CULTURAL RESOURCES ASSESSMENT
FOR THE
SKAGIT ENVIRONMENTAL BANK,
SKAGIT COUNTY, WASHINGTON

CONTAINS CONFIDENTIAL INFORMATION – NOT FOR GENERAL DISTRIBUTION

October 21, 2005

NWAA Report Number WA 05-46

NORTHWEST ARCHAEOLOGICAL ASSOCIATES, INC.
SEATTLE, WASHINGTON

CULTURAL RESOURCES ASSESSMENT FOR THE SKAGIT ENVIRONMENTAL BANK SKAGIT COUNTY WASHINGTON

Report Prepared for

Clear Valley Environmental Farm, LLC
Mount Vernon, Washington

By

Charles M. Hodges

October 21, 2005

NWAA Report Number WA 05-46

CONTAINS CONFIDENTIAL INFORMATION – NOT FOR GENERAL DISTRIBUTION

Northwest Archaeological Associates, Inc.
5418 - 20th Avenue NW, Suite 200
Seattle, Washington 98107

ABSTRACT

The proposed 776-acre Skagit Environmental Bank mitigation wetlands restoration project is located along Nookachamps Creek adjacent to the northeast boundary of the City of Mount Vernon in Skagit County. Geoarchaeological and archaeological investigations examined multiply-aged surfaces underlain by weathered glacial till and historical alluvium. No precontact archaeological resources were found; however, the remains of a trestle built by the Puget Sound and Cascade Railroad between 1911 and 1922 across Nookachamps Creek were recorded (Temporary Number SEB-1).

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

Clear Valley Environmental Farm, LLC (Clear Valley), is proposing to restore wetland functions to portions of a 776-acre parcel of dairy farmland in the lower Nookachamps Creek basin near the city of Mount Vernon in Skagit County, Washington. The project intends to restore riverine channel habitat and associated palustrine wetlands with the primary goal to provide compensatory mitigation for adverse impacts to aquatic ecosystems in the lower Skagit River watershed.

As part of the proposed project site preparation, Clear Valley contacted Northwest Archaeological Associates, Inc. (NWAA) to conduct a cultural resources assessment of the farm. In the course of providing information relating to the cultural resources of the project area, NWAA conducted prefield archival research that identified the locations of previously known prehistoric and historic cultural properties within the project and within a half-mile radius beyond the project boundaries. The prefield research was followed by geoarchaeological studies and an archaeological field survey. NWAA also contacted the Upper Skagit Tribe and the Swinomish Tribal Community to request information on culturally sensitive areas on or near the project (Appendix A).

Project Location and Description

The Skagit Environmental Bank wetlands mitigation project is adjacent to the eastern limits of the City of Mt. Vernon in Sections 10, 11, 15, and 14, T. 34 N, R. 4 E, (Figure 1). The overall project area encompasses about 776 acres of which 311 acres are slated for wetland restoration. The remaining acres will be restored to forested wetland or riparian habitat, or as foraging areas for overwintering waterfowl.

Clear Valley intends to construct compensatory wetlands on 311 acres in the lower elevations of the study area along the main stem of Nookachamps Creek, the lower reach of the East Fork of Nookachamps Creek, and lower Mud Lake Creek. The project will be developed in three phases and each phase will include restoration of riverine hydrologic processes, side-channel habitat, and associated palustrine emergent, scrub-shrub, and forested wetlands.

Regulatory Context

The protection of cultural resources in the State of Washington is guided by several pieces of legislation. Foremost among these is the Archaeological Sites and Resources Act [RCW 27.53] which prohibits knowingly excavating or disturbing prehistoric and historic archaeological sites on public or private land. The Indian Graves and Records Act [RCW 27.44] prohibits knowingly destroying American Indian graves and provides that inadvertent disturbance through construction or other activity requires reinterment under supervision of the appropriate Indian tribe.

Archaeological and historical studies are also conducted in the State of Washington under regulations of the State Environmental Protection Act (SEPA). This report provides documentation for information requested under the SEPA environmental checklist item B13, *Historic and Cultural Preservation*, and addresses the three areas of concern identified in the checklist item:

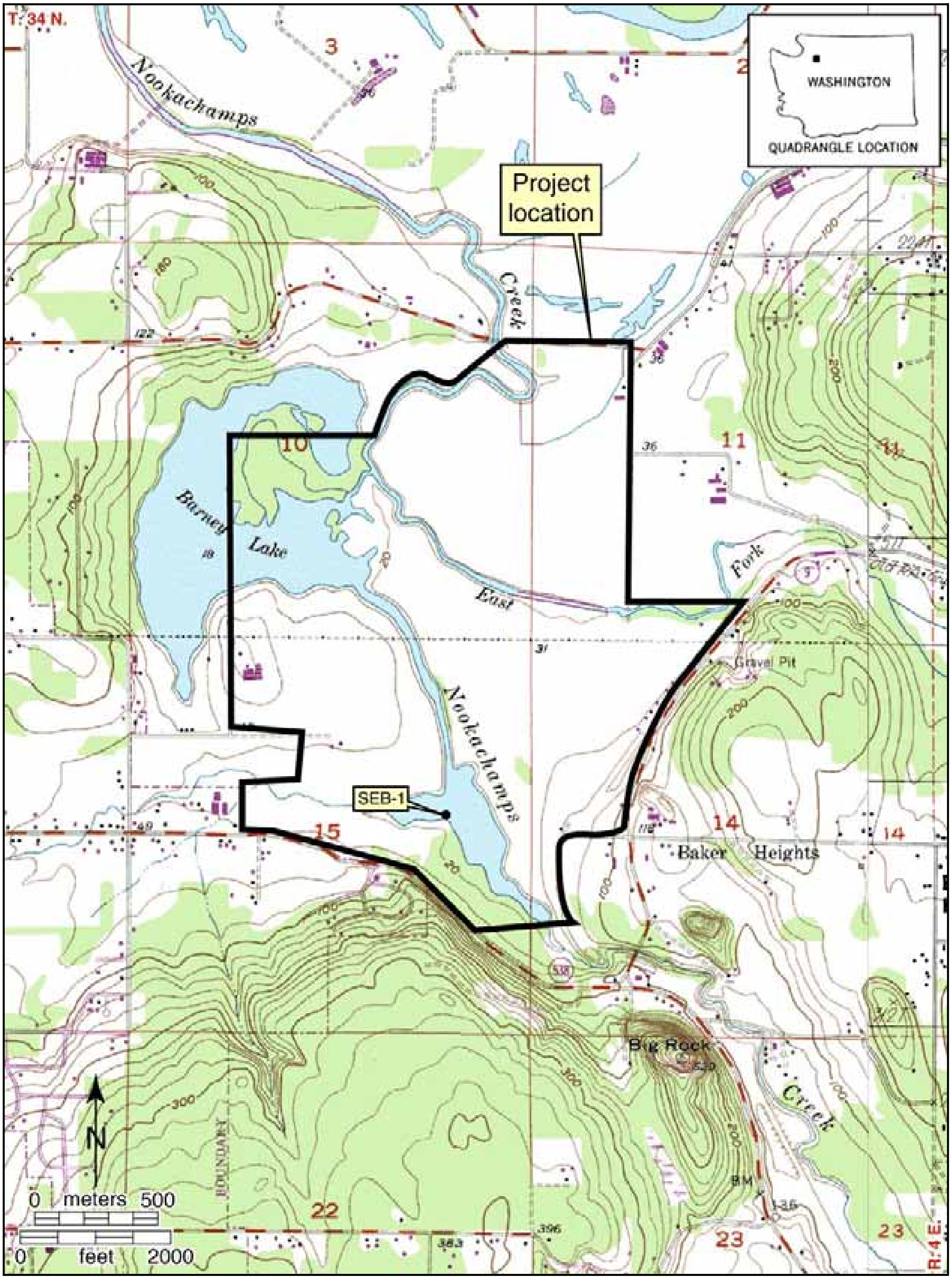

Figure 1. Project location (USGS Mt. Vernon [1956, photorevised 1981] and Sedro-Wooley [1989 provisional edition], WA, 7.5' Quads.).

13a. Identify places or objects on or adjacent to the project that are listed or proposed for listing on a historic register;

13b. Identify places or objects on or adjacent to the project that are of archaeological, scientific, or cultural importance, and;

13c. Indicate appropriate mitigation measures for historic or cultural resources.

The cultural resources assessment was designed to identify historic properties defined as any significant pre-contact Native American, ethnographic, ethnohistoric, or historic archaeological site, historic structure, or object, that may be affected by the project.

Report Organization

This report is organized into several sections and begins with summaries of the natural and cultural setting of the project and its vicinity. The summaries are followed by other sections detailing the methods used for the archaeological assessment of the parcel, expectations based on archival research, and presentation of the results generated by both the prefield research and the field investigations. The final section presents recommendations based on the results of the archival research and the fieldwork.

NATURAL AND CULTURAL BACKGROUND

Archaeological evidence indicates that the Pacific Northwest has been occupied by humans over the last 12,000 years, since the end of glaciation. Following retreat of the continental ice sheet, geomorphic, geologic, and climate changes continued to shape the landscape throughout the Holocene and have exerted an influence on people who resided in the region. The operation of natural processes such as sea level rise, changes in climate, and tectonic events have affected the potential distribution of resources used by people as well as creating landforms suitable for human occupation. At the same time, these processes have also altered the archaeological record itself by selectively preserving or destroying sites that record the lifeways of earlier resdients.

Geology and Geomorphology

The study area lies within a large north-south-oriented structural trough, called the Puget Lowland, lying between the Cascade Range on the east and the Olympic Mountains on the west and extending south from southwestern British Columbia to the Willamette Valley of western Oregon (Orr and Orr 1996). The geomorphology and surficial geology of the northern Puget Lowland is dominated by landforms and deposits associated with multiple Pleistocene glacial ice sheets that expanded southward from the mountains of southwestern British Columbia to the Strait of Juan de Fuca and the Puget Lowland (1.8 million to 10,000 years ago) (Booth and Goldstein 1994; Clague et al. 1980).

The effects of these glaciations in the Puget Lowland are expressed topographically as a series of predominantly north-trending ridges and comparatively level glacial drift uplands on which numerous surface depressions, many of which are now occupied by small lakes and peat bogs, were created as the ice retreated. The upland areas are separated by large Pleistocene glacial troughs or flutes (Galster and Laprade 1991; Liesch et al. 1963; Yount et al. 1993).

During the last glaciation, known as the Fraser Glaciation, the Puget lobe advanced south into the Puget Lowland while the Juan de Fuca lobe extended west into the Strait of Juan de Fuca north of the Olympic Mountains. The Puget lobe reached its maximum southern extent near the town of Centralia about 14,500 years before present (B.P.) (Kovanen and Slaymaker 2004; Porter and Swanson 1998). After remaining stationary for about 1000 years, the ice then began to retreat rapidly northward, reaching Seattle by 13,600 B.P. and then northern Whidbey Island by about 12,850 B.P. (Easterbrook 2003; Porter and Swanson 1998). During the time of its maximum advance, the ice attained an average thickness of about 1730 m (5,675 feet) near Mount Baker, northeast of the study area, and thinned southward to about 1200 m (4,000 feet) near the city of Everett (Booth et al. 2003; Dethier et al. 1995).

During ice advance portions of the Puget lobe pushed up the Skagit River from the Puget Lowland. The ice initially flowed almost due east (upvalley), but then later flowed south-southeast across the highlands once the glacier thickened enough to overtop divides. Evidence in the valley for the ice movement includes deposits of ice-rafted stones, flow tills, and subsidence features (Heller 1980). Alpine glaciers in the upper Skagit River at the crest of the Cascade Range had already advanced to their maximum positions and begun retreating as the Puget lobe advanced up Cascade Range valleys from the Puget Lowland (Heller 1978; Porter 1976; Waitt 1977).

During the maximum extent of the ice sheets, global sea level was about 390 feet below the present sea level (bpsl). As the ice sheets melted away, global sea level rose rapidly to about 30 feet bpsl between 13,000 years ago and 7,000 years ago. After 7,000 years ago, the rate of sea level rise slowed and by about 5,700 years ago sea level was about 16 feet bpsl. At the same time that global sea level was responding to waxing and waning of the continental ice sheets, local relative sea level in the Puget Sound basin was affected by isostatic rebound. Depending on the thickness of the overlying ice, land that had been depressed under the weight of the ice rebounded to elevations ranging between 197 and 262 feet. The rebound appears to have halted by 9,000 years ago at which time worldwide sea-level rise began to drown the early Holocene shorelines (Dragovich et al. 1994). Rising global sea level resulted in renewed deltaic sedimentation and formation of deltas in Puget Sound marine embayments such as the lower Skagit and Nooksack River valleys (Crandell 1963; Dragovich et al. 1994).

To complicate matters even more, when the western lobe of the ice sheet withdrew from the Strait of San Juan de Fuca about 13,500 years ago, marine waters invaded the northern Puget Lowland, inundating most of the San Juan Islands and Whidbey Island as well as the lowland north of Bellingham (Kovanen and Slaymaker 2004) (Figure 2). The estimated elevation of this marine invasion 48 kilometers (30 miles) north of Everett is just under 60 m (197 feet)(Dethier et al. 1995). At this elevation only the upper 70 m of Burlington Hill, just north of the proposed project, would have been exposed above sea level.

