AN ABSTRACT OF THE THESIS OF

Molly C. Kirkpatrick for the degree of Master of Arts in Interdisciplinary Studies in Applied Anthropology, Soil Science, and Geosciences presented on December 19, 2019.

Title: Assessing the Potential for a Late Pleistocene-Early Holocene Occupation at the Tahkenitch Landing Site (35DO130), Siuslaw National Forest, Oregon Dunes National Recreation Area

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The archaeological record of the First Americans is known almost exclusively from interior sites located away from coastal margins. While archaeologists hypothesize that early peoples initially migrated into the Americas along the Pacific coast, environmental changes associated with postglacial sea level rise may have destroyed or obscured such early sites. In coastal areas currently above sea level, early sites are difficult to find due to terrestrial processes of landscape erosion and deep burial. To expand our knowledge of where other early sites might be located, we must work to first find late Pleistocene-aged terrestrial deposits. Thus, the search for early sites begins as a geoarchaeological problem. By systematically exploring and describing the buried geological sequence of deposits in a landscape, we can narrow the search for late Pleistocene-aged sites. The Tahkenitch Landing site (35DO130), although currently lacking late Pleistocene-aged cultural components, is suspected to hold many of the stratigraphic quality we should be seeking in the landscape of the Oregon coast. Geoarchaeological investigations presented in this study resulted in the identification of well stratified late

Pleistocene-early Holocene aged deposits situated below one of the oldest archaeological sites along the Oregon coast. Geoprobe coring of buried site and nonsite deposits revealed a stratified record of alluvial and aeolian deposits with several buried paleosol horizons. Radiocarbon dating of these deposits and paleosols reveal a landscape history that span the period from ~42,000-3,000 RYBP. Importantly, this study revealed the presence of a paleosol developed on aeolian sand buried beneath known midden deposits that dates from 13,111-10,112 RYBP. This discovery of these late Pleistocene-aged deposits reveals important stratigraphic targets for future archaeological exploration at the Tahkenitch Landing site and in the larger Oregon coast region.

Assessing the Potential for a Late Pleistocene-Early Holocene Occupation at the Tahkenitch Landing Site (35DO130), Siuslaw National Forest, Oregon Dunes National Recreation Area

by
Molly C. Kirkpatrick

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I understand that my thesis will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my thesis to any reader upon request.

Molly C. Kirkpatrick, Author

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CHAPTER 1. INTRODUCTION

The archaeological record of the First Americans is known from a handful of sites almost exclusively in the interior, away from coastal margins. For example, we know modern humans were present in eastern Oregon at the Paisley Caves site by at least 14,500 years before present (Aikens et al. 2011; Jenkins et al. 2012) and western Idaho by ~16,000 years ago (Davis et al. 2019), but only a small number of other sites date to this time period (Adovasio et al. 1990; Dillehay 1997; Overstreet and Kolb 2003; Waters et al. 2011; Jenkins et al. 2012; Dillehay et al. 2012; Halligan et al. 2016; Dillehay et al. 2017; Waters et al. 2018). Our knowledge of the antiquity of human occupation along the Pacific coast of the Americas is far less clear. This is not because people did not live in these coastal environments, rather, it is the result of our poor understanding of where ancient landscapes remain in the modern coastal environment. Many early archaeological sites (> 8,000 years BP) are expected to have been destroyed or obscured as a result of a variety of geologic and environmental factors including sea-level rise, mass wasting, subsidence earthquakes and tsunamis (Erlandson 2008; Davis et al. 2009). Over the last 15,000 years sea level has changed position, moving eastward ~ 20-30 km along the central Oregon coast. Sea level rise affects the shore and near shore environment, influencing everything from vegetation distribution, soil formation, sediment deposition and erosional events.

The fragmented record of early archaeology along the Pacific coast can be addressed more thoroughly if one operates under a geoarchaeological framework that recognizes that preservation and distribution of archaeological sites are, in part, the result of cultural adaptations to a changing environment. The early archaeological record along the coast is more easily understood by considering post-glacial environmental change and geomorphic and geologic processes and how these factors have influenced the visibility and preservation of a late Pleistocene-early Holocene (LP-EH) landscape. Thus, the search for LP-aged sites essentially begins as a geoarchaeological problem of finding where archaeological sites are preserved and accessible in a particular landscape. Without a geoarchaeological perspective, the distribution of sites might seem to be random; however, on a fundamental level sites of particular ages will be located in very specific parts of a landscape that were formed during the time period of interest. By systematically exploring and describing the buried geological sequence of deposits in a landscape, we can narrow the search for LP-aged sites to particular target layers. Geoarchaeologists commonly refer to this strategy as seeking the "Dirt of the Right Age" (DORA). The DORA concept offers a strategic alternative to searching for LP-aged sites in challenging landscapes, such as the Oregon Coast. Such methodology is important in areas like the Siuslaw National Forest, located on the central Oregon coast where slopes are steep, and vegetation is thick. The forest floor is covered with thick duff and historic fire regimes and logging practices have caused instances of mass wasting, altering the soil accumulation across the landscape. Traditional archaeological methods can be time consuming and costly in this environment and conducting systematic pedestrian survey in the coast range is impractical. The DORA approach, when used in combination with traditional methods (background research, pedestrian survey, auger and shovel probing) and more progressive approaches (remote sensing on the ocean floor) can provide cultural resource managers with the tools of identifying high probability areas when conducting archaeological survey.

An opportunity exists to demonstrate this approach on the Siuslaw National Forest and is presented here by continuing subsurface exploration at the Tahkenitch Landing site (35DO130), a site known to contain stratified archaeological components. The Tahkenitch Landing site is a prehistoric site with successive occupation extending from the early Holocene (EH) to late Holocene (LH) south of Florence, Oregon (Figure 1). This thesis describes and presents the discovery of previously unknown LP-aged deposits at the Tahkenitch Landing Site that have the potential to contain buried archaeological components. In the following chapters, I highlight the importance of this research, describe research methods used, and present results of the geoarchaeological investigations at the Tahkenitch Landing site.

1.1 LP-EH Archaeology of the Oregon Coast

Historical accounts of the late 19th-early 20th century point to well-established populations of people occupying Oregon's coast. Although not having a written record of times before European contact, tribal communities have a long-standing oral history of living along the coast for thousands of years. The Archaeological record predating 6,000 years ago is limited to only a few sites along Oregon's Coast.

Archaeological sites associated with LP-MH landforms are typically found on bluffs or uplifted marine terraces where they are protected from wave erosion. These are atypical from what is usually found near the shore and are thought to be representative of interior terrestrial sites that would have been located a considerable distance from the LP shoreline. Excavations conducted at the Devils Kitchen site (35CS9) and at Indian Sands (35CU67C) revealed the presence of LP-EH aged archaeological remains that pre-date the modern coastline (>6,000 years BP) and have been identified as lithic-type sites rather than the shell middens sites typical of the Oregon coast location (Davis et al. 2004; Hall et al. 2005; Davis 2006; Punke and Davis 2006; Davis et al. 2008; Curteman 2016). Shell midden sites, typically located closer to the shoreline, are virtually absent from the archaeological record for the LP-EH periods as they have been submerged or eroded as eustatic sea levels rose approximately 130 m from ~23,000 years ago until reaching their modern position at 3,000 years BP (Fairbanks 1989; Fleming et al. 1998; Clark et al. 2014). Because the coastline has shifted considerably since the last glacial maximum (LGM), ~23,000 years BP, there are very few archaeological sites that display a long record of repeated occupation along the eastern Pacific. The Tahkenitch Landing site (35DO130) is a unique case. The site's lowest and oldest deposits, dated between 7,960 ± 90 and 6,880 ± 80 years BP (Minor et al. 1986), are similar in composition and age (>6,000 years BP) to those found at Indian Sands (Davis 2006) and the Devils Kitchen site (Curteman 2016), but the Tahkenitch Landing Site includes an overlying shell midden with the most intense occupation occurring between 5,200-3,000 years BP (Minor et al. 1986).

While more extensive work has been conducted at Indian Sands (Davis 2006) and Devils Kitchen (Curteman 2016, Bulder 2016) to identify the composition of the 20,000-10,000 year old deposits and where they occur, no further research has been conducted at the Tahkenitch Landing site (35DO130) beyond the initial excavation by Heritage Research Associates (HRA) in the 1980s (Minor et al. 1986). The importance of identifying LP-EH archaeological sites is becoming increasingly urgent in the face of global warming where sea levels are rapidly rising and storms along the coast appear to be gaining strength as time progresses. These sites are the rarest of known archaeological sites and are on average less than 0.5 km away from the modern shoreline, making them susceptible to erosion.

1.2 Geomorphic Setting of the Tahkenitch Landing Site (35DO130)

Located along the central Oregon coast between the towns of Florence and Reedsport, Oregon, Tahkenitch Landing now functions as a United States Forest Service day use area and boat ramp situated along the northwestern shore of Tahkenitch Lake. This portion of the Oregon coast is characterized by active sand dunes that range from one to three km wide and back the gently sloped beaches that dip west into the Pacific Ocean. These migrating dunes are responsible for creating a series of dune-dammed freshwater lakes situated on the western flanks of the steep and rugged coast range. While many of the earliest archaeological sites on the Oregon coast are situated on the stable uplifted marine-cut terraces and bluffs along that line the southern Oregon coast (Davis et al. 2008), the Tahkenitch Landing site is not. The site is located on an elevated landform, set above the shoreline of Tahkenitch Lake (Minor et al. 1986) in a former river valley carved into the bedrock hills of the Flournoy Formation, a thick sequence of bedded sandstone and siltstone dating to the middle Eocene (Beaulieu and Hughes 1975). The site's location, away from the shore (~ 2 km east of the Pacific), has maintained the integrity of buried archaeological remains.

1.2.1 Dune Placement and the Emergence of Tahkenitch Lake

The Peterson et al. (2007) study of major dune sheets along the western Pacific identified two periods of deposition within the Florence dune sheet: an initial period spanning the late Pleistocene (103,000 -11,000 BP) and another during the mid-late Holocene (8,000-1,000 BP). Tahkenitch landing is located at the intersection of the Florence dune sheet to the north and the Coos dune sheet to the south. Late Pleistocene dune sheets were formed during periods of glaciation when sea levels were at their lowest allowing for eolian processes to transport that accumulated sand on the continental shelf south of the Heceta-Perpetua-Stonewall banks (Peterson et al. 2007; Jenevein 2010). In contrast, mid-late Holocene dune sheets emerged during interglacial conditions when sea levels began to stabilize to their existing level. Ocean currents reworked and remobilized excess sand that was deposited by low energy flow from coastal streams as they adjusted to the rising baseline of the ocean. As marine transgression slowed, sand moved eastward drowning forests and infilling small coastal streams that drained west to the Pacific. The sand that infilled smaller stream channels acted as a dam, resulting in the creation of a series of natural lakes just south of Florence, Oregon. Those streams or rivers that were able to break through the sand sheet formed estuaries as sea level continued to rise to its modern level after ~6,000 years BP.

1.3 Previous Research at Tahkenitch Landing (35DO130)

The area that is now Tahkenitch Landing operated as a privately owned fishing resort from the 1930s through 1972. The resort consisted of about a dozen buildings and numerous roads and campsites scattered throughout the property to accommodate visitors to the lake. In 1973, the United States Forest Service purchased the property with plans to expand facilities at the boat launch as part of the Oregon Dunes National Recreation Area (ODNRA) on the Siuslaw National Forest (Minor et al. 1986). Prior to the development of new facilities, Forest Service staff conducted interviews with locals and previous landowners to see if there were any known cultural resources at the property or in the surrounding area. The owners reported the presence of what then was referred to as a “potlach mound” and found various cultural artifacts including tools made of bone, antler and stone. This triggered a cultural resource survey that resulted in identification of the site, requiring further testing in an effort to establish the site’s boundaries and significance.

The initial investigation consisted of two phases led by a team from Oregon State University in 1978 (Minor et al. 1986). The first phase included the excavation of fourteen auger holes and three test pits. While no artifacts were identified at this stage, the site was considered significant and necessitated further investigation of the site based on interviews with previous landowners (who encountered artifacts during their tenancy), and the depth and horizontal extent of the shell bearing deposits. In 1982, Heritage Research Associates were contracted by the Siuslaw National Forest to conduct a second phase of testing. The goal of the second phase was to define the site boundaries in both vertical and horizontal space. Heritage Research Associates began the investigation in 1982, placing total of 25 auger holes across the site where topography and surface conditions allowed. In 1984, 13 more auger holes were excavated (Minor et al. 1986). Archaeologically relevant deposits were discovered and defined in the terms of the presence or absence of "shell fragments, artifacts, fire-cracked rock, or charcoal flecks..." (Minor et al. 11:1986). Results of their auger testing refined the site boundaries to a 135-meter x 50-meter area with the densest cultural components confined to a 50-meter x 35-meter area as the result of historic construction. This area is referred to in this thesis as the "mound". Once the site boundaries were established, researchers focused their efforts in the areas where shell midden was identified.

The second phase included a series of 21, 1x1 meter units, excavated in the mound and six, 1x1 meter units were placed towards the northern extent of the site boundary (Figures 3 and 4). The results of the excavation at the Tahkenitch Landing site uncovered three cultural components defined by their flora and faunal assemblages (Minor et al. 1986). The results of the initial investigation illustrate an exceptionally rich and long record of human occupation on Oregon's Central Coast.

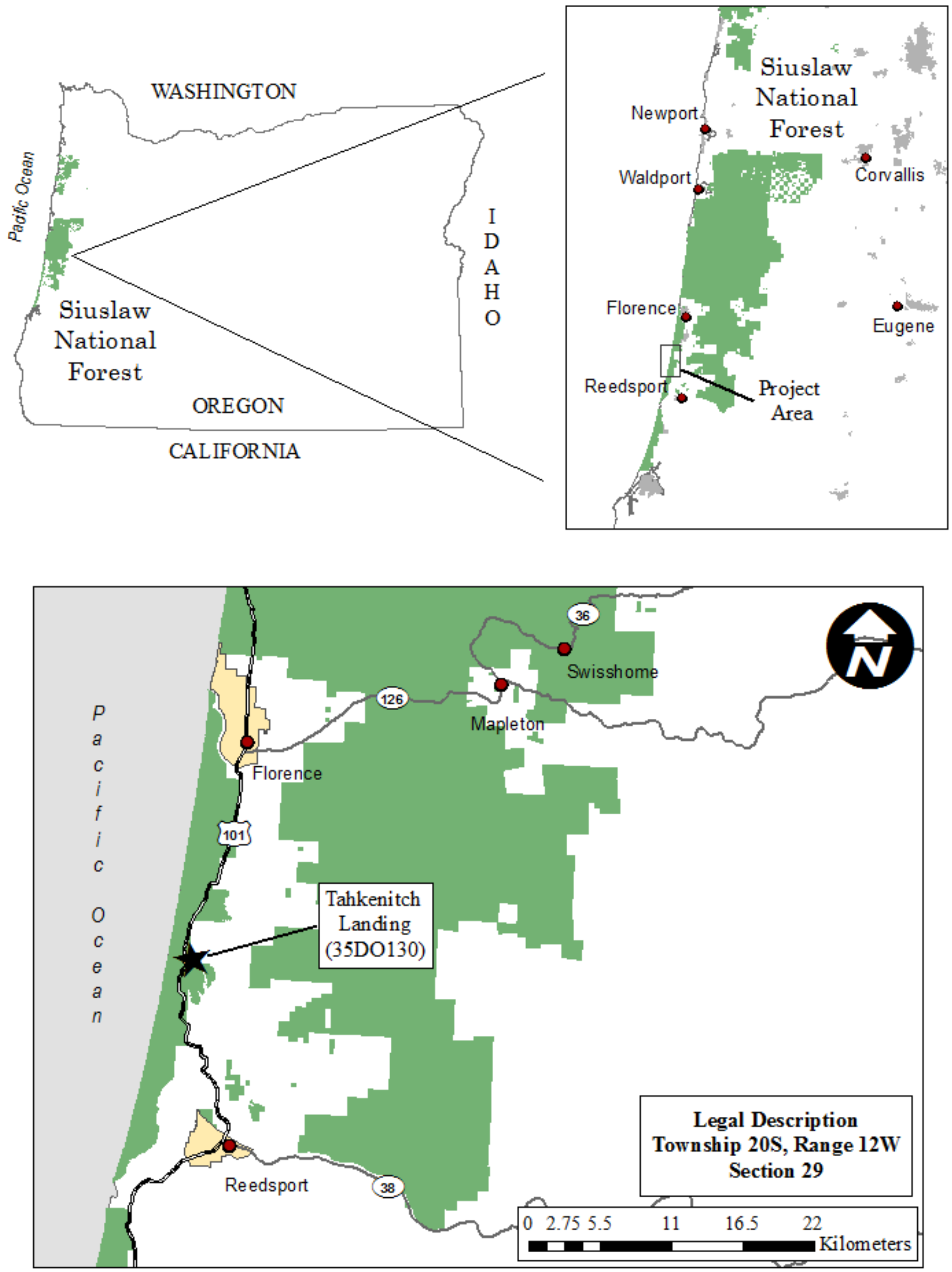

Figure 1. Location of Tahkenitch Landing (35DO130).

