5.0 HOFF DEEP TEST LOCALE

5.1 INTRODUCTION AND BACKGROUND

Geomorphologically, the Hoff Deep test locale is located along the eastern margin of the Holocene meander belt of the Red River and includes both Holocene alluvial and late Wisconsinan (Glacial Lake Agassiz) glaciolacustrine deposits. Near the test locale, the Red River valley consists of a channel belt incised into the floor of the now abandoned Lake Agassiz basin (Figure 3.3.1-3). The sampling grid was placed on the east (Minnesota) side of the river 15 m to 16.8 m (50 ft to 55 ft) above the modern channel on the inside of a low amplitude meander. Abandoned high amplitude meanders are located across the river (North Dakota). The present Red River channel formed when a neck cut-off occurred, resulting in the abandonment of the youngest channels west of the modern channel. Consequently the sampling grid lies in a near-channel levee position on the alluvial landscape and not on a point bar. East of the grid, the landscape consists of the flat Glacial Lake Agassiz plain.

The Hoff Deep sampling grid measured 40 m ×100 m (131 ft × 328 ft) with its long axis oriented northwest-southeast (Figure 3.3.1-3). It includes two flat-lying areas that are separated by a low but distinct erosional scarp (Figure 5.1-1). The eastern (southern) two-thirds of the test grid is flat and lies ca. 1.25 m (4.1 ft) above the western (northern) third of the grid. The lower, western third apparently represents Holocene alluvial deposits, while the topographically higher area (generally east and south) has been associated with Lake Agassiz deposits by the Mn/Model LfSAs (Figure 3.3.1-3). The LfSAs also indicate that the lower, alluvially derived portion of the test locale has a high suitability for preservation of buried archaeological material at moderate depths and that the southern, higher part has little or no suitability for preservation of buried resources. The placement of the testing grid takes advantage of the juxtaposition of high potential fine-grained alluvium and low potential fine-grained glaciolacustrine deposits to test the sensitivity of the geoarchaeological survey methods for detecting such boundaries.

Soils mapped at the Hoff Deep test locale are, from lowest on the landscape in the channel belt to highest on the landscape on the Glacial Lake Agassiz plain (from Jacobson 1974): (1) Cashel silty clay (fluventic haploboroll); (2) Wahpeton silty clay (udoric haploborall); and (3) Fargo silty clay (vertic haplaquoll). The Cashel and Wahpeton series are formed in alluvium and are somewhat poorly drained. The Fargo series is formed in lacustrine sediment, is poorly drained, and commonly includes vertisolic properties. Interestingly, the Wahpeton series has black banding in the C horizon (74 cm-150 cm [29.1 in-59.1 in]) that may represent the sequence of buried soils at the Mooney site (21NR0029), which suggests that buried soils may be widespread and commonly associated with Wahpeton series soils.

The geophysical survey was conducted when surface conditions were satisfactory. In general, soils were moderately dry at the time of the survey, although significant rainfall occurred for several days prior to geophysical survey. Corn was cleared from the test grid, which was also disked to remove stubble and, just prior to conducting the survey, was driven over to break up the soil clods. Trenching and coring focused first on determining the presence or absence of archaeological deposits and secondly on determining the sedimentology and stratigraphic

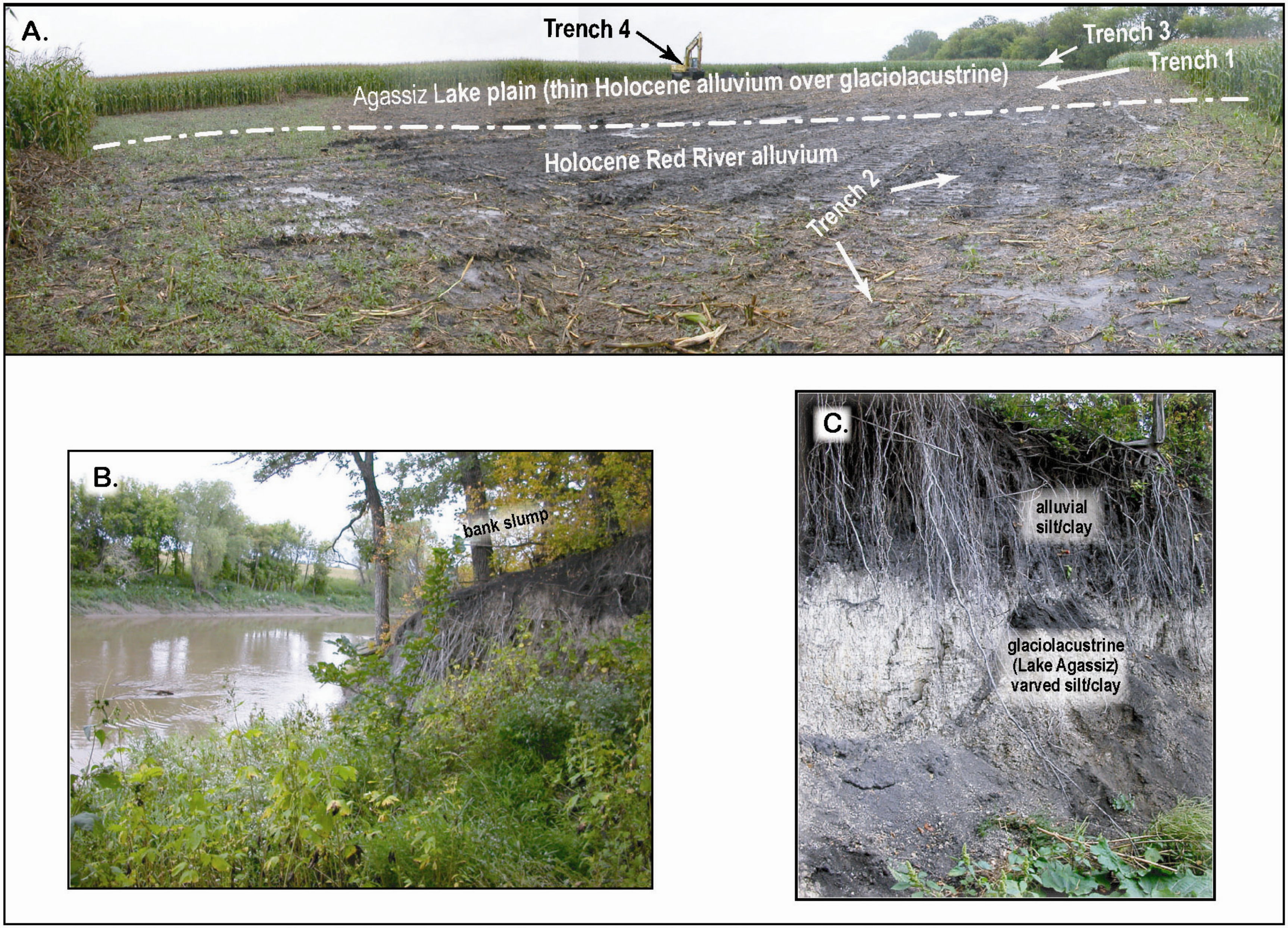

Figure 5.1-1. Hoff Deep Test Locale Overviews: (A) Testing Grid; (B) Red River; (C) Eroded Valley Margin

relationships of the deposits forming the two depositional areas that are generally north and south of the clear, but low, erosional scarp. Eighteen cores, spaced on a 20 m (66) grid pattern, were drilled. In addition, during coring, 18 locations that included buried stable landscape surfaces were identified for augering. Finally, four trenches that extended up to 4 m (13.1 ft) deep were excavated.

5.2 RESULTS OF GEOPHYSICS SURVEY

5.2.1 Magnetics

The magnetic survey data are quiet and relatively homogenous. It includes relatively little evidence for the presence of prehistoric archaeological features. The survey data do, however, show evidence of significant historic period subsurface disturbances and artifacts (Figure 5.2.1-1). For example, the magnetic survey data show numerous clustered monopolar and dipolar highs. These are metal, historic in age, and probably related to the nearby historic period farmstead occupation. Numerous historic period artifacts, such as brick, metal, and glass objects, were visible on the surface during survey. A weak dipolar band extends through the central portion of the survey area and is most likely due to the properties of subsurface soil or sediment. It is probably a natural, rather than cultural, feature.

5.2.2 Resistivity

The resistivity survey data suggest that a fairly complex stratigraphy underlies the Hoff Deep test locale. In the eastern portion of the survey grid resistivity is generally low and is apparently coincident with a relative topographic low (Figure 5.2.1-1). This resistivity low gradually expands through all five data layers (Figure 5.2.1-1 and Appendix A). In the upper data layers (i.e., <2 m [6.6 ft]), a strong resistivity high is present in the western portion of the survey grid (Figure 5.2.1-1). This larger area of resistivity high can be separated into two discrete areas within deep resistivity layers. However, in the deepest data layer (i.e., 5 m [16.4 ft]) discrete areas of resistivity high again became a single high in the western-most margin of the survey area (Figure 5.2.1-1). The relatively low resistivity areas in the east and relative highs in the west are enclosed by areas of gradational change in resistivity. It is likely that the resistivity differences reflect alluvial deposits of significantly different composition and form. What these differences are, however, is not clear from the survey data.

5.2.3 Ground Penetrating Radar

The Hoff Deep GPR data indicate extensive, probably recent activity even down to 1 m (3.3 ft). The sections show only a few reflectors, but include a number of localized parabolas that generally occur below about 0.5 m (1.6 ft) (Figure 5.2.3-1). Weak reflectors occur at about 0.5 m and 0.7 m (1.6 ft and 2.3 ft) within the survey grid and minor interruptions frequently occur in both of these reflectors. Weak disruptions, which may be cultural in origin, occur at the southeast part of the survey grid (Figure 5.2.3-1).

Two-dimensional maps of the GPR survey results are dominated by swirls made by farming (Figure 5.2.3-1). These are the large circles and swirls caused by recent disking (just prior to the

