%	none	>50%	Y	0	0	U	N/A	UE	T
BL0069C		42	48	7	KK	JA	31	21	U	U	RS	NS	L.Belton	n/a	20-50	N	unkn	>50%	none	20-50%	Y	1	1	U	N/A	UE	T
BL0139		36	56	3	GM	CF	8	7	U	U	RS	NS	none	n/a	U	N	unkn	U	U	U	U	0	0	U	N/A	UE	T
BL0140		35	56	3	MQ	CF	35	25	U	U	T0	NS	Owl	2nd	50-100	C	unkn	none	none	20-50%	Y	2	0	N	N/A	NE	N
BL0141		34	56	3	MQ	CF	28	23	U	U	T1	NS	Owl	2nd	50-100	N	unkn	none	none	<20%	Y	3	0	N	N/A	NE	N
BL0142A		37	55	3	KK	JA	34	23	P	PS	RS	NS	none	n/a	20-50	N	unkn	U	none	20-50%	Y	2	0	U	N/A	UE	T
BL0142B		37	55	3	KK	JA	16	8	S	NS	Up	M	none	n/a	20-50	N	E Arch	20-50%	none	>50%	N	0	0	N	N/A	NE	N
BL0145A		35	56	3	GM	CF	28	19	P	PS	RS	NS	none	n/a	U	N	L Prehis	<20%	none	>50%	Y	2	0	N	N/A	NE	N
BL0145B		35	56	3	GM	CF	16	8	S	NS	Up	M	none	n/a	0-20	N	Arch	none	20-50%	>50%	N	0	0	N	N/A	NE	N
BL0148A		36	57	3	JfT	JA	47	24	P	PS	C	NS	Owl	n/a	50-100	BRM	Arch	>50%	>50%	<20%	Y	14	0	U	N/A	UE	T
BL0148B		36	57	3	JfT	JA	26	24	U	U	T1	NS	Owl	n/a	300+	P	unkn	20-50%	20-50%	<20%	Y	41	0	U	N/A	UE	T
BL0149		36	56	3	GM	CF	33	22	P	PS	T1	NS	Owl	4th	500+	N	unkn	none	>50%	<20%	Y	8	0	U	N/A	UE	T
BL0153		13	34	25	JfT	JA	16	10	S	NS	S	K	Reese	n/a	0-20	P	M Arch	none	20-50%	>50%	N	0	0	N	N/A	NE	N
BL0154A	■	31	47	15	KK	JA	25	11	U	U	Up	M	N. Nolan	n/a	20-50	BRM	Arch	>50%	none	20-50%	Y	1	0	N	N/A	NE	N
BL0154B	■	31	47	15	KK	JA	34	21	U	U	C	NS	N. Nolan	n/a	U	BRM	Arch	>50%	>50%	20-50%	Y	8	0	U	N/A	UE	T
BL0154C	■	31	47	15	KK	JA	29	24	U	U	T1	NS	N. Nolan	2nd	U	N	unkn	<20%	<20%	<20%	Y	4	0	U	N/A	UE	T
BL0154D	■	31	47	15	KK	JA	36	23	U	U	RS	NS	N. Nolan	n/a	20-50	TS	unkn	>50%	none	<20%	N	0	0	N	N	NE	N
BL0155A1	■	32	45	16	JfT	JA	17	8	S	NS	Up	NS	none	n/a	50-100	N	M Arch	none	>50%	>50%	N	0	0	N	N	NE	N
BL0155A2	■	32	45	16	JfT	JA	17	8	S	NS	Up	NS	none	n/a	50-100	N	M Arch	none	>50%	>50%	N	0	0	N	U	UE	T
BL0155A3	■	32	45	16	JfT	JA	17	8	S	NS	Up	NS	none	n/a	50-100	N	M Arch	none	>50%	>50%	N	0	0	N	N	NE	N
BL0155A4	■	32	45	16	JfT	JA	17	8	S	NS	Up	NS	none	n/a	50-100	N	M Arch	none	>50%	>50%	N	0	0	N	U	UE	T
BL0155A5	■	32	45	16	JfT	JA	17	8	S	NS	Up	NS	none	n/a	50-100	N	M Arch	none	>50%	>50%	N	0	0	N	N	NE	N
BL0155B	■	32	45	16	JfT	JA	30	24	U	U	T1	NS	none	2nd	100+	BRM	unkn	none	<20%	20-50%	Y	4	0	U	N/A	UE	T
BL0157		34	46	15	PM	BD	11	13	S	NS	T2	NS	N. Nolan	4th	0-20	N	unkn	<20%	none	>50%	N	0	0	N	N/A	NE	N
BL0162		34	45	15	PM	BD	13	8	S	NS	Up	NS	N. Nolan	n/a	0-20	N	M Arch	U	>50%	20-50%	N	0	0	N	N/A	NE	N
BL0168A		33	48	13	MQ	CF	16	10	P	NS	Up	NS	Cowhouse	n/a	0-20	DS	Arch/LP	none	>50%	20-50%	N	0	0	N	N/A	NE	N
BL0168B		33	48	13	MQ	CF	34	20	P	PS	RS	NS	Cowhouse	n/a	20-50	N	unkn	<20%	none	<20%	Y	5	1	U	N/A	UE	T
BL0173		36	56	3	KK	JA	30	23	U	U	C	NS	Owl	n/a	U	N	unkn	>50%	>50%	<20%	Y	0	0	U	N/A	UE	T
BL0178		23	48	18	FO	BD	14	7	P	NS	Up	M	none	n/a	0-20	TS	unkn	>50%	>50%	>50%	N	0	0	N	N/A	NE	N
BL0179	■	31	50	13	KK	JA	16	9	S	NS	Up	M	Cowhouse	n/a	0-20	N	E Arch	none	20-50%	>50%	N	0	0	N	N	NE	N
BL0181A		35	56	3	GM	CF	46	26	P	PS	RS	M	Owl	n/a	50-100	TS	Arch/LP	>50%	none	<20%	Y	2	0	U	N/A	UE	T
BL0181B		35	56	3	GM	CF	13	9	S	NS	Up	M	Owl	n/a	0-20	N	unkn	none	<20%	>50%	N	0	0	N	N/A	NE	N
BL0182		16	36	27	KK	JA	13	8	S	NS	Up	NS	N. Reese	n/a	0-20	N	Pl/Arch	none	>50%	>50%	N	0	0	N	N/A	NE	N
BL0187A1	■	38	45	17	JfT	JA	13	10	S	NS	Up	M	none	n/a	0-20	N	unkn	none	20-50%	20-50%	N	0	0	N	N	NE	N
BL0187A2	■	38	45	17	JfT	JA	13	10	S	NS	Up	M	none	n/a	0-20	N	unkn	none	20-50%	20-50%	N	0	0	N	U	UE	T
BL0188		33	52	4	FO	BD	24	24	P	S	RS	NS	Cowhouse	n/a	U	N	unkn	none	none	<20%	Y	0	1	N	N/A	NE	N

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Site subarea	LRPA?	UTM East Grid	UTM North Grid	Training Area	Archeologist	Geomorphologist	Archaeol. Score	Geomorph Score	Context	Sealed?	Landform	Land Surface	Drainage	Stream Order	Est.Depth (cm)	Burned Rock	Archae. Age	Vandal Disturb.	Vehicle Disturb.	Erosion Disturb.	Potential deposits	No. Shovel Tests	No. Test Pits	Intact deposits?	Ubiquitous lithics?	NRHP Eligibility	Mgmt. Recom.
BL0192A		7	37	24	GM	CF	25	23	U	U	RS	NS	none	n/a	20-50	N	Arch	none	none	20-50%	Y	2	0	U	N/A	UE	T
BL0192B		7	37	24	GM	CF	14	9	S	NS	Up	NS	none	n/a	0-20	P	unkn	none	<20%	>50%	N	0	0	N	N/A	NE	N
BL0193		6	37	24	GM	CF	14	11	U	U	S	NS	none	n/a	U	TS	unkn	none	>50%	<20%	N	0	0	N	N/A	NE	N
BL0194		15	32	27	KK	JA	16	9	S	NS	Up	NS	N. Reese	n/a	0-20	BRM	Arch	none	20-50%	>50%	N	0	0	N	N/A	NE	N
BL0198A		34	48	13	MQ	CF	24	15	P	NS	Up	M	none	n/a	50-100	BRM	Arch	<20%	<20%	20-50%	Y	0	0	U	N/A	UE	T
BL0198B		34	48	13	MQ	CF	35	24	P	PS	RS	NS	none	n/a	50-100	C	unkn	none	none	<20%	Y	3	0	U	N/A	UE	T
BL0201		30	46	15	PM	BD	13	11	S	NS	Up	NS	none	n/a	0-20	N	M Arch	none	>50%	<20%	N	0	0	N	N/A	NE	N
BL0203		30	44	15	MQ	CF	17	11	S	NS	S	K	none	n/a	0-20	N	Arch/LP	none	<20%	>50%	N	0	0	N	N/A	NE	N
BL0206		30	44	15	PM	BD	14	10	S	NS	S	K	none	n/a	0-20	TS	Arch	none	20-50%	>50%	N	0	0	N	N/A	NE	N
BL0208A2	■	33	44	16	JfT	JA	13	13	S	NS	S	NS	N. Nolan	n/a	0-20	TS	unkn	none	20-50%	>50%	N	0	0	N	U	UE	T
BL0208A3	■	33	44	16	JfT	JA	13	13	S	NS	S	NS	N. Nolan	n/a	0-20	TS	unkn	none	20-50%	>50%	N	0	0	N	U	UE	T
BL0208A4	■	33	44	16	JfT	JA	13	13	S	NS	S	NS	N. Nolan	n/a	0-20	TS	unkn	none	20-50%	>50%	N	0	0	N	N	NE	N
BL0208A5	■	33	44	16	JfT	JA	13	13	S	NS	S	NS	N. Nolan	n/a	0-20	TS	unkn	none	20-50%	>50%	N	0	0	N	U	UE	T
BL0208A6	■	33	44	16	JfT	JA	13	13	S	NS	S	NS	N. Nolan	n/a	0-20	TS	unkn	none	20-50%	>50%	N	0	0	N	N	NE	N
BL0208A7	■	33	44	16	JfT	JA	13	13	S	NS	S	NS	N. Nolan	n/a	0-20	TS	unkn	none	20-50%	>50%	N	0	0	N	U	UE	T
BL0208A8	■	33	44	16	JfT	JA	13	13	S	NS	S	NS	N. Nolan	n/a	0-20	TS	unkn	none	20-50%	>50%	N	0	0	N	N	NE	N
BL0208B	■	33	44	16	JfT	JA	30	25	S	NS	T1	NS	N. Nolan	2nd	200+	TS	unkn	none	<20%	<20%	Y	190	0	U	N/A	UE	T
BL0213		30	44	15	MQ	CF	20	10	P	NS	Up	K	none	n/a	0-20	N	L Arch	none	<20%	>50%	N	0	0	N	N/A	NE	N
BL0215		38	52	6	GM	CF	8	8	U	U	Up	M	none	n/a	0-20	N	unkn	none	20-50%	>50%	N	0	0	N	N/A	NE	N
BL0230		40	48	7	GM	CF	14	10	P	NS	Up	M	none	n/a	0-20	N	Pl	none	<20%	>50%	N	0	0	N	N/A	NE	N
BL0231A	■	39	48	7	KK	JA	21	7	S	NS	Up	M	Bull	n/a	0-20	P	L Prehis	U	>50%	>50%	N	0	0	N	N	NE	N
BL0231B	■	39	48	7	KK	JA	34	23	U	U	RS	NS	Bull	n/a	20-50	P	unkn	>50%	none	<20%	Y	2	0	U	N/A	UE	T
BL0231C	■	39	48	7	KK	JA	31	20	U	U	C	NS	Bull	n/a	20-50	P	L Prehis	none	20-50%	20-50%	Y	10	0	N	N/A	NE	N
BL0231D	■	39	48	7	KK	JA	31	24	U	U	T1	NS	Bull	1st	100+	P	unkn	none	<20%	20-50%	Y	2	0	U	N/A	UE	T
BL0232A	■	39	49	7	KK	JA	17	9	S	NS	Up	M	Bull	n/a	0-20	N	Arch/LP	none	20-50%	20-50%	N	0	0	N	N	NE	N
BL0232B	■	39	49	7	KK	JA	12	16	S	NS	M	NS	Bull	n/a	U	N	unkn	none	none	>50%	N	0	0	N	N	NE	N
BL0233A	■	38	51	6	GM	JA	22	8	S	NS	Up	NS	Bull	n/a	0-20	TS	L Prehis	none	>50%	>50%	N	0	0	N	N	NE	N
BL0233B4	■	38	51	6	GM	JA	25	21	U	U	RS	NS	Bull	n/a	0-20	P	unkn	20-50%	none	20-50%	Y	0	1	U	N/A	UE	T
BL0233B5	■	38	51	6	GM	JA	25	21	U	U	RS	NS	Bull	n/a	0-20	P	unkn	20-50%	none	20-50%	Y	0	1	N	N/A	NE	N
BL0233C1	■	38	51	6	GM	JA	32	21	P	S	Up	NS	Bull	n/a	50-100	BRM	unkn	20-50%	none	20-50%	Y	0	0	U	N/A	UE	T
BL0233C2	■	38	51	6	GM	JA	32	21	P	S	Up	NS	Bull	n/a	50-100	BRM	unkn	20-50%	none	20-50%	Y	0	1	U	N/A	UE	T
BL0233C3	■	38	51	6	GM	JA	32	21	P	S	Up	NS	Bull	n/a	50-100	BRM	unkn	20-50%	none	20-50%	Y	0	1	U	N/A	UE	T
BL0336		15	35	27	JfT	JA	13	8	S	NS	S	K	none	n/a	0-20	N	Pl/Arch	none	>50%	>50%	N	0	0	N	N/A	NE	N
BL0339A		30	52	8	GM	JA	35	25	P	S	T1	NS	Cowhouse	5th	200+	TS	unkn	none	20-50%	<20%	Y	34	0	U	N/A	UE	T
BL0339B		30	52	8	GM	JA	33	21	P	S	C	NS	Cowhouse	n/a	20-50	TS	Arch/Tra	20-50%	20-50%	>50%	Y	2	0	N	N/A	NE	N
BL0339C		30	52	8	GM	JA	10	13	S	NS	S	NS	Cowhouse	n/a	0-20	N	unkn	none	none	>50%	N	0	0	N	N/A	NE	N
BL0340		31	51	8	GM	JA	31	26	U	U	T1	NS	L.Belton	2nd	100+	TS	unkn	none	<20%	<20%	Y	4	0	U	N/A	UE	T
BL0347		16	33	27	KK	JA	13	10	S	NS	S	NS	N. Reese	n/a	0-20	TS	Arch/LP	none	<20%	>50%	N	0	0	N	N/A	NE	N

Appendix F: Site Listing

Site subarea	LRPA?	UTM East Grid	UTM North Grid	Training Area	Archeologist	Geomorphologist	Archaeol. Score	Geomorph Score	Context	Sealed?	Landform	Land Surface	Drainage	Stream Order	Est.Depth (cm)	Burned Rock	Archae. Age	Vandal Disturb.	Vehicle Disturb.	Erosion Disturb.	Potential deposits	No. Shovel Tests	No. Test Pits	Intact deposits?	Ubiquitous lithics?	NRHP Eligibility	Mgmt. Recom.
BL0348		16	33	27	KK	JA	18	17	S	NS	M	K	N. Reese	n/a	0-20	TS	Arch/LP	none	<20%	>50%	N	0	0	N	N/A	NE	N
BL0357		10	41	22	GM	CF	13	8	S	NS	Up	K	none	n/a	0-20	TS	E Arch	none	20-50%	>50%	N	0	0	N	N/A	NE	N
BL0358A		8	36	24	GM	CF	26	22	U	U	T0	NS	none	1st	50-100	TS	unkn	none	<20%	<20%	Y	8	0	N	N/A	NE	N
BL0358B		8	36	24	GM	CF	16	10	S	NS	S	NS	none	n/a	0-20	C	unkn	none	<20%	>50%	N	0	0	N	N/A	NE	N
BL0370		14	35	26	JfT	JA	13	9	S	NS	S	K	none	n/a	0-20	N	E Arch	none	20-50%	>50%	N	0	0	N	N/A	NE	N
BL0372		13	33	25	JfT	JA	13	9	S	NS	Up	K	none	n/a	0-20	DS	M Arch	none	20-50%	20-50%	N	0	0	N	N/A	NE	N
BL0373A		14	36	26	JfT	JA	13	14	S	NS	S	K	none	n/a	0-20	C	E Arch	none	20-50%	>50%	N	0	0	N	N/A	NE	N
BL0373B		14	36	26	JfT	JA	30	27	U	U	T1	NS	none	2nd	100+	C	unkn	none	<20%	20-50%	Y	2	0	U	N/A	UE	T
BL0376		17	34	27	KK	JA	26	22	U	U	C	NS	none	n/a	20-50	N	unkn	none	20-50%	20-50%	Y	4	0	N	N/A	NE	N
BL0377		17	34	27	KK	JA	13	8	S	NS	Up	K	none	n/a	0-20	N	M Arch	none	20-50%	>50%	N	0	0	N	N/A	NE	N
BL0378		16	35	27	KK	JA	13	9	S	NS	S	NS	none	n/a	0-20	TS	E Arch	none	20-50%	>50%	N	0	0	N	N/A	NE	N
BL0379		16	35	27	KK	JA	16	8	S	NS	S	K	N. Reese	n/a	0-20	TS	E Arch	none	>50%	>50%	N	0	0	N	N/A	NE	N
BL0381		16	35	27	KK	JA	16	8	S	NS	S	K	none	n/a	0-20	TS	Arch/LP	none	>50%	>50%	N	0	0	N	N/A	NE	N
BL0383		17	32	27	KK	JA	13	16	S	NS	S	NS	none	n/a	0-20	N	M Arch	none	none	>50%	N	0	0	N	N/A	NE	N
BL0384		17	33	27	KK	JA	13	8	S	NS	S	NS	N. Reese	n/a	0-20	N	Arch/LP	none	>50%	>50%	N	0	0	N	N/A	NE	N
BL0386		18	33	27	KK	JA	13	8	S	NS	Up	NS	Reese	4th	0-20	TS	M Arch	none	<20%	20-50%	N	0	0	N	N/A	NE	N
BL0395		35	47	13	KK	JA	17	7	S	NS	Up	K	Cowhouse	n/a	0-20	C	unkn	none	>50%	>50%	N	0	0	N	N/A	NE	N
BL0409		10	36	24	JfT	JA	13	15	S	NS	S	M	none	n/a	0-20	N	unkn	none	<20%	>50%	N	0	0	N	N/A	NE	N
BL0413		33	43	16	PM	BD	13	11	S	NS	Up	M	none	n/a	0-20	N	unkn	none	none	20-50%	N	0	0	N	N/A	NE	N
BL0415A		31	51	8	GM	JA	31	24	U	U	T1	NS	Cowhouse	5th	300+	N	unkn	none	none	<20%	Y	12	0	U	N/A	UE	T
BL0415B		31	51	8	GM	JA	34	23	U	U	T2	NS	Cowhouse	5th	0-20	P	unkn	none	20-50%	>50%	Y	26	0	U	N/A	UE	T
BL0415C		31	51	8	GM	JA	14	12	S	NS	T2	NS	Cowhouse	5th	0-20	P	unkn	none	20-50%	>50%	N	0	0	N	N/A	NE	N
BL0415D		31	51	8	GM	JA	14	8	S	NS	Up	K	Cowhouse	n/a	0-20	TS	unkn	none	20-50%	>50%	N	0	0	N	N/A	NE	N
BL0416A		39	45	17	JfT	JA	13	9	S	NS	M	NS	L.Belton	n/a	0-20	TS	Pl/Arch	none	>50%	>50%	N	0	0	N	N/A	NE	N
BL0416B		39	45	17	JfT	JA	30	24	U	U	T1	NS	L.Belton	1st	100+	TS	unkn	none	20-50%	20-50%	Y	16	0	N	N/A	NE	N
BL0416C		39	45	17	JfT	JA	27	22	U	U	M	NS	L.Belton	n/a	200+	TS	unkn	none	20-50%	20-50%	Y	19	0	N	N/A	NE	N
BL0421		30	49	12	MQ	CF	14	16	S	NS	M	NS	none	n/a	U	TS	Pl	none	>50%	>50%	Y	0	0	U	N/A	UE	T
BL0427A		33	49	8	GM	JA	13	13	S	NS	T2	NS	L.Belton	5th	0-20	TS	Arch	none	>50%	<20%	N	0	0	N	N/A	NE	N
BL0427B		33	49	8	GM	JA	28	24	U	U	T1	NS	L.Belton	2nd	300+	TS	unkn	none	<20%	<20%	Y	7	0	U	N/A	UE	T
BL0430		33	49	13	KK	JA	13	18	S	NS	T2	NS	Cowhouse	5th	U	N	Pl/Arch	none	<20%	20-50%	N	0	0	N	N/A	NE	N
BL0431		33	49	8	KK	JA	36	20	U	U	M	NS	Cowhouse	5th	20-50	BRM	Arch	>50%	>50%	>50%	Y	3	0	U	N/A	UE	T
BL0432		33	49	13	MQ	CF	26	17	P	PS	RS	NS	none	n/a	20-50	N	unkn	none	none	>50%	Y	1	0	U	N/A	UE	T
BL0433		33	49	13	MQ	CF	40	21	P	PS	RS	NS	none	n/a	20-50	P	unkn	<20%	none	<20%	Y	0	1	U	N/A	UE	T
BL0439		34	49	8	GM	CF	13	13	S	NS	T2	NS	Cowhouse	5th	0-20	N	Arch	none	none	<20%	N	0	0	N	N/A	NE	N
BL0444		34	49	8	KK	JA	13	19	S	NS	T2	NS	L.Belton	5th	U	N	M Arch	none	20-50%	20-50%	N	0	0	N	N/A	NE	N
BL0448		31	50	13	JmT	BD	16	11	S	NS	Up	M	Cowhouse	n/a	0-20	N	unkn	none	<20%	<20%	N	0	0	N	N/A	NE	N
BL0451		30	51	8	GM	JA	15	15	S	NS	Up	K	Cowhouse	n/a	0-20	C	Arch/LP	none	20-50%	>50%	N	0	0	N	N/A	NE	N
BL0454		31	51	8	GM	JA	28	23	U	U	T0	NS	Cowhouse	5th	200+	TS	unkn	none	20-50%	<20%	Y	2	0	U	N/A	UE	T

Appendix F: Site Listing

Site subarea	LRPA?	UTM East Grid	UTM North Grid	Training Area	Archeologist	Geomorphologist	Archaeol. Score	Geomorph Score	Context	Sealed?	Landform	Land Surface	Drainage	Stream Order	Est.Depth (cm)	Burned Rock	Archae. Age	Vandal Disturb.	Vehicle Disturb.	Erosion Disturb.	Potential deposits	No. Shovel Tests	No. Test Pits	Intact deposits?	Ubiquitous lithics?	NRHP Eligibility	Mgmt. Recom.
BL0455		32	50	8	KK	JA	13	13	S	NS	M	NS	Cowhouse	n/a	0-20	P	Arch	none	20-50%	>50%	N	0	0	N	N/A	NE	N
BL0457	■	32	51	13	MQ	CF	16	13	S	NS	T2	NS	Cowhouse	4th	0-20	N	Arch	none	none	<20%	N	0	0	N	N	NE	N
BL0462		29	48	12	MQ	CF	14	10	P	NS	Up	M	none	n/a	0-20	N	Arch/LP	none	20-50%	<20%	Y	29	2	N	N/A	NE	N
BL0463-1	■	29	48	12	MQ	CF	16	12	P	NS	Up	M	none	n/a	0-20	N	Arch	none	<20%	<20%	N	0	0	N	U	UE	T
BL0463-2	■	29	48	12	MQ	CF	16	12	P	NS	Up	M	none	n/a	0-20	N	Arch	none	<20%	<20%	N	0	0	N	N	NE	N
BL0466	■	30	52	8	GM	JA	13	10	S	NS	M	NS	Cowhouse	5th	0-20	N	L Prehis	none	>50%	20-50%	N	0	0	N	N	NE	N
BL0467-1	■	33	50	8	LE	JA	14	11	S	NS	T2	NS	Cowhouse	5th	0-20	P	unkn	none	20-50%	20-50%	N	0	0	N	Y	E	P
BL0467-2	■	33	50	8	LE	JA	14	11	S	NS	T2	NS	Cowhouse	5th	0-20	P	unkn	none	20-50%	20-50%	N	0	0	N	Y	E	P
BL0467-3	■	33	50	8	LE	JA	14	11	S	NS	T2	NS	Cowhouse	5th	0-20	P	unkn	none	>50%	>50%	N	0	0	N	N	NE	N
BL0470		30	52	8	GM	JA	35	26	P	S	T1	NS	Cowhouse	5th	300+	C	unkn	>50%	>50%	<20%	Y	17	0	U	N/A	UE	T
BL0472		34	50	8	GM	CF	15	13	S	NS	T2	NS	Cowhouse	4th	0-20	TS	unkn	none	none	<20%	N	0	0	N	N/A	NE	N
BL0482		38	50	7	GM	CF	15	9	S	NS	S	M	none	n/a	0-20	TS	unkn	none	20-50%	>50%	N	0	0	N	N/A	NE	N
BL0488A		39	50	7	KK	JA	34	23	U	U	RS	NS	Bull	n/a	20-50	TS	L Prehis	20-50%	none	20-50%	Y	1	2	U	N/A	UE	T
BL0488B		39	50	7	KK	JA	12	14	S	NS	S	NS	Bull	n/a	U	N	unkn	>50%	none	20-50%	N	0	0	N	N/A	NE	N
BL0489A		39	50	7	KK	JA	18	9	S	NS	Up	M	Bull	n/a	0-20	P	Arch/LP	none	<20%	>50%	N	0	0	N	N/A	NE	N
BL0489B		39	50	7	KK	JA	10	11	S	NS	S	NS	Bull	n/a	0-20	N	unkn	none	none	>50%	N	0	0	N	N/A	NE	N
BL0489C		39	50	7	KK	JA	42	18	P	PS	Up	M	Bull	n/a	20-50	BRM	unkn	none	>50%	>50%	Y	0	1	U	N/A	UE	T
BL0490		39	50	6	KK	JA	24	19	S	NS	RS	M	Bull	n/a	20-50	TS	unkn	20-50%	none	>50%	Y	0	0	U	N/A	UE	T
BL0491		39	50	6	KK	JA	34	24	U	U	RS	M	Bull	n/a	20-50	TS	unkn	20-50%	none	<20%	Y	1	1	U	N/A	UE	T
BL0500		34	54	5	MQ	CF	13	9	S	NS	Up	NS	Bear	n/a	0-20	N	PI	none	<20%	>50%	N	0	0	N	N/A	NE	N
BL0502A	■	34	54	5	KK	JA	15	8	S	NS	Up	M	Taylor	n/a	0-20	N	PI/Arch	none	none	>50%	N	0	0	N	N	NE	N
BL0502B	■	34	54	5	KK	JA	10	13	S	NS	M	NS	Taylor	1st	U	N	unkn	none	none	>50%	N	0	0	N	N	NE	N
BL0504A		32	54	5	FO	BD	15	8	P	NS	Up	M	Taylor	n/a	0-20	N	unkn	none	20-50%	>50%	N	0	0	N	N/A	NE	N
BL0504B		32	54	5	FO	BD	33	23	P	S	RS	M	Taylor	n/a	20-50	P	unkn	none	none	>50%	N	0	0	N	N/A	NE	N
BL0505		32	54	5	MQ	CF	28	13	P	NS	Up	K	Taylor	n/a	0-20	BRM	PI/Arch	none	none	20-50%	Y	0	1	U	N/A	UE	T
BL0506		32	54	4	MQ	CF	16	9	P	NS	Up	K	Taylor	n/a	0-20	TS	unkn	none	<20%	>50%	N	0	0	N	N/A	NE	N
BL0507		32	54	4	FO	BD	16	10	P	NS	Up	NS	Taylor	n/a	0-20	N	PI/Arch	none	none	20-50%	N	0	0	N	N/A	NE	N
BL0512		35	54	3	GM	CF	30	23	U	U	M	NS	Bear	2nd	50-100	TS	PI	none	<20%	<20%	Y	16	0	U	N/A	UE	T
BL0513A		36	54	5	MQ	CF	31	22	P	PS	M	NS	Bear	n/a	100+	N	unkn	none	none	20-50%	Y	19	0	U	N/A	UE	T
BL0513B		36	54	5	MQ	CF	14	11	S	NS	M	NS	Bear	n/a	0-20	N	Arch/Tra	none	20-50%	20-50%	N	0	0	N	N/A	NE	N
BL0514-1	■	35	54	5	KK	JA	15	11	S	NS	S	NS	Bear	n/a	0-20	N	Arch/Tra	none	none	20-50%	N	0	0	N	Y	E	P
BL0514-2	■	35	54	5	KK	JA	15	11	S	NS	Up	NS	Bear	n/a	U	N	unkn	U	20-50%	20-50%	N	0	0	N	N	NE	N
BL0516A2	■	35	54	3	MQ	CF	13	10	S	NS	Up	NS	Bear	n/a	0-20	N	Arch	none	none	>50%	N	0	0	N	U	UE	T
BL0516A3	■	35	54	3	MQ	CF	13	10	S	NS	Up	NS	Bear	n/a	0-20	N	Arch	none	none	>50%	N	0	0	N	N	NE	N
BL0516BA	■	35	54	3	MQ	CF	29	17	U	U	RS	NS	Bear	n/a	U	N	unkn	U	none	U	Y	0	1	U	N/A	UE	T
BL0516BB	■	35	54	3	MQ	CF	29	17	U	U	RS	NS	Bear	n/a	U	N	unkn	U	none	U	Y	0	1	N	N/A	NE	N
BL0517		35	54	3	GM	CF	14	9	P	NS	Up	M	Bear	n/a	0-20	N	Arch	none	none	>50%	N	0	0	N	N/A	NE	N
BL0524		37	54	3	KK	JA	13	9	S	NS	Up	M	Bear	n/a	0-20	N	unkn	none	none	>50%	N	0	0	N	N/A	NE	N

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Site subarea	LRPA?	UTM East Grid	UTM North Grid	Training Area	Archeologist	Geomorphologist	Archaeol. Score	Geomorph Score	Context	Sealed?	Landform	Land Surface	Drainage	Stream Order	Est.Depth (cm)	Burned Rock	Archae. Age	Vandal Disturb.	Vehicle Disturb.	Erosion Disturb.	Potential deposits	No. Shovel Tests	No. Test Pits	Intact deposits?	Ubiquitous lithics?	NRHP Eligibility	Mgmt. Recom.
BL0525		37	54	5	MQ	CF	15	10	P	NS	Up	M	Bear	n/a	0-20	N	Arch/Tra	none	none	>50%	N	0	0	N	N/A	NE	N
BL0526		30	53	4	PM	BD	35	22	P	S	T2	NS	L.Belton	5th	100+	TS	Arch	none	>50%	<20%	Y	7	0	N	N/A	NE	N
BL0528		31	53	4	PM	BD	11	22	S	NS	RS	NS	Cowhouse	n/a	0-20	N	unkn	none	none	<20%	N	0	0	N	N/A	NE	N
BL0529		31	53	4	PM	BD	31	24	P	S	RS	NS	Cowhouse	n/a	20-50	N	unkn	none	none	<20%	Y	1	0	N	N/A	NE	N
BL0530		31	53	4	PM	BD	13	11	S	NS	Up	M	Cowhouse	n/a	0-20	N	Arch	none	none	20-50%	N	0	0	N	N/A	NE	N
BL0531		31	53	4	PM	BD	35	24	P	S	RS	NS	Cowhouse	n/a	20-50	N	unkn	<20%	none	<20%	Y	0	1	U	N/A	UE	T
BL0532		31	53	4	PM	BD	35	20	P	PS	C	NS	none	n/a	20-50	TS	Arch	none	none	20-50%	Y	4	0	U	N/A	UE	T
BL0538		32	53	4	FO	BD	27	24	P	S	RS	NS	Cowhouse	n/a	20-50	N	unkn	none	none	<20%	Y	1	0	U	N/A	UE	T
BL0545		33	53	4	FO	BD	13	12	P	NS	M	NS	Taylor	n/a	0-20	N	Arch/LP	none	none	20-50%	N	0	0	N	N/A	NE	N
BL0547		33	53	4	FO	BD	26	22	P	S	RS	NS	none	n/a	20-50	N	Pl	<20%	none	<20%	Y	2	0	N	N/A	NE	N
BL0548		33	53	5	FO	BD	14	9	P	NS	Up	NS	Taylor	n/a	0-20	N	unkn	none	none	>50%	N	0	0	N	N/A	NE	N
BL0549		33	53	5	FO	BD	14	7	P	NS	Up	M	Taylor	n/a	0-20	N	Arch	none	>50%	>50%	N	0	0	N	N/A	NE	N
BL0550		32	52	4	KK	JA	13	11	S	NS	M	NS	Cowhouse	5th	0-20	N	unkn	none	20-50%	20-50%	N	0	0	N	N/A	NE	N
BL0554A3	■	34	53	5	KK	JA	22	9	S	NS	Up	M	Taylor	n/a	0-20	N	Arch/LP	none	20-50%	>50%	N	0	0	N	N	NE	N
BL0554B1	■	34	53	5	KK	JA	50	25	P	S	Up	NS	Taylor	n/a	100+	BRM	Arch/LP	20-50%	20-50%	20-50%	Y	0	1	Y	N/A	E	P
BL0554B2	■	34	53	5	KK	JA	50	25	P	S	Up	NS	Taylor	n/a	100+	BRM	Arch/LP	20-50%	20-50%	20-50%	Y	0	1	Y	N/A	E	P
BL0556		37	54	5	MQ	CF	15	10	P	NS	Up	M	Bear	n/a	0-20	N	unkn	none	none	20-50%	N	0	0	N	N/A	NE	N
BL0559		36	53	5	MQ	CF	13	8	S	NS	Up	NS	Bear	n/a	0-20	P	Arch/Tra	none	none	>50%	N	0	0	N	N/A	NE	N
BL0560A4	■	37	53	5	KK	JA	15	9	S	NS	Up	NS	none	n/a	0-20	C	Arch/LP	none	20-50%	>50%	N	0	0	N	U	UE	T
BL0560A5	■	37	53	5	KK	JA	15	9	S	NS	Up	NS	none	n/a	0-20	C	Arch/LP	none	20-50%	>50%	N	0	0	N	N	NE	N
BL0560B5	■	37	53	5	KK	JA	10	17	S	NS	RS	NS	none	n/a	0-20	N	unkn	none	none	>50%	N	0	0	N	N	NE	N
BL0560C1	■	37	53	5	KK	JA	32	24	S	NS	RS	NS	none	n/a	20-50	N	unkn	none	none	<20%	Y	2	1	U	N/A	UE	T
BL0560C2	■	37	53	5	KK	JA	32	24	S	NS	RS	NS	none	n/a	20-50	N	unkn	none	none	<20%	Y	2	0	U	N/A	UE	T
BL0560C3	■	37	53	5	KK	JA	32	24	S	NS	RS	NS	none	n/a	20-50	N	unkn	none	none	<20%	Y	2	0	U	N/A	UE	T
BL0560D5	■	37	53	5	KK	JA	29	23	U	U	T0	NS	none	2nd	20-50	N	unkn	none	none	20-50%	Y	2	0	N	N/A	NE	N
BL0561		37	53	5	MQ	CF	18	10	P	NS	Up	NS	Owl	n/a	0-20	TS	Arch	none	none	>50%	N	0	0	N	N/A	NE	N
BL0562		36	53	5	FO	BD	14	9	P	NS	Up	M	Taylor	n/a	0-20	N	Pl/Arch	none	>50%	<20%	N	0	0	N	N/A	NE	N
BL0563A		36	52	5	FO	BD	11	9	P	NS	Up	M	Taylor	n/a	0-20	N	Pl	none	20-50%	20-50%	N	0	0	N	N/A	NE	N
BL0563B		36	52	5	FO	BD	28	22	P	S	RS	NS	Taylor	n/a	20-50	N	unkn	none	none	<20%	Y	2	0	N	N/A	NE	N
BL0564A		36	52	5	FO	BD	32	14	P	NS	Up	NS	Taylor	n/a	0-20	BRM	unkn	none	none	20-50%	Y	1	0	U	N/A	UE	T
BL0564B		36	52	5	FO	BD	22	24	P	S	Up	NS	Taylor	n/a	50-100	N	unkn	>50%	none	<20%	Y	1	0	N	N/A	NE	N
BL0564C		36	52	5	FO	BD	30	24	P	S	RS	NS	Taylor	n/a	50-100	N	unkn	>50%	none	<20%	Y	1	0	N	N/A	NE	N
BL0566A		36	52	5	FO	BD	28	22	P	PS	RS	NS	Taylor	n/a	20-50	N	unkn	none	none	<20%	Y	1	0	N	N/A	NE	N
BL0566B		36	52	5	FO	BD	14	8	P	NS	Up	M	Taylor	n/a	0-20	N	unkn	none	20-50%	>50%	N	0	0	N	N/A	NE	N
BL0567		36	52	5	FO	BD	32	27	P	PS	RS	NS	Taylor	n/a	20-50	N	unkn	none	none	<20%	Y	3	0	U	N/A	UE	T
BL0568A		36	51	5	FO	BD	33	13	P	NS	Up	M	Taylor	n/a	0-20	BRM	unkn	none	20-50%	20-50%	Y	2	0	U	N/A	UE	T
BL0568B		36	51	5	FO	BD	27	17	P	S	RS	NS	Taylor	n/a	0-20	N	unkn	<20%	none	>50%	Y	1	0	U	N/A	UE	T
BL0569		36	51	5	FO	BD	21	13	P	S	RS	NS	Taylor	n/a	0-20	N	unkn	none	none	20-50%	Y	1	0	N	N/A	NE	N

Appendix F: Site Listing

Site subarea	LRPA?	UTM East Grid	UTM North Grid	Training Area	Archeologist	Geomorphologist	Archaeol. Score	Geomorph Score	Context	Sealed?	Landform	Land Surface	Drainage	Stream Order	Est.Depth (cm)	Burned Rock	Archae. Age	Vandal Disturb.	Vehicle Disturb.	Erosion Disturb.	Potential deposits	No. Shovel Tests	No. Test Pits	Intact deposits?	Ubiquitous lithics?	NRHP Eligibility	Mgmt. Recom.
BL0570		36	51	5	JmT	BD	24	20	P	NS	RS	NS	Taylor	n/a	20-50	N	unkn	none	none	>50%	Y	2	0	N	N/A	NE	N
BL0575		35	51	4	FO	BD	34	19	P	PS	C	NS	Taylor	n/a	50-100	TS	Arch	none	>50%	>50%	Y	4	0	N	N/A	NE	N
BL0579A	■	34	51	4	KK	JA	16	12	S	NS	Up	M	none	n/a	0-20	TS	Arch/Tra	none	20-50%	20-50%	N	0	0	N	N	NE	N
BL0579B	■	34	51	4	KK	JA	33	24	U	U	RS	NS	none	n/a	20-50	N	unkn	<20%	none	20-50%	Y	4	0	U	N/A	UE	T
BL0581A		34	51	4	FO	BD	30	21	P	NS	RS	NS	Taylor	n/a	20-50	N	unkn	none	none	20-50%	Y	1	0	N	N/A	NE	N
BL0581B		34	51	4	FO	BD	34	24	P	S	RS	NS	Taylor	n/a	20-50	TS	unkn	none	none	<20%	Y	1	0	U	N/A	UE	T
BL0581C		34	51	4	FO	BD	16	9	P	NS	Up	M	Taylor	n/a	0-20	N	unkn	none	none	>50%	N	0	0	N	N/A	NE	N
BL0582A		34	51	4	FO	BD	26	24	P	NS	RS	NS	Cowhouse	n/a	50-100	N	unkn	none	none	<20%	Y	1	1	U	N/A	UE	T
BL0582B		34	51	4	FO	BD	11	9	P	NS	Up	M	Cowhouse	n/a	0-20	N	unkn	none	20-50%	20-50%	N	0	0	N	N/A	NE	N
BL0583		34	51	4	JmT	BD	9	10	S	NS	RS	NS	Cowhouse	n/a	0-20	N	unkn	U	none	>50%	N	0	0	N	N/A	NE	N
BL0589A		41	49	6	GM	JA	17	8	S	NS	Up	NS	Bull	n/a	0-20	TS	Arch/Tra	none	none	>50%	N	0	0	N	N/A	NE	N
BL0589B		41	49	6	GM	JA	23	24	U	U	RS	NS	Bull	n/a	U	N	unkn	none	none	<20%	Y	0	1	U	N/A	UE	T
BL0590A		42	49	6	GM	CF	26	24	U	U	RS	NS	L.Belton	n/a	20-50	N	unkn	none	none	<20%	Y	0	1	Y	N/A	E	P
BL0590B		42	49	6	GM	CF	13	14	S	NS	S	NS	none	n/a	U	N	Arch	none	none	>50%	N	0	0	N	N/A	NE	N
BL0592		41	49	6	GM	CF	23	22	U	U	RS	NS	Bull	n/a	0-20	N	unkn	none	none	<20%	Y	0	1	N	N/A	NE	N
BL0595		42	49	6	GM	JA	25	24	U	U	RS	NS	L.Belton	n/a	20-50	TS	unkn	none	none	20-50%	Y	2	0	U	N/A	UE	T
BL0596		42	49	6	GM	CF	32	21	U	U	RS	NS	L.Belton	n/a	20-50	TS	Arch/LP	>50%	none	<20%	Y	3	1	Y	N/A	E	P
BL0597		42	49	6	GM	CF	25	24	U	U	RS	NS	L.Belton	n/a	0-20	N	unkn	none	none	<20%	Y	2	0	U	N/A	UE	T
BL0598A	■	37	51	5	KK	JA	18	11	S	NS	Up	M	none	n/a	0-20	BRM	Arch/Tra	none	<20%	>50%	N	0	0	N	N	NE	N
BL0598B	■	37	51	5	KK	JA	10	16	S	NS	S	NS	none	n/a	U	N	unkn	none	none	>50%	N	0	0	N	N	NE	N
BL0598C	■	37	51	5	KK	JA	10	20	S	NS	RS	NS	none	n/a	0-20	N	unkn	20-50%	none	>50%	N	0	0	N	N	NE	N
BL0598DB	■	37	51	5	KK	JA	37	23	U	U	RS	NS	none	n/a	0-20	P	L Arch	20-50%	none	20-50%	Y	0	1	U	N/A	UE	T
BL0598DD	■	37	51	5	KK	JA	37	23	U	U	RS	NS	none	n/a	0-20	P	L Arch	20-50%	none	20-50%	Y	0	1	U	N/A	UE	T
BL0598E	■	37	51	5	KK	JA	45	24	P	S	S	NS	none	n/a	100+	BRM	Arch	none	none	20-50%	N	0	0	N	U	UE	T
BL0599	■	37	51	7	GM	JA	13	7	S	NS	Up	M	Cowhouse	n/a	0-20	TS	Arch	none	>50%	>50%	N	0	0	N	N	NE	N
BL0600A2	■	36	50	7	KK	JA	13	7	S	NS	Up	NS	Cowhouse	n/a	50-100	N	unkn	U	20-50%	<20%	N	0	0	N	U	UE	T
BL0600A3	■	36	50	7	MQ	JA	13	7	S	NS	Up	NS	none	n/a	0-20	N	unkn	none	>50%	>50%	N	0	0	N	N	NE	N
BL0600B	■	36	50	7	MQ	JA	27	20	U	U	T0	NS	none	1st	50-100	N	unkn	none	>50%	<20%	Y	18	0	U	N/A	UE	T
BL0608A1	■	37	49	7	KK	JA	38	12	P	S	Up	M	L.Belton	n/a	0-20	BRM	Arch/LP	none	20-50%	>50%	Y	0	1	Y	N/A	E	P
BL0608A2	■	37	49	7	KK	JA	21	12	P	S	Up	M	L.Belton	n/a	0-20	BRM	Arch/LP	none	20-50%	>50%	N	0	0	N	U	UE	T
BL0608A3	■	37	49	7	KK	JA	21	12	P	S	Up	M	L.Belton	n/a	0-20	BRM	Arch/LP	none	20-50%	>50%	N	0	0	N	U	UE	T
BL0608A4	■	37	49	7	KK	JA	21	12	P	S	Up	M	L.Belton	n/a	0-20	BRM	Arch/LP	none	20-50%	>50%	N	0	0	N	U	UE	T
BL0608A6	■	37	49	7	KK	JA	21	12	P	S	Up	M	L.Belton	n/a	0-20	BRM	Arch/LP	none	20-50%	>50%	N	0	0	N	N	NE	N
BL0608B	■	37	49	7	KK	JA	34	24	U	U	RS	NS	L.Belton	n/a	0-20	P	unkn	<20%	none	20-50%	Y	0	2	Y	N/A	E	P
BL0611		36	50	7	KK	JA	13	11	S	NS	Up	M	L.Belton	n/a	0-20	TS	unkn	none	none	<20%	N	0	0	N	N/A	NE	N
BL0612		36	50	7	KK	JA	10	15	S	NS	M	NS	Cowhouse	n/a	0-20	N	unkn	none	none	20-50%	N	0	0	N	N/A	NE	N
BL0613		36	50	7	KK	JA	22	23	U	U	RS	NS	Cowhouse	n/a	0-20	TS	unkn	20-50%	none	20-50%	N	0	0	N	N/A	NE	N
BL0615		36	50	8	KK	JA	35	23	P	PS	RS	NS	none	n/a	20-50	DS	unkn	>50%	none	<20%	Y	0	2	U	N/A	UE	T

Site subarea	LRPA?	UTM East Grid	UTM North Grid	Training Area	Archeologist	Geomorphologist	Archaeol. Score	Geomorph Score	Context	Sealed?	Landform	Land Surface	Drainage	Stream Order	Est.Depth (cm)	Burned Rock	Archae. Age	Vandal Disturb.	Vehicle Disturb.	Erosion Disturb.	Potential deposits	No. Shovel Tests	No. Test Pits	Intact deposits?	Ubiquitous lithics?	NRHP Eligibility	Mgmt. Recom.
BL0620		35	49	8	GM	CF	17	13	S	NS	T2	NS	L.Belton	4th	0-20	P	Pl/Arch	none	none	<20%	N	0	0	N	N/A	NE	N
BL0624		37	49	7	KK	JA	13	9	S	NS	Up	NS	L.Belton	n/a	0-20	N	Arch	none	none	>50%	N	0	0	N	N/A	NE	N
BL0627A		36	49	7	MQ	JA	35	24	P	PS	RS	NS	Cowhouse	n/a	20-50	P	unkn	20-50%	none	<20%	Y	4	0	U	N/A	UE	T
BL0627B		36	49	7	MQ	JA	13	8	S	NS	Up	NS	Cowhouse	n/a	0-20	N	unkn	none	20-50%	>50%	N	0	0	N	N/A	NE	N
BL0628		36	49	7	MQ	JA	14	24	S	NS	RS	NS	none	n/a	0-20	TS	unkn	none	none	20-50%	N	0	0	N	N/A	NE	N
BL0634		37	48	7	KK	JA	21	19	S	NS	M	NS	Cowhouse	n/a	U	TS	Arch	20-50%	20-50%	>50%	N	0	0	N	N/A	NE	N
BL0635		37	47	7	KK	JA	32	24	U	U	RS	NS	Cowhouse	n/a	20-50	TS	unkn	20-50%	none	<20%	Y	1	2	U	N/A	UE	T
BL0636A		38	47	7	GM	JA	15	8	S	NS	Up	M	none	n/a	0-20	N	unkn	none	none	>50%	N	0	0	N	N/A	NE	N
BL0636B		38	47	7	GM	JA	17	20	S	NS	RS	NS	none	n/a	0-20	N	unkn	none	none	20-50%	N	0	0	N	N/A	NE	N
BL0648		38	47	7	GM	JA	13	8	S	NS	Up	M	L.Belton	n/a	0-20	TS	Arch/Tra	none	20-50%	>50%	N	0	0	N	N/A	NE	N
BL0649		39	48	7	GM	CF	14	7	P	NS	Up	M	none	n/a	0-20	N	unkn	none	>50%	>50%	N	0	0	N	N/A	NE	N
BL0652		39	48	7	GM	CF	17	12	P	NS	S	NS	none	n/a	0-20	N	unkn	none	<20%	20-50%	N	0	0	N	N/A	NE	N
BL0656		39	47	7	GM	JA	17	8	S	NS	Up	M	none	n/a	0-20	TS	Arch	none	20-50%	>50%	N	0	0	N	N/A	NE	N
BL0667		39	51	6	JfT	JA	36	23	U	U	RS	NS	Bull	n/a	100+	N	unkn	>50%	none	<20%	Y	0	1	U	N/A	UE	T
BL0668		39	51	6	GM	JA	17	7	S	NS	Up	M	Bull	n/a	0-20	TS	Arch	none	>50%	>50%	N	0	0	N	N/A	NE	N
BL0669		39	51	6	JfT	JA	13	8	S	NS	Up	M	Bull	n/a	0-20	N	unkn	none	none	>50%	N	0	0	N	N/A	NE	N
BL0670A		39	51	6	JfT	JA	14	14	S	NS	M	NS	none	n/a	0-20	N	unkn	none	none	>50%	N	0	0	N	N/A	NE	N
BL0670B		39	51	6	JfT	JA	30	22	U	U	M	NS	Bull	2nd	100+	P	unkn	20-50%	none	20-50%	Y	5	0	Y	N/A	E	P
BL0670C		39	51	6	JfT	JA	34	22	P	S	RS	NS	Bull	n/a	20-50	N	unkn	20-50%	none	20-50%	Y	0	0	Y	N/A	E	P
BL0671		39	51	6	JfT	JA	40	23	U	U	RS	NS	none	n/a	100+	P	L Prehis	>50%	none	<20%	Y	0	0	Y	N/A	E	P
BL0673		39	51	6	KK	JA	13	9	S	NS	Up	M	Bull	n/a	U	N	L Prehis	none	none	>50%	N	0	0	N	N/A	NE	N
BL0674		40	50	6	GM	JA	23	23	U	U	RS	NS	Bull	n/a	20-50	N	unkn	none	none	20-50%	Y	0	1	U	N/A	UE	T
BL0681A		41	50	6	GM	CF	27	27	U	U	RS	NS	none	n/a	U	N	unkn	none	none	<20%	Y	4	0	U	N/A	UE	T
BL0681B		41	50	6	GM	CF	13	9	S	NS	Up	M	none	n/a	0-20	N	L Prehis	none	none	>50%	N	0	0	N	N/A	NE	N
BL0682		40	50	6	KK	JA	17	8	S	NS	Up	M	Bull	n/a	0-20	N	L Arch	none	none	>50%	N	0	0	N	N/A	NE	N
BL0683		40	50	7	KK	JA	21	24	U	U	RS	NS	Bull	n/a	20-50	N	unkn	none	none	<20%	Y	1	0	N	N/A	NE	N
BL0686		41	50	6	GM	CF	13	19	S	NS	RS	NS	none	n/a	0-20	N	unkn	none	none	20-50%	N	0	0	N	N/A	NE	N
BL0688		41	50	6	GM	CF	17	9	S	NS	Up	M	none	n/a	0-20	N	Arch	none	20-50%	>50%	N	0	0	N	N/A	NE	N
BL0689		41	50	6	GM	CF	15	10	S	NS	Up	M	none	n/a	0-20	N	unkn	none	<20%	>50%	N	0	0	N	N/A	NE	N
BL0691		41	50	6	GM	CF	17	10	S	NS	S	M	L.Belton	n/a	0-20	N	Arch	none	20-50%	>50%	N	0	0	N	N/A	NE	N
BL0694		40	48	7	GM	CF	27	23	U	U	RS	NS	none	n/a	20-50	N	unkn	none	none	20-50%	Y	2	0	U	N/A	UE	T
BL0695		41	48	7	GM	CF	23	24	U	U	RS	NS	none	n/a	U	N	unkn	none	none	<20%	Y	2	0	U	N/A	UE	T
BL0699A		40	49	7	KK	JA	13	8	S	NS	Up	NS	Bull	n/a	0-20	N	L Arch	none	20-50%	>50%	N	0	0	N	N/A	NE	N
BL0699B		40	49	7	KK	JA	32	23	U	U	RS	NS	Bull	n/a	20-50	TS	unkn	20-50%	none	20-50%	Y	1	1	U	N/A	UE	T
BL0703		40	48	7	GM	CF	17	13	S	NS	S	NS	L.Belton	n/a	U	TS	E Arch	none	<20%	>50%	N	0	0	N	N/A	NE	N
BL0709		41	48	7	GM	CF	14	11	S	NS	S	NS	L.Belton	n/a	0-20	P	unkn	none	<20%	>50%	N	0	0	N	N/A	NE	N
BL0711A		40	47	7	GM	JA	15	9	S	NS	Up	NS	Bull	n/a	0-20	N	unkn	none	none	>50%	N	0	0	N	N/A	NE	N
BL0711B		40	47	7	GM	JA	24	23	U	U	RS	NS	Bull	n/a	20-50	N	unkn	none	20-50%	20-50%	Y	0	1	U	N/A	UE	T

Appendix F: Site Listing

Site subarea	LRPA?	UTM East Grid	UTM North Grid	Training Area	Archeologist	Geomorphologist	Archaeol. Score	Geomorph Score	Context	Sealed?	Landform	Land Surface	Drainage	Stream Order	Est.Depth (cm)	Burned Rock	Archae. Age	Vandal Disturb.	Vehicle Disturb.	Erosion Disturb.	Potential deposits	No. Shovel Tests	No. Test Pits	Intact deposits?	Ubiquitous lithics?	NRHP Eligibility	Mgmt. Recom.
BL0716		40	47	7	GM	CF	15	8	P	NS	Up	NS	Cowhouse	n/a	0-20	N	unkn	none	>50%	U	N	0	0	N	N/A	NE	N
BL0717		40	47	7	GM	JA	13	8	S	NS	Up	M	none	n/a	0-20	N	unkn	none	20-50%	>50%	N	0	0	N	N/A	NE	N
BL0718		40	47	7	JfT	JA	13	9	S	NS	M	NS	L.Belton	n/a	0-20	N	Arch	none	20-50%	>50%	N	0	0	N	N/A	NE	N
BL0721		41	47	7	JfT	JA	13	8	S	NS	Up	M	none	n/a	0-20	N	unkn	none	none	>50%	N	0	0	N	N/A	NE	N
BL0722		41	47	7	JfT	JA	14	10	S	NS	Up	M	Bull	n/a	0-20	N	unkn	none	none	20-50%	N	0	0	N	N/A	NE	N
BL0723A		42	47	7	JfT	JA	12	9	S	NS	Up	M	Bull	n/a	0-20	N	unkn	none	none	>50%	N	0	0	N	N/A	NE	N
BL0723B		42	47	7	JfT	JA	39	23	P	S	RS	NS	Bull	n/a	20-50	N	Arch	>50%	none	<20%	Y	0	2	U	N/A	UE	T
BL0728A1		42	46	7	GM	CF	40	27	P	S	RS	NS	L.Belton	n/a	0-20	P	unkn	20-50%	none	<20%	Y	0	3	U	N/A	UE	T
BL0728A2		42	46	7	GM	CF	27	19	U	U	RS	NS	L.Belton	n/a	20-50	N	unkn	none	none	U	Y	0	2	N	N/A	NE	N
BL0728B		42	46	7	GM	CF	18	15	S	S	S	NS	L.Belton	n/a	U	P	unkn	none	none	>50%	N	0	0	N	N/A	NE	N
BL0729		34	56	3	GM	CF	13	8	S	NS	Up	NS	none	n/a	0-20	N	M Arch	none	20-50%	>50%	N	0	0	N	N/A	NE	N
BL0730		35	56	3	GM	CF	17	9	S	NS	Up	M	Owl	n/a	0-20	TS	Arch	none	<20%	>50%	N	0	0	N	N/A	NE	N
BL0731		35	56	3	GM	CF	31	26	P	S	RS	NS	Owl	n/a	20-50	P	Arch/Tra	none	none	<20%	Y	0	1	Y	N/A	E	P
BL0732		35	55	3	GM	CF	12	7	S	NS	Up	NS	none	n/a	0-20	N	Pl/Arch	none	>50%	>50%	N	0	0	N	N/A	NE	N
BL0733		35	55	3	GM	CF	14	9	S	NS	Up	M	none	n/a	0-20	N	unkn	none	<20%	>50%	N	0	0	N	N/A	NE	N
BL0734		29	47	15	PM	BD	14	10	S	NS	Up	NS	N. Nolan	n/a	20-50	N	unkn	none	>50%	<20%	N	0	0	N	N/A	NE	N
BL0740A		30	47	15	PM	BD	15	14	P	PS	M	NS	N. Nolan	n/a	0-20	DS	Arch	20-50%	20-50%	20-50%	N	0	0	N	N/A	NE	N
BL0740B		30	47	15	PM	BD	38	25	P	PS	M	NS	N. Nolan	2nd	100+	BRM	Arch	<20%	<20%	<20%	Y	19	0	U	N/A	UE	T
BL0742		33	47	13	PM	BD	14	9	S	NS	Up	NS	N. Nolan	n/a	0-20	N	Arch	none	>50%	<20%	N	0	0	N	N/A	NE	N
BL0743		34	47	13	PM	BD	32	13	P	S	Up	NS	N. Nolan	n/a	0-20	BRM	Arch	none	none	<20%	Y	0	0	U	N/A	UE	T
BL0744		34	47	13	PM	BD	43	25	P	S	RS	NS	Cowhouse	n/a	50-100	P	Arch	20-50%	none	<20%	Y	2	1	U	N/A	UE	T
BL0748		34	47	13	PM	BD	19	11	S	NS	Up	NS	Cowhouse	n/a	0-20	DS	M Arch	none	none	<20%	N	0	0	N	N/A	NE	N
BL0749		34	47	13	PM	BD	21	10	S	NS	Up	NS	Cowhouse	n/a	0-20	N	Arch	none	20-50%	<20%	N	0	0	N	N/A	NE	N
BL0750		34	47	13	PM	BD	19	12	S	NS	M	NS	Cowhouse	n/a	0-20	N	Arch	none	<20%	<20%	N	0	0	N	N/A	NE	N
BL0751A		31	48	13	MQ	CF	40	23	P	PS	T0	NS	none	2nd	U	BRM	unkn	>50%	none	<20%	Y	4	0	U	N/A	UE	T
BL0751B		31	48	13	MQ	CF	9	19	S	NS	S	NS	none	n/a	U	N	unkn	none	<20%	<20%	N	0	0	N	N/A	NE	N
BL0754		31	48	13	MQ	CF	34	22	P	PS	RS	NS	none	n/a	20-50	P	Arch	>50%	none	<20%	Y	0	1	U	N/A	UE	T
BL0755A		32	48	13	MQ	CF	14	12	S	NS	S	NS	none	n/a	0-20	N	unkn	none	none	<20%	N	0	0	N	N/A	NE	N
BL0755B		32	48	13	MQ	CF	41	22	P	PS	T1	NS	none	n/a	20-50	C	L Arch	none	<20%	<20%	Y	5	0	U	N/A	UE	T
BL0759		33	49	8	KK	JA	28	24	U	U	RS	NS	Cowhouse	n/a	0-20	N	unkn	none	none	<20%	Y	0	1	N	N/A	NE	N
BL0762		35	48	7	KK	JA	17	7	S	NS	Up	NS	Cowhouse	n/a	0-20	TS	Arch	none	>50%	>50%	N	0	0	N	N/A	NE	N
BL0765		33	48	13	MQ	CF	34	21	P	PS	RS	NS	none	n/a	50-100	N	unkn	none	<20%	<20%	Y	2	1	U	N/A	UE	T
BL0766		33	48	13	MQ	CF	20	18	P	NS	RS	NS	none	n/a	0-20	N	unkn	none	none	20-50%	Y	1	0	N	N/A	NE	N
BL0770		25	48	18	PM	BD	32	15	P	S	Up	M	none	n/a	U	BRM	Arch	none	<20%	<20%	N	0	0	N	N/A	NE	N
BL0773		25	48	18	PM	BD	31	23	P	S	RS	NS	none	n/a	U	N	Arch	20-50%	none	<20%	Y	0	1	U	N/A	UE	T
BL0786	■	7	38	24	GM	CF	13	9	S	NS	Up	M	none	n/a	0-20	N	Arch/Tra	none	<20%	>50%	N	0	0	N	U	UE	T
BL0787A2	■	9	36	24	KK	JA	13	8	S	NS	Up	M	none	n/a	0-20	N	Arch	none	20-50%	>50%	N	0	0	N	U	UE	T
BL0787A3	■	9	36	24	KK	JA	13	8	S	NS	Up	M	none	n/a	0-20	N	Arch	none	20-50%	>50%	N	0	0	N	N	NE	N