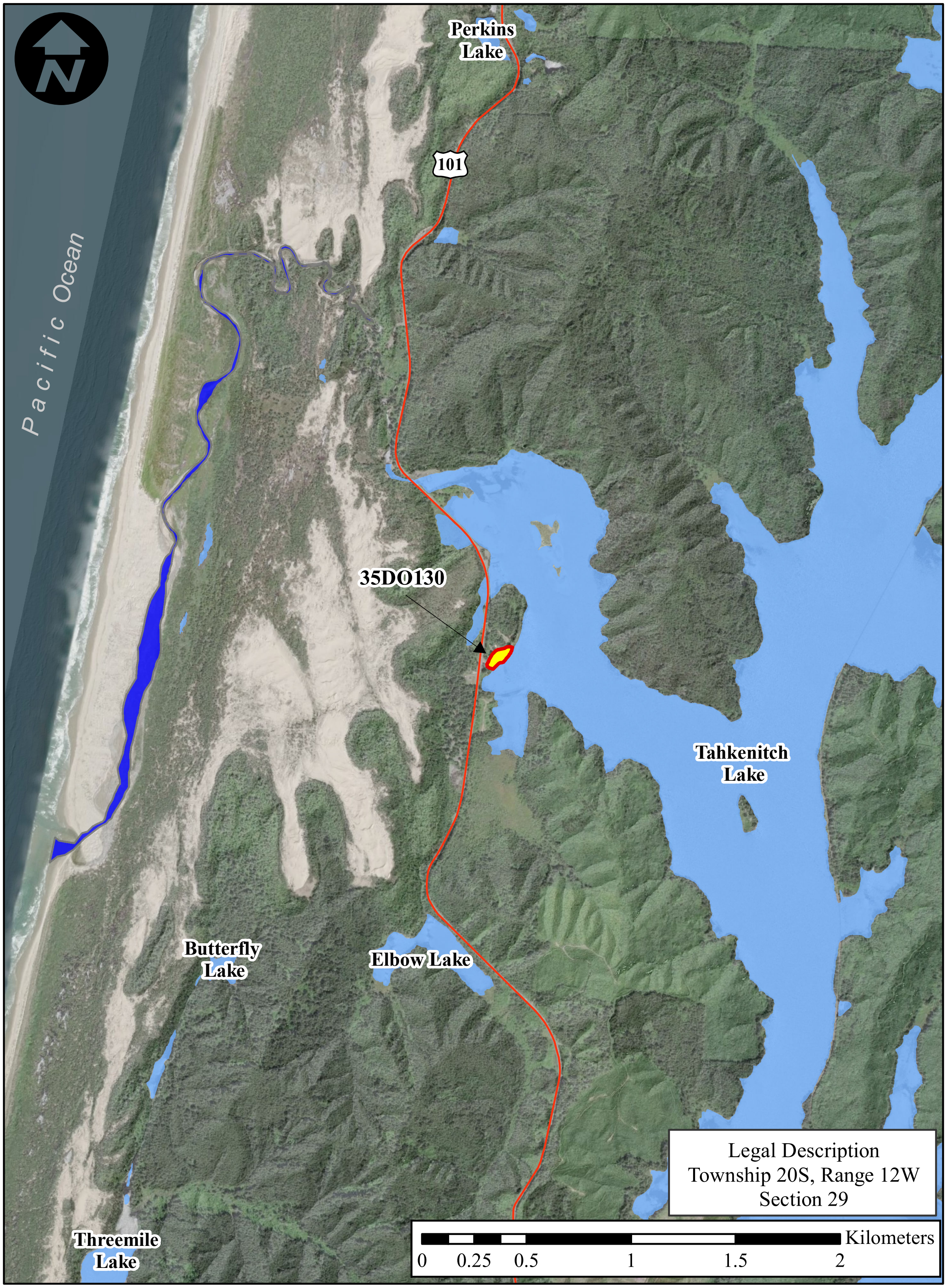

Figure 2. Geomorphic setting of the Tahkenitch Landing site (35DO130) relative to the coastal uplands surrounding Tahkenitch Lake, the dune covered coastal plain, and Pacific Ocean.

The first and earliest component designated by Minor et al. (1986) date between 8,000-5,200 years BP, based on charcoal samples collected from shell-bearing strata. While shellfish remains were present in this earliest period, it did not appear to be a substantial focus of subsistence for the site's occupants, rather, faunal remains suggest that people were reliant on deep-water fish, birds and mammals. Minor et al. (1986) concluded that the low number of artifacts and faunal remains before 5,200 years BP was the result of short term or seasonal use.

Component two dates between 5,200-3,000 years BP and represents the most intensive period of occupation at the site (Minor et al. 1986). Subsistence practices during this time appear to be focused on marine fish, whale, and a heavy reliance on marine shellfish such as bay mussel and a variety of clams. Component two also produced a high volume of artifacts and faunal and shellfish remains that were thought to represent a pattern of food refuse disposal associated with the development of a village situated near a shallow water estuarine environment where molluscs were readily available (Minor et al. 1986).

The third component is defined by a transition in resource use. At 3,000 years BP, the use of estuarine molluscs ends abruptly and the intensity of site occupation decreases. While the use of fish is still apparent, the overall concentration of faunal and mollusc remains is drastically lower in number compared to component two. Minor et al. (1986) attribute this change to an environmental change where shifting sands infilled the outlet and turned the estuary into a freshwater lake.

Preliminary investigations at Tahkenitch Landing discovered a rich material record not commonly seen along the coast. Perhaps the most intriguing aspect of the Tahkenitch Landing site is the demonstration of human response to environmental change and it is uncommon to find archaeological sites along the coast with such a detailed record of resource use. Beginning with the earliest component of the site (8,000 years BP) extending to the end of the second component (3,000 years BP), inhabitants had access to marine resources. At around 3,000 years BP dunes began to migrate north along the coast, infilling Tahkenitch Creek with sand, creating the freshwater lake Tahkenitch.

Minor et al. (1986) conducted a thorough investigation by involving a variety of specialists to help illustrate site formation and site use at Tahkenitch Landing. As with any good study, they have provided a solid base for future research. Minor et al. (1986) hinted to the presence of deeply buried deposits but were not explored because the rise in water table prevented further excavation (Minor et al. 1986:28). Questions of how the Tahkenitch Landing site fits into the larger paleocoastal landscape still remain unanswered. This study aims to address some of these questions by building on the work Heritage Research Associates conducted in the 1980s.

1.4 Research Goals

The paucity of LP-EH archaeological sites along the Oregon coast can be attributed to a variety of factors including environmental change, geologic activity, and cultural interaction with the landscape (Davis et al. 2009). The most obvious variable influencing the archaeological record along the coast is sea level rise. The eastward movement of the shoreline since the LGM has displaced LP-EH shorelines and associated features. Without these landforms and associated sites to use as reference we cannot draw meaningful or accurate conclusions as to how cultural systems functioned or adapted to a changing coastal environment without locating landforms that would have been available for use by early native peoples during the LP-EH transition.

According to Waters (1992:317), a complete geoarchaeological interpretation of an archaeological site includes a standardized analysis of strata based on their physical characteristics beyond the site boundaries, including those deposits that extend beyond the archaeological strata in both vertical and lateral space. The stratigraphy reported by Minor et al. (1986) suggests that there is a potential for deeper archaeological deposits at the site but were inaccessible at the time. The Tahkenitch Landing site provides us with a unique opportunity to evaluate the age and characteristics of deposits dating to the LP-EH at one of the longest continually occupied sites along the central Oregon coast. The goal of this thesis is to address the following questions: are there deeper, LP-EH aged stratified deposits at the Tahkenitch Landing Site? If so, what do they look like? Is there a potential for a LP-EH aged occupation at this site?

The information gathered during this research will contribute to the larger body of knowledge as it relates to the identification and distribution of LP-EH deposits, which will help narrow the search for early occupations along the Oregon coast. In the following chapters, I present methodologies that allow for the acquisition and analysis of deeply buried deposits that can be used elsewhere along the coast or beyond. The methods used during this research, if applied elsewhere, can aid in the ability to reach deeply buried deposits that would otherwise be inaccessible.

Figure 3. Georeferenced auger probes from Minor et al. (1986) at the Tahkenitch Landing site (35DO130), Douglas County, Oregon.

Figure 4. Georeferenced excavation units from Minor et al. (1986) at the Tahkenitch Landing site (35DO130), Douglas County, OR. Township 20 South, Range 12 West, Section 29.

CHAPTER 2. MODELS AND EXPECTATIONS

2.1 Paleoenvironmental Setting

While there are a handful of archaeological sites dating to the LP in the interior of the Americas (Adovasio et al. 1990; Dillehay 1997; Overstreet and Kolb 2003; Waters et al. 2011; Jenkins et al. 2012; Dillehay et al. 2012; Halligan et al. 2016; Dillehay et al. 2017; Waters et al. 2018; Davis et al. 2019), limited information remains about how these earliest people initially utilized and adapted to the coastal landscape. This lack of information is attributed to sea level rise over the last 20,000 years, which has obscured or submerged landforms that could hold buried LP-aged archaeological sites. While archaeologists generally assume that the first coastal peoples employed a foraging lifeway, direct evidence for the economic lifeways of Oregon's earliest coastal peoples is lacking. Understanding the lifeways of early coastal peoples must be understood in their past environmental context, which is provided by climate and vegetation models developed from pollen cores taken from lakes along the central Oregon coast and the interior coast range.

Worona and Whitlock (1995) identified five major climate periods over the last 42,000 years BP based on pollen cores taken from Little Lake, centrally located in the Oregon coast range. The first period is called the Nonglacial Interval (42,000 to 24,770 years BP). On Oregon's central coast, forest species include western white pine, western and mountain hemlock, a variety of fir species, and may have also supported red alder, Sitka alder, and Alaska cedar. These species suggest a cooler and wetter time relative to today (Worona and Whitlock 1995).

The second period, termed the Full Glacial Period (24,770-16,000 years BP), consisted of a parkland forest of Engelmann spruce, lodgepole pine and mountain hemlock. These species favor a cooler and drier environment. Worona and Whitlock (1995) cite ~50% less precipitation than the present.

The third period, identified as the Late-Glacial period at Little Lake is marked by an emergence of spruce, pine, mountain hemlock and fir suggesting an increase in temperature and effective moisture by 16,000 years BP (Worona and Whitlock 1995). At around 13,500 years BP a warming trend caused an increase in Douglas-fir, other fir species, western hemlock, and red and Sitka alder and a decline in spruce, mountain hemlock, and pine. By 12,000 years BP Douglas-fir and red alder dominates the central coast range.

The fourth period occurs during the EH (10,000-9,000 years BP), when North America experiences an increase in solar radiation (Worona and Whitlock 1995). In the Pacific Northwest, this translates to an intensification of seasonal climates, with temperature increase in the summer months and a decrease in effective moisture (Worona and Whitlock 1995). Species such as Douglas-fir, bracken fern and oak are present at this time support this, as they are xerophytic species well adapted to tolerate periods of limited moisture.

Marked by a transition to a temperate climate, the fifth period occurs during the late Holocene (6,000- 3,000 years BP) and includes a general trend towards cooler temperatures and moister conditions. Yew and Oregon ash pollen exist during this period, and likely existed in areas of considerable soil moisture. Douglas-fir, western red cedar and western hemlock dominate the record at Little Lake (Worona and Whitlock 1995).

The transition from the Pleistocene to the Holocene is marked by a general warming trend, with greater seasonal intensity. Oregon's present-day temperate forest does not emerge until around 6,000 years BP (Grigg and Whitlock 1998; Worona and Whitlock 1995). The transition from the LP-EH caused continental ice sheets to melt into the oceans, resulting in a slow but steady rise in global sea level worldwide. These changes influenced the distribution of forest species and the form of the landscape along Oregon's central coast.

2.2 Characteristics of Oregon's Central Coast

The coastal environment is broadly defined as the interface between the land and the ocean. While the appearance of coastlines varies worldwide, all of them are made up of a subset of environmental zones that are created and modified by the interaction of terrestrial and marine processes. Each zone has a distinct appearance and function and can co-occur along the coastline. However, these areas are not fixed on the coastal landscape and will shift laterally in response to the position of sea level (Figure 5). Each of these zones leave a distinct sedimentary signature and interpretations of environmental shifts can be made via the stratigraphic record. Understanding the development, appearance and function of these zones is extremely useful for archaeologists as we seek to understand human-environment interactions. Because each zone offers different resources, we can draw conclusions about resource use, resource availability and site formation processes in a given environment. Environmental zones relevant to the study area include littoral, estuarine, alluvial valley, and maritime. Each are described in the paragraphs below.

Maritime

The maritime environmental zone is that of the open ocean, where sediments settle out on the sea floor away from high-energy processes. Well sorted, finely textured deposits are characteristic of these environments. The open ocean would have been only been accessible by boat and would have only been utilized for travel or to gather resources. Because of this, archaeological sites are not typically found within the maritime zone. Resources available to foragers in the maritime environment include sea mammals, deep water fish, and kelp.

Littoral

Littoral zones are those situated between low and high tide along the shore adjacent to both protected and unprotected coastlines (Wells 2001). The sediments found in these areas vary greatly as they can be influenced by alluvial, aeolian, and marine processes. Outer-coast landforms associated with littoral zones can be exposed to high energy systems, making preservation of primary context archaeological sites unlikely. These areas would have been heavily used by coastal people as these environmental zones provide habitat for both marine and terrestrial species.

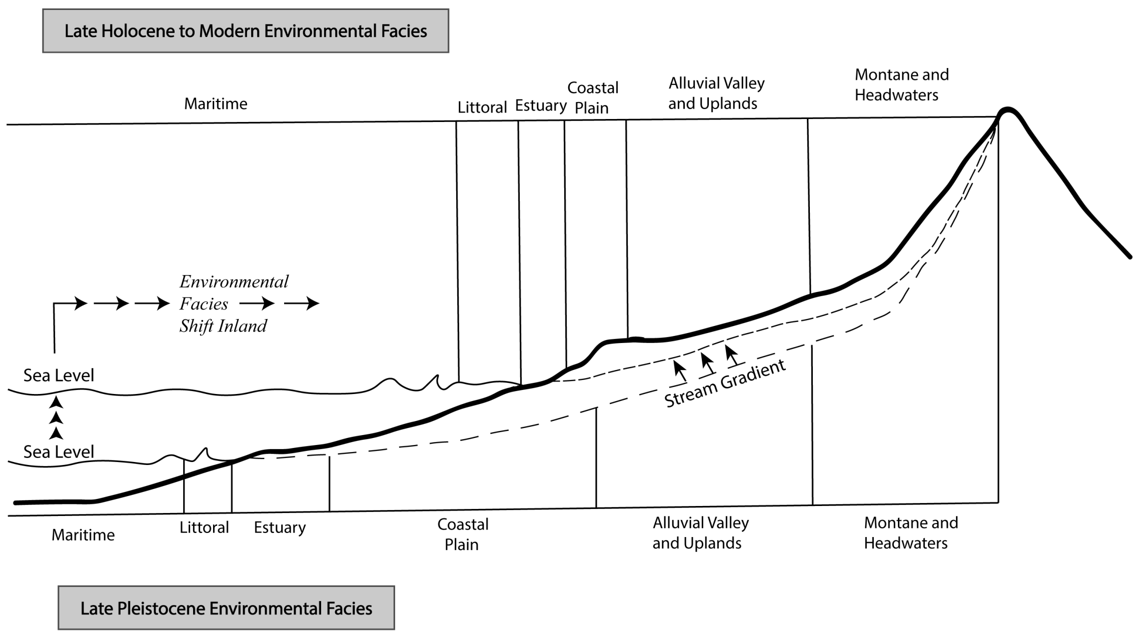

Figure 5. An illustration, from east to west identifying coastal environments in relation to sea-level transgression and regression during the late Pleistocene and early Holocene. Adapted from Davis et al. (2009) and Jenevein (2011).

Estuaries

Estuaries represent the transition zone where freshwater streams meet the sea. These areas are known for their brackish water conditions and productive ecosystemic qualities that provide a sanctuary for a variety of plants, fish, birds, and other animals. Alluvial sediments dominate the sedimentary makeup of the estuarine environment, while tidal fluctuations are responsible for the reworking and development of tidal flats and marshes that are characteristic of estuarine systems.

The estuarine zone is home to a variety of life important to coastally adapted peoples. Tidal flats provide cover for a variety of shellfish and brackish water plants and is it is not uncommon to find expansive meadows lining the shorelines of estuaries that attract terrestrial mammals such as elk and deer. These environments are also the first zones anadromous fish pass through on their way upstream to spawn. Archaeological sites located in estuarine zones often exhibit a reliance on fish, shellfish, and mammals. Shellfish are often exploited in abundance in these areas because they are easily accessible, which is why it is common to find shell middens associated with estuarine environments, like that observed at the Tahkenitch Landing site.