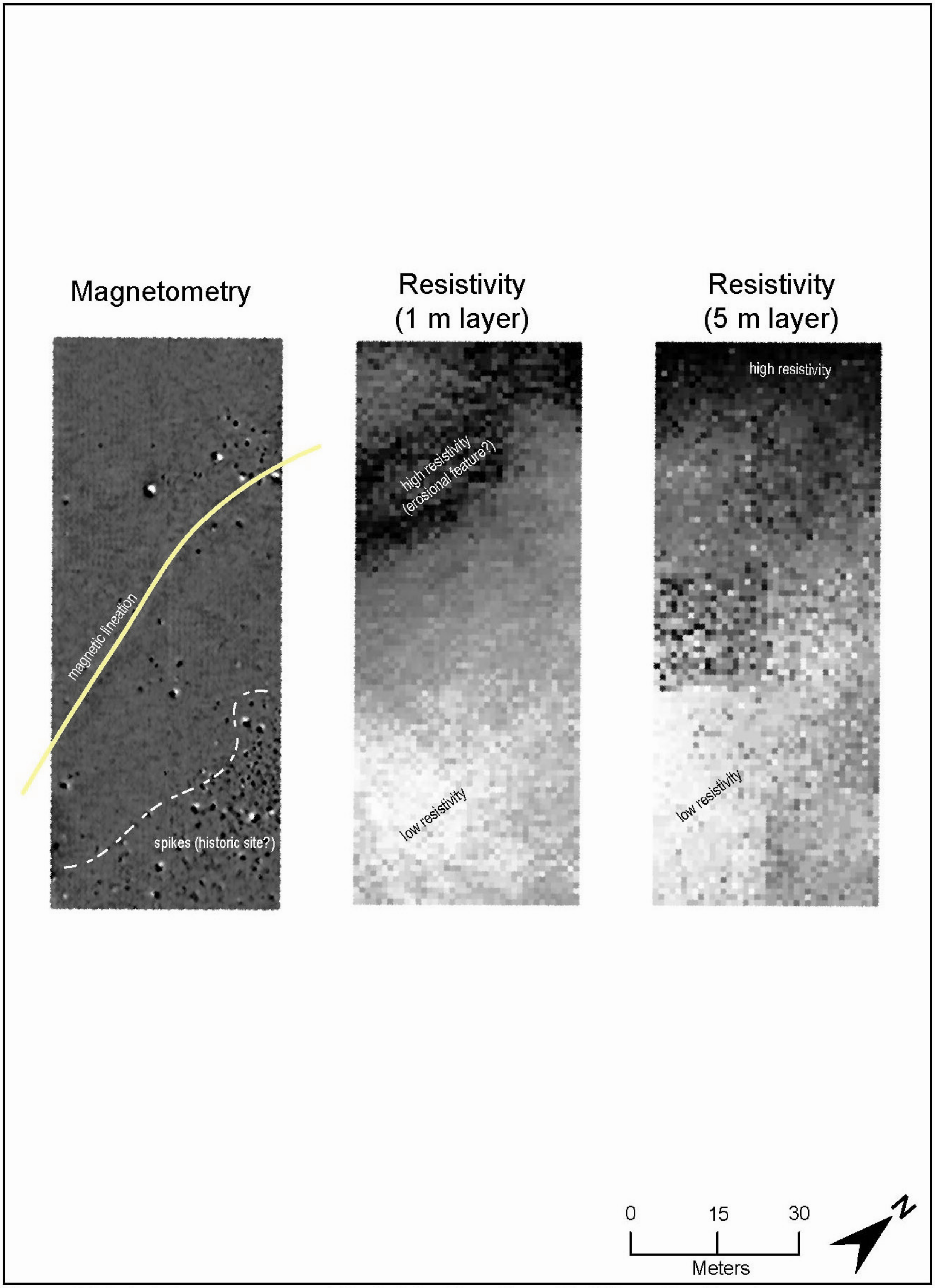

Figure 5.2.1-1. Magnetometry and Resistivity Data Plots, Hoff Deep Test Locale

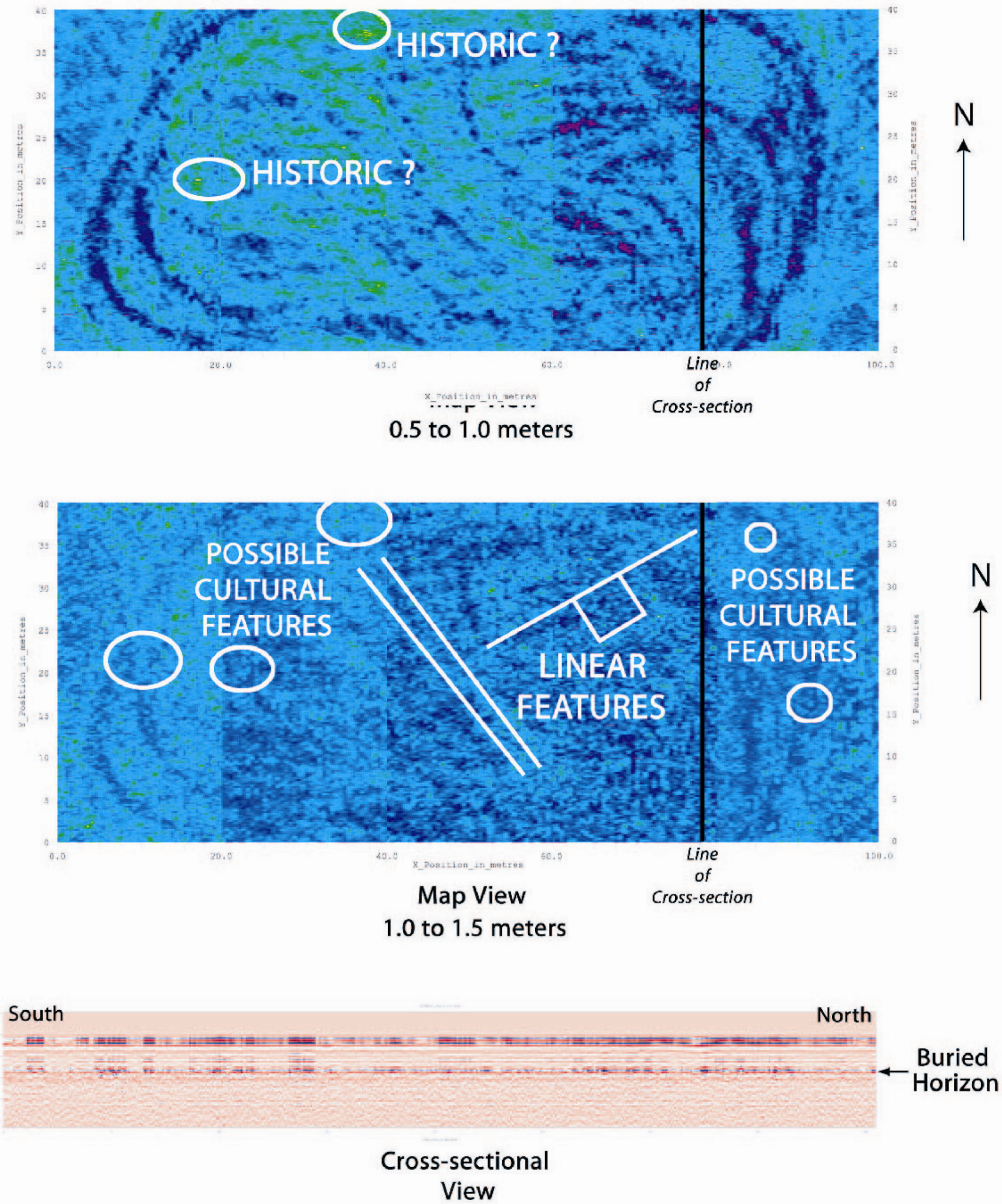

Figure 5.2.3-1. GPR Data Plots, Hoff Deep Test Locale

geophysical survey) at the test locale. Because of multiple reflections in fine-grained sediments, this pattern of disking can be seen at all depths within the sequence, making the GPR data difficult to interpret. However, numerous small (<1 m [3.3 ft]) circular features that are probably natural occur in the eastern half of the survey grid. Subtle, larger circles are especially common in the southeast part of the grid. An amphitheater-like feature occurs in the northeast part of the survey grid. A probable historic feature with indications of metal is located in the north-central portion of the survey grid, while another is suspected in the southwest portion (Figure 5.2.3-1). Several diagonal patterns are seen in the lower slices. A cluster of medium-size circular features occurs in the middle of the western part of the survey grid (Figure 5.2.3-1).

5.2.4 Discussion of Geoarchaeological Significance from Geophysical Survey

The geophysical data are generally uninformative relative to either geological or archaeological deposits at the Hoff Deep test locale. The only two exceptions to this are the presence of historic (metal) artifacts, clearly shown in the magnetic data, and some patterning to the resistivity survey data. Both the GPR and magnetic survey data indicate some spatial patterning of metal artifacts in near-surface contexts and may be relevant to the historic usage of the test locale. Neither method, however, is particularly useful in seeing subsurface archaeological phenomena, buried surfaces and soils; or understanding the sedimentology and depositional sequences at the Hoff Deep test locale. Resistivity is of some value for understanding the general patterns of the sediments.

The spatial clustering of probable metal artifacts in the southeastern and northeastern parts of the survey grid may relate to some discard pattern associated with the late-nineteenth or twentieth century Euro-American farming. The fact that several saw-cut bones and a horse tooth were noted on the surface when the geophysical survey was conducted suggests that this pattern may relate to the earlier parts of this time interval. Some hint of this is also suggested by the GPR survey data, which show occasional weak disruptions in the subsurface in the southeast part of the survey grid that may be cultural in origin. Unfortunately, the noise indicated by multiple reflections in the subsurface that are related to recent disking, coupled with the poor penetration of the GRP signal into the fine-grained sediment, renders the GPR data difficult to interpret. The presence of abundant metal and other historic artifacts may also indicate the presence of nearby, but off-grid, structures or dwellings; alternatively, they may relate to dumping.

No indications of historic usage or artifacts are revealed by the resistivity data. The general patterns to the resistivity highs and lows, however, probably reflect differences in sediment texture or other properties. The relatively strong resistivity highs in the upper data layers of the western portion of the grid generally coincide with the low, flat topographic relief that is about 1 m (3.3 ft) to 1.25 m (4.1 ft) below the rest of the test locale. This lower area apparently formed by erosion into Lake Agassiz sediments and subsequent backfilling by Holocene alluvial deposits.

5.3 RESULTS OF CORING SURVEY

5.3.1 Deposits and Soils

Deposits at the Hoff Deep test locale are clay and silty clay of both alluvial and lacustrine (proglacial lake) origin. Soils are formed in alluvium and consist of A-C and A-Ck or, in a few cases, A-Bw-C horizon sequences (Appendix B). The upper portions of a few of the soils are leached; otherwise all of the soils are unleached and often have some carbonate morphology in the form of laminae or filaments. Both surface and buried A horizons are either cumlic or mark the top of thin Ab-Cb horizon sequences. The expression of the A horizons is a function of sedimentation rates that vary over time and micro-topographic position. Proglacial lake deposits are located in lower parts of the core sequences in the center of the grid (Cores 3, 4, 15-18). They consist of laminated dark grayish brown and grayish brown (2.5Y), olive gray (5Y), and dark greenish gray (10Y) hues. Carbonate laminae or secondary carbonate accumulations that appear on the bedding planes are a characteristic part of these deposits.

5.3.2 Stratigraphy

Stratigraphy consists of discontinuous bounded alluvial units inset into and overlying lacustrine deposits. Alluvial strata are all clay and silty clay and can be differentiated only when marked by buried soils. Distinct soils are marked by Ab horizons that are separated by Cb horizons of relatively unaltered alluvium or by thick homogenous cumlic Ab horizons. The Ab horizons result from subaerial exposure of a sediment surface, a decrease in sedimentation rate, and relative geomorphic stability. This allows pedogenic processes, particularly melanization and the biological aspects of soil formation, to alter the alluvium forming a soil. Strata with A-C profiles merge laterally into strata with thick undifferentiated cumlic A horizons. Cores did not reach the base of the alluvium at the west end of the grid (Figure 5.3.2-1, Cores 5-8 and 16-18).

Using surface morphology, soils, and stratigraphy, three mini-(LfSAs) can be delineated at the Hoff Deep test locale (Figure 5.3.2-1). All three LfSAs are constructional terrace landforms that occur at slightly different elevations and have variable alluvial fill histories. Morphological variation is subtle and the stratigraphic differences are in part due to flooding and floodplain morphology when the Red River channel occupied the meander just west of the site. LfSA 1 stratigraphy consists of a cumlic soil 48 cm to 70 cm (19 in to 28 in) thick over an AC horizon that is quite dark and extends down to depths ranging from 60 cm to 100 cm (24 in to 39 in) (Figures 5.3.2-2 and 5.3.2-3). The thick upper solum is due to low rates of sedimentation on a soil with a mollic epipedon. Below the solum are a series of Cgk horizons formed in lacustrine clay deposits. They have zones of platy structure interpreted as remnant laminations and carbonate nodules or disseminated carbonate filaments.

LfSA 2 consists of alluvium with a cumlic surface soil over a single buried soil, formed in alluvium and marked by an Ab horizon, over lacustrine or alluvial deposits (Figures 5.3.2-2 and 5.3.2-3). The surface cumlic Ap/A horizon ranges from 45 cm to 100 cm (18 in to 39 in) thick. The Ab horizons are shallow, less than 85 cm (34 in) below the surface, except in Cores 1 and 8 where the buried soil is 160 cm to 180 cm (63 in to 71 in) below the surface. Below the buried A horizons are a sequence of Cgkb horizons formed in clay. Lacustrine deposits are laminated,

