

# Geomorphic Reconstruction of Alki Point in West Seattle Based on Chronostratigraphic Relationships of Mid-Late Holocene- Aged Intertidal Deposits

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## Executive Summary

A tombolo may have tied a bedrock knoll at the western tip of Alki Point to the mainland before a large magnitude 7 or greater earthquake ruptured within the Seattle fault zone, resulting in ~23 ft of uplift at Alki Point and exposing shallow beach/intertidal deposits. The purpose of this study was to (1) reconstruct the geomorphology of Alki Point during the mid-late Holocene in order to understand the conditions under which marsh deposits at Alki Point were formed, and (2) partially characterize the spatial variability of marsh deposits at Alki Point. The motivation behind this work was to provide future paleoseismic studies a basis as to where reliable paleoenvironmental data within marsh deposits can be found. This data can be used by paleoseismologists to reconstruct the abrupt or gradual nature of environmental changes that may be related to coseismic uplift or other environmental factors. Data from three sites at Alki Point and one at a marsh near Restoration Point on Bainbridge Island include; (1) stratigraphic observations from borings and trench observations, (2) radiocarbon ages, and (3) elevation data from microfossil assemblages. Two-foot contours constructed over LiDAR data for Alki Point show low topographic relief trending northwest-southeast where a tombolo may have connected a bedrock knoll near the western tip of Alki Point to the mainland, with beach ridges shoreward of and parallel to a suspected tombolo. The direction of the shore-drift at Alki Point is from the south, driving the propagation of waves towards the southern shore of Alki Point. These factors would be the most important control on sediment transport, and would have assisted in shaping a tombolo along the southern margin of Alki Point. A sample taken 6 ft above MLLW from a tree log in the middle of a peat layer shoreward of the current beach ridges had a radiocarbon age of 6264 to 6529 cal yr B.P. This would have required that one or more beach ridge(s) were further offshore from where this peat would have deposited in a quiescent intertidal environment. As sea levels rose to near to the present level ~5500-6000 cal yr B.P., the beach ridge(s) would have transgressed to the current position. The formation of a tombolo with shoreward beach ridges may have allowed for one or more marshes to form on Alki Point since shore-drift derived from the south. Ages on beach deposits below the middle peat layer at Alki Playground are between 3078 to 4826 cal yr B.P., and the age on the upper peat layer at Alki Playground is modern (after 1950 AD) to 297 cal yr B.P. This suggests that the middle peat layer encountered at two of the

Alki Point sites, was deposited sometime between 297 to 3078 cal yr B.P., after a tombolo would have formed.

## Introduction

Active shallow crustal faulting in the Puget Lowland is especially concerning because of the potential for surface rupturing magnitude 7 (M7) or greater earthquakes that can cause major damage and loss of life in densely populated regions. The Seattle fault zone (SFZ) is an active seismic threat that comprises multiple east-west trending thrust faults that cross the Puget Lowland through Seattle (Figure 1). The last known earthquake with a M7 or greater that ruptured in the SFZ occurred along the Seattle fault ~1000 cal yr B.P. (Bucknam et al., 1992; Atwater, 1999). This earthquake resulted in nearly 23 ft of uplift on the hanging wall, exposing a wave-cut platform at Restoration Point on Bainbridge Island and shallow intertidal deposits at Alki Point in West Seattle (Bucknam et al., 1992) (Figure 1). A tsunami was also generated as a result of this seismic event (Atwater and Moore, 1993). Postglacial recurrence intervals for earthquakes near M7 for the Toe Jam Hill Fault, which is a north dipping backthrust to the Seattle fault, range from ~12,000 years to as little as a century or less (Nelson et al., 2003). Since the Toe Jam Hill fault is a backthrust to the Seattle fault, it may not have ruptured during every earthquake on the Seattle fault, however; these recurrence intervals provide a partial proxy of the seismic history of the SFZ, which is not yet well understood.

## Purpose

The purpose of this study was to (1) reconstruct the geomorphology of Alki Point during the mid-late Holocene in order to understand the conditions under which marsh deposits at Alki Point were formed, and (2) partially characterize the spatial variability of marsh deposits at Alki Point. The motivation behind this work was to provide future paleoseismic studies a basis as to where reliable paleoenvironmental data within marsh deposits can be found. Marsh deposits often contain fossil diatoms, seeds, and other biota that are sensitive to changes in elevation. This data can be used by paleoseismologists to reconstruct the abrupt or gradual nature of environmental changes that may be related to coseismic uplift or other environmental factors. In order to execute this goal, I (1) used LiDAR data to observe evidence of any landforms that may have previously assisted in the formation of one or more quiescent intertidal marshes at Alki, (2)

recovered continuous core deposits and sampled organic material within the cores for radiocarbon dating at Alki Playground (Figure 2), and (3) compared the litho- and chronostratigraphic data from Alki Playground with radiocarbon data, core observations, and trench observations from three other sites. All core and trench elevations are tied to mean lower low water (MLLW), a standard tidal datum that is based on tides observed at Seattle by the National Ocean Survey (<http://www.coops.nos.noaa.gov>).

The four sites considered in this study are; (1) Alki Playground, northeast of Alki Point (hereby referred to as Alki Playground), (2) 57<sup>th</sup> Avenue Southwest between Alki Avenue Southwest and Southwest Lander Street, northwest of Alki Point (hereby referred to as 57<sup>th</sup> Ave) (SPU, 2016), (3) Spokane Street between Beach Drive Southwest and 61<sup>st</sup> Avenue Southwest, southeast of Alki Point (hereby referred to as Spokane St), and (4) a marsh near Restoration Point on Bainbridge Island (hereby referred to as the marsh at Restoration Point) (Bucknam et al., 1992; Sherrod et al., 1999) (Figure 3).

This study further delineates the suspected location(s) of at least three marshes at Alki Point, which may contain paleoenvironmental data that recorded past uplift events within the SFZ. If future studies conclude that elevation changes within these peat deposits at Alki Point are the result of coseismic uplift, it could provide additional insight into recurrence intervals for M7 or greater earthquakes that occurred in the SFZ during the mid-late Holocene.

## Site Description

Alki Point has a triangular shape with a westward-pointing apex on the western edge of West Seattle in the state of Washington (Figure 4). The term Alki Point is used in this report to refer to the area that encompasses the relatively flat uplifted platform ~23 ft above sea level in West Seattle, which is fringed to the east by a moderate topographic rise from ~200-300 ft above sea level and a bedrock knoll near the western tip of Alki Point that is ~5 acres and ~78 ft above sea level (Figure 5). A ravine from Schmitz Park in the hillslopes east of Alki Point terminates near the southern end of Alki Playground (Figure 5). The geologic map of Seattle shows that the Alki Point area consists predominantly of uplifted beach deposits (Qbu), and an exposed outcrop of the Blakely Formation (Tb) (a bedrock knoll) (Figure 6) (Troost et al., 2005). The Blakely

Formation includes marine conglomerate, sandstone, siltstone, and shale (Fulmer, 1975). On the southern shore of Alki Point, steeply dipping bedrock of the Blakely Formation can be observed at low tide, which is a resistant wave-cut platform that was uplifted during the ~1000 cal yr B.P. earthquake. The steep topography east of Alki Point are composed of interglacial deposits known as the Olympia beds, and glacial deposits from the advance of the Cordilleran ice sheet during the Vashon Stade of the Fraser Glaciation 16-19 cal k.y. B.P. (Figure 6) (Porter et al., 1998).

Unlike Restoration Point where evidence of a double tombolo enclosing a marsh is well preserved, Alki Point has been heavily developed and many pre-existing landforms were cut and/or covered by infrastructure during the mid-1800's to present day. However, Alki Point may have been a tombolo-tied island before uplift ~1000 cal yr B.P. The mainland to the east of the bedrock knoll at Alki Point has a linear form from east to west and may have represented the post-glacial coast when sea level rose to near the present level about 5500-6000 cal yr B.P. (Stark et al., 1950).

Land survey maps (T-sheets) of Alki Point from 1874 and 1899 show that: (1) topography suggests that a tombolo may have connected the bedrock knoll at the tip of Alki Point to the mainland (Figure 7), and (2) three separate areas occupied by modern marshes near the shore (Figure 8) (U.S. Coast and Geodetic Survey, 1899).

### Tectonic Setting

The tectonics in western Washington are ultimately influenced by the shear interaction between the Pacific and North American plates on the San Andreas Fault south of the Mendocino Triple Junction (MTJ) and convergence between the North American Plate and Juan de Fuca plate north of the MTJ where subduction and clockwise rotations of large blocks of continental crust accommodate relative motions (Figure 9); (Atwater, 1970; McCaffrey et al., 2013). Specifically, northern California is pushing western Washington into Canada, resulting in compression that creates a complex series of shallow thrust and backthrusts in the active forearc trough that the Puget Lowland of Washington occupies (McCaffrey et al., 2013; Pratt et al., 1997). Earthquakes

in western Washington are categorized into three main types; (1) Cascadia megathrust, (2) deep intraplate, and (3) shallow crustal faulting (Cheney, 2016).

## Previous Work

### The Marsh at Restoration Point

A marsh at Restoration Point on Bainbridge Island in the state of Washington lay near sea level between 7500 and 1000 cal yr B.P. (Figure 10) (Sherrod et al., 1999). This marsh is located on the hanging wall of the Seattle fault and it recorded four significant rapid environmental changes (events A-D) based on analysis of fossil diatoms and seeds (Sherrod et al., 1999). The cause of these environmental changes is hypothesized to be the result of; (1) earthquakes rupturing within the SFZ, (2) berm accretion, (3) berm erosion, (4) sea level rise, (5) other unknown environmental factors, and (6) a combination of two or more environmental changes. Marsh deposits include from top to bottom of borings, respectively; black mud (9 to 9.25 ft above MLLW), sandy mud (8.5 to 9 ft above MLLW), brown peat (7.5 to 8.8 ft above MLLW), brown mud (7.25 to 8 ft above MLLW), red peat (6 to 7.25 ft above MLLW), and gray mud (5 to 6 ft above MLLW) (Figure 11).

#### Event A

A sudden decrease in salinity from ~22.5% to ~8% and an increase in elevation of nearly 5 ft above MLLW between 6400-7200 cal yr B.P. was recorded from diatom assemblages (Figure 12). The site gradually returned to conditions similar to those before event A. An equivalent elevation (relative to MLLW) of the site was +12.5 +/- 2 ft ~7200 cal yr B.P., and +18.0 +/- 2 ft ~6900 cal yr B.P. (Figure 12). By ~6400 cal yr B.P., the site was at +12.8 +/- 2 ft in elevation. Inferred salinity during the same period changed from ~25 +/- 6% at ~7200 cal yr B.P., to ~8 +/- 6% at ~6900 cal yr B.P., before finally returning to ~25 +/- 6% by ~6400 cal yr B.P. (Figure 12). Sherrod et al., (1999) interpreted the data to suggest that this event could have resulted from coseismic uplift of ~1.5 m or alternatively from accretion of a beach bar bordering the brackish marsh (Sherrod et al., 1999).

#### Event B

Changes in fossil diatoms between 2000-3500 cal yr B.P. show a change in salinity and elevation. Samples at 26.6 and 24.6 ft above MLLW contained diatoms that reveal an equivalent elevation of 11.5 +/- 2 ft above MLLW (Figure 12). Another sample from 26.25 ft above MLLW show that diatoms suggest an equivalent elevation of 27.2 +/- 2 ft. The estimates from these findings suggest a change in equivalent elevation of 15.7 +/- 2 ft between 3500 and 2700 cal yr B.P. and a shift in salinity of 20 +/- 6% (Figure 12). This data was suggested to imply that tectonic uplift may have occurred (Sherrod et al., 1999).

### Event C

Changes in lithology and marsh biota record a sudden increase in salinity and a decrease in equivalent elevation shortly after 1500-1900 cal yr B.P. (Figure 12). Directly above the contact between the Brown Peat and the Sandy Mud, elevation abruptly decreases 11.8 +/- 2 ft with an associated change in salinity from ~10 +/- 6% to ~24 +/- 6% (Figure 12). These changes were short-lived, which led Sherrod et al., (1999) to interpret that berm erosion was probable, rather than tectonic subsidence. However, the lithology of the sandy mud and diatoms found within this layer show that after event C, the site remained a tidal flat from ~1700 cal yr B.P. to ~1000 cal yr B.P., which implies that tectonic subsidence or a beach berm could have created tidal flat conditions ~1700 cal yr B.P. and contributed in maintaining this environment for several hundred years after.

### Event D

The large magnitude 7 or greater earthquake ~1000 cal yr B.P. uplifted a tideflat out of the intertidal zone, which resulted in a freshwater marsh on the former tidal flat surface (Bucknam et al., 1992). Between the Sandy Mud and Black Mud, equivalent elevation increases about 19.7-24.6 ft. Biota also reveal an abrupt decrease in salinity from ~25 +/- 6% to 0 +/- 6% (Figure 12). These findings are consistent with earlier estimates that Restoration Point rose 16.5 to 23 ft ~1000 cal yr B.P. as a result of a M7 or larger earthquake on the Seattle fault (Bucknam et al., 1992).

Alki Point - 57<sup>th</sup> Avenue Southwest

During a utility project performed by Seattle Public Utilities (SPU) in May of 2016, SPU's geotechnical division advanced four borings (Figure 13). From ground surface (20.34 ft above MLLW) to bottom of boring (-1 ft below MLLW), the general sequence of units consist of sand (fill) 20.34 to 18.84 ft above MLLW, poorly graded sand (SP) 18.84 to 16.84 ft above MLLW, sand with silt (SP-SM) 16.84 to 13.84 ft above MLLW, woody peat (PT) 13.84 to 9.84 ft above MLLW, poorly graded sand (SP) 9.84 to 8.84 ft above MLLW, poorly graded gravel (GP) 8.84 to 6.34 ft above MLLW, and sand with silt (SP-SM) 6.34 to -1 ft above/below MLLW (Figure 13). Radiocarbon samples were not collected during this study, however, during May of 2018 I collected organic wood samples from the peat that SPU's Geotechnical Division had stored at their headquarters per approval from senior geologist Aaron Clark. These samples were given to Brian Sherrod for future radiocarbon and biota analysis.

### Alki Point – Spokane Street and Beach Drive Southwest

During several discussions with USGS geologist Brian Atwater in 2018, I was provided with field notes of subsurface investigations that he and his colleagues documented during several SPU utility projects during 1991 and 1997. The general stratigraphic sequence for the Spokane St investigations encountered from top to bottom; gravelly fill 23.5 to 20 ft above MLLW, sand (SP) 20 to 15.5 ft above MLLW, sandy gravel (GW) 15.5 to 12 ft above MLLW, woody mud 12 to 8 ft above MLLW, peat (PT) 8 to 6 ft above MLLW, organic sand (OL-OH) 6 to -6 ft above/below MLLW, respectively), and silty sand (SM) -6 to -16 ft below MLLW (Figure 14).

From trench observations, the contact between the sand (SP) and sandy gravel (GW) was gradational. Additionally, the contact between the upper woody mud and the lower portion of the sandy gravel (GW) was an erosional surface. The peat is 2 ft thick at the western edge of Spokane St, and pinches out ~164 ft to the east beneath Spokane St (Figure 14). A tree trunk from the middle of the peat layer at the Spokane St site gave a radiocarbon age of 6264 to 6529 cal yr B.P.

## Methods

For this project, I collected and analyzed core samples from Alki Playground and compared them to the other three sites to observe similarities and differences in the stratigraphy and chronology.

The lithostratigraphic correlation involved observing similarities and differences in the intertidal deposits with respect to composition, thickness, depth, location, and elevation. The chronostratigraphic correlation consisted of identifying layers deposited at the same time at each site without concern for the composition and was based on the radiocarbon ages obtained during this and the previous studies.

This project was executed in several phases, including:

- 1) gathering litho- and chronostratigraphic data from the Restoration Point, Spokane St, and 57<sup>th</sup> Ave SW investigations;
- 2) mapping peat at Alki using boring logs in the GeoMapNW database to determine the location for coring for peat deposits;
- 3) using ground penetrating radar at Alki Playground to observe stratigraphic variability;
- 4) obtaining permits and doing utility locates;
- 5) using a Geoprobe to obtain continuous core;
- 6) logging cores in detail in the laboratory, sampling, and preparing organic samples;
- 7) obtaining radiocarbon ages on the organic samples and calibrating ages;
- 8) creating cross-sections and composite stratigraphic logs; and-
- 9) comparing litho-and chronostratigraphy between all four sites

For the first phase, data was gathered from scientific papers, reports, manuscripts, and via direct communication with geologists directly associated with the previous work at Restoration Point, Spokane St, and 57<sup>th</sup> Ave SW.

The second phase involved using the GeoMapNW database in ArcGIS to find previous borings that had encountered peat deposits greater than 2 ft thick at Alki Point. The borings were marked on a map (Figure 15) and a drilling location was chosen based on accessibility and the highest concentration of borings with peat deposits thicker than 2 ft. Alki Playground, a City of Seattle Park, was chosen as the location for drilling and sampling due to the presence of a large grass field, which allowed us to obtain several borings across an area free of underground utilities, surface structures, and thick fill.

In the third phase, we used GPR at Alki Playground to gain a better understanding of how thick soil facies are, and if we could see any structures or variability in stratigraphy. We used a MALA RAMAC 100 Mhz GPR along the perimeter of the grass field. After the data was processed and variability in material was revealed, we confirmed Alki Playground as the desired drilling site.

The fourth phase required submitting a proposal to Seattle's Department of Parks and Recreation, to get a permit providing permission to drill at Alki Playground. Once the permit was obtained, public utility locates, and a private utility locator and drilling contractor were scheduled.

For the fifth phase, we drilled ten borings at Alki Playground (P1-P10) using a 7822 DT track-mounted Geoprobe to extract 1.5-inch diameter cores in 5-foot intervals at depths ranging from 10-20 ft. Continuous samples were obtained by driving a 5-foot core barrel into the subsurface, such that each boring had several 5-foot core runs to reach target depths. The maximum depth at each boring was limited by the presence of coarse gravel. Each core was collected in plastic tube liners inside the core barrel. Each liner captured a maximum of ~4.96 ft. The remaining 0.04 ft was captured in the drill bit. Each tube was cut open and the core was quickly logged in the field. After cores were field logged, they were wrapped in heavy duty plastic, secured with electrical tape, and labeled with the boring number and core depth interval. The borings were backfilled with bentonite. The number of borings drilled was limited by a severe snowstorm that occurred in the last hour of field work. Cores were transported to a large walk-in refrigerator at the University of Washington (UW) to ensure organic samples would be preserved until ready for sampling.

In the sixth phase, the cores were logged using the Unified Soil Classification System (USCS) per ASTM D2488 Standard Practice for Description and Identification of Soils (Visual-Manual Procedures) (ASTM D2488, 2017). This involved describing and classifying soils based on grain size distribution, color, consistency/compaction, angularity of grains, moisture, plasticity, and the contacts between each layer. Wood, charcoal, and mollusk samples were collected from various depths in several borings, cleaned, air dried, put into plastic vials, and sent to the National Ocean Sciences Accelerator Mass Spectrometry (NOSAMS) laboratory in Massachusetts for radiocarbon age determination. Additionally, samples from the 57<sup>th</sup> Ave SW

site were collected from Seattle Public Utilities (SPU) Geotechnical Division laboratory testing lab, with the permission of Aaron Clarke, a senior geologist with SPU.