Alluvial Valleys and Uplands

Alluvial processes are responsible for the formation of the steep slopes and deep valleys of the Oregon coast range as the result of erosion. The rise and fall of sea level influence the gradient of river valleys and dispersal of alluvial sediments as stream systems adjust to meet base levels. While sea level rose during the LP-EH transition, streams aggraded to meet base level rise resulting in the progressive infilling of river valleys. These areas would have been undoubtably been used by early people for transportation, navigation and/or as source for food (e.g. anadromous or freshwater fish). However, the changes in deposition rates, and stream migration through time may have either buried old living surfaces, reworked or destroyed archaeologically relevant deposits (Punke and Davis 2006). While it is common elsewhere to find archaeological sites associated with alluvial systems, the archaeological record for these areas in the interior coast range remains relatively scarce.

2.3 Influences on LP-EH Site Distribution and Visibility on the Central Oregon Coast

Based on Oregon Archaeological Records, the known distribution of archaeological sites in Oregon (Oregon State Historic Preservation Office GIS) increases away from the coast and into the eastern portion of the state. While this distribution could be interpreted a number of different ways, this section focuses on four variables (landscape change and site visibility, site preservation, cultural behaviors, and archaeological research efforts) that most likely influence the distribution of LP-EH sites along Oregon's central coast.

Landscape Change and Site Visibility

The coastal environment is a dynamic place where marine and terrestrial geomorphic processes interact to shape the landscape. Eustatic sea level rise since the LGM has drowned ancient river channels and submerged coastal plains that would have likely been used by people (Figure 6). Subsequently, little is known about the archaeological record below modern sea level. Terrestrial landscapes, and their associated archaeological sites that were not submerged as a result of eustatic sea level rise were still affected. For example, LP-EH landforms in stream basins may have been deeply buried in response to sea level rise or as the result of increased sediment loads due to slope instability in the coast range (Personius et al. 1993). This rapid deposition of sediment in coastal river valleys during the LP-EH may limit the visibility of sites in these areas and put them largely out of reach from traditional testing procedures. In contrast, headlands often receive significantly less sedimentation than alluvial basins and are susceptible to wind erosion and are less likely to contain intact buried sites.

Site Preservation

When taking into consideration the amount of preservation that has occurred at a given site, we should consider two important variables, the types of materials people used and the depositional environment. It is generally understood that tribal communities on the coast have and continue to rely heavily on flora and faunal material to make material goods such as baskets, fishing hooks, harpoons, spears, and other tools. These perishable materials do not preserve well in most coastal settings since soils along the Oregon coast are generally categorized as acidic. However, there are instances where perishable materials have been recovered from archaeological sites. Conditions favoring preservation of perishable materials are overwhelmingly found in association with shell middens. The shell deposited as a result of human activity releases calcium carbonates into the surrounding deposits increasing the alkalinity subsequently slowing the decomposition process. While perishable materials may still decompose, the increased pH will slow this process relative to non-shell bearing strata.

Regional tectonics and marine transgression are the most obvious influential factors on the visibility of archaeological sites, but the types of materials used and their susceptibility to post-depositional processes heavily influence the level of preservation and subsequent visibility at a given location.

Cultural Behavior

As noted above, there are several factors that influence the distribution, preservation, and visibility of archaeological sites along the Oregon coast, but perhaps the most important one relates to conscious decisions made by those who have lived in the past. While geologic and climactic factors influence resource availability and distribution, conscious decisions such as choosing where to obtain food or where to camp are made by individuals. We can develop expectations based on basic needs for water, food, and ease of mobility, but these concepts become more difficult when searching for LP-EH sites in a dynamic environment such as the coast. While we have the benefit of knowing basic human needs, we do not have enough examples of LP-EH archaeological sites along the central Oregon coast to know exactly how people interacted with their environment. That said, we can develop expectations of what types of resources people would have used given a specific environment if we work under the assumption that people would have been drawn to highest return locations like estuaries.

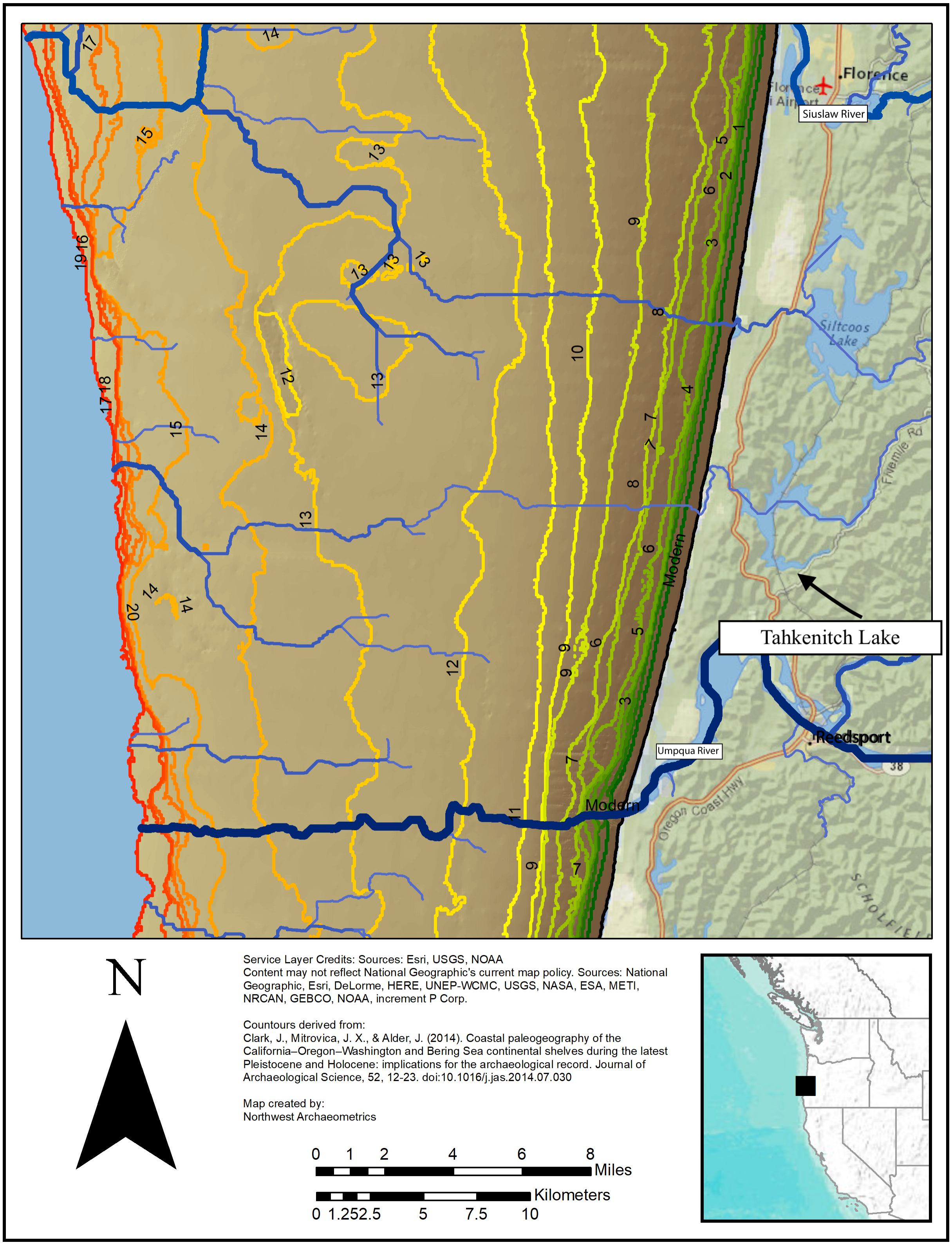

Figure 6. Illustration showing shoreline progression over the last 20,000 years on the central Oregon Coast. Map created by Northwest Archaeometrics.

Archaeological Research Efforts

After the west was opened up to homesteading (Homestead Act of 1862), much of the desirable land was placed into private hands. As a result, many of the archaeological sites along the coast have either gone unreported, have been looted, or destroyed as the result of infrastructure development (Byram 2009). Relative to the rest of the state, public land holdings along Oregon's coast are small, and access to areas considered to be high probability areas for archaeological sites remains in private holdings. Many of the archaeological projects carried out on the coast consist of identification (and subsequent avoidance) in response to various State or Federal projects. Funding for archeological survey and testing for these projects is limited, resulting in limited data recovery. Because of the limited amount of research that has been conducted along the coast, in combination with those other variables listed above, there remains a paucity of LP-EH archaeological sites.

In summary, site distribution, preservation and visibility are controlled by landscape change through time, human behavior, and archaeologically research efforts. While we know very little about the LP-EH peoples of Oregon's coast, we can seek to find other early sites by exploring locations that might have been environmentally attractive to foraging peoples and focus our efforts on landforms that have been stable since the LGM. While previous excavation below the midden was limited due to the high water table (Minor et al. 1986: 28), deeply stratified archaeological deposits were identified as one of the oldest archaeological sites on the coast. The Tahkenitch Landing site, although currently lacking LP-EH cultural components, bears many of the qualities we should seek when trying to identify a LP-EH occupation on the Oregon coast.

CHAPTER 3. METHODS

In order to explore the Tahkenitch Landing site for LP-EH deposits, we needed a way to access the archaeological deposits identified by Minor et al. (1986), and those buried below. This was accomplished by incorporating a minimally invasive approach using direct-push coring and radiocarbon dating in an effort to refine our understanding of the stratigraphic context of the Tahkenitch Landing site and surrounding area. Maintaining a good working relationship with tribal communities was integral in the early stages of this research. The Confederated Tribes of the Coos, Lower Umpqua, and Siuslaw Indians and the Confederated Tribes of the Siletz Indians were consulted throughout the process and helped develop the methods used in this research. The results of these methods provide a framework that can be used to focus future research on LP-EH deposits at the Tahkenitch Landing site and surrounding area.

3.1 Core Extraction

Because we were proposing to take cores from within the boundary of a known archaeological site and within the bounds of ancestral tribal lands, we consulted with Confederated Tribes of the Coos, Lower Umpqua, and Siuslaw Indians and the Confederated Tribes of the Siletz Indians. Together, we designed the project in a way that would minimize the impact to the site while achieving our research objectives. Tribal consultation resulted in the development three work zones identified in Figure 7. Each zone represents the maximum number of Geoprobe cores to be taken from around the campground, three within the mound, seven beyond the mound but within the site boundaries, and twenty beyond the site boundaries. All of the cores collected for this thesis were taken in March of 2015 in compliance with the Archaeological Resources Protection Act (ARPA), with a tribal representative on site. The cores were obtained using a Geoprobe 7822DT direct-push coring rig. Each core includes multiple 1.49 m long segments that are ~3 cm in diameter taken in vertical succession. Each Geoprobe core location is given a three-part unique identification number, separated by dashes (e.g. TAHK15-3B-1D or TAHK15-20C-2D). Where "TAHK15" represents the site short name (TAHK) and the year the cores were obtained (15). Next is an alphanumeric identification representing the zone (3, 7, or 20), and core (A, B, C) where the letter represents the order in which the cores were taken (e.g. A=1, B=2, C=3) in the specific zone (e.g. 3A is the first core taken in zone 3 and 3B is the second core taken in zone 3). Lastly, a number represents the segment from each Geoprobe core, followed by the letter "D" which represents the tooling used to extract the cores, in this case "D" stands for a dual tubing method. Our example "TAHK15-3B-1D" longhand reads the second core in zone 3 (3B), and the first segment of 3B (1D) and "TAHK15-20C-2D" would read the third core in zone 20 (20C) and the second segment of 20C (2D). Later in this thesis, cores are referred to by their zone and sequence (e.g. 7A or 3B). A total of 23 Geoprobe cores were excavated across the site, three from within the mound area, seven from beyond the mound but within the site boundaries, and thirteen from beyond the site (as defined by Minor et al. 1986). For those cores taken within the site, we tried to get as close to the location of the main excavation trench and other excavation units (Figure 8) so that we could obtain intact stratigraphic samples similar to what was seen during the 1984-1985 test excavation. All samples were taken to Corvallis and stored at the Oregon State University (OSU) Marine and Geology Repository where they were opened and processed. At the tribe's request, all cores were left intact and resealed to preserve their integrity for future research and are stored at the OSU Marine and Geology Repository.

3.2 Sediment and Soil Descriptions

Descriptions of the sediments and soil collected in the cores took place after all the samples were run through the ITRAX core scanner to obtain high-resolution photos and x-ray fluorescence (XRF) data. While the photos were used as a part of this thesis, those XRF data will be presented in a forthcoming report of investigations and not discussed here. While operating under the framework for lithostratigraphy presented in the North American Stratigraphic Code (NACSN 1983), sediments were described based on the following: color (Munsell Soil Color Charts, 2009); size (Udden-Wentworth scale); sphericity; textural group (Mazzullo and Graham 1988) and estimated percentage of each (gravels, sand, silt, clay); fragments of charcoal; and lower boundary characteristic (sharp, gradational, diffuse). Lithology keywords were developed based on dominate textural groups (estimated using the Comparison Chart for Visual Percentage Estimation by Terry and Chilingar 1955) and by cultural strata (e.g., midden) if observed. All boundaries were based on changes in the lithology. While the identification of soil formation was difficult to see in these cores, any visible structure was documented. The upper and lower boundary elevations reflect depth below surface in centimeters, where surface elevations were obtained from Light Detection and Ranging (LiDAR) Digital Elevation Models (DEM).

3.3 Radiocarbon Sampling

Macrobotanical and charcoal samples were taken upon opening the cores. For each sample, depth below surface and sample type was noted. Samples were placed in an aluminum foil and placed in appropriately labeled bag. Two sets of samples were sent out. The first set allowed us to focus in on which deposits were likely our DORA, which led to our second set of samples, strategically chosen to narrow in on LP-EH deposits. All charcoal samples were then sent to the DirectAMS radiocarbon laboratory where percent modern carbon (pMC) was measured using accelerator mass spectrometry (AMS) and was reported as uncalibrated radiocarbon age before present (BP) plus or minus one-sigma error. DirectAMS noted that all results have been corrected for isotopic fractionation with an unreported $\delta^{13}C$ value measured on the prepared carbon by the accelerator and the pMC reported requires no further correction for fractionation.

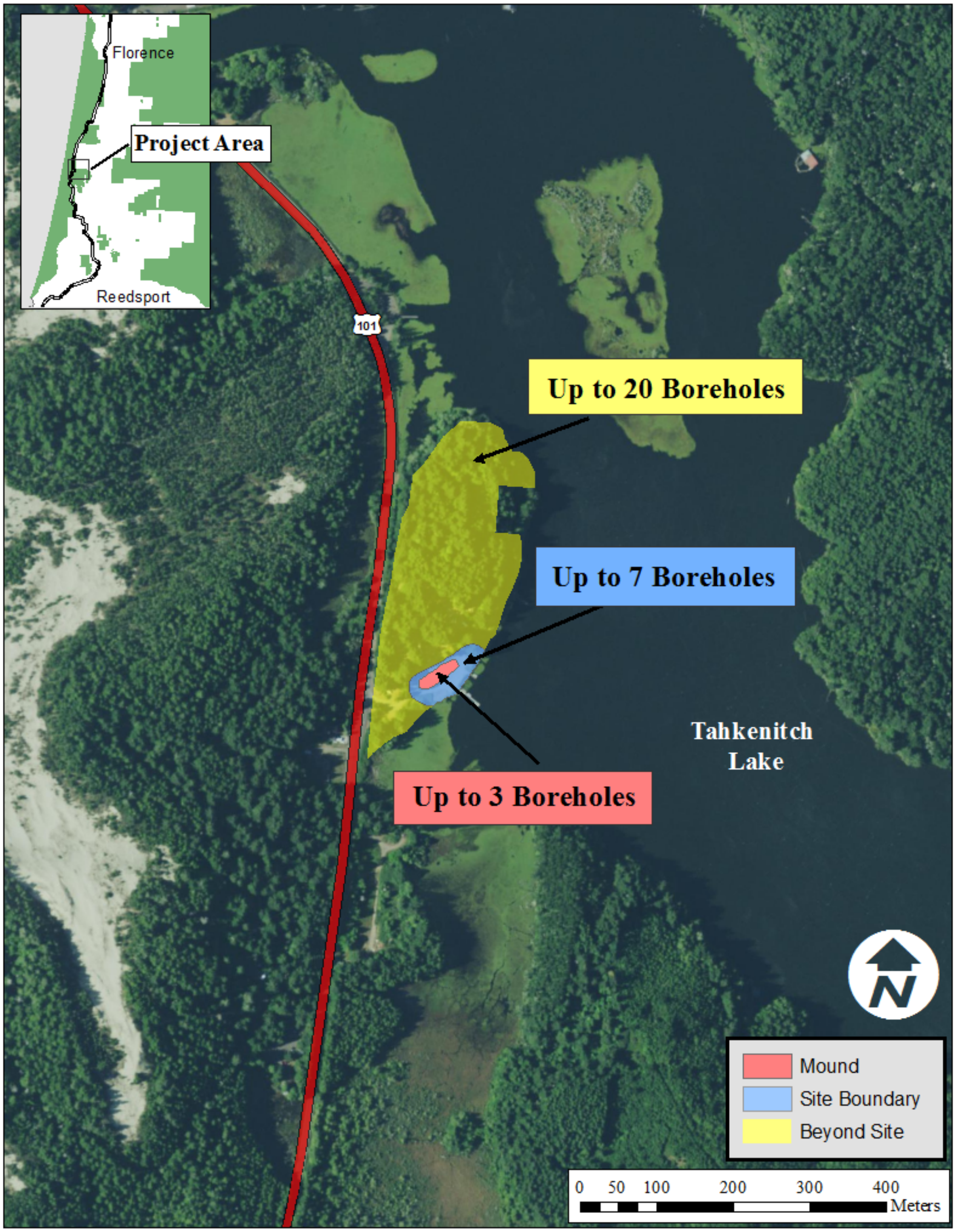

Figure 7. Location of designated areas, or zones, to extract cores in Township 20 south, Range 12 west, section 29.