Cutbanks, gravel pits, and other exposures around northern Puget Lowland show a broad mix of deposits associated with the marine incursion ranging from poorly sorted matrix-supported, cobble-rich deposits (diamictons) to laminated silty clay. Exposures of massive to laminated marine silt are common in the Mt. Vernon-Conway area; a recently studied section in the Big Lake area showed deposits of pebbly sand and gravel beneath silt containing freshwater gastropods, suggesting the area was a beach about 13,300 years ago (Dethier et al. 1995).

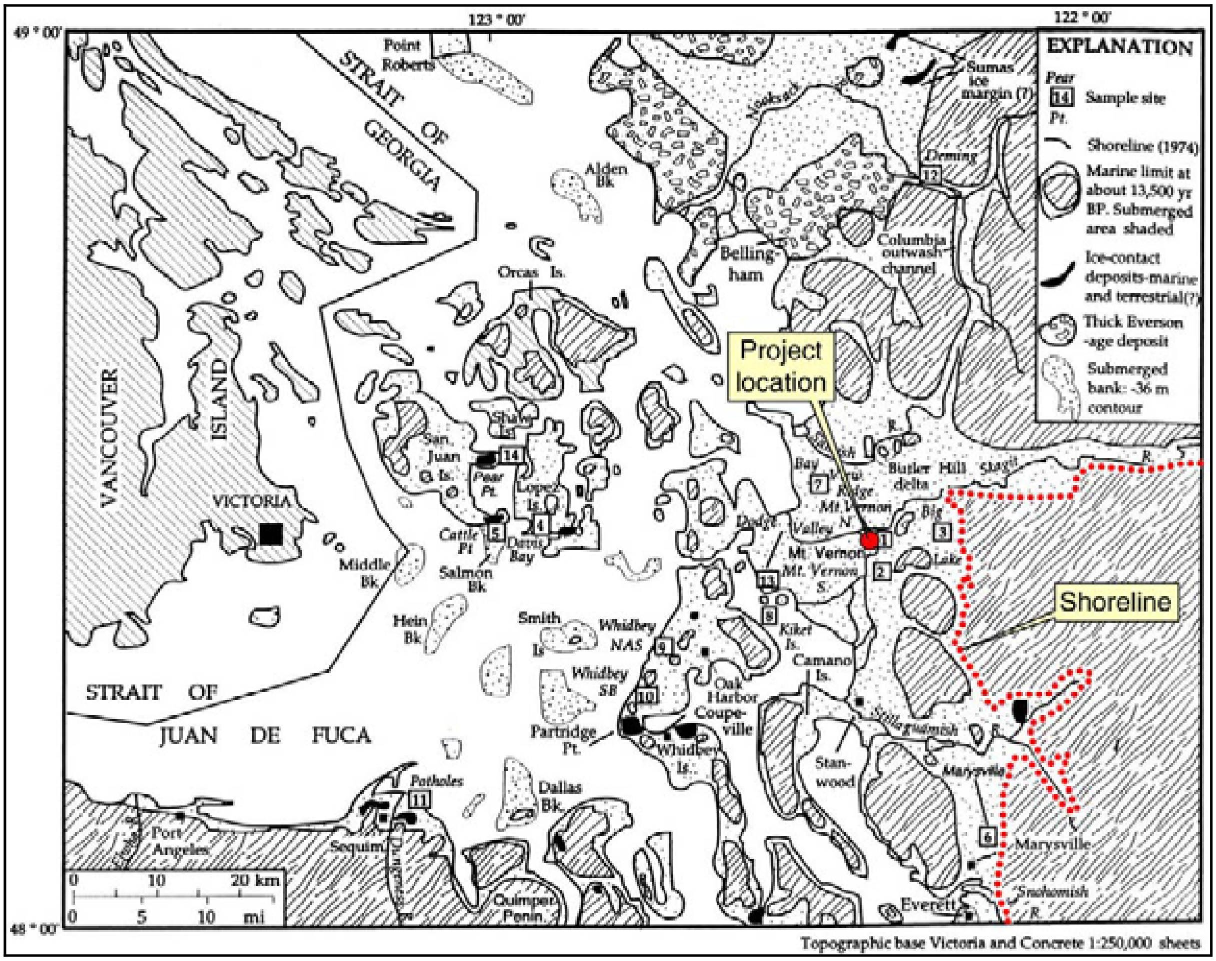

Figure 2. Map showing the limit of the marine incursion following ice retreat at about 13, 500 years ago (from Dethier et al. 1995).

Globally, present-day deltas are relatively young since they have formed only after the commencement of sea level rise during post-Pleistocene times (Stanley and Warne 1997). The lower reaches of the modern Skagit River rest on a Holocene delta that began growing (prograding) seaward about 11,000 years ago from a location near the present town of Hamilton. By about 5,000 years ago the delta had prograded Samish, Padilla, and Skagit bays and engulfed several islands, such as Burlington Hill, in the process. Areas of active delta growth shifted over time and the delta now consists of two inactive lobes, northern and western, and the currently active southern lobe where the Skagit River empties into Port Susan. The western lobe is separated from Fidalgo Island by Swinomish Channel (Thompson 1978). Delta growth has also been enhanced by sedimentation due to lahars originating on Mt. Baker and Glacier Peak. Around 5,000 years the lower Skagit River valley was inundated by lahar runout flows associated with eruptive events on Glacier Peak. These laharic sediments now form 10- to 50-foot-high terraces adjacent to the flood plain in the lower Skagit River valley and surround Burlington Hill just north of the project area (Dragovich et al. 2000).

The Puget Lowland is also a geologically active region that has experienced at least seven great earthquakes since 3500 B.P., including an event dated to 1700 A. D. (Atwater and Hemphill-Haley 1997; Atwater and Hemphill-Haley 1997; Atwater and Moore 1992). Recent paleoseismic research on the Snohomish River delta south of the project area has found evidence for five episodes of plate movement based on three episodes of liquefaction, at least one abrupt subsidence event, and at least one tsunami, all occurring since about 800 A.D. (Bourgeois 2001).

In historic times, the lower Skagit River was notorious for logjams, and steamboat travel above Mount Vernon was blocked by a large raft logjam just upstream from the town until 1879, when a hand-hewn passage through the jam was completed. According to historical documents reviewed by Collins and others (2002:102-103) this jam was 9 m (30 feet) deep and consisted of from five to eight tiers of logs ranging from three to eight feet in diameter. Beginning in the nineteenth century the Army Corps of Engineers began removing snags from most of the large rivers emptying into Puget Sound; on the lower Skagit River alone in the 10 years between 1898 and 1908, 30,000 snags were removed (Collins et al. 2002).

Through the Nookachamps reach, the Skagit River now exhibits a relatively low-sinuosity single-thread channel planform, though formerly the river exhibited a more complex meandering pattern characterized by scroll-and-swale topography, oxbow lakes, and cut-off meanders. In 1872 Nookachamps Creek joined the Skagit River through an abandoned meander of the main-stem Skagit River, but now the creek directly empties into the Skagit River. The same GLO map shows the course of the East Fork Nookachamps Creek prior to its being channelized and moved to its current position (Figure 3).

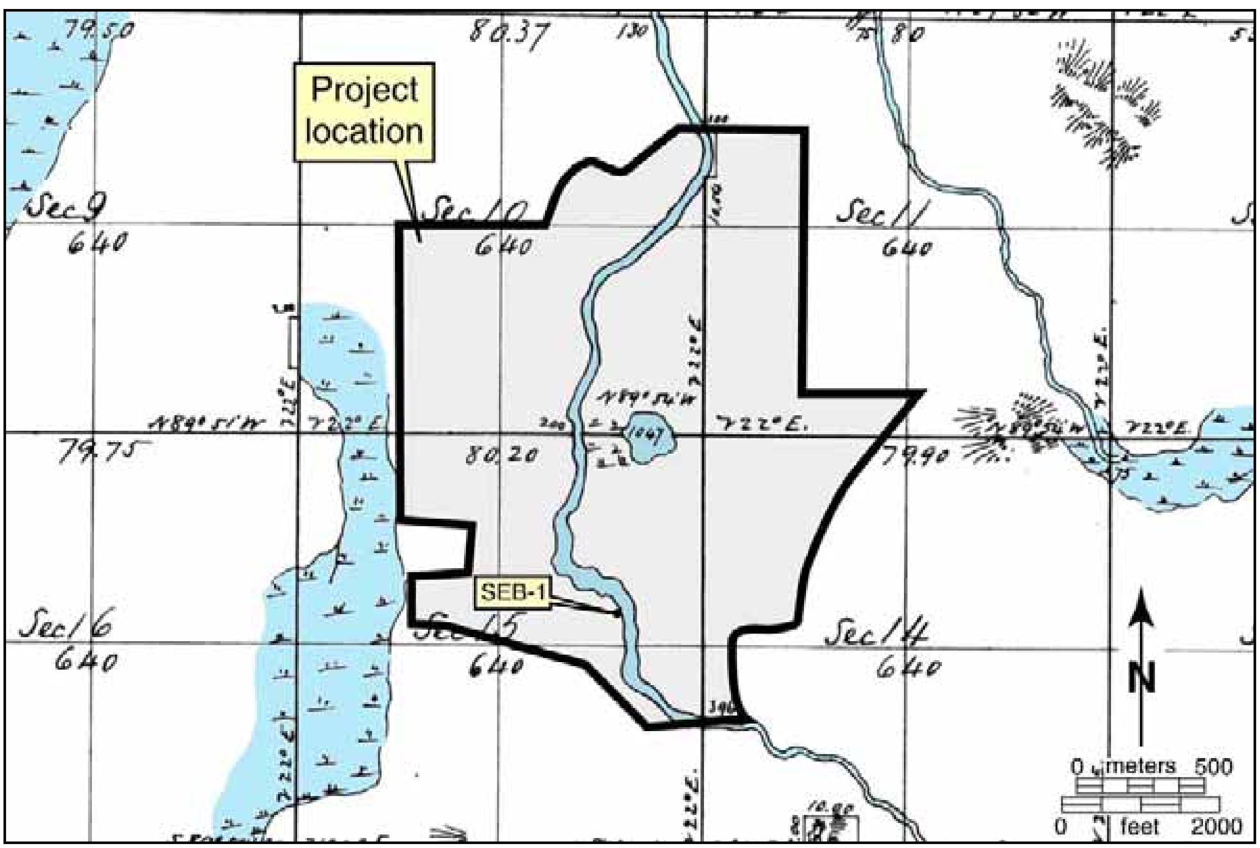

Figure 3. Portion of the GLO map for T. 34 N., R. 4 E. showing the original course of Nookachamps Creek through the study area, 1872.

Climate and Vegetation

Northwest Washington is characterized by a temperate maritime climate regime with warm summers and moderate winters. Summer average temperatures are about 61˚ F; during the winter temperatures average about 40˚ F. Rainfall is typically light during summers so that several weeks can pass without precipitation; however, winters experience frequent rains with the highest amounts of precipitation occurring late in fall and in winter.

Like most of the northwest coast of North America, the Puget Lowland is covered with extensive stands of coniferous forest that comprise the *Tsuga heterophylla* (western hemlock) vegetation zone. The species comprising the potential vegetation of this zone are western hemlock, western red cedar, and Douglas fir, with Douglas fir being the dominant species. Old growth forest understories are typically dense, consisting of shrubs and herbaceous species dominated by sword fern, salal, Oregon grape, ocean spray, blackberry, red huckleberry, and red elderberry (Franklin and Dyrness 1973). Bigleaf maple and red alder are common in moist areas subject to disturbance; stream courses and flood plains are dominated by red alder, black cottonwood, bigleaf maple, and other riparian plants. Wetlands are common in river valleys and typically support willow, alder, cranberries, cattail, reeds, wapato, nettles, and skunk cabbage.

In the nineteenth century General Land Office surveyors noted that the floodplains of Puget Lowland rivers consisted of a mix of conifers and hardwoods. Most of the trees were hardwoods, but conifers provided the most biomass (that is, were the biggest trees). Western redcedar and Douglas fir were widely distributed and found in all river valleys, but rarely lived in streamside settings (Collins et al. 2002:97-98).

Fauna

Puget Sound is a diverse marine environment that has long provided a rich array of resources for humans living around Puget Sound. The areas of open water in the Sound harbor squid, shrimp, various sea mammals, and runs of sockeye and chinook salmon, and steelhead trout. Although, salmon and steelhead trout may be the best known of Puget Sound fishes, there are 211 species of fish indigenous to Puget Sound (Kruckeberg 1991) including bottom-dwelling species such as ling cod, flounder, sole, rockfish, and invertebrates such as clams, sea cucumbers, crabs, starfish, and octopuses. The intertidal zone includes invertebrates such as crabs, shrimp, clams, oysters, mussels, sea anemones, sea stars, sponges, ribbon worms, round worms, chitons, barnacles, sea urchins, and sand dollars (Kruckeberg 1991). Marine plants include phytoplankton, eel grass, and many kinds of seaweed.

The Puget Sound basin and the western slopes of the Cascade Range contain a wide variety of marine and terrestrial resources. Larger mammals common to low- and mid-elevation forests in the Puget Lowland and Cascade Range include black-tailed deer, elk, and black bear. Black-tailed deer tend to prefer meadow fringes, and are especially fond of burns where the thick vegetation provides an abundance of browse. Although usually found in ecotones between grassy areas and forest, or in small islands of trees or shrubs, some groups live in deep, old-growth coniferous forest (Maser 1998). Both deer and elk migrate to higher elevations during the summer months where open spaces afford more sunlight and grass.