Appendix F: Site Listing

Site subarea	LRPA?	UTM East Grid	UTM North Grid	Training Area	Archeologist	Geomorphologist	Archaeol. Score	Geomorph Score	Context	Sealed?	Landform	Land Surface	Drainage	Stream Order	Est.Depth (cm)	Burned Rock	Archae. Age	Vandal Disturb.	Vehicle Disturb.	Erosion Disturb.	Potential deposits	No. Shovel Tests	No. Test Pits	Intact deposits?	Ubiquitous lithics?	NRHP Eligibility	Mgmt. Recom.
BL0787B1	■	9	36	24	KK	JA	13	14	P	S	S	NS	none	n/a	0-20	N	Arch	none	20-50%	>50%	N	0	0	N	U	UE	T
BL0787B2	■	9	36	24	KK	JA	13	14	P	S	S	NS	none	n/a	0-20	N	Arch	none	20-50%	>50%	N	0	0	N	U	UE	T
BL0788A	■	9	36	24	KK	JA	37	19	U	U	Up	M	N. Reese	n/a	0-20	BRM	Arch	20-50%	none	>50%	N	0	0	N	Y	E	P
BL0788B	■	9	36	24	KK	JA	37	19	U	U	M	NS	N. Reese	n/a	U	BRM	Arch/LP	20-50%	none	>50%	Y	3	0	U	N/A	UE	T
BL0789		9	35	24	JfT	JA	13	14	S	NS	S	M	none	n/a	0-20	N	unkn	none	20-50%	>50%	N	0	0	N	N/A	NE	N
BL0792		34	50	8	GM	CF	11	7	S	NS	Up	M	Cowhouse	n/a	0-20	N	unkn	none	>50%	>50%	N	0	0	N	N/A	NE	N
BL0793		11	33	25	JfT	JA	15	11	S	NS	S	NS	none	n/a	0-20	C	Arch	none	<20%	>50%	N	0	0	N	N/A	NE	N
BL0794		11	33	25	JfT	JA	15	11	S	NS	S	K	none	n/a	0-20	C	L Prehis	none	<20%	>50%	N	0	0	N	N/A	NE	N
BL0800		35	43	16	PM	BD	31	22	P	S	RS	NS	N. Nolan	n/a	U	N	unkn	none	none	<20%	Y	1	0	N	N/A	NE	N
BL0806		37	45	17	MQ	CF	30	22	P	PS	RS	NS	none	n/a	20-50	N	unkn	<20%	none	20-50%	Y	2	1	Y	N/A	E	P
BL0807		37	45	17	MQ	CF	18	17	P	NS	M	NS	Cowhouse	n/a	20-50	N	E Arch	none	none	>50%	Y	4	0	N	N/A	NE	N
BL0814		36	44	17	FO	BD	30	20	P	PS	S	NS	N. Nolan	n/a	100+	N	Arch	none	20-50%	20-50%	Y	5	0	N	N/A	NE	N
BL0816A		35	44	17	MQ	CF	28	24	P	PS	C	NS	N. Nolan	n/a	U	N	unkn	none	<20%	<20%	Y	9	0	U	N/A	UE	T
BL0816B		35	44	17	MQ	CF	14	9	S	NS	S	NS	N. Nolan	n/a	0-20	N	Arch/Tra	none	>50%	>50%	N	0	0	N	N/A	NE	N
BL0821		34	43	16	PM	BD	48	22	P	S	M	NS	N. Nolan	1st	U	BRM	Arch	20-50%	none	20-50%	Y	4	0	Y	N/A	E	P
BL0827		38	43	17	FO	BD	36	24	P	PS	M	NS	N. Nolan	n/a	50-100	BRM	unkn	20-50%	none	<20%	Y	3	0	U	N/A	UE	T
BL0834A1	■	32	45	16	JfT	JA	13	10	S	NS	M	NS	none	n/a	0-20	N	Arch	none	20-50%	20-50%	N	0	0	N	U	UE	T
BL0834A4	■	32	45	16	JfT	JA	13	10	S	NS	M	NS	none	n/a	0-20	N	Arch	none	20-50%	20-50%	N	0	0	N	N	NE	N
BL0834B2	■	32	45	16	JfT	JA	29	25	U	U	T1	NS	none	1st	50-100	TS	unkn	none	<20%	<20%	Y	11	0	U	N/A	UE	T
BL0834B3	■	32	45	16	JfT	JA	29	25	U	U	T1	NS	none	1st	50-100	TS	unkn	none	<20%	<20%	Y	11	0	U	N/A	UE	T
BL0837		39	44	17	MQ	CF	19	16	S	NS	M	NS	none	n/a	0-20	TS	Arch	none	none	>50%	N	0	0	N	N/A	NE	N
BL0840		33	44	16	FO	BD	18	8	P	NS	M	NS	N. Nolan	n/a	0-20	N	L Arch	none	>50%	>50%	N	0	0	N	N/A	NE	N
BL0844A1	■	33	44	16	JfT	JA	13	9	S	NS	Up	NS	N. Nolan	n/a	0-20	N	Arch/Tra	none	20-50%	20-50%	N	0	0	N	U	UE	T
BL0844A2	■	33	44	16	JfT	JA	13	9	S	NS	Up	NS	N. Nolan	n/a	0-20	N	Arch/Tra	none	20-50%	20-50%	N	0	0	N	U	UE	T
BL0844A3	■	33	44	16	JfT	JA	13	9	S	NS	Up	NS	N. Nolan	n/a	0-20	N	Arch/Tra	none	20-50%	20-50%	N	0	0	N	N	NE	N
BL0844BA	■	33	44	16	JfT	JA	38	26	U	U	RS	NS	N. Nolan	n/a	20-50	P	unkn	20-50%	none	<20%	Y	4	3	U	N/A	UE	T
BL0844BB	■	33	44	16	JfT	JA	38	26	U	U	RS	NS	N. Nolan	n/a	20-50	P	unkn	20-50%	none	<20%	Y	4	3	U	N/A	UE	T
BL0844BC	■	33	44	16	JfT	JA	38	26	U	U	RS	NS	N. Nolan	n/a	20-50	P	unkn	20-50%	none	<20%	Y	4	3	N	N/A	NE	N
BL0844BD	■	33	44	16	JfT	JA	38	26	U	U	RS	NS	N. Nolan	n/a	20-50	P	unkn	20-50%	none	<20%	Y	4	3	U	N/A	UE	T
BL0850A	■	30	43	15	KK	JA	20	9	S	NS	M	NS	none	n/a	0-20	N	Arch/LP	20-50%	20-50%	>50%	N	0	0	N	N	NE	N
BL0850B	■	30	43	15	KK	JA	13	16	S	NS	S	NS	none	n/a	0-20	N	Arch	none	>50%	>50%	N	0	0	N	N	NE	N
BL0850C	■	30	43	15	KK	JA	29	22	U	U	T1	NS	none	2nd	200+	N	unkn	none	20-50%	20-50%	Y	50	0	U	N/A	UE	T
BL0853A		33	46	16	FO	BD	14	9	P	NS	S	NS	N. Nolan	n/a	U	TS	unkn	none	20-50%	>50%	N	0	0	N	N/A	NE	N
BL0853B		33	46	16	FO	BD	34	23	P	S	C	NS	N. Nolan	n/a	50-100	TS	unkn	none	<20%	<20%	Y	9	0	N	N/A	NE	N
BL0853C		33	46	16	KK	JA	29	23	U	U	T1	NS	N. Nolan	2nd	100+	N	unkn	none	20-50%	20-50%	Y	6	0	U	N/A	UE	T
BL0868A1	■	39	45	17	JfT	JA	13	11	S	NS	Up	M	L.Belton	n/a	0-20	N	Arch	none	20-50%	20-50%	N	0	0	N	U	UE	T
BL0868A2	■	39	45	17	JfT	JA	13	11	S	NS	Up	M	L.Belton	n/a	0-20	N	Arch	none	20-50%	20-50%	N	0	0	N	N	NE	N
BL0868B	■	39	45	17	JfT	JA	27	23	U	U	RS	NS	Cowhouse	n/a	20-50	P	L Prehis	>50%	none	<20%	Y	3	0	N	N/A	NE	N

Appendix F: Site Listing

Site subarea	LRPA?	UTM East Grid	UTM North Grid	Training Area	Archeologist	Geomorphologist	Archaeol. Score	Geomorph Score	Context	Sealed?	Landform	Land Surface	Drainage	Stream Order	Est.Depth (cm)	Burned Rock	Archae. Age	Vandal Disturb.	Vehicle Disturb.	Erosion Disturb.	Potential deposits	No. Shovel Tests	No. Test Pits	Intact deposits?	Ubiquitous lithics?	NRHP Eligibility	Mgmt. Recom.
BL0869		39	45	17	JfT	JA	12	9	S	NS	S	M	L.Belton	n/a	0-20	N	unkn	none	20-50%	>50%	N	0	0	N	N/A	NE	N
BL0879		23	47	18	PM	BD	17	21	S	NS	T2	NS	none	4th	U	N	Arch	none	>50%	<20%	N	0	0	N	N/A	NE	N
BL0885		28	48	12	MQ	CF	14	11	P	NS	Up	M	none	n/a	0-20	N	E Arch	none	<20%	<20%	N	0	0	N	N/A	NE	N
BL0886		27	48	11	PM	BD	36	22	P	S	RS	NS	none	n/a	20-50	N	unkn	<20%	none	<20%	Y	3	0	U	N/A	UE	T
BL0887		27	48	11	PM	BD	24	12	S	NS	S	NS	Cowhouse	n/a	0-20	TS	Arch	none	<20%	20-50%	N	0	0	N	N/A	NE	N
BL0888		27	48	11	PM	BD	46	19	P	S	C	NS	Cowhouse	n/a	U	BRM	L Arch	>50%	none	20-50%	Y	4	0	U	N/A	UE	T
BL0889		24	47	11	GM	CF	16	10	S	NS	M	NS	Owl	n/a	0-20	TS	Pl/Arch	none	20-50%	20-50%	N	0	0	N	N/A	NE	N
BL0890		24	47	18	FO	BD	16	9	P	NS	Up	K	none	n/a	0-20	N	L Arch	none	20-50%	20-50%	N	0	0	N	N/A	NE	N
BL0894A		29	52	12	MQ	CF	22	8	P	NS	Up	NS	Cowhouse	n/a	0-20	C	Arch	none	>50%	>50%	N	0	0	N	N/A	NE	N
BL0894B		29	52	12	MQ	CF	22	20	U	U	RS	NS	Cowhouse	n/a	50-100	N	unkn	none	none	U	Y	1	0	N	N/A	NE	N
BL0898A		36	56	3	GM	CF	27	21	P	PS	M	NS	Owl	4th	20-50	TS	unkn	none	<20%	20-50%	Y	2	0	N	N/A	NE	N
BL0898B		36	56	3	GM	CF	15	15	S	NS	S	NS	Owl	n/a	0-20	TS	unkn	none	<20%	20-50%	N	0	0	N	N/A	NE	N
BL0898C		36	56	3	GM	CF	28	22	U	U	C	NS	Owl	n/a	20-50	TS	unkn	none	<20%	20-50%	Y	2	0	N	N/A	NE	N
BL1039A	■	11	40	23	LE	JA	11	8	S	NS	Up	NS	Clear	n/a	0-20	N	unkn	none	none	>50%	N	0	0	N	N	NE	N
BL1039B	■	11	40	23	LE	JA	28	26	U	U	T1	NS	Clear	3rd	50-100	C	unkn	none	20-50%	<20%	N	0	0	N	U	UE	T
CV0041A		35	56	3	GM	CF	41	28	P	S	T1	NS	Owl	4th	U	P	L Prehis	<20%	none	<20%	Y	9	0	U	N/A	UE	T
CV0041B		35	56	3	GM	CF	22	14	P	NS	M	NS	Owl	5th	0-20	P	Arch/LP	<20%	<20%	20-50%	N	0	0	N	N/A	NE	N
CV0044		33	56	2	MQ	CF	35	19	P	PS	S	NS	Owl	n/a	U	TS	unkn	>50%	none	>50%	Y	1	0	U	N/A	UE	T
CV0045A		32	56	2	MQ	CF	35	19	P	PS	M	NS	Owl	3rd	U	P	Arch	none	>50%	20-50%	Y	24	0	U	N/A	UE	T
CV0045B		32	56	2	MQ	CF	30	17	P	PS	S	NS	Owl	n/a	U	TS	Arch	U	U	>50%	Y	0	0	U	N/A	UE	T
CV0046		31	56	2	MQ	CF	33	22	P	PS	M	NS	Owl	4th	100+	N	Arch/Tra	20-50%	20-50%	<20%	Y	29	0	U	N/A	UE	T
CV0047		31	56	2	MQ	CF	34	20	P	PS	M	NS	Owl	n/a	U	BRM	Arch	20-50%	none	<20%	Y	2	0	U	N/A	UE	T
CV0048		32	56	2	MQ	CF	33	24	P	PS	M	NS	Owl	4th	U	BRM	Arch	20-50%	20-50%	<20%	Y	10	0	U	N/A	UE	T
CV0049		35	57	1	GM	CF	16	9	S	NS	S	NS	Owl	n/a	0-20	N	Arch/Tra	none	20-50%	>50%	N	0	0	N	N/A	NE	N
CV0050		34	56	3	GM	CF	32	21	U	U	M	NS	Owl	4th	U	N	M Arch	none	none	<20%	Y	4	0	U	N/A	UE	T
CV0053A3	■	18	68	53	KK	JA	13	8	S	NS	Up	M	none	n/a	0-20	N	M Arch	none	20-50%	>50%	N	0	0	N	U	UE	T
CV0053A4	■	18	68	53	KK	JA	13	8	S	NS	Up	M	none	n/a	0-20	N	M Arch	none	20-50%	>50%	N	0	0	N	N	NE	N
CV0053B	■	18	68	53	KK	JA	10	20	S	NS	S	NS	none	n/a	0-20	N	unkn	none	none	>50%	N	0	0	N	N	NE	N
CV0053C1	■	18	68	53	KK	JA	37	22	U	U	RS	NS	none	n/a	0-20	P	unkn	>50%	none	20-50%	Y	0	2	Y	N/A	E	P
CV0053C2	■	18	68	53	KK	JA	37	22	U	U	RS	NS	none	n/a	0-20	P	unkn	>50%	none	20-50%	Y	0	2	Y	N/A	E	P
CV0070A		31	60	1	GM	CF	13	9	S	NS	M	NS	none	n/a	0-20	N	unkn	none	20-50%	>50%	N	0	0	N	N/A	NE	N
CV0070B		31	60	1	GM	CF	26	21	U	U	M	NS	none	2nd	U	TS	unkn	none	>50%	<20%	Y	26	0	U	N/A	UE	T
CV0071A	■	10	63	45	JfT	JA	13	7	S	NS	Up	M	none	n/a	0-20	N	unkn	none	>50%	>50%	N	0	0	N	N	NE	N
CV0071B	■	10	63	45	JfT	JA	25	22	U	U	RS	NS	none	n/a	U	N	unkn	none	none	<20%	Y	1	0	U	N/A	UE	T
CV0073	■	33	56	1	GM	JA	16	12	S	NS	T2	NS	Owl	4th	0-20	TS	Arch	none	>50%	20-50%	N	0	0	N	N	NE	N
CV0078	■	4	46	33	JfT	JA	10	8	S	NS	Up	NS	House	n/a	0-20	TS	unkn	none	>50%	20-50%	N	0	0	N	N	NE	N
CV0082		12	54	36	KK	JA	16	10	S	NS	Up	NS	Cottonwd	n/a	0-20	DS	Arch/LP	none	<20%	>50%	N	0	0	N	N/A	NE	N
CV0084		7	57	41	MQ	CF	14	13	S	NS	T2	NS	Table Rk	5th	0-20	TS	Arch	none	>50%	<20%	N	0	0	N	N/A	NE	N

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Site subarea	LRPA?	UTM East Grid	UTM North Grid	Training Area	Archeologist	Geomorphologist	Archaeol. Score	Geomorph Score	Context	Sealed?	Landform	Land Surface	Drainage	Stream Order	Est.Depth (cm)	Burned Rock	Archae. Age	Vandal Disturb.	Vehicle Disturb.	Erosion Disturb.	Potential deposits	No. Shovel Tests	No. Test Pits	Intact deposits?	Ubiquitous lithics?	NRHP Eligibility	Mgmt. Recom.
CV0085		7	57	41	MQ	CF	13	11	S	NS	M	NS	Table Rk	5th	0-20	TS	Arch	none	>50%	20-50%	N	0	0	N	N/A	NE	N
CV0088		12	55	36	KK	JA	47	25	P	S	T1	NS	Cottonwd	5th	500+	DS	Arch	20-50%	20-50%	20-50%	Y	5	0	U	N/A	UE	T
CV0090A		11	55	36	GM	CF	33	28	P	S	T1	NS	Cowhouse	3rd	U	TS	Arch	none	<20%	<20%	Y	9	0	U	N/A	UE	T
CV0090B		11	55	36	GM	CF	22	10	S	NS	S	NS	Cowhouse	n/a	0-20	DS	Pl/Arch	none	20-50%	20-50%	N	0	0	N	N/A	NE	N
CV0091A	■	5	44	33	GM	CF	27	18	U	U	C	NS	none	1st	20-50	N	unkn	none	20-50%	20-50%	Y	43	0	N	N/A	NE	N
CV0091B1	■	5	45	33	GM	CF	13	10	S	NS	M	NS	none	n/a	0-20	N	Arch/Tra	none	>50%	20-50%	N	0	0	N	U	UE	T
CV0091B2	■	5	44	33	GM	CF	13	10	S	NS	M	NS	none	n/a	0-20	N	Arch/Tra	none	>50%	20-50%	N	0	0	N	N	NE	N
CV0093A	■	32	56	1	GM	JA	13	15	S	NS	T2	NS	Owl	4th	0-20	TS	Arch	none	>50%	20-50%	N	0	0	N	N	NE	N
CV0093B	■	32	56	1	GM	JA	26	23	U	U	T1	NS	Owl	4th	200+	N	unkn	none	20-50%	20-50%	Y	60	0	U	N/A	UE	T
CV0094A		34	57	1	JfT	JA	25	23	S	NS	T1	NS	Owl	4th	20-50	N	Arch	none	20-50%	20-50%	Y	26	0	U	N/A	UE	T
CV0094B		34	57	1	JfT	JA	27	24	S	NS	T1	NS	Owl	3rd	200+	N	Arch	none	<20%	<20%	Y	4	0	U	N/A	UE	T
CV0095		14	54	42	MQ	CF	38	23	P	PS	M	NS	Cowhouse	n/a	500+	C	unkn	none	20-50%	20-50%	Y	21	0	U	N/A	UE	T
CV0097A		13	54	42	MQ	CF	45	27	P	S	T1	NS	Cowhouse	4th	U	BRM	unkn	<20%	<20%	20-50%	Y	26	0	U	N/A	UE	T
CV0097B		13	54	42	MQ	CF	29	23	U	U	T1	NS	Cowhouse	4th	U	N	unkn	none	<20%	20-50%	N	0	0	N	N/A	NE	N
CV0098		10	55	36	KK	JA	47	25	P	S	T1	NS	Cottonwd	3rd	200+	C	L Arch	<20%	<20%	20-50%	Y	5	0	U	N/A	UE	T
CV0099		11	55	36	KK	JA	36	24	P	S	T1	NS	Cottonwd	3rd	300+	BRM	unkn	>50%	none	<20%	Y	2	0	U	N/A	UE	T
CV0100		11	55	36	GM	CF	47	28	P	S	T1	NS	Cottonwd	3rd	U	BRM	Arch/Tra	<20%	<20%	<20%	Y	35	0	Y	N/A	E	P
CV0104		7	42	22	JfT	JA	13	9	S	NS	Up	M	none	n/a	0-20	N	L Arch	none	20-50%	20-50%	N	0	0	N	N/A	NE	N
CV0105A		12	44	30	GM	CF	33	23	U	U	M	NS	Clear	3rd	U	C	unkn	none	20-50%	<20%	Y	9	0	N	N/A	NE	N
CV0105B		12	44	30	GM	CF	15	10	S	NS	M	NS	Clear	3rd	0-20	C	Pl/Arch	none	>50%	>50%	N	0	0	N	N/A	NE	N
CV0109A		10	44	30	GM	CF	26	20	U	U	T1	NS	none	3rd	U	TS	unkn	none	<20%	<20%	Y	21	0	U	N/A	UE	T
CV0109B		10	44	30	GM	CF	14	13	S	NS	T2	NS	none	n/a	0-20	TS	unkn	none	>50%	<20%	N	0	0	N	N/A	NE	N
CV0114-1	■	16	68	52	KK	JA	16	8	S	NS	Up	M	none	n/a	0-20	N	Pl/Arch	none	>50%	>50%	N	0	0	N	N	NE	N
CV0114-2	■	16	68	52	KK	JA	16	8	S	NS	Up	M	none	n/a	0-20	N	Pl/Arch	none	>50%	>50%	N	0	0	N	U	UE	T
CV0114-3	■	16	68	52	KK	JA	16	8	S	NS	Up	M	none	n/a	0-20	N	Pl/Arch	none	>50%	>50%	N	0	0	N	U	UE	T
CV0115A1	■	15	69	52	KK	JA	15	8	S	NS	Up	M	none	n/a	0-20	N	Arch/LP	none	>50%	>50%	N	0	0	N	N	NE	N
CV0115A2	■	15	69	52	KK	JA	15	8	S	NS	Up	M	none	n/a	0-20	N	Arch/LP	none	>50%	>50%	N	0	0	N	U	UE	T
CV0115B3	■	15	69	52	KK	JA	29	25	U	U	RS	NS	none	n/a	U	P	unkn	<20%	none	<20%	Y	0	1	U	N/A	UE	T
CV0117A	■	12	49	34	KK	JA	12	7	S	NS	Up	K	Clear	n/a	0-20	N	unkn	none	>50%	>50%	N	0	0	N	N	NE	N
CV0117B	■	12	49	34	KK	JA	15	11	S	NS	T2	NS	Clear	4th	0-20	TS	unkn	none	>50%	>50%	N	0	0	N	N	NE	N
CV0117C	■	12	49	34	KK	JA	32	23	U	U	T1	NS	Clear	4th	U	C	unkn	>50%	>50%	20-50%	Y	60	0	U	N/A	UE	T
CV0118A		30	58	1	JfT	JA	n/a	n/a	U	U	M	NS	Owl	n/a	U	N	unkn	U	U	U	U	0	0	U	N/A	UE	T
CV0118B		30	58	1	JfT	JA	26	24	U	U	M	NS	Owl	2nd	100+	N	unkn	none	20-50%	<20%	Y	62	0	U	N/A	UE	T
CV0118C		30	58	1	JfT	JA	16	8	S	NS	Up	NS	Owl	n/a	0-20	N	unkn	none	>50%	20-50%	N	0	0	N	N/A	NE	N
CV0124		16	58	44	KK	JA	40	17	P	PS	Up	M	Clabber	n/a	0-20	BRM	Arch/LP	none	none	20-50%	Y	0	1	U	N/A	UE	T
CV0125A2	■	16	58	44	LE	JA	20	9	S	NS	Up	NS	none	n/a	0-20	BRM	unkn	none	>50%	>50%	Y	0	1	U	N/A	UE	T
CV0125A3	■	16	58	44	LE	JA	20	9	S	NS	Up	NS	none	n/a	0-20	BRM	unkn	none	>50%	>50%	Y	0	1	U	N/A	UE	T
CV0125A4	■	16	58	44	LE	JA	20	9	S	NS	Up	NS	none	n/a	0-20	N	unkn	none	>50%	>50%	N	0	0	N	N/A	NE	N

Appendix F: Site Listing

Site subarea	LRPA?	UTM East Grid	UTM North Grid	Training Area	Archeologist	Geomorphologist	Archaeol. Score	Geomorph Score	Context	Sealed?	Landform	Land Surface	Drainage	Stream Order	Est.Depth (cm)	Burned Rock	Archae. Age	Vandal Disturb.	Vehicle Disturb.	Erosion Disturb.	Potential deposits	No. Shovel Tests	No. Test Pits	Intact deposits?	Ubiquitous lithics?	NRHP Eligibility	Mgmt. Recom.
CV0125B	■	16	58	44	LE	JA	25	21	U	U	RS	NS	none	n/a	20-50	N	unkn	none	none	>50%	Y	0	1	N	N/A	NE	N
CV0125C	■	16	58	44	LE	JA	26	23	U	U	RS	NS	none	n/a	20-50	N	unkn	none	none	>50%	Y	0	1	U	N/A	UE	T
CV0136	■	12	65	45	KK	JA	16	8	S	NS	Up	NS	Henson	n/a	0-20	DS	Arch/LP	none	20-50%	>50%	N	0	0	N	N	NE	N
CV0137		12	65	45	MQ	CF	39	22	P	PS	M	NS	Shoal	2nd	U	BRM	Arch/Tra	>50%	none	20-50%	Y	4	1	U	N/A	UE	T
CV0162		10	44	30	GM	CF	13	8	S	NS	Up	NS	none	n/a	0-20	TS	Pl/Arch	none	>50%	20-50%	N	0	0	N	N/A	NE	N
CV0164A		5	56	41	MQ	CF	14	13	P	NS	T2	NS	Table Rk	4th	0-20	TS	Arch/Tra	none	<20%	>50%	N	0	0	N	N/A	NE	N
CV0164B		5	56	41	MQ	CF	32	23	P	PS	T1	NS	Table Rk	4th	U	TS	unkn	none	<20%	20-50%	Y	3	0	U	N/A	UE	T
CV0174A		4	54	42	CL	JA	47	25	U	U	T1	NS	Table Rk	n/a	300+	P	unkn	<20%	<20%	<20%	Y	7	0	N	N/A	NE	N
CV0174B		4	54	42	CL	JA	53	23	P	PS	M	NS	Table Rk	n/a	U	BRM	Arch	>50%	none	<20%	Y	6	0	U	N/A	UE	T
CV0175		4	54	35	JfT	JA	26	11	U	U	S	NS	Table Rk	n/a	0-20	C	Arch	none	none	>50%	Y	1	0	N	N/A	NE	N
CV0184		26	66	72	KK	JA	47	26	P	S	M	NS	Henson	2nd	200+	BRM	L Arch	20-50%	none	<20%	Y	7	0	Y	N/A	E	P
CV0201A	■	19	70	53	GM	CF	26	24	U	U	T1	NS	none	3rd	U	TS	Arch	none	<20%	<20%	Y	25	0	U	N/A	UE	T
CV0201B	■	19	70	53	GM	CF	14	8	S	NS	M	NS	none	n/a	0-20	TS	Arch	none	>50%	>50%	N	0	0	N	N	NE	N
CV0203		31	59	1	AT	JA	14	13	S	NS	M	M	none	n/a	0-20	N	unkn	none	20-50%	20-50%	N	0	0	N	N/A	NE	N
CV0204		31	59	1	GM	CF	13	9	S	NS	M	NS	Owl	n/a	0-20	N	unkn	none	20-50%	>50%	N	0	0	N	N/A	NE	N
CV0205		31	59	1	AT	JA	14	10	S	NS	M	NS	none	n/a	0-20	N	unkn	none	20-50%	20-50%	N	0	0	N	N/A	NE	N
CV0206		31	59	1	AT	JA	13	10	S	NS	M	NS	none	n/a	0-20	N	unkn	none	20-50%	20-50%	N	0	0	N	N/A	NE	N
CV0208		27	61	73	MQ	CF	14	8	P	NS	Up	NS	none	n/a	0-20	N	unkn	none	>50%	>50%	N	0	0	N	N/A	NE	N
CV0227		8	40	22	GM	CF	13	11	S	NS	S	NS	none	n/a	0-20	N	Arch	none	20-50%	20-50%	N	0	0	N	N/A	NE	N
CV0240A	■	15	65	48	KK	JA	21	14	S	NS	Up	K	Henson	n/a	0-20	DS	Pl	none	>50%	>50%	N	0	0	N	N	NE	N
CV0240B	■	15	65	48	KK	JA	32	23	U	U	C	NS	Henson	n/a	20-50	DS	Pl/Arch	none	20-50%	>50%	Y	45	0	U	N/A	UE	T
CV0240C	■	15	65	48	KK	JA	32	24	U	U	T1	NS	Henson	3rd	200+	DS	Pl/Arch	none	<20%	20-50%	Y	22	0	U	N/A	UE	T
CV0271A		27	67	71	JfT	CF	13	10	S	NS	M	NS	Henson	4th	0-20	N	unkn	none	20-50%	>50%	N	0	0	N	N/A	NE	N
CV0271B		27	67	71	JfT	CF	25	24	U	U	T1	NS	Henson	4th	U	N	unkn	none	<20%	<20%	Y	4	0	U	N/A	UE	T
CV0317A	■	6	61	41	MQ	CF	32	24	P	PS	T1	NS	Cowhouse	4th	500+	N	unkn	<20%	<20%	<20%	Y	36	0	U	N/A	UE	T
CV0317B	■	6	61	41	MQ	CF	17	12	S	NS	T1	NS	Cowhouse	3rd	500+	N	Arch	<20%	<20%	<20%	N	0	0	N	N	NE	N
CV0319		4	59	41	CL	JA	35	20	P	PS	S	P	Cowhouse	n/a	0-20	BRM	Arch/LP	none	>50%	>50%	Y	6	0	U	N/A	UE	T
CV0326		9	64	45	MQ	CF	13	9	S	NS	Up	NS	none	n/a	0-20	N	unkn	none	>50%	<20%	N	0	0	N	N/A	NE	N
CV0327		9	64	45	MQ	CF	16	11	S	S	M	NS	none	n/a	0-20	C	Arch/LP	none	>50%	20-50%	N	0	0	N	N/A	NE	N
CV0332A	■	12	69	51	KK	JA	15	14	S	NS	S	K	Shoal	n/a	0-20	C	Arch	none	20-50%	>50%	N	0	0	N	N	NE	N
CV0332B	■	12	69	51	KK	JA	30	24	U	U	T1	NS	Shoal	2nd	100+	TS	unkn	none	<20%	<20%	Y	5	0	U	N/A	UE	T
CV0333		12	70	51	FO	BD	18	20	P	S	C	NS	none	n/a	U	N	L Arch	none	>50%	20-50%	Y	2	0	N	N/A	NE	N
CV0334		14	72	52	GM	JA	22	13	S	NS	M	NS	none	n/a	0-20	C	Arch/Tra	none	>50%	>50%	N	0	0	N	N/A	NE	N
CV0336A		13	72	52	GM	JA	13	15	S	NS	Up	K	none	n/a	20-50	TS	unkn	none	20-50%	>50%	N	0	0	N	N/A	NE	N
CV0336B		13	72	52	GM	JA	39	21	P	S	M	NS	none	n/a	20-50	C	Arch	none	>50%	20-50%	Y	3	0	N	N/A	NE	N
CV0337-1	■	13	71	52	GM	JA	13	11	S	NS	Up	M	none	n/a	0-20	N	L Arch	none	>50%	20-50%	N	0	0	N	N	NE	N
CV0337-2	■	13	71	52	GM	JA	13	11	S	NS	Up	M	none	n/a	0-20	N	L Arch	none	>50%	20-50%	N	0	0	N	N	NE	N
CV0337-3	■	13	71	52	GM	JA	13	11	S	NS	Up	M	none	n/a	0-20	N	L Arch	none	>50%	20-50%	N	0	0	N	N	NE	N

Appendix F: Site Listing

Site subarea	LRPA?	UTM East Grid	UTM North Grid	Training Area	Archeologist	Geomorphologist	Archaeol. Score	Geomorph Score	Context	Sealed?	Landform	Land Surface	Drainage	Stream Order	Est.Depth (cm)	Burned Rock	Archae. Age	Vandal Disturb.	Vehicle Disturb.	Erosion Disturb.	Potential deposits	No. Shovel Tests	No. Test Pits	Intact deposits?	Ubiquitous lithics?	NRHP Eligibility	Mgmt. Recom.
CV0378		31	56	2	MQ	CF	38	25	P	PS	M	NS	Owl	n/a	U	TS	Arch	none	<20%	<20%	Y	52	0	U	N/A	UE	T
CV0379		32	56	2	MQ	CF	36	25	P	PS	C	NS	Owl	n/a	U	C	unkn	<20%	none	<20%	Y	3	0	U	N/A	UE	T
CV0380		32	56	2	MQ	CF	32	24	P	PS	M	NS	Owl	3rd	U	BRM	Arch	<20%	<20%	<20%	Y	3	0	U	N/A	UE	T
CV0382		34	56	3	GM	CF	45	28	P	S	T1	NS	Owl	3rd	U	TS	unkn	none	<20%	<20%	Y	16	0	U	N/A	UE	T
CV0385		26	65	71	JfT	CF	20	11	S	NS	S	NS	Henson	n/a	0-20	N	Arch	none	<20%	>50%	N	0	0	N	N/A	NE	N
CV0386		7	61	43	KK	JA	47	27	P	S	M	NS	Cowhouse	5th	300+	TS	Arch	none	<20%	<20%	Y	44	0	Y	N/A	E	P
CV0389A		9	57	35	GM	JA	18	11	S	NS	T2	NS	Cowhouse	5th	0-20	TS	unkn	none	>50%	>50%	N	0	0	N	N/A	NE	N
CV0389B		9	57	35	GM	JA	34	23	P	S	T1	NS	Cowhouse	5th	500+	TS	unkn	>50%	>50%	<20%	Y	15	0	U	N/A	UE	T
CV0390		9	58	41	MQ	CF	17	12	P	NS	T2	NS	none	4th	0-20	N	Pl/Arch	none	20-50%	>50%	N	0	0	N	N/A	NE	N
CV0391		8	60	43	KK	JA	46	27	P	S	T1	NS	2 Yr Old	5th	500+	DS	M Arch	<20%	<20%	20-50%	Y	37	0	Y	N/A	E	P
CV0394A1	■	17	72	52	GM	JA	13	9	S	NS	Up	K	Shoal	n/a	0-20	N	E Arch	none	20-50%	>50%	N	0	0	N	N	NE	N
CV0394A2	■	17	72	52	GM	JA	13	9	S	NS	Up	K	Shoal	n/a	0-20	N	E Arch	none	20-50%	>50%	N	0	0	N	Y	E	P
CV0394B	■	17	72	52	GM	JA	26	23	U	U	T0	NS	Shoal	1st	100+	TS	unkn	none	<20%	<20%	Y	14	0	U	N/A	UE	T
CV0395		17	72	52	GM	CF	13	8	S	NS	Up	NS	none	n/a	0-20	N	E Arch	none	>50%	>50%	N	0	0	N	N/A	NE	N
CV0397A	■	17	71	52	GM	JA	26	7	U	U	Up	NS	Shoal	n/a	U	P	Arch	none	>50%	20-50%	Y	1	0	N	N/A	NE	N
CV0397B	■	17	71	52	GM	JA	28	21	U	U	S	NS	Shoal	n/a	50-100	TS	unkn	none	20-50%	<20%	Y	60	0	N	N/A	NE	N
CV0397C	■	17	71	52	GM	JA	28	24	U	U	T1	NS	Shoal	3rd	50-100	TS	unkn	<20%	<20%	<20%	Y	30	0	U	N/A	UE	T
CV0403A2	■	11	67	45	JfT	JA	15	8	S	NS	Up	NS	Henson	n/a	0-20	N	Arch/LP	none	20-50%	>50%	N	0	0	N	U	UE	T
CV0403A3	■	11	67	45	JfT	JA	15	8	S	NS	Up	NS	Henson	n/a	0-20	N	Arch/LP	none	20-50%	>50%	N	0	0	N	U	UE	T
CV0403A4	■	11	67	45	JfT	JA	15	8	S	NS	Up	NS	Henson	n/a	0-20	N	Arch/LP	none	20-50%	>50%	N	0	0	N	Y	E	P
CV0403A5	■	11	67	45	JfT	JA	15	8	S	NS	Up	NS	Henson	n/a	0-20	N	Arch/LP	none	20-50%	>50%	N	0	0	N	U	UE	T
CV0403A6	■	11	67	45	JfT	JA	15	8	S	NS	Up	NS	Henson	n/a	0-20	N	Arch/LP	none	20-50%	>50%	N	0	0	N	N	NE	N
CV0403B	■	11	67	45	JfT	JA	32	23	U	U	T1	NS	Henson	1st	50-100	P	Arch/LP	none	<20%	<20%	Y	94	0	U	N/A	UE	T
CV0403C	■	11	67	45	JfT	JA	37	24	U	U	C	NS	Henson	n/a	20-50	BRM	Arch/LP	20-50%	20-50%	20-50%	Y	6	0	U	N/A	UE	T
CV0408A	■	11	64	45	JfT	JA	18	7	S	NS	Up	M	none	n/a	0-20	P	Arch	none	>50%	>50%	N	0	0	N	N	NE	N
CV0408B	■	11	64	45	JfT	JA	27	22	U	U	RS	NS	none	n/a	U	N	unkn	U	none	<20%	Y	5	0	Y	N/A	E	P
CV0478A		9	62	43	KK	JA	32	19	U	U	S	P	2 Yr Old	n/a	20-50	C	Arch/LP	none	>50%	>50%	Y	12	0	U	N/A	UE	T
CV0478B		9	62	43	KK	JA	13	9	S	NS	S	NS	2 Yr Old	n/a	0-20	TS	Arch/LP	none	>50%	>50%	N	0	0	N	N/A	NE	N
CV0479A		9	62	43	KK	JA	28	21	U	U	S	P	2 Yr Old	n/a	20-50	TS	M Arch	none	20-50%	20-50%	Y	12	0	N	N/A	NE	N
CV0479B		9	62	43	KK	JA	15	8	S	NS	S	NS	2 Yr Old	n/a	0-20	C	M Arch	none	>50%	>50%	N	0	0	N	N/A	NE	N
CV0480		12	51	36	GM	CF	31	17	U	U	S	P	none	n/a	U	C	Arch/LP	none	>50%	20-50%	Y	17	0	N	N/A	NE	N
CV0481A		16	59	44	GM	JA	40	26	P	S	T1	NS	Clabber	3rd	300+	BRM	unkn	<20%	<20%	20-50%	Y	3	0	U	N/A	UE	T
CV0481B		16	59	44	GM	JA	24	19	U	U	C	NS	Clabber	n/a	20-50	BRM	Pl	>50%	>50%	20-50%	Y	6	0	U	N/A	UE	T
CV0481C		16	59	44	GM	JA	13	9	S	NS	S	NS	Clabber	n/a	0-20	N	unkn	20-50%	20-50%	>50%	N	0	0	N	N/A	NE	N
CV0484A		16	59	44	JmT	BD	13	14	S	NS	C	NS	Clabber	n/a	20-50	N	unkn	none	20-50%	>50%	Y	6	0	N	N/A	NE	N
CV0484B		16	59	44	JmT	BD	40	22	P	S	T1	NS	Clabber	3rd	200+	N	unkn	none	20-50%	20-50%	Y	6	0	U	N/A	UE	T
CV0493A		16	62	44	KK	JA	16	8	U	U	S	NS	Browns	n/a	0-20	TS	Arch/Tra	none	>50%	>50%	N	0	0	N	N/A	NE	N
CV0493B		16	62	44	KK	JA	16	12	S	NS	T2	NS	Browns	2nd	0-20	TS	Arch/Tra	none	20-50%	>50%	N	0	0	N	N/A	NE	N

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Site subarea	LRPA?	UTM East Grid	UTM North Grid	Training Area	Archeologist	Geomorphologist	Archaeol. Score	Geomorph Score	Context	Sealed?	Landform	Land Surface	Drainage	Stream Order	Est.Depth (cm)	Burned Rock	Archae. Age	Vandal Disturb.	Vehicle Disturb.	Erosion Disturb.	Potential deposits	No. Shovel Tests	No. Test Pits	Intact deposits?	Ubiquitous lithics?	NRHP Eligibility	Mgmt. Recom.
CV0493C		16	62	44	KK	JA	29	24	U	U	T1	NS	Browns	2nd	100+	N	unkn	none	<20%	20-50%	Y	8	0	U	N/A	UE	T
CV0495A	■	16	63	48	KK	JA	16	17	S	NS	Up	K	Browns	n/a	U	TS	Arch/LP	none	>50%	20-50%	N	0	0	N	N	NE	N
CV0495B	■	16	63	48	KK	JA	30	24	U	U	M	NS	Browns	2nd	200+	TS	Arch/LP	none	<20%	<20%	Y	36	0	U	N/A	UE	T
CV0506A2	■	29	60	1	KK	JA	13	12	S	NS	Up	NS	Owl	n/a	0-20	N	unkn	none	>50%	>50%	N	0	0	N	U	UE	T
CV0506A3	■	29	60	1	KK	JA	13	12	S	NS	Up	NS	Owl	n/a	0-20	N	unkn	none	>50%	>50%	N	0	0	N	U	UE	T
CV0506A4	■	29	60	1	KK	JA	13	12	S	NS	Up	NS	Owl	n/a	0-20	N	unkn	none	>50%	>50%	N	0	0	N	N	NE	N
CV0506A5	■	29	60	1	KK	JA	13	12	S	NS	Up	NS	Owl	n/a	0-20	N	unkn	none	>50%	>50%	N	0	0	N	N	NE	N
CV0506B	■	29	60	1	KK	JA	29	23	U	U	T1	NS	Owl	n/a	50-100	N	unkn	none	<20%	<20%	Y	24	0	U	N/A	UE	T
CV0512		8	41	22	GM	CF	13	13	S	NS	T2	NS	Clear	3rd	0-20	TS	unkn	20-50%	20-50%	20-50%	N	0	0	N	N/A	NE	N
CV0515		7	42	21	JfT	JA	13	9	S	NS	S	M	none	n/a	0-20	N	unkn	none	20-50%	>50%	N	0	0	N	N/A	NE	N
CV0517		7	41	22	JfT	JA	13	8	S	NS	Up	K	Clear	n/a	0-20	TS	unkn	none	20-50%	>50%	N	0	0	N	N/A	NE	N
CV0518A		7	41	22	GM	CF	26	23	U	U	M	NS	Clear	2nd	U	N	unkn	none	none	<20%	Y	20	0	U	N/A	UE	T
CV0518B		7	41	22	GM	CF	13	10	S	NS	S	NS	Clear	n/a	0-20	TS	Arch	none	<20%	>50%	N	0	0	N	N/A	NE	N
CV0520		7	41	22	GM	CF	14	9	S	NS	Up	NS	none	n/a	0-20	N	unkn	>50%	>50%	20-50%	N	0	0	N	N/A	NE	N
CV0560		28	60	73	MQ	CF	14	9	P	NS	S	NS	none	n/a	0-20	N	Arch	none	20-50%	>50%	N	0	0	N	N/A	NE	N
CV0578A		13	50	34	GM	CF	39	26	P	PS	T1	NS	House	2nd	U	C	M Arch	none	20-50%	20-50%	Y	16	0	U	N/A	UE	T
CV0578B		13	50	34	GM	CF	15	11	S	NS	T2	NS	House	3rd	0-20	TS	unkn	none	>50%	>50%	N	0	0	N	N/A	NE	N
CV0582		7	61	43	KK	JA	37	23	U	U	T1	NS	Cowhouse	5th	500+	TS	unkn	none	<20%	20-50%	Y	5	0	U	N/A	UE	T
CV0584A	■	7	63	43	KK	JA	18	8	S	NS	S	K	none	n/a	0-20	TS	Arch/LP	none	>50%	>50%	N	0	0	N	N	NE	N
CV0584B	■	7	63	43	KK	JA	28	22	U	U	T1	NS	none	n/a	20-50	C	unkn	none	20-50%	>50%	Y	8	0	N	N/A	NE	N
CV0587		10	64	45	MQ	CF	37	22	P	PS	M	NS	2 Yr Old	1st	50-100	BRM	unkn	20-50%	20-50%	20-50%	Y	5	0	U	N/A	UE	T
CV0594-1	■	10	54	36	MQ	CF	36	12	P	PS	Up	P	none	n/a	50-100	BRM	Arch	>50%	>50%	>50%	Y	0	2	Y	N/A	E	P
CV0594-2	■	10	54	36	MQ	CF	36	12	S	NS	Up	P	none	n/a	0-20	N	Arch	>50%	>50%	>50%	N	0	0	N	N/A	NE	N
CV0595		12	59	42	PM	CF	34	18	P	S	S	P	none	n/a	U	C	Arch	none	>50%	>50%	Y	13	0	U	N/A	UE	T
CV0597		9	63	43	KK	JA	13	7	S	NS	Up	K	2 Yr Old	n/a	0-20	TS	unkn	none	>50%	>50%	N	0	0	N	N/A	NE	N
CV0598		10	62	43	MQ	CF	14	10	P	NS	M	NS	none	n/a	U	TS	Arch	none	>50%	>50%	N	0	0	N	N/A	NE	N
CV0601A2	■	22	71	54	JfT	JA	15	12	S	NS	T2	NS	Leon	5th	0-20	DS	Arch	none	20-50%	>50%	N	0	0	N	N	NE	N
CV0601A3	■	22	71	54	JfT	JA	15	12	S	NS	T2	NS	Leon	5th	0-20	DS	Arch	none	20-50%	>50%	N	0	0	N	U	UE	T
CV0601B1	■	22	71	54	JfT	JA	27	23	U	U	T1	NS	Leon	1st	100+	DS	Arch	none	<20%	20-50%	Y	6	0	U	N/A	UE	T
CV0603	■	17	70	52	GM	JA	13	10	S	NS	M	M	none	n/a	0-20	DS	Arch/LP	none	>50%	>50%	N	0	0	N	N	NE	N
CV0618		16	70	52	KK	JA	15	9	S	NS	M	M	none	n/a	0-20	C	Arch/LP	none	>50%	>50%	N	0	0	N	N/A	NE	N
CV0620		17	71	52	KK	JA	13	8	S	NS	Up	K	Shoal	n/a	0-20	TS	unkn	none	>50%	20-50%	N	0	0	N	N/A	NE	N
CV0667A		30	58	1	JfT	JA	15	11	S	NS	M	NS	Owl	3rd	0-20	N	unkn	none	>50%	<20%	N	0	0	N	N/A	NE	N
CV0667B		30	58	1	JfT	JA	34	24	U	U	T1	NS	Owl	3rd	100+	N	unkn	none	<20%	<20%	Y	8	0	U	N/A	UE	T
CV0668A		30	58	1	JfT	JA	15	15	S	NS	Up	K	Owl	n/a	U	N	unkn	none	>50%	20-50%	N	0	0	N	N/A	NE	N
CV0668B		30	58	1	JfT	JA	27	23	U	U	M	NS	Owl	2nd	100+	N	unkn	none	<20%	20-50%	Y	3	0	U	N/A	UE	T
CV0669A	■	30	58	1	JfT	JA	18	11	S	NS	Up	K	Owl	n/a	0-20	P	Arch	none	>50%	20-50%	N	0	0	N	N	NE	N
CV0669B	■	30	58	1	JfT	JA	34	22	U	U	M	NS	Owl	2nd	200+	N	unkn	none	none	20-50%	Y	40	0	U	N/A	UE	T

Appendix F: Site Listing

Site subarea	LRPA?	UTM East Grid	UTM North Grid	Training Area	Archeologist	Geomorphologist	Archaeol. Score	Geomorph Score	Context	Sealed?	Landform	Land Surface	Drainage	Stream Order	Est.Depth (cm)	Burned Rock	Archae. Age	Vandal Disturb.	Vehicle Disturb.	Erosion Disturb.	Potential deposits	No. Shovel Tests	No. Test Pits	Intact deposits?	Ubiquitous lithics?	NRHP Eligibility	Mgmt. Recom.
CV0677		29	60	1	AT	JA	11	8	S	NS	Up	NS	none	n/a	0-20	N	unkn	none	>50%	20-50%	N	0	0	N	N/A	NE	N
CV0679		30	59	1	JfT	JA	18	9	S	NS	Up	K	Owl	n/a	0-20	TS	Arch	none	>50%	<20%	N	0	0	N	N/A	NE	N
CV0686		30	59	1	JfT	JA	32	12	U	U	Up	K	Owl	n/a	0-20	C	unkn	none	20-50%	<20%	Y	1	0	U	N/A	UE	T
CV0687		30	59	1	AT	JA	14	9	S	NS	Up	NS	none	n/a	0-20	N	unkn	none	20-50%	20-50%	N	0	0	N	N/A	NE	N
CV0721A		31	57	1	GM	JA	13	11	S	NS	T2	NS	Owl	4th	0-20	TS	Arch	none	>50%	>50%	N	0	0	N	N/A	NE	N
CV0721B		31	57	1	GM	JA	25	20	U	U	M	NS	Owl	1st	50-100	N	unkn	none	20-50%	>50%	Y	3	0	N	N/A	NE	N
CV0722		31	54	4	FO	BD	29	24	P	S	M	NS	Cowhouse	2nd	50-100	N	unkn	<20%	<20%	<20%	Y	14	0	U	N/A	UE	T
CV0724		31	54	4	FO	BD	26	12	P	NS	S	NS	Cowhouse	n/a	0-20	BRM	Arch/LP	none	<20%	20-50%	N	0	0	N	N/A	NE	N
CV0726		31	54	4	FO	BD	12	8	P	NS	Up	NS	Cowhouse	n/a	0-20	N	Arch	none	none	20-50%	N	0	0	N	N/A	NE	N
CV0727		32	57	1	JfT	JA	13	11	S	NS	T2	NS	Owl	4th	0-20	N	Arch	none	>50%	>50%	N	0	0	N	N/A	NE	N
CV0730A		32	57	1	JfT	JA	13	9	S	NS	S	NS	Owl	n/a	0-20	N	Arch	none	20-50%	>50%	N	0	0	N	N/A	NE	N
CV0730B		32	57	1	JfT	JA	26	23	U	U	M	NS	Owl	n/a	U	N	unkn	none	20-50%	20-50%	Y	6	0	U	N/A	UE	T
CV0736		30	55	2	FO	BD	13	9	P	NS	Up	M	none	n/a	0-20	N	L Arch	none	20-50%	20-50%	N	0	0	N	N/A	NE	N
CV0737		32	55	2	MQ	CF	13	9	S	NS	Up	NS	none	n/a	0-20	N	unkn	none	none	>50%	N	0	0	N	N/A	NE	N
CV0738		31	55	2	MQ	CF	15	9	P	NS	Up	M	Owl	n/a	0-20	TS	Arch	none	<20%	>50%	N	0	0	N	N/A	NE	N
CV0739A		31	55	2	NT	CF	10	9	S	NS	Up	NS	Owl	n/a	0-20	N	unkn	none	<20%	>50%	N	0	0	N	N/A	NE	N
CV0739B		31	55	2	NT	CF	25	21	P	S	RS	NS	Owl	n/a	U	N	unkn	none	none	20-50%	Y	1	0	N	N/A	NE	N
CV0740		31	55	2	MQ	CF	31	21	P	PS	M	NS	none	3rd	20-50	N	unkn	none	none	20-50%	Y	2	0	N	N/A	NE	N
CV0741		32	56	35	JfT	JA	13	10	S	NS	S	NS	none	n/a	0-20	N	Arch	none	20-50%	>50%	N	0	0	N	N/A	NE	N
CV0744		31	55	2	MQ	CF	14	9	P	NS	Up	M	Owl	n/a	0-20	TS	unkn	none	<20%	>50%	N	0	0	N	N/A	NE	N
CV0745		31	55	2	MQ	CF	14	9	P	NS	Up	M	Owl	n/a	0-20	N	L Arch	none	none	>50%	N	0	0	N	N/A	NE	N
CV0747		32	55	2	MQ	CF	15	8	P	NS	Up	NS	Owl	n/a	0-20	N	M Arch	none	<20%	>50%	N	0	0	N	N/A	NE	N
CV0748		32	56	2	MQ	CF	15	10	P	NS	Up	NS	none	n/a	0-20	N	Arch	none	U	>50%	N	0	0	N	N/A	NE	N
CV0750		32	56	2	MQ	CF	22	10	P	NS	Up	NS	Owl	n/a	0-20	N	Arch	none	<20%	>50%	N	0	0	N	N/A	NE	N
CV0751		32	56	2	MQ	CF	14	13	S	NS	T2	NS	Owl	4th	0-20	TS	Arch	none	none	>50%	N	0	0	N	N/A	NE	N
CV0754		31	56	2	FO	BD	14	9	P	NS	Up	M	Owl	n/a	U	N	unkn	none	none	>50%	N	0	0	N	N/A	NE	N
CV0755A		32	56	2	MQ	CF	28	22	P	PS	T1	NS	none	n/a	U	N	L Arch	none	20-50%	<20%	Y	4	0	U	N/A	UE	T
CV0755B		32	56	2	MQ	CF	14	12	S	NS	C	NS	none	n/a	U	N	L Arch	none	20-50%	<20%	N	0	0	N	N/A	NE	N
CV0756		31	56	2	MQ	CF	15	9	P	NS	Up	NS	Owl	n/a	0-20	N	unkn	none	<20%	>50%	N	0	0	N	N/A	NE	N
CV0757A		32	56	2	MQ	CF	21	24	P	PS	RS	NS	none	n/a	50-100	N	unkn	none	none	<20%	Y	0	1	N	N/A	NE	N
CV0757B		32	56	2	MQ	CF	14	9	P	NS	Up	NS	none	n/a	0-20	N	L Arch	none	<20%	>50%	N	0	0	N	N/A	NE	N
CV0758		33	56	2	MQ	CF	14	11	P	NS	T2	NS	Owl	n/a	0-20	N	Arch	none	>50%	>50%	N	0	0	N	N/A	NE	N
CV0760		33	56	3	GM	CF	38	26	P	S	M	NS	Owl	3rd	U	TS	Arch	20-50%	20-50%	<20%	Y	2	0	U	N/A	UE	T
CV0761		34	56	3	GM	CF	31	24	U	U	T1	NS	Owl	4th	U	N	unkn	none	none	<20%	Y	3	0	N	N/A	NE	N
CV0765		35	56	3	GM	CF	13	12	S	NS	M	NS	Owl	4th	0-20	TS	unkn	none	none	>50%	N	0	0	N	N/A	NE	N
CV0766A		35	56	3	GM	CF	26	17	U	U	M	NS	Owl	n/a	20-50	TS	Arch	none	none	>50%	Y	2	0	N	N/A	NE	N
CV0766B		35	56	3	GM	CF	17	11	S	NS	S	NS	Owl	n/a	0-20	N	unkn	none	none	>50%	N	0	0	N	N/A	NE	N
CV0769		35	57	1	JfT	JA	40	25	P	S	T1	NS	Owl	4th	U	P	unkn	none	<20%	<20%	Y	9	0	U	N/A	UE	T

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Site subarea	LRPA?	UTM East Grid	UTM North Grid	Training Area	Archeologist	Geomorphologist	Archaeol. Score	Geomorph Score	Context	Sealed?	Landform	Land Surface	Drainage	Stream Order	Est.Depth (cm)	Burned Rock	Archae. Age	Vandal Disturb.	Vehicle Disturb.	Erosion Disturb.	Potential deposits	No. Shovel Tests	No. Test Pits	Intact deposits?	Ubiquitous lithics?	NRHP Eligibility	Mgmt. Recom.
CV0771A		35	57	1	KK	JA	13	11	S	NS	Up	M	Owl	n/a	0-20	N	unkn	none	20-50%	20-50%	N	0	0	N	N/A	NE	N
CV0771B		35	57	1	GM	CF	13	9	S	NS	S	NS	Owl	n/a	0-20	N	unkn	none	20-50%	>50%	N	0	0	N	N/A	NE	N
CV0774		35	57	1	JfT	JA	19	11	S	NS	S	NS	Owl	n/a	0-20	P	Arch	none	20-50%	>50%	N	0	0	N	N/A	NE	N
CV0776		34	57	1	JfT	JA	15	16	S	NS	S	K	Owl	n/a	0-20	N	Arch	none	none	20-50%	N	0	0	N	N/A	NE	N
CV0779		34	57	1	JfT	JA	13	10	S	NS	S	K	Owl	n/a	0-20	N	L Arch	none	none	>50%	N	0	0	N	N/A	NE	N
CV0780		34	57	1	JfT	JA	15	13	S	NS	T2	NS	Owl	4th	0-20	N	Arch	none	>50%	<20%	N	0	0	N	N/A	NE	N
CV0782		33	57	1	JfT	JA	13	10	S	NS	M	NS	Owl	n/a	0-20	N	Arch	none	>50%	>50%	N	0	0	N	N/A	NE	N
CV0849A		25	66	72	KK	JA	17	8	S	NS	M	NS	Henson	n/a	0-20	BRM	Arch	>50%	>50%	>50%	N	0	0	N	N/A	NE	N
CV0849B		25	66	72	KK	JA	29	24	U	U	T1	NS	Henson	4th	200+	N	Arch	none	<20%	<20%	Y	3	0	U	N/A	UE	T
CV0855		25	65	72	JfT	CF	13	9	S	NS	Up	NS	Henson	n/a	0-20	N	Arch	none	<20%	>50%	N	0	0	N	N/A	NE	N
CV0900A	■	30	56	2	KK	JA	25	16	S	NS	M	NS	Owl	n/a	0-20	C	Arch	none	>50%	>50%	N	0	0	N	N	NE	N
CV0900B	■	30	56	2	KK	JA	31	22	U	U	T2	NS	Owl	n/a	U	TS	Pl/Arch	none	U	20-50%	Y	23	0	U	N/A	UE	T
CV0900C	■	30	56	2	KK	JA	31	23	U	U	T1	NS	Owl	n/a	200+	TS	Pl/Arch	none	20-50%	20-50%	Y	72	0	U	N/A	UE	T
CV0901		18	68	53	GM	CF	37	28	P	S	RS	NS	none	n/a	20-50	N	unkn	none	<20%	<20%	Y	2	0	U	N/A	UE	T
CV0903A1	■	16	68	53	LE	JA	23	12	P	NS	M	NS	none	n/a	0-20	BRM	Arch/LP	none	20-50%	>50%	N	0	0	N	Y	E	P
CV0903A2	■	16	68	53	LE	JA	23	12	P	NS	M	NS	none	n/a	0-20	BRM	Arch/LP	none	20-50%	>50%	N	0	0	N	Y	E	P
CV0903A3	■	16	68	53	LE	JA	23	12	P	NS	M	NS	none	n/a	0-20	BRM	Arch/LP	none	20-50%	>50%	Y	2	0	U	N/A	UE	T
CV0903B4	■	16	68	53	LE	JA	31	25	U	U	M	NS	none	n/a	200+	DS	Arch/LP	none	<20%	<20%	Y	34	0	U	N/A	UE	T
CV0903B5	■	16	68	53	LE	JA	31	25	U	U	M	NS	none	n/a	200+	DS	Arch/LP	none	<20%	<20%	Y	33	0	U	N/A	UE	T
CV0905AA		17	68	53	GM	CF	24	24	U	U	RS	NS	none	n/a	U	N	unkn	none	none	<20%	Y	0	1	U	N/A	UE	T
CV0905AB		17	68	53	GM	CF	27	23	U	U	RS	NS	none	n/a	20-50	TS	unkn	20-50%	none	<20%	Y	3	0	U	N/A	UE	T
CV0905B		17	68	53	GM	CF	13	8	S	NS	Up	NS	none	n/a	0-20	N	Arch	none	none	>50%	N	0	0	N	N/A	NE	N
CV0913A		16	66	53	KK	JA	13	8	S	NS	Up	K	Henson	n/a	0-20	TS	unkn	none	20-50%	>50%	N	0	0	N	N/A	NE	N
CV0913B		16	66	53	KK	JA	30	22	U	U	M	NS	Henson	3rd	100+	TS	Arch/LP	none	20-50%	20-50%	Y	17	0	U	N/A	UE	T
CV0916		16	65	53	KK	JA	13	9	S	NS	S	NS	Henson	n/a	0-20	N	M Arch	none	20-50%	>50%	N	0	0	N	N/A	NE	N
CV0917A		16	65	53	KK	JA	18	9	S	NS	Up	K	Henson	n/a	0-20	TS	Arch/Tra	none	<20%	>50%	N	0	0	N	N/A	NE	N
CV0917B		16	65	53	KK	JA	30	21	U	U	M	NS	Henson	3rd	20-50	TS	Arch/Tra	none	20-50%	20-50%	Y	6	0	N	N/A	NE	N
CV0918A	■	17	65	53	KK	JA	16	9	S	NS	Up	K	Henson	n/a	0-20	DS	Pl/Arch	none	20-50%	>50%	N	0	0	N	N	NE	N
CV0918B	■	17	65	53	KK	JA	23	24	U	U	T1	NS	Henson	2nd	200+	TS	unkn	none	<20%	<20%	Y	41	0	U	N/A	UE	T
CV0927A	■	17	63	48	KK	JA	16	7	S	NS	Up	K	Browns	n/a	0-20	N	Pl	none	>50%	>50%	N	0	0	N	N	NE	N
CV0927B	■	17	63	48	KK	JA	29	23	U	U	T1	NS	Browns	1st	100+	N	unkn	none	20-50%	20-50%	Y	15	0	U	N/A	UE	T
CV0929		13	66	53	KK	JA	13	8	S	NS	S	NS	none	n/a	0-20	TS	L Arch	none	20-50%	>50%	N	0	0	N	N/A	NE	N
CV0932		16	63	48	FO	BD	30	21	P	S	T2	NS	Browns	3rd	50-100	TS	Arch	none	>50%	<20%	Y	12	0	N	N/A	NE	N
CV0935A	■	13	61	44	GM	JA	13	8	S	NS	Up	M	none	n/a	0-20	C	Arch	none	20-50%	>50%	N	0	0	N	N	NE	N
CV0935B	■	13	61	44	GM	JA	43	25	P	S	RS	NS	none	n/a	20-50	P	L Prehis	none	none	<20%	Y	3	0	U	N/A	UE	T
CV0936A		13	61	44	KK	JA	13	9	S	NS	Up	K	none	n/a	0-20	N	L Arch	none	20-50%	>50%	N	0	0	N	N/A	NE	N
CV0936B		13	61	44	KK	JA	32	22	U	U	S	NS	none	n/a	U	TS	L Prehis	none	none	20-50%	Y	2	0	U	N/A	UE	T
CV0944A	■	14	63	44	KK	JA	17	8	S	NS	Up	M	none	n/a	0-20	C	Arch	none	>50%	20-50%	N	0	0	N	N	NE	N