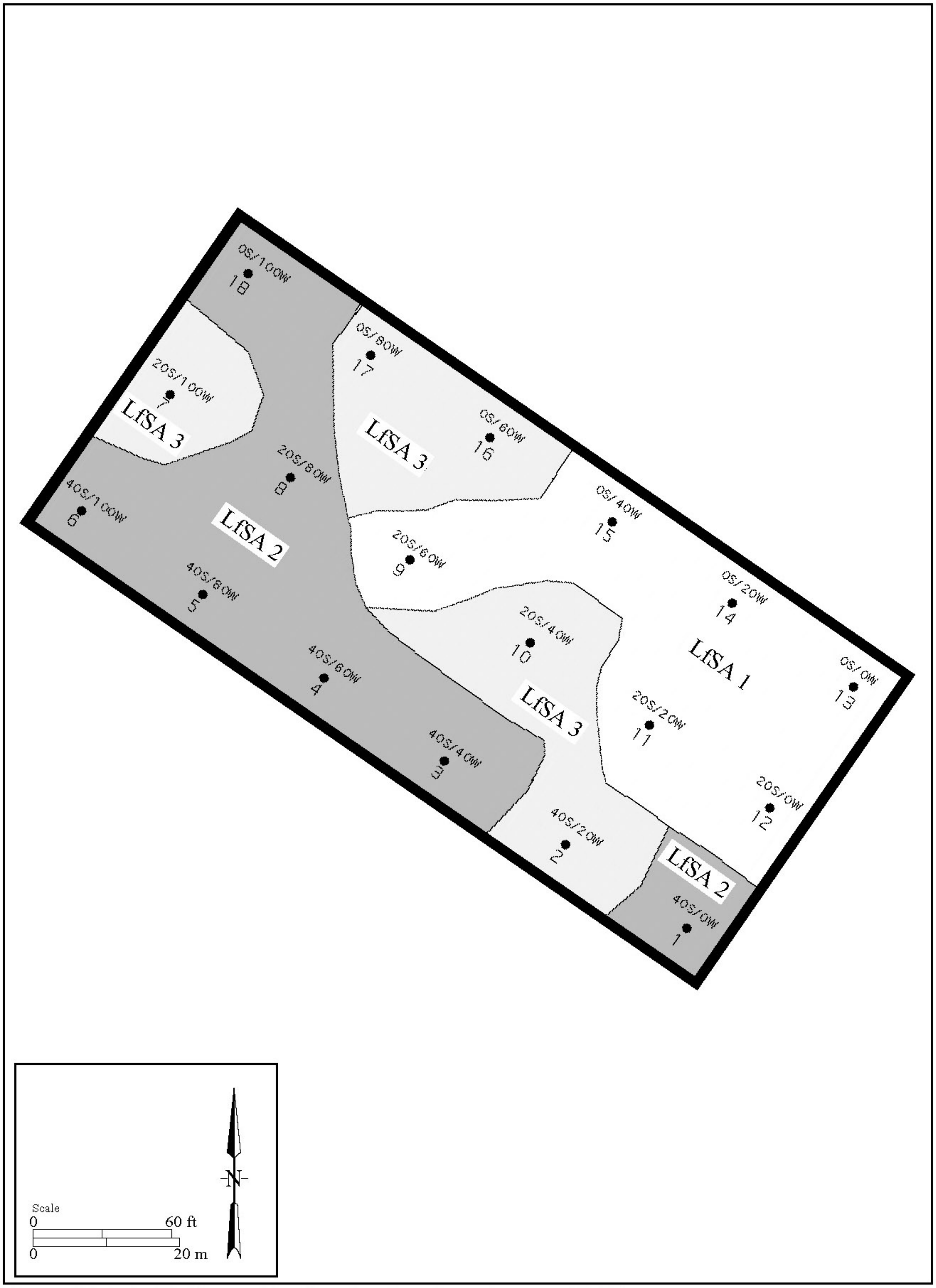

Figure 5.3.2-1. Hoff Deep Test Locale, Core Locations, and LfSAs

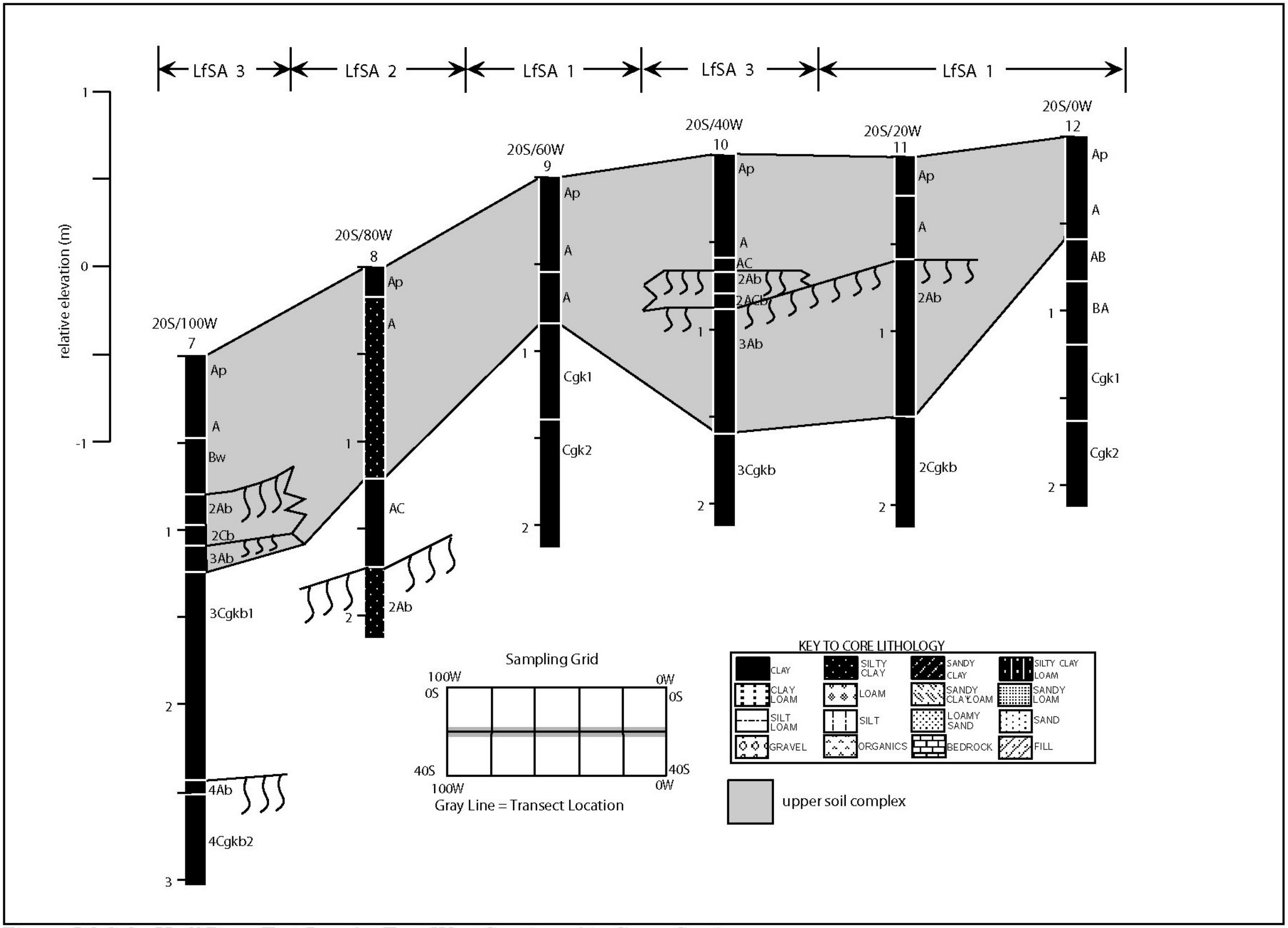

Figure 5.3.2-2. Hoff Deep Test Locale, East-West Stratigraphic Cross-Section

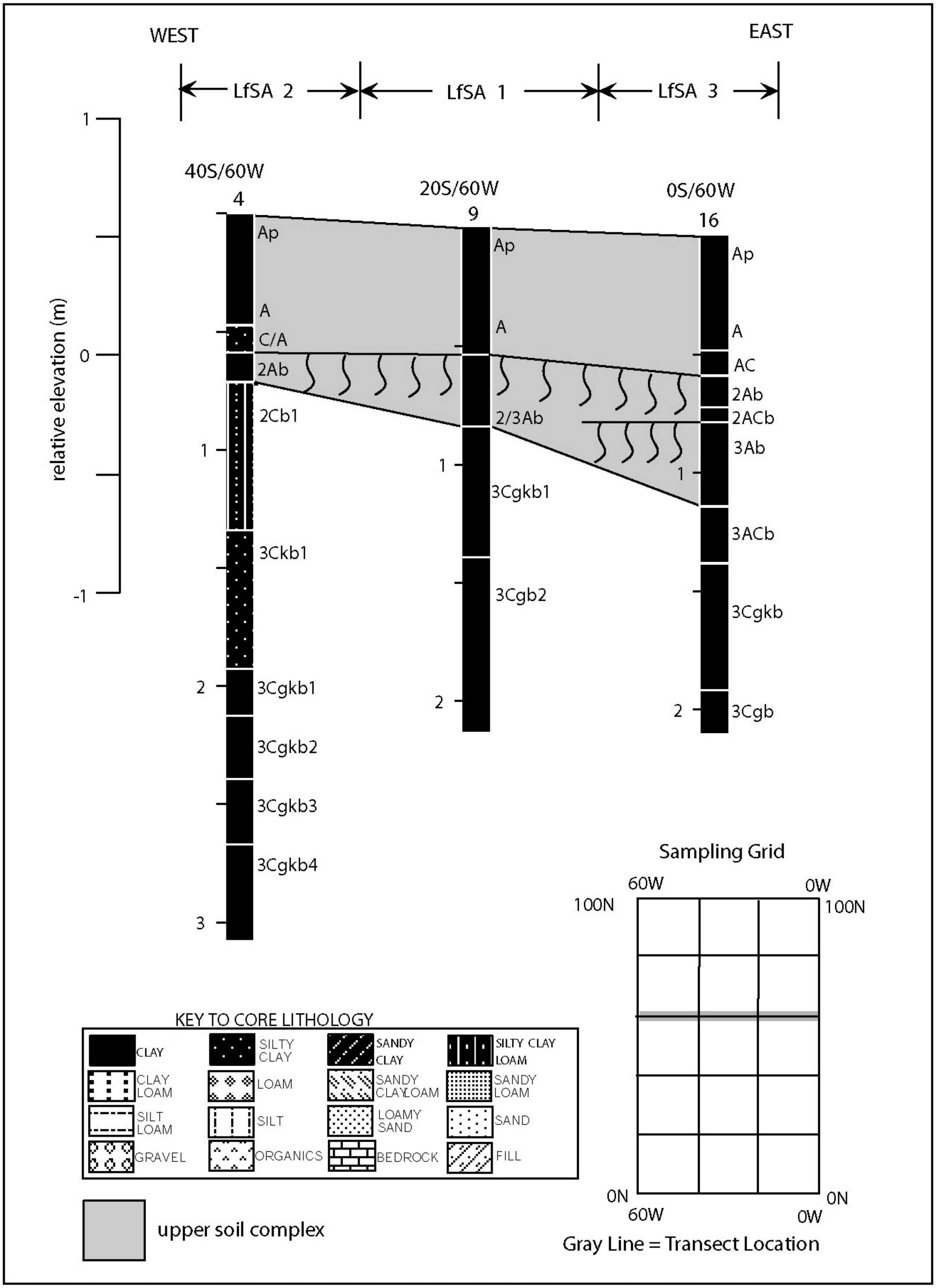

Figure 5.3.2-3. Hoff Deep Test Locale, North-South Stratigraphic Cross-Section

except in Cores 1 and 8, and the C horizons formed in alluvium are not laminated. Carbonate nodules and filaments are common in the Cgkb horizons.

LfSA 3 consists of multiple buried soils formed in alluvium (Figures 5.3.2-2 and 5.3.2-3). In three cores (Cores 2, 16, and 17) lacustrine deposits may be present at the base of the cores. The surface soil consists of a cumlic A horizon over a weak B horizon or a C horizon. The buried soils have Ab-Cb profiles, and often the lowest buried soil has a thick cumlic Ab horizon. Core 7 has a third buried soil at a depth of 2.4 m (7.9 ft). Carbonate nodules and filaments are generally only present in the Cb horizons of the lowest buried soil.

5.3.3 Discussion of Geoarchaeological Significance from Coring

The buried soils and the cumlic surface soil described above have the potential to contain archaeological deposits and, therefore, were designated targets for auger sampling. Buried soils are considered to have archaeological potential because they mark a paleo-landscape surface that was available for human habitation. The presence of a soil indicates the surface was exposed on the landscape surface for some duration of time greater than a few months or years. The longer the soil is exposed the greater the geomorphic potential for buried archaeological deposits. Age or the duration of exposure at the landscape surface is proportional to the degree of soil development. A relatively well-developed soil in this context indicates a landscape surface exposed on the order of thousands of years and a very weakly developed soil indicates a landscape surface exposed for tens to hundreds of years.

Cumlic soils are the result of low sedimentation rates. Small quantities of sediment added to the surface during floods are rapidly incorporated into the soil by bioturbation, resulting in a slow thickening of the upper solum. No discrete buried soil horizons are present and artifacts could occur anywhere in the cumlic horizon. For this reason the entire upper solum is targeted for auguring.

Auguring produced archaeological material from many of the buried and cumlic soils (see Appendices B and E). Only three core locations did not produce possible cultural materials in at least one target horizon. Archaeological sites are spatially discrete entities of varying size and artifact densities. The absence of artifacts in a targeted soil does not mean a site is not present in other locations on that buried landscape surface. At Hoff Deep, in addition to the inherent problems with any type of sampling, the buried landscape is a complex physical and temporal mosaic of small alluvial landforms that, without detailed stratigraphic information, is difficult to test with confidence. Given these physical and statistical complexities, in concert with the dynamism of human subsistence and settlement patterns spanning 12,000 years, a much greater number of samples are needed before any portion of the buried landscape at Hoff Deep can be designated low potential.

Stratigraphy and soil expression are quite variable over the relatively small area of the sampling grid. This indicates that overbank deposits do not form a uniform blanket over the floodplain. Sedimentation rates vary spatially due to the vertical and horizontal variations in flood deposition for a particular floodplain morphology and a given flood magnitude and frequency. Between floods, pedogenic processes darken and mix the flood deposits. If the flood deposits are thin, they are mixed into the soil and are no longer visible as distinct strata, resulting in thick dark cumlic soils. If the flood deposits are relatively thick, they will remain as a distinct stratum with an A-C profile. The type of soil flora and fauna and duration of pedogenesis also determine the morphology of the flood deposits (Johnson and Watson-Stegner 1990).

The archaeological record is, in part, structured by geomorphic and pedogenic processes, especially in this alluvial context. Artifacts left on an alluvial surface are subject to a complex process of burial and/or exhumation (see Ferring 1992; Holliday 2004; Monaghan and Lovis 2005). For example, an artifact scatter from a single occupation over 1.0 ac (0.4 ha) may be covered by 20 cm (8 in) of sediment at point A and by 1 cm (0.4 in) of sediment at point B. The next flood does not even reach point B and deposits 1 cm (0.4 in) of sediment at point A. Therefore, artifacts at point A are no longer near the surface, so soil forming processes act differently relative to the artifacts at points A and B. Thus, it is erroneous to assume a direct or simple correlation of specific soils with archaeological materials. Further, if in a short period of time there is another occupation, the artifacts at point A are separated stratigraphically and the artifacts at point B are mixed. This occurs because flood energy for erosion and transport is spatially limited and linear, whereas loss of flood energy and deposition are more dispersed. Standing floodwater contains suspended sediment that with time is deposited. The volume of sediment deposited at a particular point in the floodplain depends on the sediment concentration and the depth of the water at that point. As floodwaters recede, some water and sediment remain behind in low areas, varying in size from small depressions to abandoned channels. Sedimentation rates in the lows are greater because all of the sediment in that water is captured in the low. The interactions of flood magnitude/frequency and floodplain topography have produced the stratigraphic pattern at the Hoff Deep test locale, resulting in the presence of three mini-LfSAs in a 1.0 ac (0.4 ha) area.

5.4 RESULTS OF TRENCHING SURVEY

5.4.1 Stratigraphy of Soils and Sediments

The results of trenching reveal that a relatively complex sequence of Holocene alluvium, which directly overlies Lake Agassiz varved glaciolacustrine silts and clays and includes stratified archaeological material, characterizes the entire testing grid at the Hoff Deep test locale (Figures 5.4.1-1 and 5.4.1-2). This includes the area mapped by the Mn/Model LfSAs as consisting of glaciolacustrine deposits to the modern ground surface with little or no suitability for alluvially buried archaeological resources. In general, the test locale can be divided into two parts based on surface morphology and on separate depositional sequences. These areas include a topographically higher, glaciolacustrine portion (the eastern two-thirds of the test grid) and a lower alluvial portion (western one-third) (Figure 5.4.1-1). Although these areas represent somewhat differently developed depositional environments, the assumption that the higher area was underlain strictly by glaciolacustrine deposits and included no alluvium proved wrong. Trenching at the site showed that a complex alluvial sequence, albeit of variable thickness and age, occurs across the entire test locale.

Basal deposits throughout the Hoff Deep test locale consist of varved glaciolacustrine deposits that were probably formed within Lake Agassiz, a large late Wisconsinan proglacial lake that