In the seventh phase, radiocarbon age data were calibrated. Probable age ranges for the dated samples were calculated using Oxcal v4.3.2 (2017) r.5; Intcal13 atmospheric curve (Reimer et al., 2013). Radiocarbon ages and age error were input into the program, which then produced calibrations, displaying age range curves.

In the final phase, I drafted cross-sections and a composite stratigraphic log for each of the borings. A total of five cross sections were drafted from the investigations at Alki Playground; three trending north-south, one trending east-west, and one trending northwest-southeast. Calibrated radiocarbon age ranges were applied to appropriate layers in cross sections to help with interpretations. Boring logs were digitized using BoringLS software courtesy of The Riley Group Inc.

## Findings

### A. Alki Playground Subsurface Stratigraphy and Radiocarbon Ages

Five transects (Figure 16) using ten boring logs (Figures 17-26) from cores recovered at Alki Playground and boring logs from GeoMapNW on neighboring properties were used to create five cross sections (Figures 27-31). Cross sections indicate that strata appear to dip northwest towards the shore of Puget Sound, which is consistent with deposition in an intertidal and beach environment. The general sequence of units from the ground surface (20.34 ft above MLLW) to 20 ft bgs (0.34 ft above modern MLLW) generally consists of sandy silt (fill) 20.34 to 18 ft above MLLW, poorly-graded to well-graded sand (SP, SW) 18 to 15.75 ft above MLLW, peat (PT) 15.75 to 15.50 ft above MLLW, several layers of sandy gravel/gravel (GW) or gravelly sand/sand (SW, SP) 15.50 to 12.75 ft above MLLW, peat (PT) 12.75 to 12.25 ft above MLLW, then interbedded gravelly sand/sand (SW, SP) and sandy gravel/gravel (GW, GP) 12.25 to 0.25 ft above MLLW. In addition to the thicker strata mentioned above, small lenses of silt (ML), silty sand (SP-SM, SW-SM), organic sandy silt (OL-OH), and clayey gravel (GC) were also observed.

The two peat layers identified in borings at Alki Playground (Figures 27-31) are thin (0.25 to 0.50 ft) compared to boring logs from neighboring sites to the north of the park towards the shoreline, which range in thickness from 2 to 6 ft (Figures 28 & 29). The upper peat appears near the middle of the park and pinches out near the northern end Alki Playground (Figure 27). The lower peat first appears near the northern end of the park and possibly continues laterally towards the thick peat north of Alki Playground (Figures 28 & 29) (Note: The lower peat referred to for Alki Playground is not the same as the lower peat when comparing all three sites at Alki Point). Several lenses of gravel with silt and clay 7 to 5 ft above MLLW are located near the southern end of the park at boring P6, interbedded with the sandy and gravelly deposits (Figures 29 & 31). Organic samples were found sporadically throughout the cores, which include charcoal, wood, and a mollusk shell. The mollusk shell was collected in the sand above the upper peat (Figure 27). Charcoal samples were taken from the upper peat layer, while a sample from the lower peat layer consisted of woody organics. Both charcoal and wood were also encountered in the beach deposits below the lower peat layer.

Eight radiocarbon samples from five cores reveal ages ranging from modern (an age error range extending into 1950 A.D.) to 4826 cal yr B.P. at elevations ranging from 17.5 ft to 4.5 ft above MLLW, respectively (Table 1). A mollusk shell sampled from the sand layer above the upper peat and was dated from 7342-7442 cal yr B.P, indicating possible reworked sand (Figure 27). A wood sample from the organic sandy soil layer adjacent to the upper peat dates from modern to 284 cal yr B.P (Figure 31). Two charcoal samples from the upper peat layer in borings P4 and P8 date from modern to 297 cal yr B.P and modern to 294, respectively (Figures 27 & 29). The wood sample from boring P2 in the lower peat is modern (post 1950 A.D.) indicating possible contamination by modern carbon such as roots penetrating into the sample (Figures 27 & 28). Wood sampled from the clean upper middle beach deposits that underlie the lower peat date from 3078 to 3336 cal yr B.P. (Figures 29 & 31). Charcoal from the lower middle silty beach deposits date to 4616 to 4826 cal yr B.P. (Figures 29 & 31). The deepest sample collected was wood in the lower middle silty beach deposits and an age of 4296 to 4501 cal yr B.P. was determined (Figures 27, 30, & 31).

## B. Comparison to 57<sup>th</sup> Avenue Southwest Stratigraphy

Borings from 57<sup>th</sup> Ave show that sand (SP), sand with silt (SP-SM), and silty sand (SM) were encountered from the ground surface (20.34 to 18.24 ft above MLLW) to depths between 13.34 to 11.34 ft above MLLW (Figure 13). Similar to the Alki Playground site where sand (SP) and silty sand (SM) were encountered from 18 to 12.75 ft above MLLW, this material also contained organic material such as wood, rootlets, and shell fragments (Figures 27-31).

Below the sandy and silty layers at 57<sup>th</sup> Ave, woody peat with small lenses of sand and silt were encountered at elevations ranging between 13.34 to 8.34 ft above MLLW, and organic wood contents of 57-67% (Figure 13). The woody peat layer at 57<sup>th</sup> Ave SW is encountered at similar elevations to the lower woody peat at Alki Playground (12.75 to 12.25 ft above MLLW) (Figure 27-31).

Below the peat layer at 57<sup>th</sup> Ave SW, deposits consisting of sand (SP), sand with silt (SP-SM), gravel (GP), gravel with silt and sand (GP-GM), and silty gravel (GM) were encountered from 13.34 ft above MLLW until the borings were terminated at -0.66 ft below MLLW (Figure 13). This is similar to findings at Alki Playground, where similar material was encountered 12.25 to 0.25 ft above MLLW (Figure 27-31).

### C. Comparison to Spokane Street

Borings and trench observations at Spokane St show sand (SP) from 19 to 14 ft above MLLW. Sand (SP/SW) is also found at Alki Playground at similar elevations of 17.5 to 16.5 ft above MLLW (Figure 14, 27-31).

Below the sand (SP) at Spokane St, a transition to sandy mud was encountered at 14 ft above MLLW, followed by peat at 9 to 4.5 ft above MLLW, and lastly silty sand (SM) from 4.5 to -5.3 ft above/below MLLW (Figure 14). The sand layer at Alki Playground transitions to the upper peat from 15.50 to 15.25 ft above MLLW, sand from 15.25 to 13.75 ft above MLLW, lower peat from 12.25 to 12.75 ft above MLLW, sand and gravel (SW/GP) from 12.25 to 6.15 ft above MLLW, clayey gravel clayey gravel and silty sand (GC/SM) from 6.15 ft to 4.6 ft above MLLW, and gravel (GP) from 4.6 ft to 0.33 ft above MLLW (Figure 27-31).

A radiocarbon age from a tree log in the middle of the peat 7 ft above MLLW at Spokane St was 6264 to 6529 cal yr B.P., while the ages on the upper and lower peats at Alki Playground were anywhere from modern (post 1950 A.D.) to 297 cal yr B.P. Additionally, the deepest three radiocarbon samples taken at Alki Playground range from 3078 to 4501 cal yr B.P., which were collected at elevations lower than the peat sample collected at Spokane Street. Based on these depths and ages, the peat at Spokane St was not deposited at the same time as the upper and lower peat at Alki Playground.

#### D. LiDAR and T-Sheet Analysis for Alki Point

Two-foot contours generated over a digital terrain model of Alki Point reveal east-west trending linear beach ridges, which connect the bedrock knoll at the western tip of Alki Point to the mainland towards the east (Figure 32). Additionally, a T-sheet of Alki Point from 1874 shows topography with low relief between the bedrock knoll and the mainland (Figure 7). A T-sheet from 1899 shows that an area near the northern end of Alki (north of the current beach ridges) was occupied by a modern marsh (Figure 8).

## Discussion

### Depositional Environments at Alki Playground, 57<sup>th</sup> Ave, and Spokane St

Based on stratigraphic ages, a conceptual chronostratigraphic model of Alki was developed (Figure 33). At Alki Playground, the sandy silt (ML) encountered in the top of each boring is presumed to be fill material when Alki Playground was regraded in the 1930's (Sherwood, 1974).

The sediment below the fill and beneath both peat layers is mostly sand and gravel, which is reflective of modern beach deposits.

Two ages on charcoal in the upper peat layer at 17.2 and 15.6 ft above MLLW reveal that it was deposited between modern to 297 cal yr B.P. This age suggests that deposition was not the result of the ~1000 cal yr B.P. uplift event, but possibly from a highly organic environment after uplift that is representative of a coastal forest or grassland that covered this area within the last few

centuries. Historical documents describe the area that Alki Playground occupies as a sandy “meadow” before development in the early 1900’s (Sherwood, 1974). Historical documents that describe a forest covering the Alki Playground site when Native Americans occupied this location were not found; however, it is possible that a forest fire or grassland fire occurred since the upper peat was abundant in charcoal. The charcoal that was dated in the upper peat layer may also suggest that Native American fire pits could also be the source of this deposit, since Native Americans likely occupied this area at some time after uplift exposed Alki Point above sea level ~1000 cal yr B.P. This occupation of post-Seattle fault uplift or subsidence surfaces was documented at sites like West Point (Troost et al., 1994) and at Restoration Point on Bainbridge Island (Bucknam et al., 1992). Alternatively, the ages on these radiocarbon samples may not be accurate of the actual age of this layer due to contamination from roots extending into this layer.

The middle peat mapped for Alki Point at Alki Playground is suspected to be the same as the peat identified in documented borings north of Alki Playground and from 57<sup>th</sup> Ave, which have similar woody composition at similar elevations (Figure 33). The upper contact of the middle peat at Alki Playground is 12.75 ft above MLLW, the upper contact of the peat identified in borings north of Alki Playground is 13.75 ft above MLLW, and the upper contact of the peat at 57<sup>th</sup> Ave is 13.34 ft above MLLW (Figures 33). Since the middle peat appears to thicken towards to the current shoreline at Alki Playground (Figures 28 & 29), the thickest part of a marsh was likely located directly north/northeast of Alki Playground. Alki Playground appears to have occupied the southwestern edge of a marsh, and the area between Alki Playground and the modern shore to the north/northeast would have been the location of the main portion of the marsh where a maximum thickness of ~6.5 ft was observed from core samples (Figure 32). The existence of this marsh would require at least a partial isolation from tidal influences, which may be the result of one or more of the following hypotheses: (1) a tombolo that connected the bedrock knoll at western tip of Alki Point to the mainland towards the east (Figure 32), (2) a beach berm shoreward of Alki Playground and 57<sup>th</sup> Ave, or (3) other unknown environmental factors.

This tombolo hypothesis appears to be reflected in contours constructed over LiDAR data for Alki Point that shows low relief in the topography where the tombolo was connected, with beach

ridges shoreward of the suspected tombolo (Figure 32). If additional beach ridges or intertidal bars fringed the previous shoreline on the north end of Alki Point, one or more marshes may have formed (Figure 32). The direction of the shore-drift at Alki Point is south to north, which drove the propagation of waves on the southern margin of Alki Point. These factors would be the most important control on sediment transport, and would have assisted in forming beach ridges and a tombolo along the southern margin of Alki Point. Marsh deposits encountered at Alki Playground and 57<sup>th</sup> Ave may have formed as a result of these depositional and geomorphic processes.

Data was not available to help confirm or rule out any other suspected environmental factors that led to the formation of the marsh deposits at Alki Playground and 57<sup>th</sup> Ave. Based on samples taken from above and below the middle peat, deposition of the peat occurred sometime between 297 and 3078 cal yr B.P.

The contact between the middle peat and gravel marks a sedimentologic change that is significant because it represents an abrupt change in the depositional environment, where an intertidal environment strongly influenced by tidal changes abruptly shifts to a partially isolated marsh or tidal flat (Figures 27-31). This contact could be the result of seismic uplift, berm accretion, or other environmental factors.

The upper middle clean beach deposits at Alki Playground are suspected to have been deposited sometime between uplift ~1000 cal yr B.P. and roughly 4000 cal yr B.P. (Figure 33). This assumption comes from interpretations made from cross sections at Alki Playground and the age-depth relationship of these described deposits.

In the lower middle silty beach deposits, two major abrupt changes in depositional environments were observed in the cross sections of Alki Playground. Based on core observations, Figure 31 shows a major change in lithology and a sharp contact, where gravel (GP) deposits ~3.75 ft above MLLW abruptly shift to (1) sand with silt (SP-SM) near the northwestern end of the park, and (2) clayey gravel (GC) deposits ~5.5 ft above MLLW near the southeastern end of the park. The unusually high amount of fine-grained material found in the clayey gravel (GC) may be a mixture of beach deposits and colluvium derived from fluvial-transport and landslides from the

higher terrain to the east that were deposited sometime between 4616 to 4826 cal yr BP at an elevation of ~5.75 ft above MLLW. An age on wood sampled in the sand with silt (SP-SM) layer below the clayey gravel (GC) is between 4296 to 4501 cal yr B.P. at an elevation of ~4.25 ft above MLLW, which implies that the clayey gravel (GC) deposit may have been highly reworked. This transition is also seen at 57<sup>th</sup> Ave, where sand with silt (SP-SM) abruptly shifts to gravel (GP) at ~6 ft above MLLW. This abrupt transition does not appear to be the result of a large earthquake based on biota analysis at Restoration Point. Specifically, Sherrod and others (1999) documented a sudden shift from brackish to slightly less brackish biota ~4500 cal yr B.P., however; no significant equivalent elevation change occurred shortly before or after. This abrupt transition at Alki Point between these layers indicates several other possibilities based on the location of this site: (1) partial beach berm accretion allowed finer grained marine sediment to accumulate, (2) sea level rise led to erosion, followed by shallow marine sediment accumulation, (3) extensive colluvium from Schmitz Park, or (4) other unknown environmental factors.

The lower peat layer at Spokane St may have formed behind a beach berm when elevation of the site was within reach of the intertidal zone before uplift ~1000 cal yr B.P. Specifically, a beach ridge or intertidal bar may have been located offshore from the current shoreline shortly before deposition of the peat 6264 to 6529 cal yr B.P., followed by a transgression that led to the current position of the suspected beach ridges as sea levels rose (Figure 32). The transition of peat (below) to woody mud (above) could be attributed to a change from a lower intertidal environment to a higher intertidal environment with respect to MHHW. The organic sand in contact with the bottom of this peat layer represents a depositional environment that may have been near the opening of intertidal beach bars where marine sand and organic material from fluvial-transport on the mainland would have mixed. The silty sand layer at the bottom could be indicative of a marine environment or a shallow intertidal zone.

The lithostratigraphy of the three Alki Point sites compared to the Restoration Point site show little similarities. The marsh at Restoration Point is well-preserved and deposits reflect fresh, brackish, and marine environments that have not experienced any significant erosion. The Restoration Point and Spokane St sites both encounter a peat layer that was dated between 6200 to 6700 cal yr B.P. and 6264 to 6529 cal yr B.P., respectively. At Spokane St, this age came

from a tree trunk in the middle of the peat layer at ~7 ft above MLLW. At the marsh on Restoration Point, this age comes from the bottom of the red peat ~26 ft above MLLW. Since the peat at Spokane St was deposited ~21 ft lower than the peat at the marsh at Restoration Point during the same time when sea level was the same at both sites, a beach ridge must have been present shoreward at Spokane St. The red peat at the Restoration Point site is underlain by gray mud, and the change in depositional environments is attributed to an increase in elevation where brackish marine biota gradually shifts to freshwater biota. Based on diatoms and other biota in the red peat at the marsh at Restoration Point, elevation change was not abrupt or significantly large enough to suspect uplift when the peat at both of these sites was being deposited. Depositional and erosional processes are variable at all four sites, which is likely due to several environmental factors and the geographic locations between Alki Point and Restoration Point. The conceptual chronostratigraphic relationship between all four sites were inferred in this study based on age-depth relationships from limited data. Additional radiocarbon ages and drilling for core deposits would improve the characterization of these sites.

### Geomorphic Interpretation of Alki Point

The uplifted beach was identified at Alki Point over a century ago (Kimball, 1897). Landform features prior to uplift ~1000 cal yr B.P. formed as a result of the geometry of West Seattle, shore-drift directions, sea level, sediment supply, and the bedrock knoll. Since the peat layer at Spokane is 6274 to 6529 cal yr B.P., beach ridges further offshore from the current positions on land may have provided an ideal environment for the peat at Spokane St to form when it was deposited sometime shortly before 6274-6529 cal yr B.P. When sea levels rose to near the present level about 5500-6000 cal yr B.P., the bedrock knoll at the tip of Alki Point was a small island that experienced a net shore-drift from the south between the mainland and the bedrock knoll (reference). The current shoreline orientation between the mainland and the bedrock knoll is northwest-southeast, and this factor and/or an island-producing wave shadow may have led to shore-drift accretion that began forming a spit, which may have eventually developed as a tombolo tied the bedrock knoll to the mainland (Figure 34) (Stark et al., 1950; Chrzastowski, 1982). Once this tombolo connected the mainland to the bedrock knoll, the area north of the tombolo would have transitioned into a depositional zone for net shore-drift around the west end of the tip of Alki Point. In addition, fluvial deposition and colluvium from the ravine (currently

known as Schmitz Park) (Figure 34) would have added additional sediment to the northern portion of Alki Point. If partial isolation from the southerly shore-drift and accumulation of sediment was occurring, this may have aided in the development of one or more salt marshes at Alki.

The formation of a marsh on the north side of a tombolo may have also required some degree of low beach ridges or intertidal bars on the northern margin of Alki Point in order for this depositional environment to be better preserved. Based on peat identified in borings at Alki Playground and 57<sup>th</sup> Ave (the middle peat), the extent of the former marsh is suspected to include the northern edge of Alki Playground, north towards Alki Ave, further east to 57<sup>th</sup> Ave, and south down 57<sup>th</sup> Ave SW between Alki Ave SW and Lander St (Figure 32). Borings north of Alki Playground record the thickest and associated deepest part of this former marsh where peat deposits are as thick as ~6 ft. Ages from deposits above and below the middle peat at Alki Playground constrain the age of the middle peat to sometime between 297 to 3336 cal yr B.P.

The three marshes highlighted in the 1899 T-sheet of Alki Point shows evidence for modern marshes that existed before Alki was heavily developed in the 1900's (Figure 8). These marshes may have formed at the same time as the upper peat seen at Alki Playground. In addition to the other marshes identified at Alki Point in this study, these marshes may provide further insight into abrupt elevation changes that may have occurred within the last few centuries or longer, however, they have likely been cut during regrading projects since they were not observed in borings from the GeoMapNW database.

All of these marshes may record abrupt elevation changes related to coseismic uplift in the SFZ. Observing microfossil assemblages within the peat deposits encountered at all three sites on Alki Point will provide additional evidence to support: (1) the seismic history of the SFZ, (2) the depositional history and geomorphic reconstruction proposed in this study, and (3) the environmental factors that resulted in elevation changes observed in microfossil assemblages at the marsh at Restoration Point.