Appendix F: Site Listing

Site subarea	LRPA?	UTM East Grid	UTM North Grid	Training Area	Archeologist	Geomorphologist	Archaeol. Score	Geomorph Score	Context	Sealed?	Landform	Land Surface	Drainage	Stream Order	Est.Depth (cm)	Burned Rock	Archae. Age	Vandal Disturb.	Vehicle Disturb.	Erosion Disturb.	Potential deposits	No. Shovel Tests	No. Test Pits	Intact deposits?	Ubiquitous lithics?	NRHP Eligibility	Mgmt. Recom.
CV0944B	■	14	63	44	KK	JA	13	14	S	NS	S	NS	none	n/a	U	N	unkn	none	none	>50%	N	0	0	N	N	NE	N
CV0944C1	■	14	63	44	KK	JA	36	27	U	U	RS	NS	none	n/a	20-50	P	unkn	<20%	none	<20%	Y	0	3	U	N/A	UE	T
CV0944C2	■	14	63	44	KK	JA	36	27	U	U	RS	NS	none	n/a	20-50	TS	unkn	<20%	none	<20%	Y	0	3	U	N/A	UE	T
CV0946A		11	59	43	KK	JA	15	8	S	NS	S	NS	Cowhouse	n/a	0-20	C	Arch/LP	20-50%	20-50%	>50%	N	0	0	N	N/A	NE	N
CV0946B		11	59	43	KK	JA	32	21	U	U	S	P	Cowhouse	n/a	20-50	C	Arch/Tra	none	20-50%	20-50%	Y	16	0	N	N/A	NE	N
CV0946C		11	59	43	KK	JA	27	20	U	U	T1	NS	Cowhouse	2nd	50-100	TS	unkn	none	20-50%	20-50%	Y	3	0	N	N/A	NE	N
CV0947		10	59	43	JfT	CF	36	23	P	PS	S	P	none	n/a	U	BRM	Arch	none	20-50%	20-50%	Y	20	0	U	N/A	UE	T
CV0954		13	69	51	CL	JA	20	13	P	NS	S	NS	Shoal	n/a	0-20	N	Arch	none	20-50%	>50%	N	0	0	N	N/A	NE	N
CV0955-1	■	16	70	52	AT	JA	21	8	S	NS	Up	K	Shoal	n/a	0-20	P	Arch	none	20-50%	>50%	N	0	0	N	N	NE	N
CV0955-2	■	16	70	52	AT	JA	21	8	S	NS	Up	K	Shoal	n/a	0-20	P	Arch	none	20-50%	>50%	N	0	0	N	U	UE	T
CV0955-3	■	16	70	52	AT	JA	21	8	S	NS	Up	K	Shoal	n/a	0-20	P	Arch	none	20-50%	>50%	N	0	0	N	N	NE	N
CV0957A		15	70	52	GM	JA	13	10	S	NS	Up	K	Shoal	n/a	0-20	P	Arch	none	>50%	>50%	N	0	0	N	N/A	NE	N
CV0957B		15	70	52	GM	JA	29	23	U	U	T1	NS	Shoal	3rd	100+	C	unkn	none	20-50%	20-50%	Y	5	0	U	N/A	UE	T
CV0958-1	■	7	40	22	KK	JA	13	10	S	NS	Up	M	none	n/a	0-20	N	unkn	none	20-50%	20-50%	N	0	0	N	N	NE	N
CV0958-2	■	7	40	22	KK	JA	13	10	S	NS	Up	M	none	n/a	0-20	N	unkn	none	20-50%	20-50%	N	0	0	N	N	NE	N
CV0958-3	■	7	40	22	KK	JA	13	10	S	NS	Up	M	none	n/a	0-20	N	unkn	none	20-50%	20-50%	N	0	0	N	U	UE	T
CV0960A		8	59	41	MQ	CF	30	25	P	PS	T1	NS	Cowhouse	4th	500+	BRM	Arch	none	>50%	<20%	Y	39	0	U	N/A	UE	T
CV0960B		8	59	41	MQ	CF	26	22	P	PS	T0	NS	Cowhouse	2nd	100+	P	unkn	none	<20%	<20%	Y	0	0	U	N/A	UE	T
CV0967		7	44	30	GM	CF	14	8	S	NS	M	NS	none	n/a	0-20	P	unkn	none	>50%	>50%	N	0	0	N	N/A	NE	N
CV0981		8	53	35	JfT	CF	26	18	U	U	S	P	none	n/a	U	BRM	unkn	none	20-50%	20-50%	Y	10	0	N	N/A	NE	N
CV0983		8	53	35	GM	JA	13	18	S	NS	S	P	none	n/a	20-50	TS	unkn	none	>50%	>50%	N	0	0	N	N/A	NE	N
CV0984		9	53	35	JfT	CF	34	18	P	PS	S	P	none	n/a	U	BRM	E Arch	none	20-50%	20-50%	Y	7	0	U	N/A	UE	T
CV0988A		9	53	35	JfT	CF	17	14	S	NS	S	P	none	n/a	U	C	Arch	none	none	>50%	N	0	0	N	N/A	NE	N
CV0988B		9	53	35	JfT	CF	35	19	P	PS	S	P	none	n/a	U	BRM	Arch	none	none	<20%	Y	15	0	U	N/A	UE	T
CV0991		9	53	35	JfT	CF	12	9	S	NS	S	P	none	n/a	0-20	DS	unkn	none	>50%	>50%	Y	1	0	N	N/A	NE	N
CV0994A		9	61	43	KK	JA	30	22	U	U	S	P	2 Yr Old	n/a	50-100	C	unkn	none	20-50%	>50%	Y	4	0	N	N/A	NE	N
CV0994B		9	61	43	KK	JA	13	8	S	NS	S	NS	2 Yr Old	n/a	0-20	TS	unkn	none	>50%	>50%	N	0	0	N	N/A	NE	N
CV0995A		8	62	43	KK	JA	17	8	S	NS	Up	K	none	n/a	0-20	TS	Arch	none	>50%	>50%	N	0	0	N	N/A	NE	N
CV0995B		8	62	43	KK	JA	34	20	U	U	S	NS	none	n/a	20-50	C	Arch/LP	none	20-50%	20-50%	Y	2	0	N	N/A	NE	N
CV0998		8	61	43	KK	JA	13	12	S	NS	M	NS	Cowhouse	5th	0-20	P	unkn	none	20-50%	>50%	N	0	0	N	N/A	NE	N
CV0999		8	61	43	JfT	CF	13	8	S	NS	Up	NS	none	n/a	0-20	TS	Arch	none	20-50%	>50%	N	0	0	N	N/A	NE	N
CV1002		9	63	45	MQ	CF	25	14	P	NS	M	NS	2 Yr Old	n/a	20-50	C	L Arch	>50%	>50%	20-50%	Y	4	0	N	N/A	NE	N
CV1006		10	63	45	MQ	CF	29	22	U	U	RS	NS	none	n/a	U	N	unkn	none	none	20-50%	Y	1	1	N	N/A	NE	N
CV1007A		10	64	45	MQ	CF	37	22	P	PS	M	NS	2 Yr Old	2nd	U	BRM	L Prehis	<20%	<20%	20-50%	Y	9	0	U	N/A	UE	T
CV1007B		10	64	41	MQ	CF	11	18	S	NS	M	NS	2 Yr Old	2nd	U	N	unkn	U	U	>50%	N	0	0	N	N/A	NE	N
CV1008A		10	63	45	MQ	CF	22	22	U	U	RS	NS	none	n/a	U	TS	unkn	>50%	none	<20%	Y	3	1	U	N/A	UE	T
CV1008B		10	63	45	MQ	CF	16	10	P	NS	Up	NS	none	n/a	U	P	L Arch	none	>50%	>50%	N	0	0	N	N/A	NE	N
CV1010		10	64	45	MQ	CF	14	11	P	NS	Up	M	none	n/a	U	N	unkn	none	<20%	>50%	N	0	0	N	N/A	NE	N

Appendix F: Site Listing

Site subarea	LRPA?	UTM East Grid	UTM North Grid	Training Area	Archeologist	Geomorphologist	Archaeol. Score	Geomorph Score	Context	Sealed?	Landform	Land Surface	Drainage	Stream Order	Est.Depth (cm)	Burned Rock	Archae. Age	Vandal Disturb.	Vehicle Disturb.	Erosion Disturb.	Potential deposits	No. Shovel Tests	No. Test Pits	Intact deposits?	Ubiquitous lithics?	NRHP Eligibility	Mgmt. Recom.
CV1011		10	64	45	MQ	CF	28	22	P	PS	M	NS	none	n/a	0-20	N	L Prehis	20-50%	none	<20%	Y	4	0	U	N/A	UE	T
CV1012A		9	53	35	JfT	CF	19	11	S	NS	S	NS	Cottonwd	n/a	0-20	BRM	M Arch	none	>50%	>50%	N	0	0	N	N/A	NE	N
CV1012B		9	53	35	JfT	CF	35	19	P	NS	M	NS	Cottonwd	2nd	U	BRM	M Arch	none	20-50%	20-50%	Y	11	0	U	N/A	UE	T
CV1013		12	70	51	FO	BD	17	9	P	NS	S	NS	Shoal	n/a	0-20	BRM	unkn	none	>50%	>50%	N	0	0	N	N/A	NE	N
CV1023A		12	58	42	MQ	CF	43	20	P	S	S	P	Stampede	n/a	U	C	unkn	none	20-50%	20-50%	Y	18	0	U	N/A	UE	T
CV1023B		12	58	42	MQ	CF	14	11	S	NS	S	NS	Stampede	n/a	0-20	TS	unkn	none	<20%	>50%	N	0	0	N	N/A	NE	N
CV1023C		12	58	42	MQ	CF	30	21	P	PS	T0	NS	Stampede	3rd	100+	N	unkn	none	none	20-50%	Y	13	0	U	N/A	UE	T
CV1023D		12	58	42	MQ	CF	35	18	P	NS	T2	NS	Stampede	3rd	0-20	BRM	unkn	none	<20%	20-50%	Y	1	0	U	N/A	UE	T
CV1024		12	58	42	MQ	CF	36	20	P	S	Up	NS	Stampede	n/a	20-50	C	unkn	none	20-50%	<20%	Y	6	0	N	N/A	NE	N
CV1026	■	12	57	42	KK	JA	13	8	S	NS	Up	K	Cowhouse	n/a	0-20	TS	unkn	none	>50%	20-50%	N	0	0	N	N	NE	N
CV1027		12	57	42	PM	CF	37	24	P	S	S	P	Stampede	n/a	20-50	BRM	Arch	none	<20%	20-50%	Y	19	0	U	N/A	UE	T
CV1028		12	57	42	MQ	CF	17	10	P	NS	Up	NS	Stampede	n/a	0-20	C	unkn	none	<20%	20-50%	Y	2	0	N	N/A	NE	N
CV1030		11	56	36	KK	JA	42	26	P	S	T1	NS	Cowhouse	5th	500+	C	Arch	none	<20%	<20%	Y	69	0	U	N/A	UE	T
CV1033A	■	11	56	42	NT	CF	16	15	P	NS	T2	NS	Cowhouse	5th	0-20	BRM	Arch	none	20-50%	20-50%	N	0	0	N	N	NE	N
CV1033B	■	11	56	42	NT	CF	32	23	P	S	T1	NS	Cowhouse	5th	U	TS	unkn	none	20-50%	<20%	Y	33	0	U	N/A	UE	T
CV1038A		12	56	42	MQ	CF	43	23	P	S	T1	NS	Cowhouse	4th	500+	C	unkn	none	>50%	>50%	Y	6	0	U	N/A	UE	T
CV1038B		12	56	42	MQ	CF	29	18	P	S	T0	NS	Cowhouse	4th	U	N	unkn	none	>50%	>50%	N	0	0	N	N/A	NE	N
CV1043A		11	55	36	KK	JA	41	24	P	S	M	P	none	n/a	U	BRM	E Arch	none	20-50%	20-50%	Y	5	0	U	N/A	UE	T
CV1043B		11	55	36	KK	JA	16	8	S	NS	S	NS	none	n/a	0-20	TS	Arch	none	20-50%	>50%	N	0	0	N	N/A	NE	N
CV1048A	■	9	54	35	GM	JA	14	9	S	NS	Up	NS	Cottonwd	n/a	0-20	DS	unkn	none	20-50%	20-50%	N	0	0	N	N	NE	N
CV1048B	■	9	54	35	GM	JA	29	23	U	U	S	P	Cottonwd	n/a	20-50	TS	unkn	none	20-50%	20-50%	Y	23	0	N	N/A	NE	N
CV1048C	■	9	54	35	GM	JA	26	25	U	U	T0	NS	Cottonwd	n/a	20-50	BRM	unkn	none	<20%	20-50%	Y	2	0	U	N/A	UE	T
CV1049A		9	54	35	GM	JA	37	22	P	S	S	P	Cottonwd	n/a	0-20	BRM	unkn	none	20-50%	20-50%	Y	14	0	U	N/A	UE	T
CV1049B		9	54	35	GM	JA	13	10	S	NS	S	NS	Cottonwd	n/a	0-20	TS	unkn	none	20-50%	>50%	N	0	0	N	N/A	NE	N
CV1050A		11	54	36	KK	JA	43	23	P	S	S	P	none	n/a	50-100	C	Arch	none	20-50%	20-50%	Y	17	0	U	N/A	UE	T
CV1050B		11	54	36	KK	JA	13	10	S	NS	S	K	none	n/a	0-20	TS	unkn	none	none	>50%	N	0	0	N	N/A	NE	N
CV1054		15	67	53	KK	JA	18	10	S	NS	S	NS	Henson	n/a	0-20	C	Arch	none	<20%	>50%	N	0	0	N	N/A	NE	N
CV1071		14	66	53	KK	JA	16	13	S	NS	S	NS	Henson	n/a	0-20	TS	Pl/Arch	none	20-50%	>50%	N	0	0	N	N/A	NE	N
CV1077		14	65	48	MQ	CF	14	11	S	NS	T2	NS	Henson	n/a	0-20	P	Arch	none	>50%	>50%	N	0	0	N	N/A	NE	N
CV1080		13	66	51	PM	BD	20	15	U	U	Up	M	none	n/a	0-20	P	Arch	none	>50%	<20%	Y	0	1	U	N/A	UE	T
CV1084		14	64	48	MQ	CF	14	8	P	NS	Up	M	Henson	n/a	0-20	N	Arch	none	>50%	>50%	N	0	0	N	N/A	NE	N
CV1085		14	64	48	MQ	CF	34	24	U	U	RS	NS	none	n/a	100+	C	unkn	none	none	<20%	Y	0	1	U	N/A	UE	T
CV1092A1	■	14	62	44	KK	JA	45	17	P	PS	Up	M	Browns	n/a	0-20	BRM	unkn	none	>50%	>50%	Y	0	1	Y	N/A	E	P
CV1092A2	■	14	62	44	KK	JA	45	17	P	PS	Up	M	Browns	n/a	0-20	BRM	unkn	none	>50%	>50%	Y	0	2	U	N/A	UE	T
CV1092A3	■	14	62	44	KK	JA	45	17	P	PS	Up	M	Browns	n/a	0-20	DS	Pl	none	>50%	>50%	N	0	0	N	N	NE	N
CV1093		10	60	43	JfT	CF	32	19	P	PS	S	P	none	n/a	U	BRM	Arch	none	20-50%	20-50%	Y	13	0	U	N/A	UE	T
CV1097		7	60	41	MQ	CF	34	26	P	S	T1	NS	Cowhouse	4th	500+	TS	unkn	none	<20%	>50%	Y	0	0	U	N/A	UE	T
CV1098		7	60	41	MQ	CF	36	26	P	S	T1	NS	Cowhouse	4th	U	TS	L Arch	none	20-50%	20-50%	Y	5	0	U	N/A	UE	T

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Site subarea	LRPA?	UTM East Grid	UTM North Grid	Training Area	Archeologist	Geomorphologist	Archaeol. Score	Geomorph Score	Context	Sealed?	Landform	Land Surface	Drainage	Stream Order	Est.Depth (cm)	Burned Rock	Archae. Age	Vandal Disturb.	Vehicle Disturb.	Erosion Disturb.	Potential deposits	No. Shovel Tests	No. Test Pits	Intact deposits?	Ubiquitous lithics?	NRHP Eligibility	Mgmt. Recom.
CV1099		7	60	41	MQ	CF	31	24	P	PS	T1	NS	Cowhouse	4th	200+	C	unkn	20-50%	20-50%	20-50%	Y	9	0	U	N/A	UE	T
CV1101-1	■	8	60	43	KK	JA	18	8	S	NS	Up	K	Cowhouse	n/a	0-20	TS	Arch	none	20-50%	>50%	N	0	0	N	U	UE	T
CV1101-2	■	8	60	43	KK	JA	18	8	S	NS	Up	K	Cowhouse	n/a	0-20	TS	Arch	none	20-50%	>50%	N	0	0	N	N	NE	N
CV1101-3	■	8	60	43	KK	JA	18	8	S	NS	Up	K	Cowhouse	n/a	0-20	TS	Arch	none	20-50%	>50%	N	0	0	N	N	NE	N
CV1104		8	59	43	KK	JA	47	26	P	S	T1	NS	2 Yr Old	5th	500+	BRM	Arch	none	20-50%	<20%	Y	30	0	Y	N/A	E	P
CV1105		8	59	41	MQ	CF	44	28	P	S	T1	NS	Cowhouse	4th	U	C	unkn	<20%	<20%	<20%	Y	6	0	U	N/A	UE	T
CV1106		10	59	43	JfT	CF	34	21	P	PS	S	P	none	n/a	U	BRM	unkn	none	<20%	<20%	Y	7	0	U	N/A	UE	T
CV1114		8	57	41	MQ	CF	13	8	S	NS	S	NS	none	n/a	0-20	P	unkn	none	>50%	>50%	N	0	0	N	N/A	NE	N
CV1116		9	57	41	MQ	CF	38	24	P	S	T1	NS	Table Rk	4th	U	P	unkn	none	<20%	20-50%	Y	4	0	U	N/A	UE	T
CV1120		9	57	35	KK	JA	35	23	U	U	T1	NS	Table Rk	4th	300+	TS	unkn	20-50%	20-50%	20-50%	Y	2	0	U	N/A	UE	T
CV1122A		9	57	35	KK	JA	43	26	P	S	T1	NS	Table Rk	3rd	300+	BRM	unkn	none	none	20-50%	Y	2	0	U	N/A	UE	T
CV1122B		9	57	35	KK	JA	30	16	U	U	C	NS	Table Rk	n/a	0-20	BRM	unkn	none	20-50%	>50%	Y	2	0	U	N/A	UE	T
CV1123		10	57	35	KK	JA	15	13	S	NS	T2	NS	Table Rk	3rd	0-20	TS	unkn	none	20-50%	20-50%	N	0	0	N	N/A	NE	N
CV1124		10	57	35	GM	JA	20	11	S	NS	T2	NS	Cowhouse	5th	0-20	C	Arch	none	>50%	>50%	N	0	0	N	N/A	NE	N
CV1125		10	57	35	KK	JA	21	13	S	NS	T2	NS	Table Rk	3rd	0-20	BRM	unkn	none	20-50%	20-50%	N	0	0	N	N/A	NE	N
CV1129A	■	13	55	42	JfT	JA	15	13	S	NS	T2	NS	Cowhouse	5th	0-20	TS	L Arch	none	20-50%	20-50%	N	0	0	N	N	NE	N
CV1129B	■	13	55	42	JfT	JA	34	27	U	U	T1	NS	Cowhouse	2nd	200+	TS	L Arch	none	<20%	<20%	Y	22	0	U	N/A	UE	T
CV1129C	■	13	55	42	JfT	JA	33	24	U	U	T1	NS	Cowhouse	5th	200+	TS	L Arch	none	<20%	20-50%	Y	5	0	U	N/A	UE	T
CV1132		8	56	35	GM	JA	42	26	P	S	M	NS	Table Rk	n/a	200+	BRM	L Arch	20-50%	20-50%	20-50%	Y	4	0	Y	N/A	E	P
CV1133		8	56	35	KK	JA	36	24	U	U	T1	NS	Table Rk	n/a	300+	C	M Arch	none	U	<20%	Y	10	0	U	N/A	UE	T
CV1135		8	56	35	MQ	CF	30	18	U	U	S	P	none	n/a	U	C	Arch/LP	none	20-50%	<20%	Y	33	0	N	N/A	NE	N
CV1136		7	56	35	MQ	CF	48	28	P	S	T1	NS	Table Rk	3rd	500+	BRM	unkn	none	<20%	<20%	Y	22	0	U	N/A	UE	T
CV1137A		7	56	35	GM	CF	19	14	S	NS	T2	NS	Table Rk	4th	0-20	C	M Arch	none	>50%	20-50%	N	0	0	N	N/A	NE	N
CV1137B		7	56	35	GM	CF	27	23	U	U	T1	NS	Table Rk	4th	100+	N	unkn	none	20-50%	20-50%	Y	1	0	U	N/A	UE	T
CV1137C		7	56	35	GM	CF	29	18	U	U	M	NS	Table Rk	4th	U	C	unkn	none	<20%	20-50%	Y	1	0	N	N/A	NE	N
CV1138		7	56	35	JfT	JA	36	21	P	PS	Up	P	none	n/a	0-20	C	unkn	none	>50%	20-50%	Y	54	0	U	N/A	UE	T
CV1141		8	54	35	KK	JA	42	26	P	S	M	P	none	n/a	0-20	BRM	Arch	none	<20%	20-50%	Y	30	0	Y	N/A	E	P
CV1143A		7	55	35	KK	JA	38	20	P	S	S	P	Table Rk	n/a	20-50	C	L Arch	none	>50%	20-50%	Y	4	0	U	N/A	UE	T
CV1143B		7	55	35	KK	JA	20	18	U	U	S	NS	Table Rk	n/a	0-20	C	unkn	none	>50%	>50%	Y	1	0	N	N/A	NE	N
CV1145		8	54	35	GM	JA	18	14	S	NS	Up	P	none	n/a	0-20	C	Arch/LP	none	>50%	20-50%	N	0	0	N	N/A	NE	N
CV1152A		26	66	71	KK	JA	36	22	P	PS	T1	NS	Henson	4th	20-50	C	unkn	none	>50%	20-50%	Y	24	0	U	N/A	UE	T
CV1152B		26	66	71	KK	JA	29	23	P	PS	T1	NS	Henson	4th	100+	N	unkn	none	none	20-50%	Y	5	0	U	N/A	UE	T
CV1161		11	69	51	FO	BD	15	10	P	NS	S	NS	none	n/a	0-20	C	unkn	none	20-50%	>50%	N	0	0	N	N/A	NE	N
CV1162		13	69	51	CL	JA	18	7	S	NS	Up	NS	Shoal	n/a	0-20	C	unkn	none	>50%	>50%	N	0	0	N	N/A	NE	N
CV1163A		12	68	51	CL	JA	19	9	P	NS	Up	M	none	n/a	0-20	N	unkn	none	<20%	>50%	N	0	0	N	N/A	NE	N
CV1163B		12	68	51	CL	JA	29	22	S	NS	RS	NS	none	n/a	0-20	N	unkn	none	none	20-50%	Y	1	0	N	N/A	NE	N
CV1165A	■	10	65	45	JfT	JA	16	7	S	NS	Up	M	none	n/a	0-20	C	unkn	none	>50%	>50%	N	0	0	N	N	NE	N
CV1165B1	■	10	65	45	JfT	JA	28	22	U	U	RS	NS	none	n/a	100+	N	unkn	none	none	<20%	Y	4	0	N	N/A	NE	N

Appendix F: Site Listing

Site subarea	LRPA?	UTM East Grid	UTM North Grid	Training Area	Archeologist	Geomorphologist	Archaeol. Score	Geomorph Score	Context	Sealed?	Landform	Land Surface	Drainage	Stream Order	Est.Depth (cm)	Burned Rock	Archae. Age	Vandal Disturb.	Vehicle Disturb.	Erosion Disturb.	Potential deposits	No. Shovel Tests	No. Test Pits	Intact deposits?	Ubiquitous lithics?	NRHP Eligibility	Mgmt. Recom.
CV1165B2	■	10	65	45	JfT	JA	28	22	U	U	RS	NS	none	n/a	100+	N	unkn	none	none	<20%	Y	4	0	U	N/A	UE	T
CV1166A		11	63	45	MQ	CF	20	21	U	U	RS	M	none	n/a	U	P	unkn	none	none	U	Y	2	0	U	N/A	UE	T
CV1166B		11	63	45	MQ	CF	14	8	S	NS	Up	M	none	n/a	0-20	N	Arch	none	20-50%	>50%	N	0	0	N	N/A	NE	N
CV1167A		11	63	45	CL	JA	38	25	P	S	C	NS	none	n/a	100+	P	L Prehis	>50%	none	<20%	Y	4	0	U	N/A	UE	T
CV1167B		11	63	45	CL	JA	46	24	P	PS	T0	NS	none	2nd	100+	BRM	L Arch	20-50%	none	<20%	Y	8	0	U	N/A	UE	T
CV1169		12	64	45	MQ	CF	41	28	P	S	RS	NS	none	n/a	U	P	unkn	<20%	none	<20%	Y	0	1	Y	N/A	E	P
CV1172-1	■	13	68	51	KK	JA	16	7	S	NS	Up	M	none	n/a	0-20	TS	Arch	none	>50%	>50%	N	0	0	N	U	UE	T
CV1172-2	■	13	68	51	KK	JA	16	7	S	NS	Up	M	none	n/a	0-20	TS	Arch	none	>50%	>50%	N	0	0	N	N	NE	N
CV1184		16	60	44	KK	JA	13	8	S	NS	M	M	none	n/a	0-20	TS	Arch	none	>50%	>50%	N	0	0	N	N/A	NE	N
CV1186A1	■	15	59	44	GM	JA	16	7	S	NS	Up	M	Clabber	n/a	0-20	N	Arch/LP	none	>50%	>50%	N	0	0	N	N	NE	N
CV1186A2	■	15	59	44	GM	JA	16	7	S	NS	Up	M	Clabber	n/a	0-20	N	Arch/LP	none	>50%	>50%	N	0	0	N	N	NE	N
CV1186A3	■	15	59	44	GM	JA	16	7	S	NS	Up	M	Clabber	n/a	0-20	N	Arch/LP	none	>50%	>50%	N	0	0	N	U	UE	T
CV1186B	■	15	59	44	GM	JA	29	23	U	U	C	NS	Clabber	n/a	200+	N	Arch/LP	none	<20%	20-50%	Y	21	0	U	N/A	UE	T
CV1186C	■	15	59	44	GM	JA	39	24	P	S	T1	NS	Clabber	2nd	200+	C	Arch/LP	none	none	20-50%	Y	62	0	U	N/A	UE	T
CV1191		4	48	33	NT	CF	38	26	P	S	M	P	Table Rk	n/a	U	BRM	Arch	none	<20%	<20%	Y	11	0	U	N/A	UE	T
CV1194		4	48	33	NT	CF	25	18	P	NS	S	P	none	n/a	20-50	BRM	Arch	none	20-50%	20-50%	Y	3	0	U	N/A	UE	T
CV1195		5	48	33	NT	CF	27	16	P	NS	S	NS	Ripstein	n/a	U	BRM	unkn	none	20-50%	20-50%	Y	1	0	U	N/A	UE	T
CV1200A		14	54	42	MQ	CF	16	11	P	NS	T2	NS	Cowhouse	4th	0-20	C	unkn	none	>50%	>50%	N	0	0	N	N/A	NE	N
CV1200B		14	54	42	MQ	CF	31	23	P	PS	T0	NS	Cowhouse	3rd	U	TS	unkn	none	20-50%	20-50%	Y	9	0	U	N/A	UE	T
CV1206A	■	12	53	36	KK	JA	15	12	S	NS	S	NS	Cowhouse	n/a	0-20	BRM	Arch	20-50%	20-50%	>50%	N	0	0	N	N	NE	N
CV1206B	■	12	53	36	KK	JA	13	17	S	NS	T2	NS	Cowhouse	n/a	20-50	TS	unkn	none	20-50%	20-50%	N	0	0	N	N	NE	N
CV1206C	■	12	53	36	KK	JA	29	23	U	U	M	NS	Cowhouse	2nd	200+	TS	unkn	none	<20%	<20%	Y	32	0	U	N/A	UE	T
CV1206D	■	12	53	36	KK	JA	35	12	P	PS	S	NS	Cowhouse	n/a	0-20	BRM	Arch	20-50%	20-50%	>50%	Y	0	1	N	N/A	NE	N
CV1211		8	48	34	NT	CF	16	24	P	S	T1	NS	House	3rd	U	P	unkn	none	<20%	<20%	Y	20	0	U	N/A	UE	T
CV1216		6	48	33	JmT	BD	14	8	S	NS	S	K	Ripstein	n/a	0-20	N	Arch	none	>50%	>50%	N	0	0	N	N/A	NE	N
CV1218		6	48	33	JmT	BD	21	19	U	U	M	NS	House	4th	100+	DS	unkn	none	>50%	>50%	Y	0	0	U	N/A	UE	T
CV1219A	■	8	49	34	JfT	JA	15	13	S	NS	T2	NS	House	4th	0-20	DS	Arch	none	>50%	<20%	N	0	0	N	N	NE	N
CV1219B	■	8	49	34	JfT	JA	30	23	U	U	T1	NS	House	4th	300+	P	Arch	none	>50%	<20%	Y	60	0	U	N/A	UE	T
CV1221A		8	49	34	NT	CF	23	22	P	S	T0	NS	House	3rd	U	N	unkn	none	<20%	<20%	Y	6	0	U	N/A	UE	T
CV1221B		8	49	34	NT	CF	33	20	P	NS	T2	NS	House	5th	U	C	unkn	>50%	>50%	>50%	Y	2	0	U	N/A	UE	T
CV1222		6	48	33	JmT	BD	40	22	P	S	T1	NS	Ripstein	4th	300+	P	Arch	none	>50%	<20%	Y	48	0	U	N/A	UE	T
CV1225A		9	49	34	NT	CF	29	23	P	S	T1	NS	House	5th	U	TS	Arch	U	U	<20%	Y	6	0	U	N/A	UE	T
CV1225B		9	49	34	NT	CF	25	13	P	NS	T2	NS	House	5th	0-20	BRM	Arch	>50%	>50%	<20%	N	0	0	N	N/A	NE	N
CV1227		9	48	34	KK	JA	30	20	U	U	M	P	none	n/a	0-20	C	unkn	none	20-50%	>50%	Y	5	0	N	N/A	NE	N
CV1229		9	48	34	NT	CF	14	9	S	NS	M	P	House	n/a	0-20	TS	unkn	none	>50%	>50%	N	0	0	N	N/A	NE	N
CV1230		4	48	33	NT	CF	20	15	P	NS	M	NS	Ripstein	n/a	0-20	BRM	unkn	none	<20%	20-50%	Y	1	0	N	N/A	NE	N
CV1232		10	50	34	NT	CF	14	7	P	NS	Up	NS	none	n/a	0-20	C	unkn	none	>50%	>50%	N	0	0	N	N/A	NE	N
CV1235		9	49	34	NT	CF	42	29	P	S	T1	NS	House	5th	U	BRM	Arch	<20%	<20%	<20%	Y	0	0	U	N/A	UE	T

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Site subarea	LRPA?	UTM East Grid	UTM North Grid	Training Area	Archeologist	Geomorphologist	Archaeol. Score	Geomorph Score	Context	Sealed?	Landform	Land Surface	Drainage	Stream Order	Est.Depth (cm)	Burned Rock	Archae. Age	Vandal Disturb.	Vehicle Disturb.	Erosion Disturb.	Potential deposits	No. Shovel Tests	No. Test Pits	Intact deposits?	Ubiquitous lithics?	NRHP Eligibility	Mgmt. Recom.
CV1236		10	49	34	KK	JA	13	16	S	NS	T1	NS	House	4th	U	TS	Arch	none	none	>50%	N	0	0	N	N/A	NE	N
CV1237		10	48	34	JfT	JA	15	10	S	NS	S	NS	House	n/a	0-20	C	L Prehis	none	>50%	>50%	N	0	0	N	N/A	NE	N
CV1239		13	48	34	GM	CF	26	17	U	U	M	P	House	n/a	50-100	C	unkn	none	>50%	>50%	Y	51	0	N	N/A	NE	N
CV1240		10	49	34	KK	JA	13	13	S	NS	T2	NS	House	4th	0-20	TS	unkn	none	none	20-50%	N	0	0	N	N/A	NE	N
CV1242	■	11	49	34	KK	JA	13	7	S	NS	M	K	House	n/a	0-20	DS	unkn	none	>50%	>50%	N	0	0	N	N	NE	N
CV1244		11	49	34	NT	CF	48	29	P	S	T1	NS	House	4th	500+	BRM	unkn	<20%	<20%	<20%	Y	64	0	Y	N/A	E	P
CV1245		3	55	41	MQ	CF	31	21	P	PS	T2	NS	Table Rk	4th	20-50	C	Arch	none	none	20-50%	Y	40	0	N	N/A	NE	N
CV1246	■	11	49	34	JfT	JA	24	14	S	NS	Up	NS	House	n/a	U	C	Arch	none	>50%	20-50%	N	0	0	N	N	NE	N
CV1250A	■	10	49	34	KK	JA	17	16	S	NS	M	NS	House	n/a	0-20	C	unkn	none	none	<20%	N	0	0	N	N	NE	N
CV1250B	■	10	49	34	KK	JA	41	27	P	S	T1	NS	House	4th	500+	C	unkn	none	<20%	20-50%	Y	20	0	U	N/A	UE	T
CV1257		13	48	34	GM	CF	25	12	U	U	S	NS	House	n/a	0-20	DS	Arch/LP	none	<20%	>50%	Y	2	0	N	N/A	NE	N
CV1258A	■	12	50	34	JfT	JA	10	9	S	NS	S	P	none	n/a	0-20	P	Arch	none	>50%	>50%	N	0	0	N	N	NE	N
CV1258B	■	12	50	34	JfT	JA	30	23	P	NS	S	P	none	n/a	0-20	BRM	unkn	none	>50%	20-50%	Y	30	0	U	N/A	UE	T
CV1258C	■	12	50	34	JfT	JA	21	19	U	U	S	P	none	n/a	0-20	N	unkn	none	20-50%	20-50%	Y	14	0	N	N/A	NE	N
CV1261		12	47	34	KK	JA	15	9	S	NS	M	K	Clear	n/a	0-20	P	unkn	none	>50%	20-50%	N	0	0	N	N/A	NE	N
CV1262		12	49	34	NT	CF	19	13	P	NS	T2	NS	House	4th	0-20	P	unkn	none	20-50%	20-50%	N	0	0	N	N/A	NE	N
CV1269A		6	47	33	NT	CF	39	26	P	S	M	NS	House	4th	U	BRM	unkn	U	U	<20%	Y	30	0	U	N/A	UE	T
CV1269B		6	47	33	NT	CF	34	14	P	S	S	NS	House	n/a	0-20	BRM	unkn	20-50%	20-50%	20-50%	Y	3	0	U	N/A	UE	T
CV1275A1	■	5	46	33	JfT	JA	13	8	S	NS	Up	NS	House	n/a	0-20	TS	Pl/Arch	none	20-50%	>50%	N	0	0	N	U	UE	T
CV1275A6	■	5	46	33	JfT	JA	13	8	S	NS	Up	NS	House	n/a	0-20	TS	Pl/Arch	none	20-50%	>50%	N	0	0	N	N	NE	N
CV1275B2	■	5	46	33	JfT	JA	25	21	U	U	C	NS	House	3rd	0-20	C	Pl/Arch	none	20-50%	>50%	Y	217	0	N	N/A	NE	N
CV1275B3	■	5	46	33	JfT	JA	25	21	U	U	C	NS	House	3rd	0-20	C	Pl/Arch	none	20-50%	>50%	Y	39	0	N	N/A	NE	N
CV1275B7	■	5	46	33	JfT	JA	25	21	U	S	C	NS	Cowhouse	n/a	0-20	BRM	Pl/Arch	none	20-50%	20-50%	Y	1	0	U	N/A	UE	T
CV1275C4	■	5	46	33	JfT	JA	36	25	P	PS	T1	NS	House	3rd	50-100	C	Pl/Arch	20-50%	20-50%	20-50%	Y	62	0	U	N/A	UE	T
CV1275C5	■	5	46	33	JfT	JA	36	25	P	PS	T1	NS	House	3rd	50-100	C	Pl/Arch	20-50%	20-50%	20-50%	Y	250	0	U	N/A	UE	T
CV1280		12	48	34	KK	JA	13	8	S	NS	M	K	Clear	n/a	0-20	N	L Prehis	none	20-50%	>50%	N	0	0	N	N/A	NE	N
CV1282A		14	47	34	GM	CF	29	22	U	U	T1	NS	House	n/a	U	C	unkn	none	20-50%	20-50%	Y	32	0	U	N/A	UE	T
CV1282B		14	47	34	GM	CF	16	11	S	NS	S	NS	House	n/a	0-20	C	unkn	none	20-50%	20-50%	N	0	0	N	N/A	NE	N
CV1283A		4	47	33	NT	CF	16	15	S	NS	S	P	Ripstein	n/a	U	C	unkn	none	20-50%	20-50%	N	0	0	N	N/A	NE	N
CV1283B		4	47	33	NT	CF	36	28	P	PS	M	NS	Ripstein	5th	U	BRM	Arch	none	<20%	<20%	Y	14	0	U	N/A	UE	T
CV1286A	■	6	46	33	JfT	JA	15	8	S	NS	Up	K	House	n/a	0-20	DS	Pl	none	>50%	>50%	N	0	0	N	N	NE	N
CV1286B	■	6	46	33	JfT	JA	32	23	P	PS	S	NS	House	n/a	U	C	Pl	20-50%	20-50%	20-50%	Y	23	0	U	N/A	UE	T
CV1286C	■	6	46	33	JfT	JA	42	27	P	S	T1	NS	House	n/a	300+	C	Pl	<20%	<20%	20-50%	Y	33	0	U	N/A	UE	T
CV1287A		5	48	33	NT	CF	26	8	U	U	M	NS	Ripstein	n/a	50-100	N	unkn	none	<20%	<20%	Y	1	0	U	N/A	UE	T
CV1287B		5	48	33	NT	CF	21	20	S	NS	S	NS	Ripstein	n/a	0-20	BRM	unkn	none	>50%	>50%	Y	6	0	U	N/A	UE	T
CV1287C		5	48	33	NT	CF	29	21	P	PS	C	P	Ripstein	n/a	U	C	unkn	none	20-50%	<20%	Y	9	0	U	N/A	UE	T
CV1291		12	48	34	KK	JA	15	8	S	NS	Up	K	none	n/a	0-20	C	L Prehis	none	>50%	20-50%	N	0	0	N	N/A	NE	N
CV1296		4	47	33	NT	CF	15	10	P	NS	Up	P	House	n/a	0-20	C	unkn	none	>50%	>50%	N	0	0	N	N/A	NE	N

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Site subarea	LRPA?	UTM East Grid	UTM North Grid	Training Area	Archeologist	Geomorphologist	Archaeol. Score	Geomorph Score	Context	Sealed?	Landform	Land Surface	Drainage	Stream Order	Est.Depth (cm)	Burned Rock	Archae. Age	Vandal Disturb.	Vehicle Disturb.	Erosion Disturb.	Potential deposits	No. Shovel Tests	No. Test Pits	Intact deposits?	Ubiquitous lithics?	NRHP Eligibility	Mgmt. Recom.
CV1298		12	48	34	NT	CF	13	9	P	NS	Up	NS	Clear	n/a	0-20	TS	unkn	none	U	20-50%	N	0	0	N	N/A	NE	N
CV1300		12	48	34	KK	JA	15	9	S	NS	Up	K	Clear	n/a	0-20	TS	M Arch	none	20-50%	20-50%	N	0	0	N	N/A	NE	N
CV1305		6	49	33	JmT	BD	13	8	S	NS	S	NS	House	n/a	0-20	C	Arch	none	>50%	>50%	N	0	0	N	N/A	NE	N
CV1307		6	50	33	JmT	BD	26	17	P	S	S	NS	Cowhouse	n/a	0-20	P	unkn	none	>50%	>50%	Y	2	0	N	N/A	NE	N
CV1308A	■	5	46	33	JfT	JA	15	9	S	NS	Up	NS	House	n/a	0-20	DS	Pl/Arch	none	20-50%	>50%	N	0	0	N	N	NE	N
CV1308B	■	5	46	33	JfT	JA	30	25	U	U	T1	NS	House	3rd	100+	TS	Pl/Arch	none	<20%	<20%	Y	10	0	U	N/A	UE	T
CV1310A	■	5	46	33	JfT	JA	15	7	S	NS	Up	K	House	n/a	0-20	C	Pl/Arch	none	>50%	>50%	N	0	0	N	N	NE	N
CV1310B	■	5	46	33	JfT	JA	35	21	U	U	C	NS	House	n/a	100+	C	Pl/Arch	none	20-50%	20-50%	Y	21	0	U	N/A	UE	T
CV1310C	■	5	46	33	JfT	JA	31	25	U	U	M	NS	House	4th	200+	C	Pl/Arch	none	<20%	20-50%	Y	9	0	U	N/A	UE	T
CV1314		6	45	33	NT	CF	14	8	S	NS	S	NS	none	n/a	0-20	TS	unkn	none	>50%	>50%	N	0	0	N	N/A	NE	N
CV1315A		6	45	33	NT	CF	24	11	P	PS	Up	NS	House	n/a	0-20	BRM	unkn	none	20-50%	20-50%	Y	1	0	N	N/A	NE	N
CV1315B		6	45	33	NT	CF	26	18	P	S	M	NS	House	1st	U	N	unkn	none	<20%	20-50%	Y	5	0	N	N/A	NE	N
CV1316		6	45	33	NT	CF	13	10	P	NS	Up	K	none	n/a	0-20	N	unkn	none	20-50%	20-50%	N	0	0	N	N/A	NE	N
CV1329A1	■	15	71	52	AT	JA	13	11	S	NS	Up	K	Shoal	n/a	0-20	C	Pl/Arch	none	>50%	20-50%	N	0	0	N	N	NE	N
CV1329A2	■	15	71	52	AT	JA	13	11	S	NS	Up	K	Shoal	n/a	0-20	C	Pl/Arch	none	>50%	20-50%	N	0	0	N	N	NE	N
CV1329A7	■	15	71	52	AT	JA	13	11	S	NS	Up	K	Shoal	n/a	0-20	C	Pl/Arch	none	>50%	20-50%	N	0	0	N	N	NE	N
CV1329B3	■	15	71	52	AT	JA	32	23	U	U	T1	NS	Shoal	3rd	100+	TS	Pl/Arch	none	20-50%	20-50%	Y	100	0	U	N/A	UE	T
CV1329B4	■	15	71	52	AT	JA	32	23	U	U	T1	NS	Shoal	3rd	100+	TS	Pl/Arch	none	20-50%	20-50%	Y	100	0	U	N/A	UE	T
CV1329B5	■	15	71	52	AT	JA	32	23	U	U	T1	NS	Shoal	3rd	100+	TS	Pl/Arch	none	20-50%	20-50%	Y	100	0	U	N/A	UE	T
CV1329B6	■	15	71	52	AT	JA	32	23	U	U	T1	NS	Shoal	3rd	100+	TS	Pl/Arch	none	20-50%	20-50%	Y	100	0	U	N/A	UE	T
CV1330A1	■	16	71	52	KK	JA	13	8	S	NS	Up	K	Shoal	n/a	0-20	TS	M Arch	none	20-50%	>50%	N	0	0	N	N	NE	N
CV1330A2	■	16	71	52	KK	JA	13	8	S	NS	Up	K	Shoal	n/a	0-20	TS	M Arch	none	20-50%	>50%	N	0	0	N	U	UE	T
CV1330B3	■	16	71	52	KK	JA	34	24	U	U	T2	NS	Shoal	n/a	200+	C	unkn	none	20-50%	<20%	Y	147	0	U	N/A	UE	T
CV1333A	■	18	71	52	GM	JA	13	9	S	NS	Up	NS	Shoal	n/a	0-20	TS	Arch	none	<20%	>50%	N	0	0	N	N	NE	N
CV1333B	■	18	71	52	GM	JA	31	21	U	U	S	NS	Shoal	n/a	50-100	TS	Arch	none	20-50%	<20%	Y	70	0	N	N/A	NE	N
CV1333C	■	18	71	52	GM	JA	30	20	U	U	T0	NS	Shoal	3rd	50-100	TS	Arch	none	20-50%	20-50%	Y	2	0	N	N/A	NE	N
CV1334		16	70	52	GM	JA	15	18	S	NS	M	NS	none	n/a	0-20	C	Arch/LP	none	20-50%	20-50%	N	0	0	N	N/A	NE	N
CV1340		15	70	52	AT	JA	12	11	S	NS	S	NS	Shoal	n/a	0-20	TS	unkn	none	<20%	>50%	N	0	0	N	N/A	NE	N
CV1342	■	15	69	52	AT	JA	13	7	S	NS	Up	NS	none	n/a	0-20	TS	unkn	none	>50%	>50%	N	0	0	N	N	NE	N
CV1346A	■	14	70	52	GM	JA	13	11	S	NS	Up	K	Shoal	n/a	0-20	TS	Arch	none	>50%	>50%	N	0	0	N	N	NE	N
CV1346B	■	14	70	52	GM	JA	26	23	U	U	T1	NS	Shoal	n/a	50-100	TS	unkn	none	<20%	20-50%	Y	18	0	U	N/A	UE	T
CV1348A	■	17	69	52	GM	CF	23	21	U	U	RS	NS	none	n/a	0-20	TS	unkn	none	none	20-50%	Y	4	0	N	N/A	NE	N
CV1348B	■	17	69	52	GM	CF	26	18	U	U	S	NS	none	n/a	U	TS	unkn	none	20-50%	20-50%	Y	57	0	N	N/A	NE	N
CV1348C	■	17	69	52	GM	CF	13	10	S	NS	Up	NS	none	n/a	0-20	TS	Arch	none	>50%	>50%	N	0	0	N	N	NE	N
CV1348D	■	17	69	52	GM	CF	25	23	U	U	T0	NS	none	2nd	U	TS	unkn	none	<20%	<20%	Y	16	0	U	N/A	UE	T
CV1352		17	70	52	KK	JA	15	7	S	NS	Up	K	Shoal	n/a	0-20	BRM	unkn	none	>50%	>50%	N	0	0	N	N/A	NE	N
CV1354A	■	18	69	53	KK	JA	15	16	S	NS	Up	M	none	n/a	0-20	TS	Arch	none	>50%	>50%	N	0	0	N	N	NE	N
CV1354B	■	18	69	53	KK	JA	25	22	U	U	T1	NS	none	1st	100+	N	unkn	none	20-50%	20-50%	Y	8	0	U	N/A	UE	T

Appendix F: Site Listing

Site subarea	LRPA?	UTM East Grid	UTM North Grid	Training Area	Archeologist	Geomorphologist	Archaeol. Score	Geomorph Score	Context	Sealed?	Landform	Land Surface	Drainage	Stream Order	Est.Depth (cm)	Burned Rock	Archae. Age	Vandal Disturb.	Vehicle Disturb.	Erosion Disturb.	Potential deposits	No. Shovel Tests	No. Test Pits	Intact deposits?	Ubiquitous lithics?	NRHP Eligibility	Mgmt. Recom.
CV1356A		19	69	53	GM	CF	26	24	U	U	T1	NS	none	n/a	U	C	unkn	none	<20%	<20%	Y	15	0	U	N/A	UE	T
CV1356B		19	69	53	GM	CF	13	8	S	NS	M	NS	none	n/a	0-20	P	Pl/Arch	none	>50%	>50%	N	0	0	N	N/A	NE	N
CV1359A	■	19	69	53	GM	CF	36	28	P	S	T1	NS	none	n/a	U	TS	unkn	none	<20%	<20%	Y	36	0	U	N/A	UE	T
CV1359B	■	19	69	53	GM	CF	13	9	S	NS	S	NS	none	n/a	0-20	TS	Arch	none	>50%	>50%	N	0	0	N	N	NE	N
CV1364		16	68	53	GM	CF	13	8	S	NS	Up	M	none	n/a	0-20	N	Arch	none	20-50%	>50%	N	0	0	N	N/A	NE	N
CV1365A		16	68	53	GM	CF	41	26	P	S	M	NS	none	1st	U	BRM	unkn	<20%	<20%	<20%	Y	11	0	U	N/A	UE	T
CV1365B		16	68	53	GM	CF	13	12	S	NS	S	NS	none	n/a	0-20	TS	unkn	none	none	20-50%	N	0	0	N	N/A	NE	N
CV1365C		16	68	53	GM	CF	22	22	U	U	RS	NS	none	n/a	0-20	N	unkn	none	none	<20%	Y	2	0	N	N/A	NE	N
CV1367		16	68	53	GM	CF	10	14	S	NS	RS	NS	none	n/a	U	N	unkn	none	none	>50%	N	0	0	N	N/A	NE	N
CV1375		25	66	71	KK	JA	30	25	P	PS	T1	NS	Henson	n/a	300+	N	unkn	none	20-50%	<20%	Y	26	0	U	N/A	UE	T
CV1376		25	66	71	KK	JA	13	7	S	NS	Up	K	Henson	n/a	0-20	N	M Arch	none	>50%	>50%	N	0	0	N	N/A	NE	N
CV1377		25	66	71	KK	JA	13	8	S	NS	M	K	Henson	n/a	0-20	N	unkn	none	20-50%	>50%	N	0	0	N	N/A	NE	N
CV1378A		7	44	31	FO	JA	20	11	P	NS	M	NS	Turkey	n/a	0-20	BRM	Arch	none	20-50%	U	Y	2	0	N	N/A	NE	N
CV1378B		7	44	31	FO	JA	33	22	P	S	T0	NS	Turkey	2nd	200+	N	unkn	none	<20%	<20%	Y	4	0	U	N/A	UE	T
CV1379		7	44	31	FO	JA	16	8	P	NS	M	NS	Turkey	n/a	0-20	C	Arch	none	>50%	>50%	Y	1	0	N	N/A	NE	N
CV1382		7	45	31	MQ	JA	21	9	S	NS	M	K	Turkey	n/a	0-20	BRM	E Arch	none	>50%	20-50%	Y	1	0	N	N/A	NE	N
CV1383		7	45	31	MQ	JA	14	15	S	NS	M	NS	none	n/a	0-20	P	Arch	20-50%	20-50%	>50%	N	0	0	N	N/A	NE	N
CV1385		7	45	31	MQ	JA	30	19	P	PS	S	K	Turkey	n/a	20-50	TS	unkn	none	20-50%	>50%	Y	22	0	N	N/A	NE	N
CV1387		8	47	31	FO	JA	35	27	P	PS	T1	NS	Turkey	3rd	50-100	C	unkn	none	20-50%	<20%	Y	22	0	N	N/A	NE	N
CV1389A		8	46	31	FO	JA	18	7	P	NS	M	NS	Turkey	n/a	0-20	C	unkn	none	>50%	>50%	Y	1	0	N	N/A	NE	N
CV1389B		8	46	31	FO	JA	10	20	P	NS	M	NS	Turkey	n/a	U	N	unkn	none	20-50%	20-50%	Y	2	0	N	N/A	NE	N
CV1391A	■	9	47	32	FO	JA	23	17	P	PS	Up	P	House	n/a	0-20	BRM	unkn	20-50%	20-50%	20-50%	Y	3	0	N	N/A	NE	N
CV1391B	■	9	47	32	FO	JA	27	25	P	PS	M	NS	House	1st	200+	BRM	unkn	none	<20%	20-50%	Y	2	0	U	N/A	UE	T
CV1393		7	46	31	FO	JA	13	8	S	NS	S	NS	Turkey	n/a	0-20	BRM	unkn	none	>50%	>50%	Y	1	0	N	N/A	NE	N
CV1395A		7	46	31	FO	JA	16	19	P	NS	C	NS	Turkey	n/a	0-20	C	unkn	none	U	20-50%	Y	1	0	N	N/A	NE	N
CV1395B		7	46	31	FO	JA	24	25	P	PS	T2	NS	Turkey	2nd	20-50	N	unkn	none	<20%	<20%	Y	2	0	N	N/A	NE	N
CV1400		8	47	31	CL	JA	31	23	P	PS	M	P	Turkey	3rd	50-100	C	L Prehis	none	20-50%	20-50%	Y	12	0	U	N/A	UE	T
CV1401		9	47	33	JfT	JA	29	26	U	U	M	NS	House	2nd	100+	DS	L Arch	none	20-50%	20-50%	Y	7	0	U	N/A	UE	T
CV1402		8	47	31	CL	JA	17	14	S	NS	S	NS	Turkey	n/a	0-20	C	unkn	none	U	>50%	N	0	0	N	N/A	NE	N
CV1403		9	47	32	FO	JA	31	24	P	PS	M	NS	House	n/a	50-100	BRM	Arch	20-50%	20-50%	20-50%	Y	31	0	U	N/A	UE	T
CV1410A		5	53	35	KK	JA	10	9	S	NS	S	NS	Table Rk	n/a	0-20	DS	unkn	none	20-50%	>50%	N	0	0	N	N/A	NE	N
CV1410B		5	53	35	KK	JA	32	26	U	U	T1	NS	Table Rk	n/a	20-50	BRM	unkn	none	<20%	20-50%	Y	2	0	U	N/A	UE	T
CV1410C		5	53	35	KK	JA	29	23	U	U	M	NS	Table Rk	2nd	100+	TS	unkn	none	20-50%	20-50%	Y	5	0	N	N/A	NE	N
CV1412		6	59	41	MQ	CF	31	17	P	S	Up	NS	none	n/a	0-20	C	Arch/LP	none	20-50%	20-50%	Y	10	0	N	N/A	NE	N
CV1413A		8	63	43	KK	JA	13	9	S	NS	S	NS	none	n/a	0-20	TS	M Arch	none	20-50%	>50%	N	0	0	N	N/A	NE	N
CV1413B		8	63	43	KK	JA	34	21	U	U	S	NS	none	n/a	20-50	C	M Arch	none	20-50%	20-50%	Y	6	0	N	N/A	NE	N
CV1416		8	63	43	KK	JA	24	21	U	U	T1	NS	none	n/a	20-50	C	unkn	none	>50%	>50%	Y	2	0	N	N/A	NE	N
CV1422-1	■	6	56	41	KK	JA	17	12	S	NS	T2	NS	Table Rk	4th	0-20	C	Arch	none	20-50%	>50%	N	0	0	N	U	UE	T

Appendix F: Site Listing

Site subarea	LRPA?	UTM East Grid	UTM North Grid	Training Area	Archeologist	Geomorphologist	Archaeol. Score	Geomorph Score	Context	Sealed?	Landform	Land Surface	Drainage	Stream Order	Est.Depth (cm)	Burned Rock	Archae. Age	Vandal Disturb.	Vehicle Disturb.	Erosion Disturb.	Potential deposits	No. Shovel Tests	No. Test Pits	Intact deposits?	Ubiquitous lithics?	NRHP Eligibility	Mgmt. Recom.
CV1422-2	■	6	56	41	KK	JA	17	12	S	NS	T2	NS	Table Rk	4th	0-20	C	Arch	none	20-50%	>50%	N	0	0	N	N	NE	N
CV1422-3	■	6	56	41	KK	JA	17	12	S	NS	T2	NS	Table Rk	4th	0-20	C	Arch	none	20-50%	>50%	N	0	0	N	N	NE	N
CV1423A		4	55	41	CL	JA	33	25	P	PS	T2	NS	Table Rk	n/a	20-50	TS	unkn	none	<20%	20-50%	Y	36	0	N	N/A	NE	N
CV1423B		4	55	41	CL	JA	25	17	P	NS	T2	NS	Table Rk	n/a	0-20	BRM	unkn	none	<20%	>50%	Y	1	0	U	N/A	UE	T
CV1425		27	62	73	MQ	CF	15	9	P	NS	Up	M	Owl	n/a	0-20	N	unkn	none	20-50%	20-50%	N	0	0	N	N/A	NE	N
CV1430		6	56	35	JfT	JA	34	25	U	U	T1	NS	Table Rk	4th	500+	BRM	unkn	20-50%	20-50%	20-50%	Y	2	0	U	N/A	UE	T
CV1432A		5	54	35	KK	JA	39	26	U	U	C	NS	Table Rk	n/a	0-20	DS	unkn	none	<20%	20-50%	Y	3	1	U	N/A	UE	T
CV1432B		5	54	35	KK	JA	27	23	P	S	T1	NS	Table Rk	3rd	100+	C	unkn	none	<20%	20-50%	Y	4	0	U	N/A	UE	T
CV1433		5	54	35	KK	JA	13	7	S	NS	Up	K	Table Rk	n/a	0-20	DS	Arch	none	>50%	>50%	N	0	0	N	N/A	NE	N
CV1435		5	54	35	JfT	JA	12	8	S	NS	Up	K	none	n/a	0-20	DS	unkn	none	>50%	20-50%	N	0	0	N	N/A	NE	N
CV1441		12	44	30	GM	CF	27	24	P	PS	T2	NS	Clear	3rd	U	DS	Arch	none	20-50%	20-50%	Y	11	0	U	N/A	UE	T
CV1443A		12	43	30	GM	CF	36	28	P	S	T1	NS	Clear	4th	200+	BRM	unkn	<20%	<20%	<20%	Y	18	0	U	N/A	UE	T
CV1443B		12	43	30	GM	CF	14	12	S	NS	T2	NS	Clear	4th	20-50	TS	unkn	none	<20%	>50%	N	0	0	N	N/A	NE	N
CV1549		6	61	41	GM	CF	27	27	U	U	T1	NS	Cowhouse	5th	U	C	unkn	none	20-50%	<20%	Y	70	0	U	N/A	UE	T
CV1550		11	64	45	JfT	JA	21	23	U	U	RS	NS	none	n/a	20-50	N	unkn	none	none	20-50%	Y	2	0	Y	N/A	E	P
CV1551		9	63	45	GM	CF	28	25	U	U	T1	NS	2 Yr Old	3rd	100+	P	unkn	none	20-50%	<20%	Y	23	0	U	N/A	UE	T
CV1552		10	64	45	GM	CF	38	27	P	S	T1	NS	2 Yr Old	n/a	200+	C	Arch	none	<20%	U	Y	0	1	Y	N/A	E	P
CV1553		12	58	42	GM	CF	30	28	P	PS	M	P	Stampede	n/a	U	BRM	unkn	none	<20%	<20%	Y	23	0	N	N/A	NE	N
CV1554		35	57	3	GM	CF	28	23	U	U	T1	NS	Owl	4th	U	TS	unkn	none	<20%	<20%	Y	60	0	U	N/A	UE	T
CV1555		13	49	34	GM	CF	31	28	U	U	T1	NS	Clear	n/a	U	BRM	unkn	none	<20%	<20%	Y	18	0	U	N/A	UE	T
CV1556A		4	48	33	GM	CF	28	22	U	U	S	NS	Ripstein	n/a	U	C	M Arch	none	<20%	<20%	Y	43	0	N	N/A	NE	N
CV1556B		4	48	33	GM	CF	31	28	P	S	T1	NS	Ripstein	2nd	50-100	C	unkn	none	<20%	<20%	Y	39	0	U	N/A	UE	T
CV1557		8	48	3	GM	CF	39	28	P	S	T1	NS	Turkey	4th	U	C	unkn	none	none	<20%	Y	9	0	U	N/A	UE	T

APPENDIX G:

SUPPLEMENTARY FIGURES AND ILLUSTRATIONS

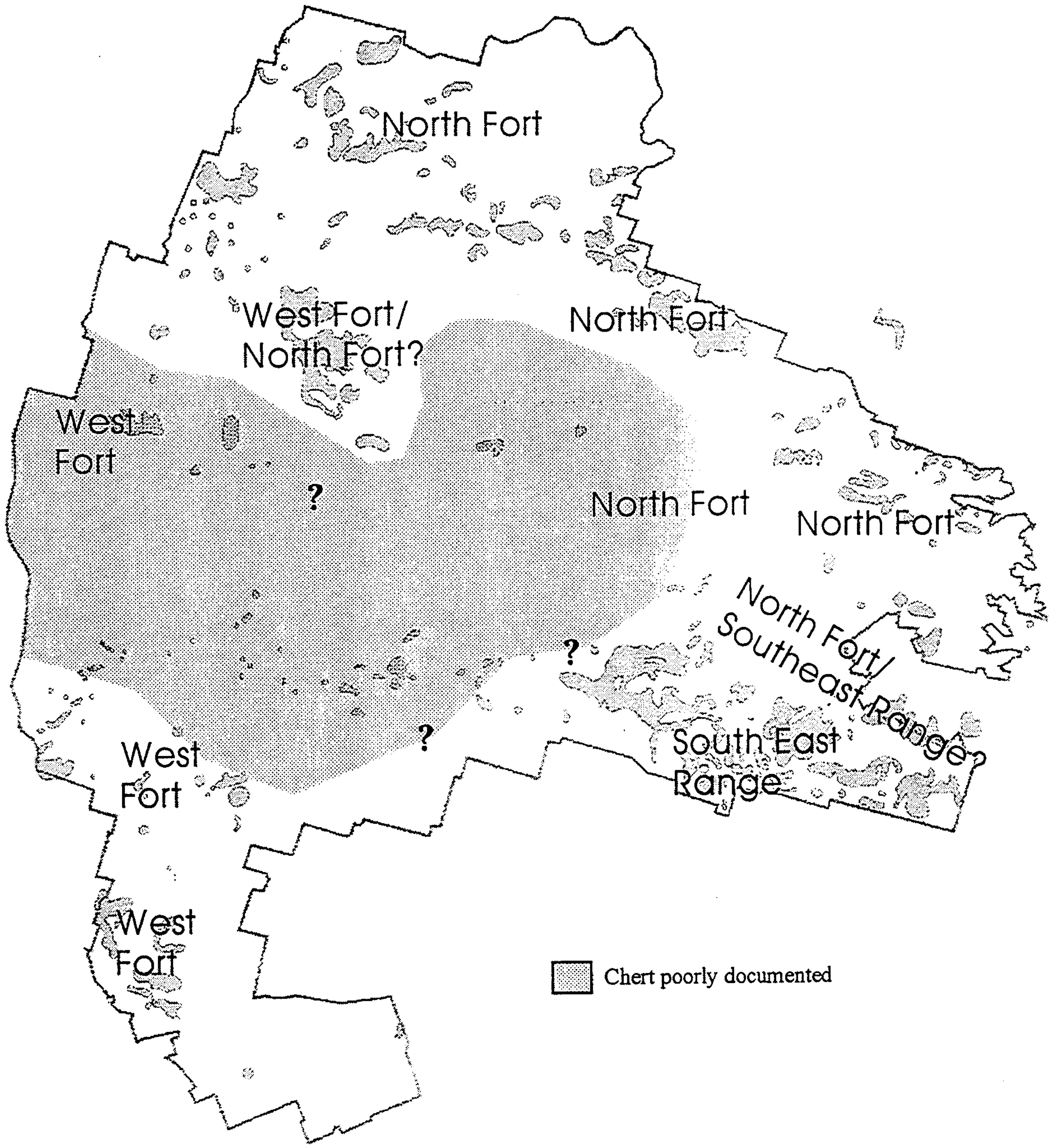

Figure G.1 Approximate Locations of Chert Provinces in Fort Hood.