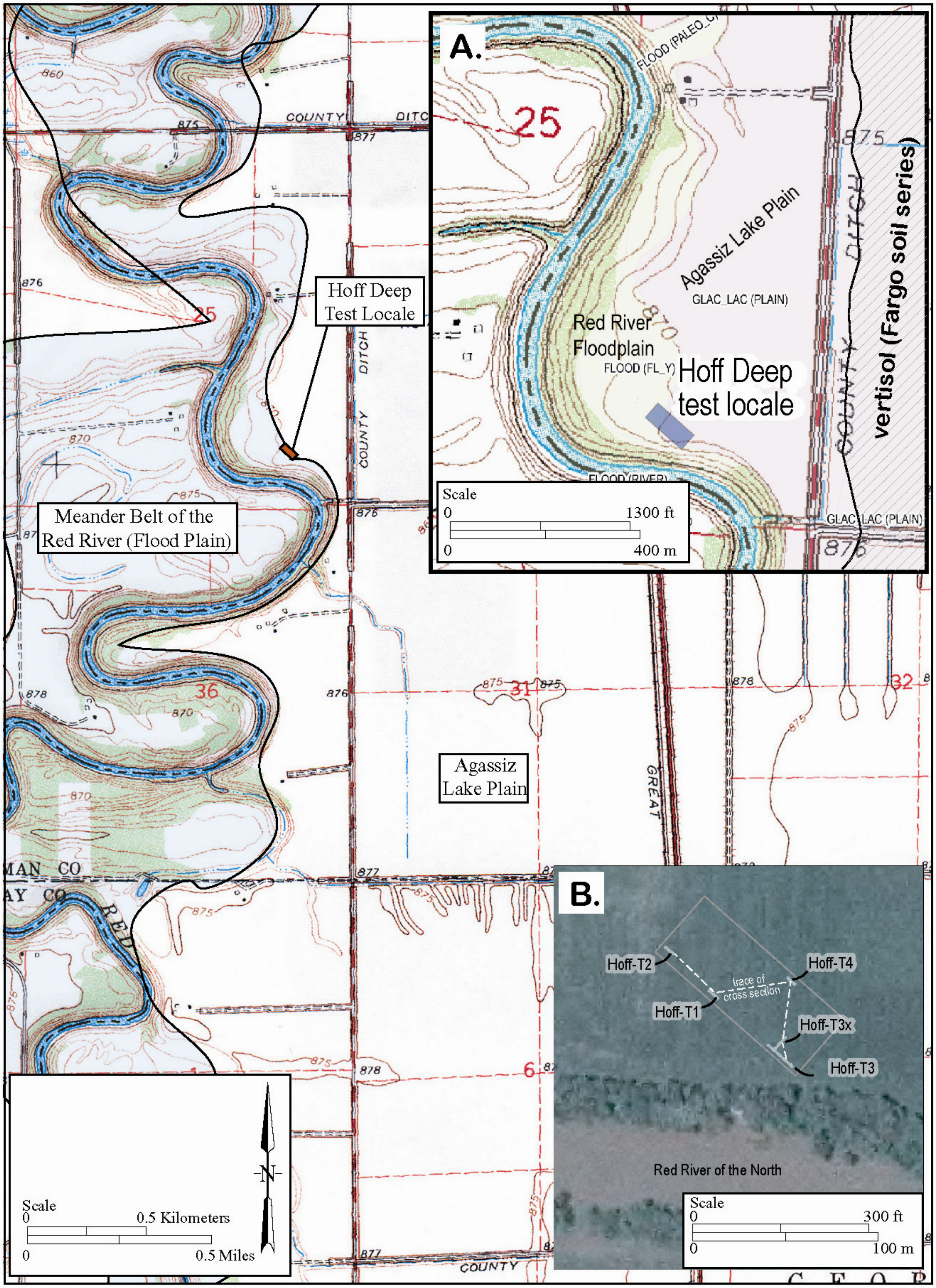

Figure 5.4.1-1. Trench Locations at the Hoff Deep Test Locale

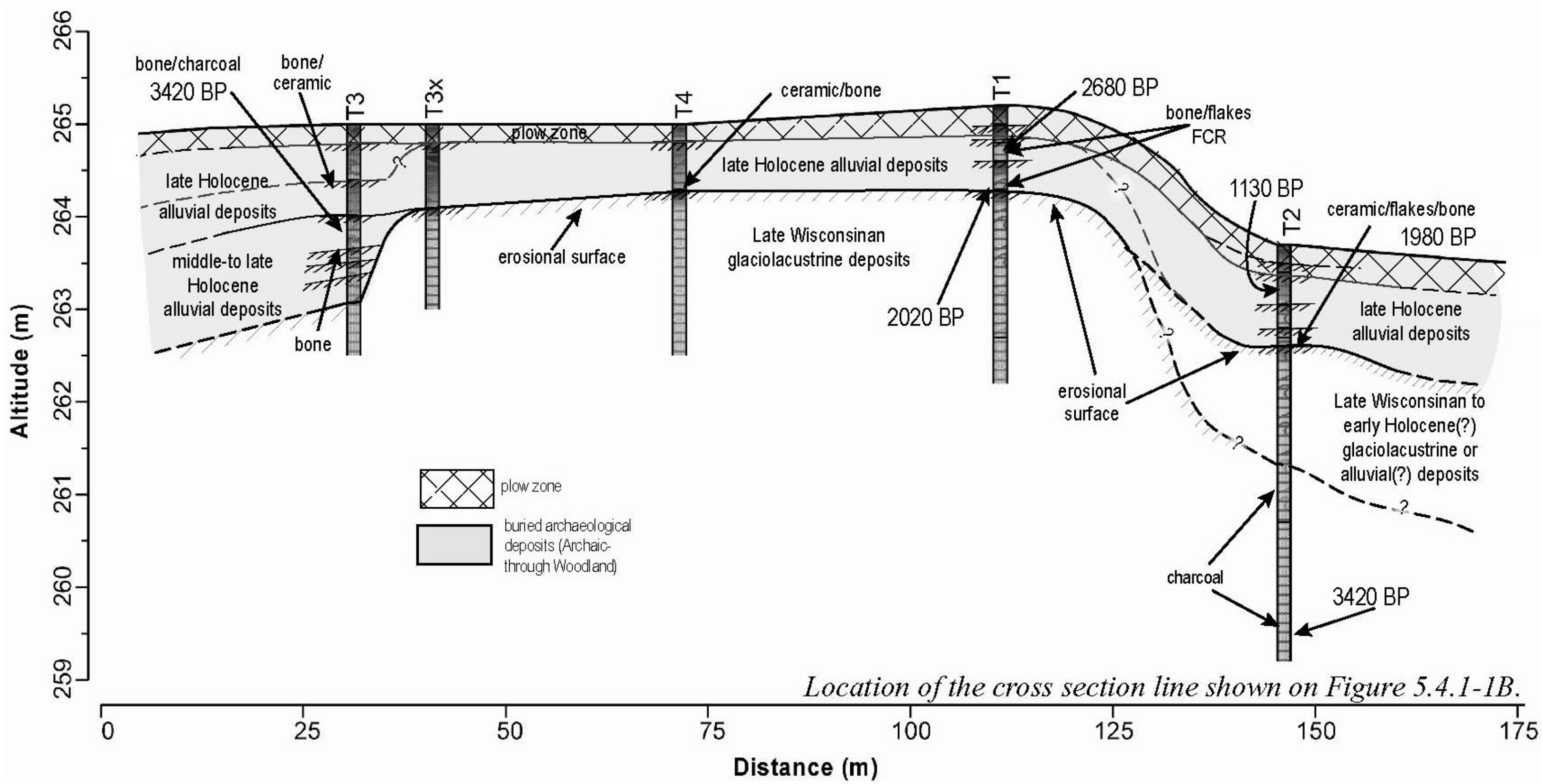

Figure 5.4.1-2. Cross Section through the Hoff Deep Test Locale

covered most of central Canada, as well as often extending southward into this part of the Red River Valley between about 14 ky BP and 8.5 ky BP (Fenton et al. 1983; Fisher 2004; Matsch 1983; Teller and Leverington 2004; Teller and Thorleifson 1983). Typically, the Lake Agassiz sediments consist of tan to light-brown/mottled reddish brown/gray, laminated (varved) silty clay and clayey silt (Figure 5.4.1-1, also see Trench 1 and 4, Appendix C). The varves commonly form couplets that include fine sand drapes and lamina between thin (a few to several millimeters thick) silty/clayey beds. The sedimentology, particularly varving, of these deposits undeniably indicates a glaciolacustrine origin. Although generally devoid of organic material, a few pieces of charcoal were noted within the sequence at Trench 2 (Figure 5.4.1-1; Appendix C). One of these, a small (ca. 500 mg) piece of *Fraxinus* sp. (Ash) wood charcoal recovered from a depth of about 4 m (13.1 ft), yielded a ^{14}C age of 3420±40 BP (Beta -200804; calibrated cal yrs B.C. 1870 to 1840 and B.C. 1780 to 1620; Appendix D). The stratigraphic context, age, and species of this charcoal are puzzling. It is clearly not compatible with inclusion into the sequence of Lake Agassiz varves, which were deposited within the lake between 10 kyBP and 14 kyBP. This implies a tremendous amount of vertical mixing, even though the varves were generally undisturbed. Such vertical displacement may be explained the fact that, in other places on the Lake Agassiz plain where varved deposits actually do extend to the surface, these sediments typically form vertisols (i.e., Fargo series soils). These clay-rich soils, with high amounts of expandable vermiculite or smectite, develop large and deep cracks during wetting and drying. In Norman County, Minnesota, such soils have been generally mapped parallel the meander belt of the Red River. Near the test locale they are present just east of the north-south road along County Ditch No. 49 (Fargo Soil Series) (Figures 5.4.1-1 and 5.4.1-3). We propose that the 3400 BP charcoal from Trench 2 may have fallen into one such crack. The depth from which it was recovered (4 m [13.1 ft] below modern surface and about 3 m [9.8 ft] below all paleosurfaces) (Figure 5.4.1-2) attests to the size that vertisol-like openings can achieve.

Alluvial silt and clay overlie the varved Lake Agassiz deposits throughout the Hoff Deep test locale, but vary in thickness and age depending on location. They are generally thickest in Trenches 2 and 3 at the corners of the grid (Figure 5.4.1-1) and thinnest on the glaciolacustrine upland in the center portion of the test area. In Trenches 1, 3x, and 4, which are located on the glaciolacustrine upland, about 1 m (3.3 ft) of Holocene alluvium overlies varved clays. The alluvium (i.e., upper 50 cm to 100 cm [19.7 in to 39.4 in]) within these trenches likely resulted from progressive accretion of Red River alluvium and probably reflects over-bank deposition (Figure 5.4.1-3). The contact between these units is generally sharp, possibly erosional, and in Trenches 3x and 4 is marked by paleosol development (2Ab) on the glaciolacustrine surface. The thicker sequence occurs in Trench 1, where approximately 85 cm (33.2 in) of massive, silty clay and clayey silt overlie glaciolacustrine deposits. The base of the alluvial sequence includes occasional charcoal flecking and small pieces of bone. The contact between these two deposits is sharp and marked by a fairly well defined paleosol (2Ab) developed in the glaciolacustrine sediment that also includes possible fire-cracked rock, occasional charcoal flecking, and small pieces of bone (Figure 5.4.1-3). The pedogenic processes related to formation of this soil have generally obliterated varving or other primary bedding structure. The soil also exhibits vertisol-like properties, which are suggested by large "cracks," in-filled with relic surface sediments, that occur at the base of the soil (Figures 5.4.1-3 and 5.4.1-4). These cracks do not appear to propagate into the overlying alluvium, suggesting that, once covered with alluvium, vertisolic processes may have ceased. Such a change in soil weathering conditions following burial of the

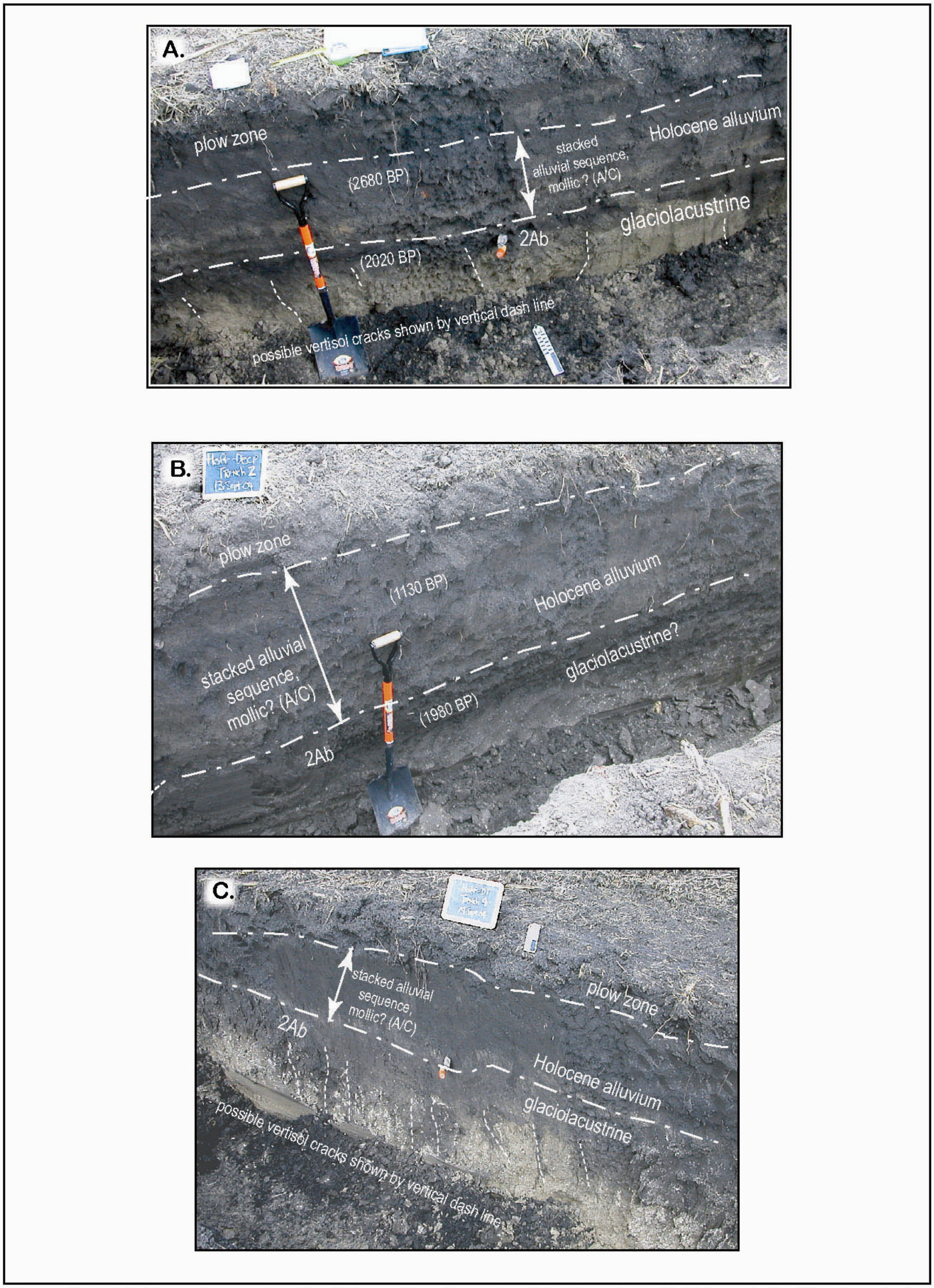

Figure 5.4.1-3. Trenches at the Hoff Deep Test Locale: (A) Trench 1; (B) Trench 2; (C) Trench 4

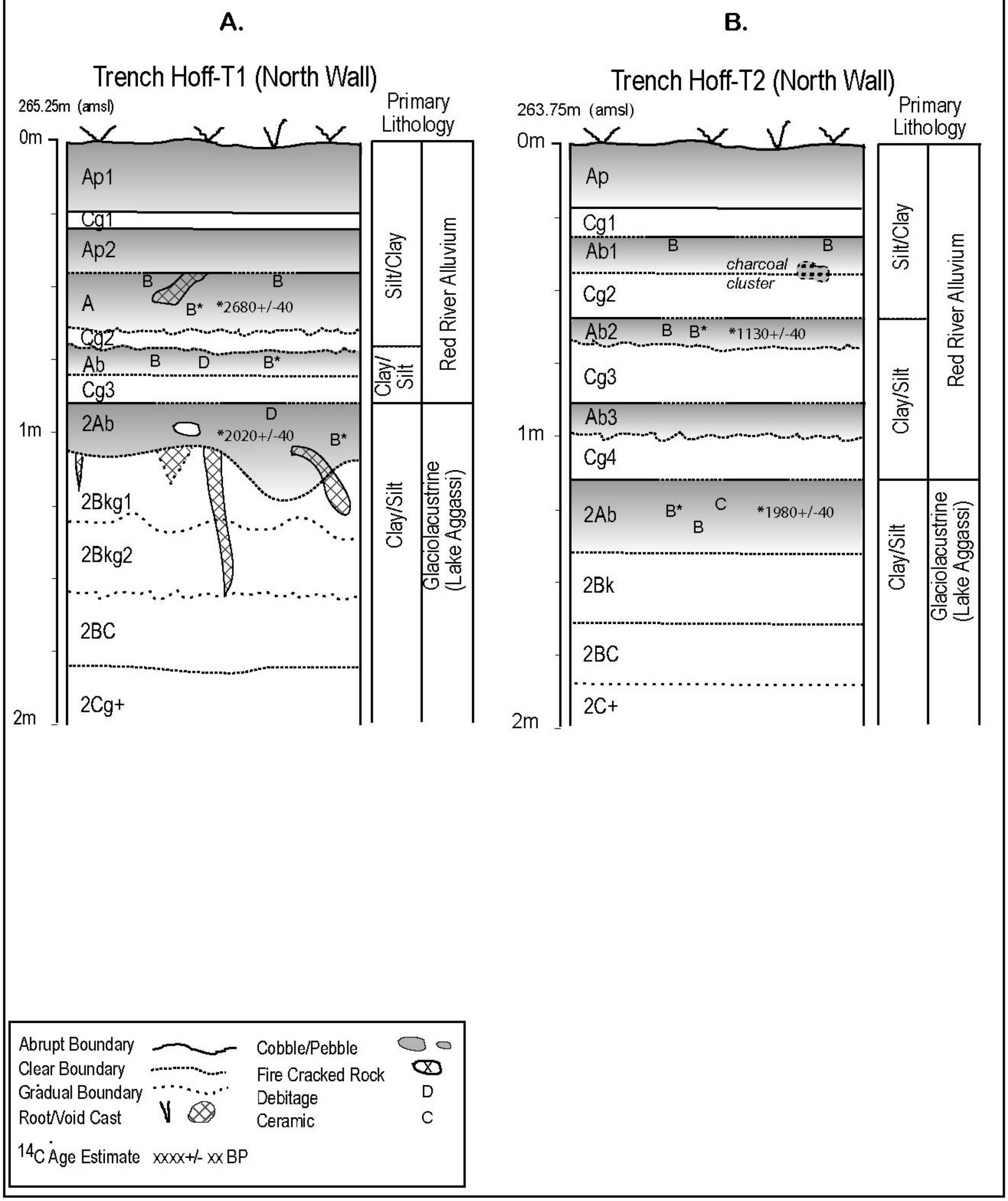

Figure 5.4.1-4. Soils and Sediments within the Upper Part of (A) Trench 1 and (B) Trench 2, Hoff Deep Test Locale

relic glaciolacustrine surface is probably related to differences in age, composition, and drainage characteristics within the aggrading and evolving landscape. For example, the alluvium may have included less clay, especially lower amounts of expandable clay, because the floodplain eroded along the upstream portions of the landform has a different composition.