At higher elevations marmots, goats, sheep and large birds (grouse and especially ptarmigan) tend to frequent alpine landscapes. Marmots, which can weigh up to 8 pounds, live in rocky areas in lava fields, rockslides, and large talus at the bases of cliffs. Mountain goats are generalist herbivores who inhabit a variety of elevations and can live in different forest types, but are always located near cliffs. In western Washington, mountain goats summer above 5,000 feet in cliffed areas and snowfields. Also at higher elevations, bighorn sheep inhabit alpine meadows, grassy mountain slopes and foothill country in proximity to rugged, rocky cliffs and bluffs. Sheep migrate seasonally and typically use larger upland areas in the summer while concentrating in sheltered valleys during the winter. Their winter range usually lies between 2,500-5,000 feet in elevation; summer range is between 6,000 and 8,500 feet.

In addition to ptarmigan and grouse, waterfowl such as ducks, geese, and swans are seasonally abundant at lower elevations. Lakes, ponds, rivers and marshes hosted migratory and resident waterfowl as well as freshwater fish (Kruckeberg 1991; Larrison 1967).

Paleoenvironments

Regional pollen data recovered from cores in lakes and wetlands in the central Puget Lowland show that there have been several climate-induced shifts in the composition and distribution of regional vegetation since the end of the Pleistocene (Tsukada 1982; Whitlock 1992). As land emerged from under the ice sheets at the end of the Fraser glaciation, the Puget Lowland was colonized initially by pioneer species such as lodgepole pine, bracken fern, and red alder, followed by Douglas fir a few centuries later (Barnosky 1985). As the climate continued to warm during the early Holocene, grasslands and oak/hazel woodlands were established and, after a brief period of suppression, Douglas fir became the dominant tree species between 10,500 and 7,000 years ago. At the height of postglacial warming, between 10,000 and 5,000 years ago, overall effective moisture levels had dropped and precipitation exhibited a marked seasonal pattern characterized by increased droughty conditions during the summer. During this period, fires were more common and local prairies in the central Puget Lowland expanded their ranges. After about 7,000 years ago, cedar and hemlock pollen began to increase and continued to do so until reaching a peak about 5,000 years ago. The modern climate regime was established by 5,000 to 4,000 years ago when cool, moist climate conditions prevailed and closed canopy cedar and hemlock climax forests came to predominate (Tsukada 1982; Whitlock 1992). The climate since then has been marked by small-scale changes fluctuating between warmer/drier and cooler/moist conditions (Leopold et al. 1982).

Cultural Setting

Prehistory

A few dated archaeological sites and surface finds attest to the presence of people in coastal western Washington and southern British Columbia by at least 11,000 years ago (Carlson 1990; Matson and Coupland 1995). People living in North America during this time period are referred to as Paleoindian and their presence is marked by a highly distinctive projectile point style known as Clovis. The earliest radiocarbon ages associated with Clovis points in the West date to about 12,000 years ago (Meltzer 2004), and several of these points have been found west of the Cascade Mountains in Washington. A single basalt fluted point was found near Coupeville on Whidbey Island (Shong and Miss 2002), and a fluted point fashioned from chert was recovered from peat deposits near Maple Valley south of Seattle (Meltzer and Dunnell 1987). Other finds have been reported from near Olympia in the southern Puget Lowland and from within the Chehalis River valley (Morgan 1999; Schalk 1988). The Clovis people are believed to have been mobile hunters whose economy was primarily focused on hunting megafauna species (such as the mammoth) that became extinct soon after the end of the last glaciation.

Other early Holocene archaeological sites in western North America contain projectile points types, such as large stemmed, shouldered, and lanceolate styles, that closely follow, or are contemporaneous with, the fluted points. The period spans from about 8000 B.P. to about 5000 B.P. and, although the period has been given different names under different prehistoric cultural chronologies, is generally referred to as the Early period. In western Washington, the regional manifestation of these early Holocene economies has been termed Olcott, after the type site in Snohomish County along the Stillaguamish River (Kidd 1964). Artifacts associated with Olcott sites include large leaf-shaped and stemmed points, scrapers, flake tools and blade cores, and typically fashioned from fine-grained extrusive volcanic rocks (Carlson 1990). The sites are often found in elevated areas at some distance from tidal areas despite their general proximity to the coast. Olcott sites have been identified around Lake Cushman on the Olympic Peninsula and on glacial terraces above Hood Canal (Wessen and Welch 1991). Features such as hearths and structures, or plant and animal remains, which would offer insights into the settlement and subsistence of these early Holocene people, are usually absent from the sites, although the Olcott component of a large archaeological site several kilometers inland from the Strait of Juan de Fuca near the town of Sequim contains discrete clusters of lithic material that have been interpreted as stone tool manufacturing locales (Morgan 1999). Olcott-like material also has been recovered farther inland at Marymoor Park in Redmond (Greengo and Houston 1971) and near the present-day Tolt Water Treatment Facility (Blukis Onat et al. 2000).

During the period from about 5000 B.P. to 2500 B.P., the human population of western Washington increased and socio-economic organization of communities exhibited greater complexity (Ames and Maschener 1999). Groups exploited a wider range of marine resources, including sea mammals, fish and shellfish, and the kinds of archaeological sites that date to this period are diversified with respect to setting and inferred function. Increasingly specialized use of local environments, such as prairies and salmon streams, is apparent from site distribution and artifact types. Ground stone implements appear in both coastal and inland sites after 5000 B.P.; and bone and antler tools, including toggling harpoons, and ground shell found in shell midden sites have also been found, suggesting marine mammal hunting.

Archaeological trends such as full-scale development of marine-oriented cultures on the Pacific coast, the presence of a mixed marine and terrestrial economy along the shores of Puget Sound, and development of an inland terrestrial mammal and riverine fishing tradition are differentiated by the Late prehistoric period, from about 2500 B.P. until widespread Euroamerican contact in the early 19th century (Ames and Maschener 1999). The period witnessed increased community-level aggregation in permanent or semi-permanent winter villages at river confluences and along tidewater shorelines. At the same time, seasonal use of specialized upland and lowland camps focused on the harvesting of targeted resources such as salmon or camas also increased. The archaeological evidence of these increasingly developing patterns is seen in the greater diversity of hunting, fishing, plant processing, and woodworking tools found in Late period sites.

Ethnography and Ethnohistory

The people in the southern Puget Sound lived in centrally located autonomous villages, and engaged in a seasonal cycle of movements to other smaller and more informal settlements in order to exploit regional resources. The village was the focal point for winter activities and served as the center of the social and ceremonial life for the local groups. Each village typically consisted of between two and four longhouses, some up to 100 feet long, and were constructed of cedar planks with shed or gabled roofs. Each house provided shelter for one to four families and was occupied from late fall to early spring. Boundaries between villages were traditionally based on watersheds, with people from each village exercising exclusive use in the areas immediately surrounding the village and for some distance upstream (Smith 1940).

Groups were not coordinated by any political structure and formed a continuous cultural series. Permanent houses were located at strategic points along waterways, generally at the mouths of rivers or of smaller streams. Territorial control was usually exercised in the area immediately above and below the village, but territories of contiguous villages rarely directly contacted each other so that there were frequent stretches of relatively unused country. The mouth of every stream of any size, however, contained from one to five named house clusters which were often within shouting distance of one another (Smith 1941).

Upper Skagit villages, like others in the Puget Sound region, might extend some miles along the river with several separate living sites within them. Houses on a tributary entering the river were sometimes regarded as belonging to the same village as the houses on the main river near the mouth of the tributary (Collins 1974). Villages were settlements inhabited in the winter and cool months where shelter was provided by permanent housing in the form of one or a cluster of several cedar post-and-plank houses. Camps, on the other hand, were used by visitors from several nearby villages. At fishing camps and particularly at hunting sites for beaver, racks and small smoke-houses were built. All settlements, apart from the most casual, were economically significant, sited at or near good fishing, game or collection areas. All villages with permanent housing were at or near excellent fishing (Snyder 1980).

During the spring, summer, and fall, people would journey from their villages to temporary camps established on streams during salmon runs. Smaller groups also traveled to other localities from which they would hunt, gather plant resources, and fish for other, non-salmonid fishes (Haeberlin and Gunther 1930; Smith 1940; Suttles and Lane 1990). Large or important game were deer, elk, bear, mountain goat, and beaver. In addition to the meat, elk and deer sinew were used as sewing thread; pelts of bear and beaver, hides of elk and deer, and wool of goats were used in fashioning clothing and other fasteners. Ducks were hunted for their flesh, feathers, and down (Snyder 1980:33-34). Hunting techniques included drives (deer only), bow-and-arrow, spearing, pits and deadfalls, and snares.

People living along the Skagit River, like other Puget Sound Salish-speaking groups, in winter relied mostly on stored foods, particularly salmon, and spent time making and repairing tools, clothing and other items, and engaging in religious and ceremonial activities. At the end of winter, the village inhabitants dispersed into smaller groups and traveled to seasonal sites throughout their territory to fish, hunt, and gather resources as they became available.

Vegetable foods included sprouts, roots and bulbs, berries, and nuts. The most important roots and bulbs were probably bracken, camas, and to a lesser extent, wapato. Important berries included the salmonberry, thimbleberry, trailing blackberry, blackcap, serviceberry, salal berry, red huckleberry, blueberry, and red and blue elderberry (Suttles and Lane 1990). Around 20 species of waterfowl were caught. Hunters went out on dark nights with fires in their canoes and caught ducks with a multiprong spear or a net on a shaft. Ducks were caught in long nets raised between pairs of high poles, in nets anchored underwater over places where herring were spawning, and in snares. Seagulls were caught with gorges (Suttles and Lane 1990:489).

The Nookachamps (also known as *dvkacäbis)* lived along the Skagit River from Mt. Vernon to Sedro Woolley and up the Nookachamps Creek drainage including Clear and Big Lakes (Smith

1941). At the time of the signing of the Treaty of Point Elliot in 1855 they still inhabited the lakes, the Nookachamps River, and the villages from Mount Vernon to just below Lyman (Blukis Onat et al. 1980).

In the vicinity of the study area were several ethnographic villages. South of the present town of Burlington on the south bank of the Skagit River and east of the railroad bridge was the village of *swiwíshəb* with one large winter house. Between Burlington and Sedro Woolley on the south bank of the Skagit and east of the mouth of Nookachamps Creek was a summer fishing village called *scácuks* with five small houses. One large winter house named *wác ʹal?ə* (“high ground”) was located on Nookachamps Creek where the creek entered the Skagit below Burlington – this location was known as a good place to get suckers and silver salmon. One large winter house called *culácab ˘s* was at Big Lake and another large winter house, sqˀəxʷs˘əd, was at Clear Lake (Collins 1974)

Before the arrival of Europeans in 1774 it is estimated that as many as 200,000 Native Americans inhabited the Northwest Coast culture area, making it one of the most densely populated nonagricultural regions of the world. Within 100 years, the aboriginal population had declined by over 80 per cent (Boyd 1990:135). The Puget Sound area suffered in the initial smallpox epidemic of 1775, as well as later epidemics in 1801. Another smallpox or measles epidemic occurred in 1824, and measles was definitely present in 1848. The 1853 smallpox epidemic in Washington and the 1862-1863 epidemic in British Columbia marginally affected the Central and Southern Coast Salish due in part to the widespread use of smallpox vaccine around the missions and populated areas (Boyd 1990:145-6).

Four of the Upper Skagit villages were signatories to the Treaty of Point Elliott in 1855, but no reservation had been established for them at the time of the treaty. The Upper Skagit finally received federal recognition in the early 1970s, and in 1984 84 acres of reservation trust land were set aside for them east of Sedro-Woolley.

History

Mount Vernon was initially settled by Joseph Dwelley and Jasper Gates in 1870 when they moved upriver from Whidbey Island (Willis 1973) but growth of the city was overshadowed by LaConner until the large log jam in the Skagit River just upstream was removed in 1879. Although the river above the logjams was explored in 1858 no permanent settlement occurred above Mount Vernon until after 1879 when the logjam was finally cleared (Blukis Onat et al. 1980).

With access to the interior, Mount Vernon began to experience rapid growth as sternwheelers arrived to serve the growing trade with towns developing up the Skagit River. With the arrival of the transcontinental railroads and the development of the logging industry, the city soon became an important transportation and transhipment center for goods moving downriver from the interior and north-south along the Puget Lowland. The growth of Mount Vernon soon outstripped LaConner and Mount Vernon was made the county seat of Skagit County in 1884.

A number of local railroads were built to take advantage of trade along the Skagit River and to move goods up and down the Skagit River. The Fairhaven and Southern Railway, building from Bellingham Bay toward Sedro, was completed to the north bank of the Skagit River in 1889.

The Seattle, Lakeshore and Eastern was completed from Seattle through the long north-south valley containing Clear Lake, Beaver Lake, Big Lake, and Lake McMurray, and continued on north through Woolley and on to Sumas at the Canadian border. The Seattle and Northern was incorporated in 1888, and began construction in 1889 at Anacortes. By 1890 regular trains were running between Anacortes and Woolley; at the latter stop, connections were made to the Seattle, Lakeshore and Eastern. Finally, the Seattle and Montana Railroad, being constructed eastward from Anacortes, was bought out by the Great Northern Railway, and when finished the line connected Seattle and New Westminster in British Columbia. By 1893, the first railway bridge was completed across the Skagit River.

Timber harvesting became an important component of the local economy after the logjam above Mount Vernon was removed and logging reached its height during the late nineteenth and early twentieth centuries with the development of large-scale operations in the foothills below Concrete. After the jams were cleared, logging proceeded rapidly up the Skagit. In 1888 there were 17 logging camps between Mount Vernon and Lyman. Mills also began to be built, and after completion of the Northern Pacific Railroad into Seattle in 1887, cedar shingles became an increasingly important commodity that was shipped to the Great Plains states served by the Northern Pacific (Willis 1973:43). One of the largest outfits was the logging operation on Day Creek.