## Conclusion

The geomorphology of Alki Point prior to uplift ~1000 cal yr B.P. was interpreted through historical maps, LiDAR, core samples, and radiocarbon data. LiDAR data and historical T-sheets show that the topography is reflective of beach ridges shoreward of a potential tombolo on the southern margin of Alki Point. These landform features would have protected Alki Point from erosional processes in a significant manner. Marsh deposits at Spokane St, Alki Playground, 57<sup>th</sup> Ave, and a modern marsh north of 57<sup>th</sup> ave highlighted in a historical land survey map provides evidence that this is a strong possibility. From historical records and core samples collected in this study, it appears that at least three salt marshes occupied Alki Point at different periods during the mid-late Holocene. Collecting paleoenvironmental data from microfossil assemblages in these marsh deposits may provide insight into past uplift events and allow scientists to better define a recurrence interval for seismic activity within the SFZ.

## Recommendations

Identifying diatom assemblages within deposits at the Spokane St, Alki Playground, and 57<sup>th</sup> Ave sites may provide evidence of past seismic events, relative sea level changes, and abrupt or gradual changes in associated depositional environments. Obtaining ages on the peat at 57<sup>th</sup> Ave and another age on the lower peat at Alki Playground is needed to decide when the potential salt marsh was initially deposited. In addition, additional borings and sampling of marsh deposits near Alki Playground and 57<sup>th</sup> Ave can help delineate the extent of the salt marsh encountered from core samples in this project.

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## Tables

**Table 1.** Calibrated radiocarbon ages on samples taken from cores at Alki Playground.

| Submitter Identification | Elevation above MLLW (ft) | Type          | Process             | F Modern | Fm Err | Age     | Age Error | $\delta^{13}C$  | $\Delta^{14}C$ | Calibrated Age (cal yr B.P) |
|--------------------------|---------------------------|---------------|---------------------|----------|--------|---------|-----------|-----------------|----------------|-----------------------------|
| P6 C-1 34"               | 17.51                     | Plant/Wood    | (OC) Organic Carbon | 0.9801   | 0.0027 | 160     | 20        | -<br>25.08      | -28.07         | Modern-284                  |
| P4 C-1 38.35"            | 17.14                     | Charcoal      | (OC) Organic Carbon | 0.9750   | 0.0019 | 205     | 15        | -<br>25.16      | -33.08         | Modern-297                  |
| P1 C-1 47.66"            | 16.37                     | Mollusc Shell | (HY) Hydrolysis     | 0.4242   | 0.0011 | 6890    | 20        | -1<br>579.31    | -              | 7342-7442                   |
| P8 C-1 52.25"            | 15.99                     | Charcoal      | (OC) Organic Carbon | 0.9755   | 0.0019 | 200     | 15        | -25.2<br>-32.64 | -              | Modern-294                  |
| P2 C-2 31.05"            | 12.75                     | Plant/Wood    | (OC) Organic Carbon | 1.1397   | 0.0023 | >modern | N/A       | -<br>27.13      | 130.25         | >Modern (post 1950 AD)      |
| P6 C-3 27.25"            | 8.07                      | Plant/Wood    | (OC) Organic Carbon | 0.6878   | 0.0025 | 3,010   | 30        | -<br>25.53      | -<br>317.92    | 3078-3336                   |
| P6 C-3 52.25"            | 5.99                      | Charcoal      | (OC) Organic Carbon | 0.5961   | 0.0015 | 4,160   | 20        | -<br>17.95      | -<br>408.84    | 4616-4826                   |
| P1 C-4 11.18"            | 4.41                      | Plant/Wood    | (OC) Organic Carbon | 0.6125   | 0.0015 | 3,940   | 20        | -<br>25.48      | -<br>392.63    | 4296-4501                   |

### Notes:

- Submitter identification information includes boring number, core number, and depth of sample from top of specified core.
- A modern age refers to a sample that has an age error range extending into 1950 A.D., which marks the time after radiocarbon concentrations were not the same as in the past due to the atomic bomb effects on this concentration.

Figures

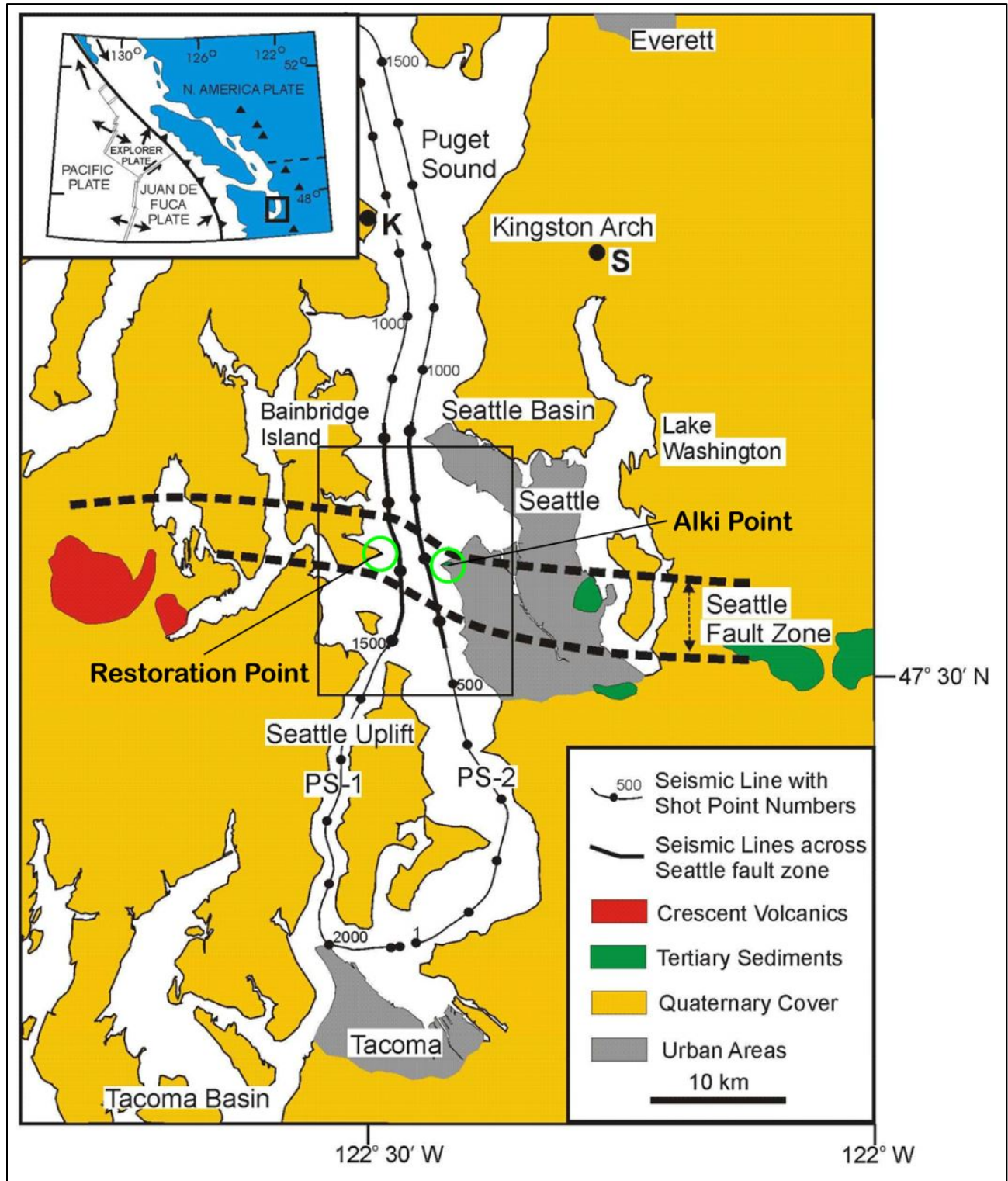


Figure 1. Map showing the extent of the Seattle fault zone (<http://www.sfu.ca/~acalvert/Web%20Site/Research/Cascadia%20Shallow/CascadiaShallow.htm>).

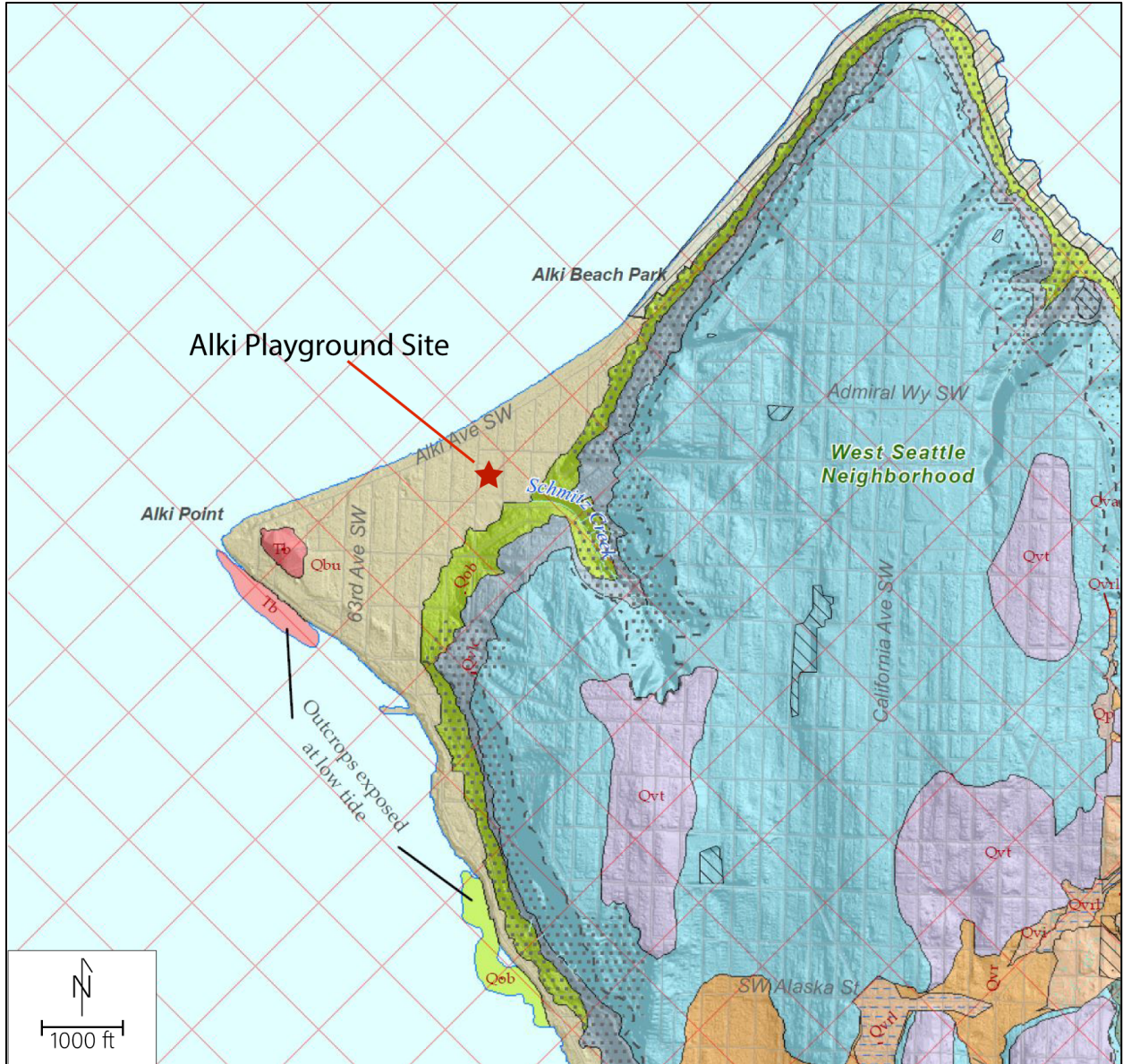


Figure 2. Location map of the Alki Playground site.

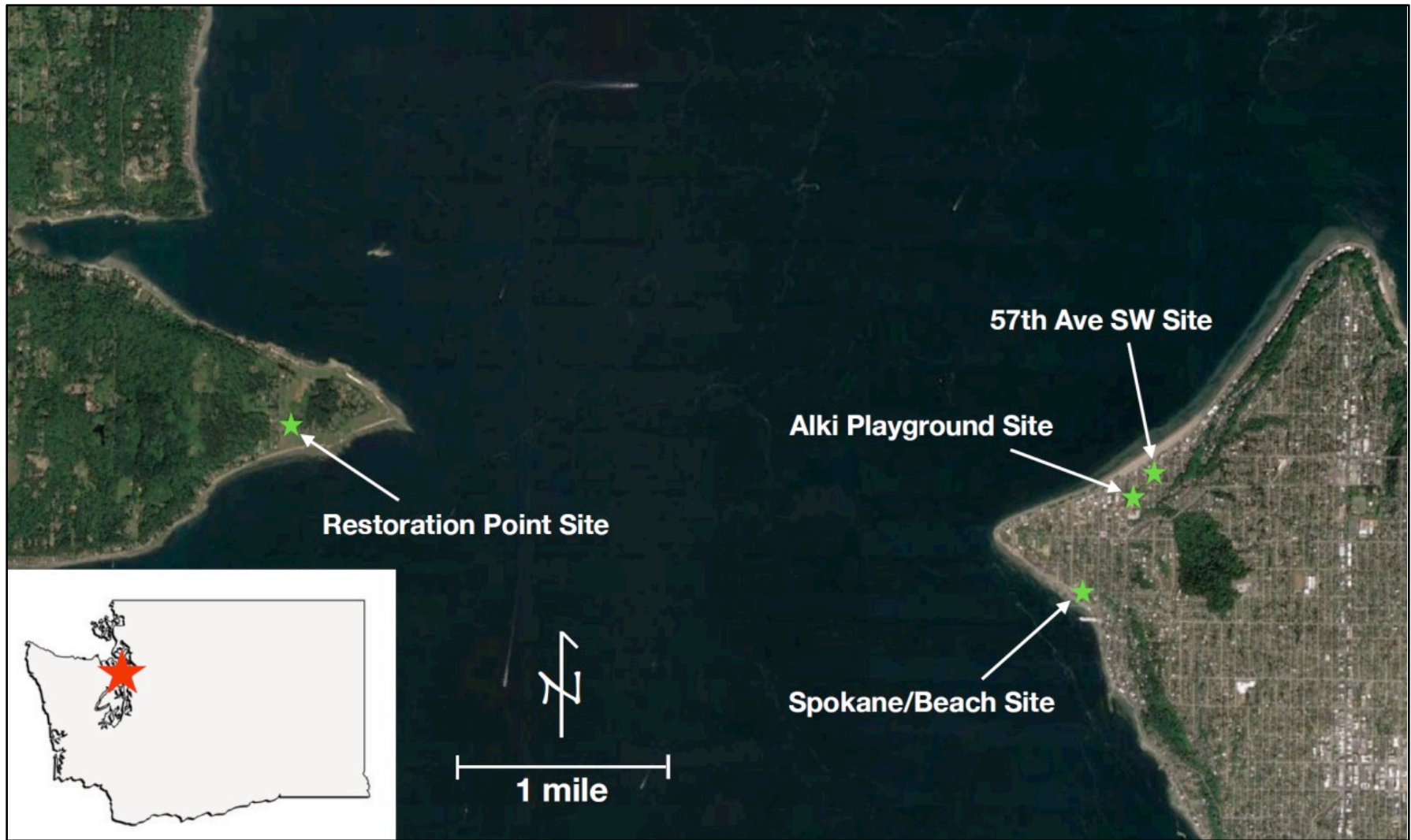


Figure 3. Location map showing the four sites considered for this project.



Figure 4. Location map of Alki in West Seattle, Washington State.

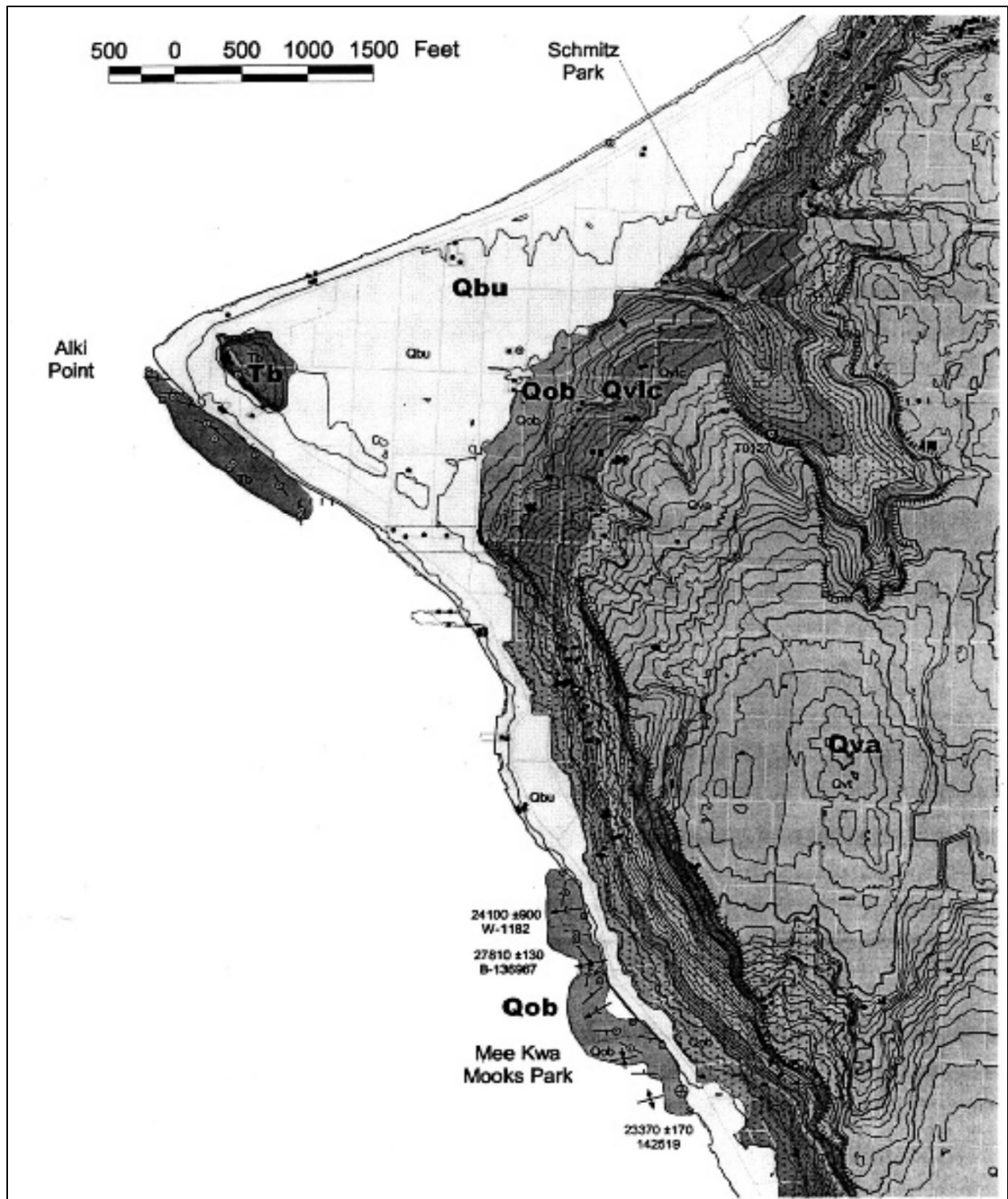


Figure 5. Topographic map of Alki Point and the steep slopes directly to the east. The bedrock knoll at the western tip of Alki Point is marked as Tb (Blakely Formation) (Troost, 2002).