Although a few relatively thin dark-gray to strong-brown discontinuous paleosols, which probably mark periods of stability on the floodplain, could be discerned within the Trench 1 alluvial sequence, elsewhere (Trenches 3x and 4) the upper part of the alluvium appears much more massive, forming a 40-cm to 50-cm (15.7-in to 19.7-in) thick, black to dark gray surface (A) soil horizon. The thick nature of the A horizon in these trenches suggests that it probably developed as a prairie soil (mollic-like epipedon) within accreted alluvium deposited during periodic flooding of the Red River. It also contains a few pieces of fire-cracked rock, lithic debitage, ceramic, and charcoal, which indicate that prehistoric occupation occurred during deposition of the alluvium. The ages for the alluviation and, consequently, the age range for buried prehistoric occupation in the upland area are given by a pair of ^{14}C age estimates on charcoal collected from the top and bottom of the sequence in Trench 1. These are 2020±40 BP (Beta -200801; calibrated cal yrs B.C. 110 to A.D. 70; Appendix D) for the base and 2680±40 BP (Beta -200800; calibrated cal yrs B.C. 900 to 800; Appendix D) for the upper part of the alluvium.

The juxtaposition of the dates may derive from the fact that they are detrital and could have been naturally redeposited or were mixed by bioturbation processes. Regardless, they do suggest that deposition was rapid and occurred during the Late Archaic or Early Woodland period. The presence of six tiny fragments of a single sherd in the alluvial stratum immediately overlying the glaciolacustrine stratum at the base of Trench 2 may be consistent with an Early Woodland age. However, the identification of the sherd as Early Woodland is equivocal.

Thicker, probably distinct, alluvial sequences also were observed in Trenches 2 and 3 (Figures 5.4.1-1, 5.1-1, 5.4.1-2 and 5.4.1-5). The earlier and thicker episode is in Trench 3. Interestingly, unlike the western portion of the testing grid, which forms a topographically lower alluvial terrace, no surface geomorphological features occur indicating that a thick alluvium actually underlies this area. An approximately 160-cm (63.0-in) thick sequence of alluvial silt and clay directly overlies the glaciolacustrine clay in Trench 3 (Figure 5.4.1-5). As noted elsewhere, the upper parts of these glaciolacustrine deposits are massive and only become varved with depth. The overlying alluvium consists of massive to faintly tabular bedded silty clay. The lower 50 cm to 60 cm (19.7 in to 23.6 in) of the alluvium is more clay-rich and consists of a series of stacked, discontinuous, 15-cm to 25-cm (5.9-in to 9.8-in) thick, dark gray (top 5 cm to 10 cm [2.0 in to 3.9 in]) and light brown/mottled gray/tan (base) ephemeral paleosols. Occasional charcoal flecking and small pieces of bone occur within the sequence. The alluvium and associated paleosol sequence probably derived from regular flooding of the Red River, and their minimum age is given by a 3420±40 BP (Beta -200805; calibrated cal yrs B.C. 1870 to 1840 and B.C. 1780 to 1620; Table 2) ^{14}C date on charcoal near the top of this sequence (Figure 5.4.1-2).

The age and character of these sediments and associated paleosols permit reconstruction of floodplain evolution and channel migration history in the Red River Valley. Evidently, sometime prior to about 3500 BP the Red River must have begun to meander, erode into its

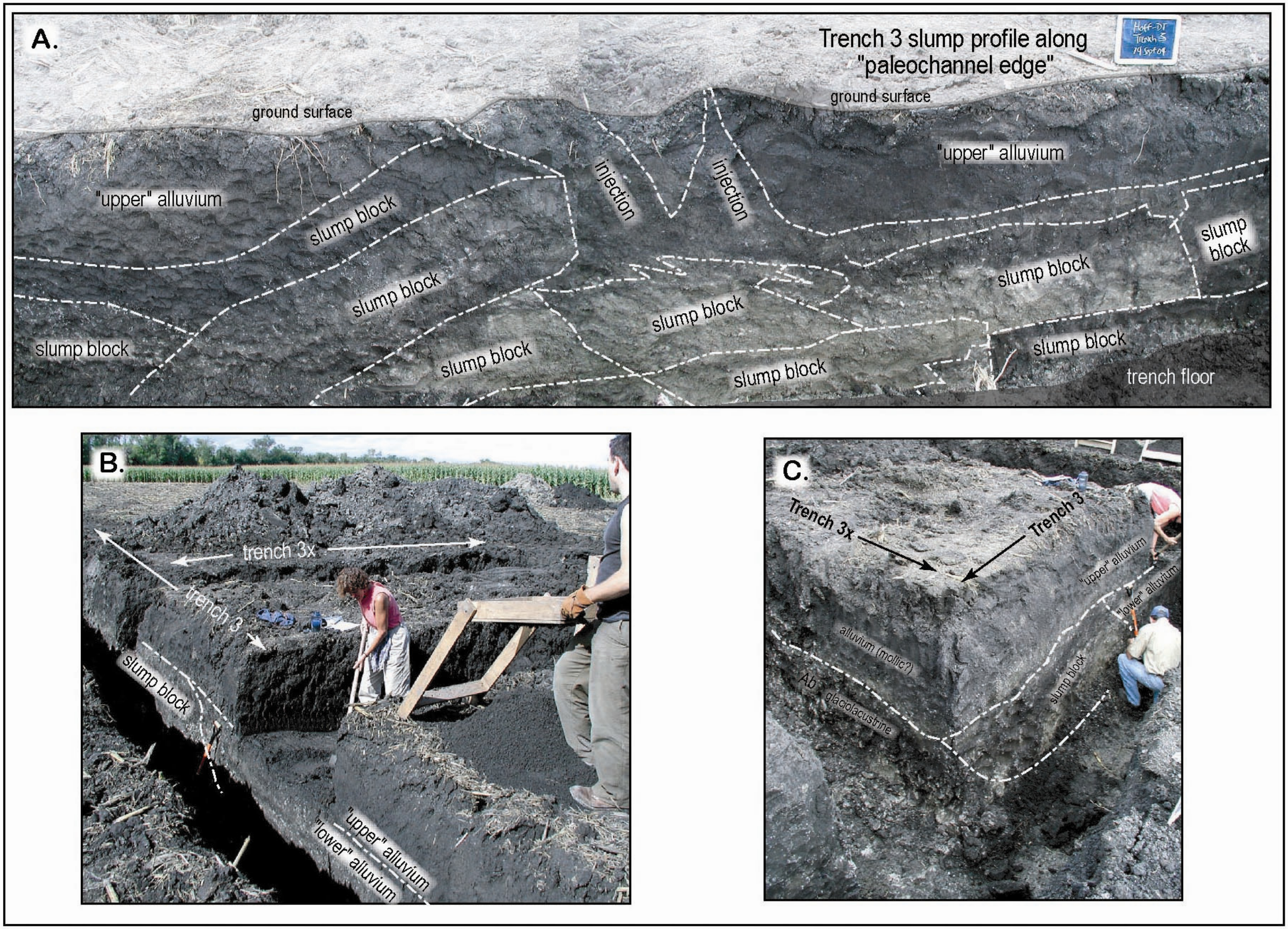

Figure 5.4.1-5. Trench 3 at the Hoff Deep Test Locale: (A)West Wall; (B) East Wall; (C) Junction of Trenches 3 and 3x

bank, and initiate vertical accretion of the basal alluvial sequence near Trench 3. The presence of several paleosols within this sequence separates it into specific flood intervals; however, the contacts between paleosols are all conformable or gradational, suggesting that while deposition was episodic, it was also relatively continuous and probably rapid. The eroded edge of glaciolacustrine deposits could be discerned on the northern end of Trench 3, where alluvium on-laps Lake Agassiz sediment. Interestingly, the glaciolacustrine deposits are also highly deformed and seemingly form a series of rotational slump blocks of sediments (Figure 5.4.1-5). These apparently developed as the Red River eroded and undercut the bank. Blocks of sediment probably broke along pre-existing vertisol-like cracks developed within the clay-rich sediments (as discussed above) and slid along listric-like fault lines by gravity (Figures 5.1-1 and 5.4.1-5). This process of bank erosion through the formation of rotational slump blocks has been described by Schwert (2003) and is apparently common throughout the Red River (Baracos and Kingerski 1998; Baracos and Render 1982; Minnesota Geological Survey 2003).

In Trench 3, the pre-3240 BP alluvial sequence is overlain by younger alluvial silt. The contact between this sequence and the underlying alluvium is sharp and marked by a relatively well-developed paleosol. The contact probably marks a comparatively long depositional hiatus that suggests a period of floodplain stability. The upper alluvium is composed of about 1 m (3.3 ft) of black to dark-gray, massive, clayey silt and also includes occasional very fine charcoal flecking, as well as pieces of burned and unburned bone. A small ceramic sherd was recovered in the upper part of the sequence (i.e., sub-plow zone). These alluvia clearly resulted from progressive accretion of Red River alluvium through vertical accretion during over-bank episodes. It can be distinguished from the lower alluvium by its more silt-rich texture and by the pattern of paleosol development within it. Rather than the series of thinner, stacked short-lived paleosols that characterizes the lower alluvium, the upper alluvial sequence actually includes two distinctive and thick paleosols. These both have thick, black, probable mollic epipedons and were probably formed during two episodes of regular vertical accretion. Their separation likely resulted because of a brief period of accelerated deposition. The plow zone has truncated the top of the upper mollic paleosol. Timing for deposition of the upper alluvial sequence is not known, but occurred after about 3400 BP (age of the top of the lower alluvial sequence) and may be similar to that either in the Trench 1 (i.e., 2000-2500 BP; Figure 5.4.1-2) or the younger Trench 2 sequence (i.e., post-2000 BP; Figure 5.4.1-2). The presence of a ceramic sherd in the alluvium indicates that deposition continued at least through the Early Woodland period.

A different, approximately 1-m (3.3-ft) thick alluvial sequence, which directly overlies probable glaciolacustrine silt and clay found within Trench 2, is located in the topographically lower part of the Hoff Deep test locale (Figures 5.4.1-1, 5.4.1-2, and 5.4.1-3). Here, the contact between the alluvial and glaciolacustrine sequence is sharp and marked by the surface (2Ab) horizon of a paleosol formed on the top of the glaciolacustrine deposits. As noted elsewhere at the test locale, the upper part of these glaciolacustrine sediments is generally massive and clay-rich, but has no distinctive bedding to demonstrate its origin. Consequently, these deposits could represent early Holocene alluvium (Figure 5.4.1-2); however, the lack of any paleosol development or evidence of depositional breaks within the sequence, the general lack of organic material within it, and the fact that these silts and clays ultimately grade progressively downward into clearly varved sediments, all suggest a probable late Wisconsinan glaciolacustrine (i.e., Lake Agassiz) origin.

The buried surface (2Ab) horizon marking the top of the glaciolacustrine silt and clay is black to strong-brown, 15 cm to 20 cm (5.9 in to 7.9 in) thick, fairly well-developed, and includes occasional charcoal flecking and fire-cracked rock, as well as small pieces of burned and unburned bone. It is overlain by a ca. 100-cm (39.4-in) thick sequence of dark-gray to strong-brown and light brown/mottled gray/tan, generally massive, silty clay and clayey silt alluvium. The plow zone truncates the top of this sequence, and at least three distinctive paleosols are situated within the alluvium. Additionally, occasional charcoal flecking, small pieces of burned and unburned bone, six tiny fragments from a single small ceramic sherd, and debitage occur within the sequence. These later artifacts indicate that prehistoric occupation occurred during alluviation. As is true for the lower alluvium in Trench 3, this sequence of alluvium and paleosols derived from regular flooding of the Red River. The ages for the alluviation and, consequently, the age range for occupation within the sequence are given by a pair of ^{14}C age estimates on charcoal collected from the top and bottom of the sequence (Figure 5.4.1-2). These are 1980±40 BP (Beta -200803; calibrated cal yrs B.C. 50 to A.D. 100; Appendix D) for the base and 1130±40 BP (Beta -200802; calibrated cal yrs A.D. 790 to 1000; Appendix D) for the upper part of the alluvium.

The sequence and ages of sediments from Trench 2 indicate that just after about 2000 BP, the Red River initiated vertical accretion. The fact that at least a few probably short-lived paleosols are within this sequence suggests that the accumulation occurred episodically during several separate flood intervals. The formation of paleosols, which contain archaeological material, within the sequence indicate intervals of weathering and limited or no deposition. Regardless, the fact that the entire sequence was deposited within 700 to 1000 years suggests that deposition also must have been rapid, allowing only minimal time between flood intervals for soil formation.

5.4.2 Discussion of Georchaeological Significance from Trenching

Originally, the grid at the Hoff Deep test locale was designed to test the sensitivity of geoarchaeological methods used in this research to differentiate areas of fine-grained alluvium with high-suitability for preserving buried archaeology from areas that are composed of low-suitability, but also fine-grained, glaciolacustrine deposits. The LfSAs were used to define the boundaries of this area and apparently mismapped these areas. In fact, at least a 1 m (3.3 ft) thick, mid- to late Holocene alluvial sequence underlies the entire test locale. As a consequence, the original testing goals were abandoned, but, from the positive standpoint, this sequence included a surprising series of alluvially buried and stratified archaeological deposits. The results of the trenching work at the Hoff Deep test locale show clearly that the geological deposits assumed and mapped by the LfSAs are not correct in this area and should be re-evaluated. Hopefully, the data offered in this report can refine the buried site-predicative framework for some elements of the LfSAs in the Red River Valley.

The results of trenching show that low density buried archaeological remains are found throughout the test locale. These consisted of bone, charcoal, fire-cracked rock, lithic debitage, and ceramic sherds that were discovered in the very first trench excavated, as well as various archaeological materials in all of the other trenches. Except for the smoothed and cordmarked, shell-tempered and grit-tempered ceramic sherds (see Section 5.5.2), which lacked decoration and are only broadly attributable to the Late Woodland period, no cultural-period or time-diagnostic artifacts were recovered. Regardless of the absence of chronologically diagnostic artifacts, several ^{14}C age estimates on charcoal collected in association with the artifacts indicate that buried occupations minimally range from 3420 BP and 1130 BP (Beta-200805 and Beta-200802, respectively; Appendix D). When placed in their stratigraphic, spatial, and depositional contexts, these dates, along with the associated sedimentological, pedological, and geomorphological characteristics, allow reconstruction of the complex history of erosion and alluviation during the middle and late Holocene along this reach of the Red River Valley.