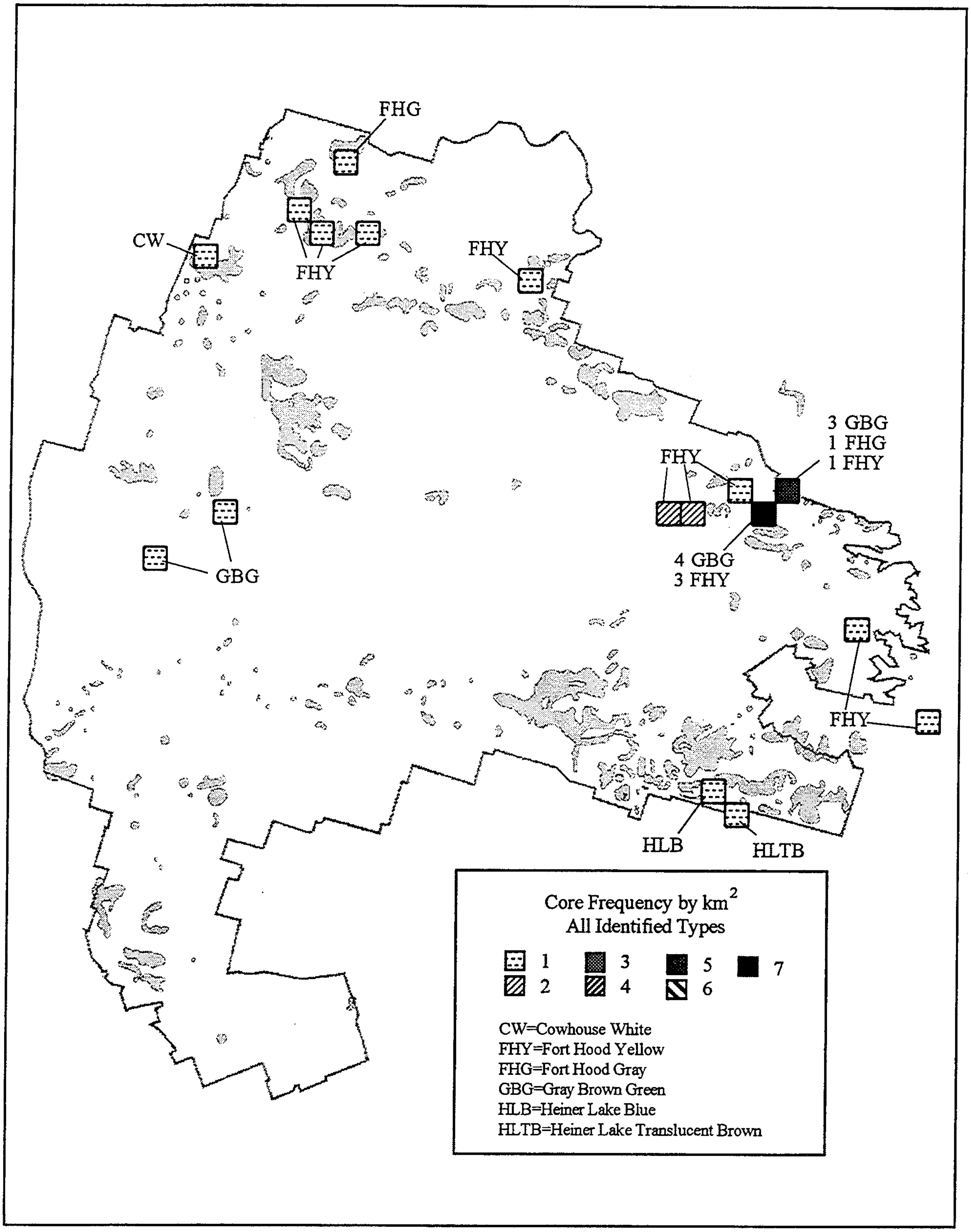

Figure G.2 Frequency Distribution of Type-Identified Cores.

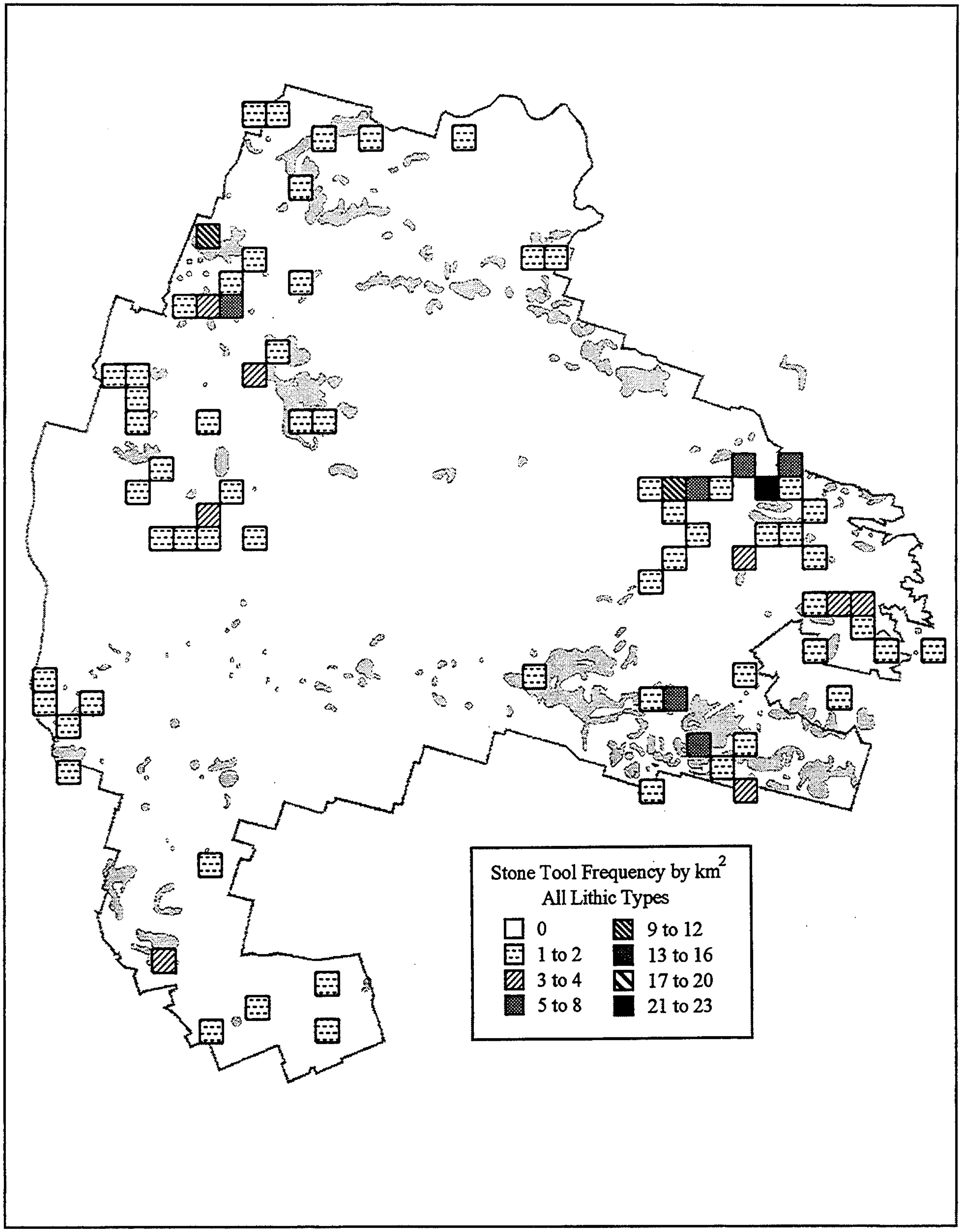

Figure G.3 Frequency Distribution of Type-Identified Tools.

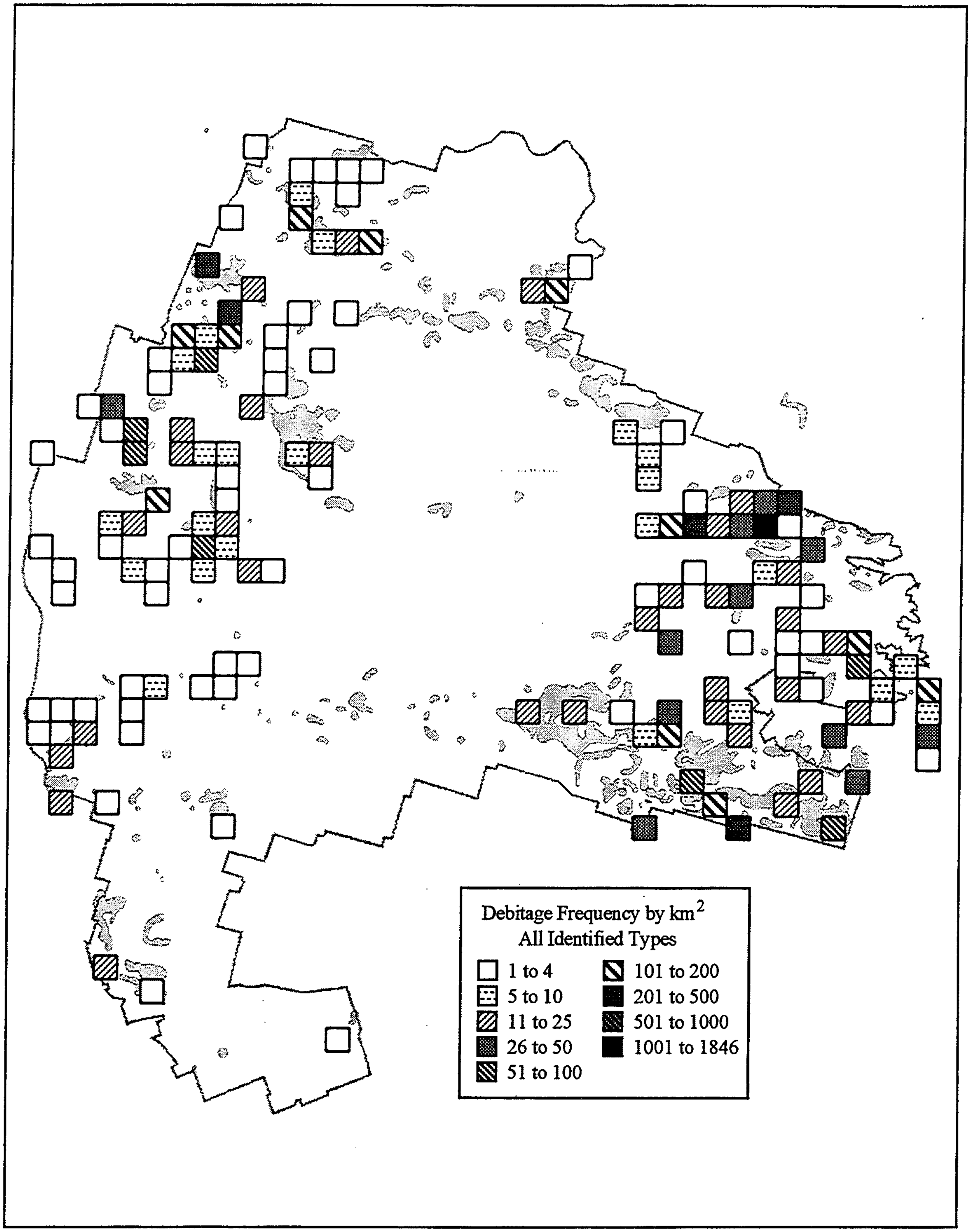

Figure G.4 Frequency Distribution of Type-Identified Debitage.

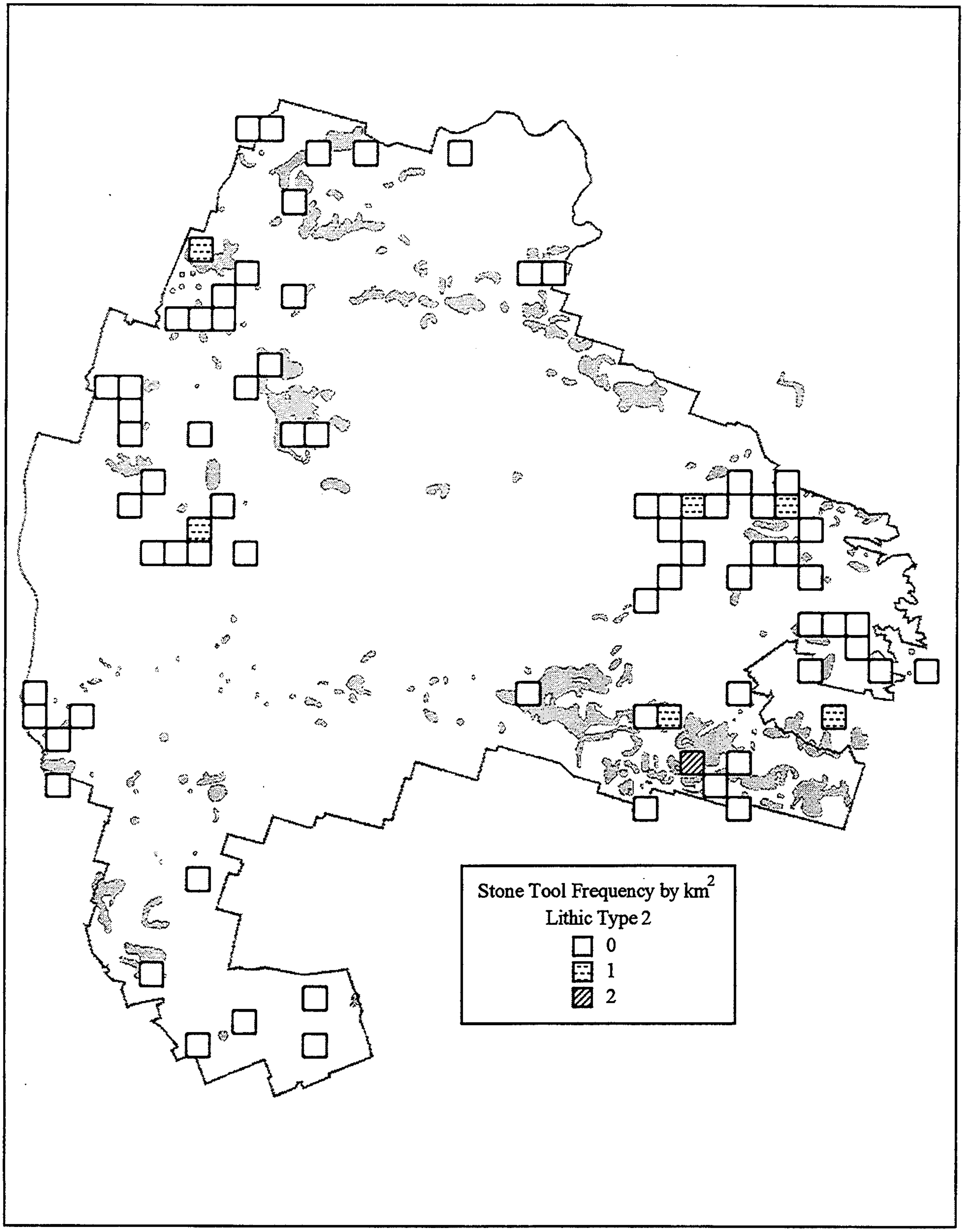

Figure G.5 Frequency Distribution of Cowhouse White (Type 2) Tools.

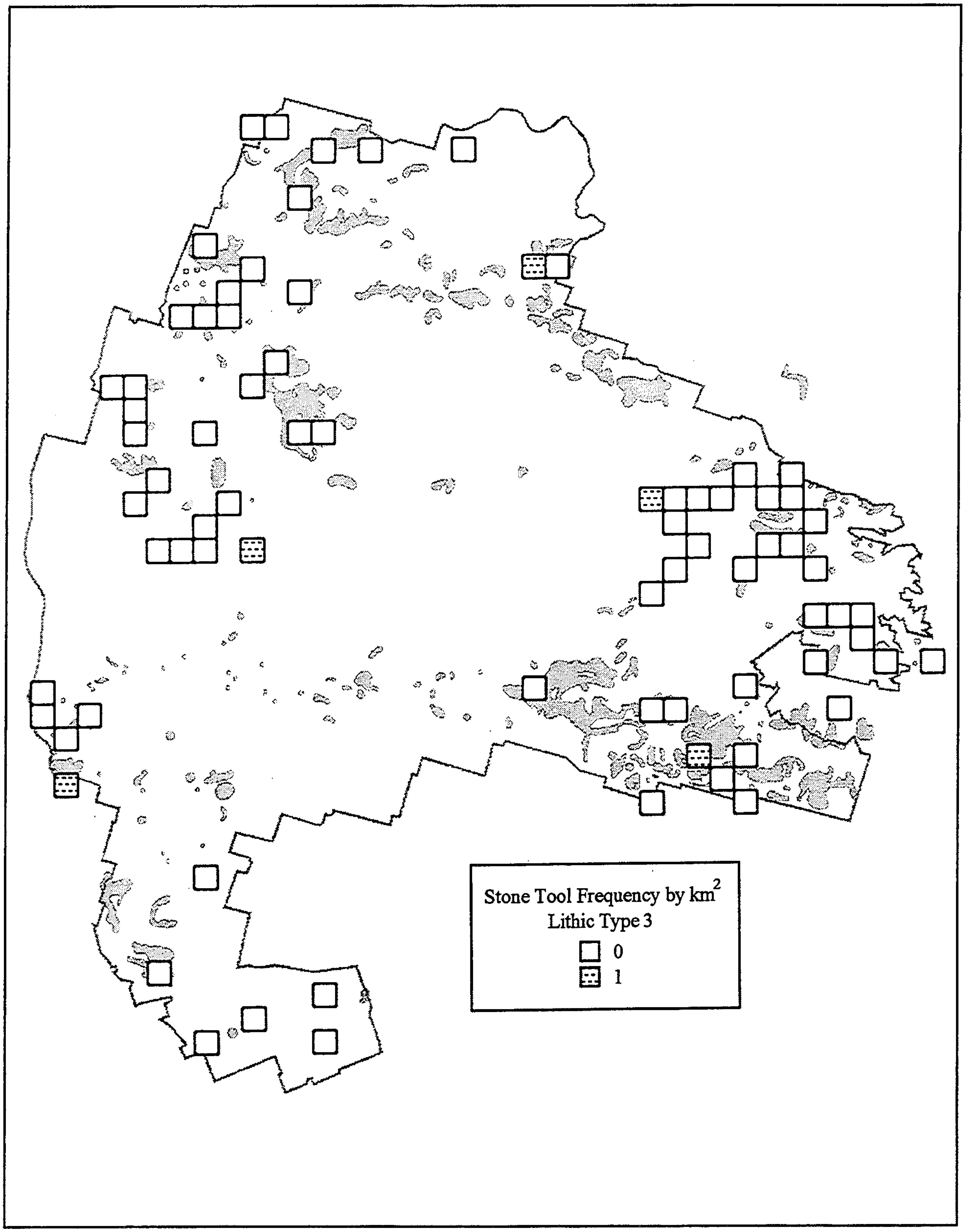

Figure G.6 Frequency Distribution of Anderson Mountain Gray (Type 3) Tools.

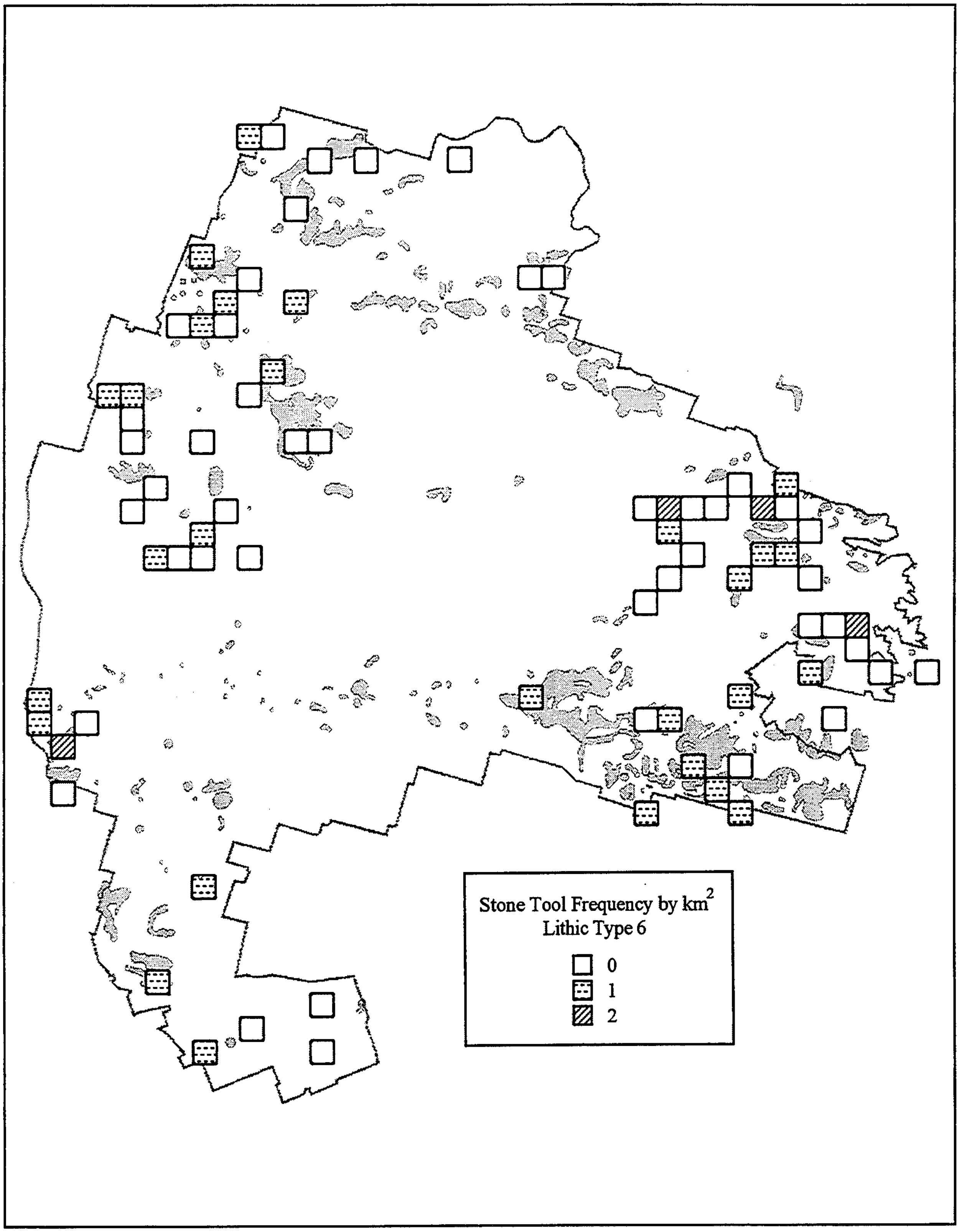

Figure G.7 Frequency Distribution of Heiner Lake Tan (Type 6) Tools.

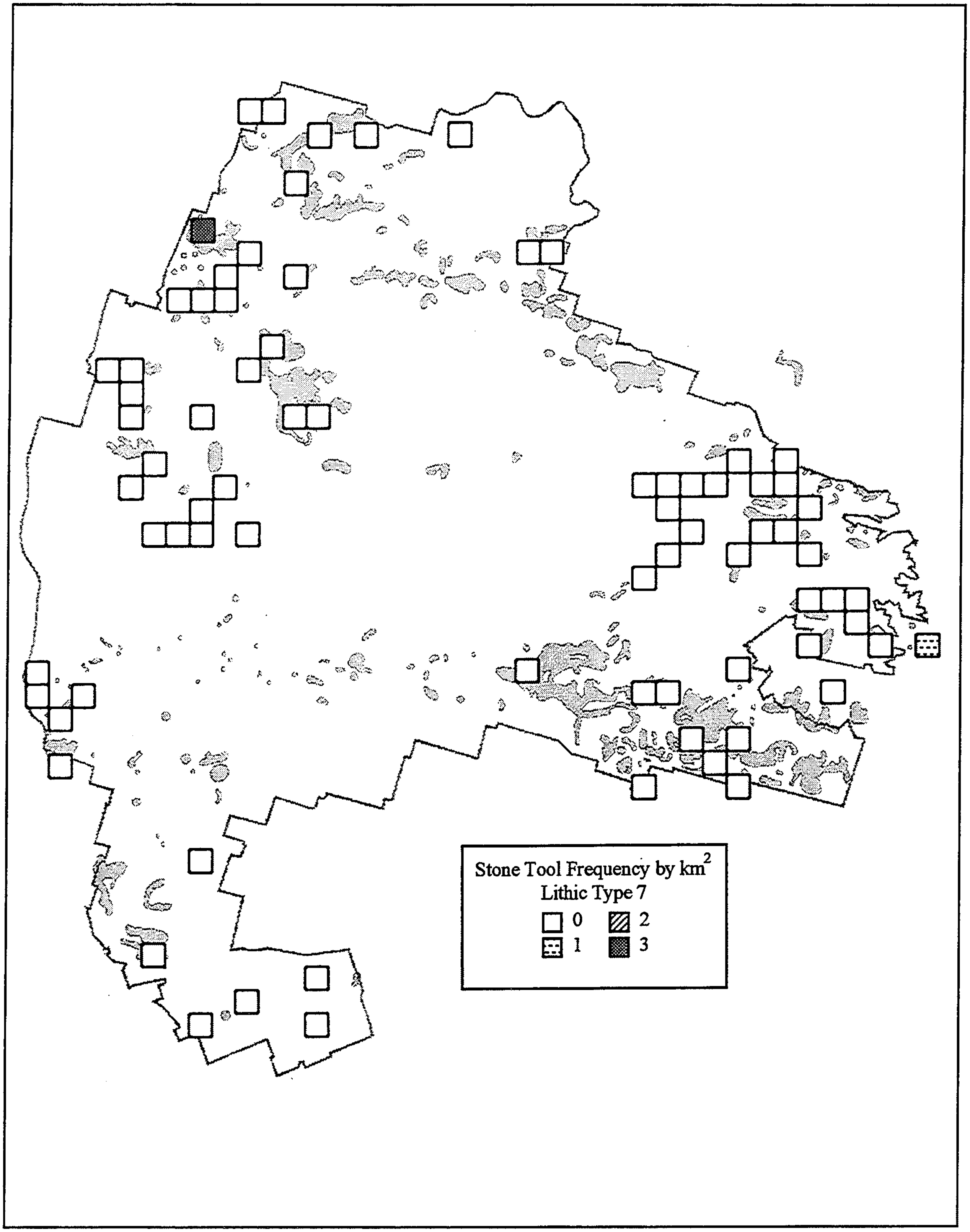

Figure G.8 Frequency Distribution of Fossiliferous Pale Brown (Type 7) Tools.

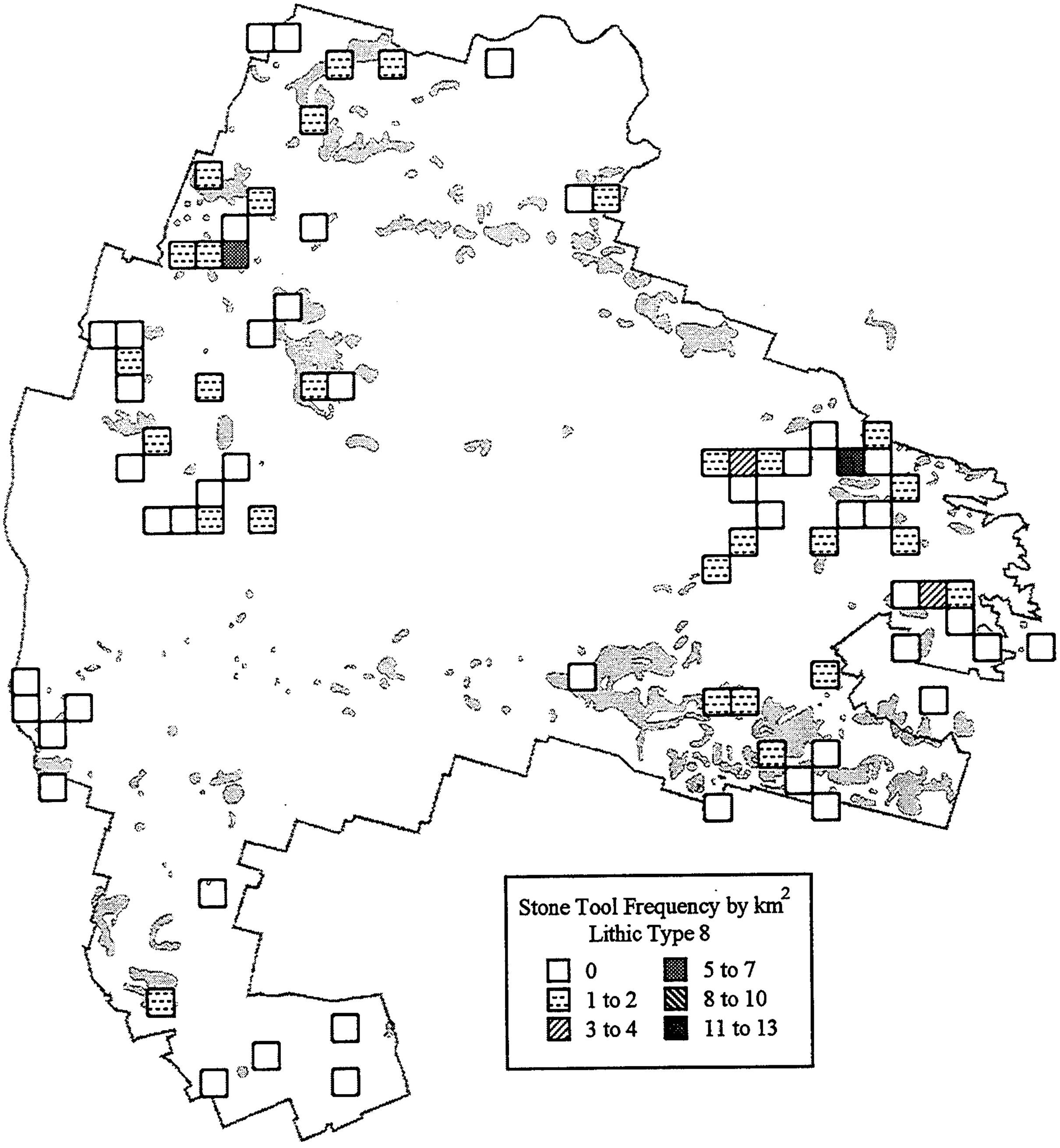

Figure G.9 Frequency Distribution of Fort Hood Yellow (Type 8) Tools.

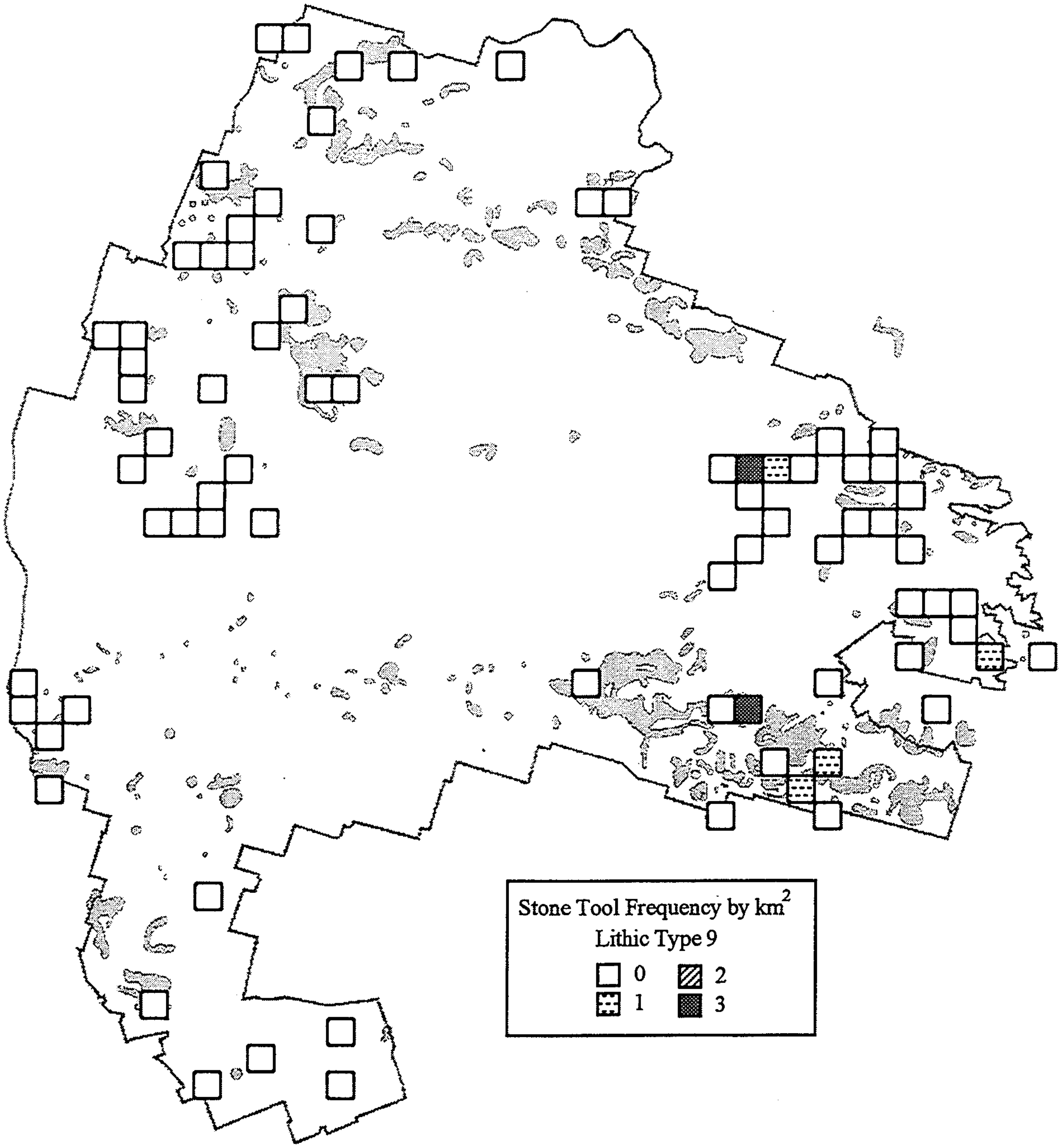

Figure G.10 Frequency Distribution of Heiner Lake Translucent Brown (Type 9) Tools.

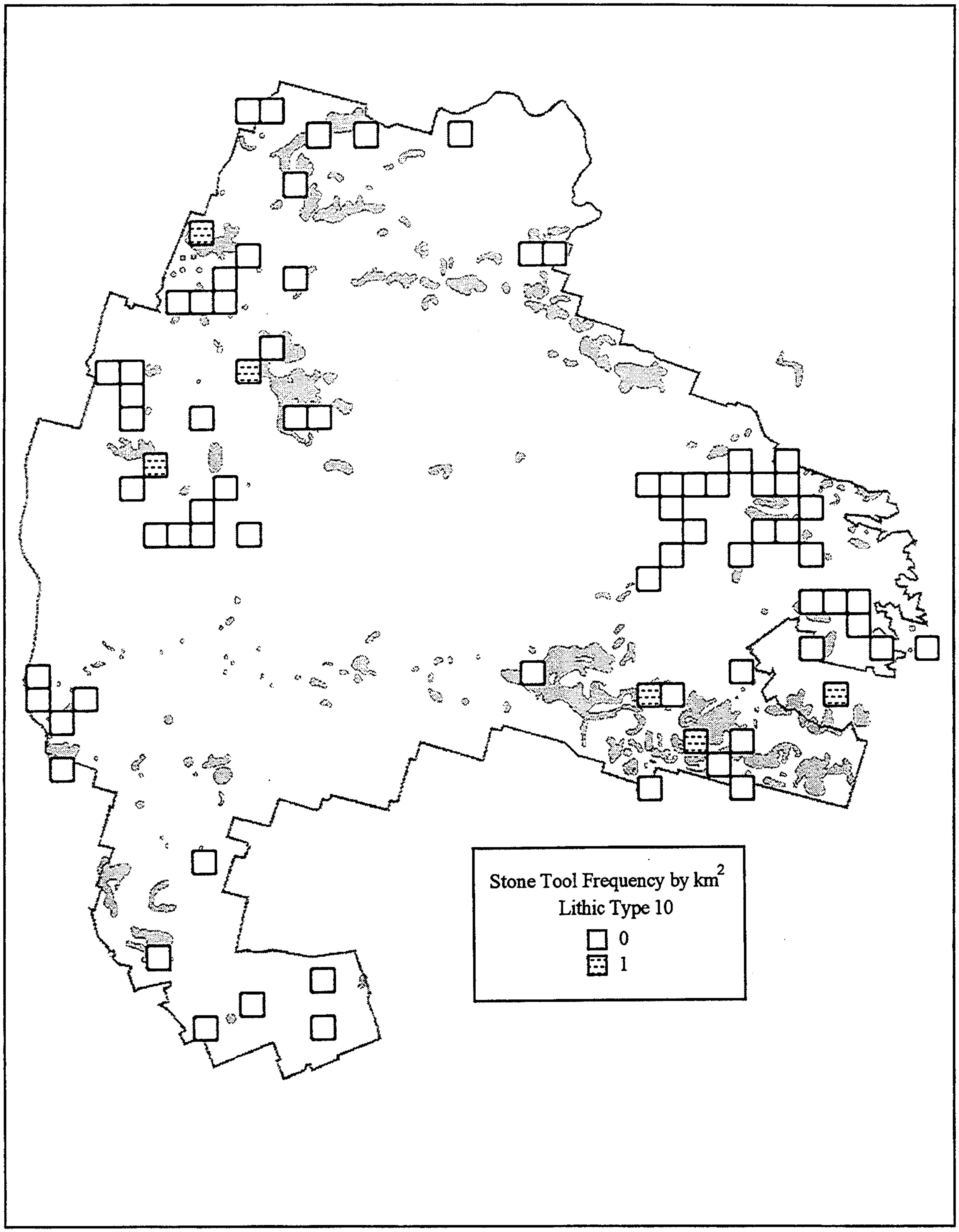

Figure G.11 Frequency Distribution of Heiner Lake Blue (Type 10) Tools.

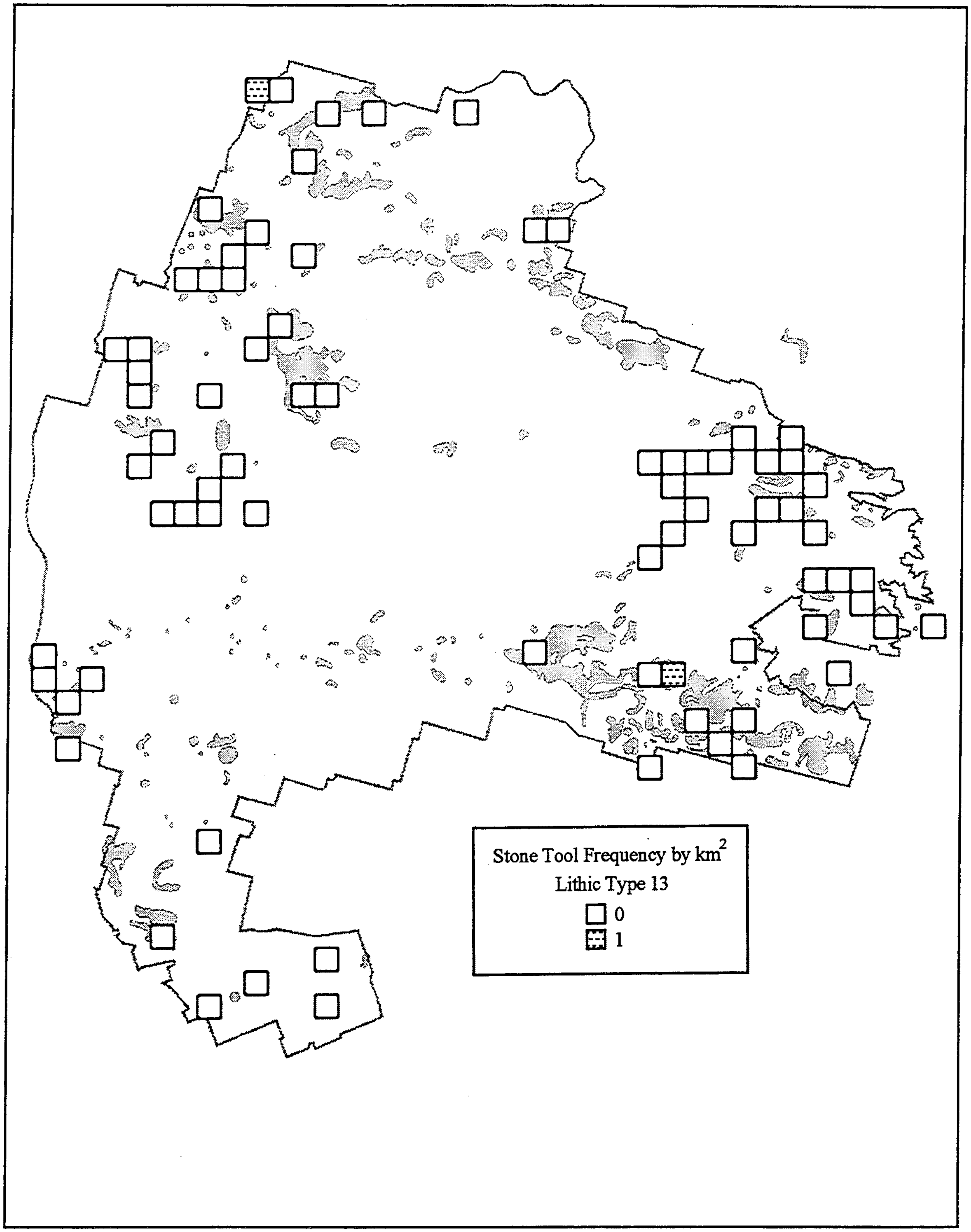

Figure G.12 Frequency Distribution of East Range Flecked (Type 13) Tools.

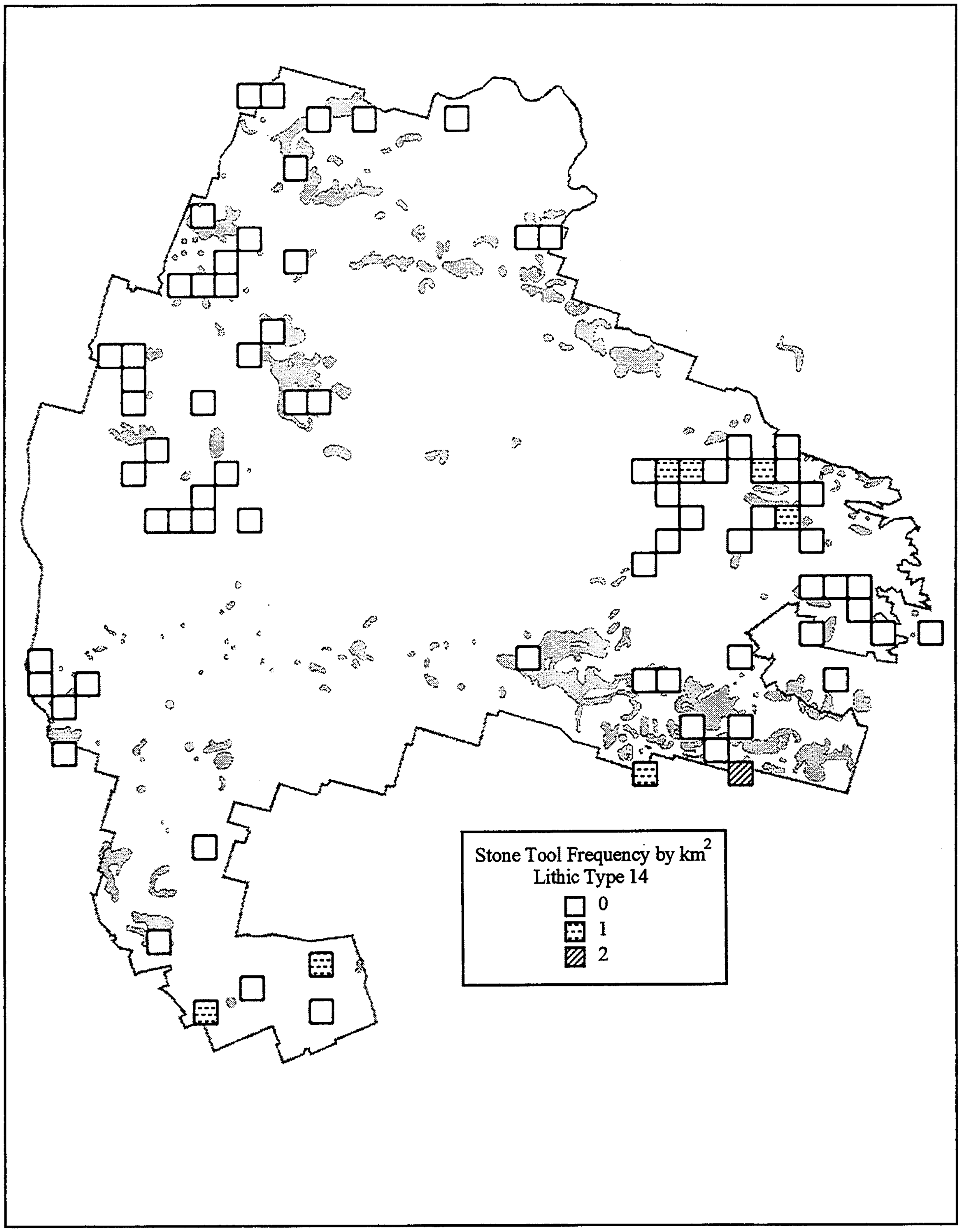

Figure G.13 Frequency Distribution of Fort Hood Gray (Type 14) Tools.

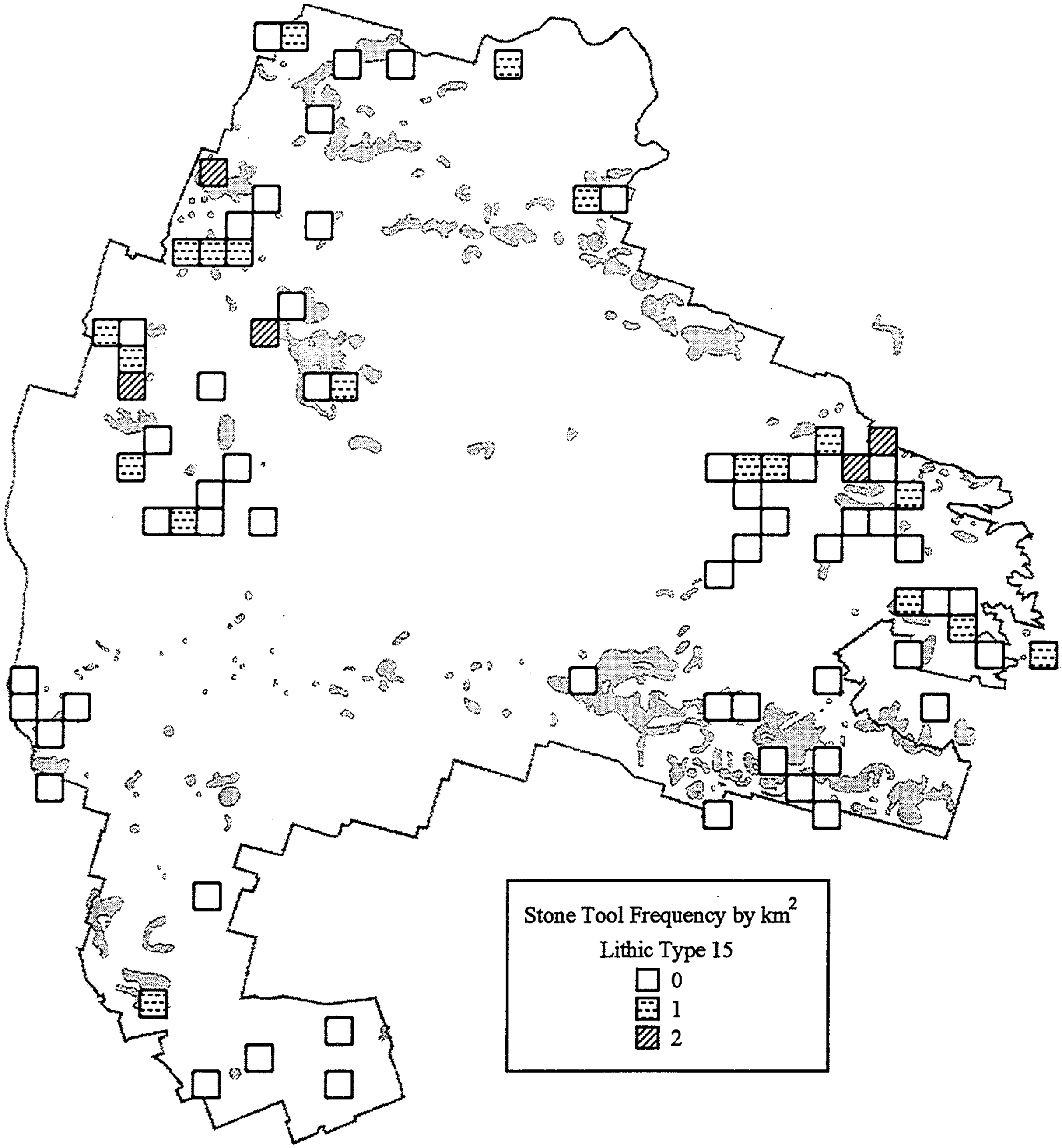

Figure G.14 Frequency Distribution of Gray-Brown-Green (Type 15) Tools.

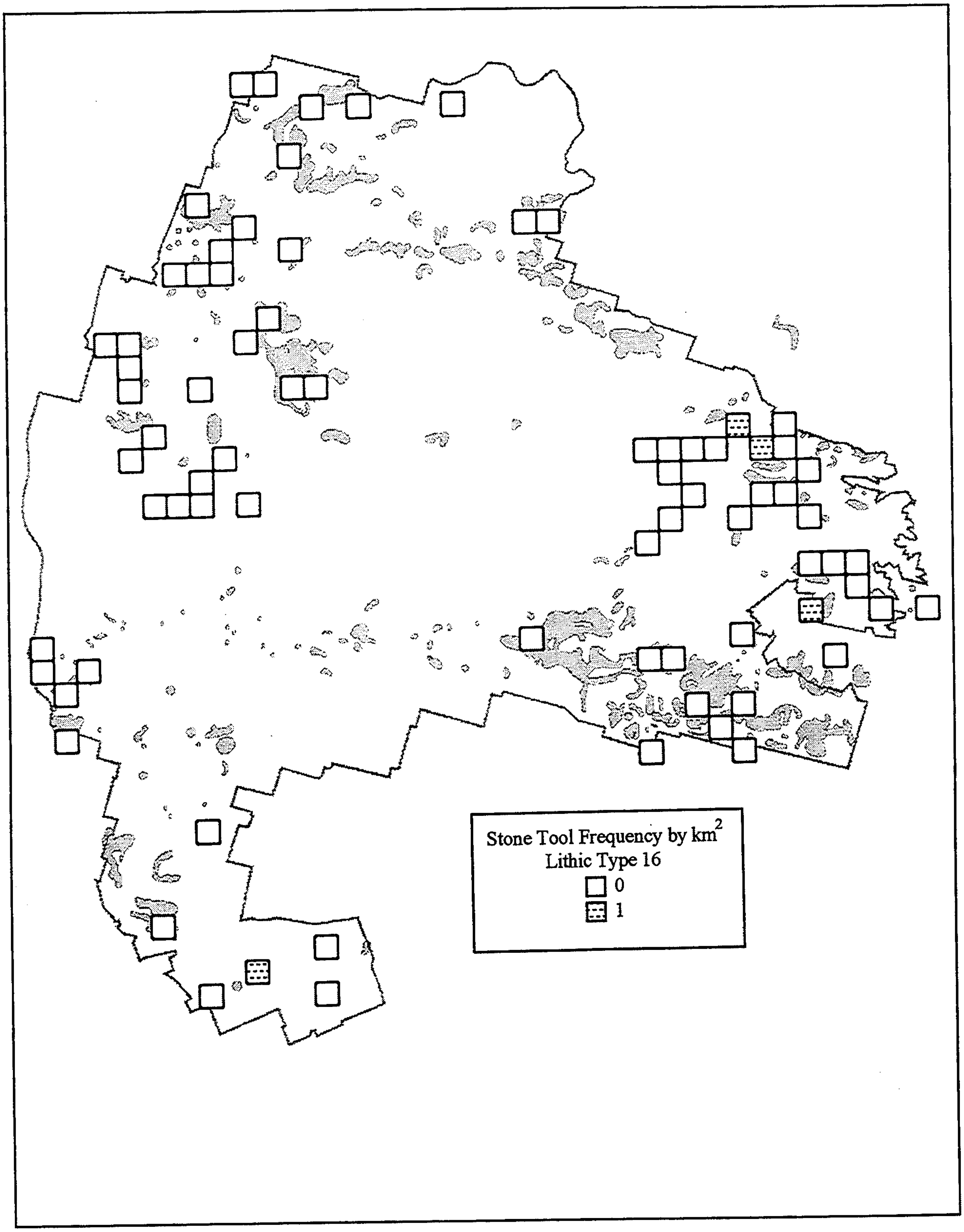

Figure G.15 Frequency Distribution of Leona Park (Type 16) Tools.

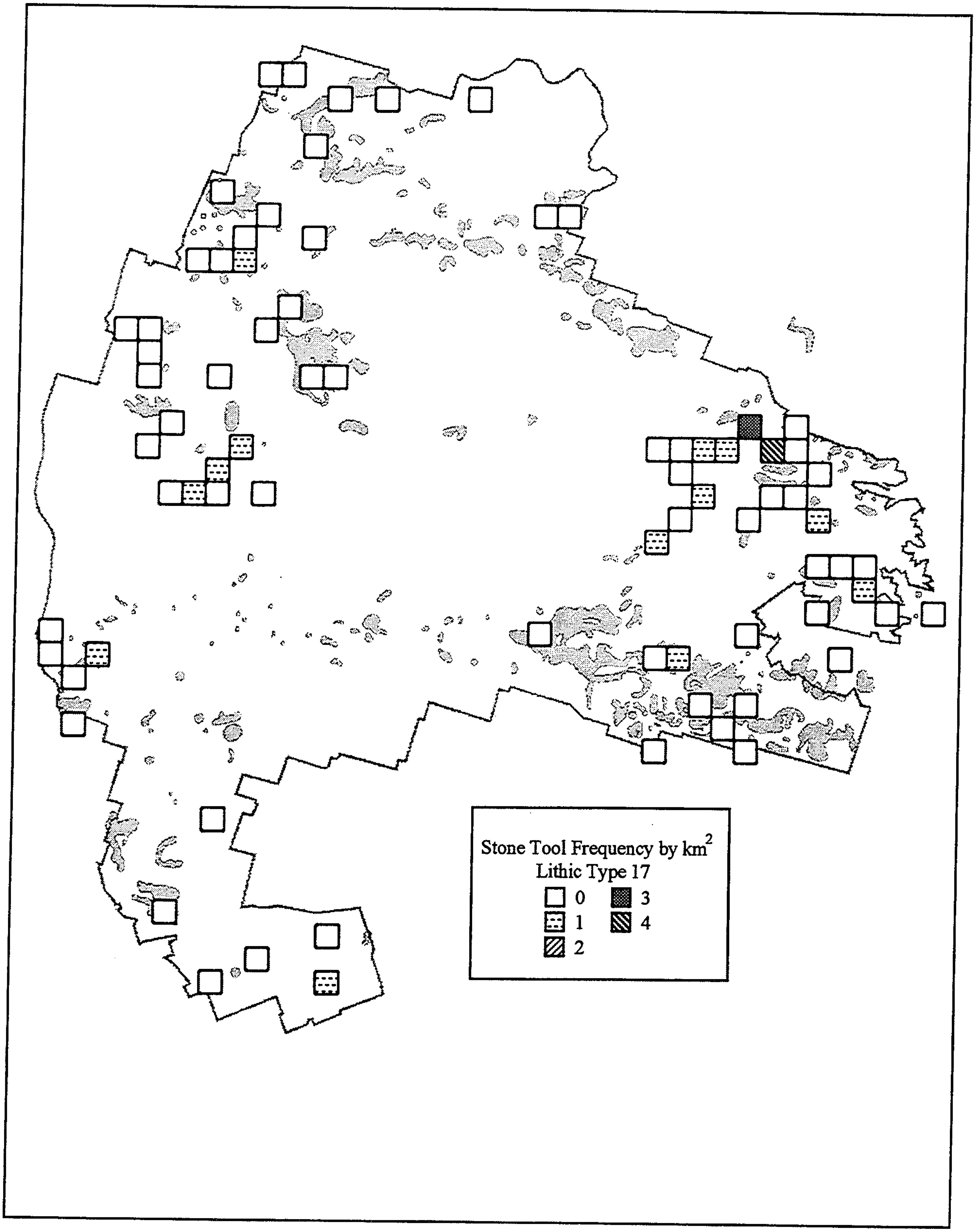

Figure G.16 Frequency Distribution of Owl Creek Black (Type 17) Tools.

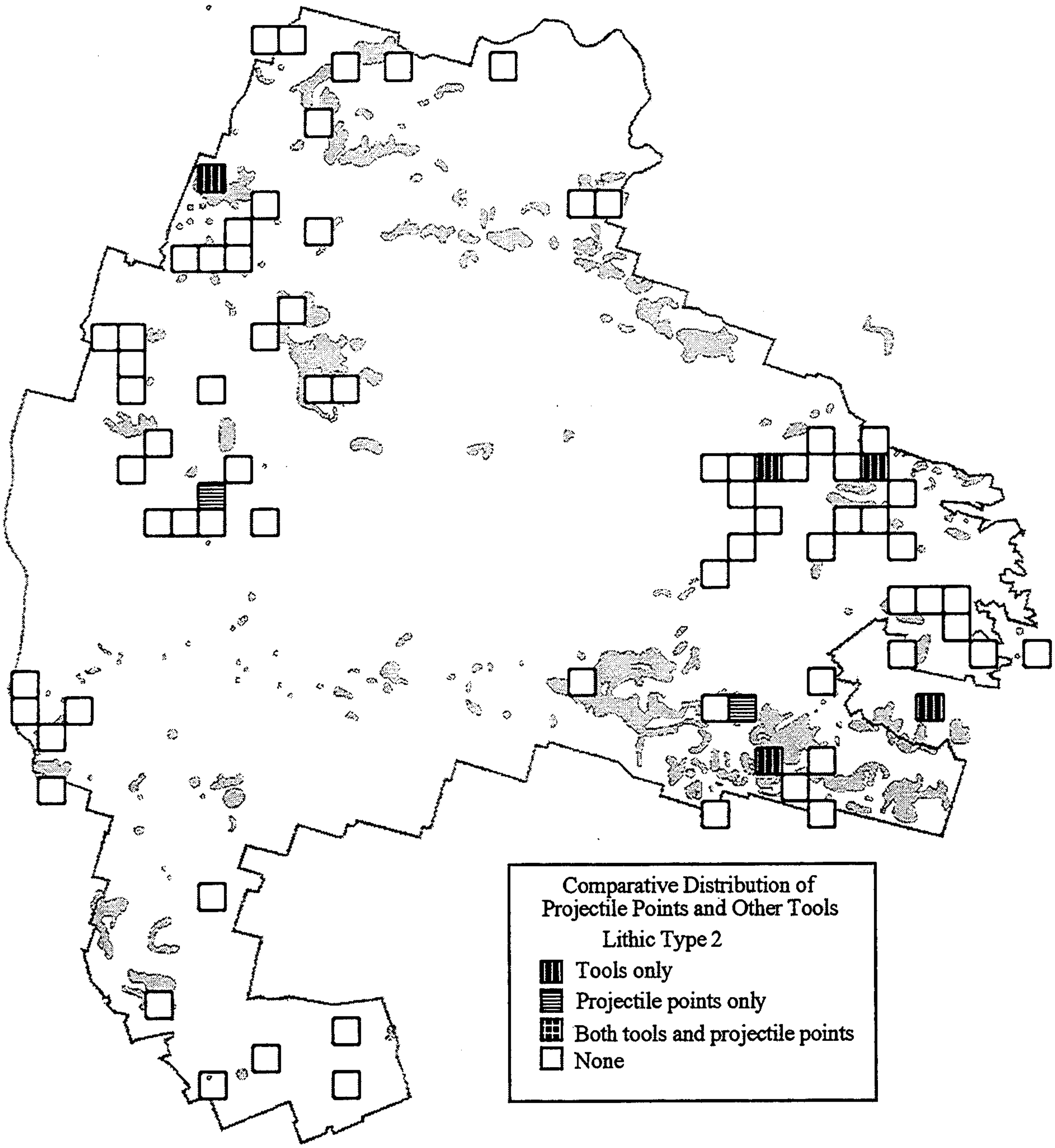

Figure G.17 Comparative Distribution of Cowhouse White (Type 2) Projectile Points and Other Tools.