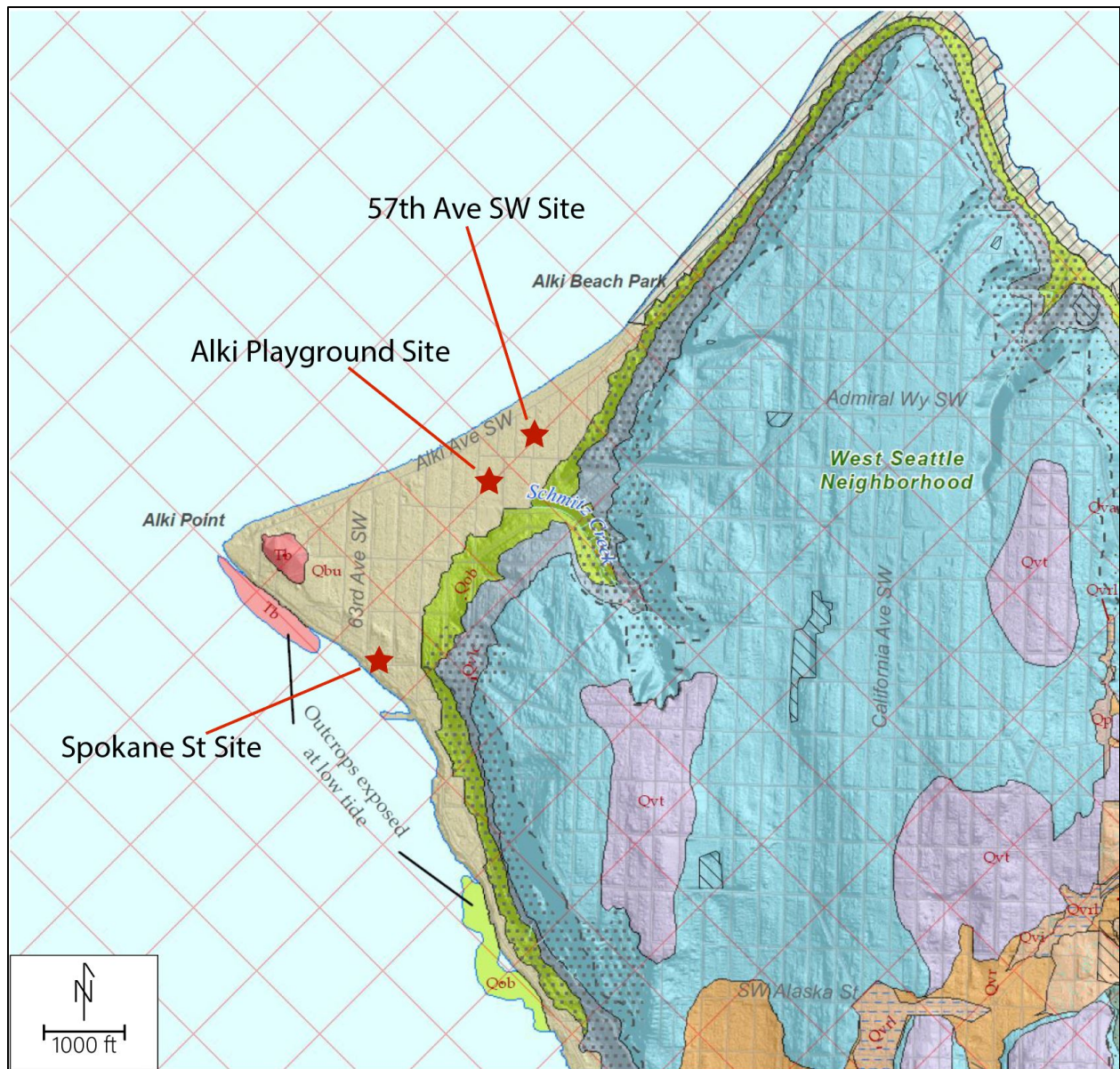


Figure 6. Geologic map of Alki Point in West Seattle, Washington (Troost et al., 2005). The red cross hatching indicates the area that is within the Seattle fault zone. Qbu-Uplifted beach deposits, Qvt-Vashon subglacial till, Qva-Vashon advanced outwash deposits, Qvlc-Lawton clay member of the Vashon drift, Tb-Blakely Formation, and Qob-Olympia beds.

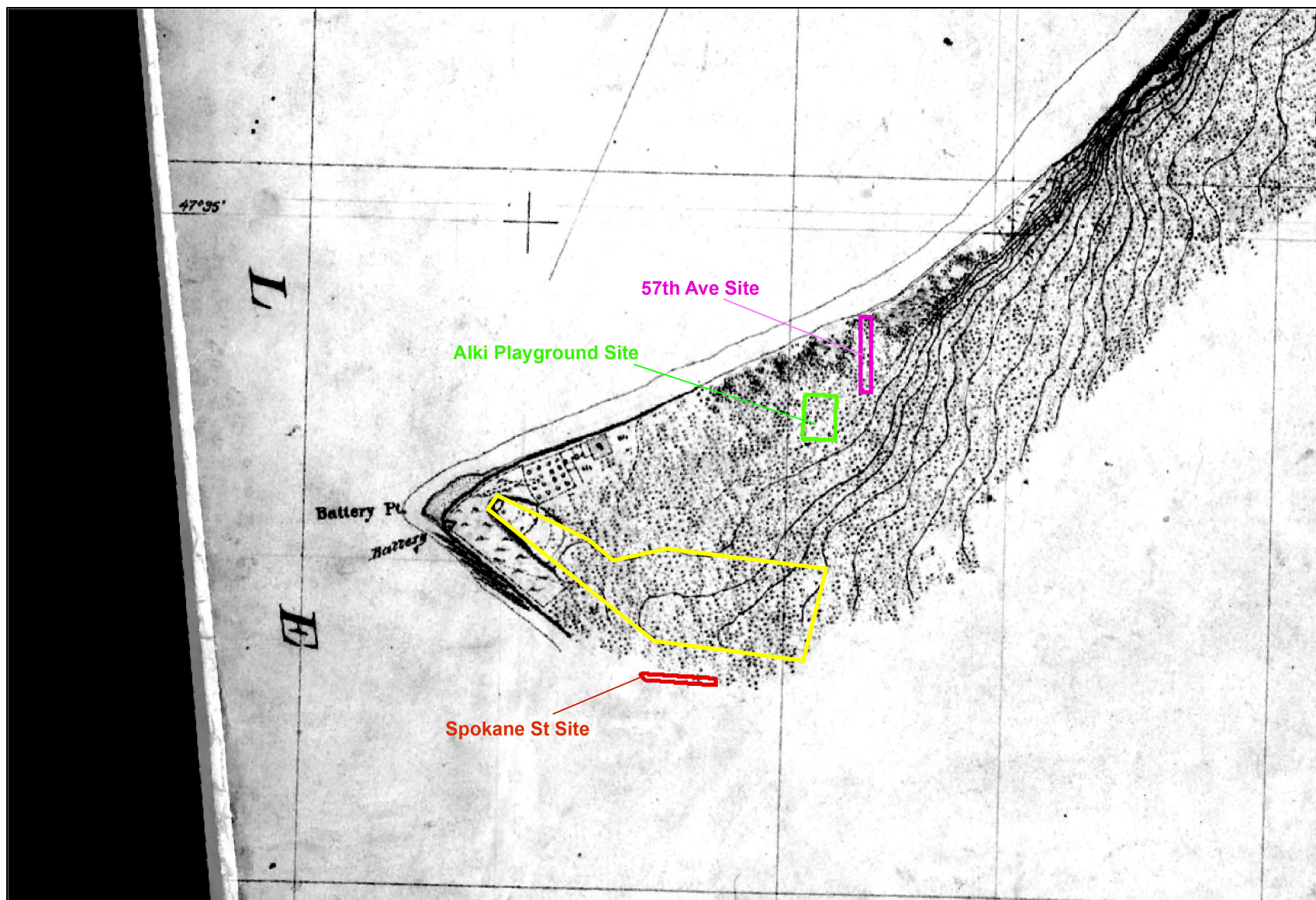


Figure 7. T-sheet from 1874 showing the topography and vegetation at Alki Point before development. Contour lines are 10 ft and the yellow line delineates the location of the suspected tombolo (U.S. Coast and Geodetic Survey, 1899).

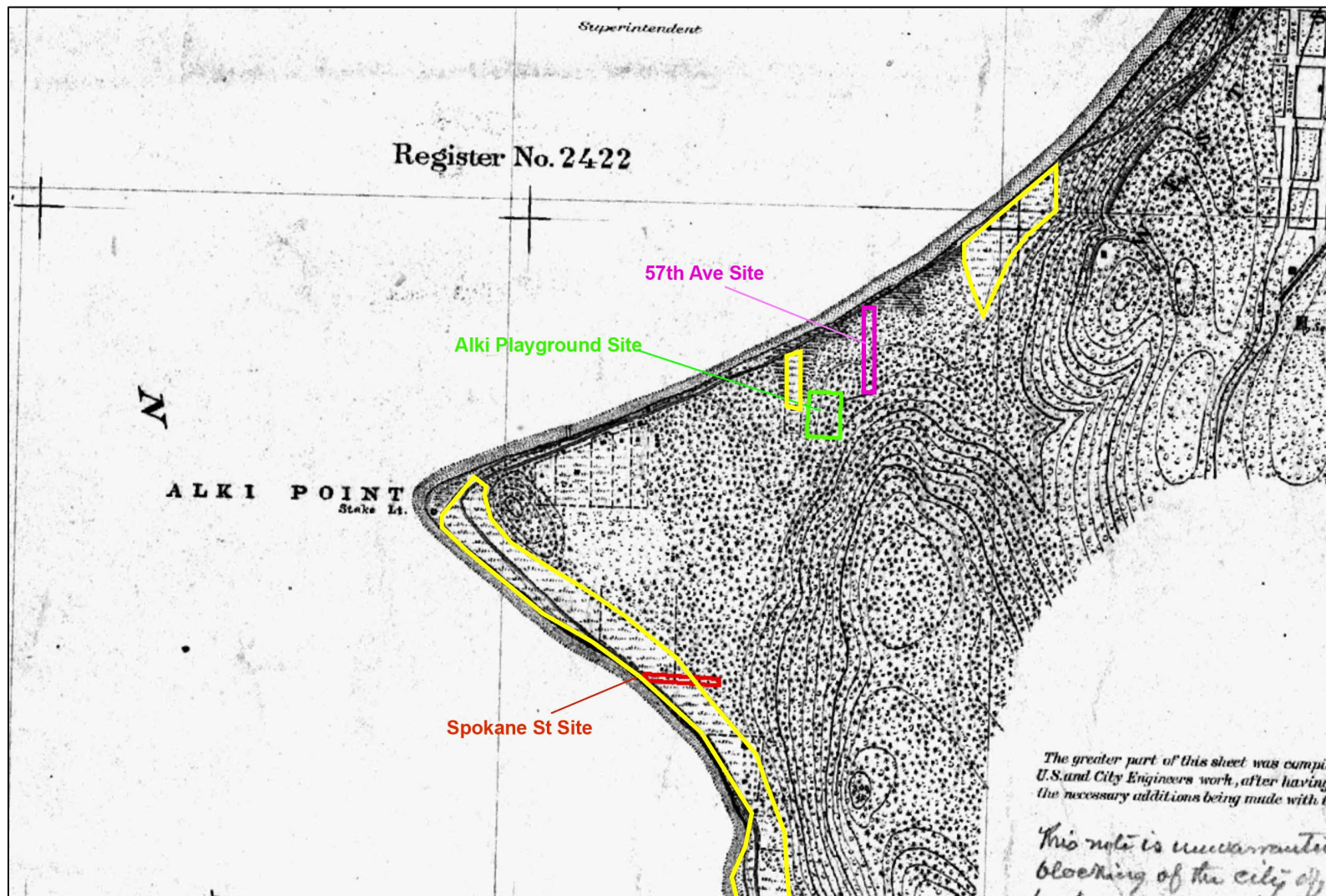


Figure 8. T-sheet from 1899 shows 20-foot contour lines. The yellow lines delineate modern marshes at Alki Point prior to further development. The tombolo can't be seen in this photo because of regrading of Alki between 1874 and 1899 (U.S. Coast Survey, 1874).

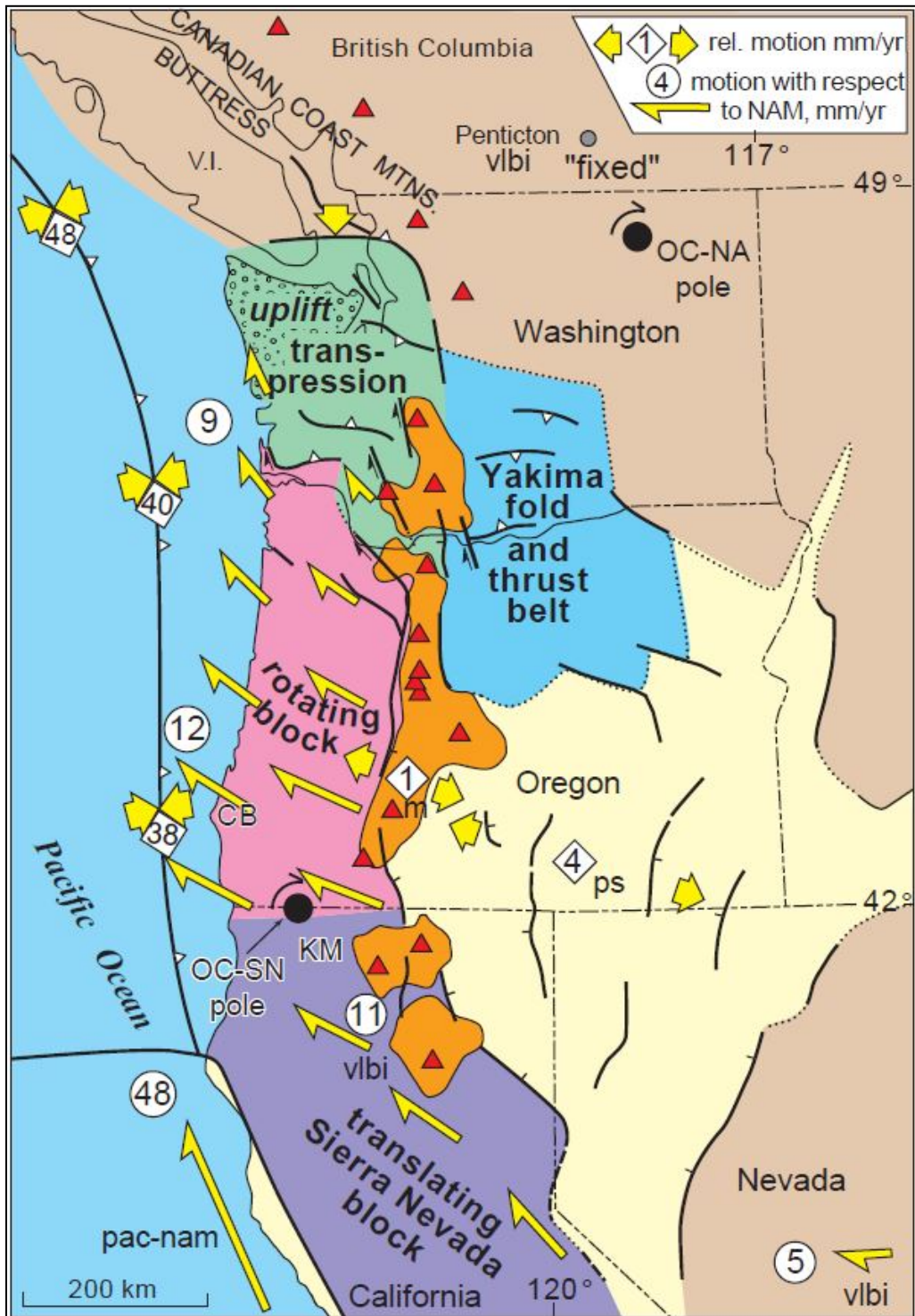


Figure 9. Schematic showing the Sierra Nevada Block pushing western Oregon, causing clockwise rotation in Western Washington, ultimately resulting in uplift and transpression (Anderson et al., 2018)

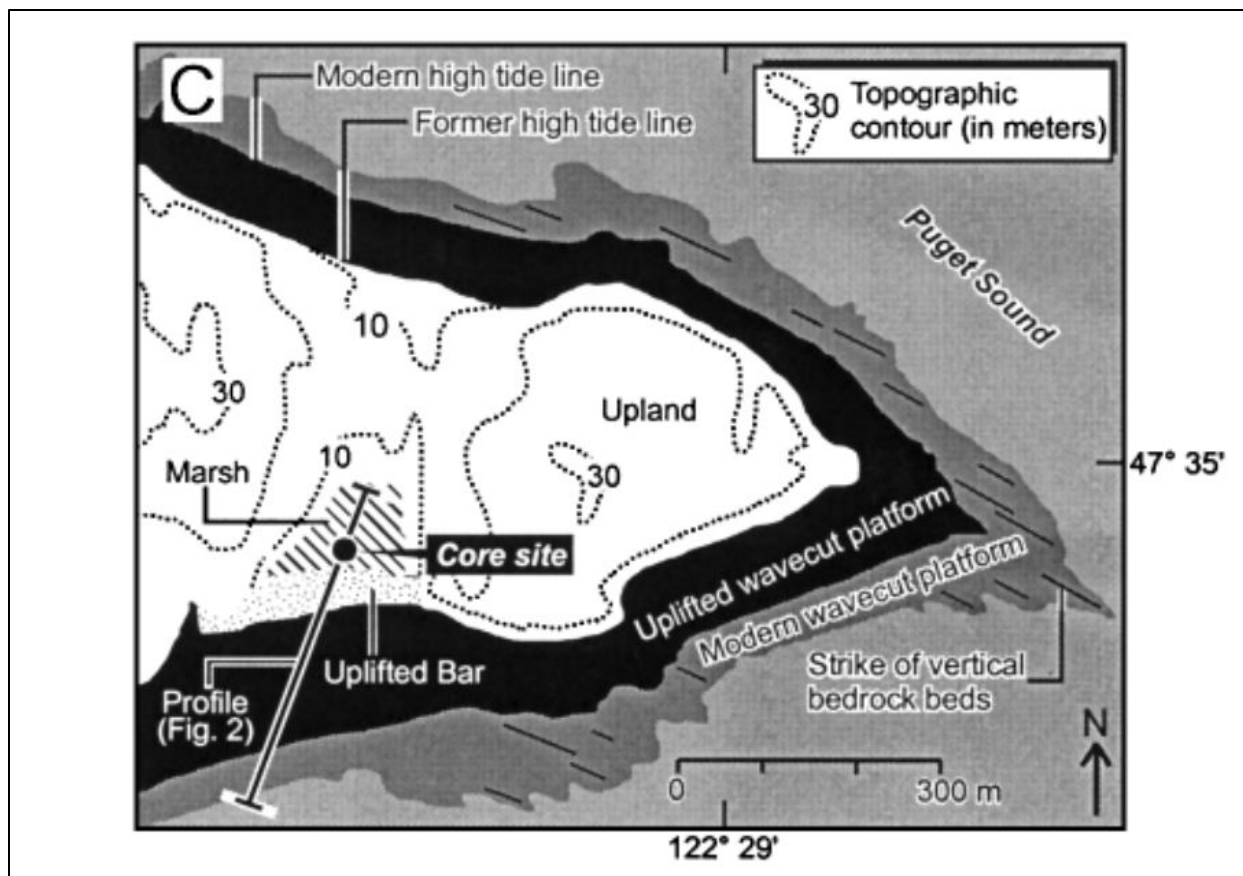


Figure 10. Location map of the marsh studied at Restoration Point on Bainbridge Island, Washington (Sherrod et al., 1999).