Sometime before 3500 BP, the Red River began to meander, erode into its bank and initiate vertical accretion of the basal alluvial sequence. Prior to this time, the Hoff Deep test locale must have contained little or no alluvium. A vertisol-like soil formed directly in varved Lake Agassiz lacustrine clay and likely marked the ground surface from the time of drainage of Lake Agassiz (ca. 8500 BP-9000 BP) through much of the middle Holocene. The fact that this soil formed directly on glaciolacustrine deposits implies that vertical alluvial accretion was rare during the early and middle Holocene in this part of the Red River Valley. Evidence of bank slumping within the initial alluvium in Trench 3 suggests vertical accretion and channel meandering were related. These data also imply that the Red River channel meandered through a process of bank erosion by undercutting the varved, clay sediment, which caused rotational slumping of sediment blocks, much as it does today (Schwert 2003). These observations suggest that the Red River became deeply inset into the Agassiz lake plain early in its history (i.e., early Holocene) and initially meandered very little. We believe that these conditions may relate to the relatively unique configuration of the Red River Valley in relation to Lake Agassiz and basin-wide isostatic rebound patterns during the early and middle Holocene.

As shown by warped strands of Lake Agassiz, isostatic depression was greatest in the north and decreased southward to the outlet at Boulder Lake, Minnesota. Consequently, isostatic depression was at a maximum in the northern end of the basin during the early Holocene, but also rebounded most rapidly in this same area once Lake Agassiz drained. The Red River probably formed progressively within the relative Lake Agassiz depression left after the lake drained, first from the southern parts of its basin (post-9500 BP) (Fisher 2004) and over the next 1500 years expanding north into the progressively shrinking “core” of the lake in Canada. Because it was much lower in the north, due to isostatic depression, the early Holocene Red River channel gradients were probably comparatively steep and resulted in generalized channel incision; however, as the northern part of the valley progressively rose relative to the south through early Holocene isostatic rebound, the channel gradient must have progressively lowered, which would have resulted in initiation of horizontal channel migration. Based on the timing and character of deposits at the Hoff Deep test locale, we propose that the adjustment from vertical channel incision to horizontal channel migration occurred during the middle Holocene after 4000 BP to 5000 BP. This hypothesis has important archaeological ramifications for site locations and preservation. If correct, for example, the Red River meander belt (Figure 5.4.1-1) developed after 5000 BP and, once meandering was initiated, would probably have destroyed most of the Early and Middle Archaic sites that may have been adjacent to the river.

5.5 RESULTS OF ARCHAEOLOGICAL TESTING

5.5.1 Previous Investigations at Hoff Deep Test Locale

A buried, probably stratified Archaic through late Woodland-age archaeological site was discovered at the Hoff Deep test locale and is informally referred to as the Hoff Deep archaeological site. Prior to this research, no surface or subsurface testing had taken place near the Hoff Deep site. Despite the fact that an extensive scatter of artifacts (>15 ac [6 ha]) was present on surface around the Hoff Deep testing locale, the site was unknown prior to the Mn/DOT DTP project. That buried deposits are present at the Hoff Deep locale, however, is not particularly surprising because two of the best known stratified sites in the region, Canning (21NR0009; Michlovic 1986) and Mooney (21NR0029; Michlovic 1987), are located along the Red River just north of the study area. More detail of these sites and their importance to the geoarchaeological understanding of the Red River Valley are given in Chapters 2.0 and 3.0. Interestingly, while all these sites occur in areas designated as having a high suitability for preservation of buried archaeological deposits, the Canning and Mooney sites actually are situated within quite different depositional settings from that of the Hoff Deep area. In addition, buried deposits at the Hoff Deep test locale were even discovered within areas that were considered to have a low suitability for buried archaeological deposits. Taken together, these observations probably reflect that a generally high potential for site burial probably characterizes most alluvial settings within the Red River Valley.

5.5.2 Current Investigations at Hoff Deep Test Locale

Stratigraphic data obtained from the coring and the trenching phases of the investigations at the Hoff Deep test locale indicate the presence of a complex sequence of fine-textured alluvial sediments measuring between approximately 85 cm and 1.6 m (2.8 ft and 5.2 ft) thick. These alluvial sediments directly overlie glaciolacustrine deposits and contain a series of ephemeral and well-developed paleosols. All of the paleosols that were tested for archaeological materials produced artifacts, primarily in the form of burned, calcined, and unburned animal bone. Although diagnostic artifacts are limited to a small number of ceramics, most of which appear to be related to Late Woodland Sandy Lake wares (see below), radiocarbon dates from the site indicate that site occupation probably began during the Late Archaic or Early Woodland periods. Because of the sequence of stacked paleosols at the Hoff Deep test locale, archeological testing during both the augering and trenching was oriented principally towards sampling the individual paleosols.

Systematic surface collection of the Hoff Deep test locale produced only a small amount of cultural material. Artifacts were even somewhat scarce on the surface. This may be because the test grid was disked a few days prior to the survey and had not sufficiently weathered to produce good surface collecting conditions.

The coring phase of the investigations identified 39 target horizons at 18 core locations within the test grid. Five of the core locations identified only a single target horizon, six core locations identified two or three target horizons each, and one core location identified four target horizons. Augering produced cultural material from 24, or 61.5 percent, of the target horizons

(Appendices B and E). Although cultural material was not recovered from all of the identified target horizons, the fact that most of the core locations produced cultural material from one or more target horizons suggests that the prehistoric occupation of the Hoff Deep test locale is both spatially expansive and stratified. These data also indicate that the test locale grid is wholly contained within the limits of the site, and the site's spatial extent is currently undefined.

Four 50 cm × 50 cm (20 in × 20 in) test units were excavated during the archaeological testing phase at the Hoff Deep test locale. One unit was placed along the wall of each of the backhoe trenches excavated. A fifth, less formal, test unit was excavated in Trench 3x to expose a small cultural feature noted in the wall of the trench. The paleosols that occurred within this test unit, however, were not sampled. The four formal test units sampled 12 of the 14 target horizons or paleosols exposed in the trench walls (see Figures 5.5.1-1a to 5.5.1-1d).

Because of the compaction and fine-texture of the sediments at the Hoff Deep test locale, as well as to determine the vertical distribution of the cultural material in the paleosols, arbitrary 5-cm (2-in) excavation levels were used. Soil conditions made screening of the sediments extremely difficult, and a combination of shoveling, skimming, hoeing, and troweling were necessary to remove the sediments from each test unit. Cultural material, primarily in the form of animal bone fragments, was recovered from all but two of the sampled paleosols. Non-bone cultural material (i.e. prehistoric ceramic, debitage, and fire-cracked rock) was restricted to three separate paleosols. The precision of identifying the upper and lower boundaries of the target horizons in the trench wall was greater than that afforded during the coring and augering phases.

Test Unit 1 was placed off the side of Trench 1 (Figure 5.5.1-1b). The stratigraphic sequence exposed in Test Unit 1 is relatively complex, consisting of ten strata. The first three strata consist of two black silt loam plow zones separated by a thin mottled very dark grayish brown and dark grayish brown silt loam Cg1 horizon. Below this the stratigraphy consists of a series of two stacked A or Ab-Cg horizons overlying the basal 2Ab horizon that formed in the glaciolacustrine sediments. These horizons tended to be dark (black to very dark grayish brown) and fine textured (silt loam to clay loam) and had diffuse to clearly defined lower boundaries. Three strata (Stratum IV, VI, and VIII) were designated for investigation in Test Unit 1. The highest and the lowest strata each required four excavation levels, while the middle stratum required only a single excavation level. Cultural material, almost exclusively small animal bone fragments, was recovered from all three of the target strata (Appendices E and F). A single flake and a small fragment of fire-cracked rock were also recovered from Stratum VIII.

Test Unit 2 was placed off the side of Trench 2, which is located near the southwestern corner of the test locale (Figure 5.5.1-1a). A slightly simpler sequence of seven strata was exposed in this test unit. Except for minor differences in the thickness, color, and texture of the horizons and the lack of two stacked plow zones, the stratigraphic sequence in Test Unit 2 is markedly similar to that seen in Test Unit 1. Three strata (Stratum II, IV, and VI) were identified as target horizons and subjected to formal testing. Testing of Stratum II required seven excavation levels, while only two excavation levels were necessary in each of the other two paleosols exposed in this test unit. The paleosols ranged from dark gray to brown or strong brown in color and were composed of either silt loam or silty clay loam. Cultural material was present in only the upper- and lower-most strata, although much charcoal flecking was noted in the middle stratum