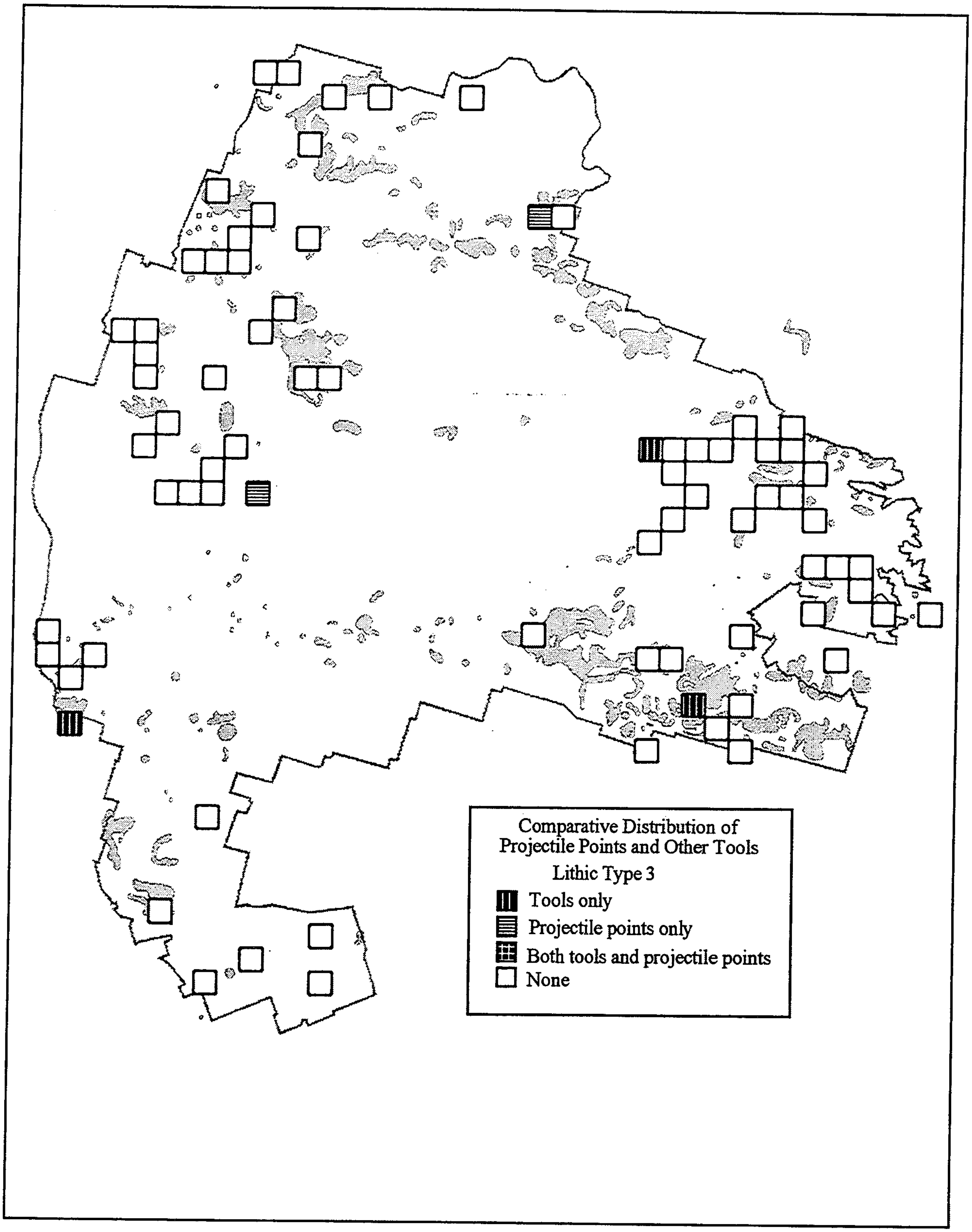

Figure G.18 Comparative Distribution of Anderson Mountain Gray (Type 3) Points and Others.

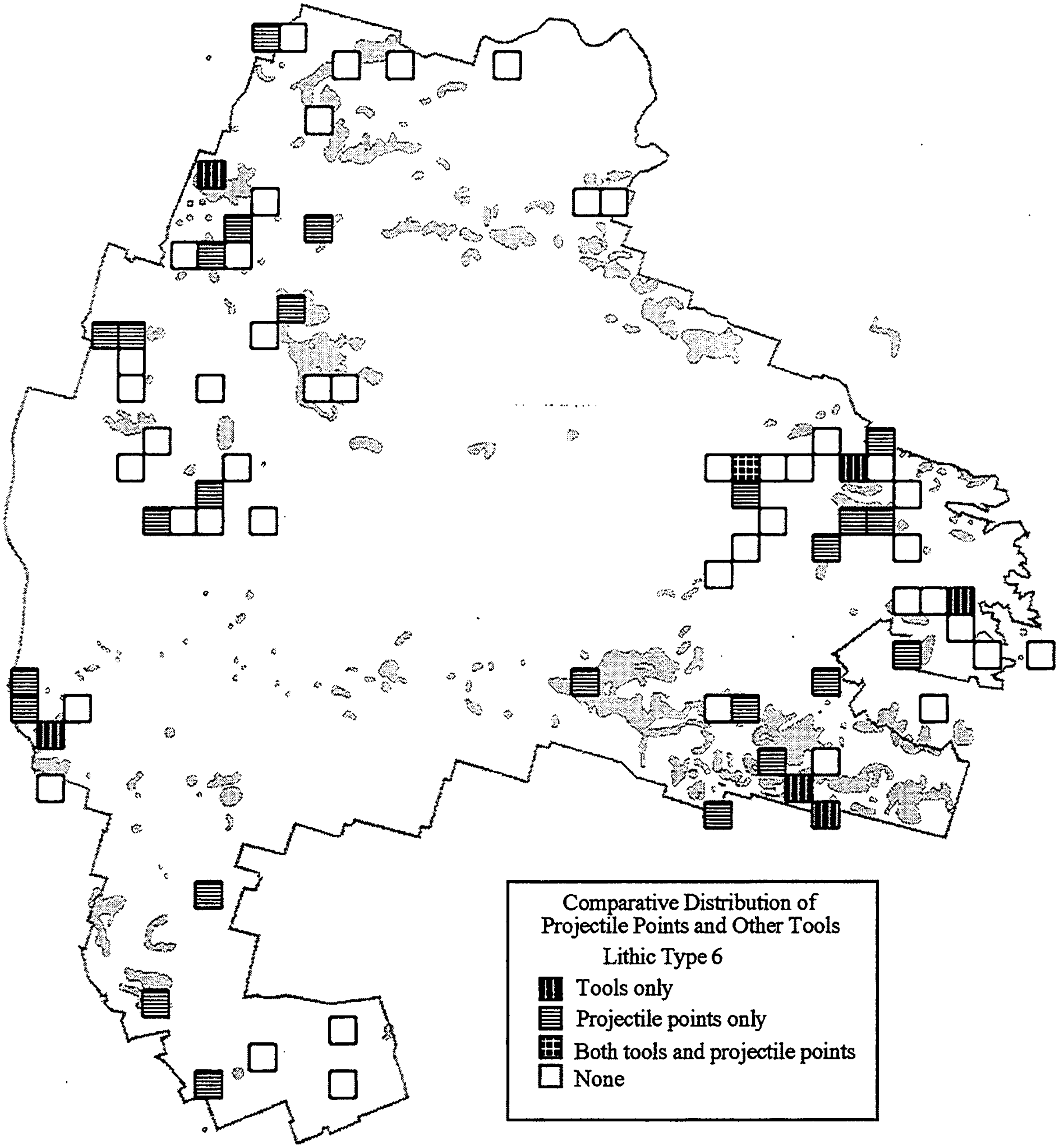

Figure G.19 Comparative Distribution of Heiner Lake Tan (Type 6) Projectile Points and Other Tools.

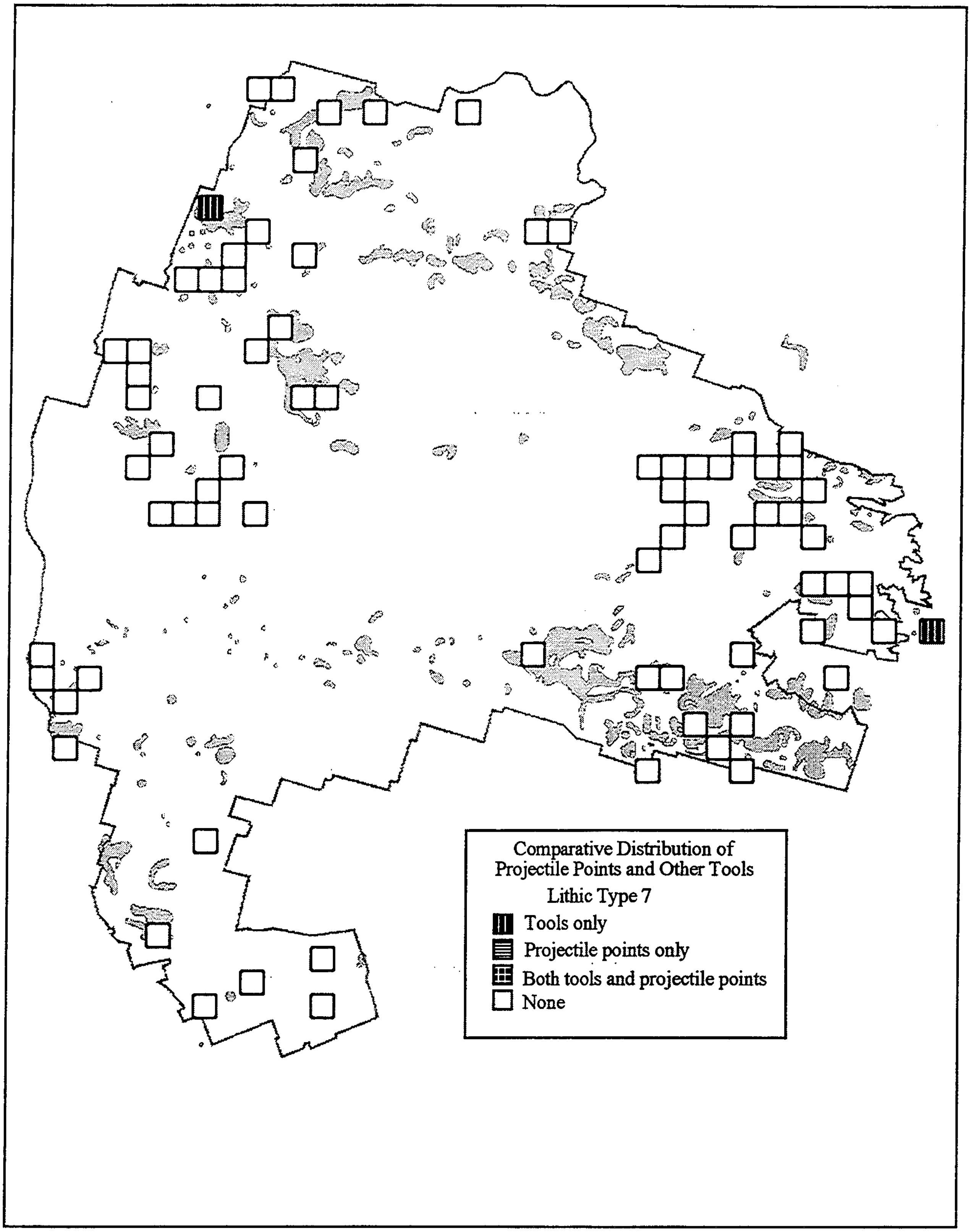

Figure G.20 Comparative Distribution of Fossiliferous Pale Brown (Type 7) Points and Other Tools.

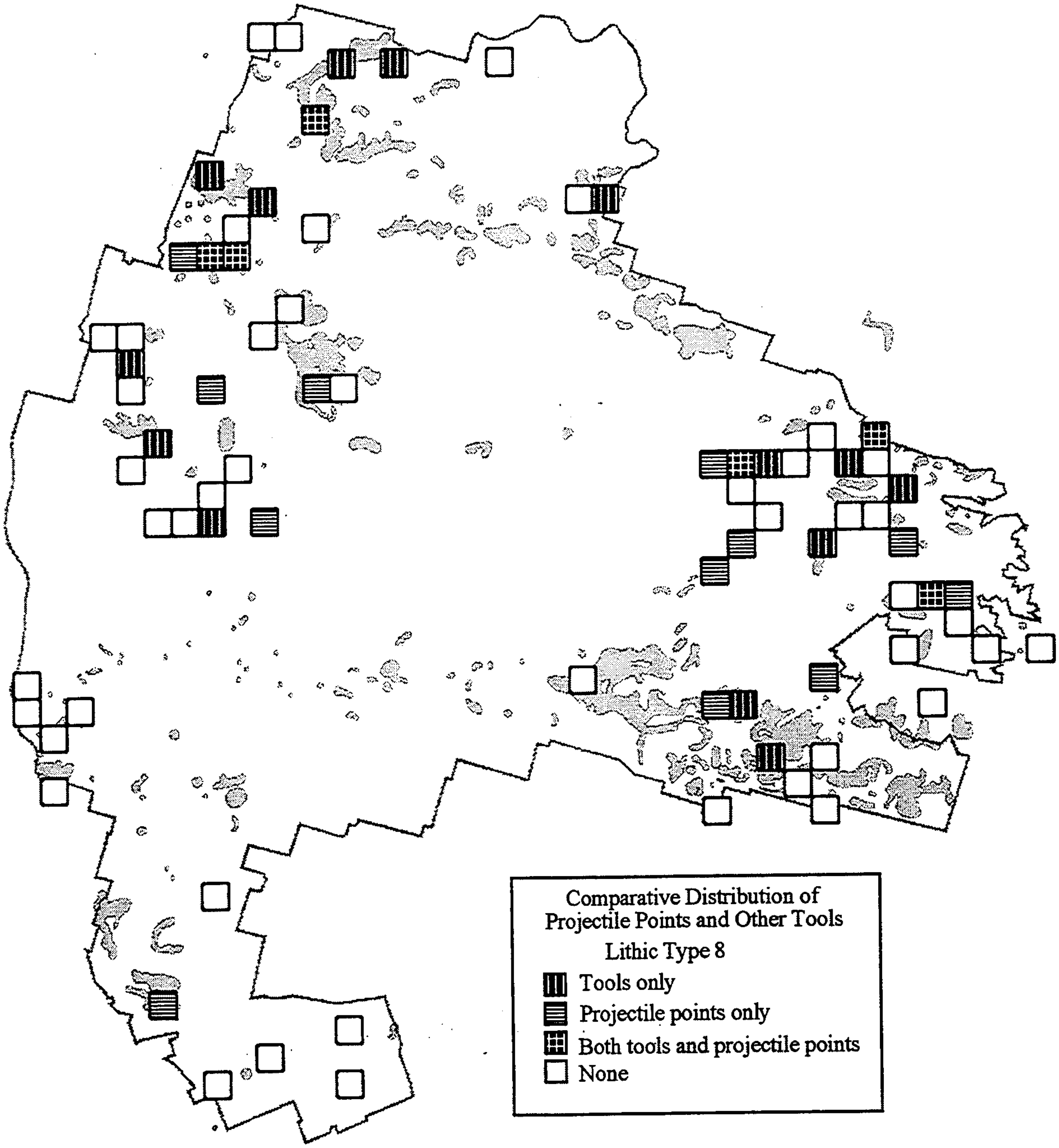

Figure G.21 Comparative Distribution of Fort Hood Yellow (Type 8) Projectile Points and Other Tools.

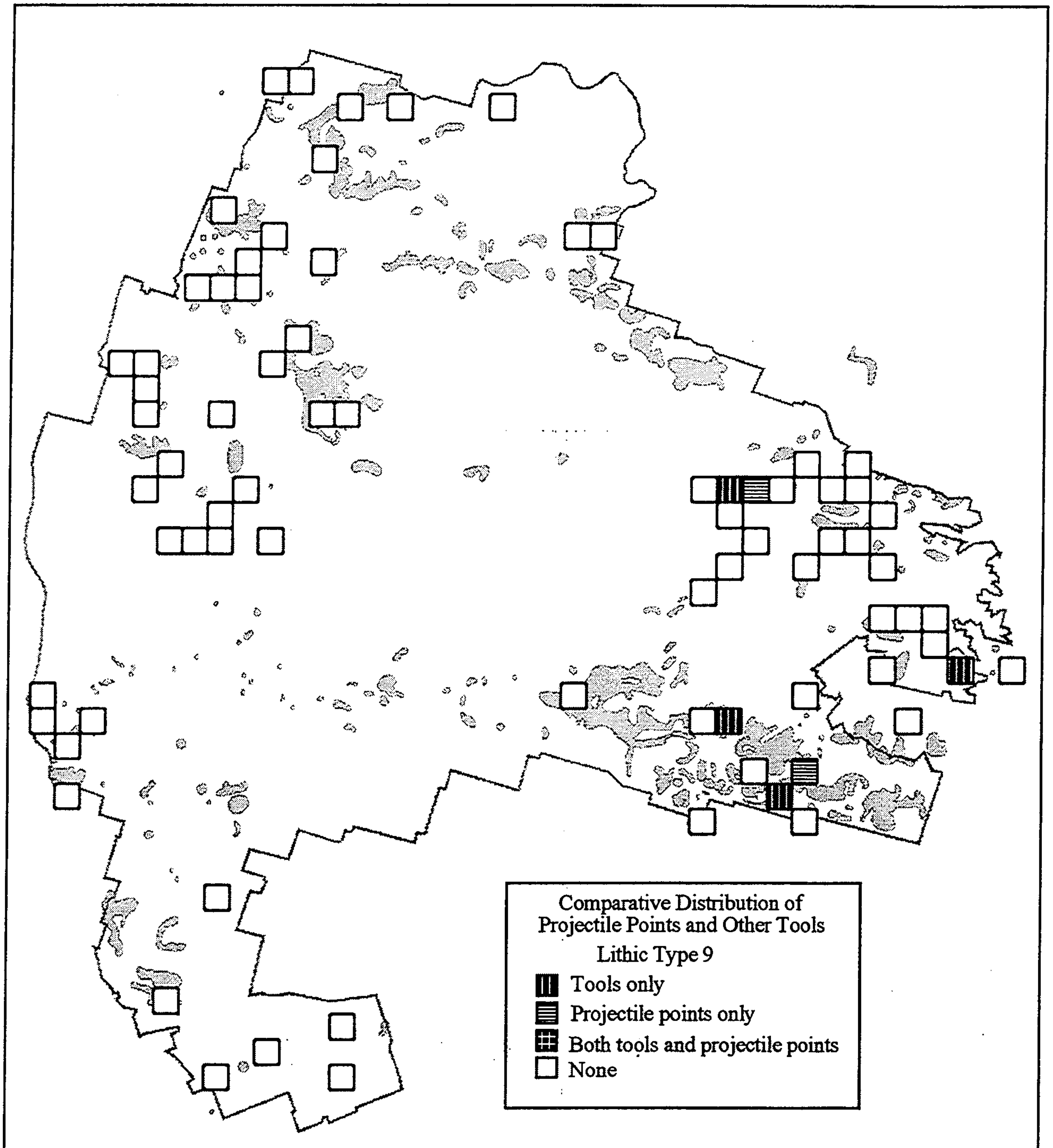

Figure G.22 Comparative Dist. of Heiner Lake Translucent Brown (Type 9) Points and Other Tools.

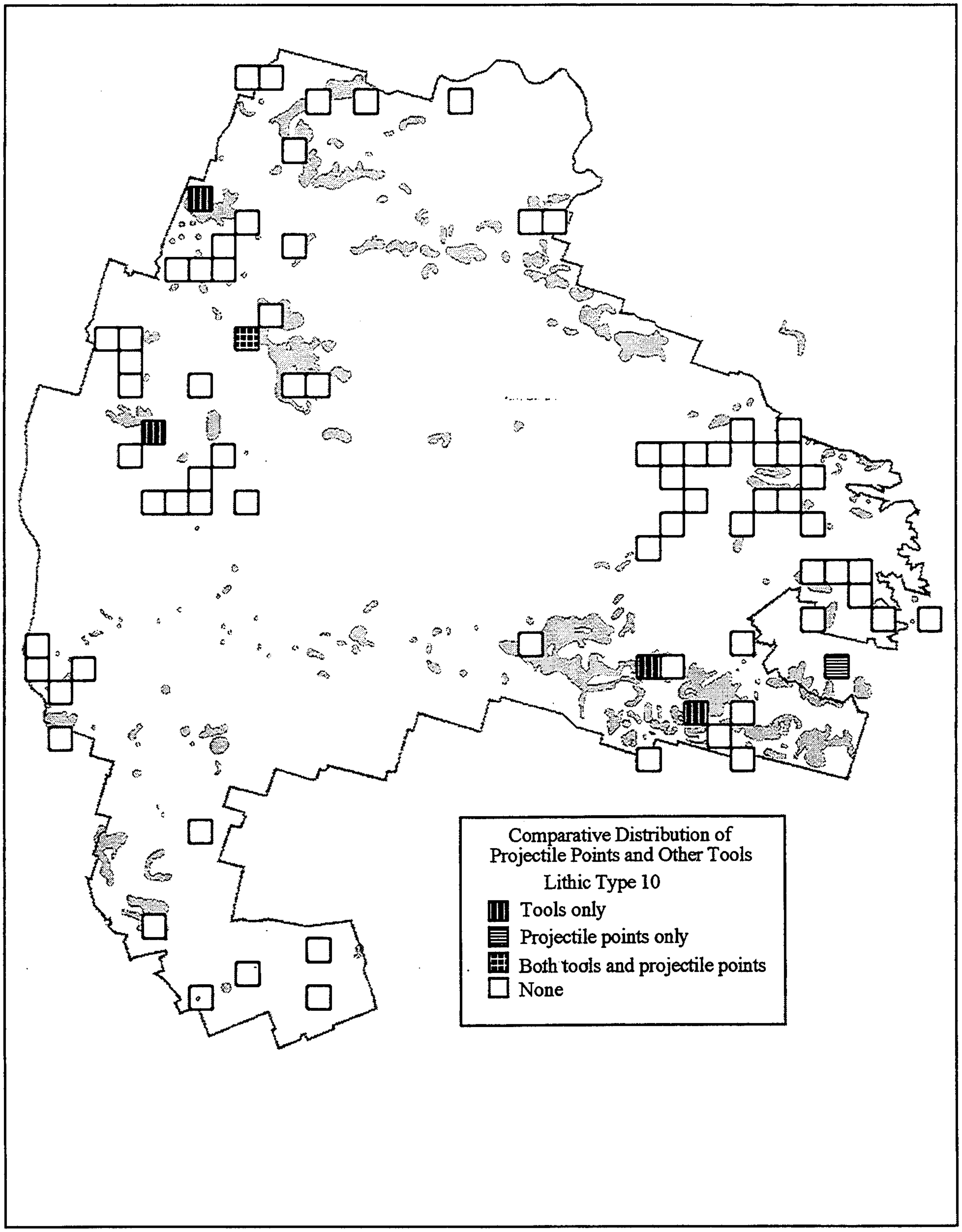

Figure G.23 Comparative Distribution of Heiner Lake Blue (Type 10) Projectile Points and Other Tools.

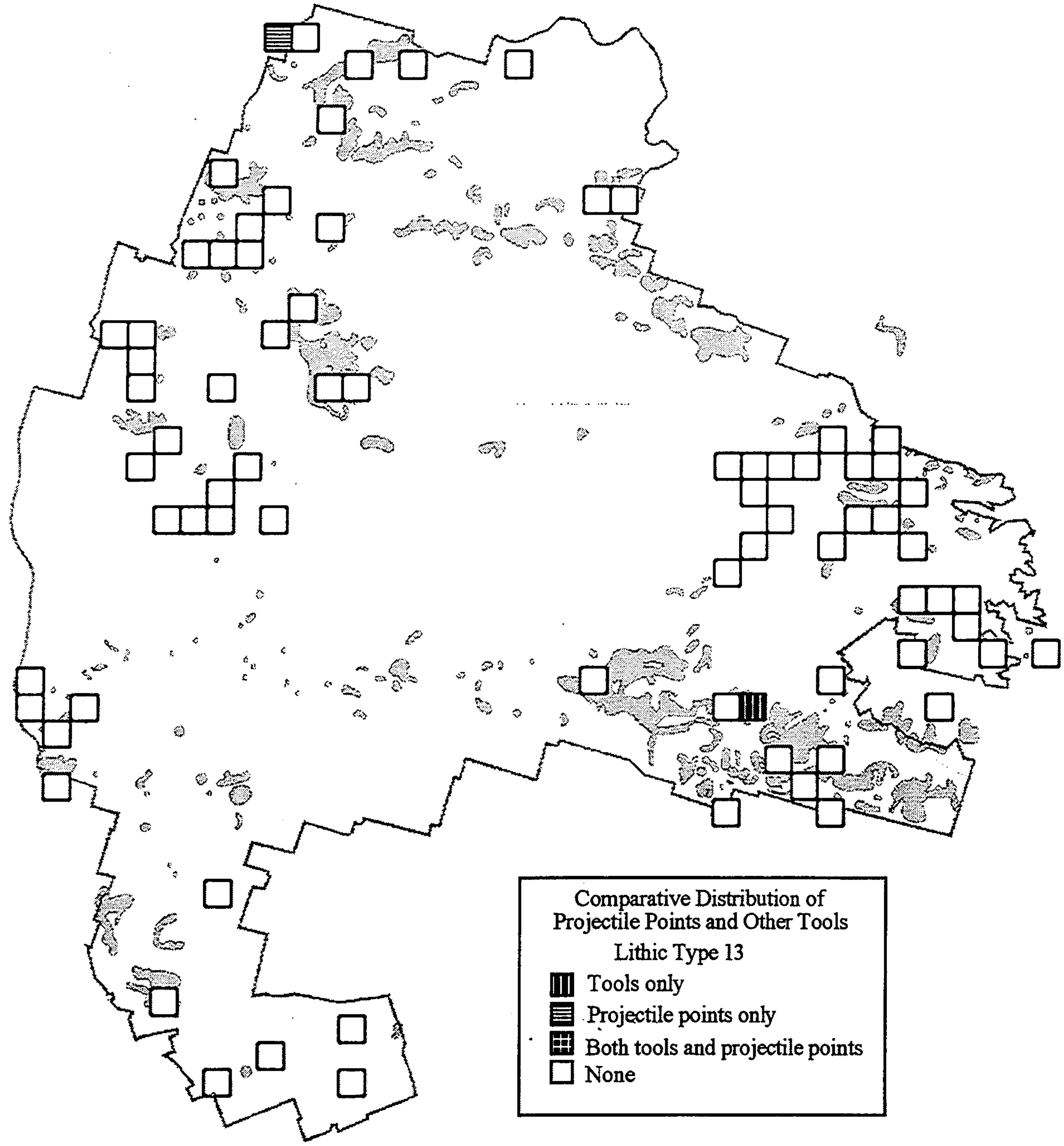

Figure G.24 Comparative Distribution of East Range Flecked (Type 13) Points and Other Tools.

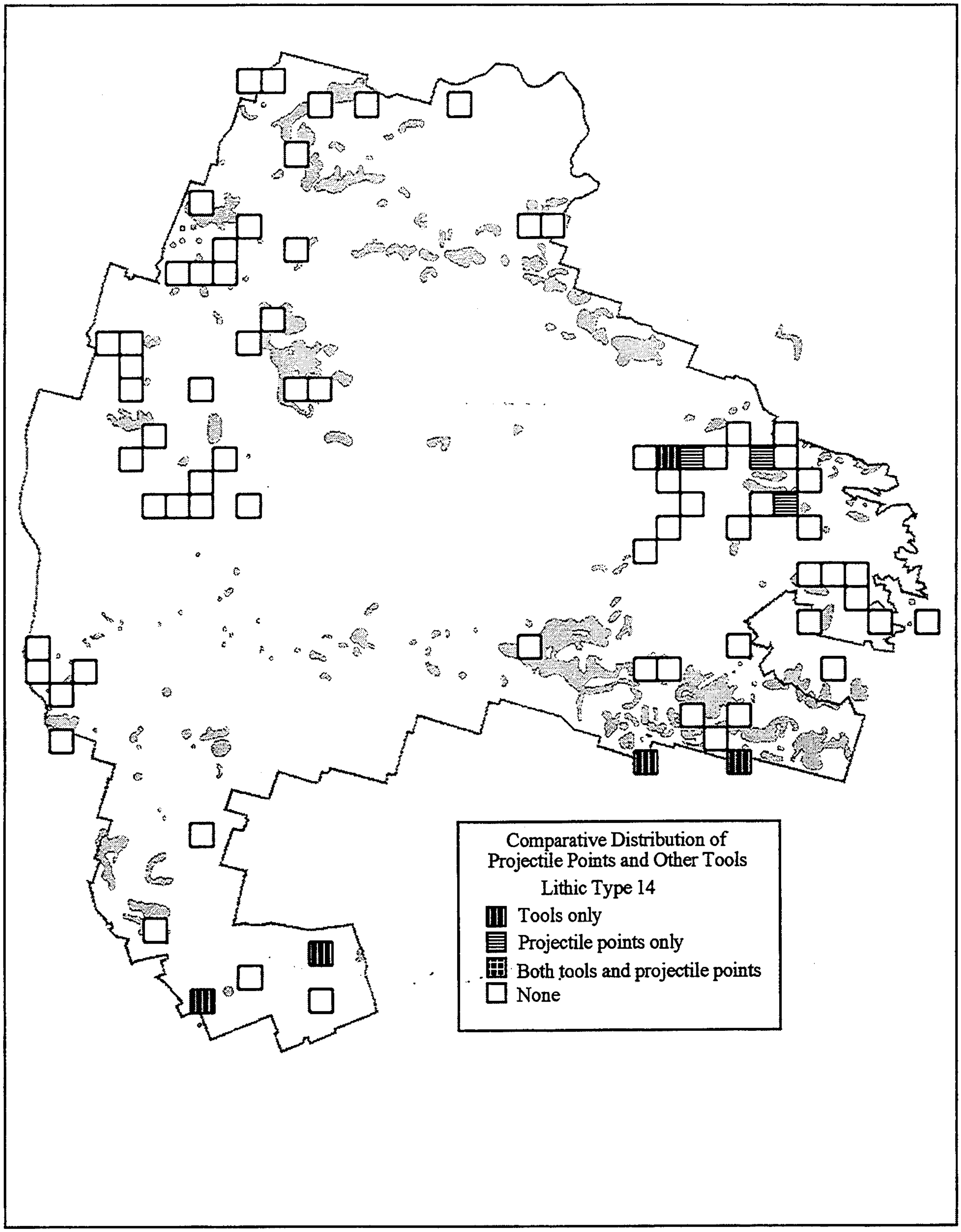

Figure G.25 Comparative Distribution of Fort Hood Gray (Type 14) Projectile Points and Other Tools.

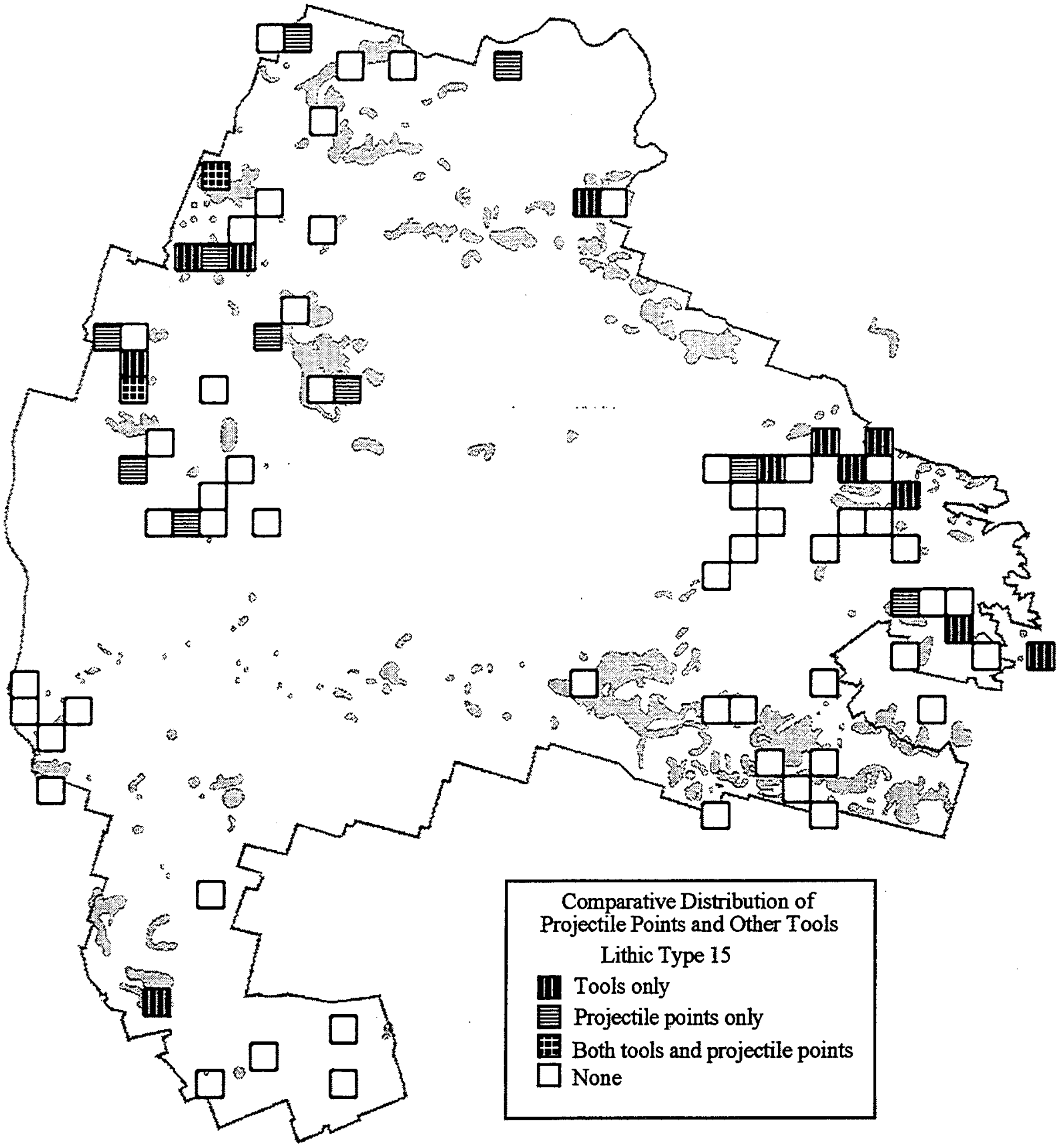

Figure G.26 Comparative Distribution of Gray-Brown-Green (Type 15) Points and Other Tools.

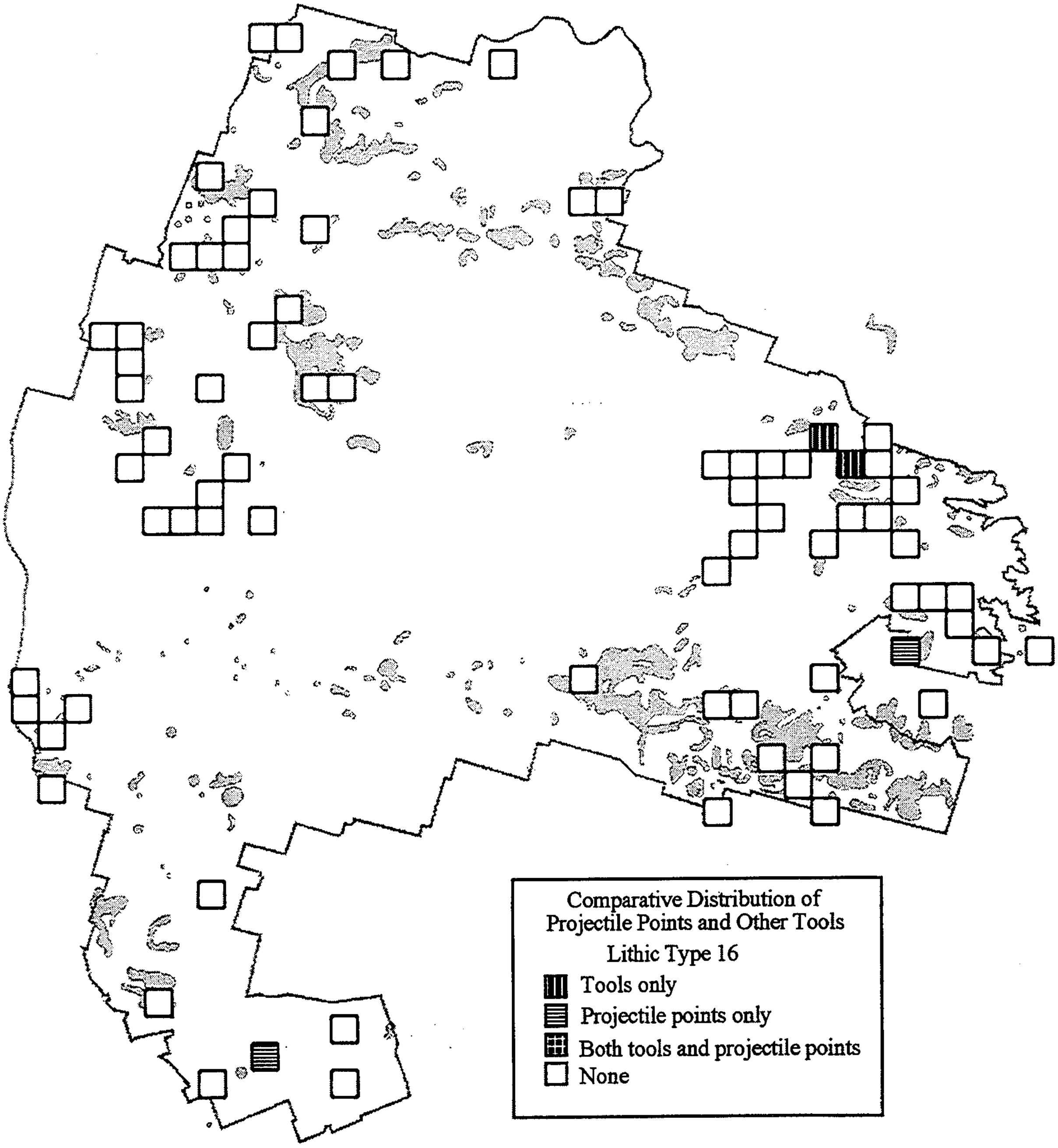

Figure G.27 Comparative Distribution of Leona Park (Type 16) Projectile Points and Other Tools.

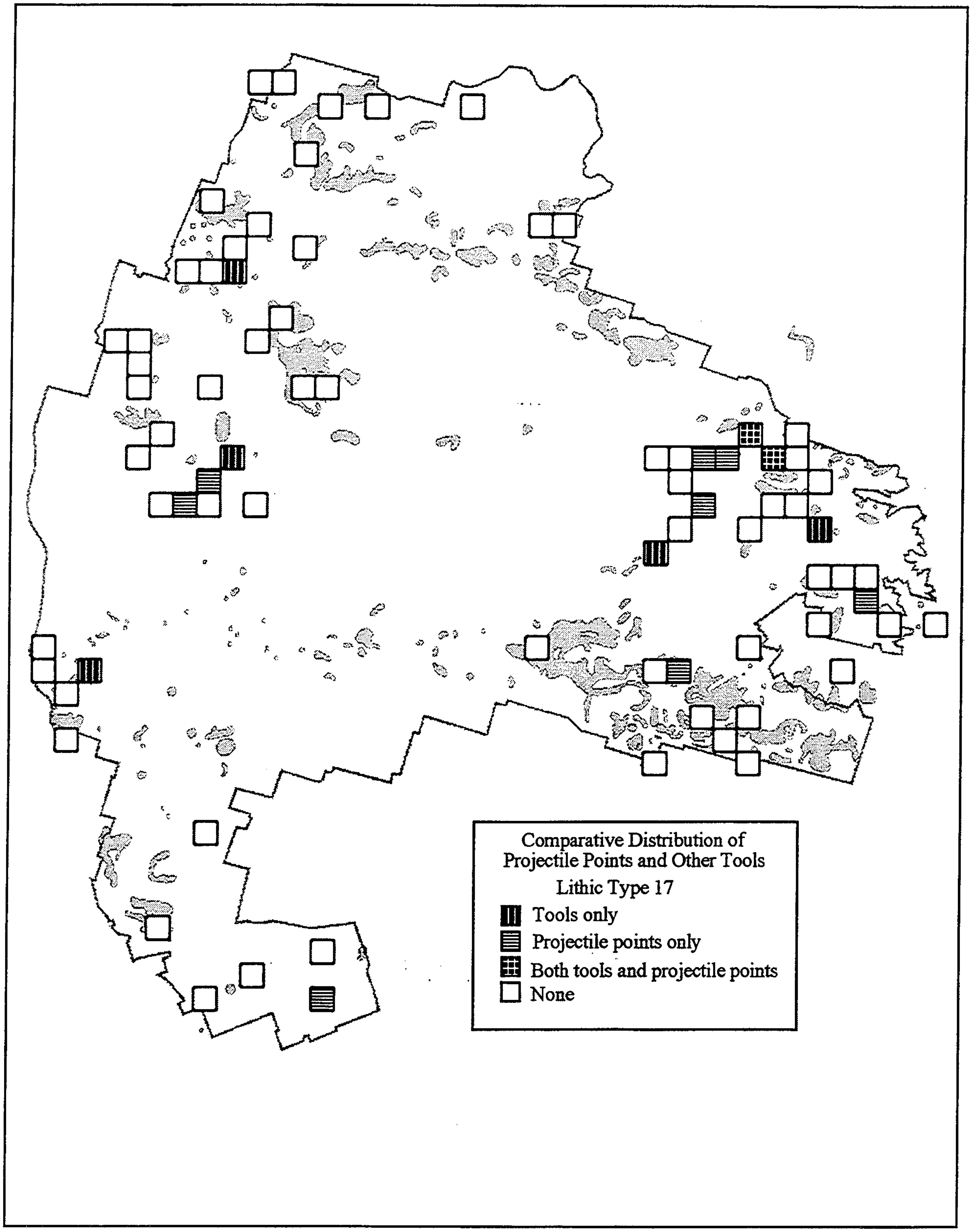

Figure G.28 Comparative Distribution of Owl Creek Black (Type 17) Projectile Points and Other Tools.

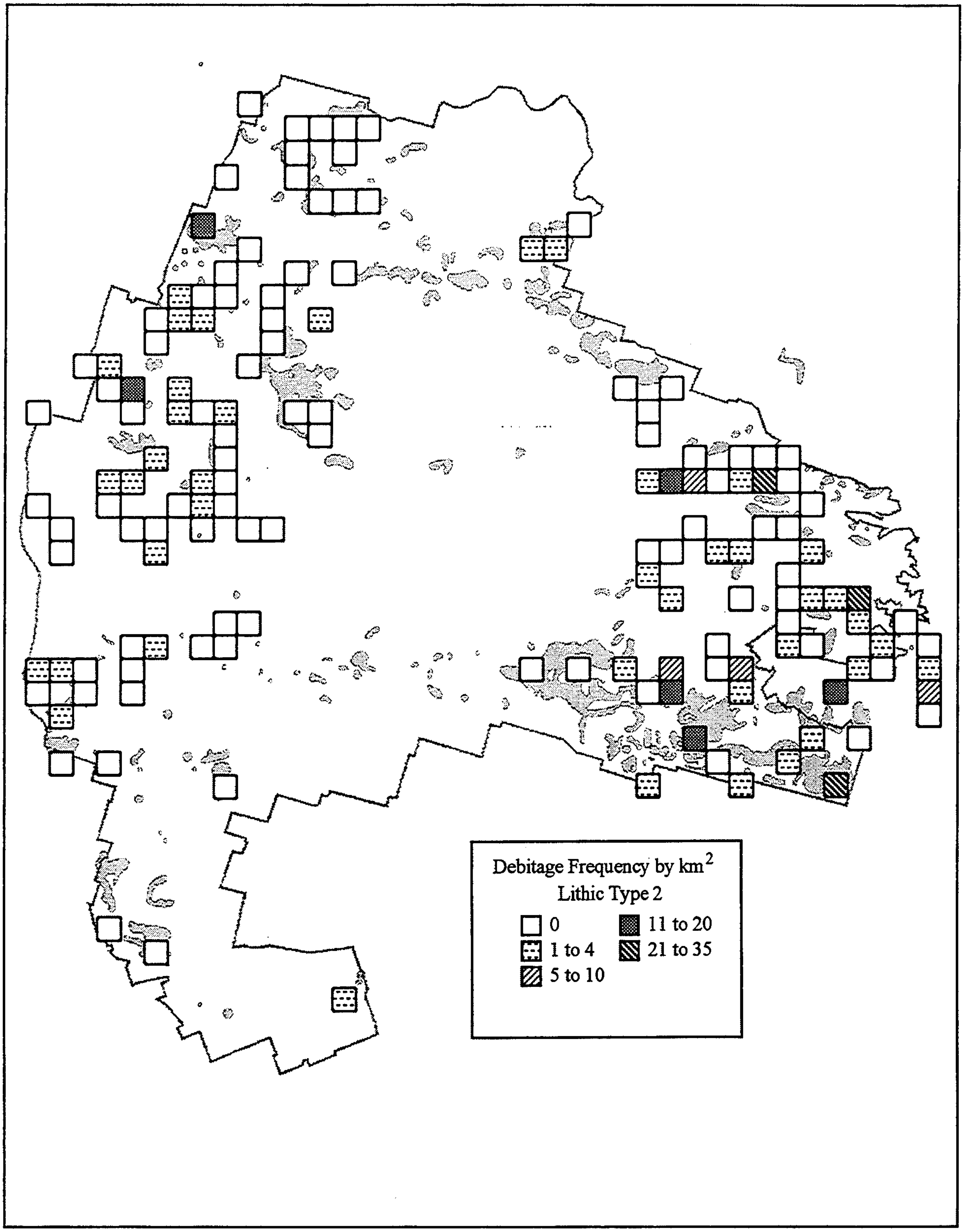

Figure G.29 Frequency Distribution of Cowhouse White (Type 2) Debitage.

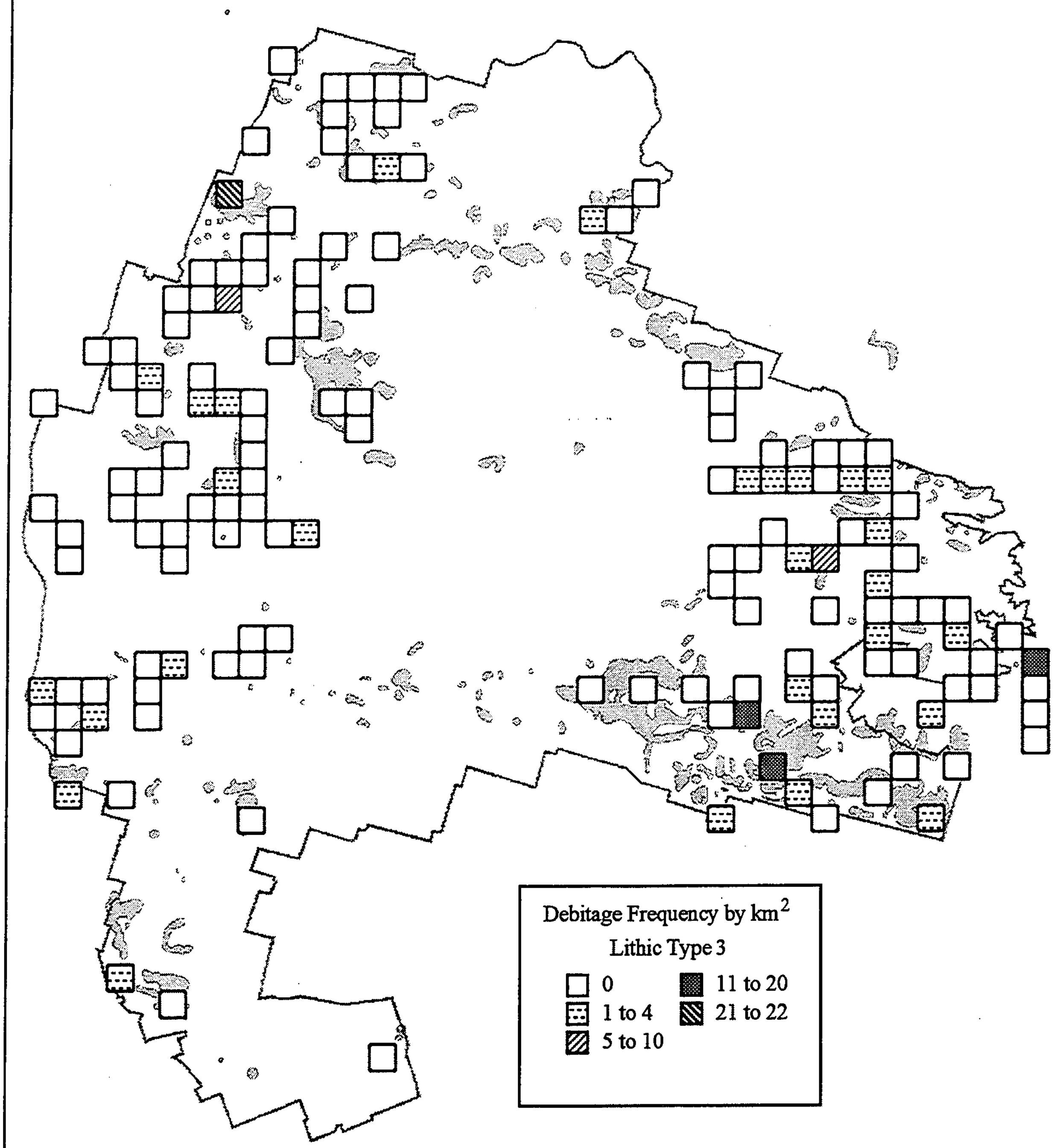

Figure G.30 Frequency Distribution of Anderson Mountain Gray (Type 3) Debitage.

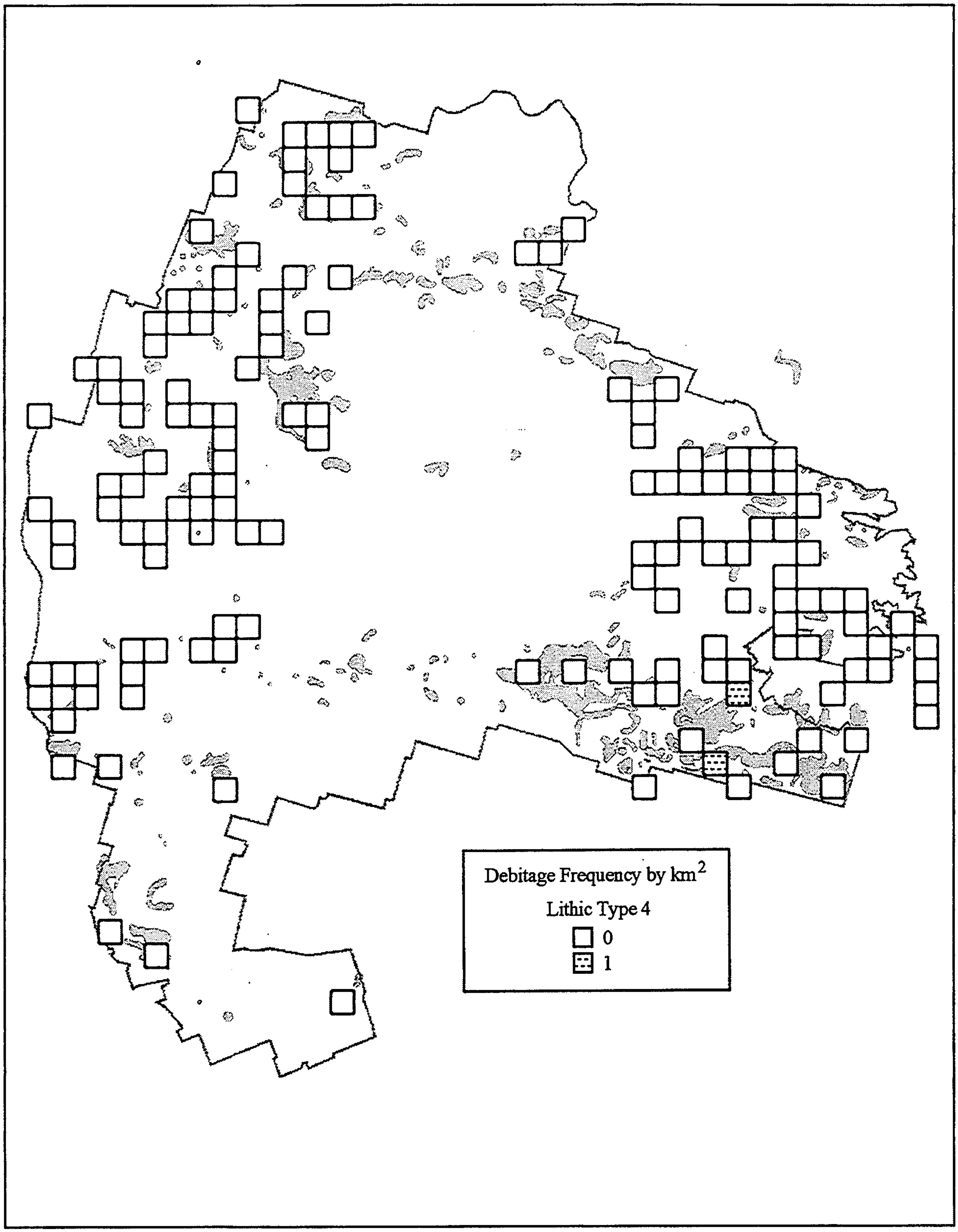

Figure G.31 Frequency Distribution of Seven Mile Mountain Novaculite (Type 4) Debitage.

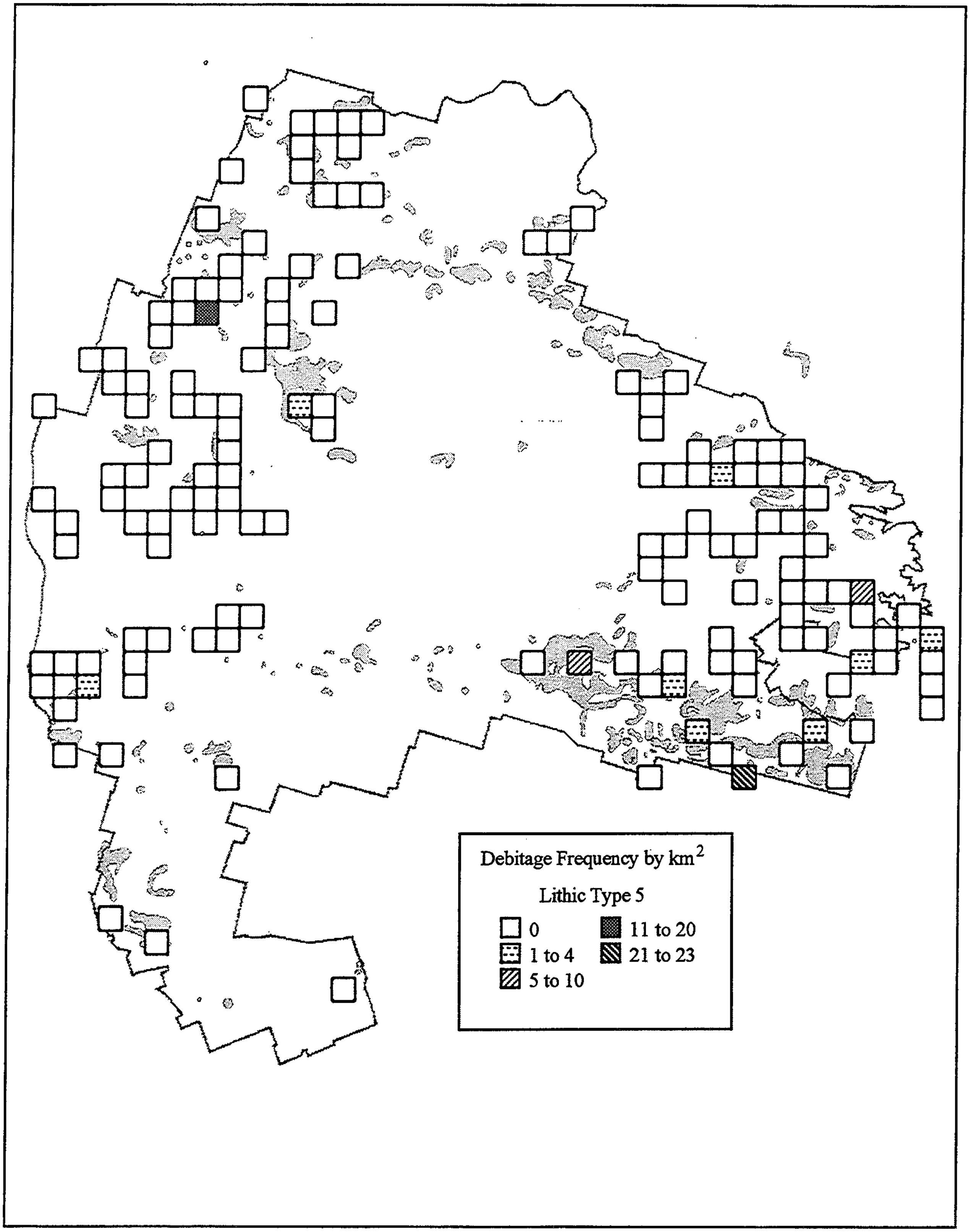

Figure G.32 Frequency Distribution of Texas Novaculite (Type 5) Debitage.

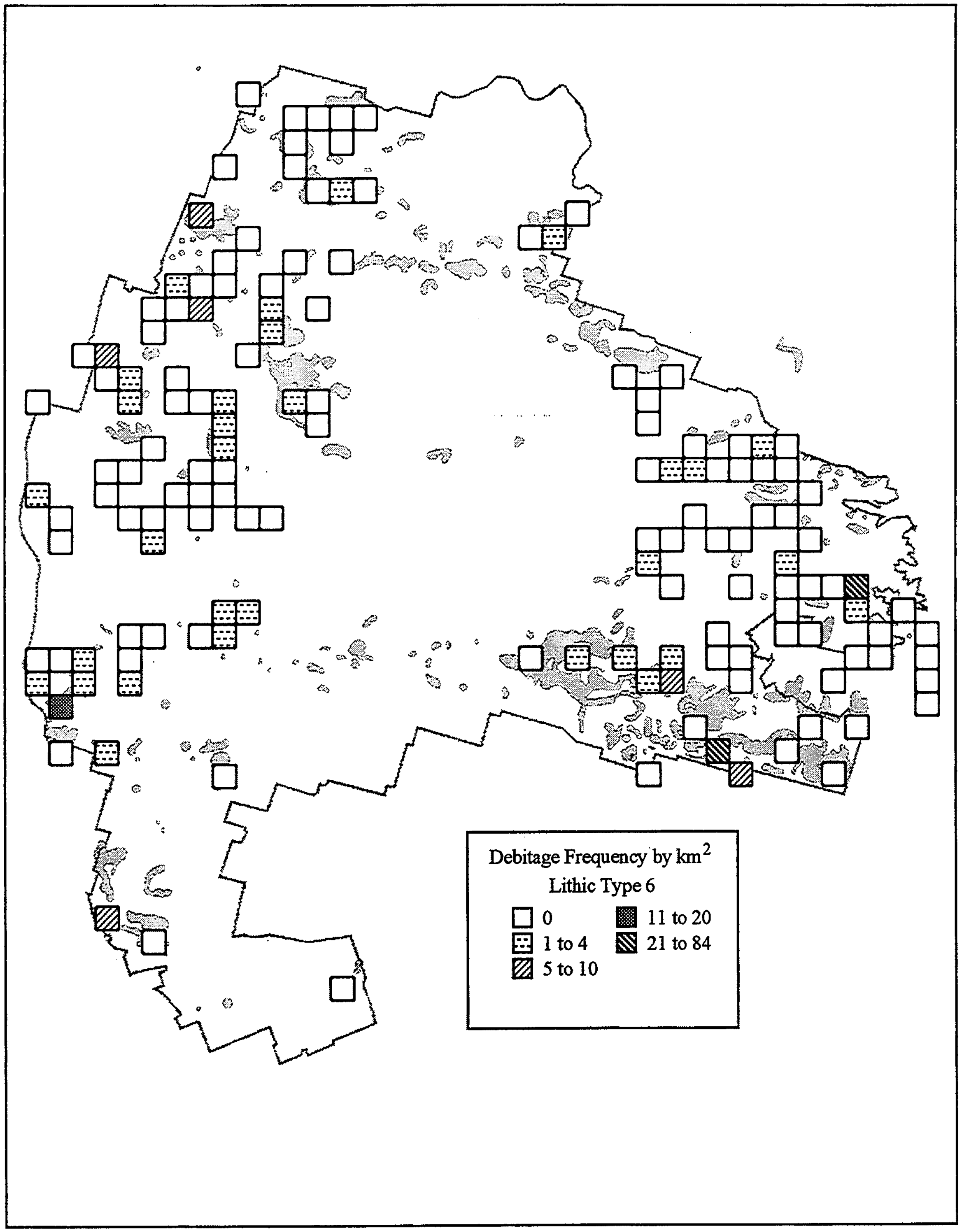

Figure G.33 Frequency Distribution of Heiner Lake Tan (Type 6) Debitage.