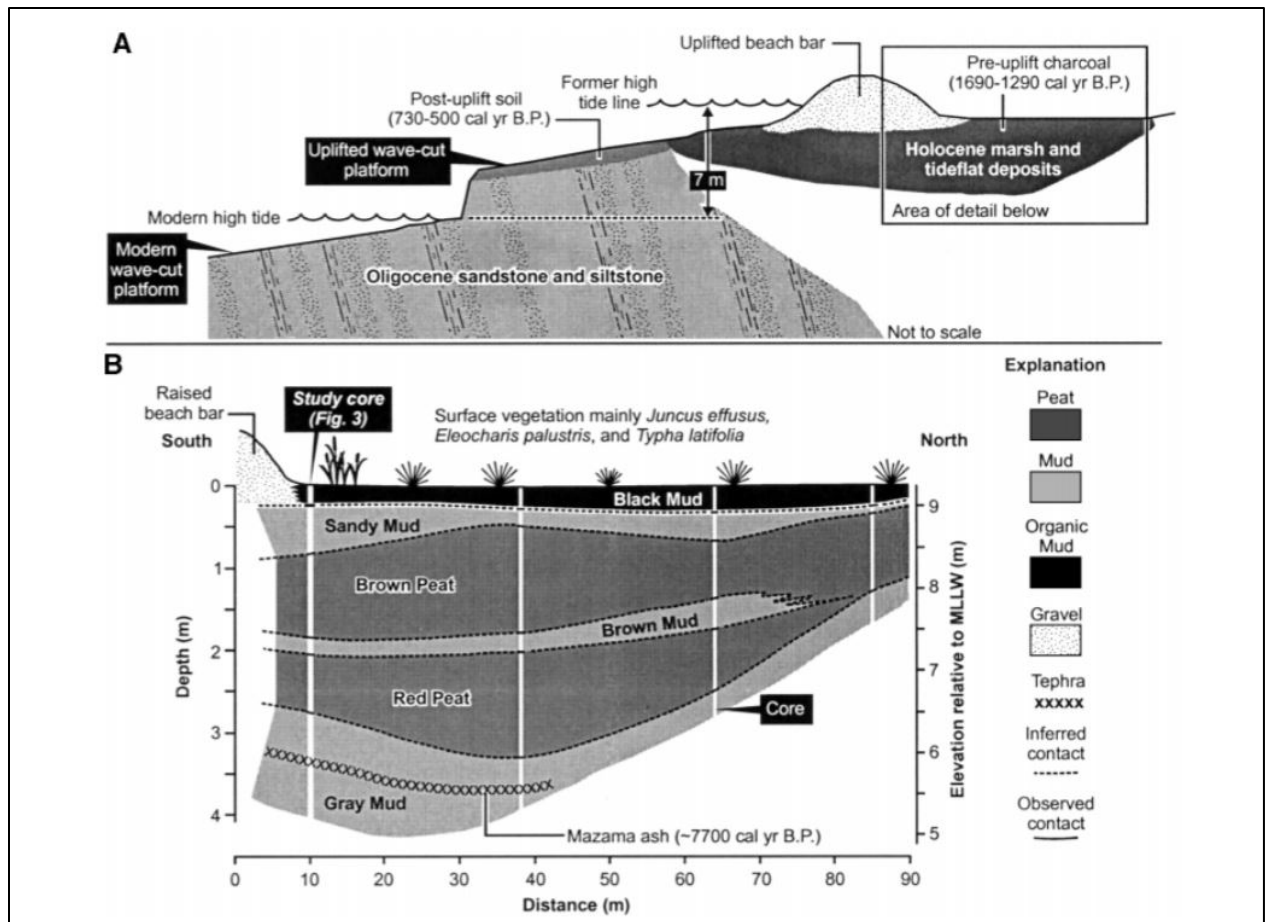


Figure 11. Diagrammatic cross-section from Sherrod et al. (1999) across an uplifted wave-cut platform at Restoration Point and cross-section of marsh constructed from cores. Additional stratigraphic data are from Bucknam et al. (1994). Uplift at this site ~1000 cal yr B.P. was about 23 ft, as measured by the difference in the elevations of the former shoreline angle and the present shoreline angle (Bucknam et al., 1992).

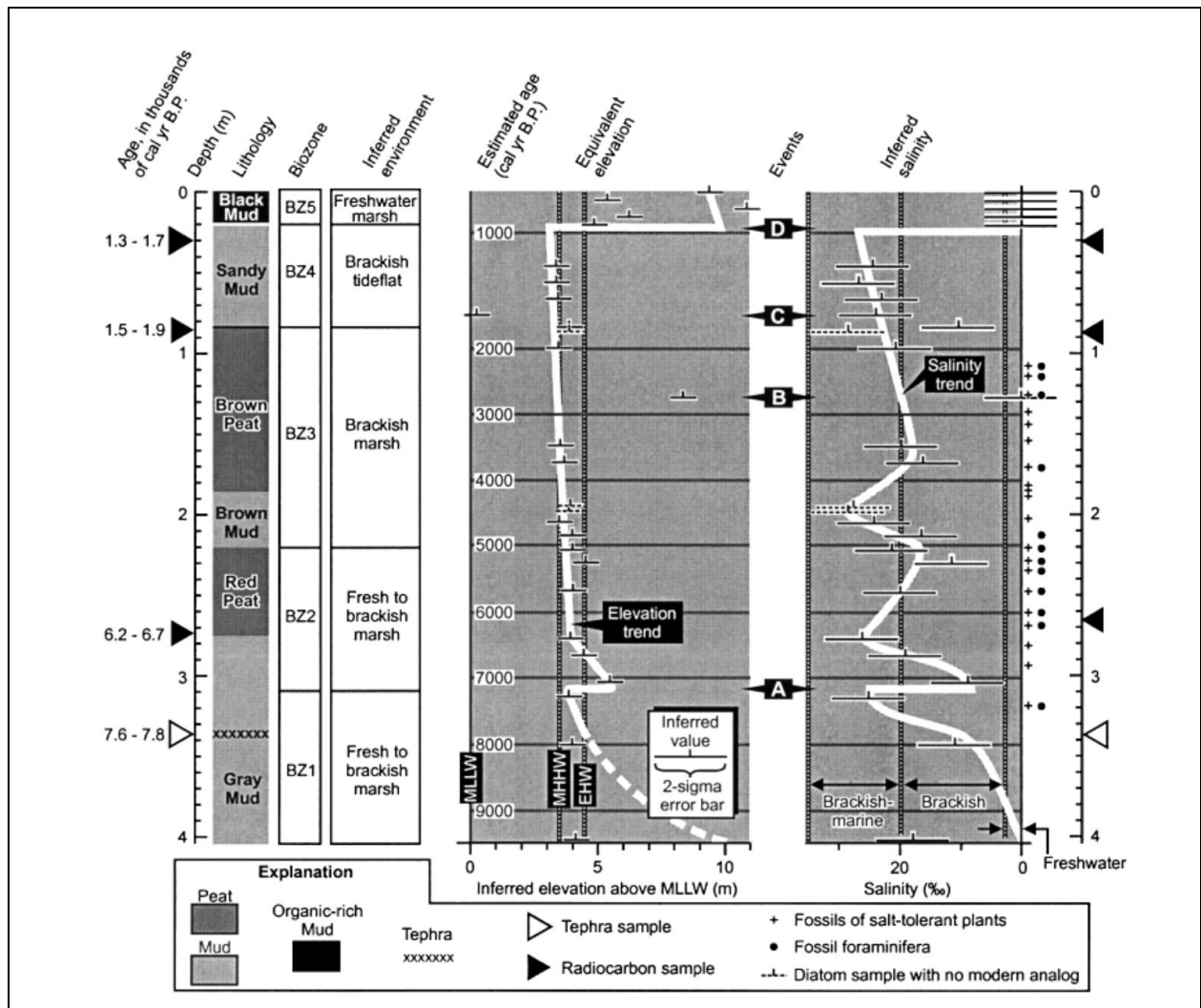


Figure 12. Summary diagram of environmental changes at Restoration Point. Heavy white lines are visually fitted through inferred elevation and salinity datapoints in consideration of all available biostratigraphic and lithologic data (Sherrod et al., 1999).

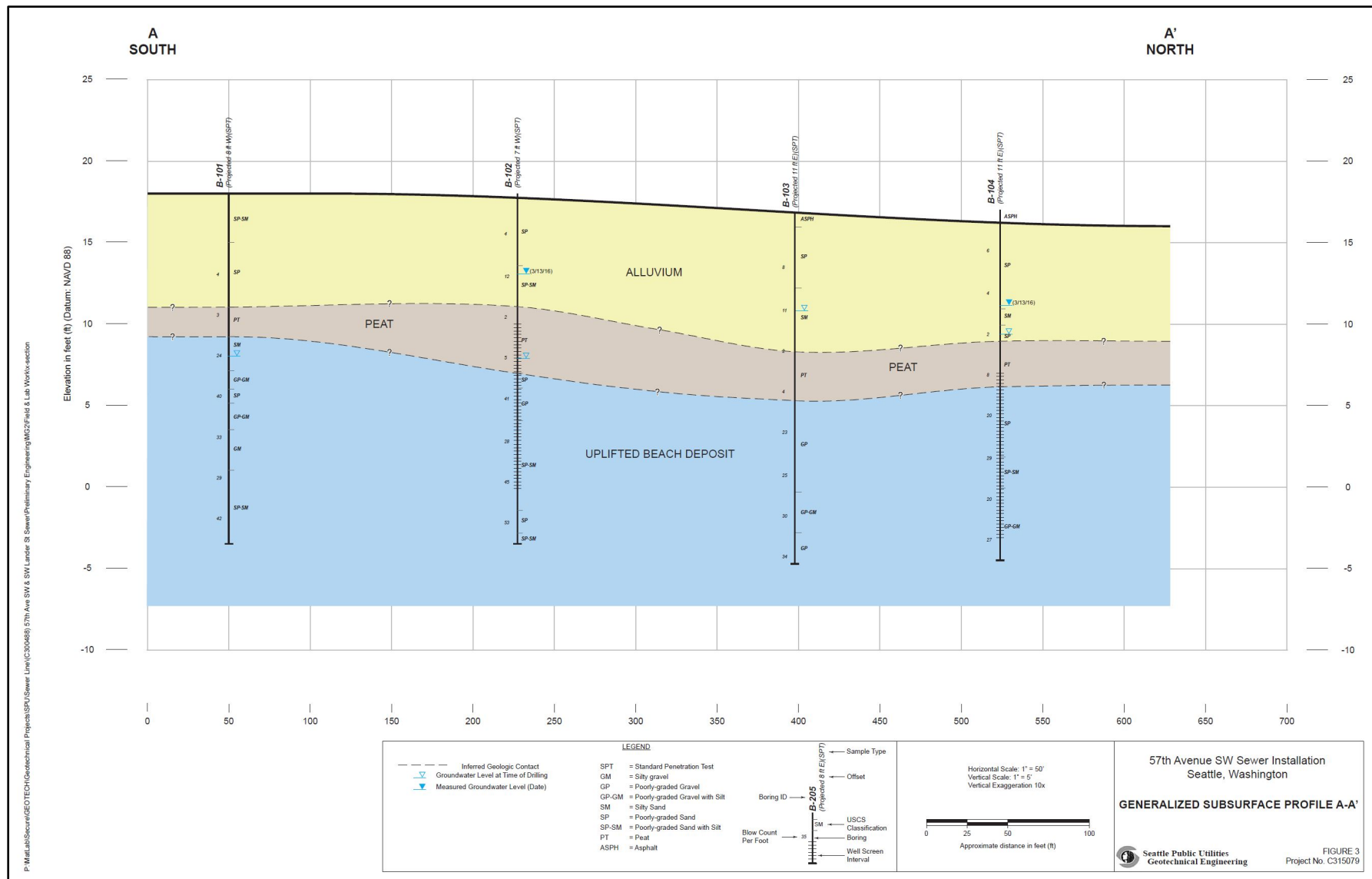


Figure 13. Cross-section showing borings B-101-B-104 from SPU (2016) sewer installation project for the 57<sup>th</sup> Ave site.

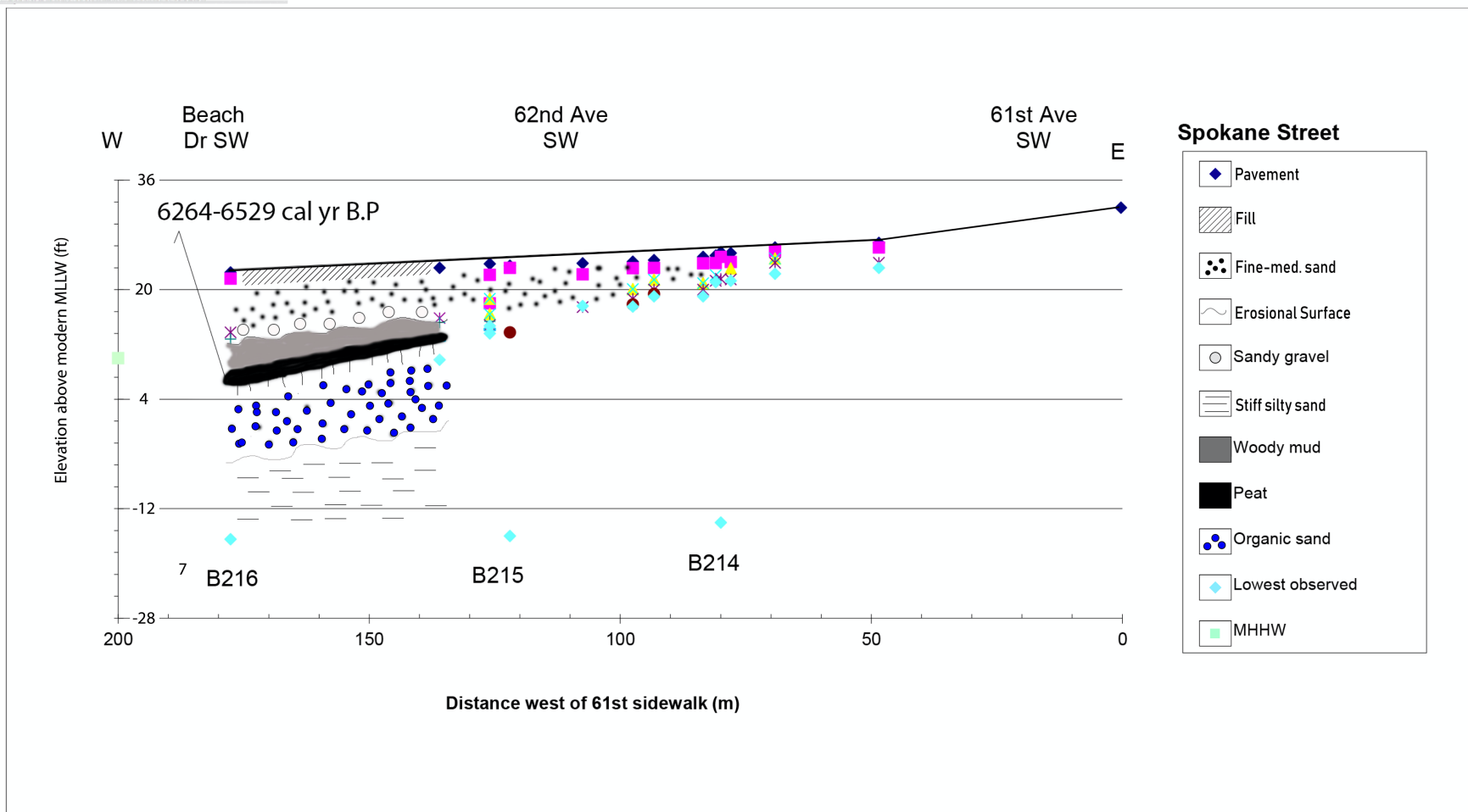


Figure 14. A revised cross-section I created based on work from (written communication, B. Atwater, 2018) investigations at Spokane St between Beach Dr SW & 61<sup>st</sup> Ave SW. Lowest observed stands for the bottom of boring.



Figure 15. Map of borings near Alki Playground that have >2 ft of peat identified (GeoMapNW, 2018). The red circle represents the area the highest concentration of borings with >2 ft of peat.

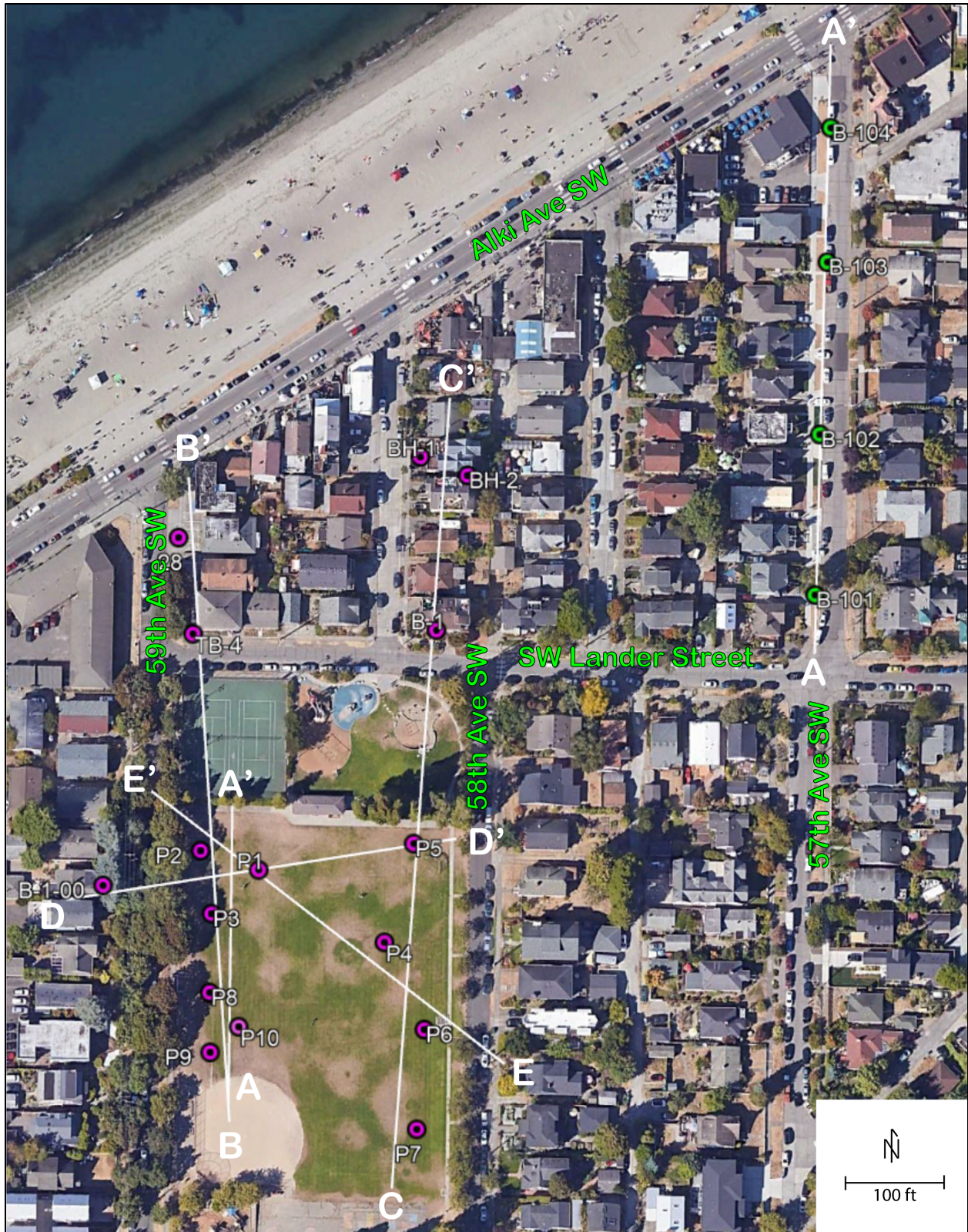






Figure 16. Location of borings and cross-section lines A-E at Alki Playground and neighboring properties. Borings and cross section line from the 57<sup>th</sup> Ave SPU project are also marked.