An important component of logging was transporting the freshly cut timber to the mills via narrow-gauge logging railroads. One of the larger railroad logging operations was the Puget Sound and Cascade Railroad which operated from just south of Sedro Woolley on the south side of the Skagit River to Finney Creek from whence it carried logs to the mills at Sedro Woolley. Construction of the line began in 1911 and the first load of logs was shipped out in late 1912. The new railroad consisted of 10 miles of track, three locomotives and forty cars; by 1922, the line had been extended over Nookachamps Creek and up the Skagit River (Thompson 1989).

As important as logging has been in the history of the lower Skagit Valley, farming has been the main industry. The early cash crops produced in the valley focused on oats, barley, hay, and potatoes. Most of these crops were raised for sale to the mining camps and urban markets of California. Hops were also grown while cabbage, turnip, cauliflower, and mustard were raised for seed (Oakley 2004; Willis 1973). The tulip bulb industry developed out of the seed production industry, beginning in 1906 with bulbs imported from Holland. By the late 1920s, farms were also growing vegetables under contract with packing companies, including peas, green beans, and spinach (Oakley 2004).

Almost all early farms kept small herds of dairy cattle but the area began producing quantities of butter and milk when creameries were introduced after 1895. Major changes occurred with the advent of pasteurization and the increase of milk production due to the introduction of purebred stock. Dairying became a much more commercialized operation and co-ops (such as Darigold) were formed to help defray the costs of breeding programs and equipment upgrades.

Nookachamps Creek and the lower Skagit River are notorious for flooding. Indeed, neighbors, referring to an early settler family of the lower Skagit River, observed that “They built a house on the banks of the Nookachamps, which was a mistake, as it flooded frequently. Finally in 1936, they bought five acres on the hill just south of where they lived adjoining their property. They moved their house and barn up on the hill, and the next serious flood was about 15 years later.” (Solidaritet Lodge #396 2001:154).

Although there were some early attempts to build flood protection levees along the river, the first real effort to reign in the floods began in the 1890s, especially after the major floods of 1892, 1893, and 1894. The flood of 1894 inundated practically the whole flood plain of the Skagit River from above Marblemount to salt water; a flood in 1909 covered almost the whole delta (Willis 1975).

Previous Archaeological Research

A review of previous archaeological research informs about the range and types of sites, artifacts, and features found by previous archaeological projects in the vicinity of the project. The information gathered about site stratigraphy and geomorphology, site types, site assemblage characteristics, features, and the conditions of discovery can be used to extrapolate to nearby areas to estimate the probability for discovery of archaeological resources in the study area.

Few cultural resources studies have been carried in the proximity of the proposed project (Table 1). Two precontact archaeological sites have been recorded in upland settings overlooking Nookachamps Creek just downstream from the study area (Table 2). Archaeological site 45-SK-69 is located on drift upland north of Barney Lake and is just outside the project area along its northern and northwestern boundary. The second site, 45-SK-70 is downstream on a lower terrace overlooking the left (west) bank of Nookachamps Creek a short distance below the study area.

Farther downstream, however, an extensive study along the Skagit River flood plain (Bush 2004) did not find archaeological materials in spite of using pedestrian survey, shovel probing, and backhoe trenching throughout a sizable flood plain tract on the left bank of the Skagit River just below the confluence of Nookachamps Creek with the Skagit River.

Table 1. Previous Archaeological Research Within One Mile of the Skagit Environmental Bank Project Area.

AUTHOR	DATE	TITLE	RESULTS
James Hale, Ross Smith, Richard Hutchings	June 2004	Cultural Resource Assessment of the CREP Buffer Installation Project at the Moore Property, Skagit County, Washington	No new cultural resources identified
Kelly R. Bush	June 2004	Archaeological Investigation Report, Nookachamps Mitigation Preserve Project, Mount Vernon, Washington	No new cultural resources identified
Sheila A. Stump	June 1990	Class I Historic Properties Inventory of the Proposed AT&T Fiber Optic Cable Route Blaine to Everett, Washington	Inventory showed 59 historic properties, 2 historic districts, 17 archaeological sites and 18 ethnographic sites along corridor.

Table 2. Previous Sites Recorded Within One Mile of the Skagit Environmental Bank Project Area.

SITE NO.	COMPILER	DATE	SITE TYPE	RELATIONSHIP TO PROJECT
45SK69	W. Dancey; Onat, Schmidt, Cressman, Oswald, Woodruff	September 1969; August 1974	Shell midden with associated artifacts	0.15 mile north of project area
45SK70	W. Dancey; Onat, Schmidt, Cressman, Oswald, Woodruff	September 1969; August 1974	Midden, cooking depression and burial	0.3 mile north of project area
26-00186	unknown	no date	South Fork Nookachamps Creek Bridge	

EXPECTATIONS

The landscape setting and the presence of previously recorded archaeological sites downstream from the study area suggested high potential for significant archaeological materials to be present in the study area. The landscape setting includes flood plain areas as well as adjacent upland areas overlooking the riparian zones along Nookachamps, East Fork Nookachamps, and Mud Lake Creeks. Surfaces of variable antiquity are probably represented within the project area in addition to the potential for buried surfaces under the central flood plain closest to the channel of Nookachamps Creek.

METHODS

Fieldwork employed backhoe trenches (BHT), bucket augers (AH), shovel probes (SP), and pedestrian survey to examine the project area for potentially significant archaeological materials (Figure 4). The whole 776-acre parcel was considered when deciding on sampling strategy, but particular attention was paid to the 311 acres proposed for restoration.

Phase 1 fieldwork used geoarchaeological techniques to collect geomorphic and sedimentological data to develop a landscape history of the study area and search for buried occupation surfaces. Thirteen backhoe trenches (BHTs) were excavated using a rubber-tired backhoe equipped with a standard 2-foot-wide bucket. Each trench was excavated to a depth of five feet (150 cm) below the modern surface. Both trench walls were inspected, and one wall was cleaned thoroughly and examined for the presence of archaeological materials. The depositional sequence in each trench was described and illustrated with graphical logs (Appendix B). Sediment descriptions and the definition of bounding contacts are based on visual inspection and hand texturing. Selected trenches were excavated below five feet and the sediment brought up in each bucket-load was examined for archaeological materials. The backhoe trench data was supplemented during the Phase 2 archaeological investigations with six hand-excavated auger holes.

Thirteen backhoe trenches were excavated during Phase 1. The Nookachamps Creek flood plain south of the creek's confluence with East Fork Nookachamps Creek was transected with two lines of backhoe trenches. The southern transect consisted of BHTs 1 through 6 which were placed at intervals ranging from 75 to 100 m. The second transect consisted of AHs 5 and 6, and BHTs 9, 10, and 11 placed at considerably wider intervals along the current course of East Fork Nookachamps Creek.

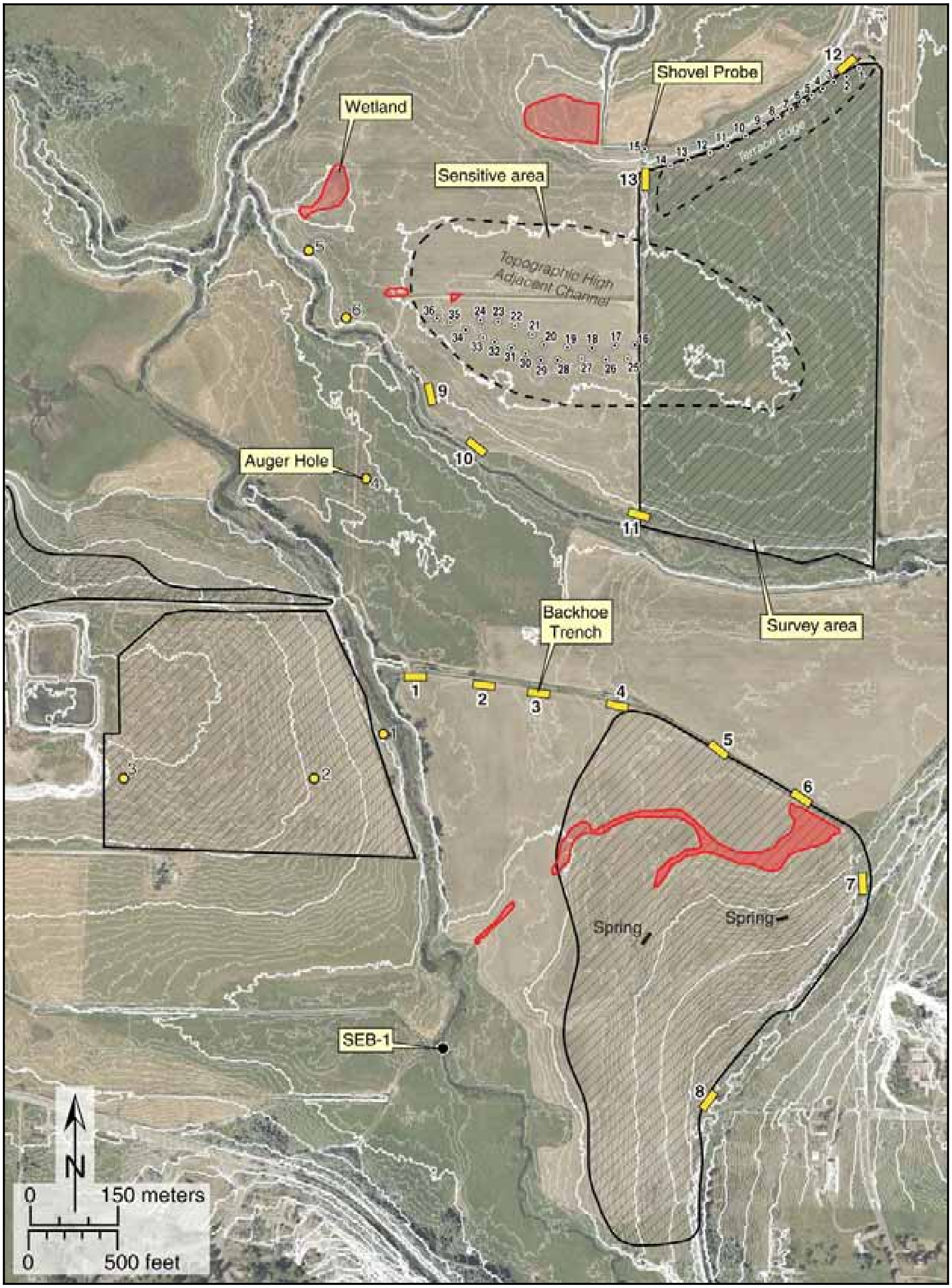

Figure 4. Locations of backhoe trenches, auger holes, shovel probes, and pedestrian survey blocks within the study area.

The fill underlying the terrace above Mud Lake Creek was examined with BHT 12, and BHT 13 was placed in the approximate nineteenth century location of the East Fork Nookachamps Creek channel as depicted by the GLO (Figure 3). The lower valley slopes above the flood plain were examined with two backhoe trenches on the east slope (BHTs 7 and 8) and three auger holes on the west slope (AHs 1 - 3).

The Phase 2 archaeological fieldwork employed pedestrian survey and shovel probes to examine more closely areas of the project considered to have high potential for harboring archaeological materials. Using the results of the Phase 1 backhoe work, selected areas above 40 feet elevation were surveyed in transects with surveyors spaced 30 m (about 100 feet) apart. Areas surveyed included a rectangle extending south from Mud Lake Creek to East Fork Nookachamps Creek, the high ground on the lower valley slopes in the southeast portion of the project, the slope below the milking barns on the west slope, and the high ground along the southern margins of Barney Lake. Visibility ranged from excellent (early corn) to poor (pasture). Fifteen shovel probes were excavated at 30-m intervals along the terrace edge overlooking Mud Lake Creek in the northeast portion of the study area; an additional 21 shovel probes were placed in a staggered pattern at approximate 30-m intervals along a subtle curvilinear topographic high on the flood plain overlooking the present confluence of Nookachamps Creek and East Fork Nookachamps Creek.

Ash-sized volcanic tephra recovered from AH 6 was sent to GeoAnalytical Laboratories at Washington State University for glass identification (Appendix D).

RESULTS

Geoarchaeological Fieldwork

Eight of the backhoe trenches (BHT 1 - 6, and 9 - 11) exposed sequences of overbank alluvium underlying the flood plain along the main axis of Nookachamps Creek and East Fork Nookachamps Creek. Bounding contacts within beds and between major bedsets were well preserved and easily traced. In BHTs 1-6, the bases of the trenches were dominated by sand (0.063 mm to 2 mm) that consistently exhibited a fining upward trend from medium sand (0.25 mm) at the base to a very fine sand (0.063) just below the plowzone at the modern surface. Concomitant with the upward decrease in sand size, the silt-sized fraction (particles less than .063 mm) comprised an increasingly greater proportion of the sediments, from the almost total absence of silt at the base of the sequence to comprising more than 50 per cent of the matrix near the surface.

The deeper sand beds where silt was absent exhibited internal sedimentary structures representing different water flow regimes. These structures included graded beds (normally graded and sand-silt couplets), horizontal beds and laminae, and planar cross-bedded laminae as well as ripple-laminated sand (Figure 5). These bedding structures were typically found at depths ranging between about 50 and 170 cmbs and were most common in the trenches along the transect comprised of BHTs 1-6. The graded beds were predominantly sand-silt couplets in which each couplet was characterized by a base of sand capped by a silt drape (Figure 6). The couplets were often found stacked in beds above the bedded sand and extended upward to the

Figure 5. Close-up of ripple-laminated sand.