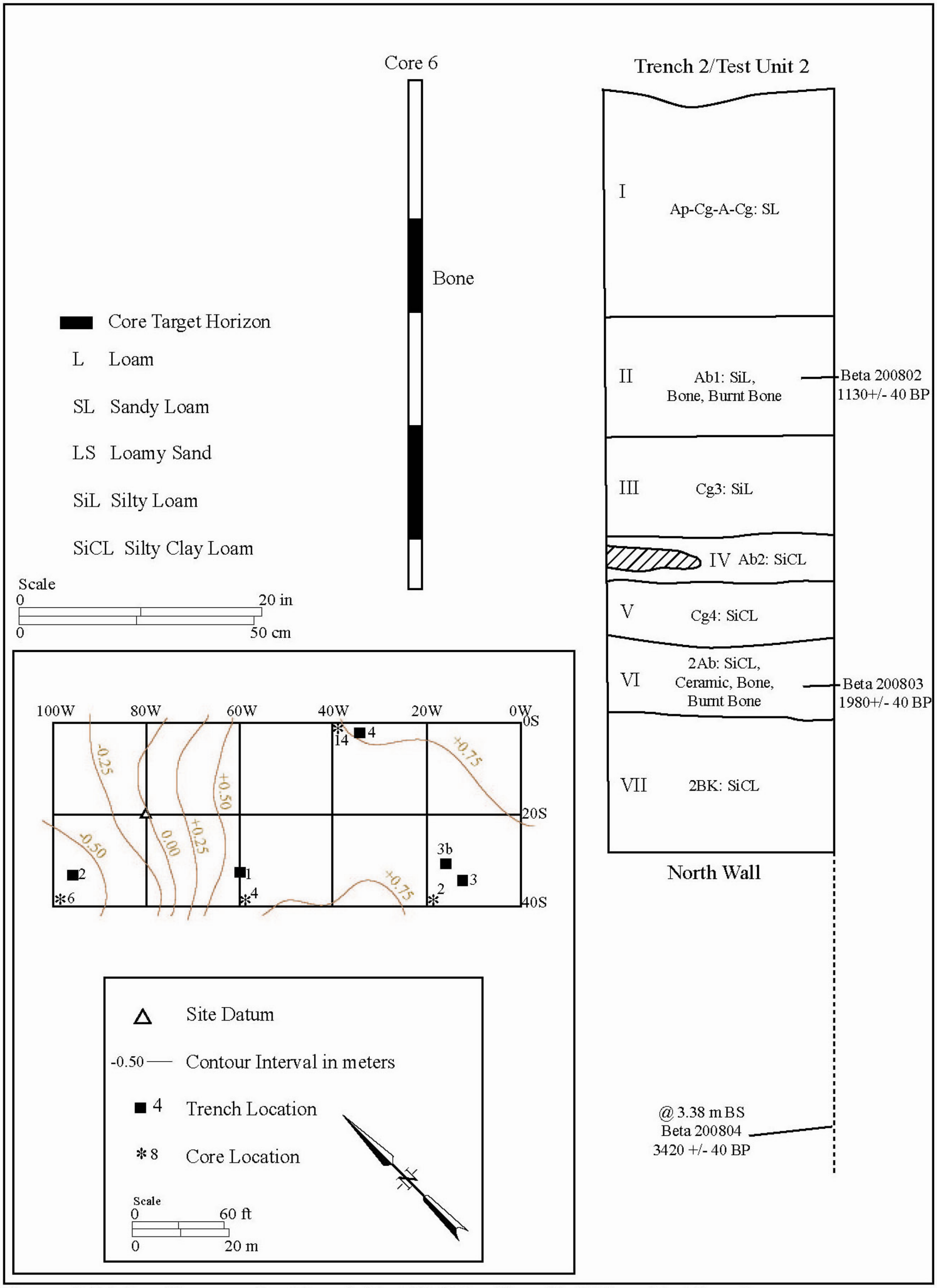

Figure 5.5.1-1a. Comparative Trench/Test Unit Profiles, Hoff Deep Test Locale

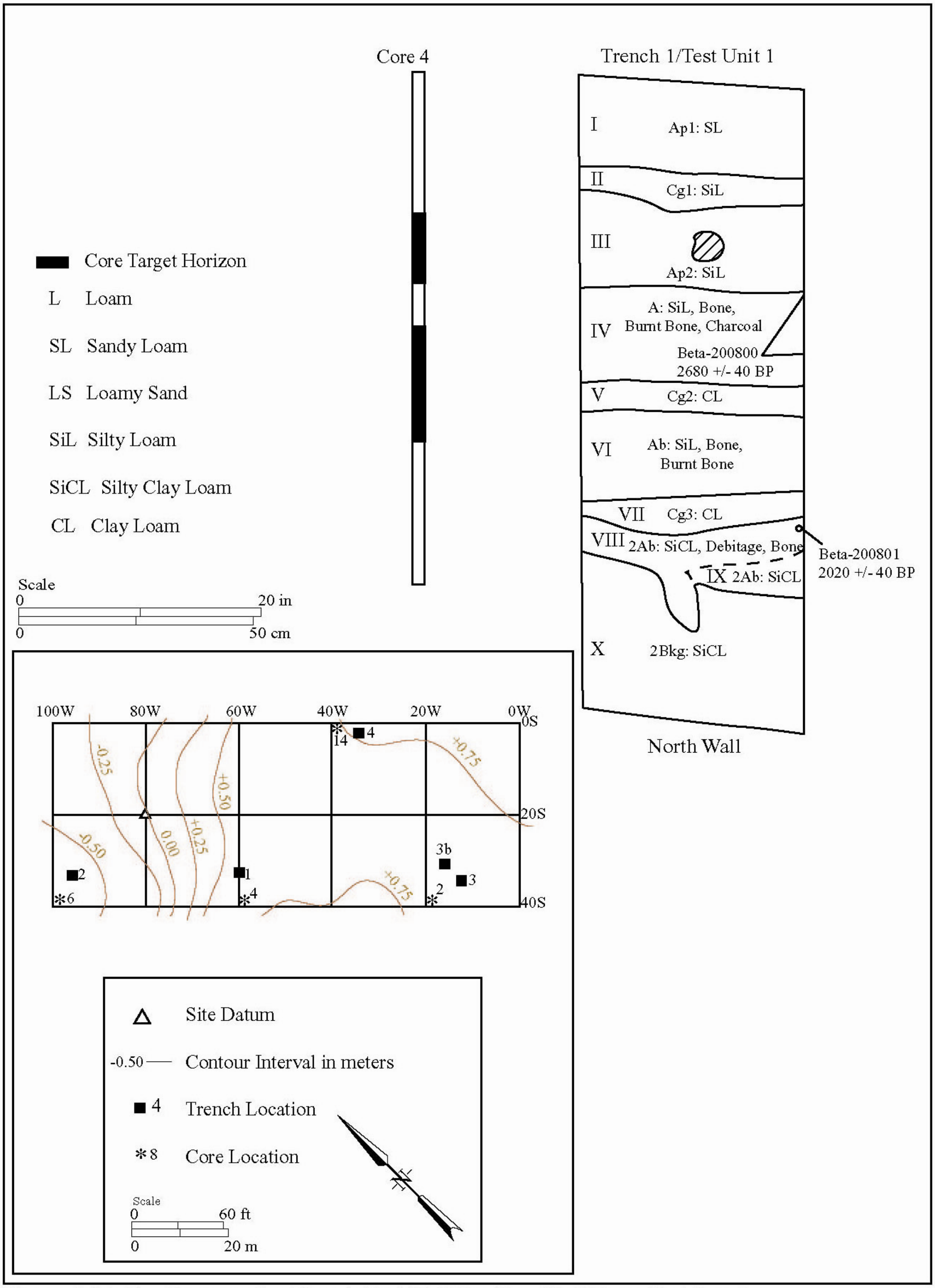

Figure 5.5.1-1b. Comparative Trench/Test Unit Profiles, Hoff Deep Test Locale

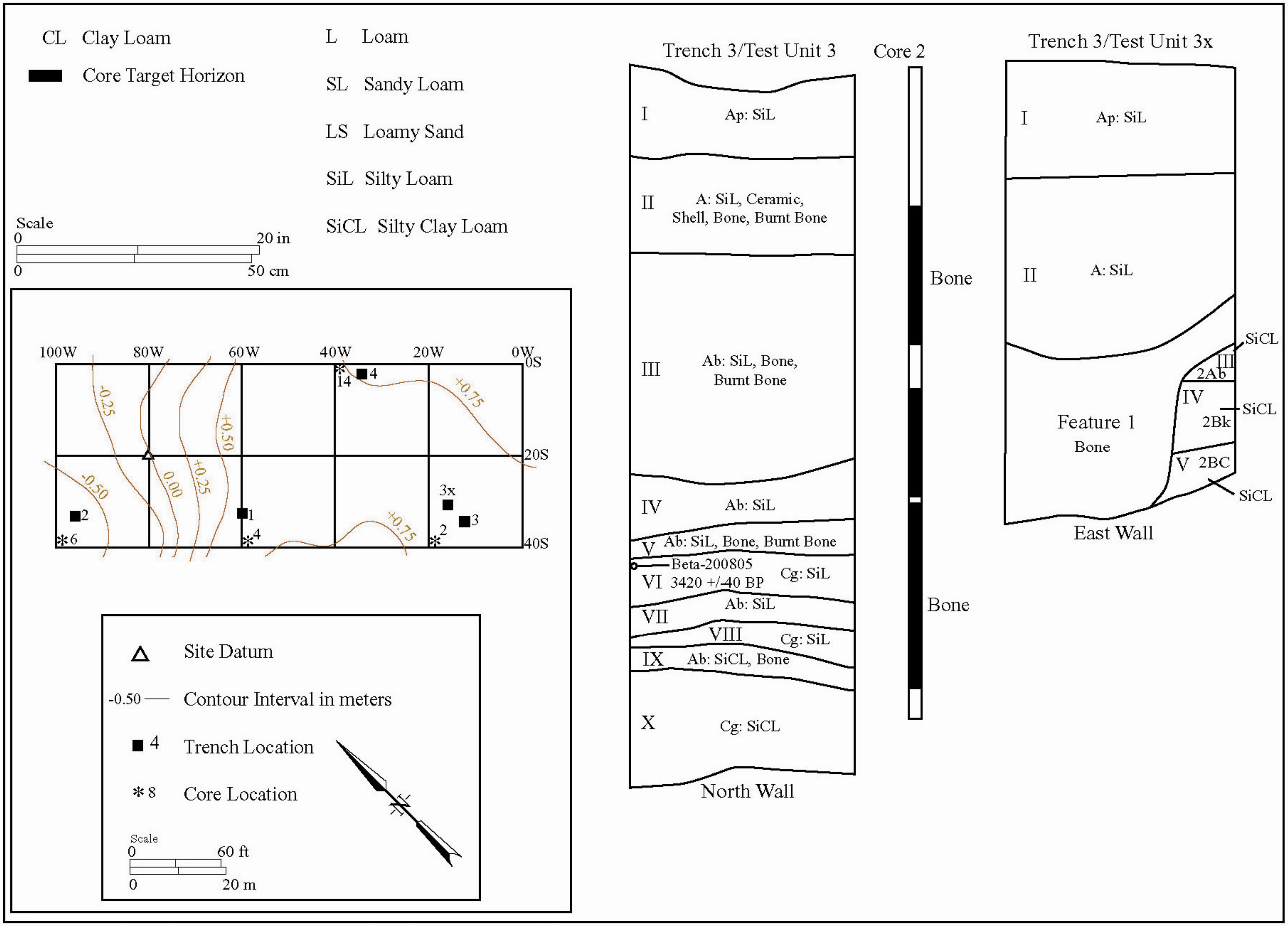

Figure 5.5.1-1c. Comparative Trench/Test Unit Profiles, Hoff Deep Test Locale

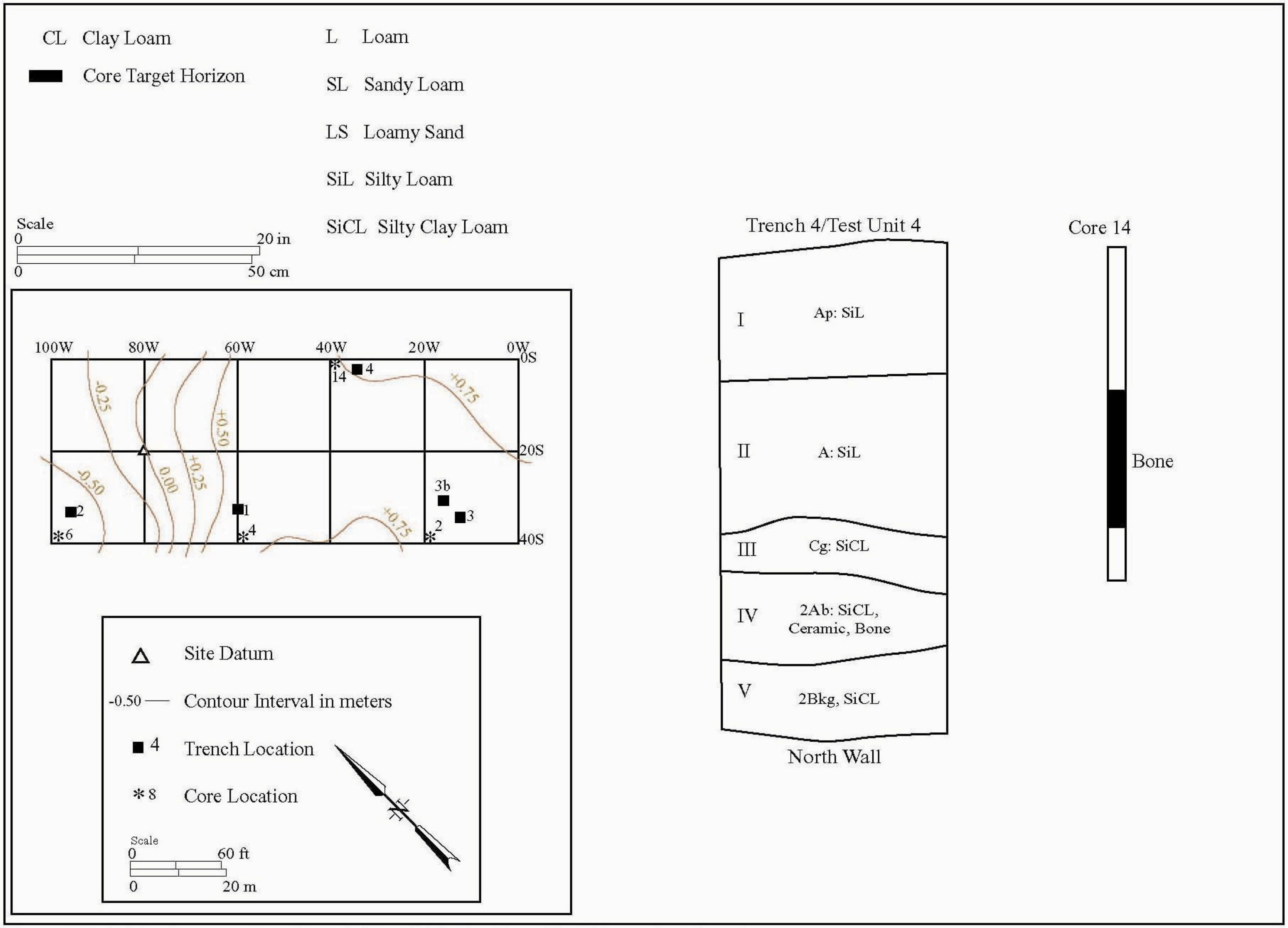

Figure 5.5.1-1d. Comparative Trench/Test Unit Profiles, Hoff Deep Test Locale

(Stratum IV). In addition to the small amount of bone present in Stratum II and Stratum VI, six tiny ceramic fragments from a single sherd occurred in Stratum VI. Based on the limited data obtainable from these sherds it is unclear whether they are intrusive into that stratum or not (see below).

The third test unit, Test Unit 3, was placed toward the eastern end of Trench 3, which is located in the southeastern part of the test locale (Figure 5.5.1-1c). Ten strata were exposed in this trench and test unit. This sequence consists of four stacked A and Ab horizons under the plow zone that are, in turn, underlain by a series of stacked Ab-Cg horizons extending to a depth of at least 155 cm (61 in). Similar to the other test units, these strata tended to be dark, ranging from black to very dark grayish brown, and fine textured, consisting of silt loams except for the lowest Ab horizon, which was composed of a silty clay loam. Based on the field observations in Trench 3, five strata (Stratum II, III, V, VI, and IX) were designated for investigation. The excavation of Stratum II required six levels, Stratum III required ten levels, and the remaining three strata required two levels each. Cultural material was present in all of the strata except for Stratum VII. Save for one small ceramic sherd, all of the artifacts from these strata consisted of small fragments of burned and unburned animal bone. These strata, particularly Strata II, III, and IX, exhibit the highest relative densities of bone encountered in the test units, ranging from 39 (65.2 gm) to 23 (10.2 gm) to 27 (9.3 gm) fragments, respectively. Not only are the densities of cultural material relatively high in this test unit, but, based on the 3420 BP radiocarbon date (Appendix D), it also contains at least two paleosols that are probably Late Archaic in age.

Test Unit 3b was excavated solely to expose and recover the remains of a small cultural feature that was exposed by Trench 3x. In profile, Feature 1 consists of a well-defined steep-sided and flat-bottomed discoloration about 46 cm (18 in) deep and about 38 cm (15 in) in diameter as exposed in the trench wall. The feature originated in Stratum II and cut through Stratum III, IV, and V (Figure 5.5.1-1c). The portion of the feature exposed in plan in the test unit indicated that it was probably circular or ovoid in shape and extended about 40 cm (16 in) into the test unit. The matrix consists of mixed black to very dark gray clay loam with a small area of oxidized soil and charcoal flecking towards its center. No cultural material was recovered from the feature matrix, although 21 fragments of bone, 13 of which are from a bison vertebrae centrum, were recovered from the overlying Stratum II sediments.

Located in Trench 4 in the north-central part of the test locale, Test Unit 4 exhibited the least complex stratigraphic sequence encountered in the test units (Figure 5.5.1-1d). Only five strata were identified in this test unit. In addition to the plow zone this stratigraphic sequence included two relatively thick paleosols (Stratum II and Stratum IV). Because of continued rain at the time of the investigations at the Hoff Deep test locale, and related concerns of potential trench collapse during the excavation of this last test unit at the site, only the lowest paleosol, Stratum IV, was systematically tested. This stratum consisted of a black to very dark grayish brown silty clay loam and required three excavation levels for its removal. Cultural material recovered from this stratum is limited to two tiny prehistoric ceramic sherds of equivocal typological affiliation and three tiny animal bone fragments. No charcoal was observed in this stratum.

5.5.3 Artifact Assemblage

A small assemblage of prehistoric ceramic and lithic artifacts was recovered from the investigations conducted at the Hoff Deep test locale (Appendix E). These artifacts are in addition to the 389 fragments of animal bone (Appendix F) that numerically dominate the overall artifact assemblage from this previously unidentified site. Bone, ceramics, and lithic artifacts were surface collected from across the entire testing grid; in addition, bone was recovered from 15 of the 18 auger sites and all four of the test units excavated. In contrast, ceramics and lithics were recovered in five of the 18 auger sites and all four of the test units (Appendix E).

The ceramic assemblage produced the only temporally and culturally sensitive type of prehistoric artifact recovered from the Hoff Deep test locale. Despite the lack of rim and decorated sherds, distinctive aspects of the surface treatment and temper characteristics indicate that these ceramics date to the Late Woodland period and are most likely associated with Sandy Lake ware.

The 23 (15.1 gm) prehistoric ceramic sherds from the investigations at the Hoff Deep test locale are almost uniformly small and exhibit a high degree of homogeneity in their paste and temper characteristics and only a limited range of variability in exterior surface treatment. The recovered sherds are almost uniformly small in size (1 cm to 3 cm in diameter).

The majority of the exterior surfaces are exfoliated. Of the nine sherds retaining their exterior surfaces, six exhibit well smoothed exteriors, two exhibit cordmarking on their exterior, and a single sherd exhibits wipe marks on both the exterior and interior surfaces. While wiped surfaces do not appear to be a common surface treatment type among Late Woodland ceramics in the Red River Valley, Birk (1977a) notes the presence of wipe marks on a smoothed-over cordmarked surface of a Sandy Lake ware vessel from the Onigum Point site in Cass County, Minnesota. The interior surfaces of 14 sherds are either smoothed or well smoothed, with the remainder having exfoliated interior surfaces.

All of the sherds exhibit silty pastes that are moderately compact to compact and have laminar structures. Twelve of the sherds are tempered with small amounts of fine felsic grit, specifically crushed quartzite, except for one that is tempered with crushed limestone. Small amounts of finely crushed shell temper are evident on eight sherds, one of which has a mixed shell and grog temper. The lack of any visible temper in the remaining three sherds probably relates to the small size of the sherds and the small amount of temper that is typically used in Sandy Lake ceramics. Thickness measurements could only be obtained for seven sherds and these range from 4.1 mm to 7.2 mm thick and an average 5.1 mm. These thicknesses are well within the range reported for Sandy Lake wares (Anfinson 1979:178).