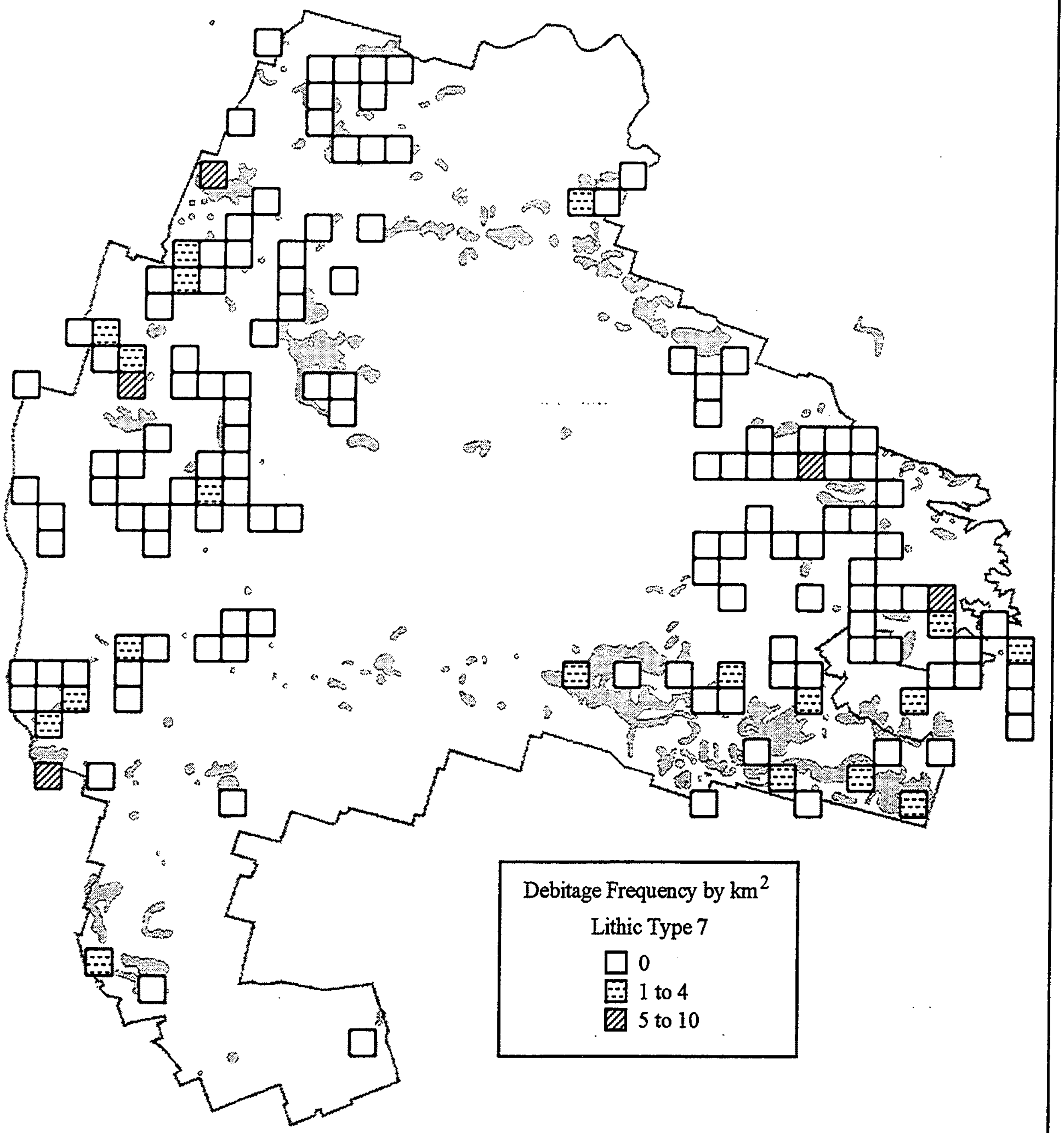

Figure G.34 Frequency Distribution of Fossiliferous Pale Brown (Type 7) Debitage.

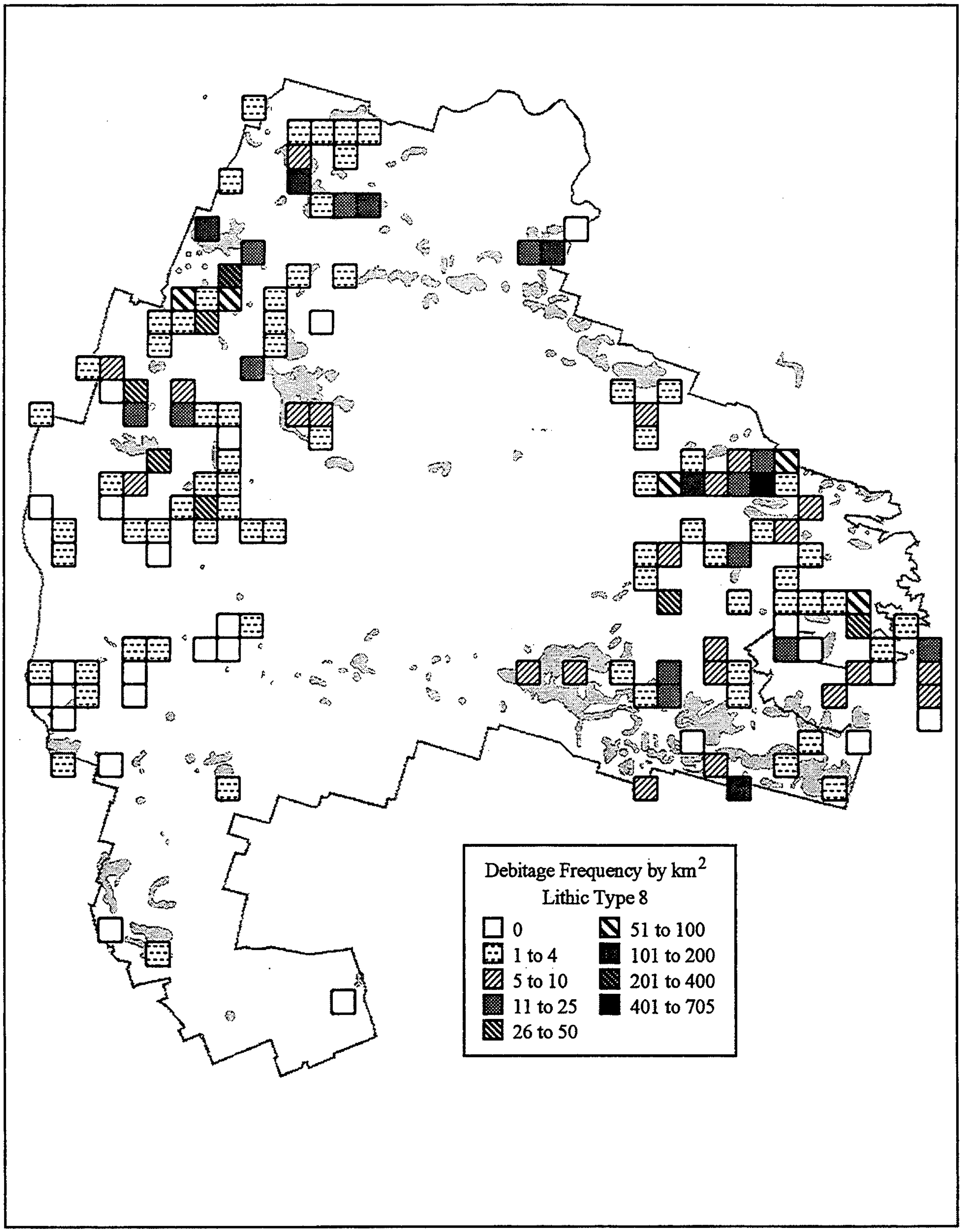

Figure G.35 Frequency Distribution of Fort Hood Yellow (Type 8) Debitage.

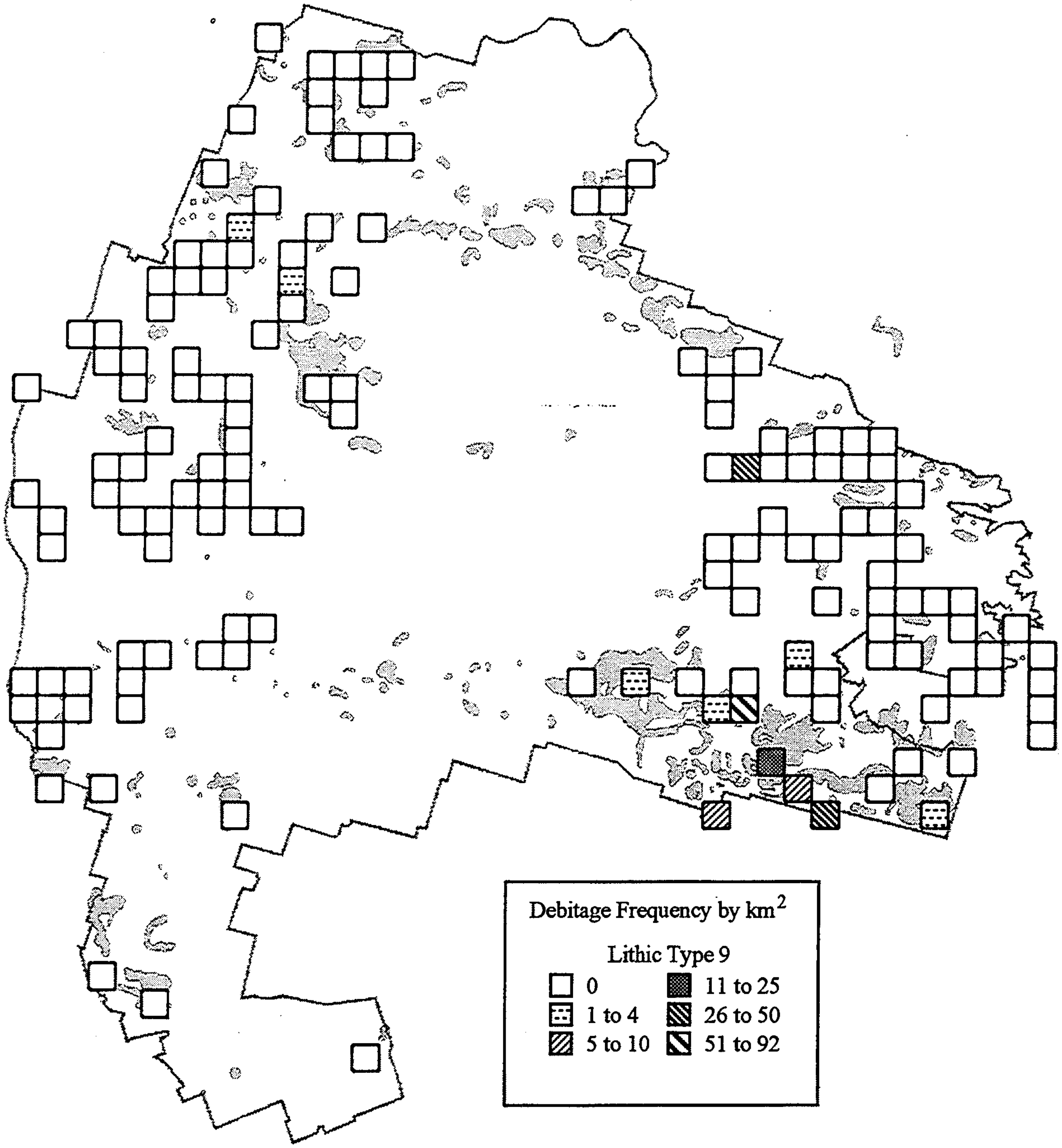

Figure G.36 Frequency Distribution of Heiner Lake Translucent Brown (Type 9) Debitage.

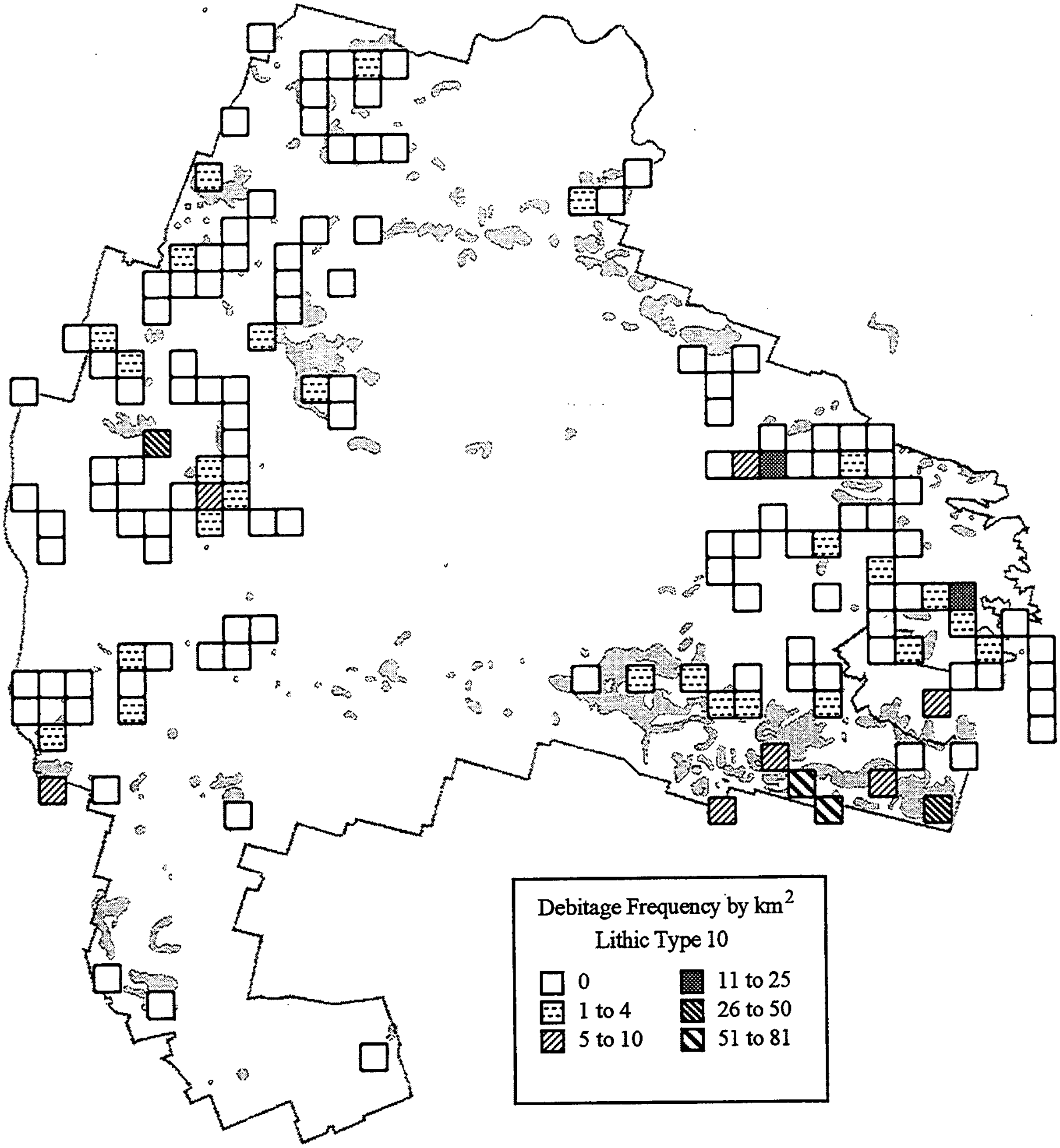

Figure G.37 Frequency Distribution of Heiner Lake Blue (Type 10) Debitage.

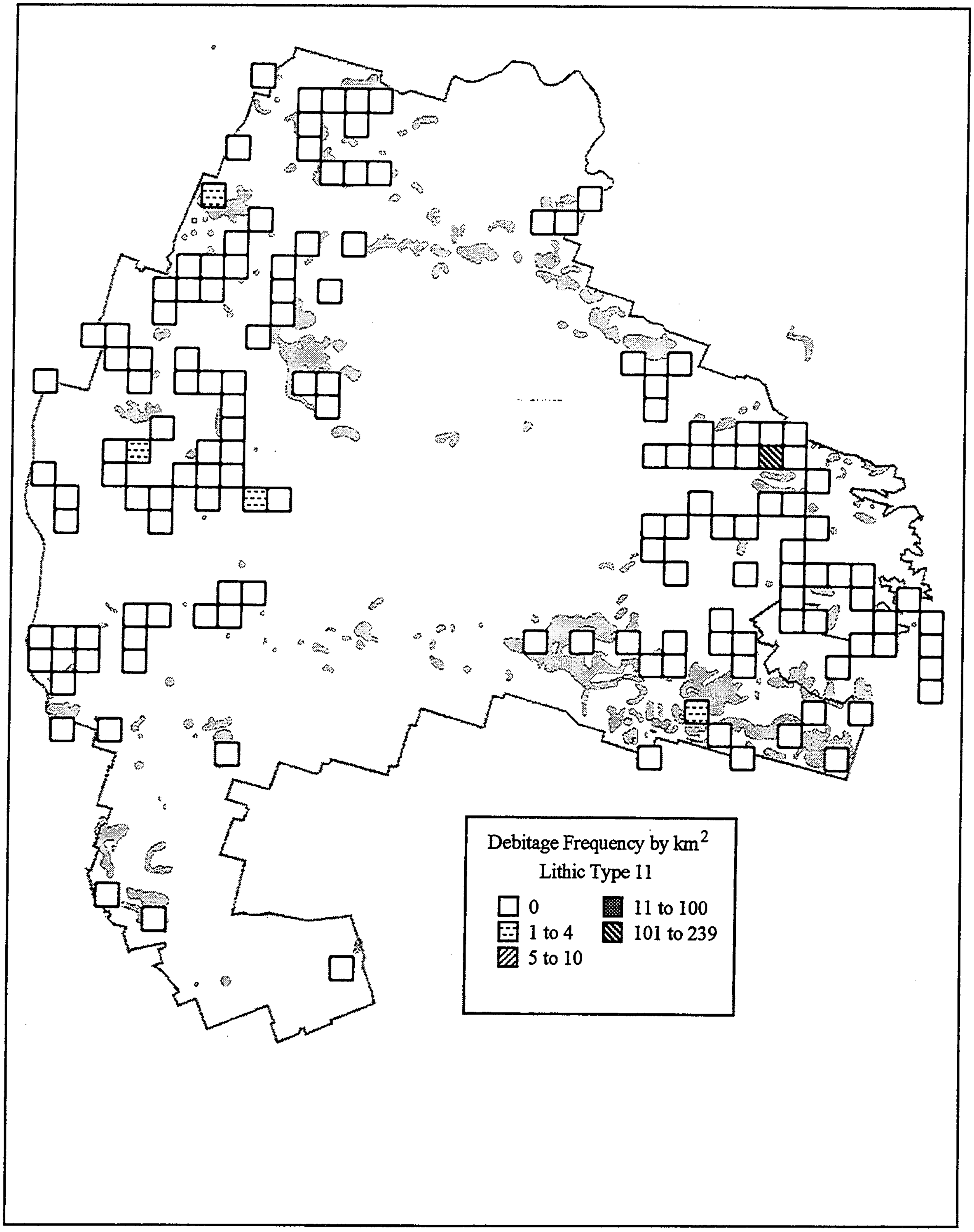

Figure G.38 Frequency Distribution of East Range Flat (Type 11) Debitage.

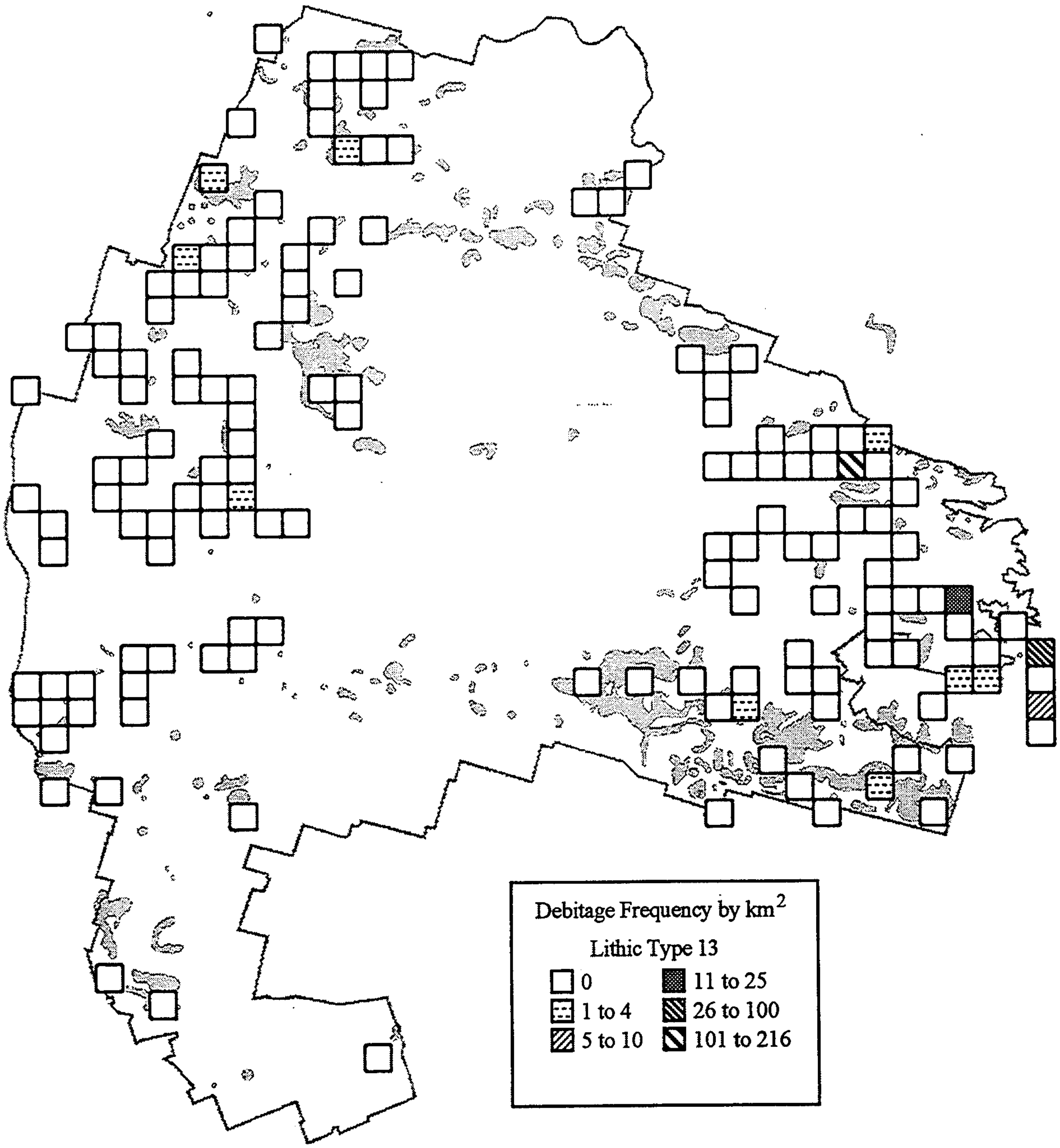

Figure G.39 Frequency Distribution of East Range Flecked (Type 13) Debitage.

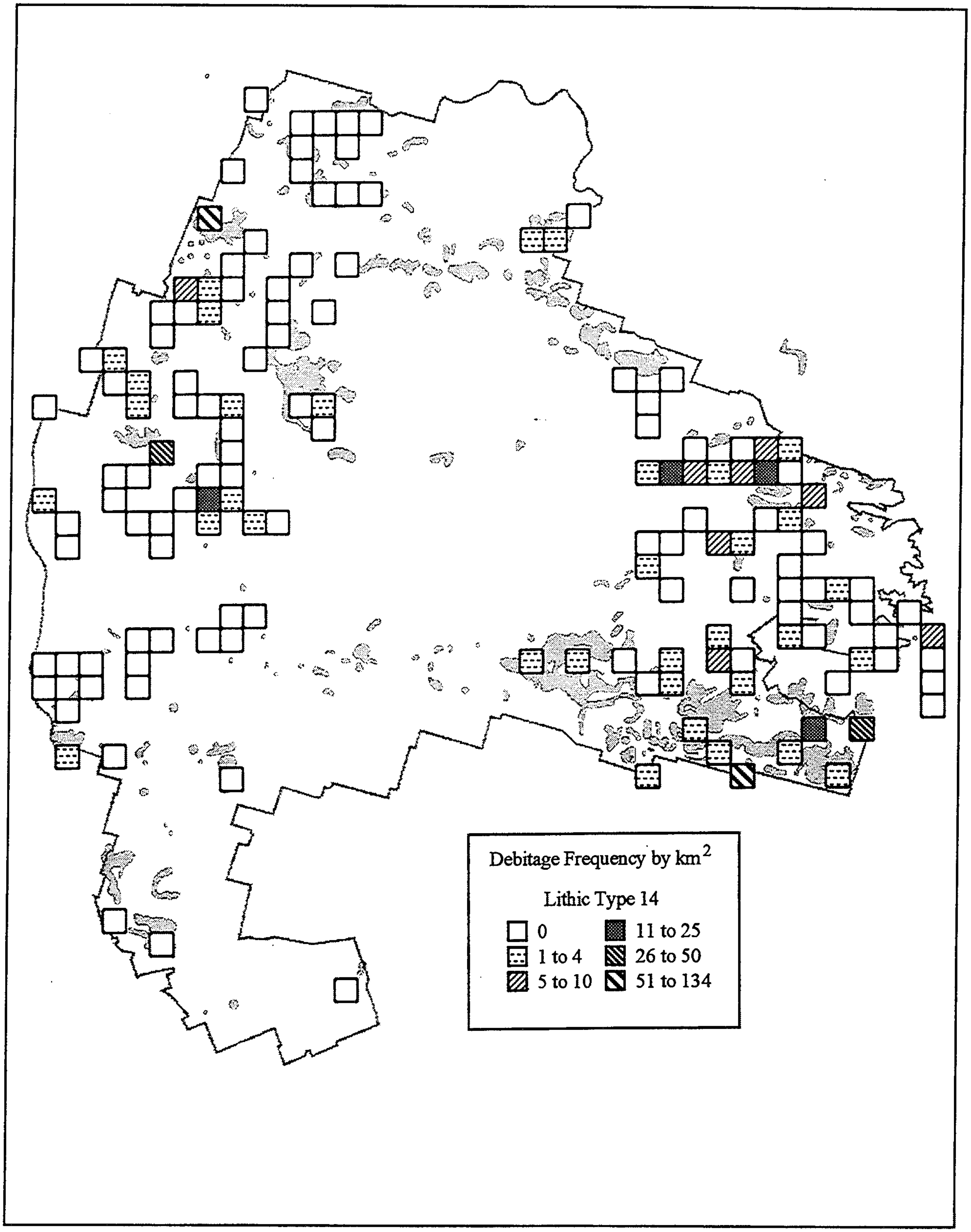

Figure G.40 Frequency Distribution of Fort Hood Gray (Type 14) Debitage.

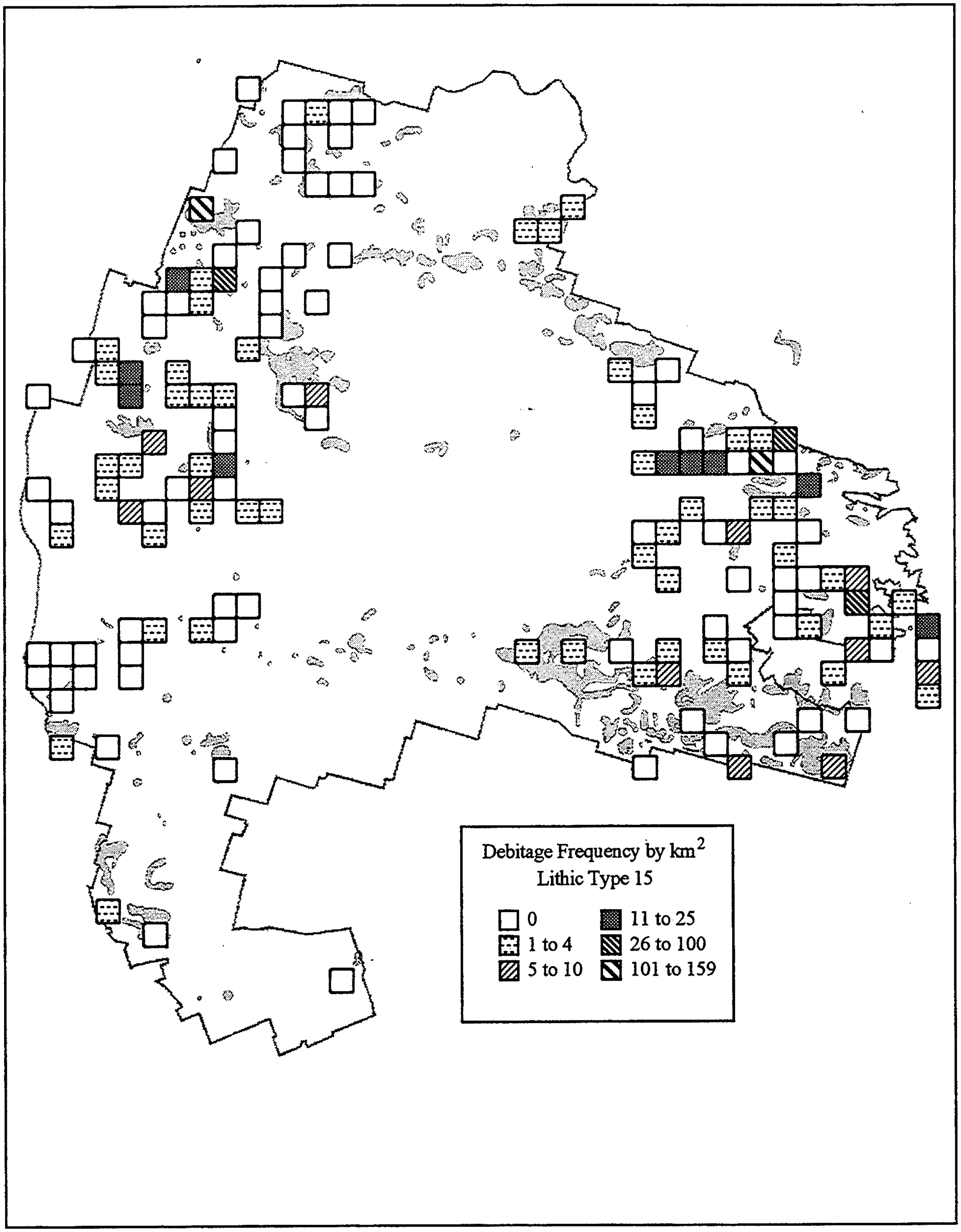

Figure G.41 Frequency Distribution of Gray-Brown-Green (Type 15) Debitage.

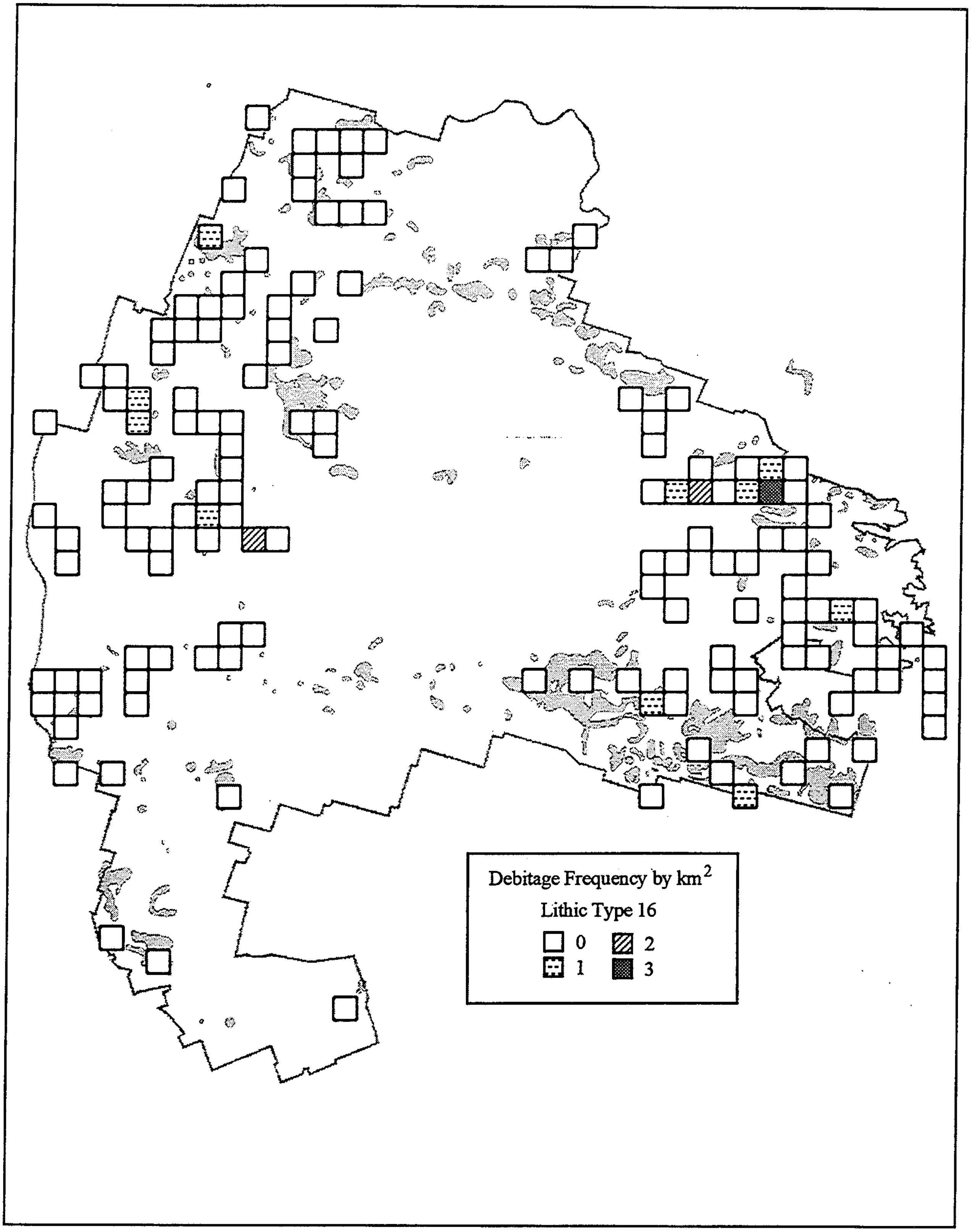

Figure G.42 Frequency Distribution of Leona Park (Type 16) Debitage.

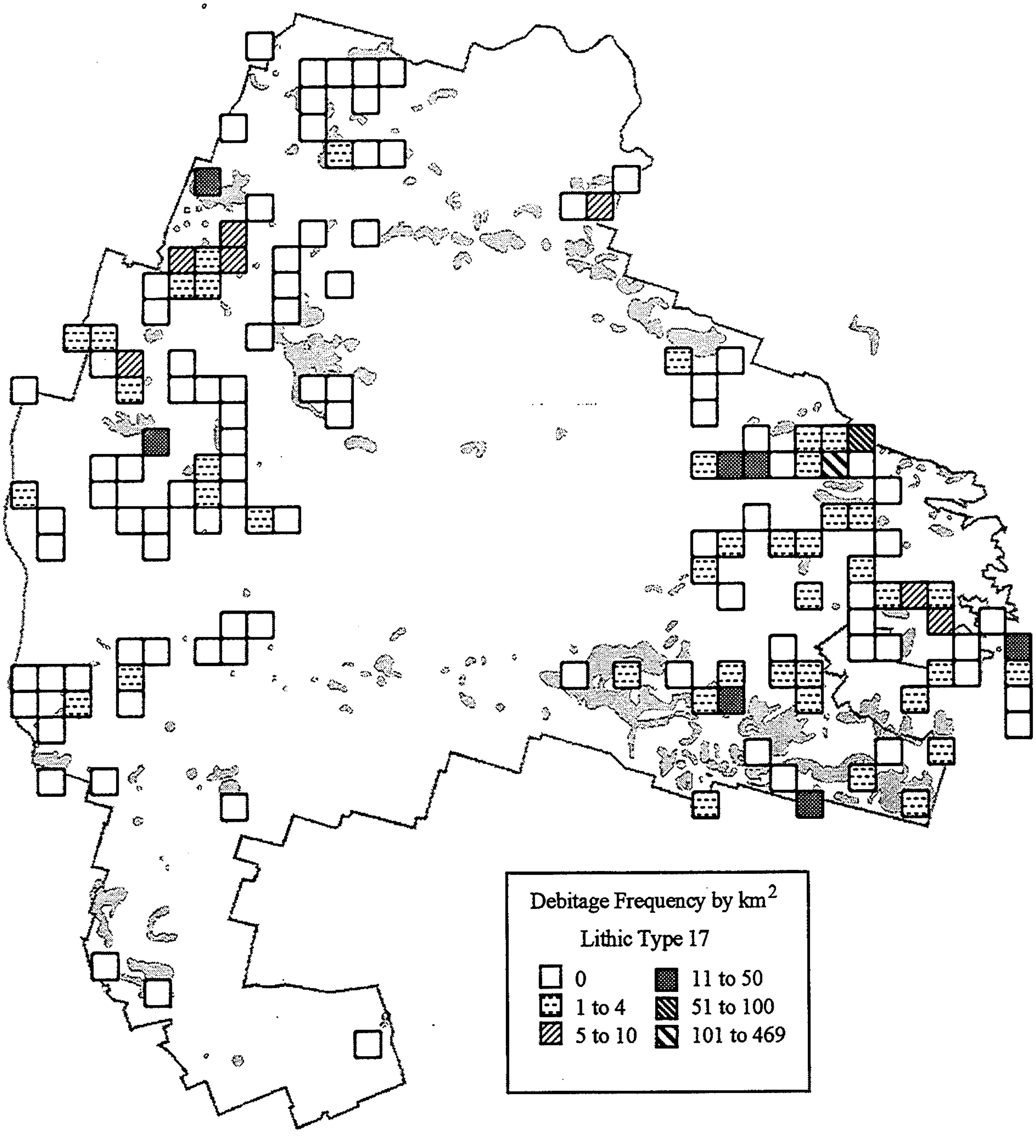

Figure G.43 Frequency Distribution of Owl Creek Black (Type 17) Debitage.

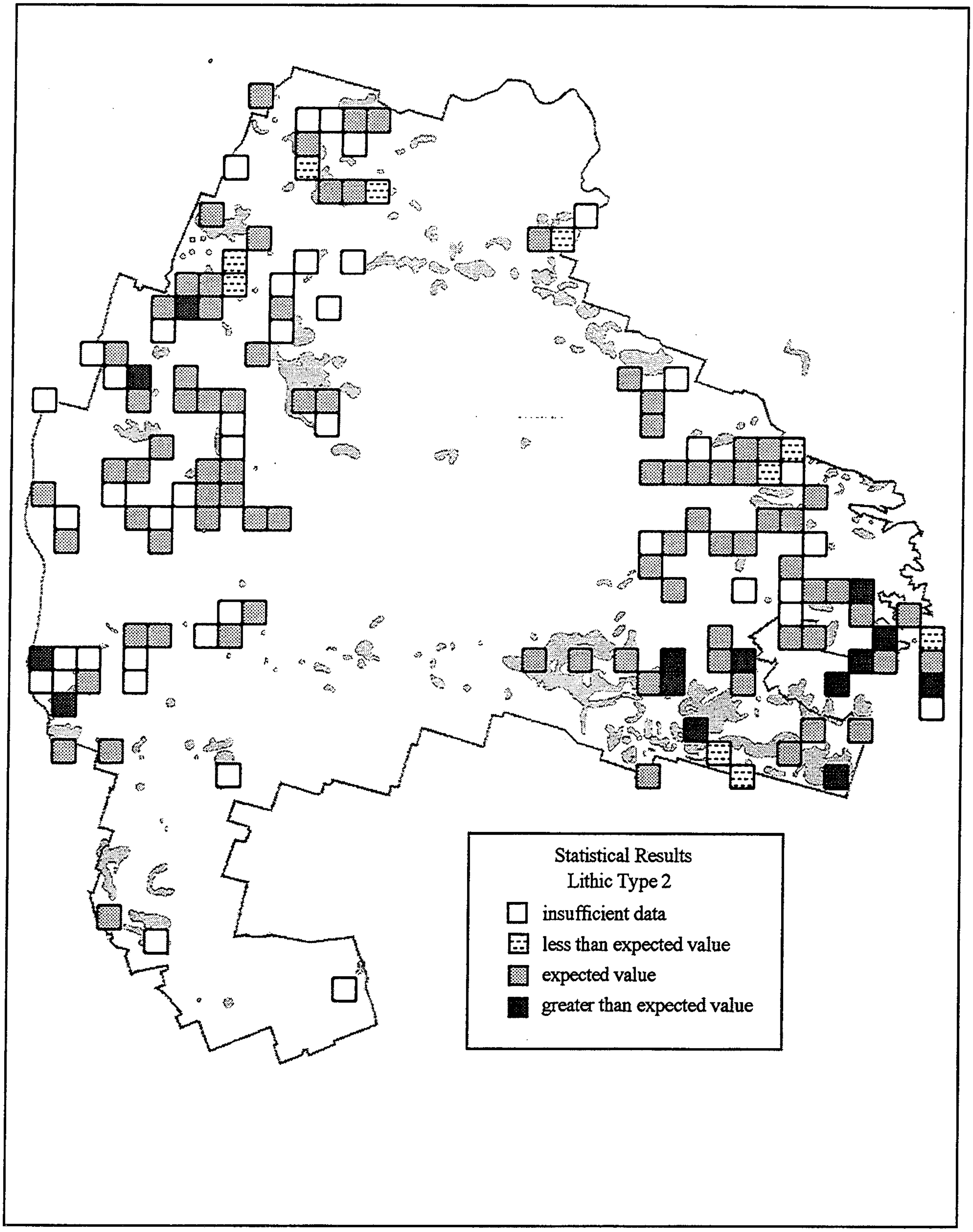

Figure G.44 Statistical Results for Cowhouse White (Type 2) Debitage.

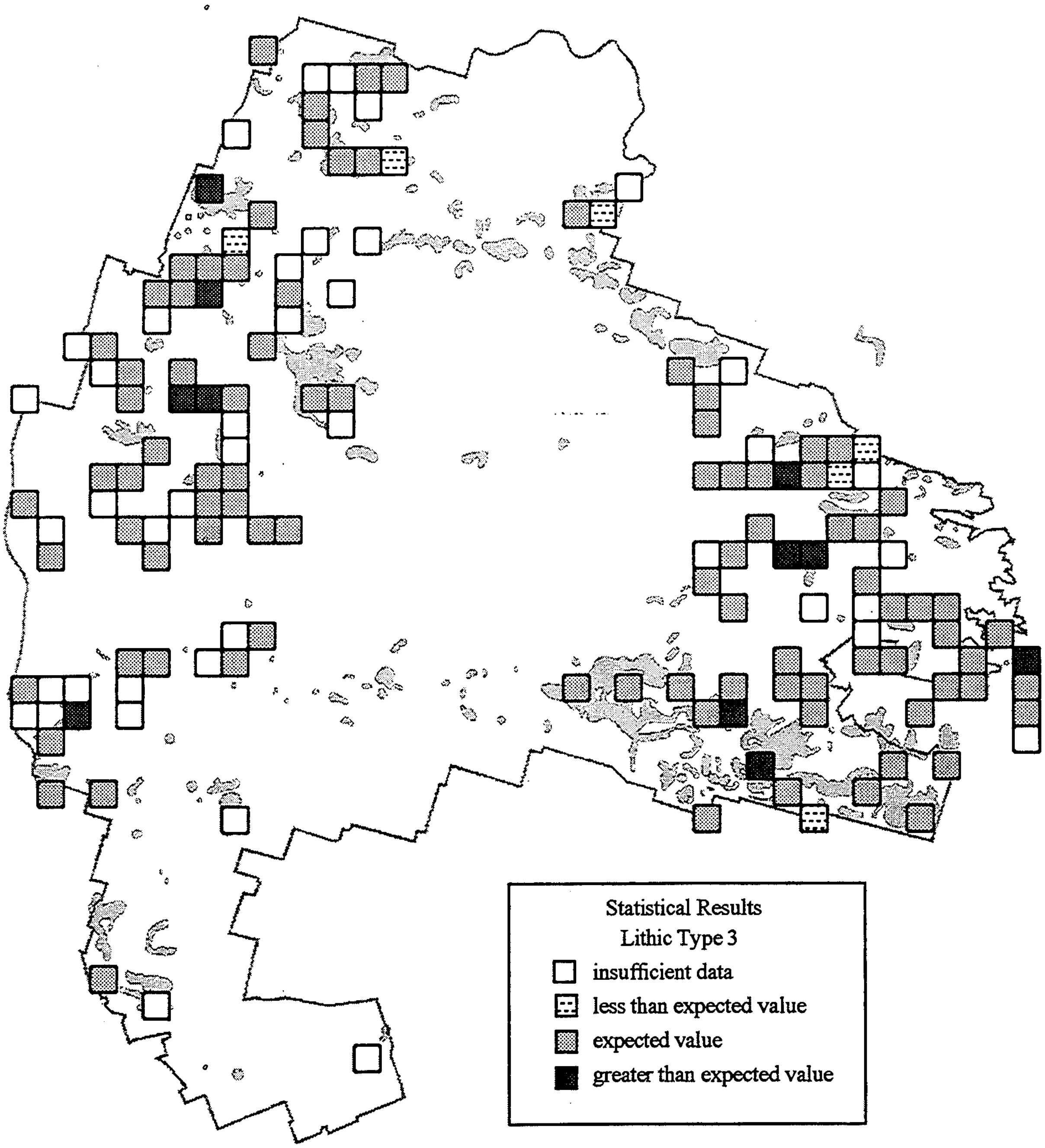

Figure G.45 Statistical Results for Anderson Mountain Gray (Type 3) Debitage.

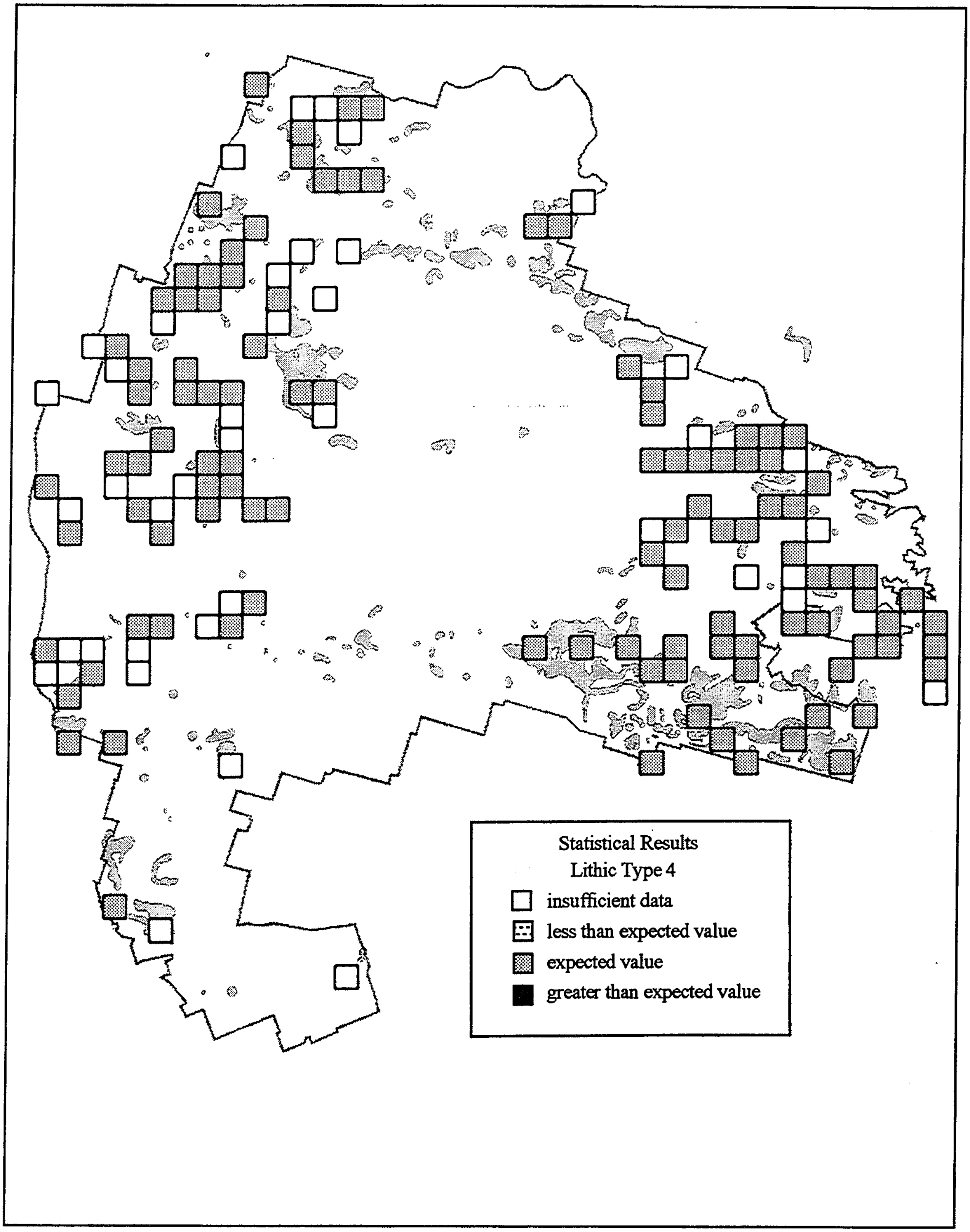

Figure G.46 Statistical Results for Seven Mile Mountain Novaculite (Type 4) Debitage.

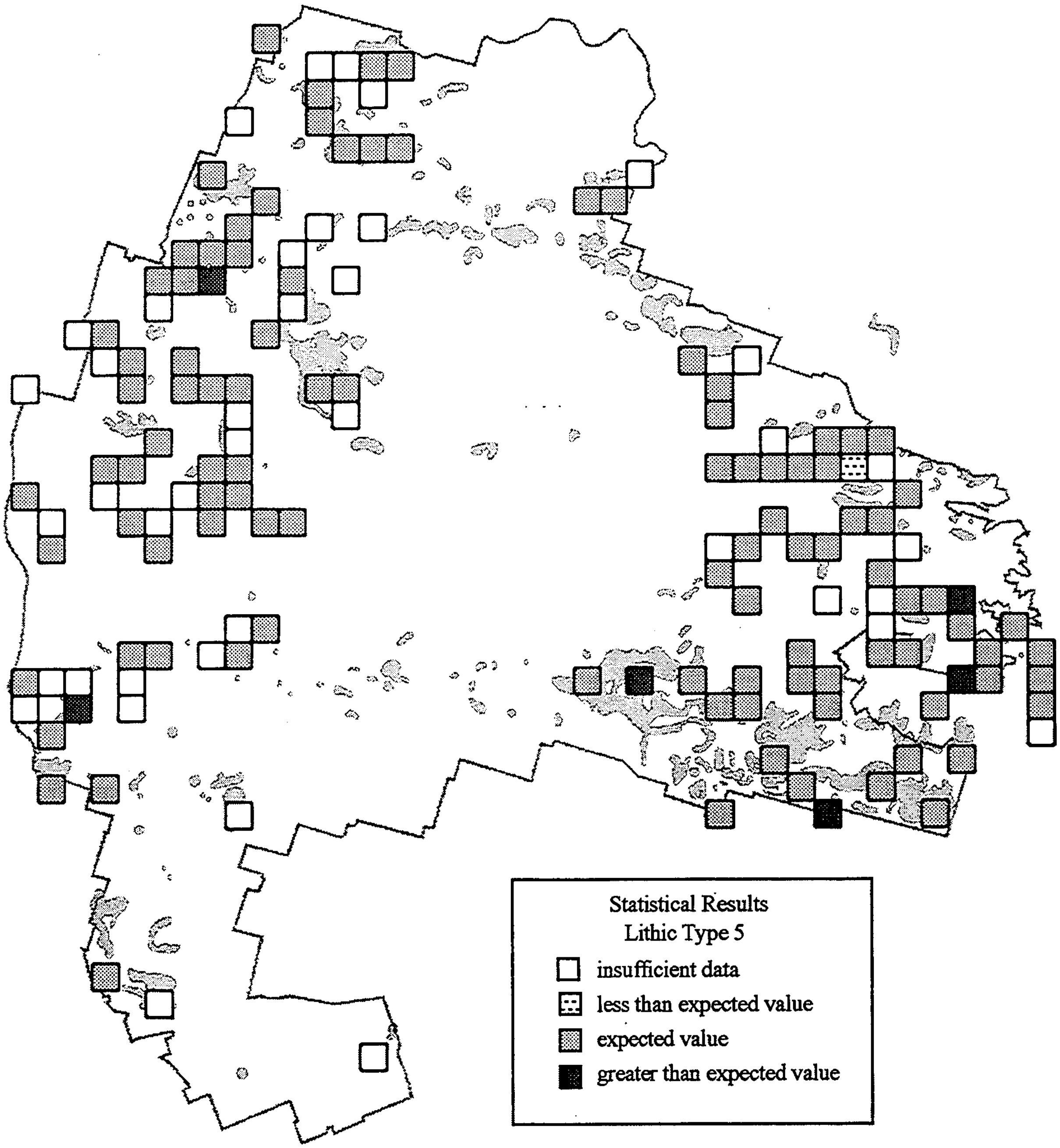

Figure G.47 Statistical Results for Texas Novaculite (Type 5) Debitage.

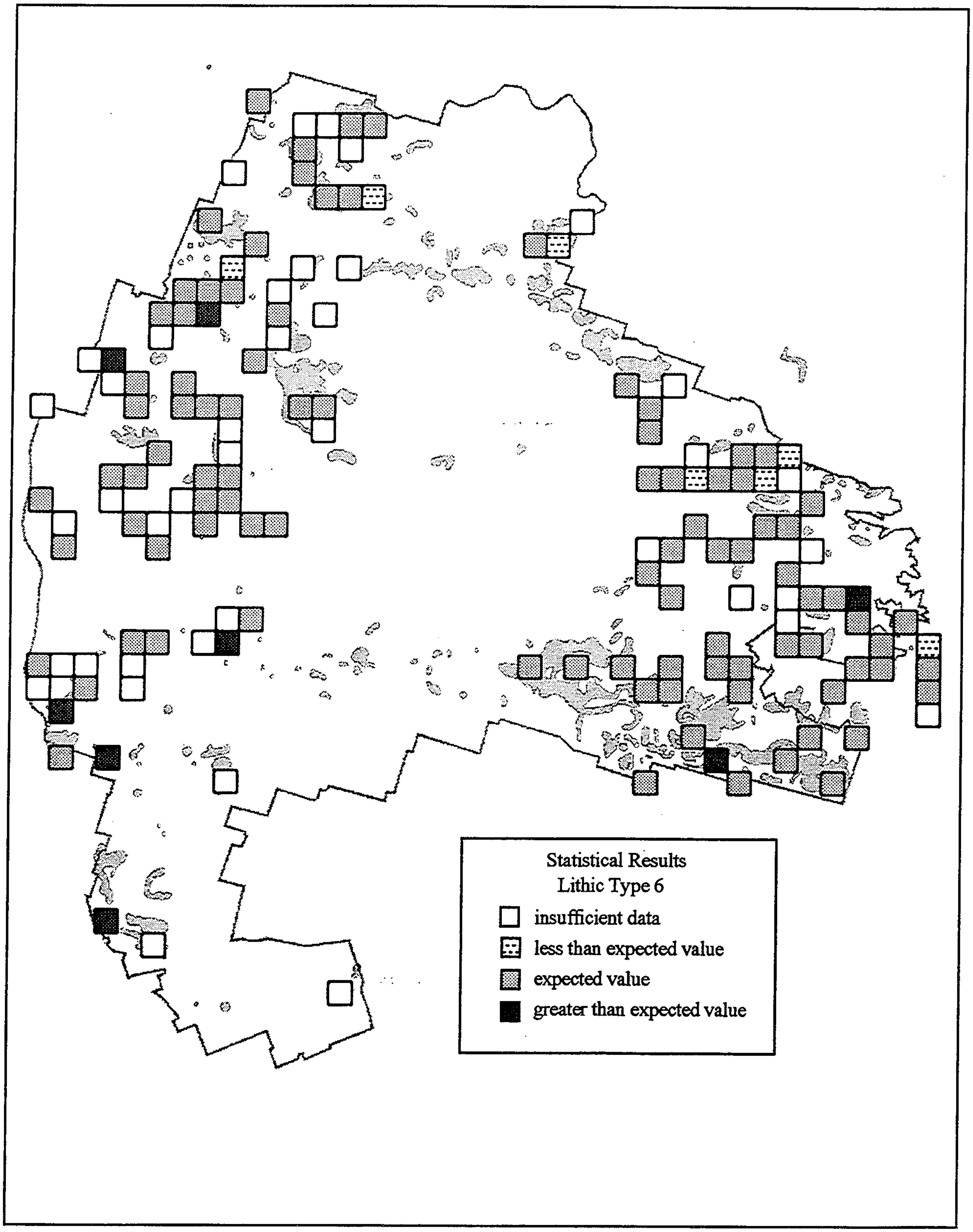

Figure G.48 Statistical Results for Heiner Lake Tan (Type 6) Debitage.

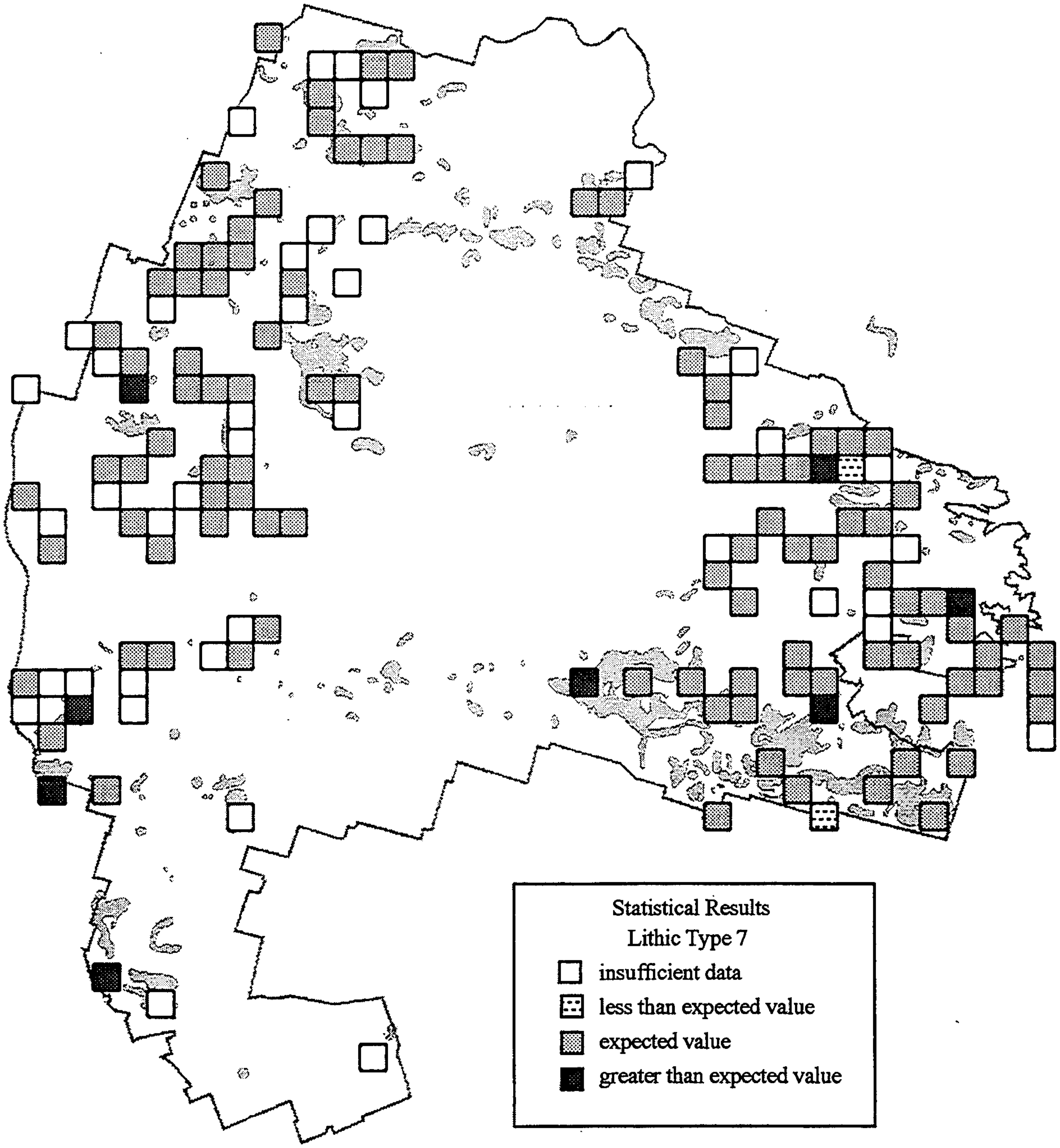

Figure G.49 Statistical Results for Fossiliferous Pale Brown (Type 7) Debitage.