Figure 6. Close-up of sand-silt couplet; silt drape is well-expressed overlying sand in middle ground of photograph.

base of the plowzone. Internal bedding contacts (at the boundary between the sand and the silt, and at the boundary between each of the couplets) varied from horizontal and smooth to slightly convolute.

Biogenic traces, such as root casts or insect burrows, and other evidence for periods of soil formation indicating a stable surface, such as darkening of the sediments due to the addition of soil organic matter, were not observed. Flotsam that may have been floated into the valley by floodwaters, such as leaves, twigs, or branches which are typically found at the contact between sand-silt couplets, was also notably absent.

The backhoe trenching also revealed facies assemblage differences between the BHT 1-6 group of trenches and the group of auger holes and trenches (BHTs 9-11, and AHs 5 and 6) excavated along the current alignment of East Fork Nookachamps Creek. The upper portions of the East Fork backhoe trenches and auger holes were dominated by massive silt and slightly sandy silt beds exhibiting few internal sedimentary structures. Additionally, a layer of ash-sized volcanic tephra layer was encountered below the silt in AHs 4 and 6 between 120 and 130 cmbs which was subsequently identified as a 2,000-year-old tephra originating from Glacier Peak (Appendix D). The deeper portions of the auger holes showed that sand-silt couplets lay south and north (AHs 4 and 5, respectively) of a coarse sand found at 210 cmbs in AH 6. The bracketing suggests the auger holes may be aligned across a channel meander of ancestral Nookachamps Creek or across a paleochannel of East Fork Nookachamps Creek.

The plowzone, that is, the surface and near-surface sediments affected by agricultural tilling, was between 30 and 50 cm thick and easily distinguished from the underlying intact sediments (Figure 7).

Figure 7. Base of plowzone (basal contact is at blade of profiling tool).

The west and east valley slopes above the flood plain were examined with BHTs 7 and 8 (east slope), and AHs 1, 2, and 3 (west slope). Backhoe Trenches 7 and 8, in the southeast portion of the study area adjacent to a series of springs, encountered dense silt and clay containing dispersed poorly sorted pebble-gravel. A thin organic-rich layer (designated ***Ah*** for humic A horizon) was found at the upper bounding contact of the dense clay in Trench 7 and represents a relict spring deposit (Figure 8). A light-colored, gritty, silt-sized deposit overlies the organic-rich Ah horizon, and represents either diatomaceous earth or a fine-grained volcanic tephra.

On the west slope of the valley, AHs 1, 2, and 3 were excavated to define the lower leading edge of the dense pebbly clay. Auger Hole 1 was placed at the foot of the slope and was excavated to 100 cmbs before encountering the pebbly clay. The other two auger holes were much more shallow, encountering the dense clay at 40 and 30 cmbs, respectively. During the pedestrian survey, pebbles and small cobbles were observed at the surface on the slope above AH 1.

Farther north in the northeast portion of the study area and adjacent the terrace edge overlooking Mud Lake Creek, Trench 12 encountered massive medium to coarse sand (.25 mm to 2 mm) below 110 cmbs that extended to the base of excavation at 230 cmbs. Above the sand was a series of poorly graded finer-grained deposits reminiscent of the sand-silt couplets found in the trenches at lower elevations on the flood plain. The final trench, BHT 13, was excavated at the base of the slope west of the Mud Lake Creek terrace where the slope joined the flood plain. The vertical sequence in the upper portion of this trench was similar to BHTs 1 through 6 but granules were found in a coarse sand at the base of the trench at about 230 cmbs.

Figure 8. Ah layer (dark-colored layer) associated with relict spring.

Archaeological Fieldwork

The backhoe trenching program suggested that the flood plain portion of the project area was of relatively recent origin, and that much older surfaces were exposed at or near the surface at elevations about 35 feet or higher. Accordingly, the study area was sampled with a combination of shovel probes and pedestrian survey (Figure 4). The two areas subjected to more detailed examination with shovel probes were along the leading edge of the terrace overlooking Mud Lake Creek and on the topographic high on the Nookachamps flood plain north of the current alignment of East Fork Nookachamps Creek. The four blocks selected for examination with pedestrian survey were areas on the valley slopes starting between 35 and 40 feet elevation and extending in places down to the flood plain.

No precontact archaeological materials were recovered from the shovel probes nor were any observed on the surface during the pedestrian survey. A few of the shovel probes, notably those at the terrace edge overlooking Mud Lake Creek, showed traces of burning preserved as small nodules of fire-oxidized and -cemented matrix and dispersed charcoal flecking. Most of these occurrences were at the base of the plow zone or just below (30-40 cmbs), and so were interpreted to be the result of agricultural operations.

Historical archaeological remains were limited to the remnants of a railroad trestle spanning Nookachamps Creek in the southern portion of the project (Figure 9). This was part of a much longer trestle spanning the Nookachamps flood plain as part of the logging railroad system built by the Puget Sound and Cascade Railroad beginning in 1911 (Figure 10) (Thompson 1989).

Figure 9. Railroad trestle bents at Nookachamps Creek, recorded as Field No. SEB-1; view to the southwest.

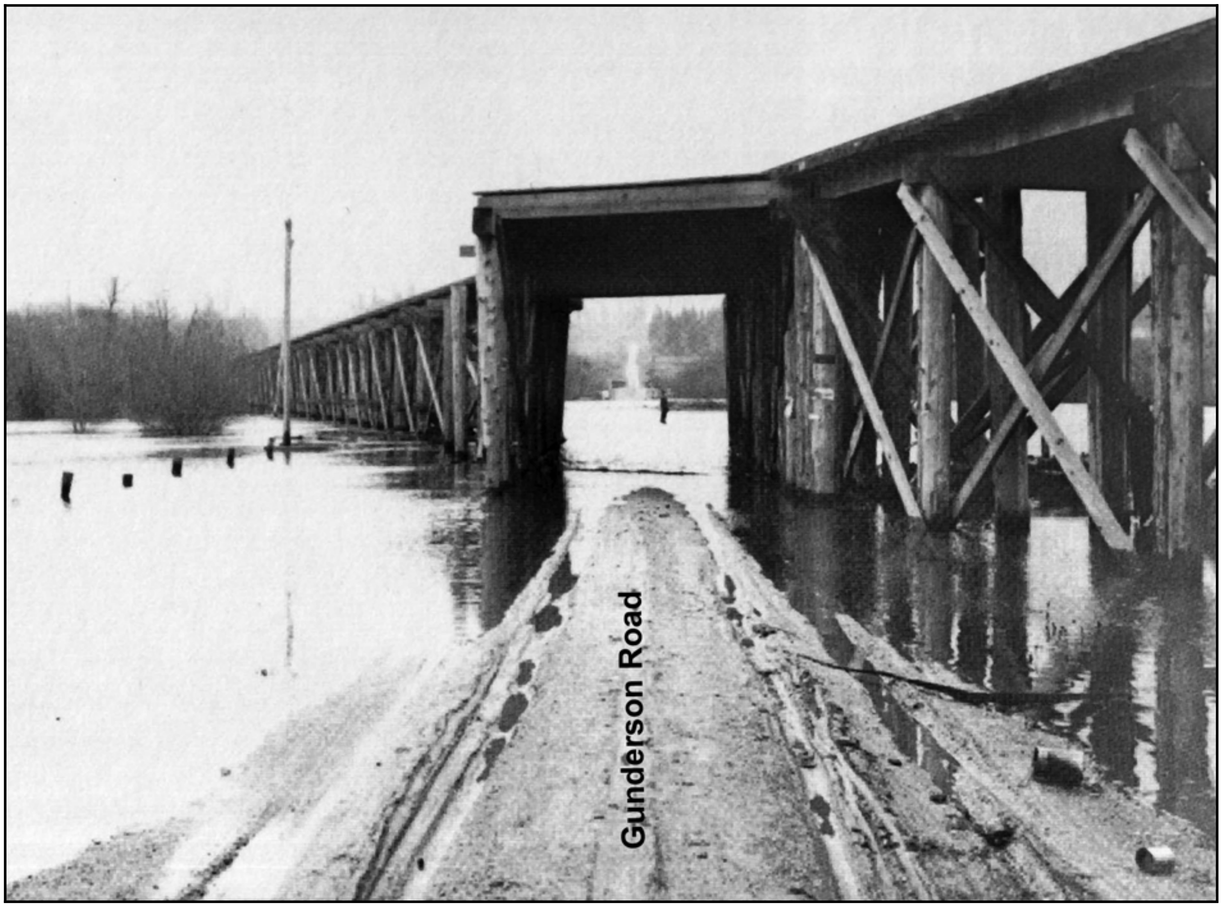

Figure 10. Historic photo of Puget Sound and Cascade Railroad trestle crossing the flooded Nookachamps Creek, c. 1925; view to the east (Thompson 1989).

DISCUSSION

The lack of buried soils, biogenic traces, or flotsam in the subsurface deposits on the lower slopes and along the axis of Nookachamps Creek indicate that at least the upper three feet of the valley alluvium is of relatively recent origin, and possibly may have been deposited in the last century. The lack of woody debris seems particularly significant and may indicate that most of the alluvium was deposited after the surrounding land had been cleared of forest and the bottom lands were in agricultural production.

The degree of consolidation and the lack of marine shell in the pebbly clay sediments found in BHTs 7 and 8, and AHs 1 -3 suggest that this deposit represents glacial till. The surface of the till in Trenches 7 and 8 is at about 40 feet elevation above mean sea level (amsl) and in both trenches is within 30 cm of the surface. The lack of flood alluvium overlying the till indicates the surface was above flood stage for most floods on Nookachamps Creek. The thin veneer of unconsolidated sediment just under the surface is either slopewash or the weathered top of the glacial till that has been further affected by agricultural tilling.

The basal coarse-grained sand in BHT 12 overlooking Mud Lake Creek may represent the distal margins of a small paraglacial fan formed from reworked glacial outwash or morainal deposits which are exposed in the quarry face to the east of SR 9. The sediments comprising the depositional sequence in BHT 12 overlying the basal coarse sand is flood alluvium expressed as weakly graded deposits. The poor expression of the bedding and the elevation of the trench at about 38 feet amsl suggests that only the largest floods along Nookachamps Creek reached this elevation.

The slopes along the eastern boundary of the project below SR 9 (Figure 11) may have been formed by water movement of much higher magnitude than would have been characteristic of the Nookachamps basin during the Holocene following the end of the glacial period. The lack of marine shell in the sediments under the higher surfaces of the project, and the lack of sediment depositional geometries representing beach or other shore geomorphic features, suggests the Nookachamps basin temporarily served as a meltwater conduit for a brief period between retreat of the Puget ice lobe and marine inundation following the opening of the Strait of Juan de Fuca. The long, smooth slope topography, the weathering of the top of the till, and the thin veneer of slopewash indicates little modification of the surface above the flood limit since glacial retreat.

At a smaller scale, the bedding structures of the lithofacies exposed in the backhoe trenches and in the hand augers point to a predominance of turbulent flood regimes characterized by low flow rates, a thin water column, and the presence of minor roughness elements on the flood plain surface. The rippled sand may be related to the creation of sand sheets through the

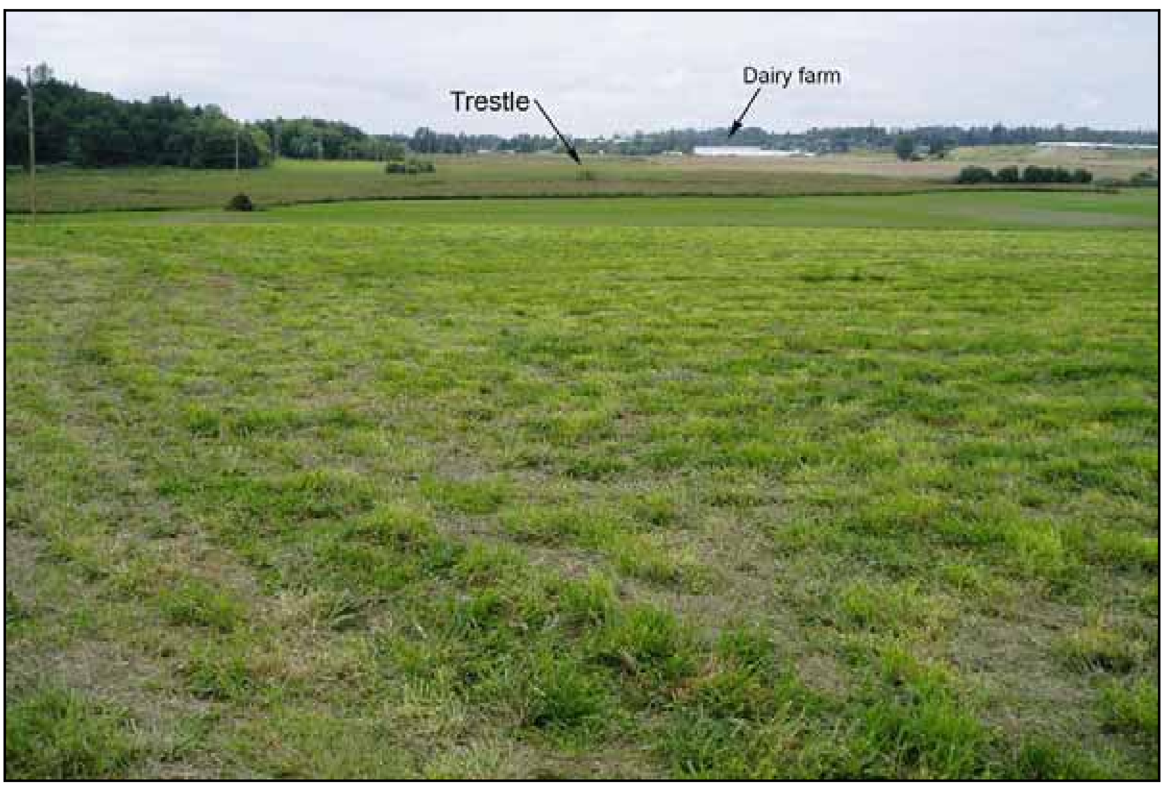

Figure 11. View of long, smooth slope gradients on east valley wall overlooking Nookachamps Creek.

coalescing of crevasse splays caused as flood water leaves the channel and accesses the overbank area of the flood plain. Ripple cross-lamination and parallel lamination are common features of sand sheets, though they are often destroyed by roots. The internal organization and geometry of crevasse splays are not well documented but are often interbedded with flood plain silts and clays. Rapid sedimentation may be reflected in climbing ripple cross-lamination, though crevasse splays may be colonized by plants with resulting disturbance of depositional structures (see Collinson 1978, and Reineck and Singh 1980 for more complete description).