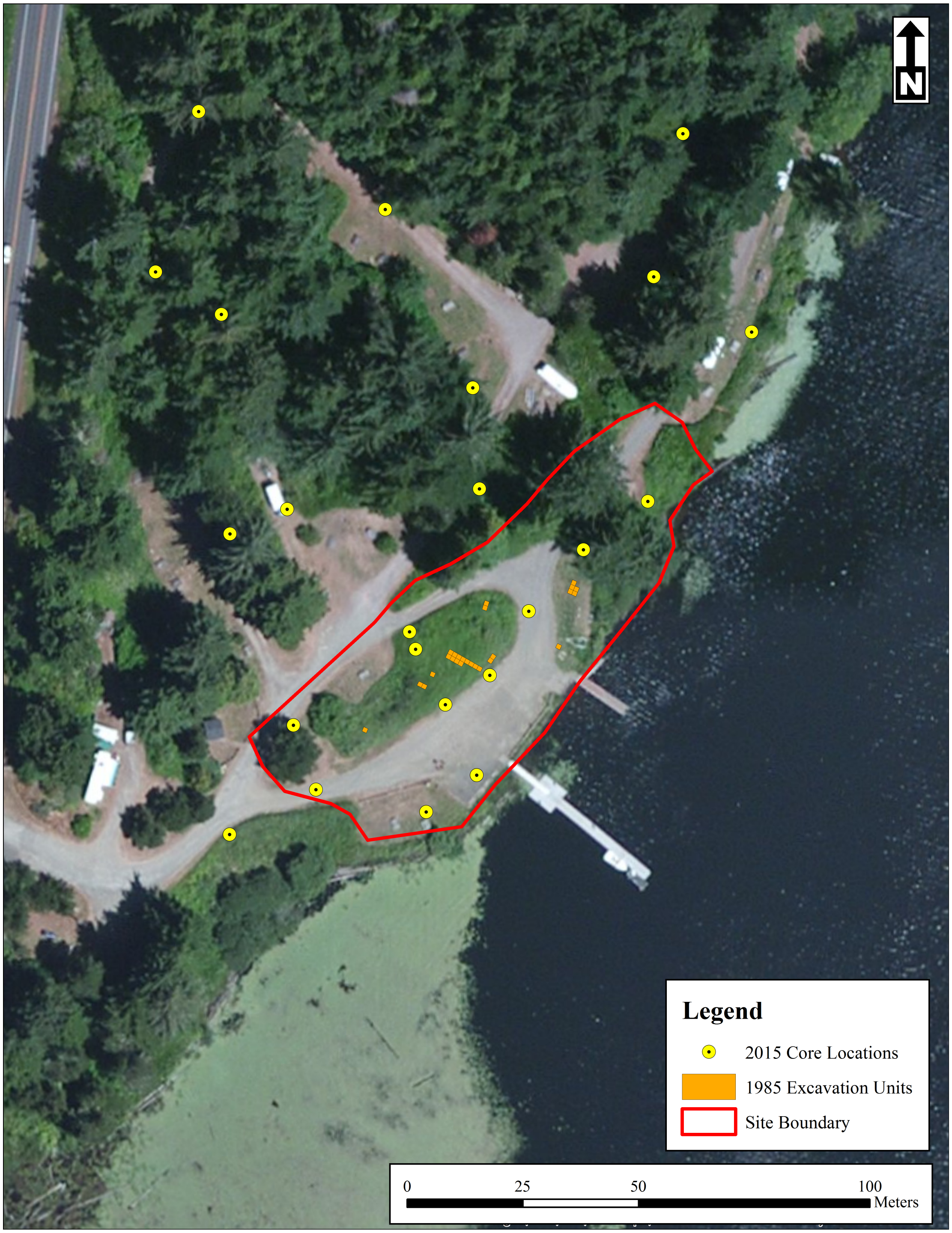

Figure 8. Location of 2015 cores in comparison to the 1984 excavation.

CHAPTER 4. RESULTS

This chapter reports the results of stratigraphic analysis from a selected set of Geoprobe core samples taken from the Tahkenitch Landing site and the surrounding area. These cores were selected based on their location relative to the site boundaries so that the focus of this thesis would remain on identifying LP-EH aged deposits, and their position relative to known archaeological deposits. Analysis includes descriptions of the lithostratigraphic units, their inclusive radiocarbon dates, and how they relate to each other. The lithostratigraphy and associated dates have been correlated to the stratigraphic analysis conducted by Patricia McDowell in the report by Minor et al. (1986). Interpretation of the results of the Geoprobe coring study are organized in reference to stratigraphic fence diagrams that crosscut the site along a SE-NW and SW-NE perspective (Figure 9).

4.1 Site Stratigraphy

The lithostratigraphic units were identified on the basis of their inclusive lithological characteristics and were subsequently correlated to those described by Minor et al. (1986; Table 1). While many of the deposits closest to the surface have been disturbed as the result of historic use at the site (e.g., development of the fishing resort in the 1930s) the stratigraphic units similar to those observed in the 1984-1985 test excavation appear to be relatively intact.

From all of the cores recovered, five (3A, 3B, 7E, 7F and 7G) contained stratigraphic units that were described by Minor et al. (1986). Summaries of these cores and their relation to the deposits described by Minor et al. (1986) are described in the paragraphs below.

4.1.1 Geoprobe Cores

CORE 3A

This core is located on the northeastern edge of the mound, aligned with the lower flanks of the 1984 trench excavation. The stratigraphy in this core (Figure 10) resembles that profiled from unit R (Figure 18) on the northeastern, lowest extent of the trench excavation. Of all of the cores recovered, this core contains the densest lens of shell midden, identified by McDowell and Minor (Minor et al. 1986:33, 36) as Stratum 2B. Stratum 2B is located on the eastern flanks of the mound area and lies above stratum 4A and/or 4B (Minor et al. 1986). Stratum 4B is the lowest shell stratum and is found in a poorly sorted loamy sand matrix with few fine charcoal fragments (Minor et al. 1986:33, 38). The lowest cultural stratum, 4A, consists of organic rich loamy sand with few (or no) fine shell or bone fragments (Minor et al. 1986:33, 38). Unit R, the excavation unit on the easternmost extent of the main excavation trench next to the gravel parking lot, displays the following sequence of strata from bottom to top: 4A-4B-2B (Figure 18). This sequence of strata appears to be present in Core 3A. The lithostratigraphic units (LU) identified in this study correspond with the strata described by Minor et al. (1986) as follows: LU2 to 4A,

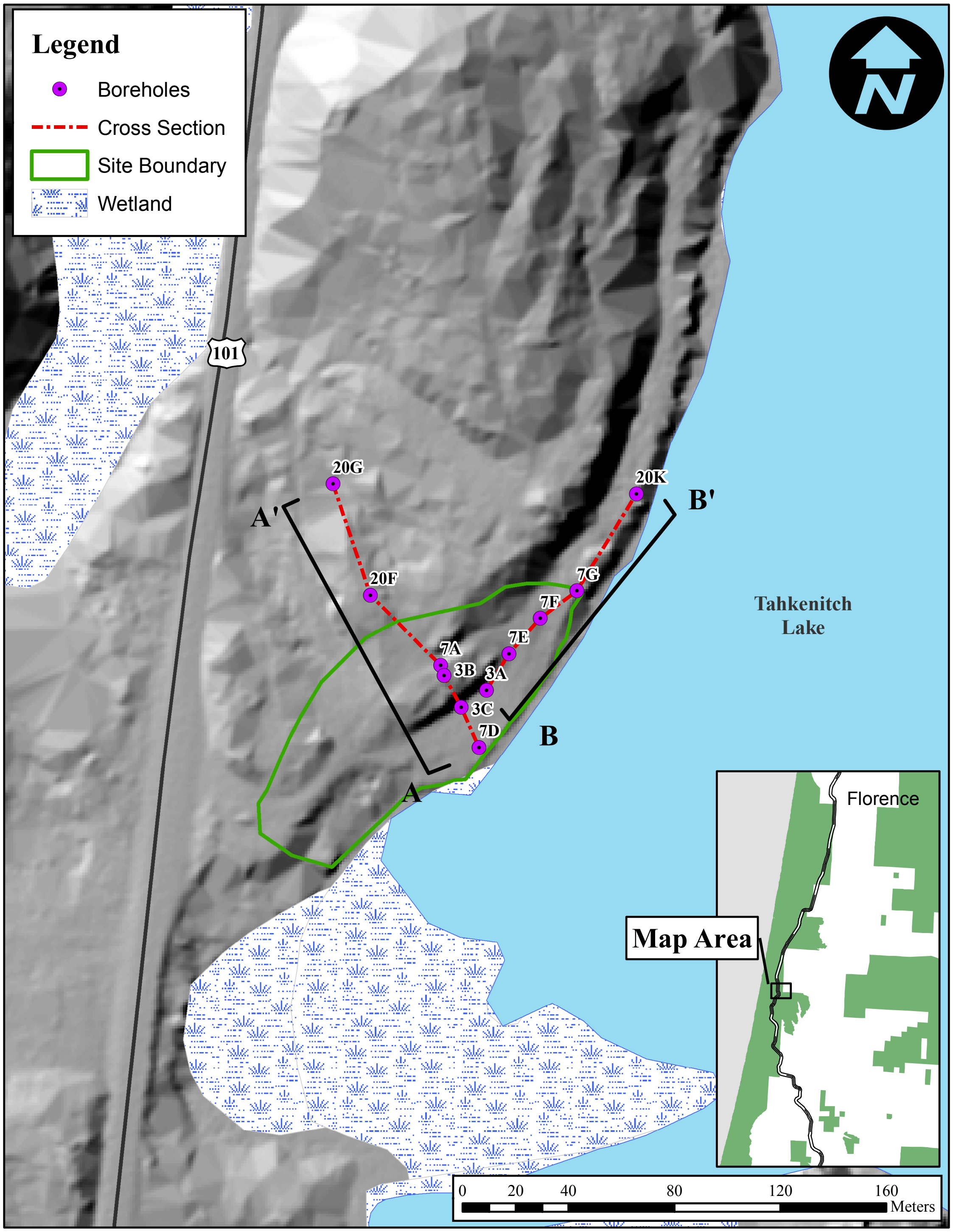

Figure 9. Aerial view of cross sections A-A’ (SE-NW) and B-B’ (SW-NE).

Table 1. Adaptation of Table 5-2 from Minor et al. (1986) and summary of interpretation taken from Minor et al. (36-39:1986).

Stratum	Field Description	Cultural Significance	Summary of Stratum Composition
2A	Black sand without shell	Top layer of cultural deposits	Black organic-rich, moderately sorted, fine to medium subangular to rounded sands. Buried soil A-horizon. Overlies and sometimes interfingers Stratum 2B. Dates <4,340 ± 80 BP.
2B	Black sand with shell	Upper shell deposit	Midden. Very dark brown organic-rich, poorly sorted, fine to medium, subangular to rounded sands. Common shell fragments. Soil A-horizon. Deposit is concentrated in the eastern portion (downslope) in the mound area. Underlies 2A and overlies 4A and 4B. Dates between 3,120 ± 80 BP to 3,160 ± 60 BP.
3	Shell deposit in tan matrix	Separate shell stratum	Brown moderately well sorted, fine to medium, angular to rounded sand. Common shell fragments. Thick lens of layers of burned and unburned shell. Truncated by stratum 2A on the western edge of the mound area (uphill). Possibly a cooking pit. No dates available, however it overlies 2B, and is interpreted as being younger than 3,100-3,200 BP.
4B	Shell deposit in dark brown matrix	Lowest shell deposit	Black poorly sorted, fine to medium, subrounded to rounded loamy sand. Deposit overlies Stratum 4A. Dates to 5,100 ± 70 BP.
4A	Brown sand with very little or no shell	Lowest cultural stratum	Very dark brown organic-rich, poorly sorted, medium subrounded to rounded loamy sand. Contains anywhere between 15-34% silt and clay. The deposit is thin in the western portion of the mound area (uphill) and thickens moving east. This stratum is overlain by 1, 2A, 2B, 3 and 4B. Dates between 6,880 ± 80 BP and 7,960 ± 90 BP.
5	Yellow sand	Sterile sediments	Reddish brown, moderately well-sorted, very fine subangular to rounded sands. Eolian deposit that was seen in the basal deposits of the excavation units in the western portions of the

		underlying the cultural deposits	main excavation trench. This unit it overlain by stratum 4A. It was estimated that this deposit does not extend eastward under the parking lot, and it only present under the bench on which the site is located. Soil C horizon.
6	Loam	Sterile loam underlying the cultural deposits	A loamy deposit primarily seen in the eastern portion of the mound excavation. It is overlain by stratum 5. General extent of this deposit is not known because it was only identified in a shovel probe after the trench excavation. Fine disseminated charcoal present. Interpreted as marine terrace or alluvial sediments, possibly a truncated paleosol as a result of the occupation or could be the lower portion of a soil that formed underneath and contemporaneously with the occupation identified in 4A.

LU3 to 4B and LU4 to 2B (Figure 11). A date of 10,112 ± 40 radiocarbon years before present (years BP) was produced in this study from the lowest cultural strata (4A) (Minor et al. 1986), identified in this core as LU2. Overlying LU3, LU2 produced a date of 5,724 ± 34 years BP. The composition and age of stratum LU3 corresponds to the Minor et al. (1986) stratum 4B. The stratigraphy and associated dates obtained from this Geoprobe core are consistent with successive deposition when including the 8,000-6,800 BP radiocarbon dates that Minor et al. (1986) recovered in stratum 4A. While LP-aged dates recovered as a result of this study were not directly linked to cultural materials (i.e. shell midden or lithics) their successive nature and stratigraphic position support the early dates obtained by Minor et al. (1986).

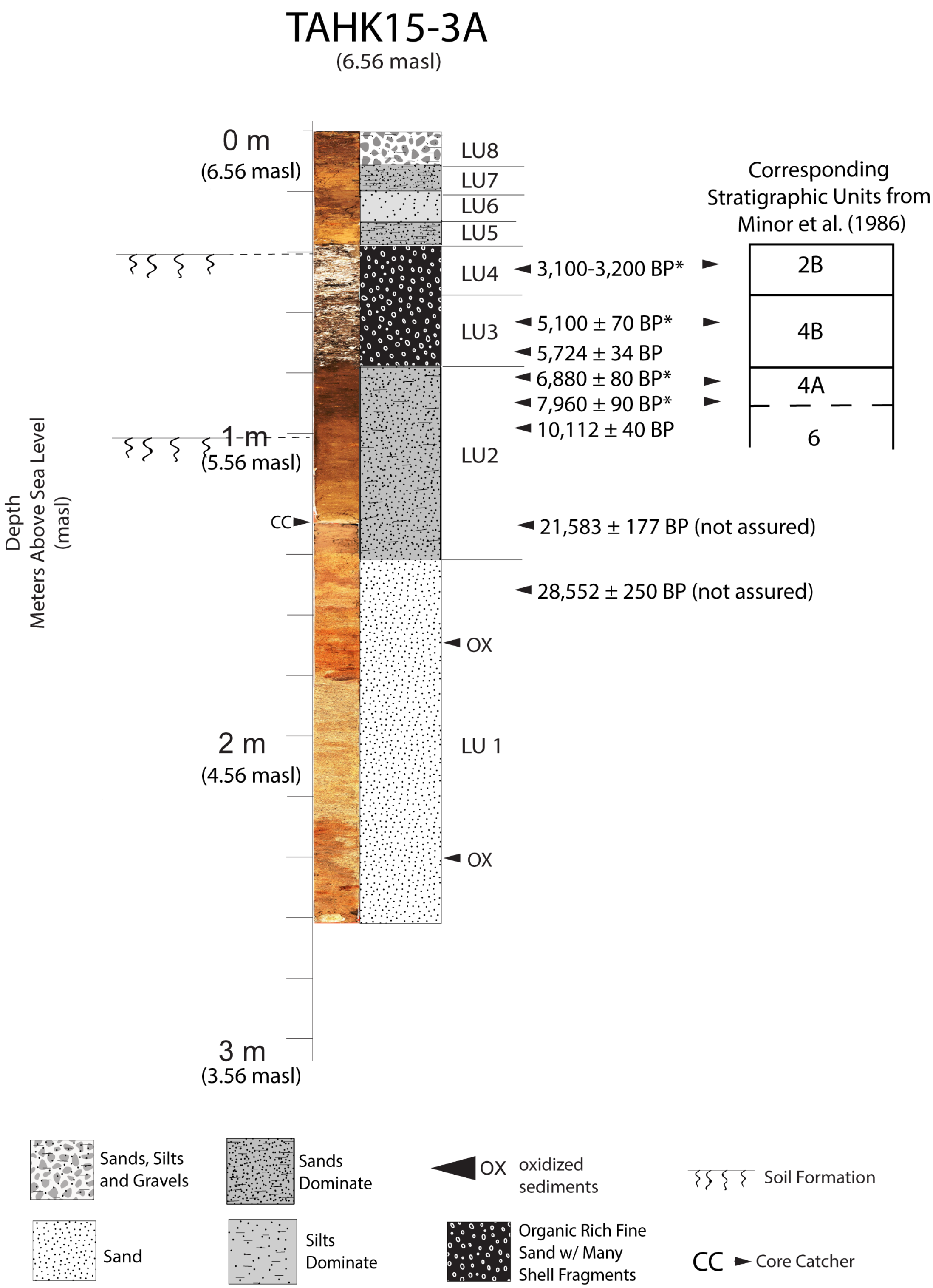

Figure 10. Log for Geoprobe Core 3A. All dates reported as radiocarbon dates (BP). * Signifies dates collected by Minor et al. (1986).