The characteristics of the ceramics recovered from the Hoff Deep test locale conform most closely to Sandy Lake ware (Anfinson [ed.] 1979; Cooper and Johnson 1964; Birk 1977b). These ceramics consist of relatively thin-walled vessels with cordmarked (Sandy Lake Corded) and smoothed exterior surfaces (Sandy Lake Smoothed) that are tempered with either shell or grit. In their original definition of Sandy Lake ware, Cooper and Johnson (1964) note that the shell tempering is typically finely ground and is not used in large amounts, and that the paste is compact with a laminar structure that is prone to splitting. Use of a small amount of temper also appears to hold for those vessels where grit was used as the tempering agent (e.g., Birk 1977b).

The distribution of Sandy Lake ware extends across much of northern Minnesota into extreme northwestern Wisconsin and parts of southeastern Manitoba and southwestern Ontario. Within the Red River Valley, Michlovic (1983) reports that the ceramic assemblage from the Norman County-Red River survey was dominated by cordmarked, shell tempered Sandy Lake ceramics. Sandy Lake ceramics are not well dated, but are believed to generally date between about 1850 BP and 250 BP (A.D. 100 and A.D. 1700 in Anfinson [ed.] 1979:175). Five thermoluminescence dates on Sandy Lake sherds from the Red River valley place the age of Sandy Lake ware in that region to between about 900 BP and 500 BP (Michlovic 1988). Three of those dates are from the Mooney site, including a date of 780 BP (A.D. 1170 in Michlovic 1987). Although the 1130± 40 BP radiocarbon date from the Hoff Deep test locale is not associated with any of the Sandy Lake ceramics, based on the 780 BP date from the Mooney site, it is viewed as a reasonable approximation for the initial appearance of Sandy Lake wares at the site.

The lithic assemblage from the Hoff Deep Test Locale is limited to one expedient chipped stone tool, a ground stone tool preform fragment, two flakes, and 12 fragments of fire-cracked rock with an aggregate weight of 622 gm (Appendix E). The lone chipped stone tool from the site is a retouched and edge damaged flake. The tool is made from a medium-size ovoid-shaped blocky secondary flake of dark gray quartz with a planoconvex cross section. Intentional retouch along the distal half of one lateral edge creates a backed edge, and edge damage in the form of short steeply angled micro-flaking is present on the opposite distal corner. This tool appears to have been used as an expedient cutting tool. It measures 34.7 mm in length, 37.3 mm in width, and 12.6 mm in thickness.

Lithic debitage is limited to one small bifacial thinning flake of Knife River chalcedony and a small flat secondary flake fragment made from a medium-textured yellowish brown quartzite. A ground stone tool preform fragment was collected from the surface of the site about 13 m (43 ft) west of the testing grid. It consists of a disto-medial fragment of a probable axe or large celt preform with a probable biconvex cross section (Figure 5.5.2-1). Both lateral edges and the proximal end of the tool are missing. The intact faces have been pecked and the bit end of the tool exhibits short flake scars on one face. It is made from basalt and has fragmentary measurements of 102.9 mm in length, 80.9 mm in width, and 47.9 mm in thickness.

Three hundred eighty-nine bone and shell fragments are present in the Hoff Deep assemblage (Appendix F). Ninety-nine of the specimens were found on the surface; the rest occurred in targeted soil horizons. Given the presence of prehistoric artifacts on the surface, a significant portion of bone from the surface is probably prehistoric as well. Sixteen bone fragments are identified as bison and, together, they represent a single bison. Although no cut marks were observed on these bones, and none are burned or calcined, a possible drill hole is evident in the distal portion one of the bison phalanx. One unburned metatarsus distal shaft fragment is identified bovid, but also compares favorably with bison. No cut marks were observed on this bone.

Figure 5.5.2-1. Probable Axe or Celt Preform from the Hoff Deep Test Locale

Undiagnostic mammal remains are ubiquitous in the assemblage. One hundred twenty-five specimens are listed as large mammals. Twenty bones from large mammals are burned or calcined. A possible chop or cleaver mark is present on one indeterminate fragment. Seven specimens are considered to be from extra-large mammals and are likely bison. Eight indistinct fragments of bone are categorized as being from medium to large mammals. None display cut marks or evidence of burning. Indeterminate mammal bone fragments account for 145 specimens. With the exception of a single small tooth fragment, none are identified to type or exhibit butchering marks or other evidence of cultural modification. However, 47 are either burned or calcined. Fifty-nine specimens are too small to identify to either element or taxon. Of these, 19 are burned or calcined; none exhibit butchering marks or other evidence of processing. Ten freshwater mussel or mollusk shell fragments are recognized in the assemblage. One partial left valve is identified as threeridge (*Amblema plicata*). Threeridges are common across the Midwest and found in small to large rivers in substrates of mud, sand, or gravel (Cummings and Mayer 1992). The remaining shell fragments are too small to reliably classify. Three pieces of snail (Gastropoda) shell also are present in the assemblage.

Twenty-two frog or toad (order Amphibia) elements were recovered, representing a single animal. None exhibit butchering marks or evidence of burning. Given the condition and context in which the remains were found (all from same test unit, level, and stratum), these are probably either natural or intrusive.

5.5.4 Discussion of Archaeological Significance

Archaeological investigations at the Hoff Deep test locale reveal the presence of stratified cultural deposits extending back to at least the Late Archaic period. The results of these investigations suggest that the density of cultural material at the site is low and that fragmentary animal bone is the most numerous and ubiquitous of the archaeological remains. While the occurrence of non-faunal artifacts was sporadic across the site, animal bone and shell were found in virtually every excavated provenience except for one of the auger locales (S0/W0).

Except for bone, the majority of artifacts were from the surface of the site. This includes nine of the ceramic sherds, both of the stone tools, and one of the flakes. In augers, ceramics consistently occurred at depths between 30 cm and 90 cm (12 in and 35 in) below the current ground surface. A similar distribution was also noted in the trenches. Although the nine ceramic sherds from the surface comprise 39 percent of the assemblage by count, they represent 93 percent of the aggregate ceramic weight. This begs the question of site formation and integrity. Although ceramics were recovered from a number of sub-surface contexts, their small size coupled with the reverse order in vertical distribution of the radiocarbon dates in Trench 1 (Figure 5.4.1-2) raises concerns about the stratigraphic integrity at the site.

The archaeological test units shed some light on the nature of site disturbances. For example, six tiny fragments of a single sherd occurred in the first excavation level of Stratum VI in Test Unit 2, while in Test Units 3 and 4 ceramics occurred in Stratum II and Stratum IV, respectively (Figures 5.5.1-1a, 5.5.1-1c, 5.5.1-1d). In the latter two instances, the strata containing ceramics were either not dated (Test Unit 4) or overlay a horizon with significantly older radiocarbon ages (i.e., Stratum VI in Test Unit 3 dated to 3420 BP). These relationships suggest at least a broad stratigraphic consistency in places on the site. In Trench 2, however, the 1980 BP radiocarbon date (ca. 118 cm [46.5 in] below surface in Stratum VI) predates the possible occurrence of Sandy Lake ware in the region. Thus, the date is inaccurate, the ceramics are not Sandy Lake ware, or the ceramics are intrusive. The age of 1130 BP for Stratum II in Test Unit 2, on the other hand, while somewhat early, is consistent with the age Sandy Lake ware. While no ceramics were found in Test Unit 2, one sherd was recovered from the 30 cm to 50 cm (12 in to 10 in) target horizon in a nearby auger (S20/W100). The depths at which ceramics were found in the other augers do not necessarily correlate with strata in the test units nearest to each auger location. The only other non-faunal artifact from sub-plow zone contexts is a single bifacial thinning flake of Knife River flint and it was recovered from Stratum VIII of Test Unit 1, which is dated to 2020 BP (Figure 5.5.1-1b).

The Hoff Deep archaeological site is a low-density archaeological site dating to at least the Late Archaic period (ca. 3400 BP). The low density of cultural material, along with the near ubiquitous presence of faunal remains throughout the vertical and horizontal extent of the test locale, suggests that the buried occupations were probably short-duration encampments. The hunting of large mammals, including bison, was likely a major focus at this site. The presence of (probable) Sandy Lake ware ceramics in both buried and surface contexts reflect relatively rapid alluviation at the site. While the cultural affiliation of the pre-Late Woodland occupations of the site cannot be determined due to a lack of diagnostic artifacts, Sandy Lake ceramics have been associated with the Psinomani culture (Gibbon et al. 1994). Although sites containing Sandy Lake ceramics are common in the middle Red River Valley (Michlovic and Schneider 1993), the apparent large size of the Hoff Deep archaeological site, as indicated by its surface expression, suggests that the site has the potential to reveal information regarding faunal extraction and processing during the Late Woodland period.

5.6 SYNTHESIS AND INTEGRATION

When considered alone, the geophysical data are generally uninformative relative to either geological or archaeological deposits at the Hoff Deep test locale. For example, the original interpretation of the Hoff Deep locale noted the relative lack of patterning in the magnetic data. A weak dipolar band extended north-south through the central area, and a scatter of 'spike' anomalies arising from historic debris was present in the east. The subsurface testing results indicate that there is a strong correlation between the location of the dipolar band and the boundary between LfSAs 2 and 3 that were defined during the coring survey (Figures 5.2.1-1 and 5.3.2-1). LfSA 2 and 3 are of archaeological interest as they contain paleosols capable of being occupied prehistorically (Figures 5.3.2-1, 5.4.1-2 and 5.4.1-3). Topographic effects that could have produced this anomaly (e.g. sloughs or agricultural ditches) are not present. Whether this anomaly actually indicates this border is difficult to assess without more detailed data on the magnetic properties of the soils described during the geoarchaeological coring and trenching work.

The resistivity data are somewhat easier to relate to the information collected during coring and trenching. In the 2 m (6.6 ft) to 4 m (13 ft) probe spacing datasets, higher resistance areas in the southwest are apparent. These correspond somewhat with LfSA 3, which is an area of thicker mid- to late-Holocene alluvium (Figures 5.3.2-1 and 5.4.1-2). The higher resistivity of these sediments may indicate that they have a finer pore space than the shallower Late Wisconsinan or early Holocene alluvium or lacustrine deposits in LfSA 2 found in the topographically higher areas east of LfSA 3. The resistivity data could not discriminate any of the other LfSAs defined through coring (Figure 3.2-1).

From the perspective of this study, coring and augering produced considerable evidence of buried land surfaces and associated human occupation. Even through most of the artifacts found in the augers were animal bone, ceramics and lithics were also found (Appendix E). These data clearly argue that additional investigation should be undertaken. Specifically, the coring survey reveals that stratigraphy and soil expression are quite variable over the relatively small area of the sampling grid and that the buried landscape is a complex physical and temporal mosaic of small alluvial landforms. As noted in Section 5.3.3, the assumption of a direct or even simple correlation of specific soils with specific archaeological materials is erroneous. Given these physical and statistical complexities, in concert with the dynamic patterns of human subsistence and settlement spanning 12,000 years, a much greater number of core/auger samples are needed before any portion of the buried landscape at Hoff Deep can be designated low potential. This same observation was also noted during the trenching work at the site and is at odds with the original LfSA representation that at least part of the site actually has a low suitability for preservation of buried archaeological material.

The trenching results mirror the results of the coring survey and provide additional details that allow reconstruction of the complex history of erosion and alluviation during the middle and late Holocene along this reach of the Red River Valley. These data indicate that the middle and late Holocene accretion of alluvium was first confined to the southern part of the Hoff Deep test locale near Trench 3, but by about 2500 BP sediment had also begun to accrete on the glaciolacustrine upland near Trenches 1 and 4, and by about 2000 BP also began to fill the topographically lower area surrounding Trench 2 (Figures 5.4.1-1 and 5.4.1-2). The presence of several variably developed paleosols within the stratigraphic sequences exposed throughout the area suggests that sediments accumulated episodically and as parts of separate, variably intensive flood intervals.

From the standpoint of identifying buried archaeological resources and directly pertinent to the goals of this project, we reiterate that at the Hoff Deep test locale, as is true of most sites where archaeological materials were identified, buried cultural material was identified in the first trench excavated. An increasingly complex sedimentary and cultural stratigraphy was also noted in each additional trench. Regardless of complexity, however, many details of the stratigraphic and taphonomic relationships between the archaeology, sedimentary deposits, and soil horizons were rendered clear in the trench profiles. One of the strengths of backhoe trenching, which none of the other methods share, is the ability to allow direct study of the relationships between natural and cultural deposits.

While detail is more apparent in trenches, they are necessarily fewer in number. Many more cores were placed in the test locale than backhoe trenches. As a result the core data were able to provide considerably more information about the spatial distribution of the paleosols and sedimentary sequence than was possible using trenches alone. Conversely, the core data were not able to resolve the finer-scale details concerning the stacked soil horizons that were observed within the trenches (for example, compare Figures 5.3.2-2 and 5.3.2-1 with Figures 5.4.1-2, 5.4.1-3 and 5.4.1-4). In addition, unlike the precise stratigraphic positions that artifacts could be placed at along trench profile walls, the augering intervals were necessarily large, making it impossible to say much about the archaeological context for artifacts that were found while augering.

Clearly, from a purely archaeological standpoint, additional work is required to sort out the relationships between the stratigraphy and the associated archaeological components. Specifically, the relationship of the ceramic found in Stratum VI of Trench 2 to the 1980 BP date and the reverse order of the 2020 BP date in Stratum VII and 2680 BP date in Stratum IV in Trench 1 indicate that ambiguities remain in the data. This has profound implications for evaluating the National Register eligibility of the site and its components, especially because so few artifacts other than the 389 mostly tiny fragments of bone were recovered. This and similar locations that include buried, low artifact-densities occupations with small and/or poorly preserved faunal remains present challenges for site eligibility (i.e., also see Chapter 8.0). Consideration of such sites with an understanding of just how dynamic the Hoff Deep depositional environment is, in fact, turns the National Register evaluation process on its head.

During even the early phases of both the coring and trenching survey, it was clear that the Hoff Deep site "may be likely to yield, information important in prehistory." But rather than immediately appeal to National Register Criterion D, perhaps the bigger question that must be addressed is whether Hoff Deep will yield information in sufficient quantity and quality to warrant determining it eligible for listing on the National Register. As implied in the discussion in Section 5.3.3, we do not know how the archaeological record at different locations within an individual site has been altered by flood episodes of differing magnitudes or, as noted by the trenching survey (Section 5.4), how much disturbance is related to vertisol processes or to bank slumping (Trench 3; Figure 5.4.1-1). Furthermore, at different times and in different situations, floods may involve erosion, transport, and/or deposition of not just sediments but also archaeological deposits and artifacts. Simply put, the evaluation of site integrity is not possible given our current understanding of the site and its geoarchaeological context. This will require development of a research strategy designed to refine our understanding of the site formation processes and determine whether the archaeological deposits are intact. Such an approach should be integrated into the Phase II evaluation process related to NRHP eligibility, but should also precede a more traditional type of Phase II assessment and aim to provide a three dimensional geoarchaeological context from which an archaeological testing strategy can be developed. The real management challenge of buried sites is not discovery, which is relatively straightforward, but rather defining the horizontal and vertical boundaries of the site components as well as assessing the density and distribution of artifacts and features so that probabilistic statements may be made about the quality and quantity of data.