The sets of graded bedding and flood couplets, and the thick silt beds north of East Fork Nookachamps Creek, on the other hand, indicate a flood regime where water remained ponded on the flood plain after initial flooding along the creek.

The general model proposed for the typical mode of flooding within this reach of Nookachamps Creek is that flood water on the Skagit River moves upstream up Nookachamps Creek initially confined within the channel and the levees along the creek. As flooding continues, water eventually spills over the banks or breaks through channel levees to flow onto the flood plain of Nookachamps Creek. In the upper (southern) portion of the project area, the flood water flows downstream paralleling the channel (hence, creating parallel- and ripple-laminated sand deposits) until it can rejoin the channel or is trapped in ponds on the flood plain (denoted by the thick silt beds near East Fork Nookachamps). The sand-silt couplets are interpreted as flood deposits associated with flooding along Nookachamps Creek rather than the result of backflooding up the creek from the Skagit River.

Figure12 shows a large-scale cross section across the central portion of the proposed project area based on the data retrieved from BHTs 1 - 8 and AHs 1-3 in the south-central portion of the proposed project.

The lack of precontact archaeological materials is surprising given the indications that the slopes above the flood plain had been stable since emergence in the early portion of the Holocene at least 7,000 years ago.

RECOMMENDATIONS

Backhoe trenches, auger holes, shovel probes, and pedestrian survey revealed no intact precontact or historical archaeological resources within the proposed *Skagit Environmental Bank* project that would be affected by development of the project. Though the remains of a portion of the Puget Sound and Cascade Railroad trestle across Nookachamps Creek were recorded, the dismantlement of the railroad after its abandonment has resulted in the loss of contextual and associative relationships among historical features and artifacts, suggesting the trestle does not attain historical significance.

NWAA recommends that no further archaeological work is necessary.

In spite of the lack of archaeological materials, there is always a possibility that undiscovered prehistoric or historic cultural resources may be inadvertently encountered during ground-disturbing activities. If prehistoric or historical cultural resources are observed in the project area during construction, work should be temporarily suspended at that location and a

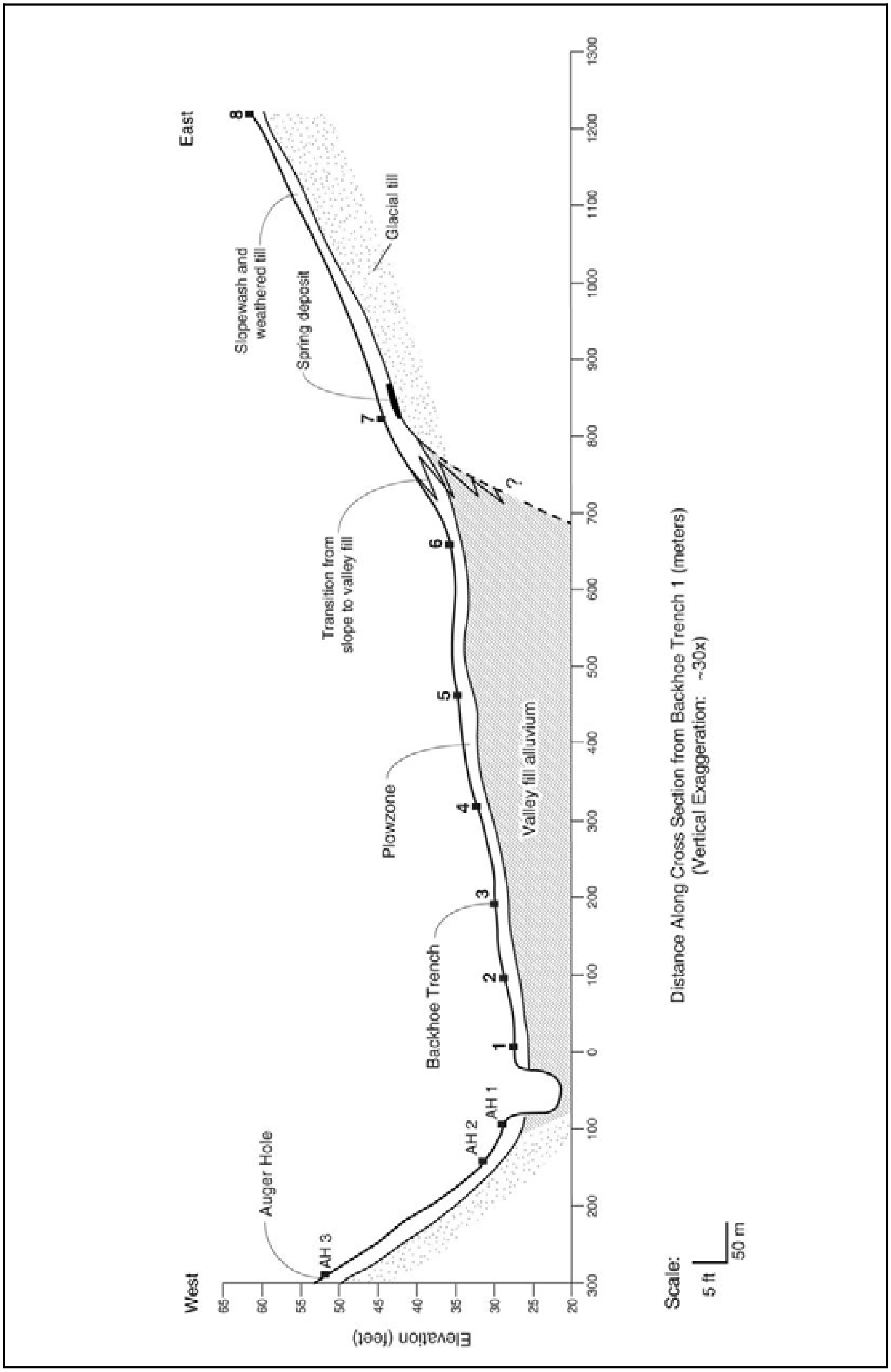

Figure 12. Generalized east-west cross section through south-central portion of study area based on BHTs 1 - 8 and AHs 1 - 3.

professional archaeologist should be retained to document and assess the discovery. The Washington Department of Archaeology and Historic Preservation (DAHP) and the affected Tribes should be contacted for any issues involving Native American sites.

If project activities expose human remains, either in the form of burials or isolated bones or teeth, or other mortuary items, work in that area should be stopped and local law enforcement officials, the DAHP in Olympia, and the affected Tribes should be immediately contacted. In no case should additional excavation be undertaken until a protocol has been agreed upon by the above mentioned parties. No exposed human remains should be left unattended.

REFERENCES CITED

Ames, Kenneth M. and Herbert D. Maschener
1999 *Peoples of the Northwest Coast: Their Archaeology and Prehistory*. Thames and Hudson. New York.

Atwater, Brian F. and Eileen Hemphill-Haley
1997 *Recurrence Intervals for Great Eathquakes of the Past 3,500 Years at Northeastern Willapa Bay, Washington*. U. S. Geological Survey Prefessional Paper 1576. Washington, D.C.

Atwater, Brian F. and Andrew L. Moore
1992 A Tsunami About 1000 Years Ago in Puget Sound, Washington. *Science* 258:1614-17.

Barnosky, Cathy W.
1985 Late Quaternary Vegetation Near Battle Ground Lake, Southern Puget Trough, Washington. *Geological Society of America Bulletin* 96:263-71.

Blukis Onat, Astrida R., Lee A. Bennett, and Jan L. Hollenbeck
1980 *Cultural Resource Overview and Sample Survey of the Skagit Wild and Scenic River. Study Area on the Mt. Baker-Snoqualmie National Forest, Washington State*. Prepared for Mt. Baker-Snoqualmie National Forest, Seattle, Washington. Institute of Cooperative Research, Contract #53-05M6-9-0050N. Seattle.

Blukis Onat, Astrida R., Maury E. Morgenstein, Philippe D. LeTourneau, Robert P. Stone, Jerre Kosta, and Paula Johnson
2000 *Archaeological Investigations at stuwe'yuq - Site 45KI464, Tolt River, King County, Washington*. BOAS, Inc., Seattle, Washington.

Booth, Derek B. and Barry Goldstein
1994 Patterns and Processes of Landscape Development by the Puget Lobe Ice Sheet. In *Regional Geology of Washington State,* edited by R. Lasmanis and E. S. Cheney, pp. 207-218. Washington State Department of Natural Resources Division. Olympia, Washington.

Booth, Derek B., Kathy G. Troost, John J. Clague, and Richard B. Waitt
2003 The Cordilleran Ice Sheet. *Developments in Quaternary Science* 1:17-43.

Bourgeois, Joanne and Samuel Johnson
2001 Geologic Evidence of Earthquakes at the Snohomish Delta, Washington, in the Past 1200 Yr. *Geological Society of America Bulletin* 113:482-94.

Bush, Kelly R.
2004 *Nookachamps Mitigation Preserve Project, Mount Vernon, Washington*. Prepared for Wildlands of Washington, Inc. Equinox Research and Consulting, Inc., Report 04-057. Sedro Woolley, Washington.

Carlson, Roy L.
1990 History of Research in Archaeology. In *Handbook of North American Indians, Volume 7: Northwest Coast,* edited by W. Suttles, pp. 107-115. Smithsonian Institution. Washington, D.C.

Clague, J. J., J. E. Armstrong, and W. H. Mathews
1980 Advance of the Late Wisconsin Cordilleran Ice Sheet in Southern British Columbia Since 22,000 Yr B.P. *Quaternary Research* 13:322-26.

Collins, Brian D., David R. Montgomery, and Andrew D. Haas
2002 Historical Changes in the Distribution and Functions of Large Wood in Puget Lowland Rivers. *Canadian Journal of Fisheries and Aquatic Resources* 59:66-76.

Collins, June M.
1974 *Valley of the Spirits, the Upper Skagit Indians of Western Washington*. University of Washington Press. Seattle.

Collinson, J. D.
1978 Alluvial Sediments. In *Sedmentary Environments and Facies,* edited by H. G. Reading, pp. 15-60. Elsevier. New York.

Crandell, Dwight R.
1963 *Surficial Geology and Geomorphology of the Lake Tapps Quadrangle, Washington. Professional Paper 388-A*. U. S. Geological Survey. Washington, D. C.

Dethier, D. P., Fred Jr. Pessl, R. F. Keuler, M. A. Balzarini, and D. R. Pevear
1995 Late Wisconsin Glaciomarine Deposition and Isostatic Rebound, Northern Puget Lowland, Washington. *Geological Society of America Bulletin* 107:1288-303.

Dragovich, Joe D., Jr. D. T. McKay, David P. Dethier, and James E. Beget
2000 Holocene Glacier Peak Lahar Deposits in the Lower Skagit River Valley, Washington. *Washington Geology* 28:19-22.

Dragovich, Joe D., Patrick T. Pringle, and Timothy J. Walsh
1994 Extent and Geometry of the Mid-Holocene Osceola Mudflow in the Puget Lowland - Implications for Holocene Sedimentation and Paleogeography. *Washington Geology* 22:3-26.

Easterbrook, Don J.
2003 Cordilleran Ice Sheet Glaciation of the Puget Lowland and Columbia Plateau and Alpine Glaciation of the North Cascade Range, Washington . In *Western Cordillera and Adjacent Areas,* edited by Terry W. Swanson , pp. 137-157. The Geological Society of America. Boulder, Colorado.

Franklin, Jerry F. and C. T. Dyrness
1973 *Natural Vegetation of Oregon and Washington*. Pacific Northwest Forest and Range Experiment Station, Forest Service, U. S. Department of Agriculture. U. S. Government Printing Office, Washington D. C.

Galster, Richard W. and William T. Laprade
1991 Geology of Seattle, Washington, United States of America. *Bulletin of the Association of Engineering Geologists* 28:239-302.

Greengo, Robert E. and Robert B. Houston
1971 *Prehistory of the Marymoor Site, Sammamish River, Washington*. University of Washington, Department of Anthropology. Seattle.

Haeberlin, Hermann and Erna Gunther
1930 *The Indians of Puget Sound*. University of Washington Press. Seattle.