Table 2. Summary of stratigraphy from 3A.

Lithostratigraphic Unit (LU)	Lithology Keyword	Description
8	Surface silt, sand and gravels	Dark brown (7.5YR 3/3); very fine sandy silt w/ sub-rounded to sub-angular pebble sized basalt gravels; massive; sharp lower bedding plane; 20% gravel; 40% silt; 40% VF sand.
7	Sands dominate	Dark yellowish brown (10YR 4/4) sand w/ silt; massive; sharp lower bedding plane; 70% medium sand; 20% silt; 10% clay
6	VF Sands and silts dominate	Very dark grayish brown (10YR 3/2) silty sand; massive; gradational lower bedding plane (1 cm); 60% VF sand; 25% silt; 15% clay
5	Sands dominate	Dark yellowish brown (10YR 4/4) silt, clay and sub-angular medium sand; massive; sharp lower bedding plane; 50% medium sand; 30% silt; 20% clay
4	Black sand and silt with shell	Very dark brown (10YR 2/2) organic rich sub-rounded to rounded fine to medium sand with many shell fragments and common charcoal fragments; poorly sorted; massive; sharp lower bedding plane.
3	Black sand and silt with shell	Black (10YR 2/1) organic rich sub-rounded to rounded fine to medium sand w/silt and many shell fragments and common charcoal fragments; poorly sorted; massive; sharp lower bedding plane.
2	Sands dominate	Dark brown (10YR 3/3 and 4/2) and dark brown (7.5YR 3/2) silty sand; massive; gradational lower bedding plane (1.5cm); 30% medium sand; 30% VF sand; 30% silt; 10% clay (sand content increases with depth)

1	Oxidized sand	Dark yellowish brown (10YR 4/4 and 5/6) and brown (7.5YR 4/6) rounded to sub-rounded medium sand; moderately-well sorted; massive; 90% medium sands; 10% fine sands

CORE 3B

Core 3B is located uphill, directly westward from Core 3A in the mound area of the site. While we do not have dates from the cultural stratum for this core, the stratigraphic units observed are consistent with the stratigraphic profiles from the western units of the excavation trench described by Minor et al. (1986). Culturally relevant deposits begin at 40 cm below surface (cmbs) and consists of black sand devoid of shell (LU8) before transitioning to a stratum of very dark gray sand with common fine shell fragments (LU7). LU8, shown in Figure 11, appears to be a buried paleosol, corresponding with McDowell's description of Unit 2A. Based on her description in the 1986 report (Minor et al. 1986:38), Stratum 2A overlays Stratum 4A and Stratum 4B in units L, M, and N (Figure 18) (Minor et al. 1986:34). Without dates from Strata LU5-8, the only way to match these deposits to those identified in 1986 is through sediment descriptions. Below LU5, at 117 cmbs in LU4, a date of 29,553 ± 146 years BP was recovered.

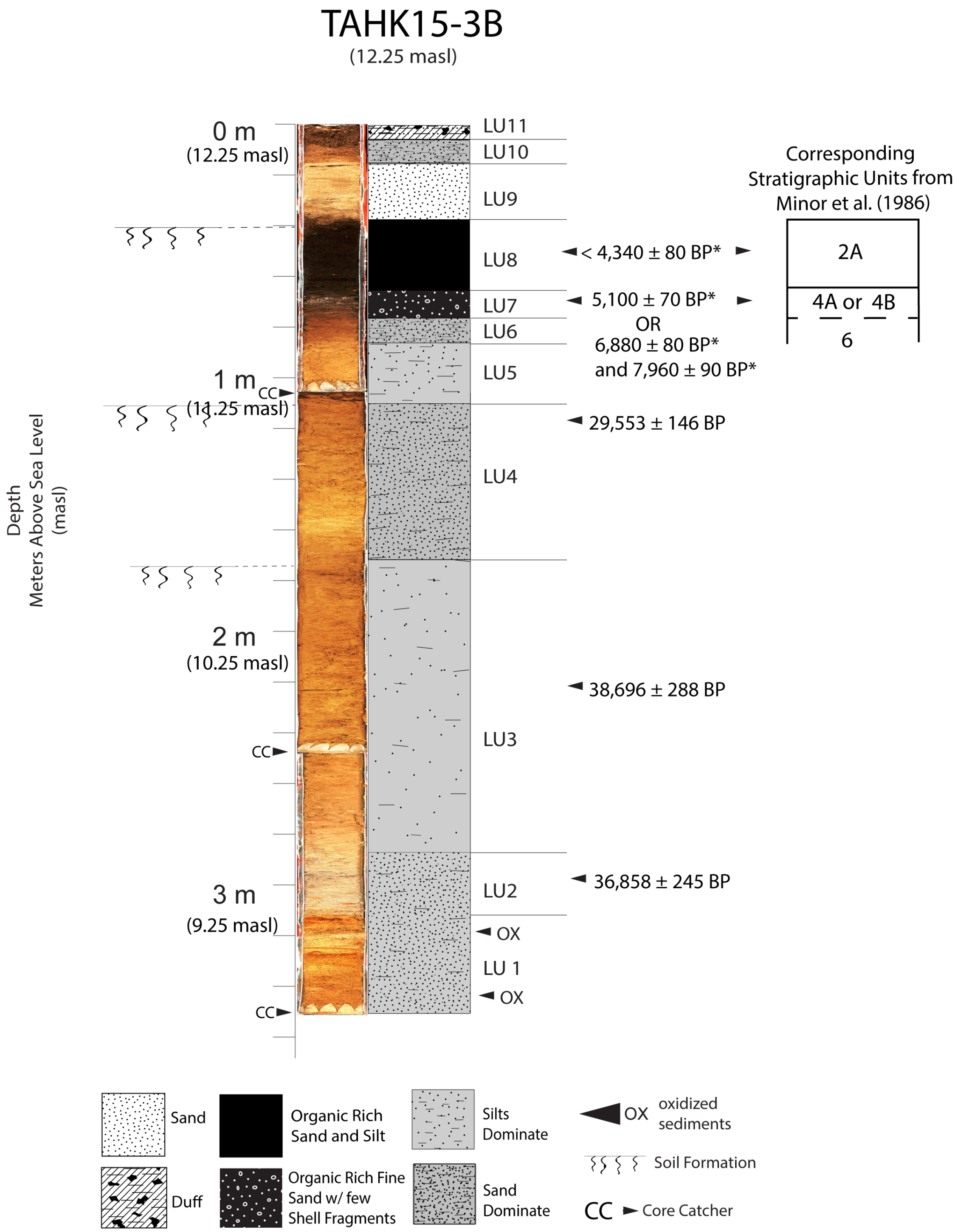

Figure 11. Log for Geoprobe Core 3B. All dates reported as radiocarbon dates (BP). * Signifies dates collected by Minor et al. (1986).

Table 3. Summary of stratigraphy from Geoprobe Core 3B.

Lithostratigraphic Unit (LU)	Lithology Keyword	Description
11	Duff	Organic mat at the surface with silt.
10	Sands dominate	Dark brown (10YR 3/3) sub-rounded sand w/silt; massive; sharp lower bedding plane; 70% medium sand; 20% fine sand; 10% silt
9	Sand	Brown (10YR 4/3) sub-rounded sand w/silt; massive; sharp lower bedding plane; 90% fine sand; 10% medium sand
8	Organic rich sand, void of shell	Black (10YR 2/1) organic-rich fine sand to medium sand; massive; gradational lower bedding plane (0.5 cm); 70% fine sand; 30% medium sand
7	Very dark gray sand, with shells	Very dark gray (10YR3/1) organic rich fine and medium sands with common shell fragments; sharp lower bedding plane; 65% fine sand; 15% medium sand; 10% silt
6	Sands dominate	Very dark grayish brown (10YR 3/2) silt, clay and fine sand; massive; gradational lower bedding plane (0.5 cm); 50% fine-VF sand; 40% silt; 10% clay
5	Silts dominate	Dark yellowish brown (10YR 4/4) silt, clay and very fine sand; massive; sharp lower bedding plane (end of core); 20% clay; 15% VF sand; 65% silt
4	Sands dominate	Dark yellowish brown (10YR 4/4) silt, clay and very fine sand; massive; gradational lower bedding plane (1.5 cm); 10% clay; 40% fine

		sand; 10% VF sand; 10% medium sand; 30% silt
3	Silts dominate	Dark yellowish brown (10YR4/4) silt, clay and very fine sand; massive; gradational lower bedding plane (1.5 cm); 20% clay; 15% VF sand; 65% silt
2	Sands dominate	Grayish brown (10YR 5/2) sand, silt and clay w/ many fine strong brown (7.5 YR 5/8) fine iron nodules; massive; sharp lower bedding plane; 30% silt; 45% fine-medium sand; 25% clay
1	Sands dominate	Yellowish brown (10 YR 5/4) rounded to sub-rounded fine sand w/ silt; massive; gradational lower bedding plane (1 cm); 70% fine-medium sand; 30% silt

CORE 7E

This core is located just north of the mound area in the gravel area (Figure 10). A total of four radiocarbon ages were obtained from this core ranging from 26,000-3,000 years BP. The first two dates, 3,084 ± 24 years BP and 3,138 ± 27 years BP were taken from LU4 (Figure 12). While LU4 matches the textural description of stratum 2A, it is not clear how these dates fit given the age of 2A is not clear in the 1986 report. There is no obvious answer to why there is a 26,000 year BP date stratigraphically above the 15,000 year BP date. Further dating of this section would resolve this problem.

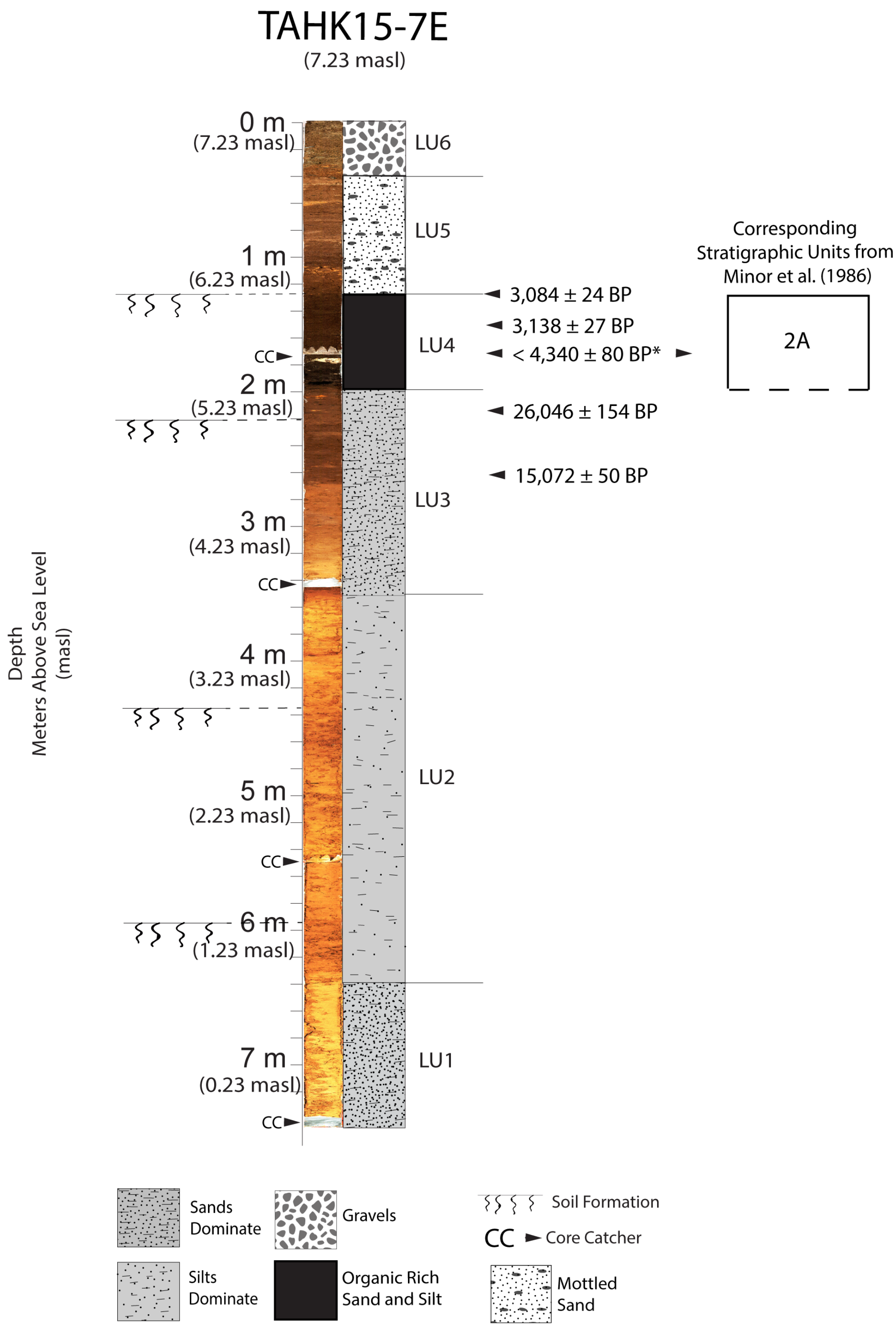

Figure 12. Log for Geoprobe Core 7E. All dates reported as radiocarbon dates (BP). * Signifies dates collected by Minor et al. (1986).

Table 4. Summary of Geoprobe Core 7E Strata.