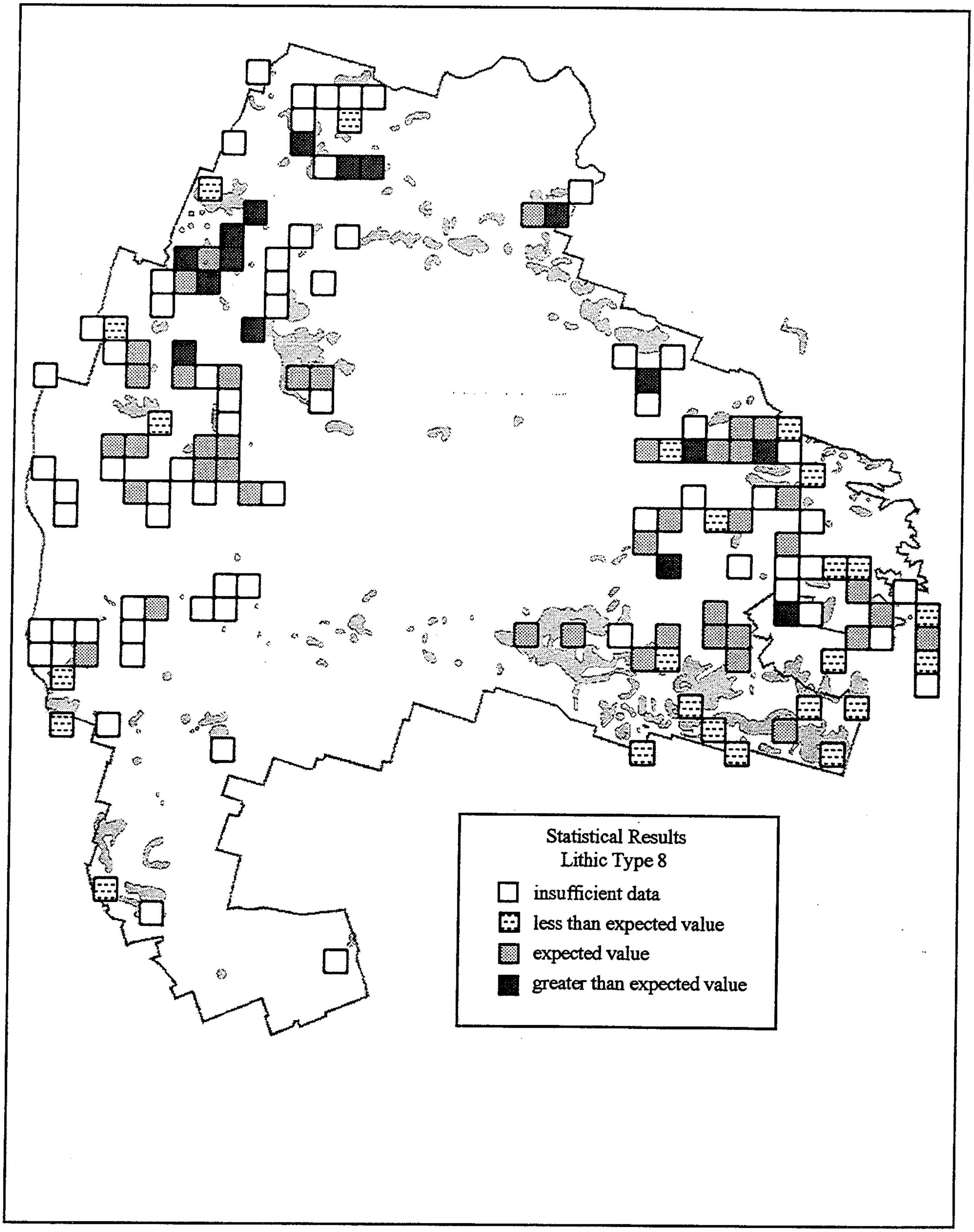

Figure G.50 Statistical Results for Fort Hood Yellow (Type 8) Debitage.

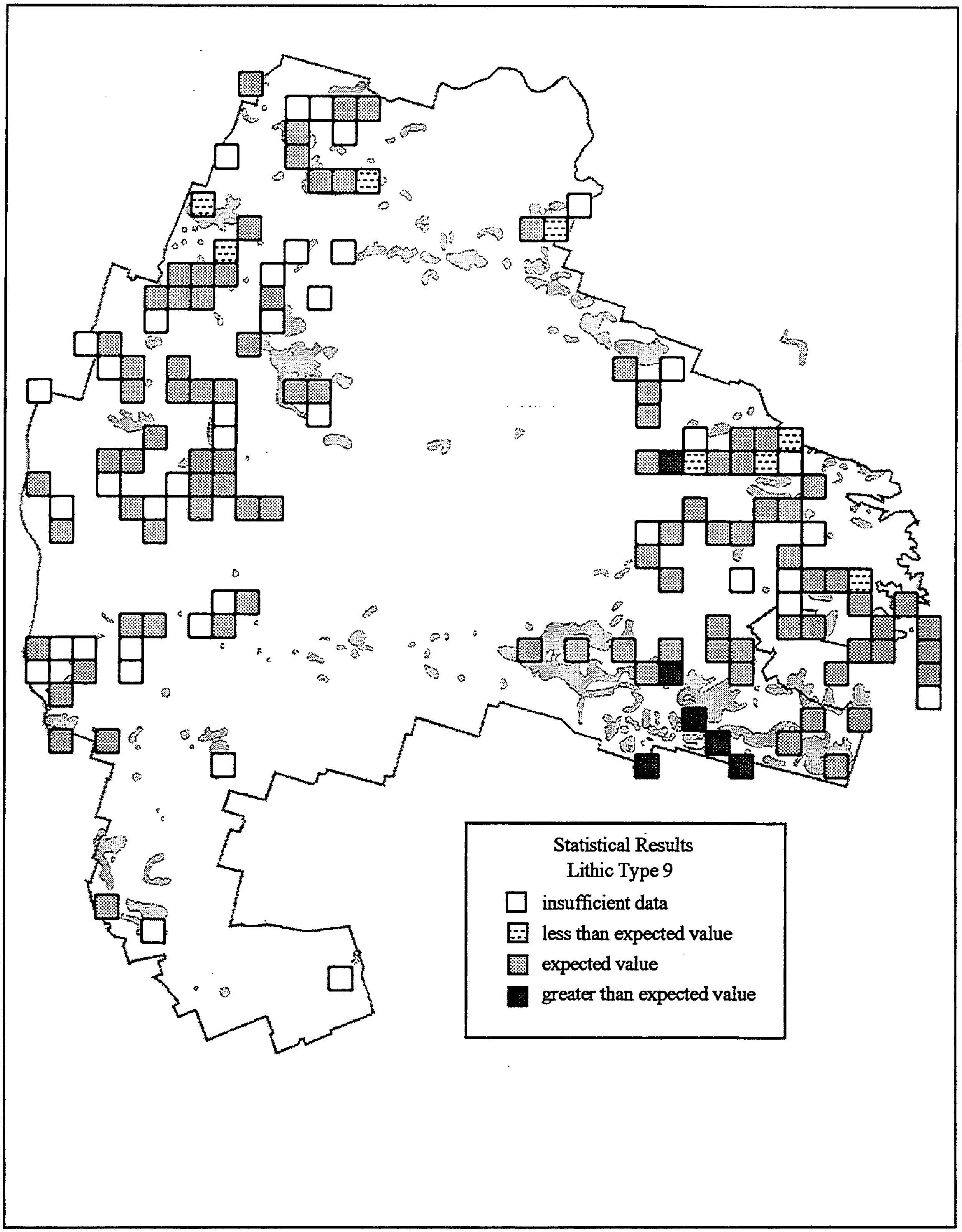

Figure G.51 Statistical Results for Heiner Lake Translucent Brown (Type 9) Debitage.

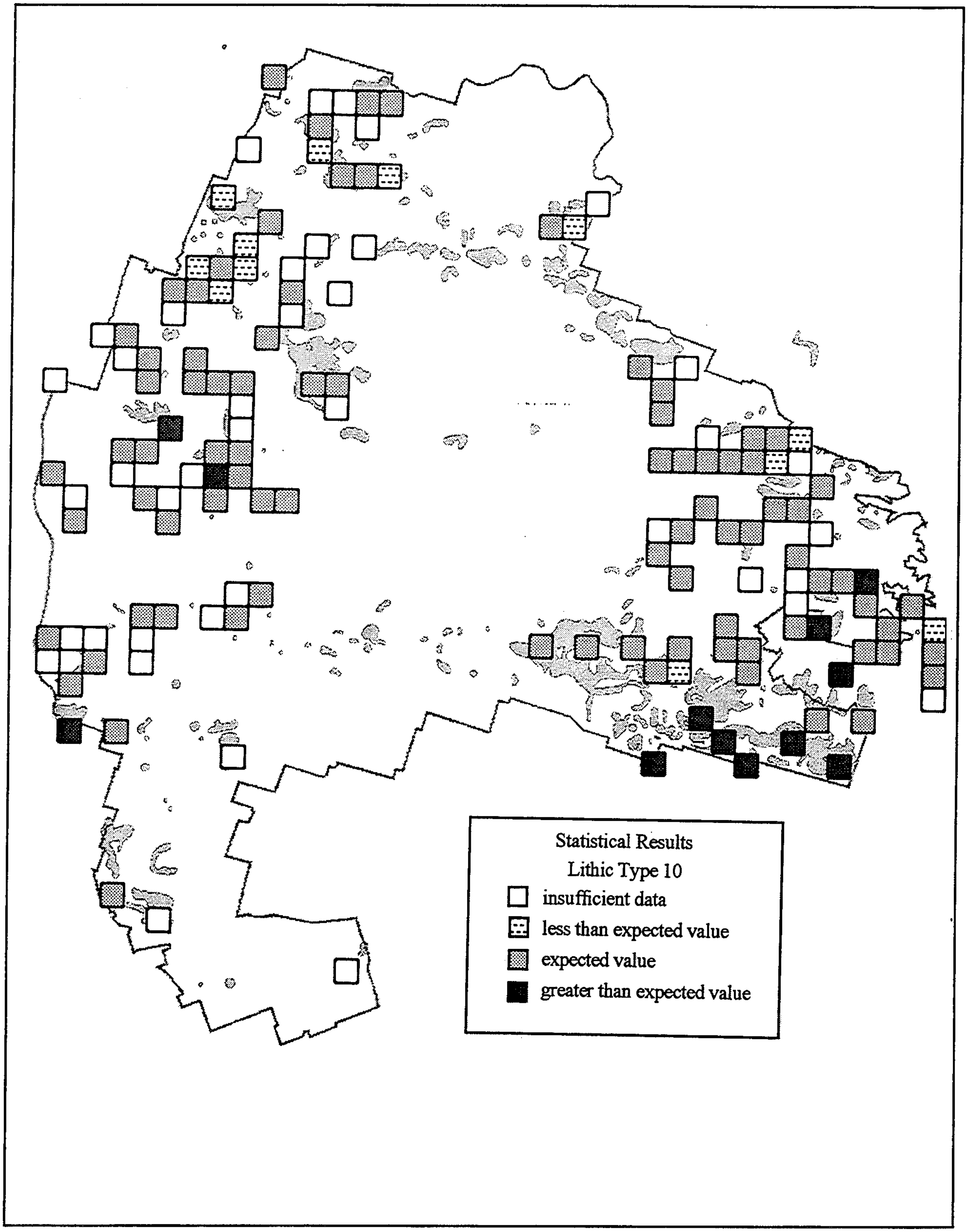

Figure G.52 Statistical Results for Heiner Lake Blue (Type 10) Debitage.

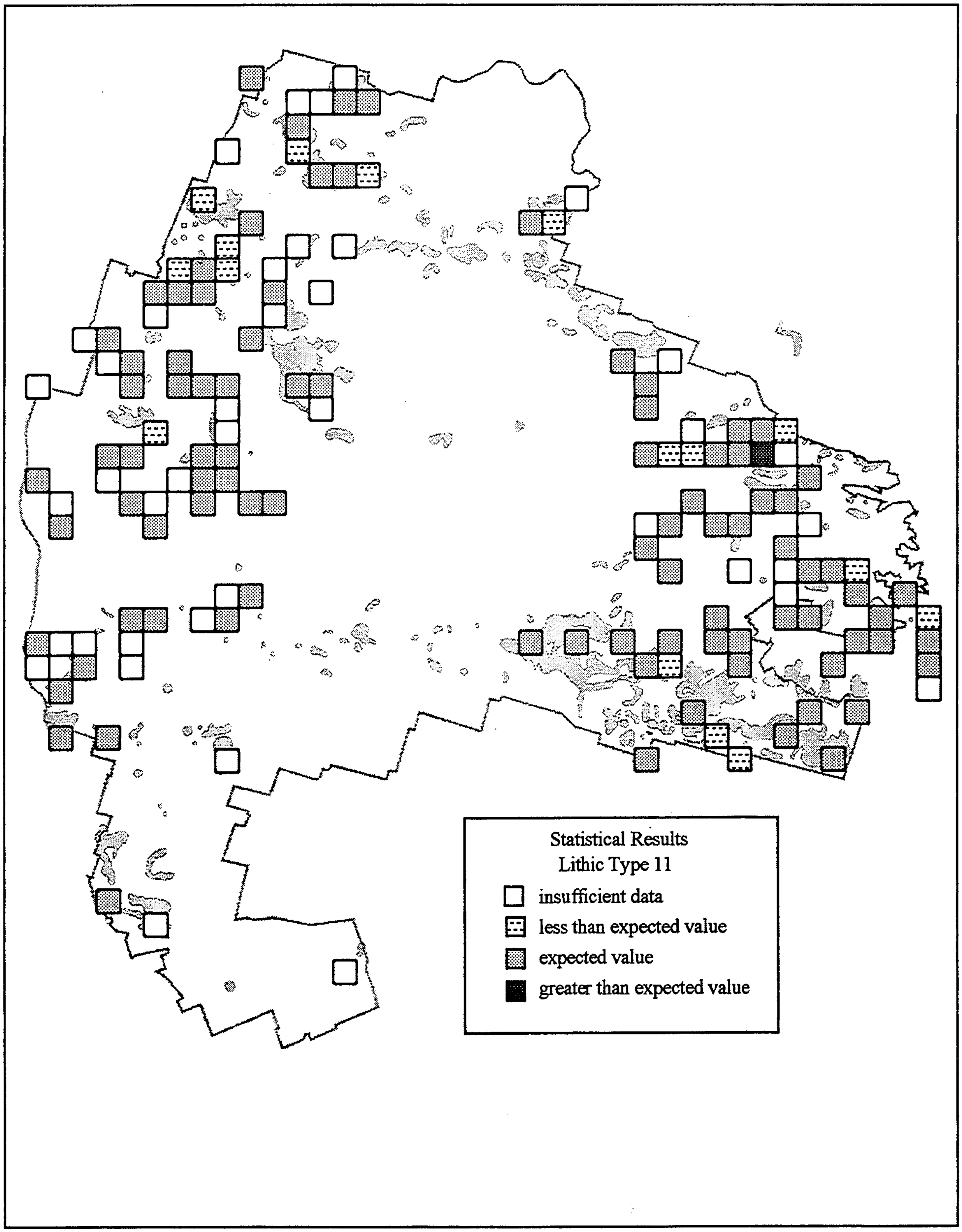

Figure G.53 Statistical Results for East Range Flat (Type 11) Debitage.

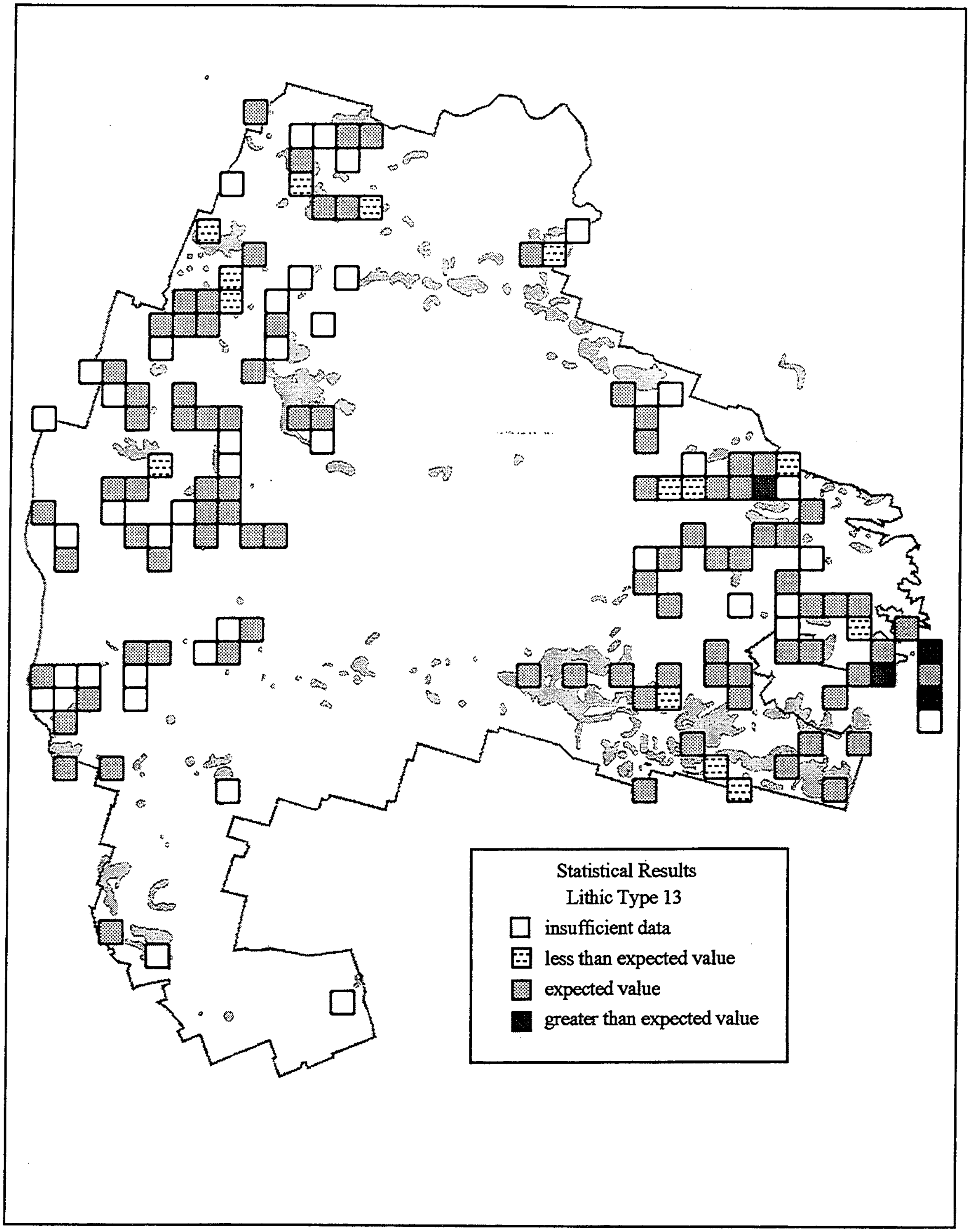

Figure G.54 Statistical Results for East Range Flecked (Type 13) Debitage.

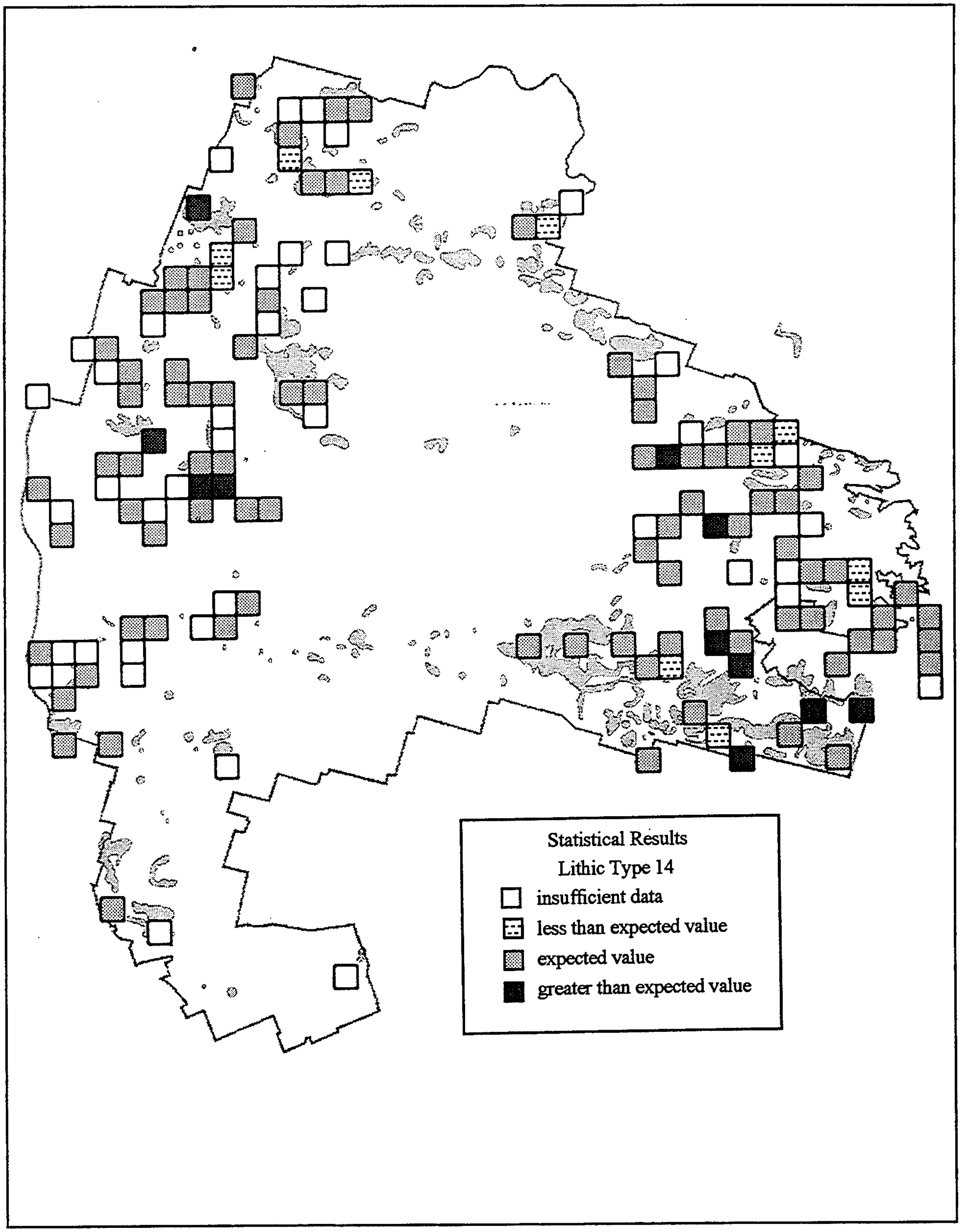

Figure G.55 Statistical Results for Fort Hood Gray (Type 14) Debitage.

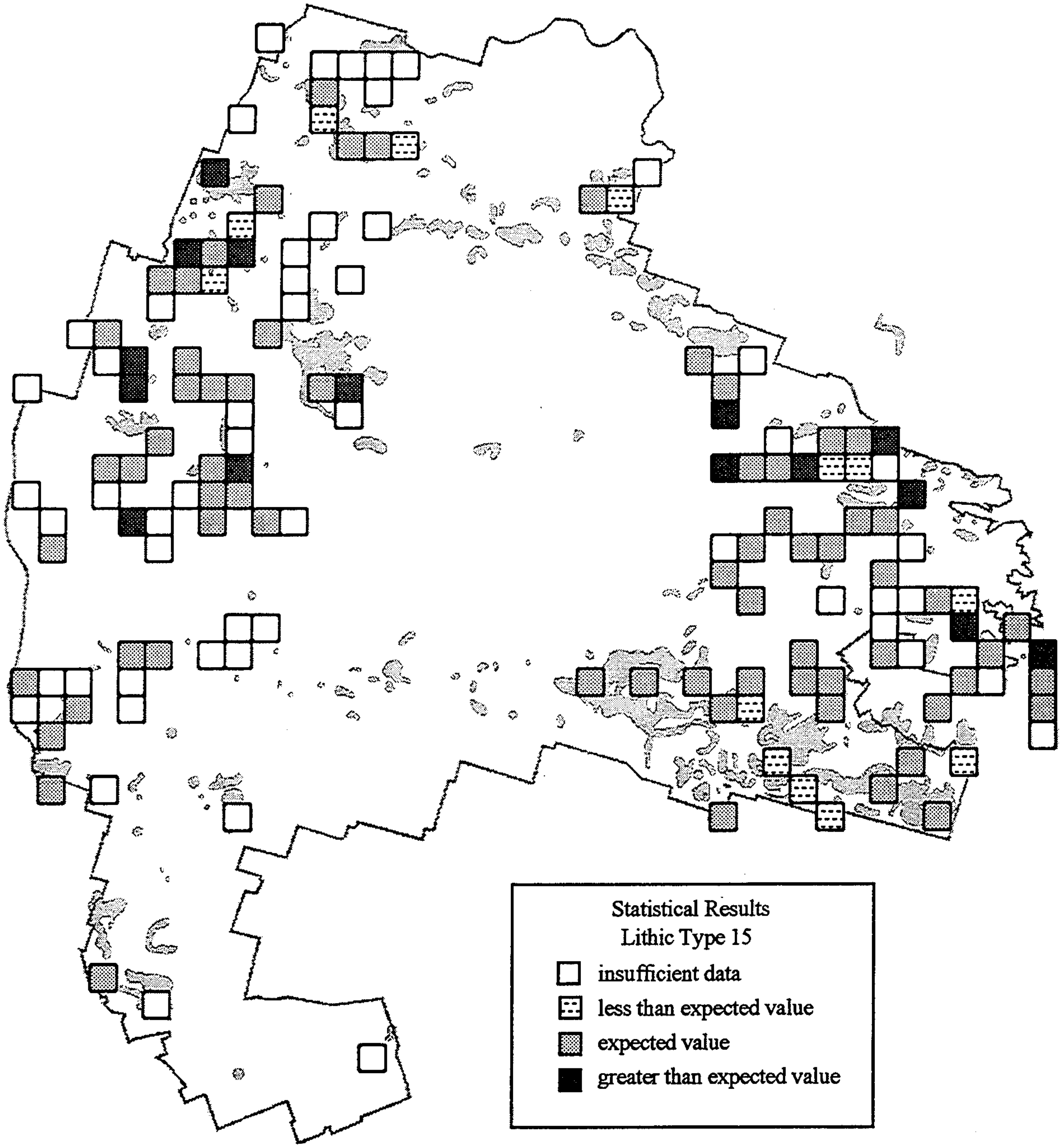

Figure G.56 Statistical Results for Gray-Brown-Green (Type 15) Debitage.

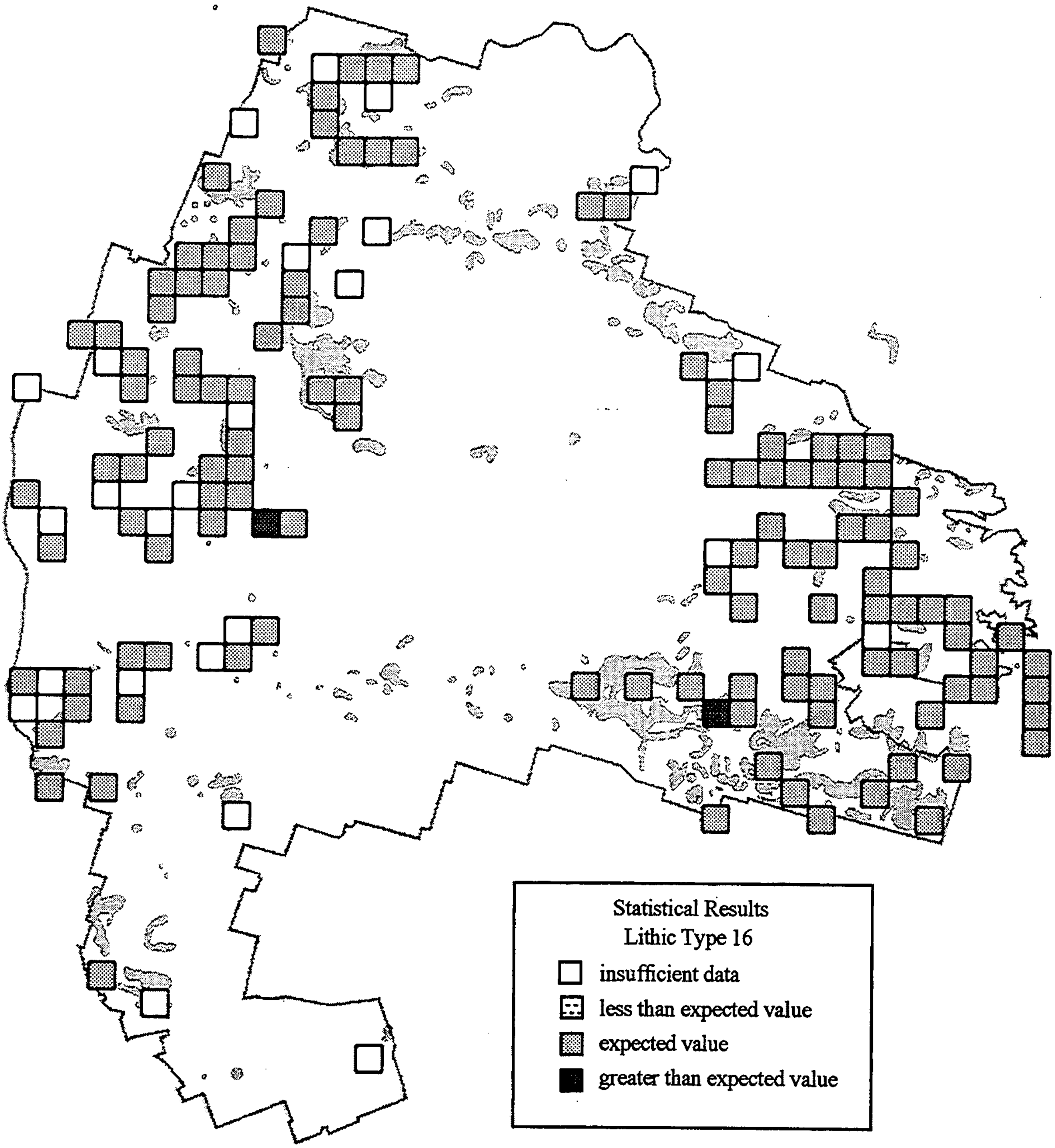

Figure G.57 Statistical Results for Leona Park (Type 16) Debitage.

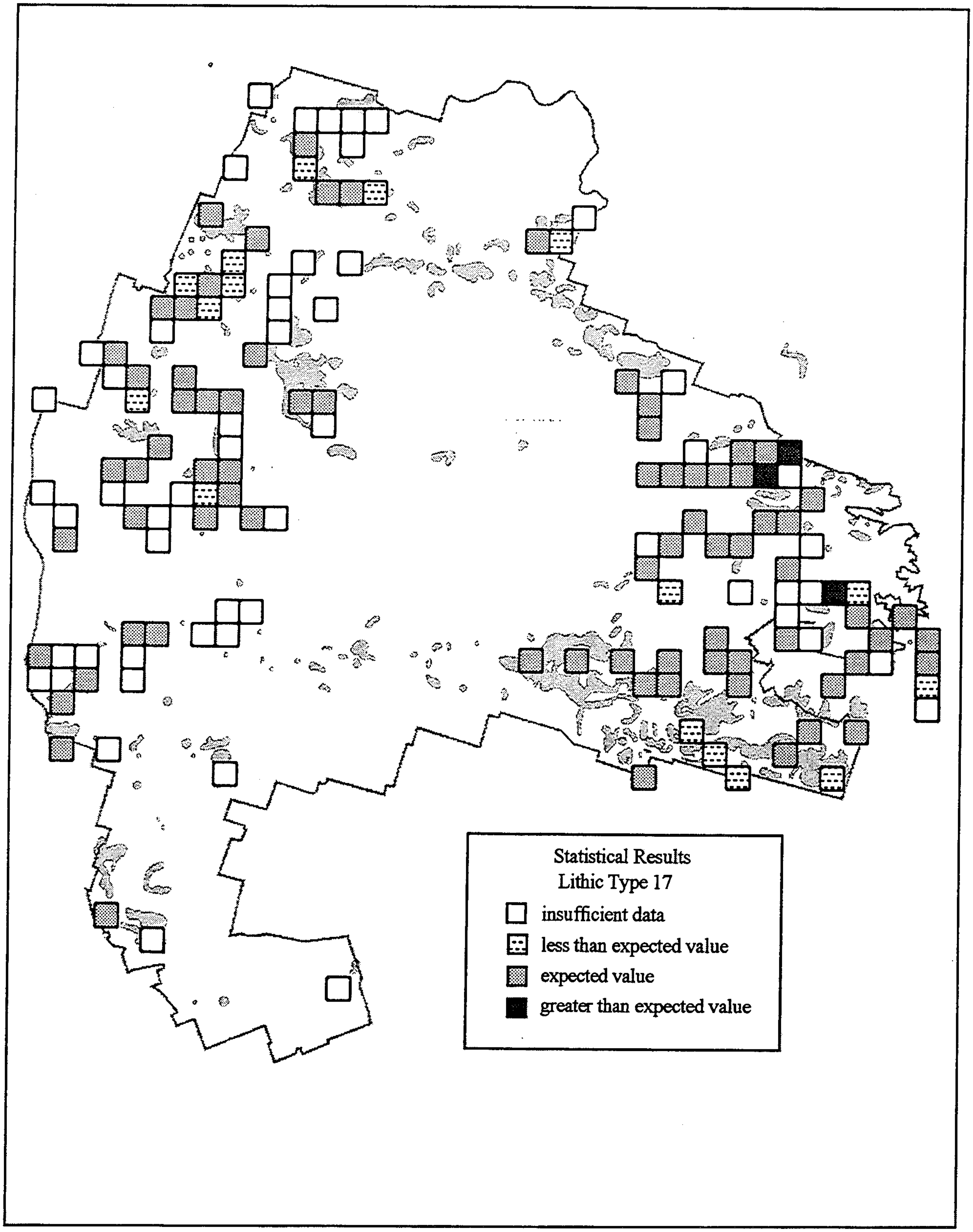

Figure G.58 Statistical Results for Owl Creek Black (Type 17) Debitage.

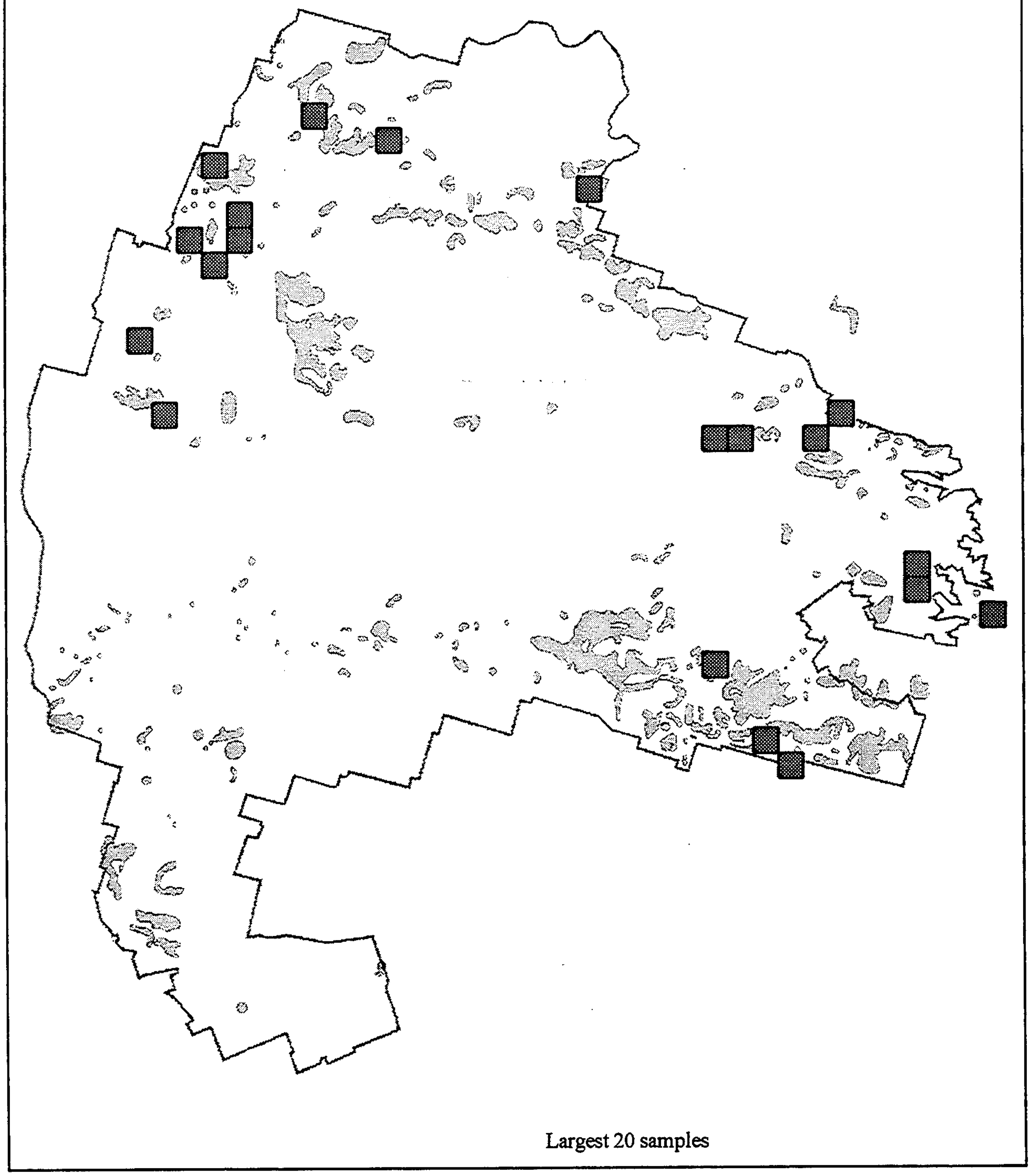

Figure G.59 Distribution of PK Squares with 20 Largest Flake Samples.

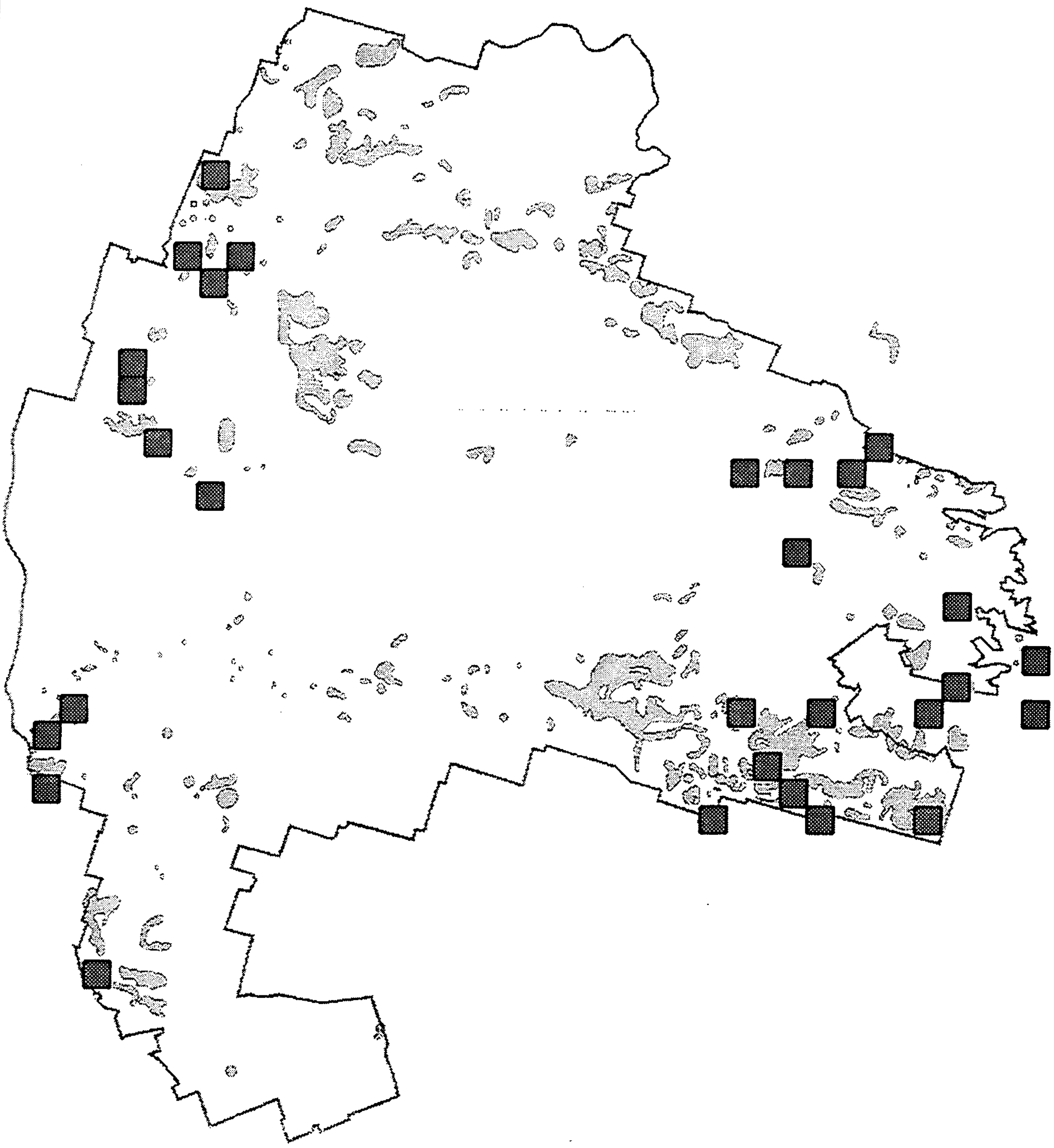

Figure G.60 Distribution of PK Squares with More than Two Greater than Expected Observations.

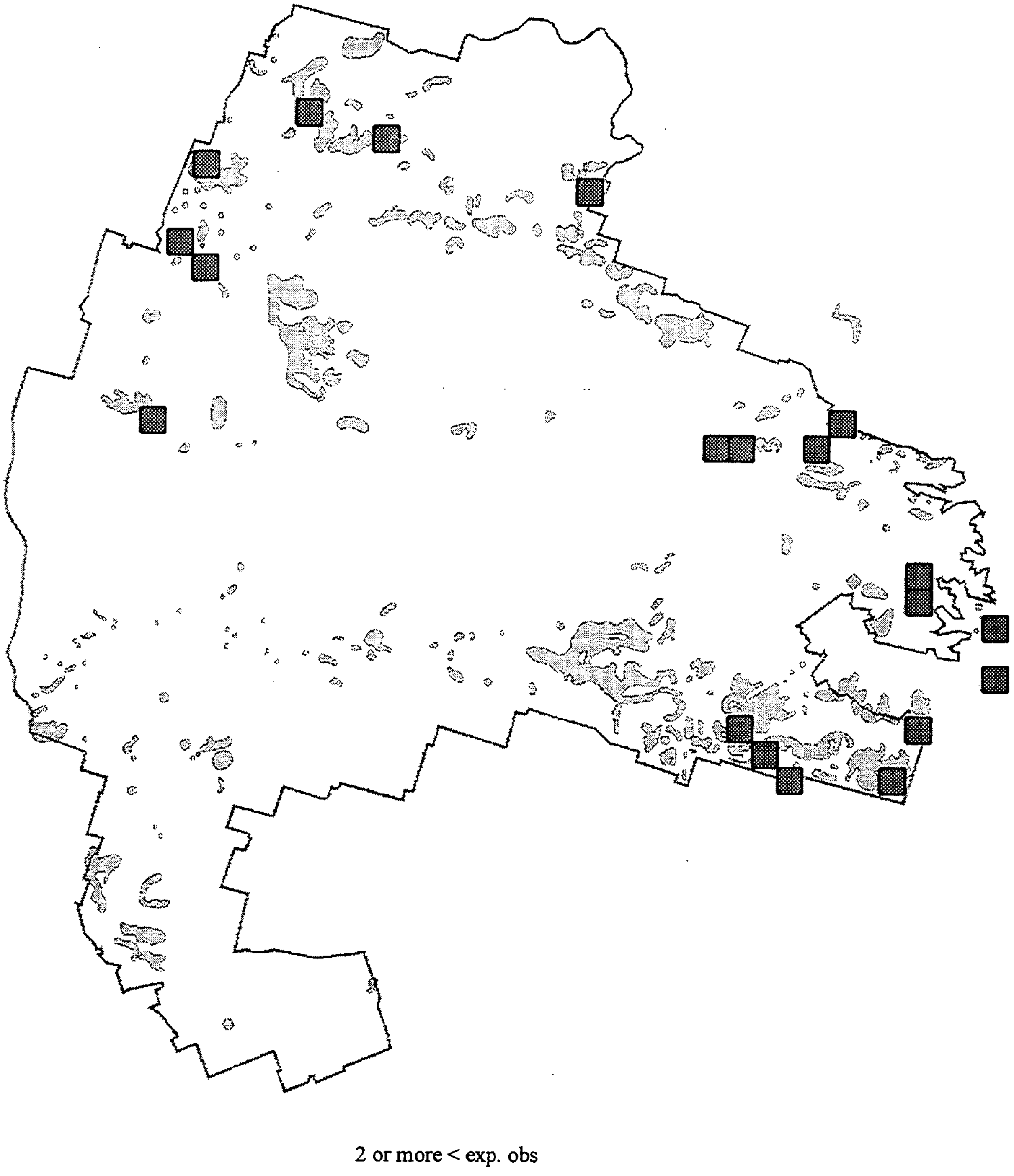

Figure G.61 Distribution of PK Squares with More than Two Less than Expected Observations.

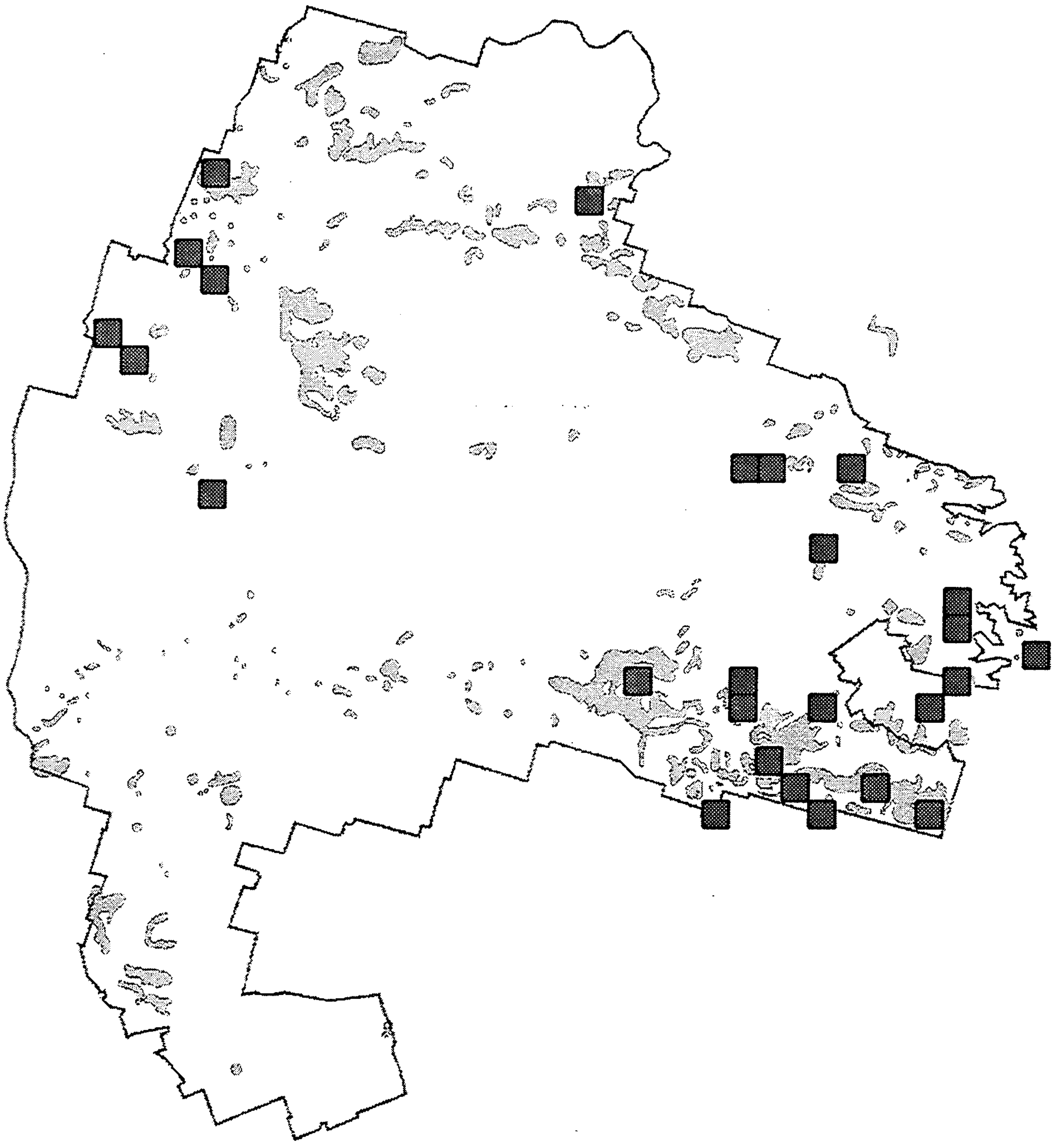

Figure G.62 Distribution of PK Squares with Most Diverse Chert Types.

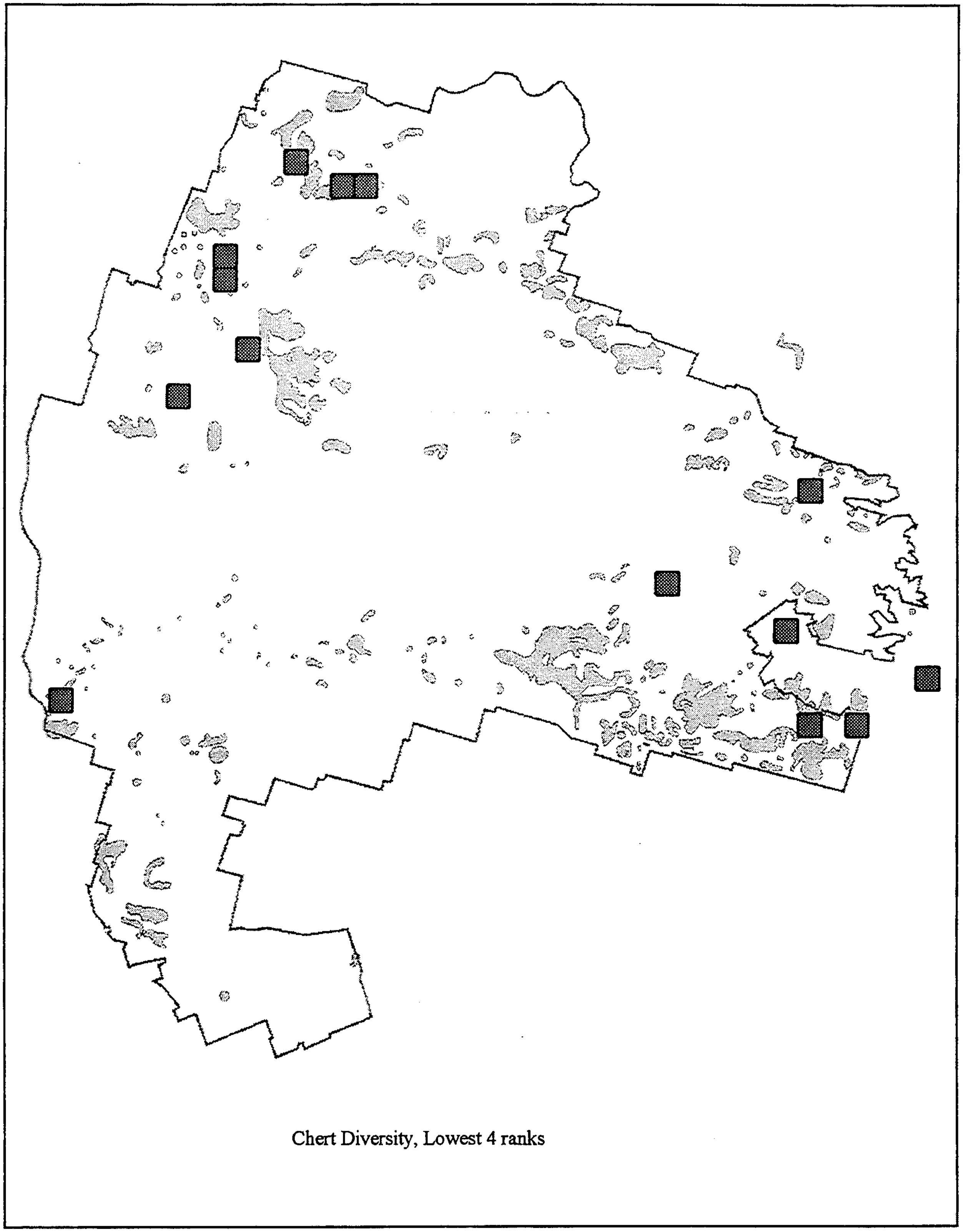

Figure G.63 Distribution of PK Squares with Least Diverse Chert Types.

Table G.1 Type-Identified Chert Artifacts by Class and PK Square.

Cores

E-N	2	3	4	5	6	7	8	9	10	11	13	14	15	16	17	TOTAL
9-54	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
11-67	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
12-56	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
15-69	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
16-68	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
17-71	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
18-68	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
25-66	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
31-56	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2
32-56	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2
33-44	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
34-43	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
34-57	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
35-56	0	0	0	0	0	0	3	0	0	0	0	0	4	0	0	7
36-57	0	0	0	0	0	0	1	0	0	0	0	1	3	0	0	5
39-51	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
42-47	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1

Tools

E-N	2	3	4	5	6	7	8	9	10	11	13	14	15	16	17	TOTAL
4-47	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
4-48	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
5-44	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
5-46	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	2
6-47	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
7-61	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	2
8-56	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
8-59	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2
8-60	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	2
8-61	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
9-36	0	0	0	0	1	0	1	0	0	0	0	0	1	0	0	3
9-54	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
9-57	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	2
10-54	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	2
10-64	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	2
11-33	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	2
11-40	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
11-54	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
11-55	1	0	0	0	1	0	0	0	0	0	0	0	0	0	1	3
11-59	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
11-64	0	0	0	0	1	0	2	0	0	0	0	0	1	0	0	4

11-67	1	0	0	0	1	3	2	0	1	0	0	0	2	0	0	10
12-56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
12-64	0	0	0	0	0	0	5	0	0	0	0	0	1	0	1	7
12-65	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
13-34	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
13-54	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	2
13-61	0	0	0	0	0	0	0	0	1	0	0	0	2	0	0	3
13-66	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
13-72	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	2
14-62	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
14-72	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
15-59	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
15-65	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
15-69	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2
16-33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
16-35	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
16-59	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
16-71	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
18-71	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
22-71	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
25-48	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
25-66	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	2
26-66	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
30-43	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	2
30-47	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	2
30-52	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	2
30-56	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	2
31-47	1	0	0	0	1	0	1	3	0	0	1	0	0	0	1	8
31-53	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
31-55	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
31-56	0	0	0	0	2	0	3	3	0	0	0	1	1	0	0	10
32-45	2	1	0	0	1	0	1	0	1	0	0	0	0	0	0	6
32-54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
32-56	1	0	0	0	0	0	1	1	0	0	0	1	1	0	1	6
33-44	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	2
33-56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
34-43	0	0	0	0	1	0	0	0	0	0	0	2	0	0	0	3
34-45	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
34-48	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	2
34-53	0	0	0	0	1	0	2	0	0	0	0	0	0	0	0	3
34-57	0	0	0	0	0	0	0	0	0	0	0	0	1	1	3	5
35-54	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
35-56	0	0	0	0	2	0	13	0	0	0	0	1	2	1	4	23

36-54	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	2
36-56	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
36-57	0	0	0	0	1	0	2	0	0	0	0	0	2	0	0	5
37-49	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	2
37-51	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
37-53	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	2
37-55	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	2
38-47	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	2
38-51	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	3
39-50	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	2
39-51	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0	3
40-49	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
42-49	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	2

Debitage

E-N	02	03	04	05	06	07	08	09	10	11	13	14	15	16	17	Total
4-47	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
4-48	2	1	0	0	0	0	1	0	0	0	0	0	0	0	0	4
4-55	0	0	0	0	1	0	0	0	0	0	0	1	0	0	1	3
4-59	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
5-44	0	1	0	0	0	10	3	0	9	0	0	1	1	0	0	25
5-46	4	0	0	0	14	1	0	0	1	0	0	0	0	0	0	20
5-48	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
5-53	0	0	0	0	0	0	3	0	0	0	0	0	1	0	0	4
5-54	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
6-47	0	3	0	3	1	4	4	0	0	0	0	0	0	0	3	18
6-48	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	2
6-61	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	2
7-37	0	1	0	0	8	4	0	0	0	0	0	0	1	0	0	14
7-44	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	3
7-55	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
7-56	1	0	0	0	0	0	4	0	0	0	0	0	2	0	0	7
7-60	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
7-61	3	0	0	0	6	2	6	0	3	0	0	4	3	0	1	28
8-47	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	2
8-48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
8-49	0	0	0	0	0	1	2	0	1	0	0	0	0	0	0	4
8-54	0	0	0	0	0	0	3	0	0	0	0	0	5	0	0	8
8-56	2	0	0	0	0	0	5	0	0	1	0	0	4	0	0	12
8-59	0	0	0	0	4	6	22	0	0	0	0	1	21	1	1	56
8-60	12	3	0	0	1	1	33	0	1	0	0	1	16	1	6	75
9-36	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
9-49	1	1	0	0	0	0	4	0	0	0	0	0	1	0	0	7
9-53	1	0	0	0	1	0	0	0	0	0	0	0	1	0	0	3

9-54	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
9-57	3	0	0	0	0	0	34	0	28	0	0	28	7	0	12	112
9-62	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2
9-63	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	4
10-55	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
10-59	2	4	0	0	0	0	11	0	0	0	0	0	2	0	0	19
10-60	1	0	0	0	0	0	10	0	0	0	0	0	1	0	0	12
10-63	4	0	0	0	0	1	1	0	0	0	0	0	0	0	3	9
10-64	2	0	0	0	1	1	81	0	1	0	1	8	21	0	8	124
11-49	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
11-54	0	0	0	0	0	0	3	0	1	0	0	1	1	0	0	6
11-55	2	0	0	0	0	1	29	0	9	0	0	13	5	1	1	61
11-56	1	1	0	0	0	0	4	0	1	0	0	0	1	0	1	9
11-59	0	2	0	0	0	0	3	0	0	0	0	0	1	0	0	6
11-63	1	10	0	12	10	0	47	0	0	0	0	1	2	0	1	84
11-64	0	0	0	0	0	0	2	0	0	0	0	1	2	0	3	8
11-67	20	22	0	0	7	8	172	0	1	1	1	77	104	1	50	464
12-43	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
12-49	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	3
12-50	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
12-55	0	0	0	0	0	0	4	0	1	0	1	3	0	0	0	9
12-56	0	0	0	0	0	0	3	0	0	0	0	0	11	0	0	14
12-57	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	2
12-58	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
12-59	1	0	0	0	1	0	3	0	0	0	0	1	1	0	0	7
12-64	0	0	0	0	0	0	81	0	0	0	0	0	26	0	5	112
12-65	0	0	0	0	0	0	296	1	0	0	0	0	0	0	6	303
12-69	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
13-50	0	0	0	0	1	0	2	0	0	0	0	0	0	0	0	3
13-54	0	0	0	0	0	0	3	0	0	1	0	1	4	2	2	13
13-61	0	0	0	0	0	0	12	0	1	0	0	0	3	0	0	16
13-66	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	12
13-72	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	3
14-54	0	1	0	0	0	0	1	0	0	0	0	0	1	0	0	3
14-62	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	2
14-63	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	3
14-64	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
15-59	0	0	0	1	1	0	5	0	1	0	0	0	0	0	0	8
15-65	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2
15-69	0	0	0	0	0	0	102	0	0	0	0	0	0	0	0	102
15-70	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	6
15-71	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
16-58	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2

16-59	0	0	0	0	0	0	5	0	0	0	0	2	5	0	0	12
16-63	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
16-68	0	0	0	0	0	0	4	0	0	0	1	0	0	0	1	6
16-71	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	2
17-34	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
17-65	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
17-68	0	1	0	0	1	0	16	0	0	0	0	0	0	0	0	18
17-71	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	3
17-72	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
18-68	0	0	0	0	0	0	188	0	0	0	0	0	0	0	0	188
18-71	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	3
25-48	0	0	0	0	0	4	5	0	0	0	0	2	2	0	0	13
25-66	1	1	0	0	0	1	11	0	1	0	0	1	4	0	0	20
26-66	1	0	0	0	1	0	183	0	0	0	0	1	2	0	9	197
27-48	0	0	0	7	1	0	7	1	1	0	0	1	3	0	1	22
27-67	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
29-48	1	0	0	0	1	0	1	0	1	0	0	0	0	0	0	4
29-60	0	0	0	0	0	0	3	0	0	0	0	0	1	0	1	5
30-43	3	1	0	0	0	0	7	8	8	0	0	2	0	0	1	30
30-47	0	0	0	0	1	0	3	1	1	0	0	0	1	1	1	9
30-52	1	0	0	0	1	0	4	0	0	0	0	2	1	0	2	11
30-53	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
30-56	1	0	0	0	0	0	2	0	0	0	0	1	4	0	1	9
30-58	0	0	0	0	0	0	1	0	0	0	0	0	4	0	0	5
30-59	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	10
31-47	18	12	0	2	5	0	14	92	1	0	1	1	8	0	13	167
31-48	7	0	0	0	1	1	16	0	0	0	0	3	1	0	3	32
31-51	4	0	0	0	0	0	40	0	0	0	0	0	1	0	0	45
31-53	0	0	0	0	0	0	7	0	0	0	0	0	3	0	1	11
31-56	11	4	0	0	4	0	55	28	5	0	0	21	24	1	21	174
31-60	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
32-45	13	20	0	1	0	0	0	12	7	1	0	3	0	0	0	57
32-54	0	0	0	0	0	0	3	0	0	0	0	0	1	0	0	4
32-56	6	1	0	0	1	0	118	0	16	0	0	10	24	2	34	212
32-57	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2
33-44	0	1	1	0	84	2	5	10	54	0	0	1	0	0	0	158
33-48	0	2	0	0	0	0	5	0	0	0	0	5	1	0	1	14
33-49	0	0	0	0	0	0	10	1	0	0	0	3	0	0	0	14
33-53	1	3	0	0	0	0	3	0	0	0	0	8	0	0	2	17
33-56	0	4	0	1	0	0	8	0	0	0	0	1	11	0	0	25
34-43	2	0	0	23	10	0	179	32	81	0	0	134	9	1	22	493
34-47	1	1	1	0	0	2	4	0	1	0	0	4	1	0	1	16
34-48	5	0	0	0	0	0	2	0	0	0	0	0	0	0	1	8

34-51	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	2
34-53	1	8	0	0	0	0	25	0	1	0	0	1	9	0	4	49
34-56	1	0	0	0	0	6	18	0	0	0	0	6	0	1	3	35
34-57	0	0	0	0	0	0	8	0	0	0	0	0	1	0	2	11
35-54	0	0	0	0	0	0	1	0	0	0	0	0	2	0	2	5
35-56	31	1	0	0	0	0	705	0	2	239	216	21	159	3	469	1846
35-57	0	0	0	0	1	0	16	0	0	0	0	5	2	1	4	29
36-44	2	0	0	0	0	1	4	0	8	0	2	1	0	0	1	19
36-49	3	0	0	0	0	0	14	0	0	0	0	1	0	0	0	18
36-50	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
36-51	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2
36-52	0	1	0	0	2	0	4	0	1	0	0	0	4	0	1	13
36-54	0	1	0	0	0	0	6	0	0	0	0	1	4	0	1	13
36-56	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	2
36-57	0	0	0	0	0	0	67	0	0	0	2	4	74	0	69	216
37-45	3	0	0	1	0	0	1	0	0	0	0	15	0	0	0	20
37-49	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	3
37-51	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1	3
37-53	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2
37-55	0	0	0	0	0	0	6	0	0	0	0	5	17	0	0	28
38-43	27	1	0	0	0	1	1	1	28	0	0	4	6	0	1	70
38-47	18	3	0	0	0	1	6	0	9	0	0	0	1	0	1	39
38-51	2	0	0	0	0	0	1	0	1	0	0	2	1	1	8	16
39-45	0	0	0	0	0	0	0	0	0	0	0	32	0	0	1	33
39-48	4	0	0	4	0	0	6	0	0	0	1	1	6	0	2	24
39-50	4	4	0	0	4	1	39	0	4	0	0	0	32	0	6	94
39-51	35	0	0	9	29	6	58	0	17	0	13	0	10	0	4	181
40-48	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	3
40-49	4	0	0	0	0	0	1	0	1	0	0	0	1	0	0	7
41-50	0	0	0	0	0	0	4	0	0	0	0	0	1	0	0	5
42-46	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2
42-47	7	0	0	0	0	0	7	0	0	0	9	0	7	0	0	30
42-48	1	0	0	0	0	0	5	0	0	0	0	0	0	0	1	7
42-49	0	18	0	3	0	1	21	0	0	0	35	7	24	0	11	120

Table G.2 Frequencies of Type-Identified Projectile Points and Tools.