Heller, Paul.
1978 *Pleistocene Geology and Related Landslides in the Lower Skagit and Baker Valleys, North Cascades, Washington*. Bellingham, Washington, Western Washington University.

Heller, Paul L.
1980 Multiple Ice Flow Directions During the Fraser Glaciation in the Lower Skagit River Drainage, Northern Cascade Range, Washington. *Arctic and Alpine Research* 12:299-308.

Kidd, Robert S.
1964 *A Synthesis of Western Washington Prehistory From the Perspective of Three Occupation Sites*. Masters Thesis, Department of Anthropology, University of Washington, Seattle.

Kovanen, Dori J. and Olav Slaymaker
2004 Relict Shorelines and Ice Flow Patterns of the Northern Puget Lowland From LIDAR Data and Digital Terrain Modelling. *Geografiska Annalar* 86 A:385-400.

Kruckeberg, Arthur R.
1991 *The Natural History of Puget Sound Country*. University of Washington Press. Seattle.

Larrison, Earl J.
1967 *Mammals of the Northwest: Washington, Oregon, Idaho, and British Columbia*. Seattle Audubon Society. Seattle, Washington.

Leopold, Estella B., Rudy Nickmann, John I. Hedges, and John R. Ertel
1982 Pollen and Lignin Records of Late Quaternary Vegetation, Lake Washington. *Science* 218:1305-7.

Liesch, Bruce A., Charles E. Price, and Kenneth L. Walters
1963 *Geology and Ground-Water Resources of Northwestern King County, Washington. Water Supply Bulletin No. 20*. Division of Water Resources, Department of Conservation. Olympia, Washington.

Matson, R. G. and G. C. Coupland
1995 *The Prehistory of the Northwest Coast.* Academic Press. San Diego, California.

Meltzer, David J.
2004 Peopling of North America. In *The Quaternary Period in the United States,* edited by A. R. Gillespie, S. C. Porter, and B. F. Atwater, pp. 539-563. Elsevier, Amsterdam.

Meltzer, David J. and Robert C. Dunnell
1987 Fluted Point From the Pacific Northwest. *Current Research in the Pleistocene* 4:64-67.

Morgan, Vera E. editor
1999 *The SR-101 Sequim Bypass Archaeological Project: Mid- to Late-Holocene Occupations on the Northern Olympic Peninsula, Clallam County, Washington*. Prepared for Washington Department of Transportation. Archaeological and Historical Services, Eastern Washington University, Cheney, Eastern Washington University Reports in Archaeology and History 100-108. Cheney, Washington.

Orr, Elizabeth L. and William N. Orr
1996 *Geology of the Pacific Northwest*. The McGraw-Hill Companies, Inc. New York.

Porter, Stephen C.
1976 Pleistocene Glaciation in the Southern Part of the North Cascade Range, Washington. *Geological Society of America Bulletin* 87:61-75.

Porter, Stephen C. and Terry W. Swanson
1998 Radiocarbon Age Constraints on Rates of Advance and Retreat of the Puget Lobe of the Cordilleran Ice Sheet During the Last Glaciation. *Quaternary Research* 50:205-13.

Reineck, H.-E. and I. B. Singh
1980 *Depositional Sedimentary Environments With Reference to Terrigenous Clastics*. Corrected Second Printing. Springer-Verlag, Berlin.

Schalk, Randall F.
1988 *The Evolution and Diversification of Native Land Use Systems on the Olympic Peninsula*. Prepared for National Park Service. Institute for Environmental Studies, University of Washington, Seattle, Washington.

Shong, Michael and Christian J. Miss
2002 *Cultural Resources Investigations of the Proposed Hamilton Sand and Gravel Mine, Skagit County, Washington*. Prepared for Centennial Resources, LLC. Northwest Archaeological Associates, Seattle, Washington.

Smith, Marian W.
1940 *The Puyallup-Nisqually*. Columbia University Press. New York.

1941 The Coast Salish of Puget Sound. *American Anthropologist* 43:197-211.

Snyder, Sally
1980 Aboriginal Settlements in the Skagit Drainage System. In *Cultural Resource Overview and Sample Survey of the Skagit Wild and Scenic River: Study Area on the Mt. Baker-Snoqualmie National Forest, Washington State. Volume 2.,* edited by Astrida R. Blukis-Onat, Lee A. Bennett, and Jan L. Hollenbeck, pp. 19-39. Institute of Cooperative Research. Seattle, Washington.

Solidaritet Lodge #396
2001 *Scandinavians of the Skagit Area*. Snohomish Publishing Company. Mount Vernon, Washington.

Stanley, Daniel J. and Andrew G. Warne
1997 Holocene Sea-Level Change and Early Human Utilization of Deltas. *GSA Today* 7:1-7.

Suttles, Wayne and Barbara Lane
1990 Southern Coast Salish. In *Northwest Coast. Volume 7,* edited by Wayne Suttles, pp. 485-502. Smithsonian Institution. Washington, D.C.

Thompson, Dennis B.
1989 *Logging Railroads in Skagit County*. Northwest Short Line. Seattle, Washington.

Thompson, Gail
1978 *Prehistoric Settlement Changes in the Southern Northwest Coast: A Functional Approach*. Reports in Archaeology No. 5. University of Washington Department of Anthropology. Seattle, Washington.

Tsukada, M.
1982 Pseudotsuga Menziesii (MIRB) Fanco: Its Pollen Dispersal and Late Quaternary History in the Pacific Northwest. *Japanese Journal of Ecology 32:159-187* 32:159-87.

Waitt, Richard B. Jr.
1977 Evolution of Glaciated Topography of Upper Skagit Drainage Basin, Washington. *Arctic and Alpine Research* 9:183-92.

Wessen, Gary G. and Jean M. Welch
1991 *A Report of Cultural Resource Survey Activities in the Lake Cushman Project Area, Mason County, Washington*. Report on file, Department of Archaeology and Historic Preservation, Olympia, Washington.

Whitlock, Cathy
1992 Vegetational and Climatic History of the Pacific Northwest During the Last 20,000 Years: Implications for Understanding Present-Day Biodiversity. *The Northwest Environmental Journal* 8:5-28.

Willis, Margaret E. (editor)
1973 *Chechacos All: The Pioneering of Skagit*. Skagit County Historical Society. Mount Vernon, Washington.

Willis, Margaret E. (editor)
1975 *Skagit Settlers: Trials and Triumphs, 1890-1920*. Skagit County Historical Society. Mount Vernon, Washington.

Yount, J. C., J. P. Minard, and G. R. Dembroff
1993 *Geologic Map of Surficial Deposits in the Seattle 30 x 60 Quadrangle. OFR 93-233*. U. S. Geological Survey. Washington, D.C.

APPENDIX A: Tribal Correspondence

Northwest Archaeological Associates, Inc.
Cultural Resources Management Services
5418 20th Avenue NW, Suite 200, Seattle, WA 98107

June 1, 2005

Mr. Ray Williams
Cultural Resources
Swinomish Tribal Community

RE: Skagit Environmental Bank: Wetland Mitigation Project

Dear Mr. Williams,

Clear Valley Environmental Farm, LLC, (Clear Valley) is proposing to construct a 311-acre wetlands mitigation bank, called the Skagit Environmental Bank, on 776 acres of dairy farmland near the town of Mount Vernon. The parcel is adjacent to and northeast of the Mount Vernon city limits on the Nookachamps Creek flood plain in Sections 10, 11, 14, and 15, T 34 N., R 4 E (see attached map). Northwest Archaeological Associates, Inc. (NWAA) has been retained by Clear Valley to provide an cultural resources assessment of the proposed project area.

The purpose of the proposed project is to create a general-use wetlands mitigation bank that will restore reaches of the main stem of Nookachamps Creek, the East Fork of Nookachamps Creek, and Mud Lake Creek, as well as associated historic flood plain wetlands. The proposed wetlands project will be carried out in three phases that will create or restore riverine channel habitat and restore 311 acres to palustrine, scrub-shrub, and forested wetlands. Because the project area was wetland before agricultural development, the archaeological assessment will be conducted in two parts, with the first part consisting of geoarchaeological investigations focused on soil profile characterization, determining the presence of buried surfaces, and reconstruction of the local landscape history. The second part of the field investigations will be contingent on the findings of the geoarchaeological fieldwork and will be a fine-grained examination of the portions of the project deemed to have high potential for archaeological resources.

I am writing to let the Swinomish Tribal Community know that NWAA will be conducting the geoarchaeological component of the field investigations on June 9th and 10th, and I would like to invite members of the Tribe out to the project to monitor the fieldwork. As part of our contract with Clear Valley, NWAA will prepare a draft cultural resources technical report at the conclusion of the fieldwork. I would like to know if the Tribe has any concerns regarding historic properties in or near the project that should be considered in early planning. We respect concerns about sharing sensitive information and we will work with you in a way that accommodates those concerns.

This letter is intended as a technical inquiry solely related to the identification of cultural resources for the permit review process. It does not constitute a formal policy-level request for consultation, which is the responsibility of the proponent.

Sincerely,

Charles M. Hodges
Geoarchaeologist/Senior Archaeologist

Tel: (206) 781-1909
Fax: (206) 781-0154
Email: cmhodges@northwestarch.com

Northwest Archaeological Associates, Inc.
Cultural Resources Management Services
5418 20th Avenue NW, Suite 200, Seattle, WA 98107

June 1, 2005

Mr. Scott Schuyler
Cultural Resources Policy Representative
Upper Skagit Indian Tribe

RE: Skagit Environmental Bank: Wetland Mitigation Project

Dear Mr. Schuyler,

Clear Valley Environmental Farm, LLC, (Clear Valley) is proposing to construct a 311-acre wetlands mitigation bank, called the Skagit Environmental Bank, on 776 acres of dairy farmland near the town of Mount Vernon. The parcel is adjacent to and northeast of the Mount Vernon city limits on the Nookachamps Creek flood plain in Sections 10, 11, 14, and 15, T 34 N., R 4 E (see attached map). Northwest Archaeological Associates, Inc. (NWAA) has been retained by Clear Valley to provide an cultural resources assessment of the proposed project area.

The purpose of the proposed project is to create a general-use wetlands mitigation bank that will restore reaches of the main stem of Nookachamps Creek, the East Fork of Nookachamps Creek, and Mud Lake Creek, as well as associated historic flood plain wetlands. The proposed wetlands project will be carried out in three phases that will create or restore riverine channel habitat and restore 311 acres to palustrine, scrub-shrub, and forested wetlands. Because the project area was wetland before agricultural development, the archaeological assessment will be conducted in two parts, with the first part consisting of geoarchaeological investigations focused on soil profile characterization, determining the presence of buried surfaces, and reconstruction of the local landscape history. The second part of the field investigations will be contingent on the findings of the geoarchaeological fieldwork and will be a fine-grained examination of the portions of the project deemed to have high potential for archaeological resources.

I am writing to let the Upper Skagit Indian Tribe know that NWAA will be conducting the geoarchaeological component of the field investigations on June 9th and 10th, and I would like to invite members of the Tribe out to the project to monitor the fieldwork. As part of our contract with Clear Valley, NWAA will prepare a draft cultural resources technical report at the conclusion of the fieldwork. I would like to know if the Tribe has any concerns regarding historic properties in or near the project that should be considered in early planning. We respect concerns about sharing sensitive information and we will work with you in a way that accommodates those concerns.

This letter is intended as a technical inquiry solely related to the identification of cultural resources for the permit review process. It does not constitute a formal policy-level request for consultation, which is the responsibility of the proponent.