Lithostratigraphic Unit (LU)	Lithology Keyword	Description
6	Surface gravels	Crushed angular gravels
5	Mottled sand	Very dark brown (10YR 2/2) fine sand w/ silt; mottled; gradational lower bedding plane (1.5 cm); 90% fine sand; 10% silt
4	Organic rich sand, void of shell	Very dark grayish brown (10YR 3/2) grades to black (10YR 2/1) organic-rich fine sand to medium sand; massive; gradational lower bedding plane (0.5 cm); 70% fine sand; 30% medium sand
3	Sands dominate	Very dark grayish brown (10YR 3/2) grades to dark brown (10YR 3/3) sand w/ silt and clay; massive; gradational lower bedding plane (0.5 cm); 10% clay; 40% fine sand; 10% VF sand; 10% medium sand; 30% silt
2	Silts dominate	Dark yellowish brown (10YR 4/4) grades to dark yellowish brown (10YR 4/6) silt, clay and very fine sand; massive; sharp lower bedding plane; 20% clay; 15% VF sand; 65% silt
1	Sands dominate	Dark yellowish brown (10YR 4/4) sand w/ silt and clay; massive; end of core; 10% clay; 40% fine sand; 10% VF sand; 10% medium sand; 30% silt

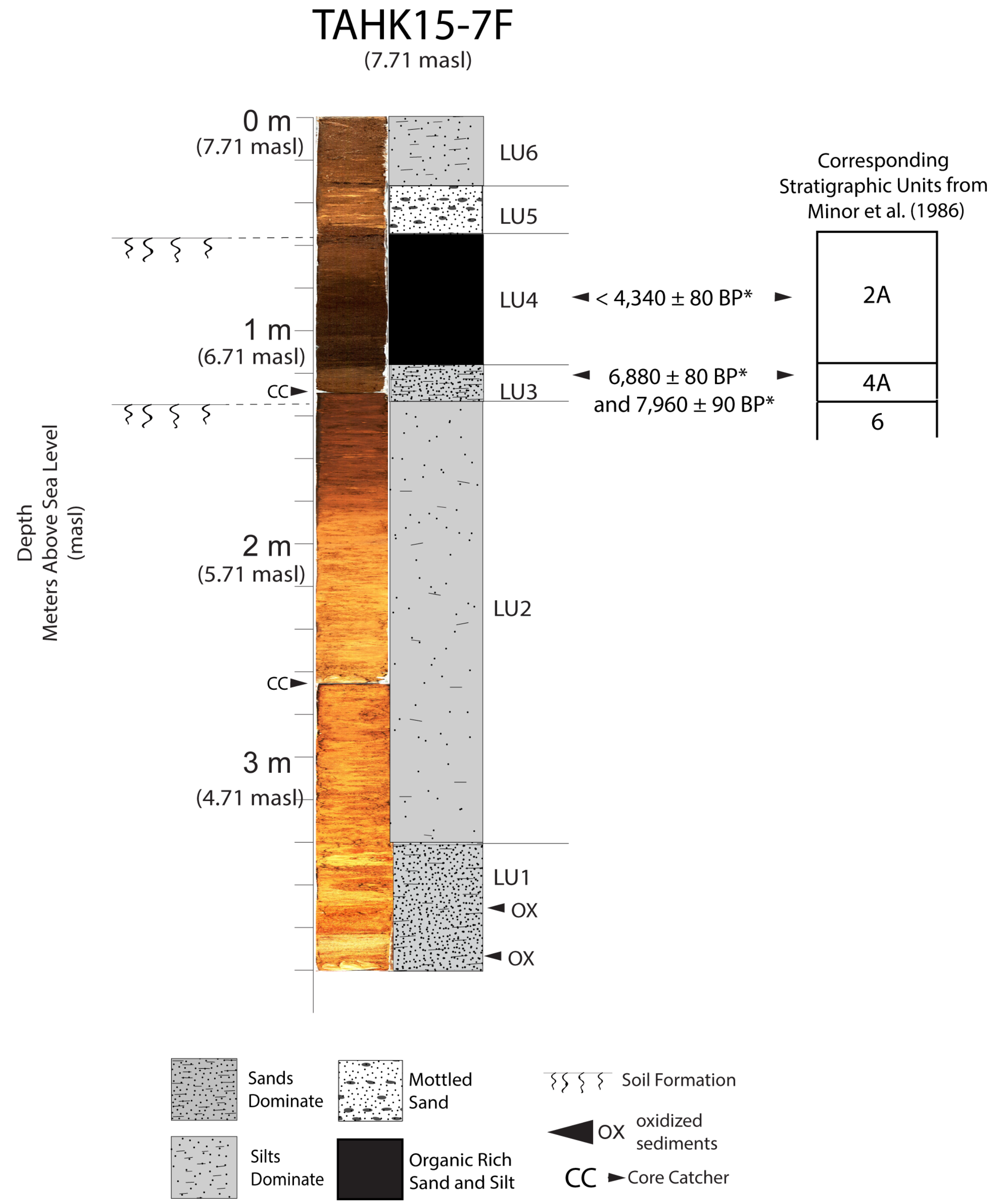

Figure 13. Log for Geoprobe Core 7F. * Signifies dates collected by Minor et al. (1986).

Table 5. Summary of Geoprobe Core 7F strata.

Lithostratigraphic Unit (LU)	Lithology Keyword	Description
6	Surface silty sand	Very dark brown (10YR 2/2) silty sand; massive; gradational lower bedding plane (1 cm); 70% VF sand; 30% silt
5	Mottled sand	Very dark brown (10YR 2/2) fine sand w/ silt; mottled; sharp lower bedding plane; 90% fine sand; 10% silt
4	Organic rich sand, void of shell	Very dark grayish brown (10YR 3/2) grades to black (10YR 2/1) organic-rich fine to medium sand; massive; gradational lower bedding plane (0.5 cm); 70% fine sand; 30% medium sand
3	Sands dominate	Very dark grayish brown (10YR 3/2) silt, clay and fine sand; massive; gradational lower bedding plane (0.5 cm); 10% clay; 60% fine-VF sand; 30% silt
2	Silts dominate	Dark yellowish brown (10YR 4/4) silt, clay and very fine sand w/ disseminated charcoal fragments; massive; gradational lower bedding plane (1.5 cm); 20% clay; 15% VF sand; 65% silt
1	Sands dominate	Dark yellowish brown (10YR 4/4) silt, clay and very fine sand; massive; gradational lower bedding plane (1.5 cm); 10% clay; 40% fine sand; 10% VF sand; 10% medium sand; 30% silt

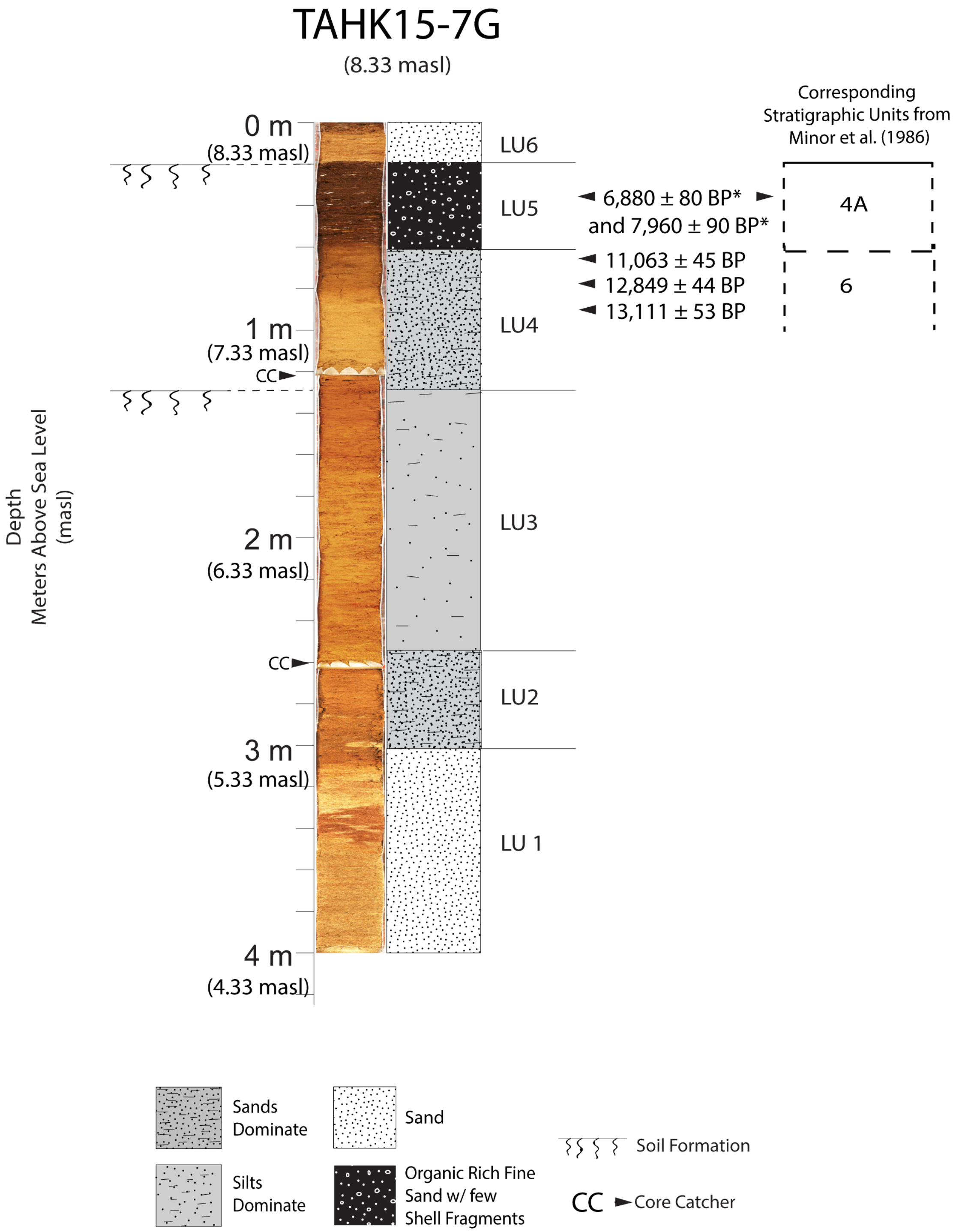

Figure 14. Log for Geoprobe Core 7G. Dashed boundary on the corresponding units represents assumed correlation based on sediment descriptions and associated dates. All dates reported as radiocarbon dates (BP).

Table 6. Summary of Geoprobe Core 7G Strata.

Lithostratigraphic Unit (LU)	Lithology Keyword	Description
6	Surface sand	Yellowish brown (10YR 5/6) sub-rounded fine and medium sands; massive; sharp lower bedding plane; 75% medium sand; 15% fine sand; 10% silt
5	Organic rich sand and silt with shell	Black (10YR 2/1) medium sand and silt; massive; gradational lower bedding plane (2 cm); 45% medium sand; 15% fine sand; 40% silt
4	Sands dominate	Dark brown (10YR 3/3) grades to dark yellowish brown (10YR 4/4) medium sand and silt; massive; gradational lower bedding plane (1 cm); 45% medium sand; 15% fine sand 40% silt
3	Silts dominate	very dark brown (10YR 3/3) silt, clay and fine sand; massive; gradational lower bedding plane (0.5 cm); 10% clay; 40% fine-VF sand; 50% silt
2	Sands dominate	dark yellowish brown (10YR 3/4 and 4/4) silty sand; massive; gradational lower bedding plane (1 cm);10% medium sand; 50% VF sand; 40% silt
1	Sand	yellowish brown (10YR 5/6) and light gray (10YR 7/2) rounded to sub-rounded fine to medium sized sand; massive; sharp lower bedding plane (end of core); 80% medium sands; 20% fine sands

CORE 7F

Core 7F is located to the north beyond the gravel parking lot near lakeside. Just as described in the 1986 report, the uppermost deposits in this area are disturbed from the surface to a depth of ~ 60 cmbs. The disturbed deposits are made up of silty sand at the surface that transition to mottled sand. The lower boundary of these deposits is sharp, and there is a clear distinction between the disturbed overburden and the intact cultural deposits below. LU4 consists of very dark grayish brown to black organic-rich fine to medium sands void of shell (Table 5). Its color and composition match Stratum 2A identified in the mound area. LU3, stratigraphically below LU4, is very dark grayish brown and consists of fine to very fine sand with a greater percentage of small particle fraction of clay and silt. LU3 and LU4 are thought to be the two lithostratigraphic units that correspond with Strata 2A (<4,340 ±80 BP) and 4A (8,000-5,200 years BP) identified in the 1986 report (Figure 13). LU2 and LU1 are stratigraphically lower than the cultural deposits and are therefore older. While their age is not directly known, these deposits resemble other nearby silt dominated deposits ranging in age between 42,000-15,000 years BP.

CORE 7G

Core 7G is located at the most northern extent of the site boundary. Surface deposits from this core consist of sand (LU6) that transitions to a black matrix of sand and silt with common shell fragments (Table 6). The boundary between LU5 and the lower LU4, which is described as a sand-dominated matrix devoid of any obvious cultural material (i.e., no shell or bone), is gradual and diffuse. Three radiocarbon samples were collected from LU4: one at 68 cmbs (11,063 ± 45 years BP), another at 74 cmbs (12,849 ± 44 years BP) and a third at 89cmbs (13,111 ± 53 years BP) (Figure

14). Without dates from LU5 we can only speculate as to its age. Based on those dates recovered from LU4 and no obvious signs of disturbance (unconformity between LU5 and LU4 or mottling) it is likely that LU5 correlates to stratum 4A, which is a brown sandy matrix with little shell dating to 6,880 ± 80 BP to 7,960 ± 90 BP (Minor et al. 1986). The depositional sequence seen in this core is similar to that observed in 3A, where dates from 10,000 years BP to 21,000 years BP were obtained from a sand-dominated unit below cultural material.

Stratigraphic Summary

Below LU4 lies a silt dominated unit, the same unit where the earliest dates recovered for this study were found. The cultural deposits observed in the Geoprobe cores taken from within the site boundaries are overlain by modern sand and silt. It appears that the cultural deposits are more deeply buried (20 cm to a 1 m below the surface) closer to the mound area. Moving north and east, the cultural deposits are closer to the surface, which is likely the result of removal of sediments during construction or demolition of the 1930s resort. Core 7D, taken from the parking lot just west of the shoreline contains midden deposit but is buried under almost a meter of poorly sorted sands and silts. The cultural strata appear finely laminated and are reminiscent of sedimentary structures formed near shorelines suggesting that these deposits have likely been reworked with the rise and fall of Tahkenitch Lake. Across the site, the deposits that underlie the cultural strata are composed of very fine sediments that alternate between sand dominated and silt dominated packages, repeatedly grading from dark to light color with depth. This pattern of color (from dark to light) and visible fine subangular blocky structural development in the profile and redox features are interpreted as a series of buried soils. Cores that were recovered beyond the site boundaries consist of sterile (i.e. lacking cultural material) aeolian sand overlying a series of buried paleosols (mentioned above). An example of this can be seen in Geoprobe core 20F in cross section A-A' (Figure 16) and Geoprobe core 20K in cross section B-B' (Figure 17).

4.1.2 Periods Defined

A summary of the stratigraphic evidence for these periods are discussed below and synthesized in Figure 15, which shows a composite stratigraphy of the Tahkenitch Landing site. Two fence diagrams have also been developed to show the relationship between the cores described here and the associated archaeological periods (Figures 16 and 17).

PERIOD ONE (42,000-20,000 years BP)

This period includes the deepest and oldest deposits observed during this study, predating the cultural occupation at the site. The deepest deposits are composed of a fining upward sequence of graded bedding (from sand to silt) (Figure 15 Ia), characteristic of alluvial deposits (Waters 1992). These alluvial deposits are only observed in Geoprobe cores 3C and 20K and are interpreted as Quaternary Alluvium (Qal) by Beaulieu and Hughes (1975). While we don't know the exact age of these deposits, we can assume based on the dates obtained from overlying deposits that they predate 42,308 ± 545 years BP.

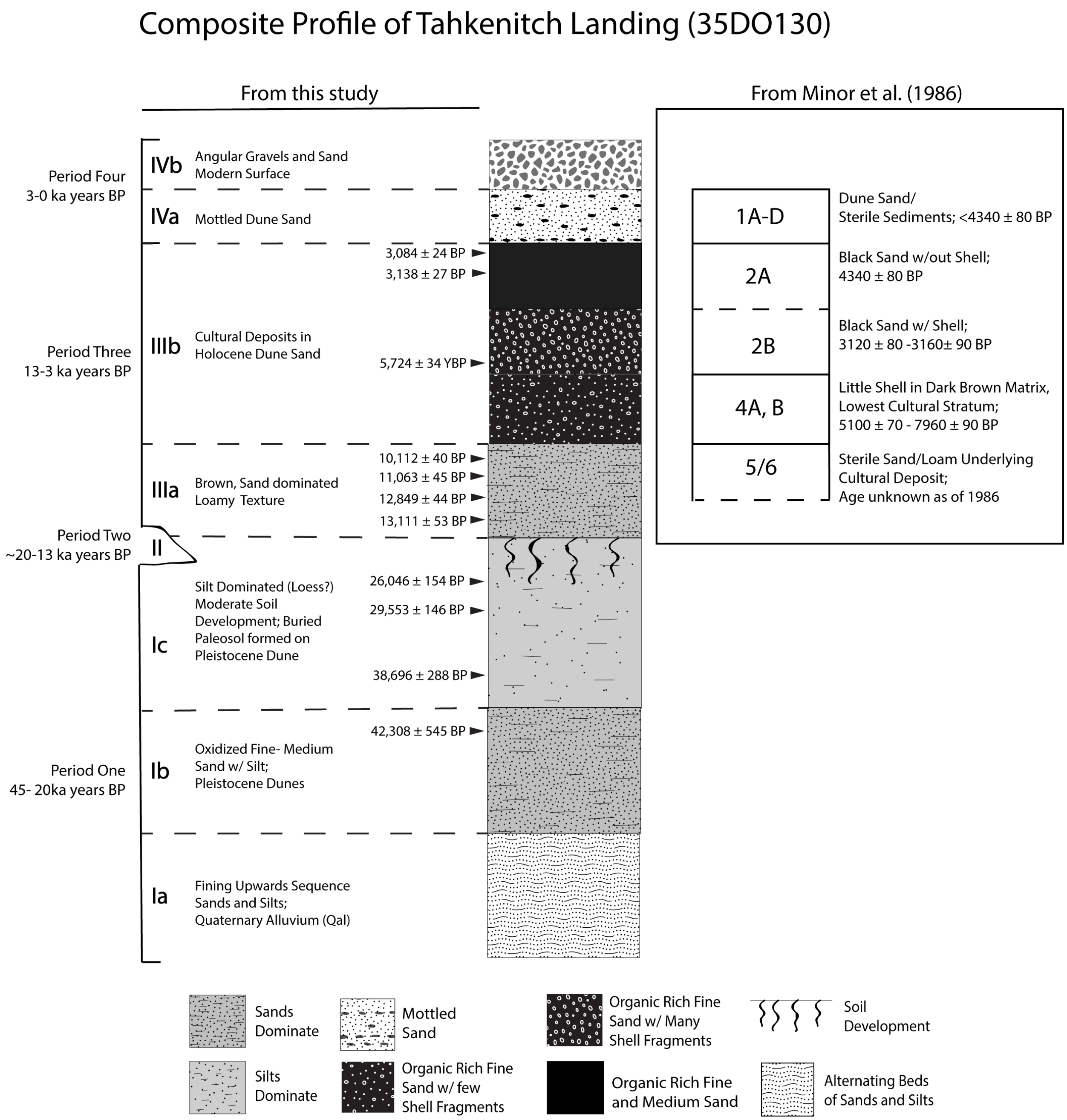

Figure 15. Composite profile of sediments and associated periods and their correlation to Minor et al. (1986). Roman numerals (i.e., Ia, Ib) represent subsections of primary components. All dates are reported as radiocarbon ages (BP).