|  |  |
|--|--|
| Project: <b>Paleoseismic Studies in the Seattle Fault Zone</b> | <b>Log of Boring P1</b><br><b>Sheet 1 of 4</b> |
| Project Location: <b>Alki Playground &amp; Whale Tail Park</b> |  |
| Project Number: <b>N/A</b>                                     |  |

|  |  |   |
|--|--|---|
| Date(s) Drilled: <b>2/8/2019</b>                 | Logged By: <b>Eric Dunham</b>  | Checked By:                                 |
| Drilling Method: <b>Direct Push</b>              | Drill Bit Size/Type: <b>2.25"</b>  | Total Depth of Borehole: <b>20 feet bgs</b> |
| Drill Rig Type: <b>7822DT Geoprobe</b>           | Drilling Contractor: <b>Cascade</b>                                      | Approximate Surface Elevation:              |
| Groundwater Level and Date Measured: <b>7.5'</b> | Sampling Method(s):  | Hammer Data:                                |
| Borehole Backfill: <b>Bentonite</b>              | Location: <b>54.5' south of SW and 32' west of SE corner of bathroom</b> |   |

| Elevation (feet) | Depth (feet) | Material Type | Graphic Log   | MATERIAL DESCRIPTION  | REMARKS AND OTHER TESTS |
|------------------|--------------|---------------|---|---|-------------------------|
|                  | 0            |               |   | No Recovery   |                         |
|                  | 1            | ML            |  | 7.5YR 3/2-dark brown, ML-sandy SILT w/ trace f. gravel, gravels are sub-rounded, moist, massive, low-plasticity   |                         |
|                  | 2            |               |   |   |                         |
|                  | 3            | SW            |  | 2.5Y 5/2-grayish brown, SW-SAND w/ trace gravels, gravels are f.-c. and sub-rounded to rounded, moist, massive, sand is f.-c. (mostly medium grained), mollusc shell sampled at 3.97 ft bgs, lower contact at 4.354'-4.792' bgs (5.25"-gradational) |                         |
|                  | 4            |               |   |   |                         |
|                  |              | SP            |  | 2.5Y 5/3-light olive brown, SP-SAND, fine-med grained, moist, massive, lower contact at 4.79' (material too loose to see at bottom of core)   |                         |
|                  |              | PT            |  | about 0.5" of peaty/organic sandy material found at the   |                         |

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Figure 17.1. Boring log descriptions of P1 from Alki Playground.

Project: **Paleoseismic Studies in the Seattle Fault Zone**  
 Project Location: **Alki Playground & Whale Tail Park**  
 Project Number: **N/A**

**Log of Boring P1**  
**Sheet 2 of 4**

| Elevation (feet) | Depth (feet) | Material Type | Graphic Log | MATERIAL DESCRIPTION   | REMARKS AND OTHER TESTS |
|------------------|--------------|---------------|-------------|--|-------------------------|
|                  | 5            |               |             | No Recovery  |                         |
|                  | 6            | SP            |             | 2.5Y 6/2-light yellowish brown, SP- SAND, f-m. grained sand, moist, massive, lower contact at 6.42'-6.60' (0.25")  |                         |
|                  | 7            | SM<br>SW      |             | 2.5Y 3/3-dark olive brown, SM-silty SAND, fine-grained, moist, massive, tr. fine roots at bottom, lower contact at 6.48'-6.51' (0.30")<br>2.5Y 4/2-dark grayish brown, SW-SAND w/ f. gravels, sand is f-c grained, gravels are sub-angular-sub-rounded, moist, massive, lower contact at 7.64 +/- 3" (gradational)   |                         |
|                  | 8            | GW            |             | 2.5Y 5/2-grayish brown, GW-GRAVEL w/ sand, gravels are f-c. and sub-rounded-angular, sands are f-c. grained, moist, massive, lower contact at 8.92'-8.99' (0.75")  |                         |
|                  | 9            | GW<br>SW      |             | 2.5YR 4/3-reddish brown, GW-GRAVEL w/ sand, gravels are f-c. & sub-rounded-angular, sands are f-m. grained, moist, massive, oxidation, contact around 9.15' (no clear contact zone)<br>10YR 4/1-dark gray, SW-SAND w/ gravel, gravels are f-c. (90% fine), sub-rounded-rounded, sands are f-c. grained, moist, massive, lower contact @ 13' +/- 3" (gradational) |                         |
|                  | 10           |               |             |  |                         |

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Figure 17.2. Boring log descriptions of P1 from Alki Playground.

|  |  |
|--|--|
| Project: <b>Paleoseismic Studies in the Seattle Fault Zone</b> | <b>Log of Boring P1</b><br><b>Sheet 3 of 4</b> |
| Project Location: <b>Alki Playground &amp; Whale Tail Park</b> |  |
| Project Number: <b>N/A</b>                                     |  |

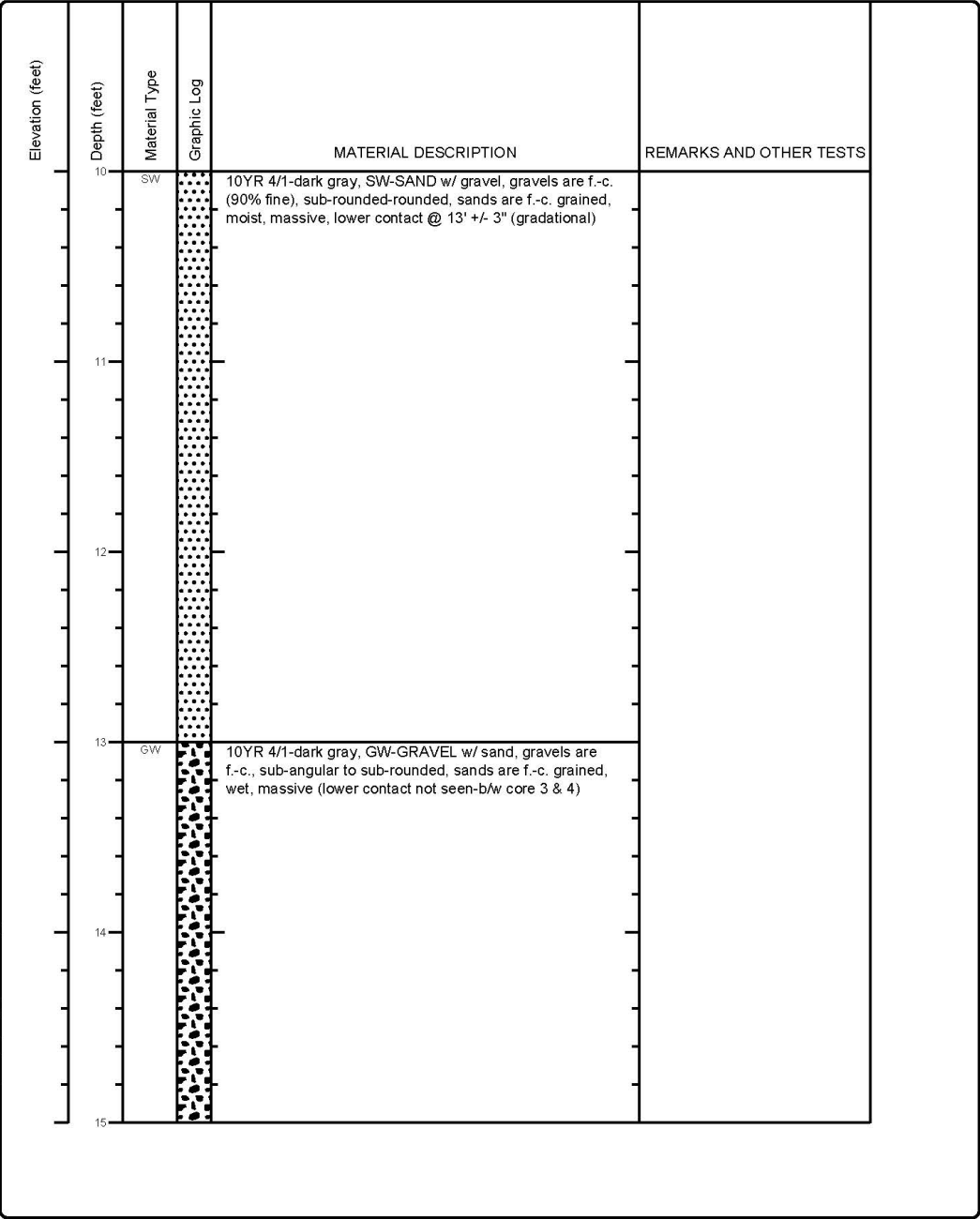


Figure 17.3. Boring log descriptions of P1 from Alki Playground.

|  |  |
|--|--|
| Project: <b>Paleoseismic Studies in the Seattle Fault Zone</b> | <b>Log of Boring P1</b><br><b>Sheet 4 of 4</b> |
| Project Location: <b>Alki Playground &amp; Whale Tail Park</b> |  |
| Project Number: <b>N/A</b>                                     |  |

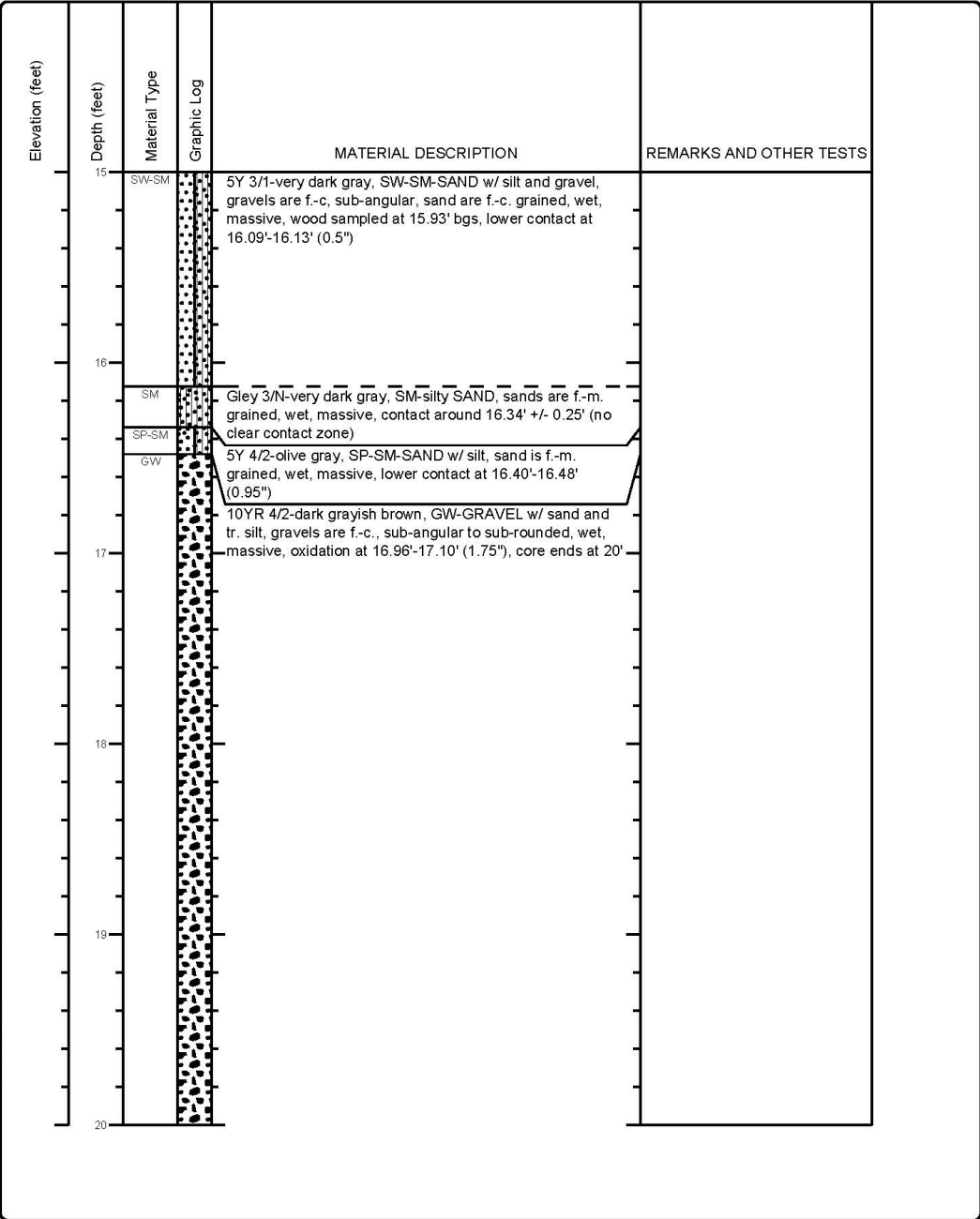


Figure 17.4. Boring log descriptions of P1 from Alki Playground.

|  |  |
|--|--|
| Project: <b>Paleoseismic Studies in the Seattle Fault Zone</b> | <b>Key to Log of Boring<br/>Sheet 1 of 1</b> |
| Project Location: <b>Alki Playground &amp; Whale Tail Park</b> |  |
| Project Number: <b>N/A</b>                                     |  |
























| Elevation (feet)   | Depth (feet) | Material Type   | Graphic Log   | MATERIAL DESCRIPTION   | REMARKS AND OTHER TESTS |
|--|--------------|---|---|--|-------------------------|
| 1  | 2            | 3   | 4   | 5  | 6                       |
| <b>COLUMN DESCRIPTIONS</b>   |              |   |   |  |                         |
| <b>1</b> Elevation (feet): Elevation (MSL, feet).<br><b>2</b> Depth (feet): Depth in feet below the ground surface.<br><b>3</b> Material Type: Type of material encountered.   |              |   |   | <b>4</b> Graphic Log: Graphic depiction of the subsurface material encountered.<br><b>5</b> MATERIAL DESCRIPTION: Description of material encountered. May include consistency, moisture, color, and other descriptive text.<br><b>6</b> REMARKS AND OTHER TESTS: Comments and observations regarding drilling or sampling made by driller or field personnel. |                         |
| <b>FIELD AND LABORATORY TEST ABBREVIATIONS</b>   |              |   |   |  |                         |
| CHEM: Chemical tests to assess corrosivity<br>COMP: Compaction test<br>CONS: One-dimensional consolidation test<br>LL: Liquid Limit, percent   |              |   | PI: Plasticity Index, percent<br>SA: Sieve analysis (percent passing No. 200 Sieve)<br>UC: Unconfined compressive strength test, Qu, in ksf<br>WA: Wash sieve (percent passing No. 200 Sieve) |  |                         |
| <b>MATERIAL GRAPHIC SYMBOLS</b>  |              |   |   |  |                         |
|  Well graded GRAVEL (GW)   |              |  Poorly graded SAND (SP)                          |   |  |                         |
|  SILT, SILT w/SAND, SANDY SILT (ML)   |              |  Poorly graded SAND with Silt (SP-SM)            |   |  |                         |
|  Peat   |              |  Well graded SAND (SW)                           |   |  |                         |
|  Silty SAND (SM)  |              |  Well graded SAND with Silt (SW-SM)              |   |  |                         |
| <b>TYPICAL SAMPLER GRAPHIC SYMBOLS</b>   |              |   |   |  |                         |
|  Auger sampler  |              |  Continuous                                      |   |  2-inch-OD unlined split spoon (SPT)  |                         |
|  Bulk Sample  |              |  Grab Sample                                     |   |  Shelby Tube (Thin-walled, fixed head)  |                         |
|  3-inch-OD California w/ brass rings  |              |  2.5-inch-OD Modified California w/ brass liners |   |  Water level (at time of drilling, ATD)  |                         |
|  CME Sampler  |              |  Pitcher Sample                                  |   |  Water level (after waiting)   |                         |
| <b>OTHER GRAPHIC SYMBOLS</b>   |              |   |   |  |                         |
|  Minor change in material properties within a stratum  |              |   |   |  |                         |
|  Inferred/gradational contact between strata   |              |   |   |  |                         |
|  Queried contact between strata  |              |   |   |  |                         |
| <b>GENERAL NOTES</b>   |              |   |   |  |                         |
| 1: Soil classifications are based on the Unified Soil Classification System. Descriptions and stratum lines are interpretive, and actual lithologic changes may be gradual. Field descriptions may have been modified to reflect results of lab tests.<br>2: Descriptions on these logs apply only at the specific boring locations and at the time the borings were advanced. They are not warranted to be representative of subsurface conditions at other locations or times. |              |   |   |  |                         |

Figure B-1

Figure 17.5. Boring log descriptions of P1 from Alki Playground.

|  |  |
|--|--|
| Project: <b>Paleoseismic Studies in the Seattle Fault Zone</b> | <b>Log of Boring P2</b><br><b>Sheet 1 of 3</b> |
| Project Location: <b>Alki Playground &amp; Whale Tail Park</b> |  |
| Project Number: <b>N/A</b>                                     |  |

|  |  |   |
|--|--|---|
| Date(s) Drilled: <b>2/8/2019</b>                 | Logged By: <b>Eric Dunham</b>  | Checked By:                                 |
| Drilling Method: <b>Direct Push</b>              | Drill Bit Size/Type: <b>2.25"</b>  | Total Depth of Borehole: <b>15 feet bgs</b> |
| Drill Rig Type: <b>7822DT Geoprobe</b>           | Drilling Contractor: <b>Cascade</b>  | Approximate Surface Elevation:              |
| Groundwater Level and Date Measured: <b>7.5'</b> | Sampling Method(s):  | Hammer Data:                                |
| Borehole Backfill: <b>Bentonite</b>              | Location: <b>26' E of FNC &amp; 36' S from S edge of sidewalk by 59th St &amp; tennis courts</b> |   |