	T-2		T-3		T-6		T-7		T-8		T-09		T-10		T-13		T-14		T-15		T-16		T-17	
E-N	T	Pts	T	Pts	T	Pts	T	Pts	T	Pts	T	Pts	T	Pts	T	Pts	T	Pts	T	Pts	T	Pts	T	Pts
4-47	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4-48	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5-44	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5-46	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6-47	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
7-61	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
8-56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
8-59	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
8-60	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
8-61	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9-36	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0
9-54	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9-57	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
10-54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
10-64	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0
11-33	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
11-40	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11-54	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11-55	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
11-59	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11-64	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0
11-67	1	0	0	0	1	0	3	0	2	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0
12-56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
12-64	0	0	0	0	0	0	0	0	4	1	0	0	0	0	0	0	0	0	1	0	0	0	1	0
12-65	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13-34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
13-54	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13-61	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0
13-66	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13-72	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
14-62	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14-72	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
15-59	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15-65	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15-69	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16-33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
16-35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
16-59	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
16-71	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18-71	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

22-71	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
25-48	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25-66	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
26-66	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30-43	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
30-47	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
30-52	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0
30-56	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31-47	0	1	0	0	0	1	0	0	1	0	3	0	0	0	1	0	0	0	0	0	0	0	0	1
31-53	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31-55	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31-56	0	0	0	0	1	1	0	0	2	1	3	0	0	0	0	0	1	0	0	1	0	0	0	0
32-45	2	0	1	0	0	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
32-54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
32-56	1	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1	1	0	0	0	0	1
33-44	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
33-56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
34-43	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
34-45	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
34-48	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34-53	0	0	0	0	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34-57	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	2
35-54	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35-56	0	0	0	0	2	0	0	0	11	2	0	0	0	0	0	0	0	1	2	0	1	0	2	2
36-54	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
36-56	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36-57	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0
37-49	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
37-51	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
37-53	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0
37-55	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
38-47	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
38-51	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39-50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
39-51	0	0	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40-49	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
42-49	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0

APPENDIX H:

PROJECTILE POINT ATTRIBUTES

APPENDIX H: PROJECTILE POINT ATTRIBUTES

This appendix consists of a series of seven tables that (1) summarize the diagnostic attribute data presented in Suhm and Jelks (1962) and Turner and Hester (1985) for the 36 dart point and the 11 arrow point types identified during the projectile point analysis, and (2) tabulate the number of specimens from the Fort Hood assemblage that meet each of the specific criteria. Additional attributes identified, but not addressed by either Suhm and Jelks (1962) or Turner and Hester (1985), are also presented for the Fort Hood collection, as is a total for all unknowns. Each table serves as a summary for a distinct morphological attribute. Following these seven summary tables are an additional 45 tables (H.8 through H.52) which summarize the metric observations for each of the point types represented in the collection.

GENERAL SHAPE.Table H.1 summarizes the general shape of a projectile point when seen in outline. Suhm and Jelks (1962) and Turner and Hester (1985) use triangular, lanceolate, and leaf-shape, while the Fort Hood analysis uses the terms lanceolate and triangular.

FLAKING. Table H.2 shows the pattern formed by the removal of pressure flakes along the blade edges of the projectile point. Suhm and Jelks (1962) and Turner and Hester (1985) discuss parallel, random, minimal, and alternately beveled. The Fort Hood projectile point attributes include all the above as well as collateral. Definitions used in this analysis are based on Crabtree (1972).

SHOULDER SHAPE. Table H.3 summarizes the shape of the shoulders, if present. Discussions in Suhm and Jelks (1962) and Turner and Hester (1985) recognize the following terms; barbed, extremely barbed, straight, and round. The Fort Hood analysis identifies whether shoulders are barbed, extremely barbed, abrupt, round/sloping, and not applicable (N/A).

NOTCHING. Table H.4 summarizes the location of notches, if any, on the projectile point. Suhm and Jelks (1962) and Turner and Hester (1985) identify basal, corner, and side notching. Analysis of the Fort Hood points included these as well as side and basal notching, corner and basal notching, and the absence of notching (No Notch).

STEM SHAPE. Table H.5 summarizes the morphological variation within stem shapes. Characteristic stem shapes identified by Suhm and Jelks (1962) and Turner and Hester (1985) include straight, expanding, contracting, and alternately beveled. The Fort Hood analysis included these and also noted if a stem was absent all together.

BASE SHAPE. Table H.6 summarizes variations in base shape. Suhm and Jelks (1962) and Turner and Hester (1985) identify the following variations: concave, convex, straight, pointed, and indented. These terms are the same as those used in the Fort Hood analysis.

MISCELLANEOUS ATTRIBUTES. Table H.7 summarizes details about other morphological variations noted in Suhm and Jelks (1962) and Turner and Hester (1985) and also noted on the Fort Hood projectile points. Included in this category are round tangs, the presence or absence of serration along the blade edges, beveled cross-sections (X-Section), basal thinning, and basal grinding.

Table H.1 General Shape

	Suhm & Jelks, Turner & Hester*			**Fort Hood Collection****			
Type	Triangular	Lanceolate	Leaf	Triangular	Lanceolate	Leaf	Unknown
Dart Points							
Andice	Y						1
Angostura			Y		4		2
Barber		Y			1		1
Bell	Y						1
Bulverde	Y			2	1		4
Carrollton	Y			1			1
Castroville	Y			13	1		7
Darl	Y			3	9		1
Edgewood	Y			4			
Ellis	Y			9			1
Ensor	Y			21			2
Fairland	Y			6	1		1
Frio	Y			5			1
Gary	Y						1
Godley	Y						1
Golondrina		Y					1
Gower				3	2		1
Hoxie					1		4
La Jita					1		
Lange	Y			3			1
Marcos	Y			6			1
Marshall	Y			7	2		3
Martindale	Y			3	2		1
Montell	Y			3			
Morhiss	Y	Y					1
Morrill	Y				1		
Nolan	Y						1
Palmillas	Y		Y		2		
Pandale		U			1		
Pedernales	U		O	12	14		16
Plainview		Y			1		
Travis	Y		Y				1
Uvalde	E	E		2			2
Wells	Y						5
Williams	Y				2		2
Yarbrough	Y			5			
Arrow Points							
Alba	Y			2			
Bonham	Y			4	1		2
Cliffton	Y			2			2
Cuney	Y			2			
Perdiz	Y			3			1
Scallorn	Y			24	1		4
Steiner	Y			1			
Washita	Y						1
Young	Y		Y	1			

A = Always, E = Either, G = Generally, N = Never, O = Often
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* Listed as Diagnostic
** Number of Specimens

Table H.2 Flaking

Type	Suhm & Jelks, Turner & Hester*				Fort Hood Collection**					
	Parallel	Random	Minimal	Alt. Bev.	Parallel	Collateral	Random	Minimal	Alt. Bev.	Unknown
Dart Points										
Andice										1
Angostura	Y					2	3			1
Barber	Y				1					1
Bell										1
Bulverde							5		1	1
Carrollton							1	1		
Castroville							16			5
Darl				S		2	4		8	
Edgewood				S			4			
Ellis						1	7	1		1
Ensor					2	5	10		3	3
Fairland							5		2	1
Frio							4		1	1
Gary							1			
Godley										1
Golondrina		G								1
Gower							6			
Hoxie							1			4
La Jita							1			
Lange						1	1		1	1
Marcos							5			2
Marshall						2	8			2
Martindale						1	5			
Montell						1	2			
Morhiss							1			
Morrill							1			
Nolan							1			
Palmillas							2			
Pandale						1				
Pedernales						3	31	1	2	5
Plainview	Y				1					
Travis							1			
Uvalde							3		1	
Wells						1	3			1
Williams							4			
Yarbrough				S		2	2		1	
Arrow Points										
Alba							1			1
Bonham					3	1	1	1		1
Cliffton			S			1	1	1		1
Cuney							2			
Perdiz					1	1	2			
Scallorn					7	2	15	2		3
Steiner								1		
Washita										1
Young			Y					1		

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** Number of Specimens

Table H.3 Shoulder Shape

	Suhm & Jelks, Turner & Hester *				**Fort Hood Collection****					
Type	**Barbed**	**Ext Barbed**	**Straight**	**Round**	**Barbed**	**Ext Barbed**	**Abrupt**	**Round/ Sloping**	**Unknown**	**N/A**
Dart Points										
Andice		Y							1	
Angostura									1	5
Barber									1	1
Bell		Y							1	
Bulverde	Y		Y		2		4		1	
Carrollton	Y		Y				2			
Castroville		Y			9	7	2		2	1
Darl							9	2		3
Edgewood	Y				2		2			
Ellis	Y				8	1	1			
Ensor	Y		Y		14		7		2	
Fairland					1		5		2	
Frio	Y	Y			2		2	1	1	
Gary	S		Y		1					
Godley			Y					1		
Golondrina									1	
Gower							1	5		
Hoxie							1	1	2	1
La Jita					1					
Lange	O				3		1			
Marcos	A				6	1				
Marshall	A	U			10		1		1	
Martindale	Y				2		3	1		
Montell	U		S		2	1				
Morhiss	R		Y					1		
Morrill			E	E				1		
Nolan	N		Y	Y				1		
Palmillas	Y	Y	Y	Y				2		
Pandale								1		
Pedernales	Y	Y	Y		12		18	6	5	1
Plainview										1
Travis				Y					1	
Uvalde	E			E	1	1	2			
Wells			Y				2	2	1	
Williams	Y				2			1	1	
Yarbrough	N	N	Y		1		2	2		
Arrow Points										
Alba	Y				2					
Bonham	U		S		5	1		1		
Cliffton			Y		4					
Cuney	Y					2				
Perdiz	U		S		3	1				
Scallorn	U		S		18	5	3		3	
Steiner	Y				1					
Washita							1			
Young										1

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** Number of Specimens

Table H.4 Notching

Type	Suhm & Jelks, Turner & Hester*			Fort Hood Collection**						
	Basal	Corner	Side	Basal	Corner	Side	Side & Basal	Corner & Basal	No Notch	Unknown
Dart Points										
Andice	Y								1	
Angostura				1					4	1
Barber				2						
Bell	Y									1
Bulverde					2				5	
Carrollton									2	
Castroville		Y		2	16					3
Darl				3					11	
Edgewood					2	1			1	
Ellis		Y			10					
Ensor			Y			21				2
Fairland				1		2			4	1
Frio	Y	Y	Y			3	1	2		
Gary									1	
Godley									1	
Golondrina				1						
Gower				4		1				1
Hoxie				1					2	2
La Jita					1					
Lange					4					
Marcos		Y			6	1				
Marshall	Y	Y			12					
Martindale		Y			5				1	
Montell	Y							3		
Morhiss									1	
Morrill										1
Nolan									1	
Palmillas			Y						2	
Pandale									1	
Pedernales				26	1			2	10	3
Plainview									1	
Travis									1	
Uvalde					2			2		
Wells									5	
Williams		Y			3				1	
Yarbrough									5	
Arrow Points										
Alba					2					
Bonham					6				1	
Cliffton					3					1
Cuney	Y				2					
Perdiz					3				1	
Scallorn		Y			25	2				2
Steiner					1					
Washita			Y			1				
Young									1	

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** Number of Specimens

Table H.5 Stem Shape

	Suhm & Jelks, Turner & Hester *				Fort Hood Collection**					
Type	Straight	Expanding	Contracting	Alt. Bev	Straight	Expanding	Contracting	Alt. Bev	None	Unknown
Dart Points										
Andice	Y					1				
Angostura									4	2
Barber									2	
Bell						1				
Bulverde	U		U		5	1	1			
Carrollton	G						2			
Castroville	G	U				18				3
Darl	Y	Y		S	7	4			3	
Edgewood		Y				4				
Ellis		Y				10				
Ensor		Y				23				
Fairland		Y				8				
Frio						6				
Gary	R		Y				1			
Godley		Y				1				
Golondrina										1
Gower	Y					6				
Hoxie		Y			1	2			1	1
La Jita		Y				1				
Lange	U	Y				4				
Marcos		A				7				
Marshall	Y	Y				12				
Martindale		Y				6				
Montell	S	U				3				
Morhiss	Y		S			1				
Morrill	Y	R	R		1					
Nolan	G	S	S	A	1					
Palmillas		Y				2				
Pandale	Y	S	S			1				
Pedernales	U	S	S		24	9	4		1	4
Plainview									1	
Travis	U	S	S		1					
Uvalde		Y				4				
Wells	S		U	Y	3		2			
Williams		Y				4				
Yarbrough	Y	Y				5				
Arrow Points										
Alba	U	R			2					
Bonham	Y				3	4				
Cliffton					1		2			1
Cuney	E	E				2				
Perdiz			Y		2		2			
Scallorn		Y				29				
Steiner	Y	Y				1				
Washita						1				
Young										1

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** Number of Specimens

H.6 Base Shape

	Suhm & Jelks, Turner & Hester*					Fort Hood Collection**					
Type	Concave	Convex	Straight	Pointed	Indented	Concave	Convex	Straight	Pointed	Indented	Unknown
Dart Points											
Andice								1			
Angostura	Y		Y			4					2
Barber					Y	2					
Bell							1				
Bulverde	Y	Y	U			2		4			1
Carrollton		Y	Y				1				1
Castroville		Y	Y			1	12	6			2
Darl	U		Y			13					1
Edgewood	Y		Y			3					1
Ellis		Y	Y			3	1	6			
Ensor	Y		G			8	2	13			
Fairland	Y					8					
Frio	A				S	4		2			
Gary		Y		S			1				
Godley		Y					1				
Golondrina	Y									1	
Gower	Y					2				2	2
Hoxie						4					1
La Jita							1				
Lange	Y	Y	U			1		3			
Marcos	R	Y	Y				4	3			
Marshall	Y	Y	Y			10		2			
Martindale	E				E	6					
Montell		Y					1	1			1
Morhiss		G	S				1				
Morrill	R	R	Y			1					
Nolan	R	S	U					1			
Palmillas		Y	S				2				
Pandale	Y	Y	Y				1				
Pedernales	Y				Y	31	1			6	4
Plainview	A					1					
Travis	S	S	U				1				
Uvalde	Y					4					
Wells	O	Y		Y		2	2	1			
Williams		Y					4				
Yarbrough	S	S	U			1	2	2			
Arrow Points											
Alba		E	E								2
Bonham		E	E				5	1			1
Cliffton							2		1		1
Cuney	Y						1	1			
Perdiz				O			2		2		1
Scallorn	E	E	E			6	10	12			1
Steiner											
Washita							1				
Young	R	Y	Y			1					

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** Number of Specimen

Table H-7 Miscellaneous Attributes

	Suhm & Jelks, Turner & Hester*					**Fort Hood Collection****				
Type	**Round Tang**	**Serration**	**Beveled X-Section**	**Basal Thinng**	**Basal Grinding**	**Round Tang**	**Serration**	**Beveled X-Section**	**Basal Thinng**	**Basal Grinding**
Dart Points										
Andice									1	
Angostura					Y	3			4	5
Barber					Y	2			2	1
Bell						1			1	
Bulverde				Y		4		1	6	
Carrollton				S		1			2	
Castroville						15	1		20	4
Darl		S	S		S	10	3	8	14	1
Edgewood						3			3	
Ellis						10			9	1
Ensor						21	1	3	22	5
Fairland		S	R			4		2	8	
Frio						6	1	1	6	
Gary						1				
Godley						1			1	
Golondrina					Y				1	1
Gower						6		2	5	1
Hoxie				Y	Y	4		1	5	4
La Jita	Y			Y		1				
Lange						3	1	1	4	1
Marcos						4			7	
Marshall						8	1	1	12	2
Martindale						6			6	1
Montell						3			3	
Morhiss	Y					1			1	
Morrill		S				1			1	1
Nolan						1			1	
Palmillas						2			2	
Pandale						1			1	1
Pedernales				O		30		2	37	3
Plainview				U	Y	1			1	1
Travis						1			1	
Uvalde		S				4		1	4	1
Wells		O			U	4			4	2
Williams	Y					3			4	
Yarbrough					O	2		1	5	1
Arrow Points										
Alba		S				2	2			
Bonham		S				5	2		2	
Cliffton						3	1		1	
Cuney						1			2	
Perdiz		S				2	2		2	
Scallorn		O				13	6		23	
Steiner		Y				1			1	
Washita						1				
Young										

A = Always, E = Either, G = Generally, N = Never, O = Often
R = Rarely, S = Sometimes, U = Usually, Y = Yes

* Listed as Diagnostic
** Number of Specimens

Table H.8. Measurements - Andice.

#		High	Low	AVG	SD	CoV
0	L	0.0	0.0	0.00	0.00	n/a
0	W	0.0	0.0	0.00	0.00	n/a
1	T	0.8	0.8	0.80	0.00	n/a
1	ST	0.7	0.7	0.70	0.00	n/a
0	BW	0.0	0.0	0.00	0.00	n/a
0	BL	0.0	0.0	0.00	0.00	n/a
1	SW	1.9	1.9	0.00	0.00	n/a
1	SL	1.7	1.7	0.00	0.00	n/a
1	BSW	1.9	1.9	0.00	0.00	n/a
0	W	0.0	0.0	0.00	0.00	n/a

AVG=average, SD=Standard Deviation, CoV=Coefficient of Variation
L=max. length, W=max width, T=max thickness, ST=stem thickness
BL=base length, BW=base width, SW=stem width, SL=stem length
BSW=base width, WGT=weight, (all measurements in centimeters, weight in grams)

Table H.9. Measurements - Angostura

#		High	Low	AVG	SD	CoV
1	L	0.6	0.6	0.60	0.00	n/a
1	W	2.6	2.6	2.60	0.00	n/a
1	T	0.8	0.8	0.80	0.00	n/a
2	ST	0..8	0.6	0.70	0.10	14.29%
1	BW	0.6	0.6	0.60	0.00	n/a
1	BL	2.6	2.6	2.60	0.00	n/a
0	SW	0.0	0.0	0.00	0.00	n/a
0	SL	0.0	0.0	0.00	0.00	n/a
4	BSW	1.5	1.0	1.30	1.00	14.39%
1	W	13.7	13.7	13.7	0.00	n/a

AVG=average, SD=Standard Deviation, CoV=Coefficient of Variation
L=max. length, W=max width, T=max thickness, ST=stem thickness
BL=base length, BW=base width, SW=stem width, SL=stem length
BSW=base width, WGT=weight, (all measurements in centimeters, weight in grams)

Table H.10. Measurements - Barber

#		High	Low	AVG	SD	CoV
0	L	0.0	0.0	0.00	0.00	n/a
0	W	0.0	0.0	0.00	0.00	n/a
1	T	0.6	0.6	0.60	0.00	n/a
0	ST	0.0	0.0	0.00	0.00	n/a
1	BW	1.7	1.7	1.70	0.00	n/a
0	BL	0.0	0.0	0.00	0.00	n/a
0	SW	0.0	0.0	0.00	0.00	n/a
0	SL	0.0	0.0	0.00	0.00	n/a
0	BSW	0.0	0.0	0.00	0.00	n/a
0	W	0.0	0.0	0.00	0.00	n/a

AVG=average, SD=Standard Deviation, CoV=Coefficient of Variation
L=max. length, W=max width, T=max thickness, ST=stem thickness
BL=base length, BW=base width, SW=stem width, SL=stem length
BSW=base width, WGT=weight, (all measurements in centimeters, weight in grams)

Table H.11. Measurements - Bulverde

#		High	Low	AVG	SD	CoV
1	L	4.5	4.5	4.50	0.00	n/a
5	W	3.2	2.6	2.82	0.22	7.90%
5	T	0.9	0.8	0.86	0.05	5.70%
7	ST	0.8	0.6	0.71	0.06	8.94%
7	BW	2.9	2.6	2.73	0.13	4.77%
1	BL	2.9	2.9	2.90	0.00	n/a
7	SW	2.0	1.3	1.73	0.24	14.07%
6	SL	1.8	1.3	1.60	0.17	10.83%
6	BSW	2.2	1.3	1.63	0.31	19.25%
2	W	12.7	8.8	10.75	1.95	18.14%

AVG=average, SD=Standard Deviation, CoV=Coefficient of Variation
L=max. length, W=max width, T=max thickness, ST=stem thickness
BL=base length, BW=base width, SW=stem width, SL=stem length
BSW=base width, WGT=weight, (all measurements in centimeters, weight in grams)

Table H.12. Measurements - Carrollton

#		High	Low	AVG	SD	CoV
0	L	0.0	0.0	0.00	0.00	n/a
0	W	0.0	0.0	0.00	0.00	n/a
1	T	0.8	0.8	0.80	0.00	n/a
2	ST	0.7	0.7	0.70	0.00	0.00%
0	BL	0.0	0.0	0.00	0.00	n/a
0	BW	0.0	0.0	0.00	0.00	n/a
2	SW	2.2	1.8	2.00	0.20	10.00%
2	SL	2.0	1.8	1.85	0.15	8.11%
1	BSW	1.5	1.5	1.50	0.00	n/a
0	W	0.0	0.0	0.00	0.00	n/a

AVG=average, SD=Standard Deviation, CoV=Coefficient of Variation
L=max. length, W=max width, T=max thickness, ST=stem thickness
BL=base length, BW=base width, SW=stem width, SL=stem length
BSW=base width, WGT=weight, (all measurements in centimeters, weight in grams)

Table H.13. Measurements - Castroville

#		High	Low	AVG	SD	CoV
2	L	4.9	3.9	4.40	0.50	11.36%
6	W	3.8	2.6	3.18	0.44	13.86%
15	T	0.9	0.5	0.71	0.11	15.90%
19	ST	0.8	0.4	0.65	0.11	16.76%
6	BW	3.8	2.6	3.18	0.44	13.86%
2	BL	3.6	2.7	3.15	0.45	14.29%
19	SW	2.7	1.4	2.04	0.33	16.10%
19	SL	1.5	0.8	1.21	0.18	15.34%
17	BSW	3.0	1.6	2.29	0.36	15.71%
1	W	9.3	9.3	9.3	0.00	n/a

AVG=average, SD=Standard Deviation, CoV=Coefficient of Variation
L=max. length, W=max width, T=max thickness, ST=stem thickness
BL=base length, BW=base width, SW=stem width, SL=stem length
BSW=base width, WGT=weight, (all measurements in centimeters, weight in grams)

Table H.14. Measurements - Darl

#		High	Low	AVG	SD	CoV
4	L	7.4	4.2	5.13	1.32	25.72%
12	W	2.0	1.4	1.6	0.15	9.55%
14	T	0.8	0.5	0.6	0.08	12.60%
12	ST	0.6	0.3	0.5	0.08	16.33%
12	BW	2.0	1.4	1.6	0.15	9.55%
4	BL	6.3	2.9	4.0	1.37	34.32%
10	SW	1.5	1.0	1.27	0.13	9.99%
11	SL	1.5	0.8	1.18	0.22	18.33%
11	BSW	1.6	1.1	1.33	0.13	9.69%
5	W	8.4	3.2	4.76	1.85	38.93%

AVG=average, SD=Standard Deviation, CoV=Coefficient of Variation
L=max. length, W=max width, T=max thickness, ST=stem thickness
BL=base length, BW=base width, SW=stem width, SL=stem length
BSW=base width, WGT=weight, (all measurements in centimeters, weight in grams)

Table H.15. Measurements - Edgewood

#		High	Low	AVG	SD	CoV
1	L	3.5	3.5	3.5	0.00	n/a
3	W	2.8	2.2	2.5	0.24	9.60%
3	T	0.7	0.7	0.7	0.00	n/a
4	ST	0.6	0.6	0.6	0.00	n/a
3	BW	2.8	2.2	2.5	0.24	9.60%
1	BL	2.4	2.4	2.4	0.00	n/a
4	SW	1.7	1.5	1.58	0.08	5.06%
4	SL	1.1	0.8	0.95	0.15	10.53%
2	BSW	2.1	2.0	2.05	0.05	2.44%
0	W	0	0	0	0.00	n/a

AVG=average, SD=Standard Deviation, CoV=Coefficient of Variation
L=max. length, W=max width, T=max thickness, ST=stem thickness
BL=base length, BW=base width, SW=stem width, SL=stem length
BSW=base width, WGT=weight, (all measurements in centimeters, weight in grams)

Table H.16. Measurements - Ellis

#		High	Low	AVG	SD	CoV
2	L	4.6	4.0	4.30	0.30	6.98%
7	W	2.7	2.3	2.46	0.16	6.50%
7	T	0.7	0.5	0.60	0.05	8.33%
10	ST	0.5	0.4	0.47	0.05	10.64%
7	BW	2.7	2.3	2.46	0.16	6.50%
2	BL	3.8	3.2	3.50	0.00	n/a
10	SW	1.6	1.2	1.38	0.12	8.70%
10	SL	1.1	0.8	0.90	0.09	10.00%
6	BSW	2.1	1.6	1.80	0.30	16.66%
4	W	6.0	2.6	4.45	1.21	27.19%

AVG=average, SD=Standard Deviation, CoV=Coefficient of Variation
L=max. length, W=max width, T=max thickness, ST=stem thickness
BL=base length, BW=base width, SW=stem width, SL=stem length
BSW=base width, WGT=weight, (all measurements in centimeters, weight in grams)

Table H.17 Measurements - Ensor

#		High	Low	AVG	SD	CoV
2	L	6.0	4.0	5.00	1.00	20.00%
14	W	2.7	2.1	2.26	0.20	8.85%
20	T	0.7	0.5	0.60	0.06	10.00%
22	ST	0.6	0.4	0.52	0.06	11.54%
18	BW	2.7	1.8	2.20	0.22	10.00%
2	BL	5.0	3.2	4.10	0.90	21.95%
21	SW	1.7	1.3	1.47	0.11	7.48%
23	SL	1.2	0.7	0.90	0.13	14.44%
12	BSW	2.4	1.8	2.15	0.19	8.84%
3	W	6.4	3.4	5.03	1.24	24.65%

AVG=average, SD=Standard Deviation, CoV=Coefficient of Variation
L=max. length, W=max width, T=max thickness, ST=stem thickness
BL=base length, BW=base width, SW=stem width, SL=stem length
BSW=base width, WGT=weight, (all measurements in centimeters, weight in grams)

Table H.18. Measurements - Fairland

#		High	Low	AVG	SD	CoV
5	L	5.1	3.0	4.26	0.72	16.90%
6	W	2.9	1.9	2.25	0.31	13.78%
7	T	0.7	0.6	0.61	0.03	4.92%
7	ST	0.6	0.5	0.54	0.05	9.26%
7	BW	2.9	1.9	2.24	0.29	12.95%
5	BL	4.1	2.1	3.06	0.68	22.22%
7	SW	2.2	1.3	1.71	0.30	17.54%
6	SL	1.4	0.9	1.18	0.20	16.95%
7	BSW	2.6	1.4	1.93	0.38	19.69%
5	W	7.6	3.2	5.24	1.59	30.34%

AVG=average, SD=Standard Deviation, CoV=Coefficient of Variation
L=max. length, W=max width, T=max thickness, ST=stem thickness
BL=base length, BW=base width, SW=stem width, SL=stem length
BSW=base width, WGT=weight, (all measurements in centimeters, weight in grams)

Table H.19. Measurements - Frio

#		High	Low	AVG	SD	CoV
0	L	0.0	0.0	0.00	0.00	n/a
3	W	2.4	2.0	2.23	0.17	7.62%
5	T	0.7	0.5	0.58	0.07	12.07%
5	ST	0.6	0.4	0.50	0.06	12.00%
3	BW	2.4	2.0	2.23	0.17	7.62%
0	BL	0.0	0.0	0.00	0.00	n/a
5	SW	1.7	1.4	1.58	0.12	7.59%
5	SL	1.0	0.8	0.92	0.07	7.61%
3	BSW	2.4	2.0	2.17	0.17	7.83%
0	W	0.0	0.0	0.00	0.00	n/a

AVG=average, SD=Standard Deviation, CoV=Coefficient of Variation
L=max. length, W=max width, T=max thickness, ST=stem thickness
BL=base length, BW=base width, SW=stem width, SL=stem length
BSW=base width, WGT=weight, (all measurements in centimeters, weight in grams)

Table H.20. Measurements - Gary

#		High	Low	AVG	SD	CoV
0	L	0.0	0.0	0.00	0.00	n/a
1	W	2.4	2.4	2.40	0.00	n/a
1	T	0.9	0.9	0.90	0.00	n/a
1	ST	0.9	0.9	0.90	0.00	n/a
1	BW	2.4	2.4	2.40	0.00	n/a
0	BL	0.0	0.0	0.00	0.00	n/a
1	SW	1.4	1.4	1.40	0.00	n/a
1	SL	1.7	1.7	1.70	0.00	n/a
1	BSW	1.1	1.1	1.10	0.00	n/a
0	W	0.0	0.0	0.00	0.00	n/a

AVG=average, SD=Standard Deviation, CoV=Coefficient of Variation
L=max. length, W=max width, T=max thickness, ST=stem thickness
BL=base length, BW=base width, SW=stem width, SL=stem length
BSW=base width, WGT=weight, (all measurements in centimeters, weight in grams)

Table H.21. Measurements - Godley

#		High	Low	AVG	SD	CoV
0	L	0.0	0.0	0.00	0.00	n/a
1	W	1.9	1.9	1.90	0.00	n/a
1	T	0.7	0.7	0.70	0.00	n/a
1	ST	0.7	0.7	0.70	0.00	n/a
1	BW	1.9	1.9	1.90	0.00	n/a
0	BL	0.0	0.0	0.00	0.00	n/a
1	SW	1.3	1.3	1.30	0.00	n/a
1	SL	0.8	0.8	0.80	0.00	n/a
1	BSW	1.7	1.7	1.70	0.00	n/a
0	W	0.0	0.0	0.00	0.00	n/a

AVG=average, SD=Standard Deviation, CoV=Coefficient of Variation
L=max. length, W=max width, T=max thickness, ST=stem thickness
BL=base length, BW=base width, SW=stem width, SL=stem length
BSW=base width, WGT=weight, (all measurements in centimeters, weight in grams)

Table H.22. Measurements - Golondrina

#		High	Low	AVG	SD	CoV
0	L	0.0	0.0	0.0	0.00	n/a
0	W	0.0	0.0	0.0	0.00	n/a
0	T	0.0	0.0	0.0	0.00	n/a
0	ST	0.0	0.0	0.0	0.00	n/a
0	BW	0.0	0.0	0.0	0.00	n/a
0	BL	0.0	0.0	0.0	0.00	n/a
0	SW	0.0	0.0	0.0	0.00	n/a
0	SL	0.0	0.0	0.0	0.00	n/a
1	BSW	2.4	2.4	2.40	0.00	n/a
0	W	0.0	0.0	0.00	0.00	n/a

AVG=average, SD=Standard Deviation, CoV=Coefficient of Variation
L=max. length, W=max width, T=max thickness, ST=stem thickness
BL=base length, BW=base width, SW=stem width, SL=stem length
BSW=base width, WGT=weight, (all measurements in centimeters, weight in grams)

Table H.23. Measurements - Gower

#		High	Low	AVG	SD	CoV
1	L	3.9	3.9	3.90	0.22	5.64%
3	W	2.6	2.1	2.30	0.22	9.57%
6	T	0.8	0.6	0.70	0.06	8.57%
6	ST	0.6	0.5	0.57	0.05	8.77%
3	BW	2.6	2.1	2.30	0.22	9.57%
1	BL	2.9	2.9	2.90	0.00	n/a
5	SW	1.8	1.6	1.68	0.07	4.17%
6	SL	1.7	1.0	1.27	0.28	22.00%
4	BSW	2.0	1.7	1.80	0.12	6.66%
1	W	4.7	4.7	4.70	0.00	n/a

AVG=average, SD=Standard Deviation, CoV=Coefficient of Variation
L=max. length, W=max width, T=max thickness, ST=stem thickness
BL=base length, BW=base width, SW=stem width, SL=stem length
BSW=base width, WGT=weight, (all measurements in centimeters, weight in grams)

Table H.24. Measurements - Hoxie

#		High	Low	AVG	SD	CoV
0	L	0.0	0.0	0.00	0.00	n/a
3	W	2.4	0.8	1.80	0.71	39.44%
2	T	0.7	0.6	0.65	0.05	7.69%
2	ST	0.6	0.5	0.55	0.05	9.10%
2	BW	2.4	2.2	2.30	0.10	4.35%
0	BL	0.0	0.0	0.00	0.00	n/a
2	SW	1.6	1.5	1.55	0.05	3.23%
2	SL	1.2	1.2	1.20	0.00	n/a
4	BSW	1.7	1.5	1.63	0.08	4.91%
0	W	0.0	0.0	0.00	0.00	n/a

AVG=average, SD=Standard Deviation, CoV=Coefficient of Variation
L=max. length, W=max width, T=max thickness, ST=stem thickness
BL=base length, BW=base width, SW=stem width, SL=stem length
BSW=base width, WGT=weight, (all measurements in centimeters, weight in grams)

Table H.25. Measurements - La Jita

#		High	Low	AVG	SD	CoV
0	L	0.0	0.0	0.00	0.00	n/a
0	W	0.0	0.0	0.00	0.00	n/a
0	T	0.0	0.0	0.00	0.00	n/a
1	ST	0.6	0.6	0.60	0.00	n/a
0	BW	0.0	0.0	0.00	0.00	n/a
0	BL	0.0	0.0	0.00	0.00	n/a
1	SW	1.9	1.9	1.90	0.00	n/a
1	SL	1.2	1.2	1.20	0.00	n/a
0	BSW	0.0	0.0	0.00	0.00	n/a
0	W	0.0	0.0	0.00	0.00	n/a

AVG=average, SD=Standard Deviation, CoV=Coefficient of Variation
L=max. length, W=max width, T=max thickness, ST=stem thickness
BL=base length, BW=base width, SW=stem width, SL=stem length
BSW=base width, WGT=weight, (all measurements in centimeters, weight in grams)

Table H.26. Measurements - Lange

#		High	Low	AVG	SD	CoV
2	L	5.2	4.8	5.00	0.20	4.00%
2	W	3.0	2.4	2.70	0.30	11.11%
3	T	0.7	0.6	0.63	0.05	7.40%
4	ST	0.8	0.5	0.58	0.13	22.41%
2	BW	3.0	2.4	2.70	0.30	11.11%
2	BL	4.0	3.8	3.90	0.10	2.56%
3	SW	1.9	1.5	1.63	0.19	11.66%
4	SL	1.2	1.0	1.08	0.08	4.44%
4	BSW	2.1	1.4	1.73	0.26	15.00%
2	W	1.1	6.2	6.65	0.45	6.77%

AVG=average, SD=Standard Deviation, CoV=Coefficient of Variation
L=max. length, W=max width, T=max thickness, ST=stem thickness
BL=base length, BW=base width, SW=stem width, SL=stem length
BSW=base width, WGT=weight, (all measurements in centimeters, weight in grams)

Table H.27 Measurements - Marcos

#		High	Low	AVG	SD	CoV
1	L	0.0	0.0	0.00	0.00	n/a
3	W	3.3	2.6	2.87	0.31	10.80%
5	T	0.8	0.6	0.72	0.07	9.72%
6	ST	0.6	0.5	0.53	0.05	9.43%
3	BW	3.3	2.6	2.87	0.31	10.80%
1	BL	3.0	3.0	3.00	0.00	n/a
6	SW	2.2	1.3	1.63	0.30	18.40%
6	SL	1.3	0.7	0.98	0.21	21.43%
3	BSW	2.3	1.7	1.40	0.26	18.57%
0	W	0.0	0.0	0.00	0.00	n/a

AVG=average, SD=Standard Deviation, CoV=Coefficient of Variation
L=max. length, W=max width, T=max thickness, ST=stem thickness
BL=base length, BW=base width, SW=stem width, SL=stem length
BSW=base width, WGT=weight, (all measurements in centimeters, weight in grams)

Table H.28. Measurements - Marshall

#		High	Low	AVG	SD	CoV
3	L	6.5	3.7	4.90	1.18	24.00%
3	W	3.8	1.9	2.87	0.78	27.18%
9	T	0.8	0.5	0.64	0.08	12.50%
11	ST	0.7	0.5	0.57	0.07	12.28%
3	BW	3.8	1.9	2.87	0.78	27.18%
3	BL	5.4	2.7	3.90	1.12	28.72%
11	SW	2.1	1.3	1.58	0.19	12.00%
11	SL	1.2	0.9	1.08	0.09	8.33%
8	BSW	2.5	1.4	1.80	0.31	17.22%
3	W	14.7	5.6	9.67	3.78	39.10%

AVG=average, SD=Standard Deviation, CoV=Coefficient of Variation
L=max. length, W=max width, T=max thickness, ST=stem thickness
BL=base length, BW=base width, SW=stem width, SL=stem length
BSW=base width, WGT=weight, (all measurements in centimeters, weight in grams)

Table H.29. Measurements - Martindale

#		High	Low	AVG	SD	CoV
1	L	3.6	3.6	3.60	0.00	n/a
6	W	3.4	2.4	2.83	0.32	11.31%
6	T	0.9	0.6	0.75	0.10	13.33%
6	ST	0.7	0.5	0.60	0.06	10.00%
6	BW	3.4	2.4	2.83	0.32	11.31%
1	BL	2.3	2.3	2.30	0.00	n/a
6	SW	1.9	1.5	1.70	0.14	8.24%
6	SL	1.6	1.0	1.25	0.24	19.20%
5	BSW	2.4	1.9	2.06	0.17	8.25%
1	W	5.4	5.4	5.4	0.00	n/a

AVG=average, SD=Standard Deviation, CoV=Coefficient of Variation
L=max. length, W=max width, T=max thickness, ST=stem thickness
BL=base length, BW=base width, SW=stem width, SL=stem length
BSW=base width, WGT=weight, (all measurements in centimeters, weight in grams)

Table H.30. Measurements - Montell

#		High	Low	AVG	SD	CoV
0	L	0.0	0.0	0.00	0.00	n/a
0	W	0.0	0.0	0.00	0.00	n/a
3	T	0.7	0.5	0.60	0.08	13.33%
3	ST	0.5	0.5	0.50	0.00	n/a
0	BW	0.0	0.0	0.00	0.00	n/a
0	BL	0.0	0.0	0.00	0.00	n/a
3	SW	2.3	1.9	2.17	0.19	8.76%
3	SL	1.1	1.1	1.1	0.00	n/a
3	BSW	2.6	2.2	2.40	0.16	6.67%
0	W	0.0	0.0	0.00	0.00	n/a

AVG=average, SD=Standard Deviation, CoV=Coefficient of Variation
L=max. length, W=max width, T=max thickness, ST=stem thickness
BL=base length, BW=base width, SW=stem width, SL=stem length
BSW=base width, WGT=weight, (all measurements in centimeters, weight in grams)

Table H.32. Measurements - Morrill

#		High	Low	AVG	SD	CoV
0	L	0.0	0.0	0.00	0.00	n/a
0	W	0.0	0.0	0.00	0.00	n/a
1	T	0.9	0.9	0.90	0.00	n/a
1	ST	0.7	0.7	0.70	0.00	n/a
0	BW	0.0	0.0	0.00	0.00	n/a
0	BL	0.0	0.0	0.00	0.00	n/a
1	SW	1.7	1.7	1.70	0.00	n/a
1	SL	1.7	1.7	1.70	0.00	n/a
0	BSW	0.0	0.0	0.00	0.00	n/a
0	W	0.0	0.0	0.00	0.00	n/a

AVG=average, SD=Standard Deviation, CoV=Coefficient of Variation
L=max. length, W=max width, T=max thickness, ST=stem thickness
BL=base length, BW=base width, SW=stem width, SL=stem length
BSW=base width, WGT=weight, (all measurements in centimeters, weight in grams)

Table H.33. Measurements - Nolan

#		High	Low	AVG	SD	CoV
0	L	0.0	0.0	0.00	0.00	n/a
1	W	2.6	2.6	2.60	0.00	n/a
1	T	1.0	1.0	1.00	0.00	n/a
1	ST	0.8	0.8	0.80	0.00	n/a
1	BW	2.6	2.6	2.60	0.00	n/a
0	BL	0.0	0.0	0.00	0.00	n/a
1	SW	1.5	1.5	1.50	0.00	n/a
1	SL	1.6	1.6	1.60	0.00	n/a
1	BSW	1.4	1.4	1.40	0.00	n/a
0	W	0.0	0.0	0.00	0.00	n/a

AVG=average, SD=Standard Deviation, CoV=Coefficient of Variation
L=max. length, W=max width, T=max thickness, ST=stem thickness
BL=base length, BW=base width, SW=stem width, SL=stem length
BSW=base width, WGT=weight, (all measurements in centimeters, weight in grams)

Table H.34. Measurements - Palmillas

#		High	Low	AVG	SD	CoV
1	L	4.9	4.9	4.90	0.00	n/a
2	W	3.2	2.1	2.65	0.55	20.75%
2	T	1.1	0.8	0.95	0.15	15.79%
2	ST	0.7	0.6	0.65	0.05	7.69%
2	BW	3.2	2.1	2.65	0.55	20.75%
1	BL	3.7	3.7	3.70	0.00	n/a
2	SW	1.6	1.2	1.40	0.20	14.29%
2	SL	1.5	1.2	1.35	0.15	11.11%
2	BSW	1.8	1.3	1.55	0.25	16.13%
1	W	0.9	0.9	0.90	0.00	n/a

AVG=average, SD=Standard Deviation, CoV=Coefficient of Variation
L=max. length, W=max width, T=max thickness, ST=stem thickness
BL=base length, BW=base width, SW=stem width, SL=stem length
BSW=base width, WGT=weight, (all measurements in centimeters, weight in grams)

Table H.35. Measurements - Pandale

#		High	Low	AVG	SD	CoV
0	L	0.0	0.0	0.00	0.00	n/a
1	W	1.9	1.9	1.90	0.00	n/a
1	T	0.8	0.8	0.80	0.00	n/a
1	ST	0.5	0.5	0.50	0.00	n/a
1	BW	1.9	1.9	1.90	0.00	n/a
0	BL	0.0	0.0	0.00	0.00	n/a
1	SW	1.3	1.3	1.30	0.00	n/a
1	SL	1.4	1.4	1.40	0.00	n/a
1	BSW	1.6	1.6	1.60	0.00	n/a
1	W	6.9	6.9	6.90	0.00	n/a

AVG=average, SD=Standard Deviation, CoV=Coefficient of Variation
L=max. length, W=max width, T=max thickness, ST=stem thickness
BL=base length, BW=base width, SW=stem width, SL=stem length
BSW=base width, WGT=weight, (all measurements in centimeters, weight in grams)

Table H.36. Measurements - Pedernales

#		High	Low	AVG	SD	CoV
6	L	5.0	3.9	4.57	0.45	9.85%
26	W	3.5	2.0	2.59	0.41	15.83%
35	T	1.1	0.6	0.81	0.12	14.81%
37	ST	1.0	0.5	0.68	0.12	17.65%
27	BW	3.5	2.0	2.59	0.40	15.44%
7	BL	3.8	2.3	3.19	0.53	16.61%
36	SW	2.4	1.4	1.71	0.23	13.45%
34	SL	2.4	1.1	1.65	0.30	18.18%
27	BSW	2.0	1.1	1.61	0.18	11.18%
6	W	16.3	5.7	9.45	3.54	37.46%

AVG=average, SD=Standard Deviation, CoV=Coefficient of Variation
L=max. length, W=max width, T=max thickness, ST=stem thickness
BL=base length, BW=base width, SW=stem width, SL=stem length
BSW=base width, WGT=weight, (all measurements in centimeters, weight in grams)

Table H.37. Measurements - Plainview

#		High	Low	AVG	SD	CoV
0	L	0.0	0.0	0.00	0.00	n/a
0	W	0.0	0.0	0.00	0.00	n/a
0	T	0.0	0.0	0.00	0.00	n/a
0	ST	0.0	0.0	0.00	0.00	n/a
0	BW	0.0	0.0	0.00	0.00	n/a
0	BL	0.0	0.0	0.00	0.00	n/a
0	SW	0.0	0.0	0.00	0.00	n/a
0	SL	0.0	0.0	0.00	0.00	n/a
1	BSW	1.7	1.7	1.7	0.00	n/a
0	W	0.0	0.0	0.00	0.00	n/a

AVG=average, SD=Standard Deviation, CoV=Coefficient of Variation
L=max. length, W=max width, T=max thickness, ST=stem thickness
BL=base length, BW=base width, SW=stem width, SL=stem length
BSW=base width, WGT=weight, (all measurements in centimeters, weight in grams)

Table H.38. Measurements - Travis

#		High	Low	AVG	SD	CoV
0	L	0.0	0.0	0.00	0.00	n/a
0	W	0.0	0.0	0.00	0.00	n/a
1	T	0.8	0.8	0.80	0.00	n/a
1	ST	0.7	0.7	0.70	0.00	n/a
0	BW	0.0	0.0	0.00	0.00	n/a
0	BL	0.0	0.0	0.00	0.00	n/a
1	SW	1.5	1.5	1.50	0.00	n/a
1	SL	1.4	1.4	1.40	0.00	n/a
1	BSW	1.4	1.4	1.40	0.00	n/a
0	W	0.0	0.0	0.00	0.00	n/a

AVG=average, SD=Standard Deviation, CoV=Coefficient of Variation
L=max. length, W=max width, T=max thickness, ST=stem thickness
BL=base length, BW=base width, SW=stem width, SL=stem length
BSW=base width, WGT=weight, (all measurements in centimeters, weight in grams)

Table H.38. Measurements - Uvalde

#		High	Low	AVG	SD	CoV
0	L	0.0	0.0	0.00	0.00	n/a
2	W	2.8	2.6	2.70	0.10	3.70%
4	T	0.7	0.5	0.65	0.09	13.80%
4	ST	0.7	0.4	0.58	0.11	18.97%
2	BW	2.8	2.6	2.70	0.10	3.70%
0	BL	0.0	0.0	0.00	0.00	n/a
4	SW	1.6	1.2	1.38	0.15	10.87%
4	SL	1.4	1.0	1.23	0.15	12.20%
3	BSW	1.8	1.5	1.67	0.12	7.19%
0	W	0.0	0.0	0.00	0.00	n/a

AVG=average, SD=Standard Deviation, CoV=Coefficient of Variation
L=max. length, W=max width, T=max thickness, ST=stem thickness
BL=base length, BW=base width, SW=stem width, SL=stem length
BSW=base width, WGT=weight, (all measurements in centimeters, weight in grams)

Table H.39. Measurements - Wells

#		High	Low	AVG	SD	CoV
0	L	0.0	0.0	0.00	0.00	n/a
3	W	2.4	2.2	2.30	0.08	3.48%
3	T	0.8	0.7	0.73	0.05	6.85%
4	ST	0.7	0.7	0.70	0.00	0.00%
3	BW	2.4	2.2	2.30	0.08	3.48%
0	BL	0.0	0.0	0.00	0.00	n/a
3	SW	1.5	1.3	1.43	0.09	6.29%
5	SL	2.5	1.8	2.14	0.26	12.15%
4	BSW	1.3	1.0	1.18	0.11	9.32%
0	W	0.0	0.0	0.00	0.00	n/a

AVG=average, SD=Standard Deviation, CoV=Coefficient of Variation
L=max. length, W=max width, T=max thickness, ST=stem thickness
BL=base length, BW=base width, SW=stem width, SL=stem length
BSW=base width, WGT=weight, (all measurements in centimeters, weight in grams)

Table H.40. Measurements - Williams

#		High	Low	AVG	SD	CoV
0	L	0.0	0.0	0.00	0.00	n/a
3	W	3.2	3.0	3.07	0.09	2.93%
4	T	1.0	0.7	0.78	0.13	16.67%
4	ST	0.7	0.6	0.65	0.05	7.69%
3	BW	3.2	3.0	3.07	0.09	2.93%
0	BL	0.0	0.0	0.00	0.00	n/a
4	SW	2.0	1.6	1.78	0.15	8.43%
4	SL	1.4	1.1	1.30	0.12	9.23%
3	BSW	2.2	1.9	2.07	0.12	5.80%
0	W	0.0	0.0	0.00	0.00	n/a

AVG=average, SD=Standard Deviation, CoV=Coefficient of Variation
L=max. length, W=max width, T=max thickness, ST=stem thickness
BL=base length, BW=base width, SW=stem width, SL=stem length
BSW=base width, WGT=weight, (all measurements in centimeters, weight in grams)

Table H.41. Measurements - Yarbrough

#		High	Low	AVG	SD	CoV
2	L	5.9	4.6	5.25	0.65	12.38%
5	W	2.6	1.8	2.18	0.30	13.76%
5	T	0.7	0.6	0.62	0.04	6.45%
5	ST	0.6	0.5	0.54	0.05	9.26%
5	BW	2.6	1.8	2.18	0.30	13.76%
2	BL	4.5	3.5	4.00	0.50	12.50%
5	SW	1.7	1.2	1.54	0.19	12.34%
5	SL	1.4	1.1	1.24	0.10	8.06%
5	BSW	1.7	1.4	1.66	0.15	9.04%
3	W	7.1	5.1	6.03	0.82	13.60%

AVG=average, SD=Standard Deviation, CoV=Coefficient of Variation
L=max. length, W=max width, T=max thickness, ST=stem thickness
BL=base length, BW=base width, SW=stem width, SL=stem length
BSW=base width, WGT=weight, (all measurements in centimeters, weight in grams)

Table H.42. Measurements - Indeterminate Dart Points

#		High	Low	AVG	SD	CoV
4	L	4.7	2.10	2.98	1.06	35.57%
17	W	4.6	1.8	2.44	0.66	27.05%
38	T	1.3	0.5	0.73	0.17	23.29%
32	ST	1.0	0.4	0.60	0.15	25.00%
18	BW	4.6	0.6	2.27	0.81	35.68%
4	BL	3.4	1.1	1.95	0.95	48.72%
28	SW	2.2	1.1	1.61	0.30	18.63%
29	SL	2.3	0.6	1.15	0.34	29.57%
20	BSW	2.9	1.4	1.97	0.42	21.32%
4	W	7.2	2.3	4.08	2.02	49.51%

AVG=average, SD=Standard Deviation, CoV=Coefficient of Variation
L=max. length, W=max width, T=max thickness, ST=stem thickness
BL=base length, BW=base width, SW=stem width, SL=stem length
BSW=base width, WGT=weight, (all measurements in centimeters, weight in grams)

Table H.43 - Summary of Arrow Points

Number Identified	Type
2	Alba
7	Bonham
4	Cliffton
2	Cuney
4	Perdiz
29	Scallorn
1	Steiner
1	Washita
1	Young
15	Indeterminate Arrow
66	TOTAL

Table H.44. Measurements - Alba

#		High	Low	AVG	SD	CoV
0	L	0.0	0.0	0.00	0.00	n/a
0	W	0.0	0.0	0.00	0.00	n/a
2	T	0.3	0.3	0.30	0.00	n/a
2	ST	0.2	0.2	0.20	0.00	n/a
0	BW	0.0	0.0	0.00	0.00	n/a
0	BL	0.0	0.0	0.00	0.00	n/a
2	SW	0.5	0.4	0.45	0.05	11.11%
0	SL	0.0	0.0	0.00	0.00	n/a
0	BSW	0.0	0.0	0.00	0.00	n/a
0	W	0.0	0.0	0.00	0.00	n/a

AVG=average, SD=Standard Deviation, CoV=Coefficient of Variation
L=max. length, W=max width, T=max thickness, ST=stem thickness
BL=base length, BW=base width, SW=stem width, SL=stem length
BSW=base width, WGT=weight, (all measurements in centimeters, weight in grams)

Table H.45. Measurements - Bonham

#		High	Low	AVG	SD	CoV
0	L	0.0	0.0	0.00	0.00	n/a
2	W	2.3	1.9	2.10	0.20	9.52%
6	T	0.4	0.3	0.35	0.05	14.29%
7	ST	0.5	0.2	0.3	0.09	30.00%
2	BW	2.3	1.9	2.1	0.20	9.52%
0	BL	0.0	0.0	0.00	0.00	n/a
7	SW	0.8	0.4	0.57	0.12	21.05%
6	SL	0.9	0.4	0.78	0.18	23.08%
6	BSW	0.8	0.4	0.62	0.12	19.35%
0	W	0.0	0.0	0.00	0.00	n/a

AVG=average, SD=Standard Deviation, CoV=Coefficient of Variation
L=max. length, W=max width, T=max thickness, ST=stem thickness
BL=base length, BW=base width, SW=stem width, SL=stem length
BSW=base width, WGT=weight, (all measurements in centimeters, weight in grams)

Table H.46 Measurements - Cliffton

#		High	Low	AVG	SD	CoV
0	L	0.0	0.0	0.00	0.00	n/a
2	W	2.4	2.0	2.20	0.20	9.10%
3	T	0.4	0.4	0.40	0.00	n/a
3	ST	0.3	0.3	0.30	0.00	n/a
2	BW	2.4	2.0	2.20	0.20	9.10%
0	BL	0.0	0.0	0.00	0.00	n/a
3	SW	0.8	0.6	0.70	0.08	11.43%
3	SL	0.9	0.5	0.73	0.17	23.29%
3	BSW	0.7	0.4	0.53	0.12	22.64%
0	W	0.0	0.0	0.00	0.00	n/a

AVG=average, SD=Standard Deviation, CoV=Coefficient of Variation
L=max. length, W=max width, T=max thickness, ST=stem thickness
BL=base length, BW=base width, SW=stem width, SL=stem length
BSW=base width, WGT=weight, (all measurements in centimeters, weight in grams)

Table H.47. Measurements - Cuney

#		High	Low	AVG	SD	CoV
1	L	2.6	2.6	2.60	0.00	n/a
1	W	1.5	1.5	1.50	0.00	n/a
2	T	0.3	0.3	0.30	0.00	n/a
2	ST	0.3	0.2	0.25	0.05	20.00%
1	BW	1.5	1.5	1.50	0.00	n/a
1	BL	2.1	2.1	2.10	0.00	n/a
1	SW	0.6	0.6	0.60	0.00	n/a
2	SL	0.5	0.4	0.45	0.05	11.11%
2	BSW	0.8	0.8	0.80	0.00	n/a
1	W	0.9	0.9	0.90	0.00	n/a

AVG=average, SD=Standard Deviation, CoV=Coefficient of Variation
L=max. length, W=max width, T=max thickness, ST=stem thickness
BL=base length, BW=base width, SW=stem width, SL=stem length
BSW=base width, WGT=weight, (all measurements in centimeters, weight in grams)

Table H.48. Measurements - Perdiz

#		High	Low	AVG	SD	CoV
1	L	4.3	4.3	4.30	0.00	n/a
2	W	1.7	1.6	1.65	0.05	3.03%
4	T	0.4	0.3	0.33	0.04	12.12%
4	ST	0.3	0.3	0.30	0.00	0.00%
2	BW	1.7	1.6	1.65	0.05	3.03%
1	BL	3.6	3.6	3.60	0.00	n/a
4	SW	0.7	0.5	0.60	0.10	16.67%
4	SL	1.5	0.5	0.90	0.37	41.11%
4	BSW	0.5	0.3	0.43	0.08	18.60%
2	W	1.5	0.9	1.20	0.30	25.00%

AVG=average, SD=Standard Deviation, CoV=Coefficient of Variation
L=max. length, W=max width, T=max thickness, ST=stem thickness
BL=base length, BW=base width, SW=stem width, SL=stem length
BSW=base width, WGT=weight, (all measurements in centimeters, weight in grams)

Table H.49. Measurements - Scallorn

#		High	Low	AVG	SD	CoV
6	L	3.9	2.1	2.90	0.59	20.34%
19	W	1.8	1.0	1.37	0.18	13.14%
26	T	0.5	0.2	0.36	0.07	19.44%
29	ST	0.4	0.2	0.28	0.05	17.86%
17	BW	1.8	1.2	1.41	0.16	11.35%
6	BL	3.4	1.7	2.38	0.59	24.79%
27	SW	0.9	0.5	0.60	0.11	18.33%
29	SL	0.8	0.3	0.57	0.10	17.54%
24	BSW	1.3	0.6	0.91	0.18	19.78%
1	W	1.3	0.5	0.94	0.26	27.66%

AVG=average, SD=Standard Deviation, CoV=Coefficient of Variation
L=max. length, W=max width, T=max thickness, ST=stem thickness
BL=base length, BW=base width, SW=stem width, SL=stem length
BSW=base width, WGT=weight, (all measurements in centimeters, weight in grams)

Table H.50. Measurements - Steiner

#		High	Low	AVG	SD	CoV
0	L	0.0	0.0	0.00	0.00	n/a
1	W	2.2	2.2	2.20	0.00	n/a
1	T	0.4	0.4	0.40	0.00	n/a
1	ST	0.2	0.2	0.20	0.00	n/a
1	BW	2.2	2.2	2.20	0.00	n/a
0	BL	0.0	0.0	0.00	0.00	n/a
1	SW	1.0	1.0	1.00	0.00	n/a
1	SL	0.4	0.4	0.40	0.00	n/a
1	BSW	1.0	1.0	1.00	0.00	n/a
0	W	0.0	0.0	0.0	0.00	n/a

AVG=average, SD=Standard Deviation, CoV=Coefficient of Variation
L=max. length, W=max width, T=max thickness, ST=stem thickness
BL=base length, BW=base width, SW=stem width, SL=stem length
BSW=base width, WGT=weight, (all measurements in centimeters, weight in grams)

Table H.51. Measurements - Young

#		High	Low	AVG	SD	CoV
1	L	2.4	2.4	2.40	0.00	n/a
1	W	1.7	1.7	1.70	0.00	n/a
1	T	0.4	0.4	0.40	0.00	n/a
0	ST	0.0	0.0	0.00	0.00	n/a
1	BW	1.7	1.7	1.70	0.00	n/a
1	BL	2.4	2.4	2.40	0.00	n/a
0	SW	0.0	0.0	0.00	0.00	n/a
0	SL	0.0	0.0	0.00	0.00	n/a
1	BSW	1.7	1.7	1.70	0.00	n/a
1	W	1.6	1.6	1.60	0.00	n/a

AVG=average, SD=Standard Deviation, CoV=Coefficient of Variation
L=max. length, W=max width, T=max thickness, ST=stem thickness
BL=base length, BW=base width, SW=stem width, SL=stem length
BSW=base width, WGT=weight, (all measurements in centimeters, weight in grams)

Table H.52. Measurements - Indeterminate Arrow Points

#		High	Low	AVG	SD	CoV
2	L	2.5	1.8	2.15	0.35	16.28%
8	W	2.10	1.3	1.64	0.28	17.07%
13	T	0.4	0.3	0.35	0.05	14.29%
9	ST	0.4	0.2	0.29	0.07	24.14%
8	BW	2.10	1.3	1.63	0.29	17.79%
5	BL	3.3	1.8	2.42	0.50	20.66%
3	SW	0.8	0.5	0.63	0.12	19.05%
2	SL	0.6	0.4	0.50	0.10	20.00%
4	BSW	1.8	0.6	1.23	0.43	34.96%
1	W	1.0	1.0	1.00	0.00	n/a

AVG=average, SD=Standard Deviation, CoV=Coefficient of Variation
L=max. length, W=max width, T=max thickness, ST=stem thickness
BL=base length, BW=base width, SW=stem width, SL=stem length
BSW=base width, WGT=weight, (all measurements in centimeters, weight in grams)