The deposits overlying Qal appear to be aeolian in nature, consisting of oxidized fine to medium sized sand with silt (Figure 15 Ib) and fine upward displaying moderate soil development with fine blocky structure (Figure 15 Ic). The composition of these deposits resemble stratum 6 described by Minor et al. (1986) as likely being alluvial in nature. Patricia McDowell (Minor et al. 1986:99) describes a difference in interpretation about the extent of Quaternary alluvial deposits in the vicinity of the Tahkenitch Landing site. She points to a discrepancy between two maps, one from Beaulieu and Hughes (1975) and another from Pinto et al. (1972) as it relates to the definition of the low land surface that is the western shore of Tahkenitch Lake in the area of transect B-B' in Figure 9. Beaulieu and Hughes (1975) mapped this area as Quaternary alluvium (Qal) while Pinto et al. (1972) have the western shore of Tahkenitch mapped as mountain front marsh. However, the mapping carried out by Pinto et al. (1972) was not intended to map geologic units, but rather to inventory the natural landscape at the time of publication. The mountain front marsh mapped by Pinto et al. (1972) is likely a product of, or heavily influenced by the construction of an outlet gate to increase the depth of Tahkenitch Lake, which occurred as early as 1949 (Siuslaw National Forest Coastal Lakes Watershed Analysis 1998). It is unclear why the two maps were compared based on geology, but I assume here it was in an effort to identify the source of alluvium that deposited stratum 6. Because the excavation at Tahkenitch did not extend deep enough to prove either correct, McDowell (Minor et al. 1986:99, 101) provides alternate explanations:

> This land surface could have been formed by alluvium deposited by the drainage occupied by Elbow Lake, during an earlier stage of sand dune development. With no dunes present, the Elbow Lake drainage

> probably would have flowed northwest or west to the ocean without flowing through Tahkenitch Lake at all. The Elbow Lake drainage would have flowed north into Tahkenitch Lake only if there were dunes somewhere to the northwest, and west, blocking its passage to the beach along this shorter route. In this case, the low-lying surface on the western shore of Tahkenitch Lake could have been built as a delta from the Elbow Lake drainage into an early dune dammed Tahkenitch Lake. A later readvance of the dunes could have partly overridden the delta/alluvial surface.

The alternative, McDowell states, is that deposits could also be dune sand or marine terrace deposits.

Pinto et al. (1972) Beaulieu and Hughes (1975) both identified stabilized dunes northwest and west of Elbow Lake, and a ridge just west of Tahkenitch Lake, and Highway 101. The presence of stabilized dunes to the west and northwest of Elbow Lake lends to McDowell's hypothesis of alluvial deposition as delta deposits from Elbow Lake into an early dune dammed Tahkenitch Lake. However, radiocarbon dates collected during this study suggest that these fine-dominated (silts and VF sands) (Figure 15 Ic) deposits predate the damming of Tahkenitch Lake by an average of 25,000 years. Research later conducted by Beckstrand (2001) and Peterson et al. (2006, 2007) on the origins, age and distribution of Oregon's Coastal Pleistocene and Holocene dune sheets have mapped and characterized Pleistocene dune deposits within the study area. It is possible that a Pleistocene dune migration could have dammed Tahkenitch Creek at an earlier time, allowing for the deposition of delta deposits from nearby Elbow Lake. However, radiocarbon dates associated with the paleosols at Tahkenitch Landing (<46,690-26,240 years BP) fall within the range of Pleistocene dune emplacement along the central Oregon coast (Peterson et al. 2006, 2007) and are reminiscent of the anomalous thick paleosols described by Peterson et al. (2006 and 2007) and Beckstrand (2001). Peterson (2006) notes instances of loess deposition atop the Pleistocene dunes, which may form the parent material for some of the paleosols present at Tahkenitch Landing (i.e., geoprobe cores 3B or 7G). These deposits are well sorted, finely textured, and massive, similar to the composition of loess. Without doing more intensive quantitative particle-size analysis, the presence of loess in the upper deposits cannot be confirmed. By comparing the deposits observed at Tahkenitch with the descriptions of Pleistocene dunes and associated paleosols presented by Peterson (2006, 2007) and Beckstrand (2001), I conclude that the paleosols observed at the Tahkenitch Landing site represent the same kind of paleosol developed in Pleistocene dunes along the central Oregon Coast. All of these soils were buried with the growth of Holocene dune sheets.

PERIOD TWO (26,000-13,000 years BP)

During this study we were unable to obtain radiocarbon ages between 26,000- and 13,000 years BP. Thus, period two is described here as the time gap between periods one and three (Figure 15 II) and the transition between Period One and Two, marked by a nonconformity between sand-dominated deposits and an underlying paleosol (Figure 15). The lack of dates between 26,000-13,000 years BP does not necessarily mean that this time is absent in the in the stratigraphic record as it could be found later with refined sampling methods. Because of this, it is not clear whether or not this time gap represents differences in soil formation across the site (some places are stable while others are not), erosional processes, or radiocarbon sample selection. The stratigraphy at the Tahkenitch Landing site are similar to those reported by (Davis et al. 2004, 2008), where Pleistocene aged aeolian dune sands are interbedded with paleosols, that underlie Holocene aged dune sand along coastal headland sites. The association of these deposits, and associated unconformities is unclear at this time. The LP-aged stratigraphic record of the Oregon coast is incomplete due to the presence of unconformities at several sites. If this is a regional pattern, we don't yet know why but it is an important part of Oregon's early geoarchaeological record.

PERIOD THREE (13,000-3,000 years BP)

Period three as defined in this study includes all three cultural components identified by Minor et al. (1986), outlined in section 1.4 of this thesis. This period encompasses the known time of cultural occupation and older deposits that, while archaeologically sterile, have the potential to hold earlier unidentified occupations. The lowest deposits associated with this period range in age from 13,000-10,000 years BP (Figure 15 IIIa) are sand dominated, lack shell and organic matter. The grain size composition of these units is suggestive of aeolian transport (well to moderately sorted fine and medium sands) with an input of silt from *in situ* weathering. The younger deposit that overlie the sterile sand-dominated deposits are organic-rich fine sand and silts that contain abundant shell fragments common throughout (Figure 15 IIIb). While no cultural materials were identified in the lower LP-aged deposits, the radiocarbon dates demonstrate successive deposition through time, casting doubt on the argument that the earliest dates recovered during the 1985 excavation are the product of old wood and stratigraphically out of place.

PERIOD FOUR (3,000-0 years BP)

By 3,000 years BP the intensity of the prehistoric occupation drastically reduced, and the site appears to be virtually abandoned. Previous interpretations of the cultural components point to a major shift in resource availability. The number of mammals and birds are nearly absent, and while the use of fish is still present, the number of individuals processed at the site greatly decreased. Minor et al. (1986) suggest that the site undergoes a gradual transition from an estuary to a freshwater lake, as seen in the continued use of brackish water fish while brackish water shellfish is nearly absent. During this transition, it is likely that inhabitants of the site moved to a more desirable location to set up more permanent dwellings, only using the site as a summer fishing camp, or intermittently into historic times.

A private fishing resort was constructed and used through the 1970s after which the Siuslaw National Forest acquired the property. The heavy use of the site in historic times along with the construction of the fishing resort is reflected in the mottled and disturbed deposits at or near the modern surface (Figure 15 IVa and IVb). It is clear that construction has altered the visibility and preservation of prehistoric components near the modern surface.

4.2 Revised Site Chronology

A total of 18 radiocarbon dates were produced from samples collected in Geoprobe cores as part of this project: seven from the mound area and eleven from beyond the mound but within the site boundaries (Table 7). Two of the samples taken from within the mound produced ages that were not assured by the laboratory because the analyzed materials produced low beam current due to the small carbon mass of the samples (Table 7a).

Dates obtained from the site range in age from 42,308 ± 545 years BP to 3,084 ± 24 years BP. The earliest dates, ranging between 42,000 – 26,000 years BP were all taken from a meter or more below the surface, in deposits not associated with cultural components. All the LP-EH aged dates (15,000-10,000 years BP), with the exception of one, came from deposits that are similar to those described by Minor et al. (1986: 39) as a sterile loam directly underlying the cultural deposit.

Dates recovered from cultural strata align well with the ages reported from Minor et al. (1986). Two dates we recovered in LU4 in Geoprobe core 7E (3,084 ± 24 years BP and 3,138 ± 27 years BP) are consistent with those recovered from strata 2A by Minor et al. (1986) (see Figures 18 and 19 for an illustration of site stratigraphy with dates from Minor et al. 1986 report).The other radiocarbon age obtained from the shell midden came from LU3, in Geoprobe core 3A. This stratum consists of sand and silt with many shell fragments and is dated to 5,724 ± 34 years BP. This date aligns well with the lowest cultural deposit (4B) reported by Minor et al. (1986) (5,100 ± 70 years BP) a loamy sand with common shell fragments.

Table 7. Summary of radiocarbon samples. Sample ID coded as site abbreviation (TAHK) + core ID (3A).

Sample ID	Sample Type	Depth Below Surface (cm)	Lithostratigraphic Unit	Radiocarbon age	
				BP	1σ error
TAHK3A	charcoal	79	LU 3	5,724	34
TAHK3A	charcoal	99	LU 2	10,112	40
TAHK3A	charcoal	130	see below		
TAHK3A	charcoal	156	see below		
TAHK7E	charcoal	124	LU 4	3,084	24
TAHK7E	charcoal	128	LU 4	3,138	27
TAHK7E	charcoal	218	LU 3	26,046	154
TAHK7E	charcoal	272	LU 3	15,072	50
TAHK7A	charcoal	48	LU 5	8,225	36
TAHK7A	charcoal	136	LU 5	27,547	136
TAHK7A	charcoal	185	LU 3	42,308	545
TAHK7A	charcoal	194	LU 3	36,811	275
TAHK7G	charcoal	68	LU 4	11,063	45
TAHK7G	charcoal	74	LU 4	12,849	44
TAHK7G	charcoal	89	LU 4	13,111	53
TAHK3B	charcoal	117	LU 4	29,553	146
TAHK3B	charcoal	236	LU 3	38,696	288
TAHK3B	charcoal	299	LU 2	36,858	245

Table 7a. Samples are not assured and are indicative only. The analyzed materials produced low beam current in the AMS due to small carbon mass. The accuracy of the measurement is, therefore, not assured.

Sample ID	Sample Type	Depth Below Surface (cm)	Fraction of modern		Radiocarbon age	
			pMC	1σ error	BP	1σ error
TAHK3A	charcoal	130	6.81	0.15	21,583	177
TAHK3A	charcoal	156	2.860	0.089	28,552	250

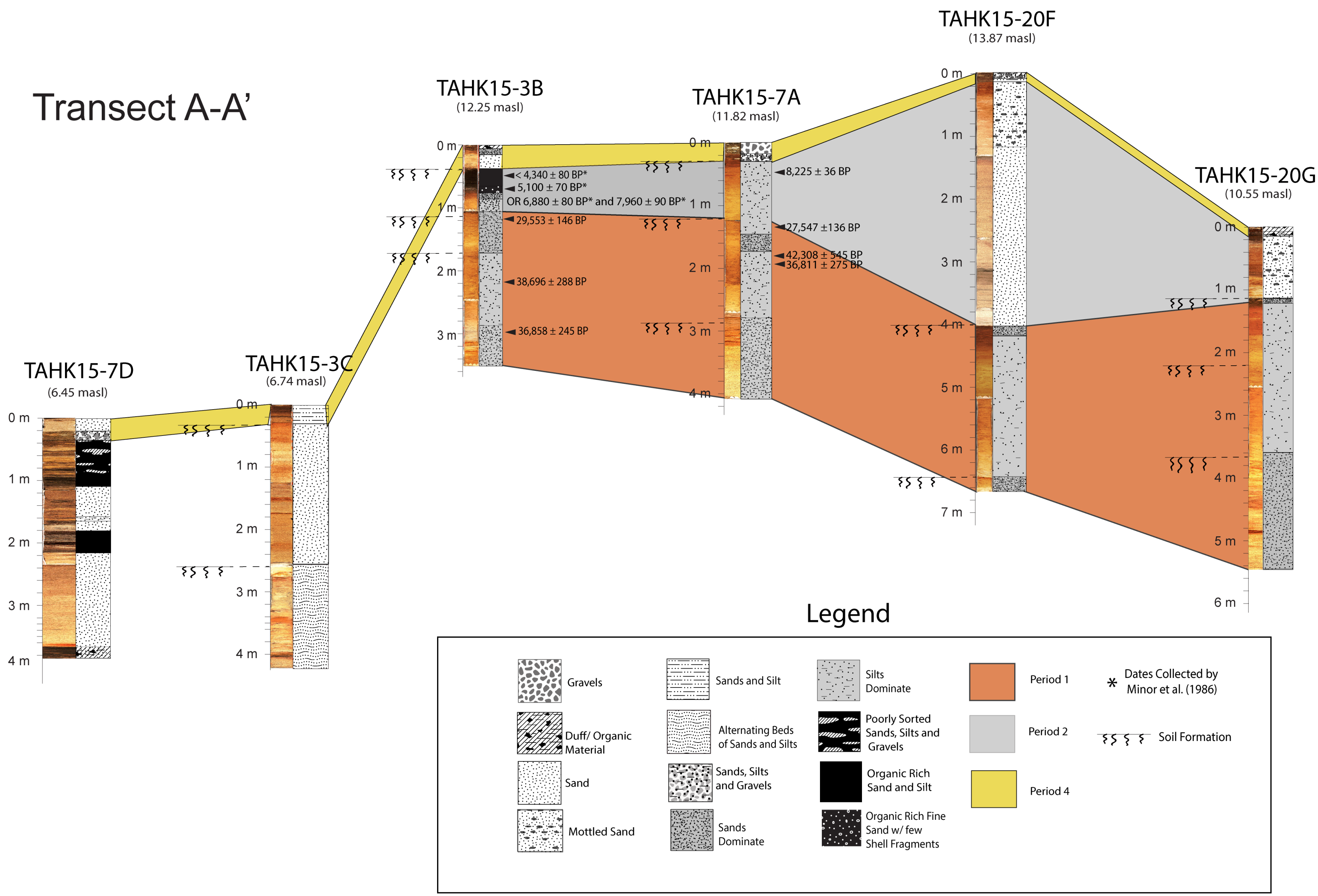

Figure 16. Cross Section A-A’.

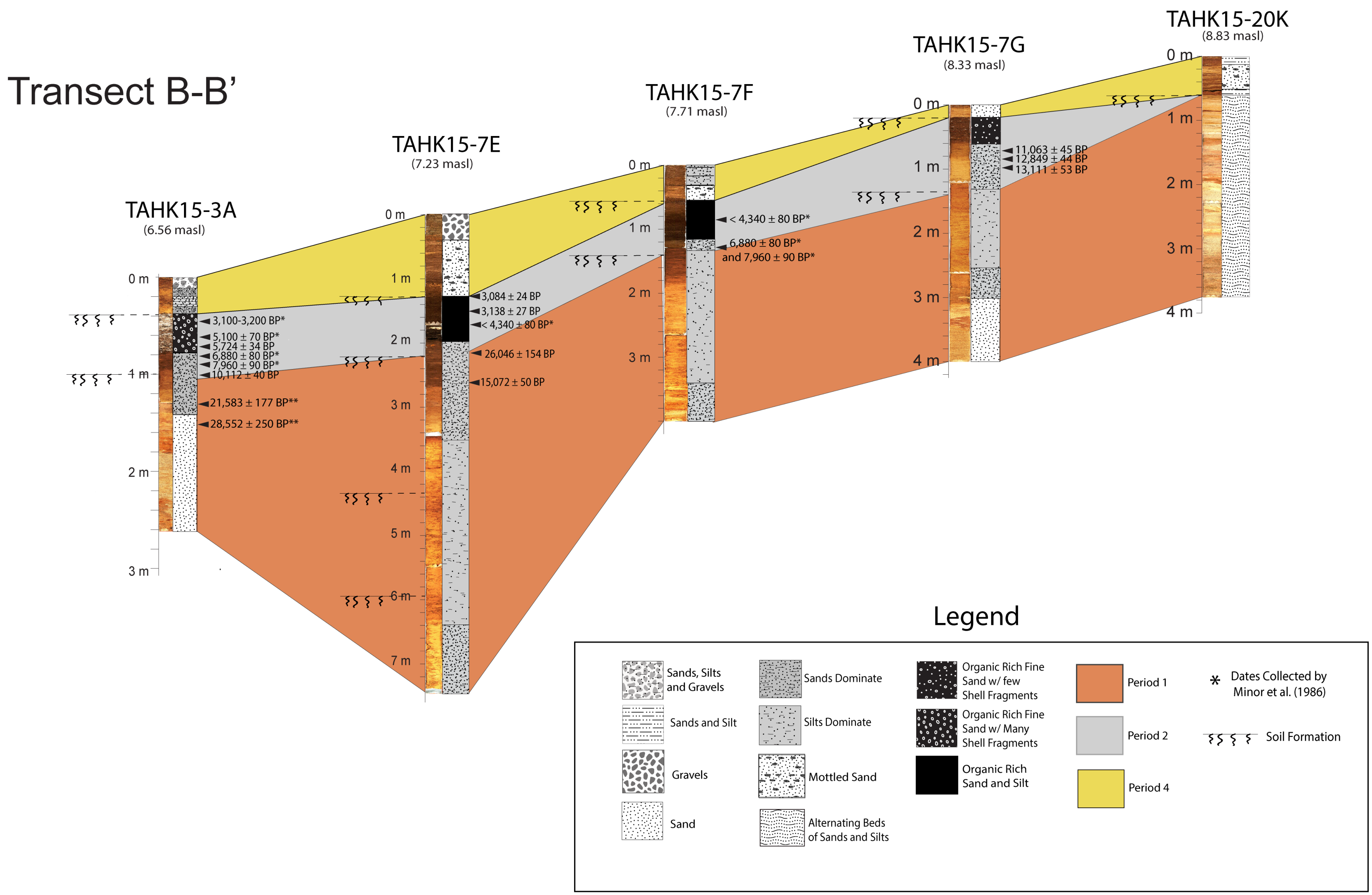

Figure 17. Cross Section B-B'. **Signifies dates not assured by radiocarbon laboratory.