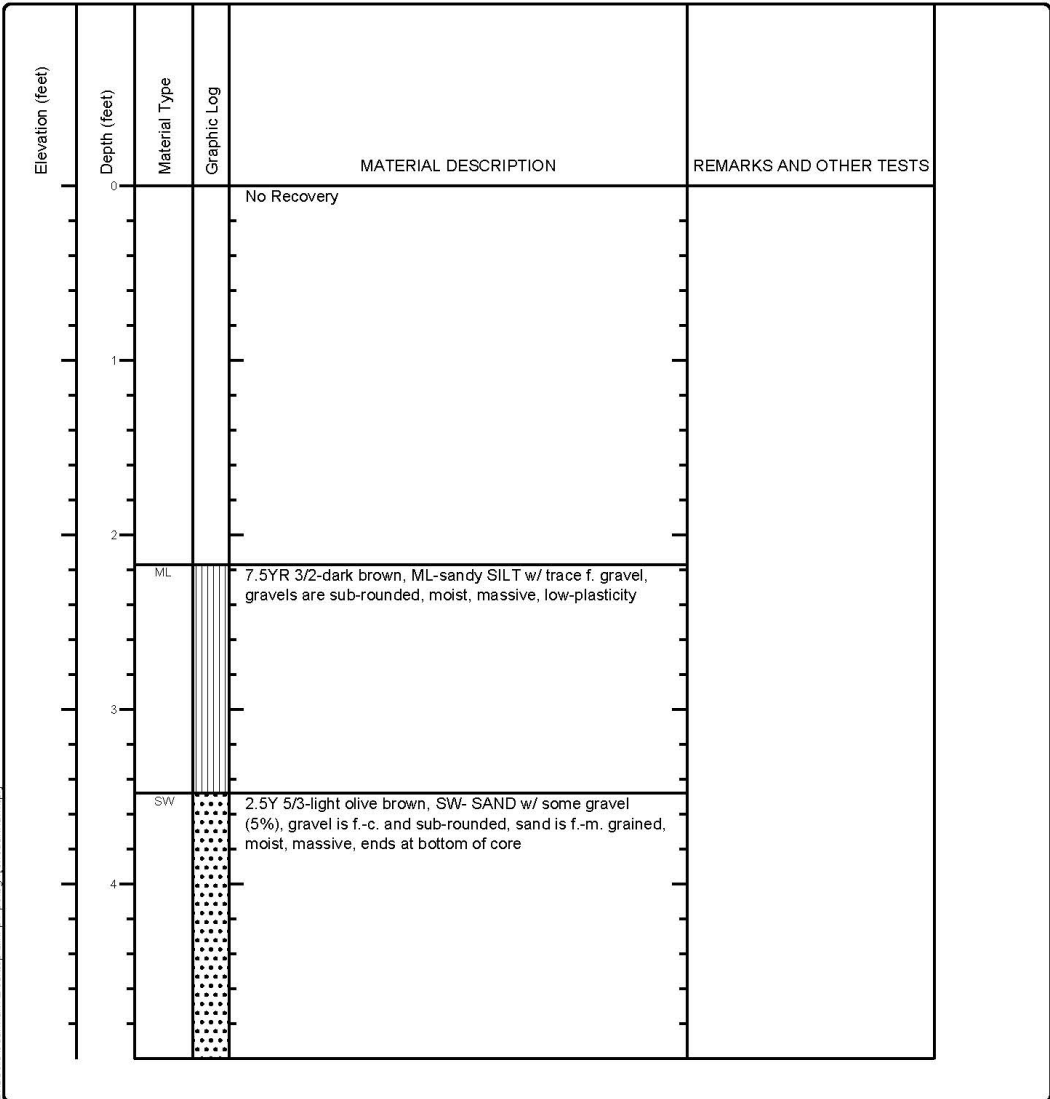


Figure 18.1. Boring log descriptions of P2 from Alki Playground.

|  |  |
|--|--|
| Project: <b>Paleoseismic Studies in the Seattle Fault Zone</b> | <b>Log of Boring P2</b><br><b>Sheet 2 of 3</b> |
| Project Location: <b>Alki Playground &amp; Whale Tail Park</b> |  |
| Project Number: <b>N/A</b>                                     |  |

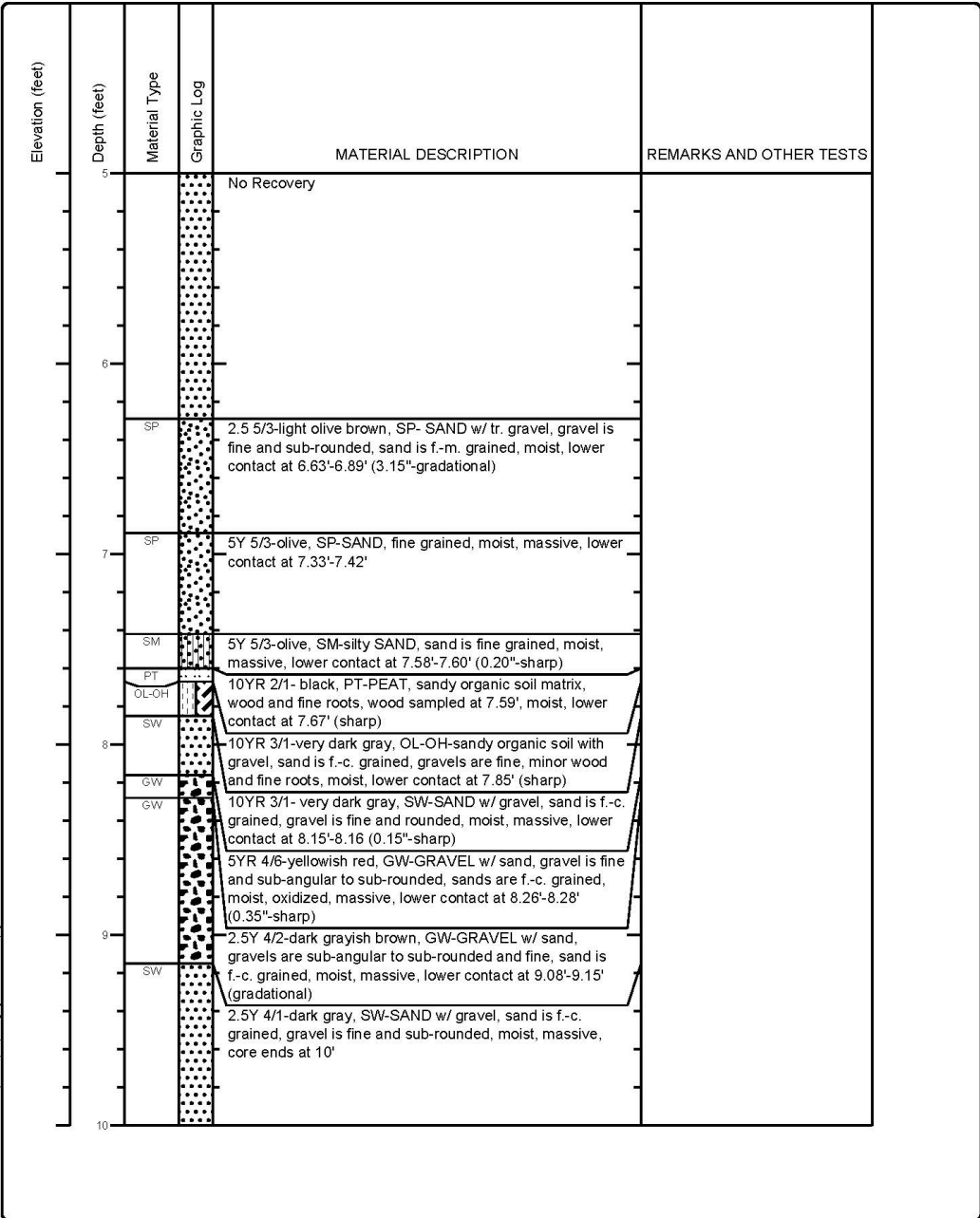


Figure 18.2. Boring log descriptions of P2 from Alki Playground.

|  |  |
|--|--|
| Project: <b>Paleoseismic Studies in the Seattle Fault Zone</b> | <b>Log of Boring P2</b><br><b>Sheet 3 of 3</b> |
| Project Location: <b>Alki Playground &amp; Whale Tail Park</b> |  |
| Project Number: <b>N/A</b>                                     |  |

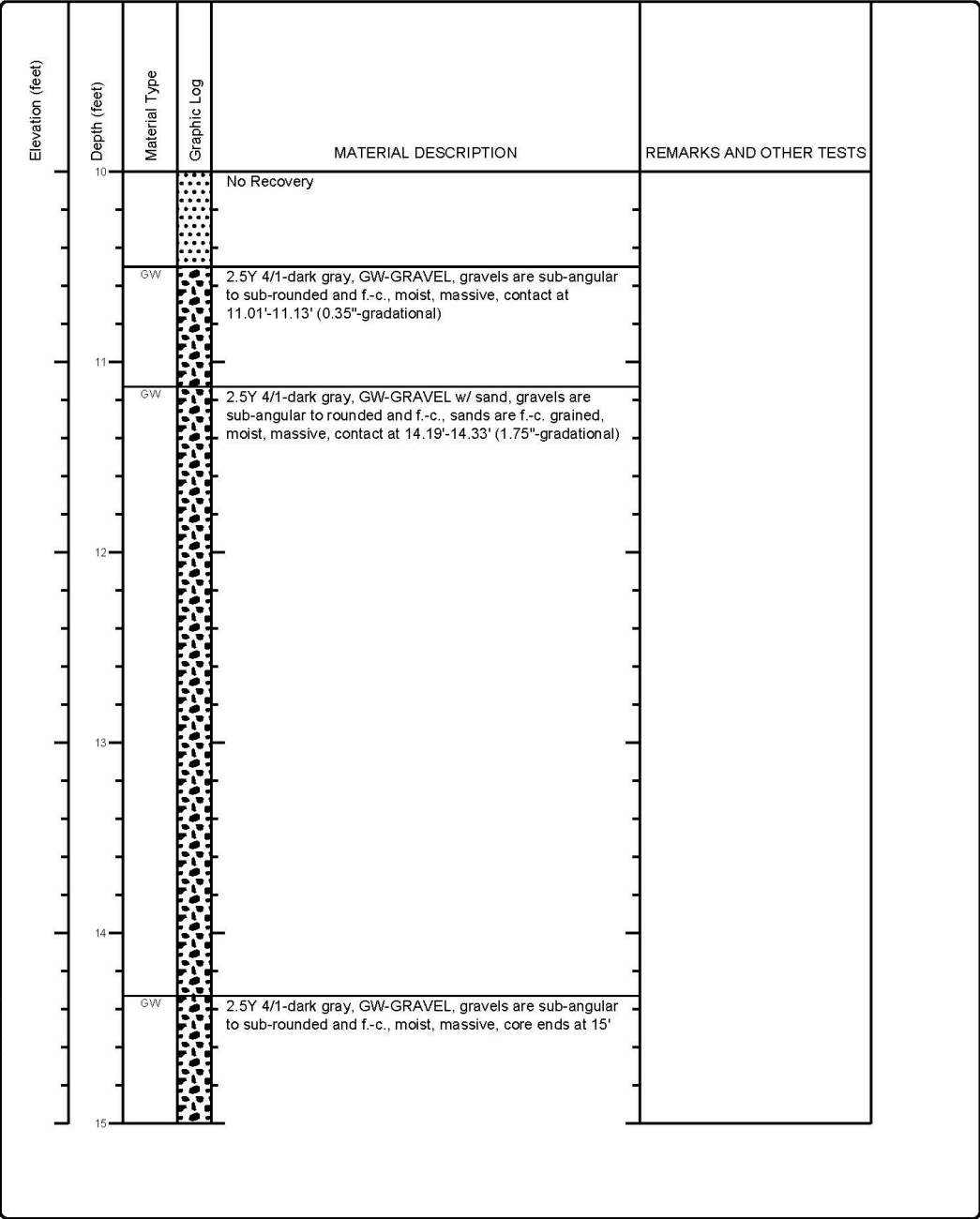


Figure 18.3. Boring log descriptions of P2 from Alki Playground.

|  |  |
|--|--|
| Project: <b>Paleoseismic Studies in the Seattle Fault Zone</b> | <b>Log of Boring P3</b><br><b>Sheet 1 of 3</b> |
| Project Location: <b>Alki Playground &amp; Whale Tail Park</b> |  |
| Project Number: <b>N/A</b>                                     |  |

|  |   |                                |
|--|---|--------------------------------|
| Date(s) Drilled: <b>2/8/2019</b>                 | Logged By: <b>Eric Dunham</b>   | Checked By:                    |
| Drilling Method: <b>Direct Push</b>              | Drill Bit Size/Type: <b>2.25"</b>   | Total Depth of Borehole:       |
| Drill Rig Type: <b>7822DT Geoprobe</b>           | Drilling Contractor: <b>Cascade</b>   | Approximate Surface Elevation: |
| Groundwater Level and Date Measured: <b>7.5'</b> | Sampling Method(s):   | Hammer Data:                   |
| Borehole Backfill: <b>Bentonite</b>              | Location <b>35' from FNC, 100' from edge of sidewalk by (59th St &amp; tennis courts)</b> |                                |

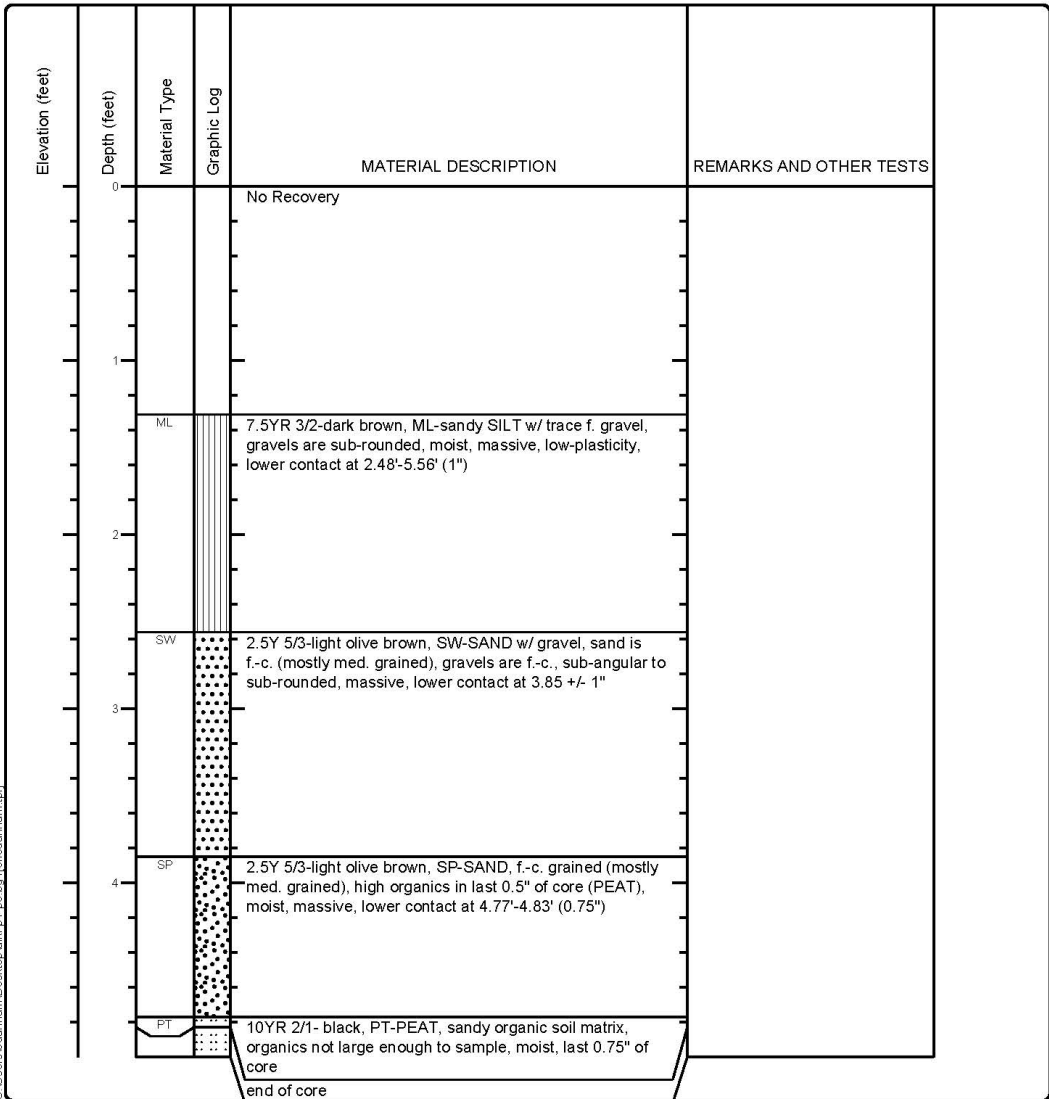


Figure 19.1. Boring log descriptions of P3 from Alki Playground.

|  |  |
|--|--|
| Project: <b>Paleoseismic Studies in the Seattle Fault Zone</b> | <b>Log of Boring P3</b><br><b>Sheet 2 of 3</b> |
| Project Location: <b>Alki Playground &amp; Whale Tail Park</b> |  |
| Project Number: <b>N/A</b>                                     |  |

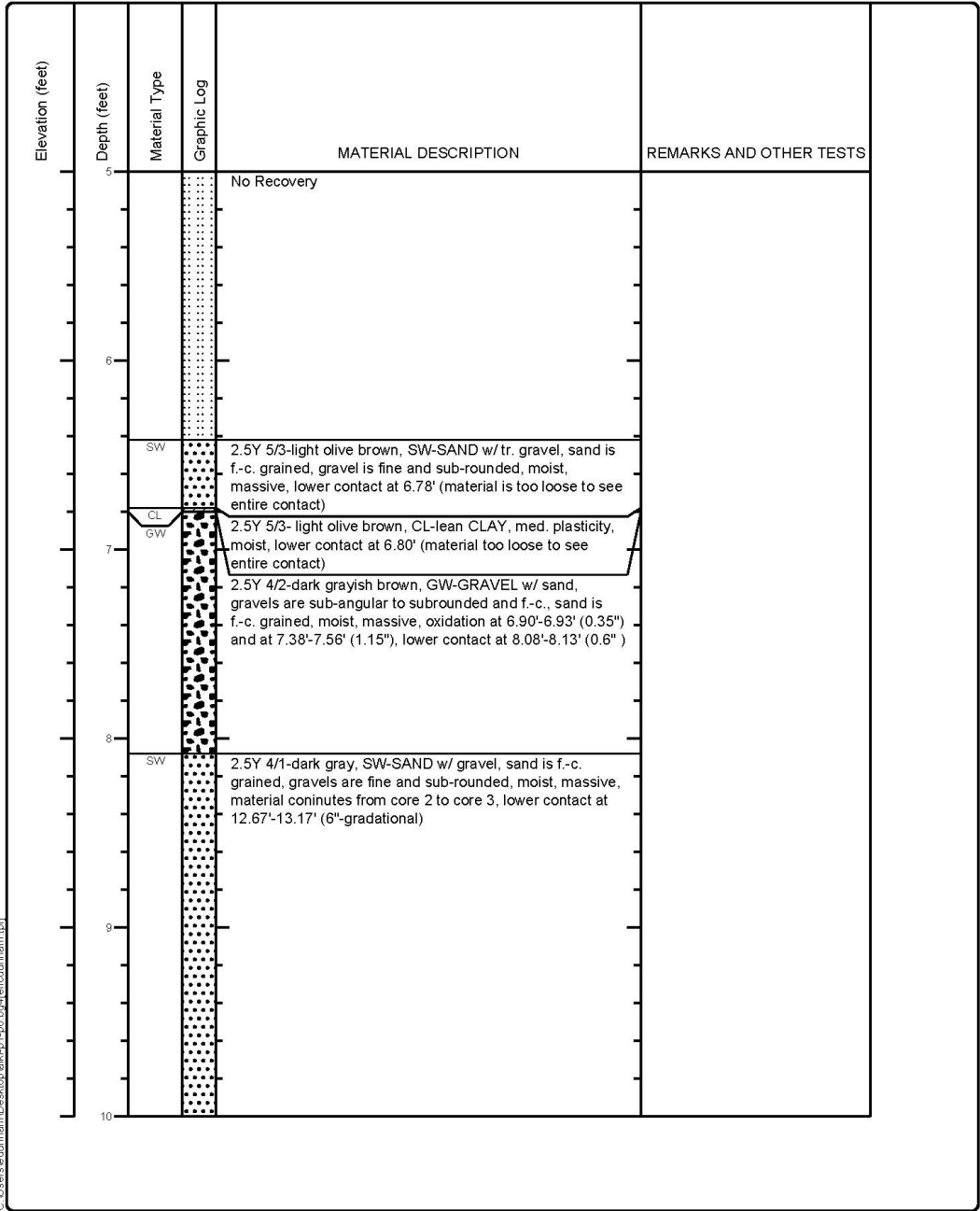


Figure 19.2. Boring log descriptions of P3 from Alki Playground.