Sincerely,

Charles M. Hodges

Charles M. Hodges
Geoarchaeologist/Senior Archaeologist

Tel: (206) 781-1909
Fax: (206) 781-0154
Email: cmhodges@northwestarch.com

APPENDIX B: Graphical Logs of Backhoe Trenches and Auger Holes

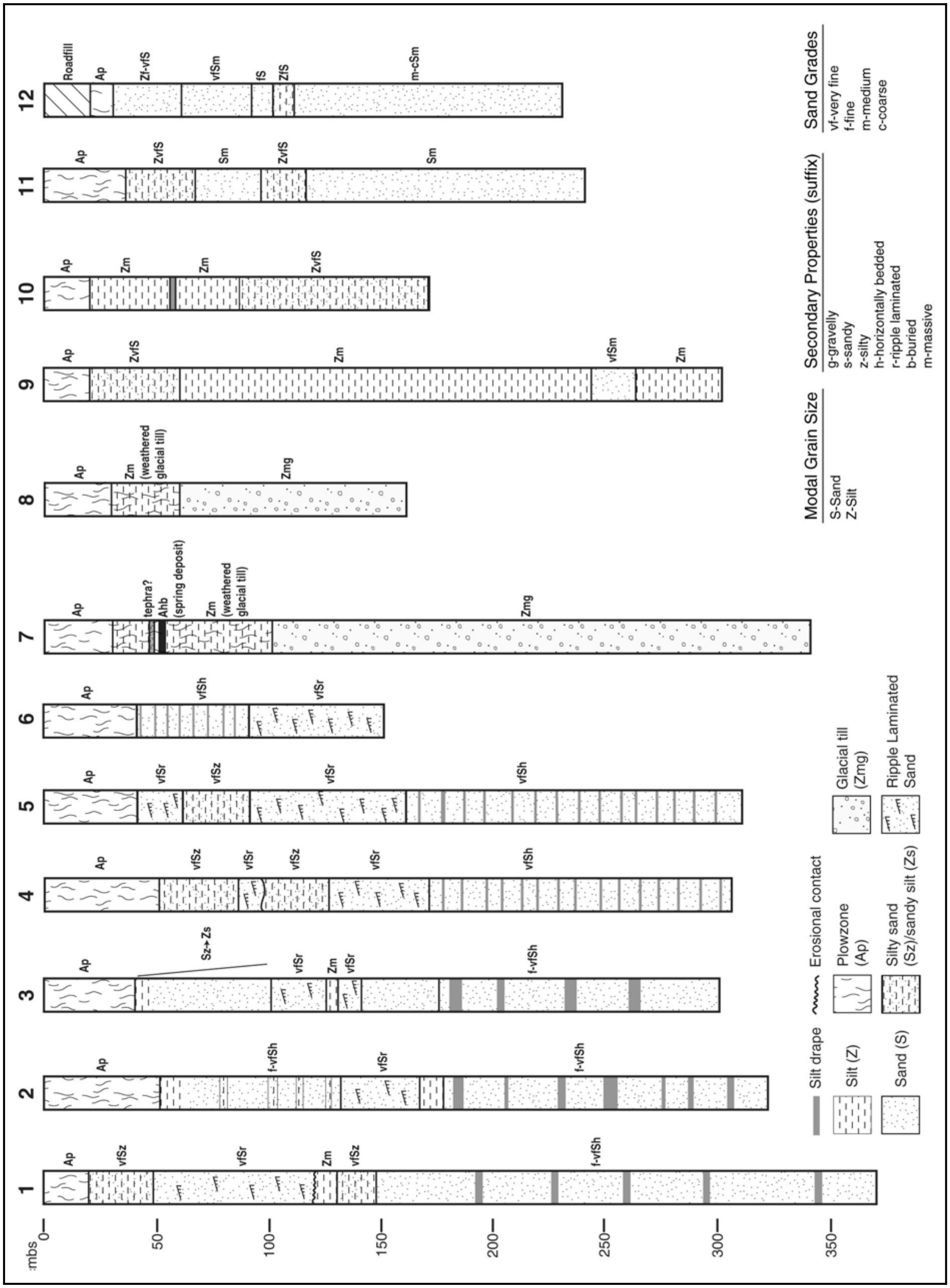

Figure B-1. Graphical logs of auger holes.

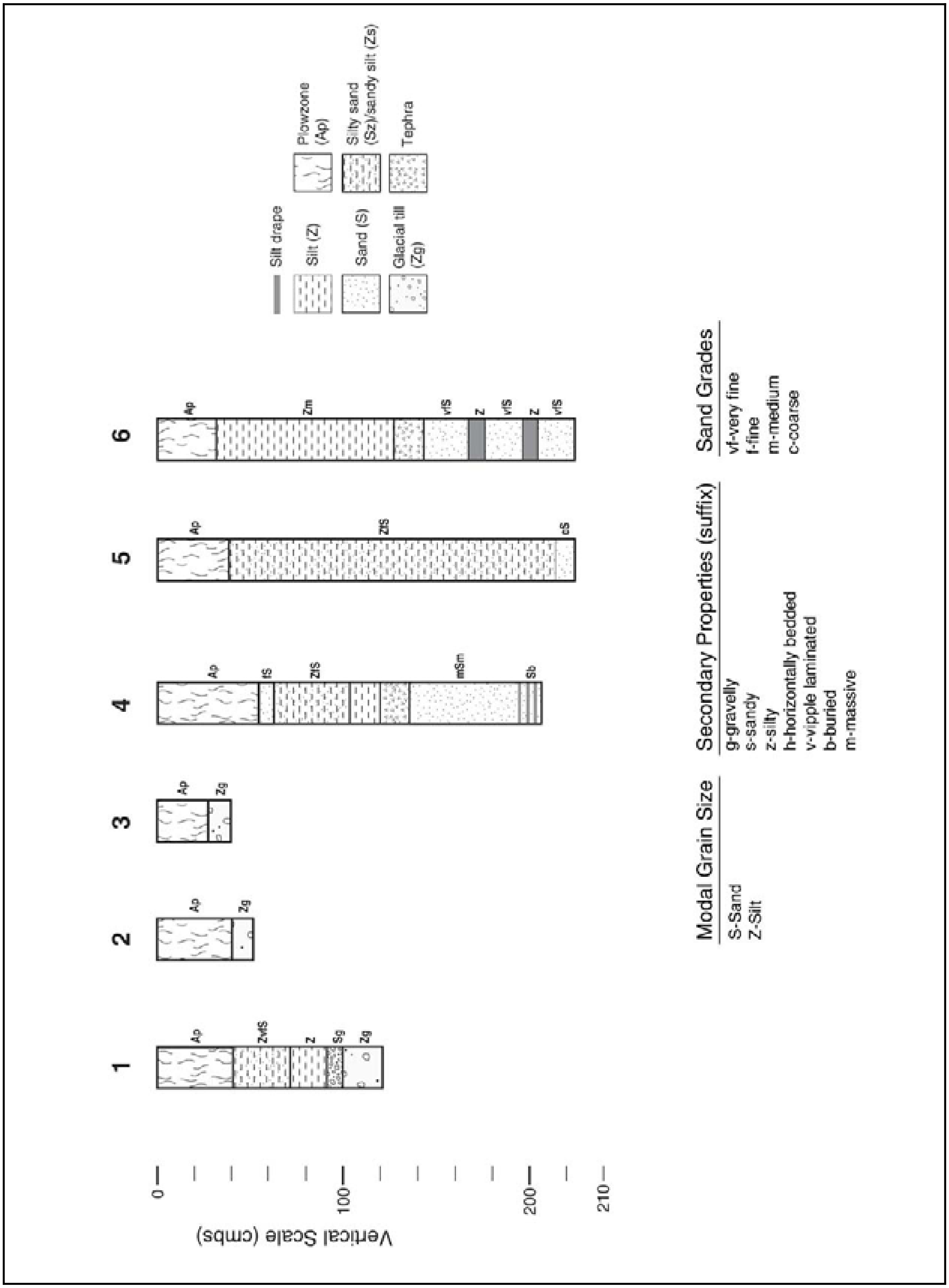

Figure B-2. Graphical logs of backhoe trenches.

APPENDIX C: Shovel Probe Data

Table C-1. Shovel Probe Summary for Skagit Environmental Bank.

PROBE NO.	DESCRIPTION	CULTURAL MATERIAL
1	0-14cm: Silty loam, small pebbles. 14-28cm: Gravelly sand, small pebbles, compact,oxidization, gray silt lenses. 28-50cm: Dark gray silt, compact. 50-60cm: Light tan silt.	None
2	0-28cm: Brown silt, slightly sandy. 28-40cm: Yellowish brown sandy silt, lighter colored silt lenses. 40-44cm:Brown silt, some oxidization. 44-68cm:Yellowish gray silt.	None
3	0-26cm: Dark grayish brown sandy silt, gravelly. 26-70cm: Yellowish brown sandy silt, lighter colored silt lenses.	None
4	0-14cm: Silty loam, small pebbles. 14-23cm:Dark gray silt, charcoal flecking. 23-32cm: Tan silt, compact, dry. 32-35cm: Gray ash, oxidization below. 35-60cm: Tan silt, charcoal flecking, dry.	None
5	0-11cm: Brown silt, slightly sandy. 11-26cm: Gray silt, very compact. 26-61cm: Yellowish brown sandy silt, lighter colored silt lenses.	None
6	0-22cm: Grayish brown silty sand. 22-40cm: Grayish brown silt, charcoal flecking. 40-61cm: Yellowish brown sandy silt, lighter colored silt lenses.	None
7	0-14cm: Sandy gravel, oxidized silt lenses. 14-30cm: Dark silt, compact, charcoal flecks and fragments. 30-47cm: Light tan silt, compact, charcoal flecking. 47-50cm: Oxidized silt, ash miture. 50-60cm: Light tan silt.	None
8	0-9cm: Medium brown silt, slightly sandy. 9-20cm: Light gray silt, compact, oxidized lenses. 20-61cm: Light yellowish brown silt.	None
9	0-10cm: Medium brown sandy silt. 10-32cm: Grayish brown silt, oxidization at bottom, charcoal concentrations. 32-62cm: Yellowish brown silt.	None
10	0-15cm: Sandy gravel, burned wood, charcoal flecking, heavily compacted. 15-40cm: Brown silt, ash and oxidization lenses. 40-45cm: Dark reddish brown silt, high charcoal content. 45-60cm: Light tan silt.	None
11	0-18cm: Grayish brown silt, gravels and sand. 18-40cm: Gray silt, 2 highly organic bands, very compact. 40-71cm: Yellowish brown silt.	None
12	0-12cm: Grayish brown silt, gravels and sand. 12-50cm: Yellowish brown silt, charcoal. 50-71cm: Gray silt mottled with yellowish brown silt, patchy oxidization.	None
13	0-21cm: Sandy gravel, patchy oxidization, compact. 21-60cm: Gray silt, charcoal flecking.	None
14	0-16cm: Grayish brown silt, some gravel and sand. 16-32cm: Gray silt, oxidized mottling. 32-61cm: Light gray silt, heavily compacted.	None
15	0-40cm: Gravish brown silt.	None
16	0-31cm: Brown silt, charcoal flecking. 31-60cm: Light gray silt, mottled oxidization.	None
17	0-37cm: Brown silt. 37-64cm: Gray silt, mottled oxidization. 64-72cm: Grayish brown, fine sand.	None
18	0-34cm: Brown silt. 34-41cm: Light gray silt, mottled oxidization. 41-60cm: Light gray sand, loosely compacted.	None

Table C-1. Shovel Probe Summary for Skagit Environmental Bank.

PROBE NO.	DESCRIPTION	CULTURAL MATERIAL
19	0-38cm: Medium brown silt. 38-65cm: Gray silt, mottled oxidization. 65-70cm: Grayish brown fine sand.	None
20	0-42cm: Medium brown silt. 42-67cm: Grayish brown fine sand.	None
21	0-32cm: Medium brown silt. 32-60cm: Light gray silt, mottled oxidization.	None
22	0-38cm: Brown silt. 38-62cm: Gray silt, mottled oxidization.	None
23	0-32cm: Medium brown silt. 32-60cm: Light gray silt, mottled oxidization.	None
24	0-38cm: Medium brown silt. 38-47cm: Light gray clay. 47-53cm: Dark gray silt, organically rich, oxidization lenses. 53-62cm: Gray silt, mottled oxidization.	None
25	0-44cm: Medium brown silt. 44-71cm: Gray silt, mottled oxidization.	None
26	0-33cm: Brown silt. 33-60cm: Gray silt, mottled oxidization.	None
27	0-44cm: Medium brown silt. 44-71cm: Gray silt, mottled oxidization.	None
28	0-34cm: Medium brown silt. 34-70cm: Gray silt, mottled oxidization.	None
29	0-35cm: Medium brown silt. 35-60cm: Gray silt, mottled oxidization.	None
30	0-38cm: Medium brown silt. 38-60cm: Gray silt, mottled oxidization.	None
31	0-38cm: Medium brown silt. 38-51cm: Gray silt, mottled oxidization. 51-65cm: Yellowish brown silt.	None
32	0-31cm: Medium brown silt. 31-60cm: Gray silt, mottled oxidization.	None
33	0-33cm: Medium brown silt. 33-51cm:Yellowish brown silt. 51-65cm:Gray silt, mottled oxidization.	None
34	0-33cm: Medium brown silt. 33-51cm:Yellowish brown silt.	None
35	0-34cm: Medium brown silt. 33-60cm:Tan silt, mottled oxidization.	None
36	0-34cm: Medium brown silt. 34-60cm:Yellowish brown silt.	None

APPENDIX D: Tephra Glass Identification

WASHINGTON STATE UNIVERSITY
Department of Geology

September 8, 2005

Mr. Charlie Hodges
Northwest Archaeological Associates, Inc.
Suite 200
5418 20th Avenue NW
Seattle, WA 98107

Dear Charlie,

As you suspected the tephra you provided is from Glacier Peak and I believe it is Glacier Peak tephra A which dates to approximately 2000 BP. It an excellent match (0.98) to a tephra sample from the Twin Lake core (55-56 cmbs) taken by Jon Riedel of North Cascades National Park. I've only recently been able to correlate it to the tephra A described by Jim Beget back in the 80's. It nice you've now provided me with another locality for this hard to find tephra.

I trust these results will be useful in your study. Thanks for using our service.

Sincerely,

Nick

Franklin F. (Nick) Foit, Jr.
Professor and Director of the Microbeam Lab

PO Box 642812, Pullman, WA 99164-2812
509-335-3009 • Fax: 509-335-7816 • geology@wsu.edu • www.wsu.edu/~geology

TABLE 1. GLASS CHEMISTRY OF NOOKACHAMPS CREEK TEPHRA

Oxide	HODGES SEB-T1
SiO_2	78.40(0.50)
Al_2O_3	11.85(0.33)
Fe_2O_3	1.16(0.18)
TiO_2	0.27(0.09)
Na_2O	3.32(0.09)
K_2O	3.96(0.21)
MgO	0.15(0.04)
CaO	0.80(0.12)
Cl	0.10(0.03)
Total**	100
Number of shards analyzed	17
Probable Source/Age	Glacier Peak A ~2000 BP
Similarity Coefficient***	0.98

* Standard deviations of the analyses given in parentheses
** Analyses normalized to 100 weight percent
*** Borchardt et al. (1972) J. Sed. Petrol., 42, 301-306

APPENDIX E: Site Record

(Submitted to DAHP under separate cover)