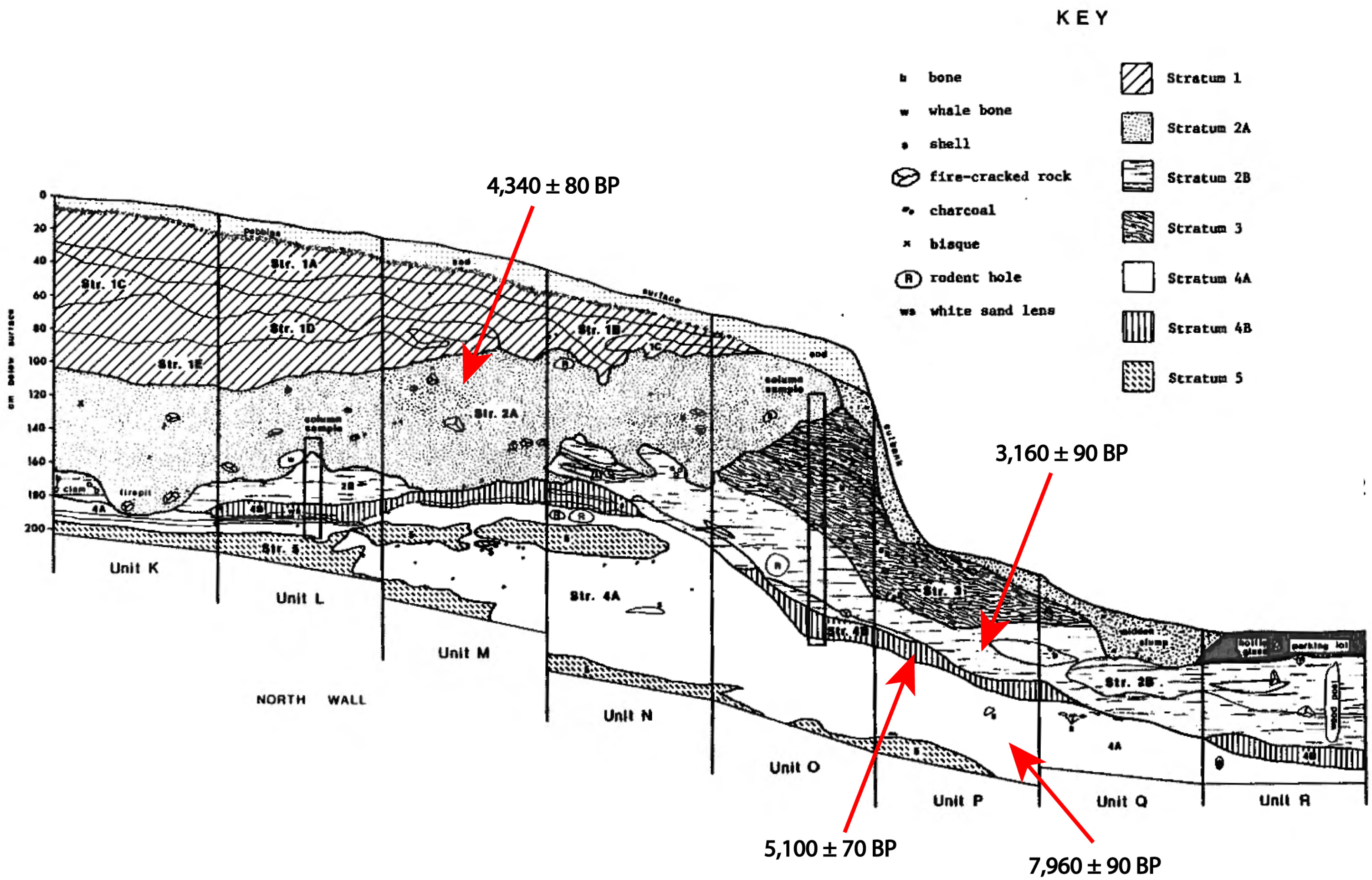

Figure 18. Illustration from Minor et al. (1986 Figure 5-1) showing the stratigraphic profile from the trench excavation in the mound. Modified to display where dates were recovered in the 1984 excavation.

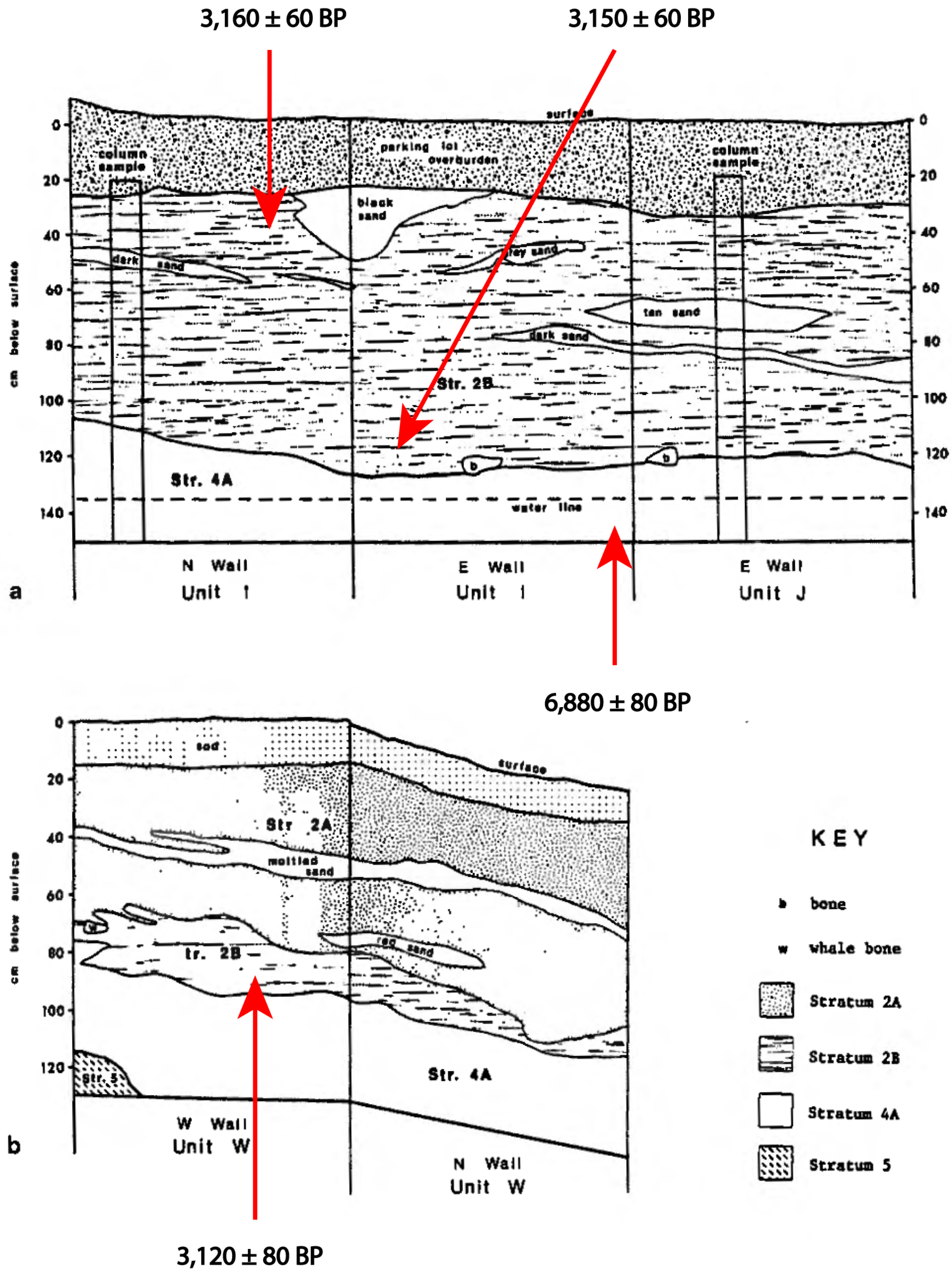

Figure 19. Illustration from Minor et al. (1986 Figure 5-2) showing stratigraphic profiles of units I, J and W. Modified in this report to display where dates were recovered in the 1984 excavation.

CHAPTER 5. DISCUSSION AND CONCLUSIONS

5.1 Discussion

The goal of this project was to provide a refined understanding of the geoarchaeological framework of the Tahkenitch Landing site (35DO130) and to identify and describe the extent of LP-EH deposits in previously unexplored areas. The following sections will further discuss the results of this project, suggest future research directions and will consider implications for LP-EH archaeology on the central Oregon coast.

5.1.1 Deposition at 35DO130

In the 1986 report, Patricia McDowell was tasked with helping define site stratigraphy and reconstructing the setting of the Tahkenitch Landing site. In chapter 10 of the Minor et al. (1986) report, McDowell provides a thorough discussion about the origins of the landform on which the site sits and provides a compelling reconstruction of the landscape at the time of occupation. While the Holocene occupation was addressed by Minor et al. (1986), the underlying and assumedly older deposits were not discussed in great detail as they were beyond the scope of the project. This study reveals that the deposits underlying the shell midden at the Tahkenitch Landing site appear to be stratified, intact, and include numerous paleosols developed on Pleistocene-aged dune deposits similar to those reported by Peterson et al. (2006) and Davis et al. (2004; 2008) and Jenevein (2011). This study also shows that older Quaternary alluvial deposits (Qal) underlie Pleistocene-aged dunes in many parts of the site, and in some cases lie directly under the cultural deposits described by Minor et al. (1986). In the areas where Qal directly underlies the cultural deposits, the DORA is not present. Qal, which predates the emergence of Pleistocene dunes, appears in Cores 3C and 20K as the deepest stratigraphic unit encountered in this study.

Why don't we see the DORA everywhere? This could be for a few different reasons: 1) the dunes did not extend to that portion of the site (see Geoprobe core 20K) and Tahkenitch Landing represents an eastern limit for Pleistocene dune advancement, 2) LP-EH deposits were previously deposited but have since been eroded, or 3) the choices we made to submit radiocarbon samples have influenced the visibility of the DORA (DORA could be there and we just haven't measured it).

5.1.2 LP-EH Deposits

While Minor et al. (1986) identified an early Holocene occupation at the Tahkenitch Landing Site, no dates were obtained from the strata below these cultural components during the initial investigation. The results of this study show that sediments and soils dating to the LP-EH are present at the Tahkenitch Landing locality and that earlier cultural occupations may be present in this "Dirt of the Right Age".

The absence of marine or estuarine deposits that date to the LP-EH transition is not surprising at this location given that local sea levels would have been considerably lower prior to the emergence of estuarine conditions ~8,000 years BP. The backdrop of Tahkenitch Landing at the time of the LP-EH transition would have been an interior terrestrial environment similar to today, but with a stream system that incised more deeply into the landscape and extended further west on to an exposed coastal plain. Figure 6 illustrates coastline locations relative to Tahkenitch Lake over the last 20,000 years BP and shows the hypothesized path of a LP-EH Tahkenitch Creek drainage.

The geomorphic setting for the Tahkenitch Landing site is unique in that it marks the boundary between the expansive dune sheets and the rugged coast range. The contextual aspects of the site (ecology, food and fuel availability, and topographic shelter away from the shoreline) help explain why people continually used this site. Elsewhere along the Oregon coast is high relief, where coastal cliffs lie adjacent to the steep coast range and the coastal plain is essentially non-existent. These types of environments are typically harsh and provide little in the way of dry fuel and shelter from the coastal weather. The Tahkenitch Landing site provides a unique opportunity to observe intact sequences of sediment deposition spanning the last 42,000 years BP along the Oregon Coast. Dirt of the right age likely exists at the Tahkenitch Landing site because rather than being exposed to erosional processes of the modern coastline, it is situated in an area of deposition where alluvial, aeolian and estuarine processes have been moving over the landscape for the last 40,000 years.

5.2 Future Research at the Tahkenitch Landing Site and Surrounding Area

Because of the relative ease of access and the presence of deeply buried terrestrial deposits, the Tahkenitch Landing site offers researchers an opportunity to explore the potential for buried LP-EH terrestrial sites. While it is clear that some of the MH-LH archaeological record has been impacted by the construction of the private fishing resort, the older deposits located at the site appear to be intact. Furthermore, the overlying shell midden may slow degradation of perishable materials of the underlying deposits if leaching has occurred throughout the soil profile. The paleosol located below the cultural deposits represent the DORA target needed to advance the search for LP-EH aged archaeological sites at Tahkenitch Landing. While traditional excavation would provide greater detail, it may be difficult to reach these depths without encountering the water table at this location. Shallow groundwater held back archaeological investigation in the 1980s; however, a shift to exploration with the Geoprobe resulted in the discovery of previously unknown LP-EH aged terrestrial sediments with associated buried soils. Building on this study and focusing on areas where LP-EH aged deposits are located at or near the surface would be the next logical step to further explore the potential for early archaeological sites. As Minor et al. (1986) suggest, other areas with similar physiographic settings to Tahkenitch should be investigated such as the old Crown Zellerbach compound just south of Tahkenitch Landing, and Siltcoos Lake to the North. The area to the west may hold deposits of similar age to those at Tahkenitch Landing but are capped by tens to hundreds of feet of Holocene aged dunes. Finding these locations under active dune sheets may be challenging, but stabilized surfaces may be identified through coring or with the use of ground penetrating radar.

5.3 Conclusion

The work conducted by Heritage Research Associates in the 1980s shed light on one of the most significant archaeological sites along the central Oregon coast. This site is not only rich in cultural materials such as lithics, bone and antler tools, as well as other personal items, it reflects human adaption in a changing landscape. While Minor et al. (1986) conducted exceptional work, their primary focus was on the obvious midden deposits confined to the mound area. Since the time Minor et al. (1986) reported on their findings, there has been an increasing interest on locating LP-EH archaeological sites on the coastal margin. HRA's comprehensive reporting hinted that LP-EH aged deposits might be present at the Tahkenitch Landing site. This study builds upon the work of the HRA team and led to the discovery of LP-EH deposits that might hold archaeological evidence of earlier human occupants at the site.

This study presents a geoarchaeological approach to locating LP-EH aged deposits along Oregon's central coast. The methods used allowed us to collect a substantial amount of geoarchaeological information about the Tahkenitch Landing site without opening large excavation units, further disrupting culturally sensitive materials. The geoarchaeological methods used in this study, while seemingly simple, proved to be effective and should be useful for similar studies or as part of the management of cultural resources.

The use of direct-push coring in combination with radiocarbon dating proved extremely successful in conducting landscape-scale archaeological assessments as is evident by the identification of successive deposition across most of the site. Twelve dates collected from within the site and outside of the site boundaries show good age-depth association, suggesting the presence of an intact stratigraphic sequence across Tahkenitch Landing. The litho- and chronostratigraphic results presented in this study show that LP-EH transition sediments exist at or near the boundaries of stratum 4A and stratum 6, with dates ranging from ~13,000 years BP to ~10,000 years BP. While no new cultural material was identified, this study identified the presence, character, and distribution of LP-EH aged sediments and paleosols in good buried contexts across the site. In doing so, this study highlights geoarchaeological targets for archaeological exploration and demonstrates the potential that seeking the dirt of the right age holds for expanding our knowledge of the past along Oregon's central coast. The results of this project provide a more complete picture of the site formation processes and illustrates an exceptional example of environmental facies shift since the last glacial maximum.

The dates recovered as a result of this project aided in the identification and correlation of cultural components identified by Minor et al. (1986). Additional dates collected below the previously identified cultural components indicate that there are intact LP-EH deposits present at the Tahkenitch Landing Site.

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