|  |  |
|--|--|
| Project: <b>Paleoseismic Studies in the Seattle Fault Zone</b> | <b>Log of Boring P3</b><br><b>Sheet 3 of 3</b> |
| Project Location: <b>Alki Playground &amp; Whale Tail Park</b> |  |
| Project Number: <b>N/A</b>                                     |  |

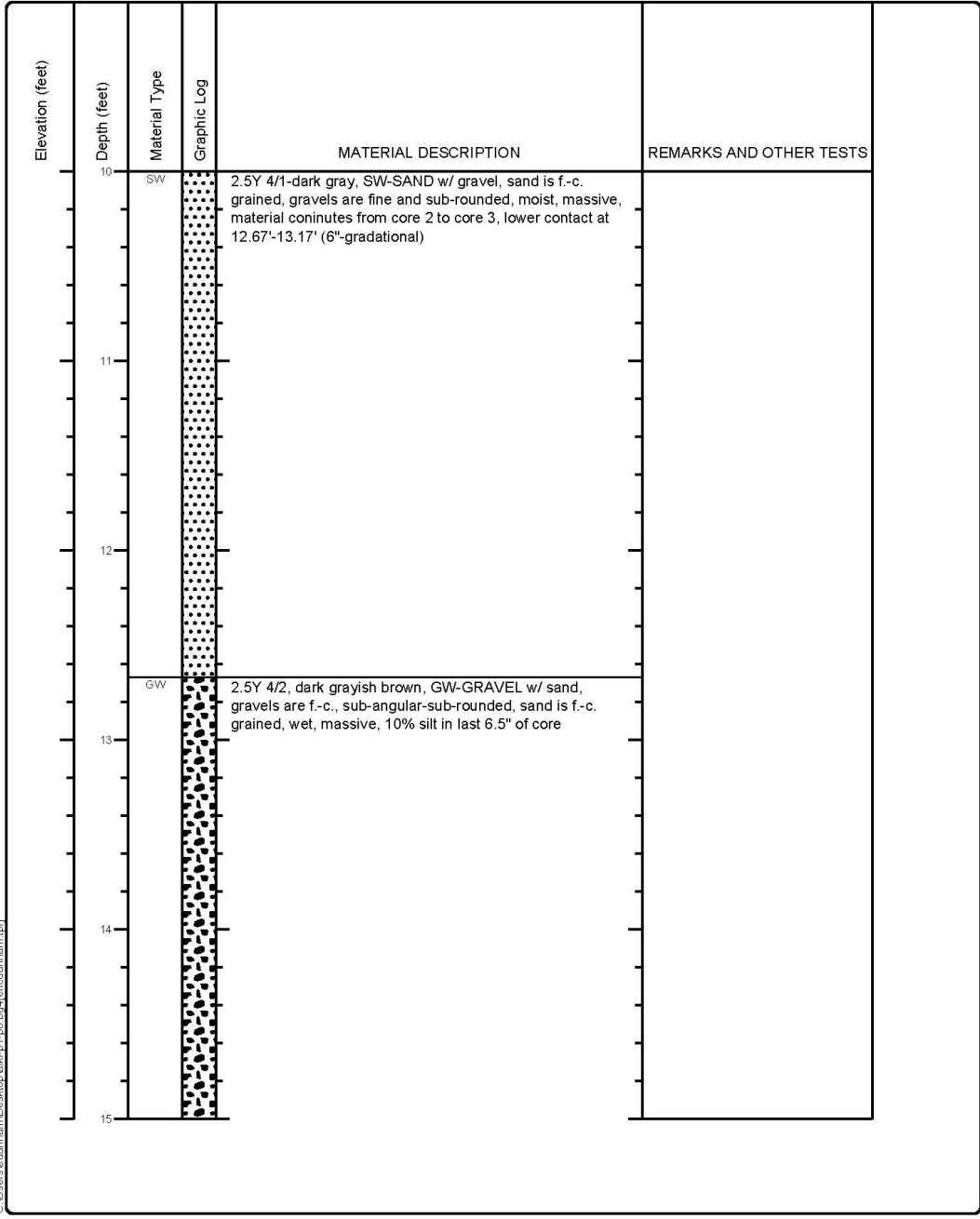


Figure 19.3. Boring log descriptions of P3 from Alki Playground.

|  |  |
|--|--|
| Project: <b>Paleoseismic Studies in the Seattle Fault Zone</b> | <b>Log of Boring P4</b><br><b>Sheet 1 of 3</b> |
| Project Location: <b>Alki Playground &amp; Whale Tail Park</b> |  |
| Project Number: <b>N/A</b>                                     |  |

|  |  |                                |
|--|--|--------------------------------|
| Date(s) Drilled: <b>2/8/2019</b>                 | Logged By: <b>Eric Dunham</b>  | Checked By:                    |
| Drilling Method: <b>Direct Push</b>              | Drill Bit Size/Type: <b>2.25"</b>  | Total Depth of Borehole:       |
| Drill Rig Type: <b>7822DT Geoprobe</b>           | Drilling Contractor: <b>Cascade</b>  | Approximate Surface Elevation: |
| Groundwater Level and Date Measured: <b>7.5'</b> | Sampling Method(s):  | Hammer Data:                   |
| Borehole Backfill: <b>Bentonite</b>              | Location: <b>84' west of TBC on 58th St in line with middle of 2722 58th St property</b> |                                |

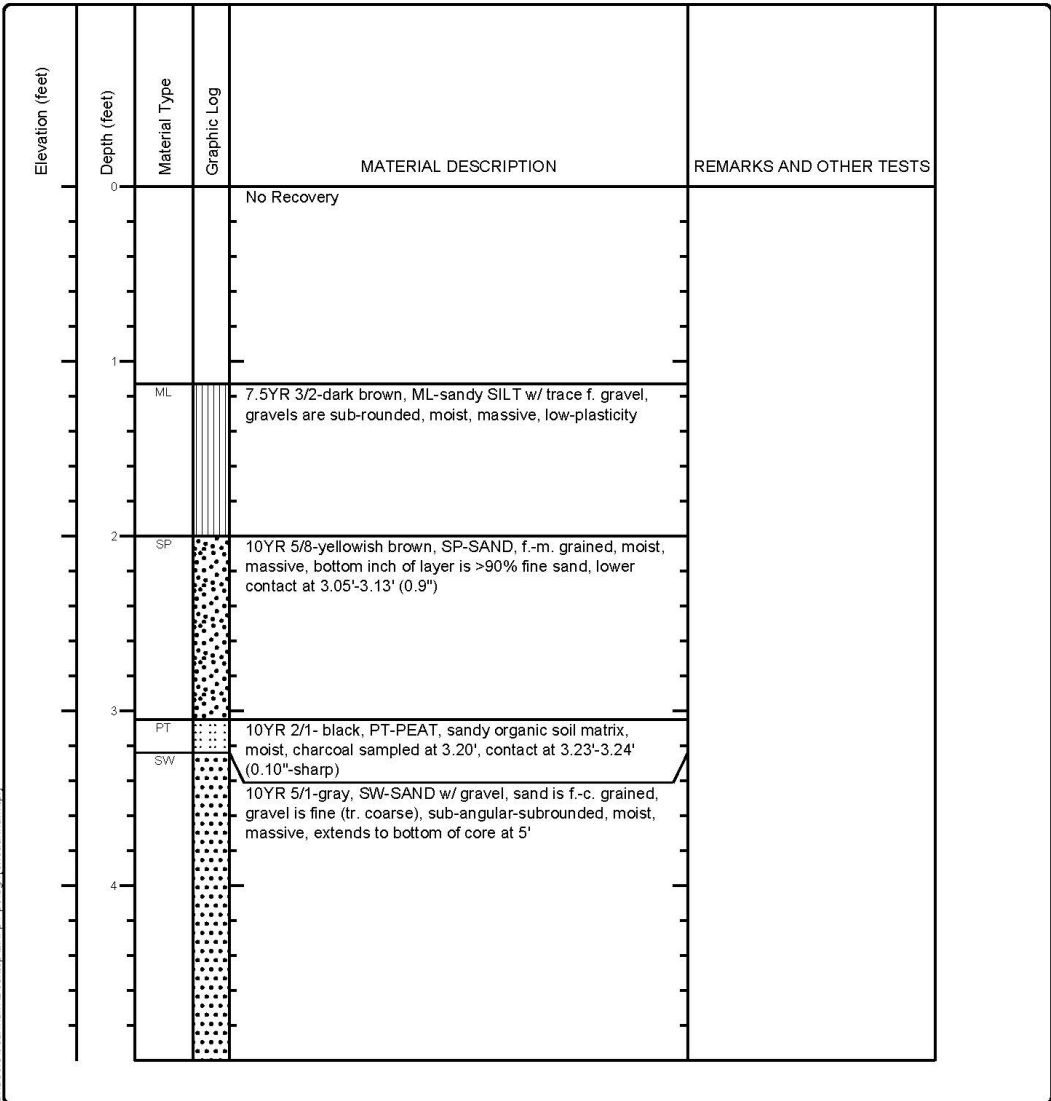


Figure 20.1. Boring log descriptions of P4 from Alki Playground.

|  |  |
|--|--|
| Project: <b>Paleoseismic Studies in the Seattle Fault Zone</b> | <b>Log of Boring P4</b><br><b>Sheet 2 of 3</b> |
| Project Location: <b>Alki Playground &amp; Whale Tail Park</b> |  |
| Project Number: <b>N/A</b>                                     |  |

| Elevation (feet) | Depth (feet) | Material Type | Graphic Log | MATERIAL DESCRIPTION  | REMARKS AND OTHER TESTS |
|------------------|--------------|---------------|-------------|---|-------------------------|
|                  | 5            |               |             | No Recovery   |                         |
|                  | 6            | SW            |             | 10YR 5/3-brown, SW-SAND, f.-c. grained, moist, massive, lower contact at 6.35'-6.38' (0.35"-sharp)  |                         |
|                  |              | PT<br>SP      |             | 10YR 2/2-very dark brown, PT-PEAT, sandy matrix, f.-c. grained, moist, massive, lower contact at 6.40'-6.44' (0.40"-sharp)  |                         |
|                  |              | SP-SM<br>GW   |             | 10YR 5/3-brown, SP-SAND, med. grained, moist, massive, lower contact at 6.60'-6.65' (0.65"-sharp)   |                         |
|                  | 7            |               |             | 10YR 3/3-dark brown, SP-SM-silty SAND, fine grained, moist, massive, lower contact at 6.63'-6.65' (0.25"-sharp)   |                         |
|                  |              |               |             | 10YR 4/2-dark grayish brown, GW-GRAVEL w/ sand, gravels are f.-c., sub-angular-sub-rounded, sands are f.-c. grained, moist, massive, gravel percentage increases towards the bottom of layer, lower contact at 8.48'-8.54' (0.75")  |                         |
|                  | 8            |               |             |   |                         |
|                  |              | SP            |             | 10YR 4/1-dark gray, SP-SAND, f.-m. grained, mostly med. grained, moist, massive, lower contact at 8.83'-8.92' (1")  |                         |
|                  | 9            |               |             |   |                         |
|                  |              | GW            |             | 10YR 4/2-dark gray brown, GW-GRAVEL w/ sand, gravels are f.-c., sub-angular-sub-rounded, sands are f.-c. grained, wet, massive, material highly oxidized and broken down to sandy SILT from 9.67'-9.79' (1.5"), material continues from bottom of core 2 through top of core 3, lower contact 10.57'-10.60' (0.45"-sharp) |                         |
|                  | 10           |               |             |   |                         |

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Figure 20.2. Boring log descriptions of P4 from Alki Playground.

|  |  |
|--|--|
| Project: <b>Paleoseismic Studies in the Seattle Fault Zone</b> | <b>Log of Boring P4</b><br><b>Sheet 3 of 3</b> |
| Project Location: <b>Alki Playground &amp; Whale Tail Park</b> |  |
| Project Number: <b>N/A</b>                                     |  |

| Elevation (feet) | Depth (feet) | Material Type | Graphic Log | MATERIAL DESCRIPTION  | REMARKS AND OTHER TESTS |
|------------------|--------------|---------------|-------------|---|-------------------------|
|                  | 10           | GW            |             | 10YR 4/2-dark gray brown, GW-GRAVEL w/ sand, gravels are f.-c., sub-angular-sub-rounded, sands are f.-c. grained, wet, massive, material highly oxidized and broken down to sandy SILT from 9.67'-9.79' (1.5"), material continues from bottom of core 2 through top of core 3, lower contact 10.57'-10.60' (0.45"-sharp) |                         |
|                  | 11           | SP            |             | 2.5Y 5/2-grayish brown, SP-SAND w/ gravel, sand is f.-c. grained (mostly med. grained), gravel is fine and sub-angular-sub-rounded, wet, massive, lower contact at 11.92'-12.17' (3"-gradational)   |                         |
|                  | 12           | SW            |             | 2.5Y 5/2-grayish brown, SW-SAND w/ gravel, sand is f.-c. grained, gravel is f.-c., sub-angular-sub-rounded, higher % of coarse sands at 12.92'-13.13' (2.5"), wet, massive, lower contact at 13.21'-13.38' (2.10"-gradational)  |                         |
|                  | 13           | SP            |             | 2.5Y 5/2-grayish brown, SP-SAND, f.-m. grained, wet, massive, lower contact at 13.66'-13.73' (0.80")  |                         |
|                  | 14           | GW            |             | 2.5Y 5/2-grayish brown, GW-GRAVEL w/ sand, gravel is f.-c., sub-angular-sub-rounded, sand is f.-m. grained, moist, wet, massive, end of core at 15'   |                         |
|                  | 15           |               |             |   |                         |

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Figure 20.3. Boring log descriptions of P4 from Alki Playground.

|  |  |
|--|--|
| Project: <b>Paleoseismic Studies in the Seattle Fault Zone</b> | <b>Log of Boring P5</b><br><b>Sheet 1 of 4</b> |
| Project Location: <b>Alki Playground &amp; Whale Tail Park</b> |  |
| Project Number: <b>N/A</b>                                     |  |

|  |   |                                |
|--|---|--------------------------------|
| Date(s) Drilled: <b>2/8/2019</b>                 | Logged By: <b>Eric Dunham</b>   | Checked By:                    |
| Drilling Method: <b>Direct Push</b>              | Drill Bit Size/Type: <b>2.25"</b>   | Total Depth of Borehole:       |
| Drill Rig Type: <b>7822DT Geoprobe</b>           | Drilling Contractor: <b>Cascade</b>   | Approximate Surface Elevation: |
| Groundwater Level and Date Measured: <b>7.5'</b> | Sampling Method(s):   | Hammer Data:                   |
| Borehole Backfill: <b>Bentonite</b>              | Location: <b>18' N and 9' W of NW corner of batting cage at NE corner of park</b> |                                |

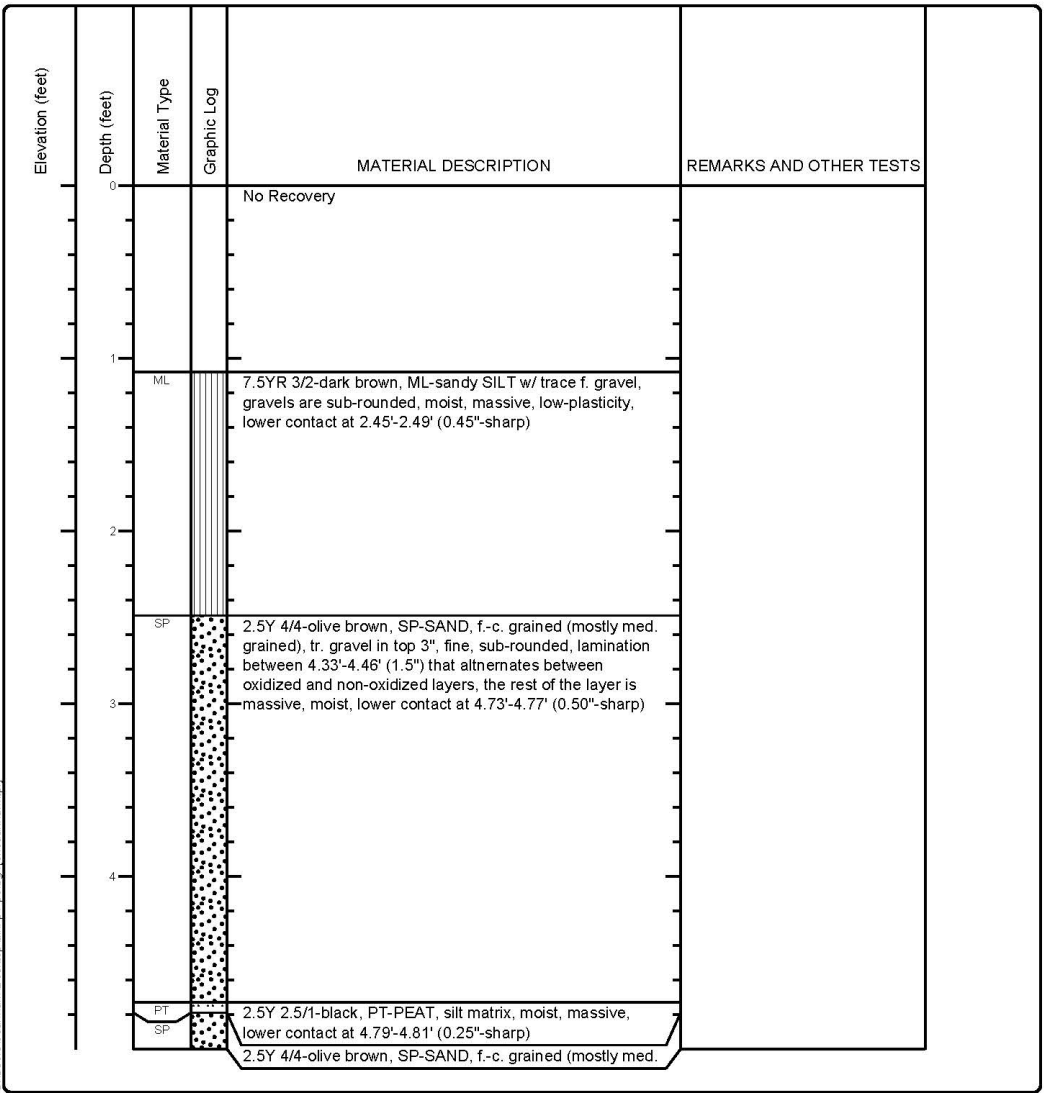


Figure 21.1. Boring log descriptions of P5 from Alki Playground.

|  |  |
|--|--|
| Project: <b>Paleoseismic Studies in the Seattle Fault Zone</b> | <b>Log of Boring P5</b><br><b>Sheet 2 of 4</b> |
| Project Location: <b>Alki Playground &amp; Whale Tail Park</b> |  |
| Project Number: <b>N/A</b>                                     |  |

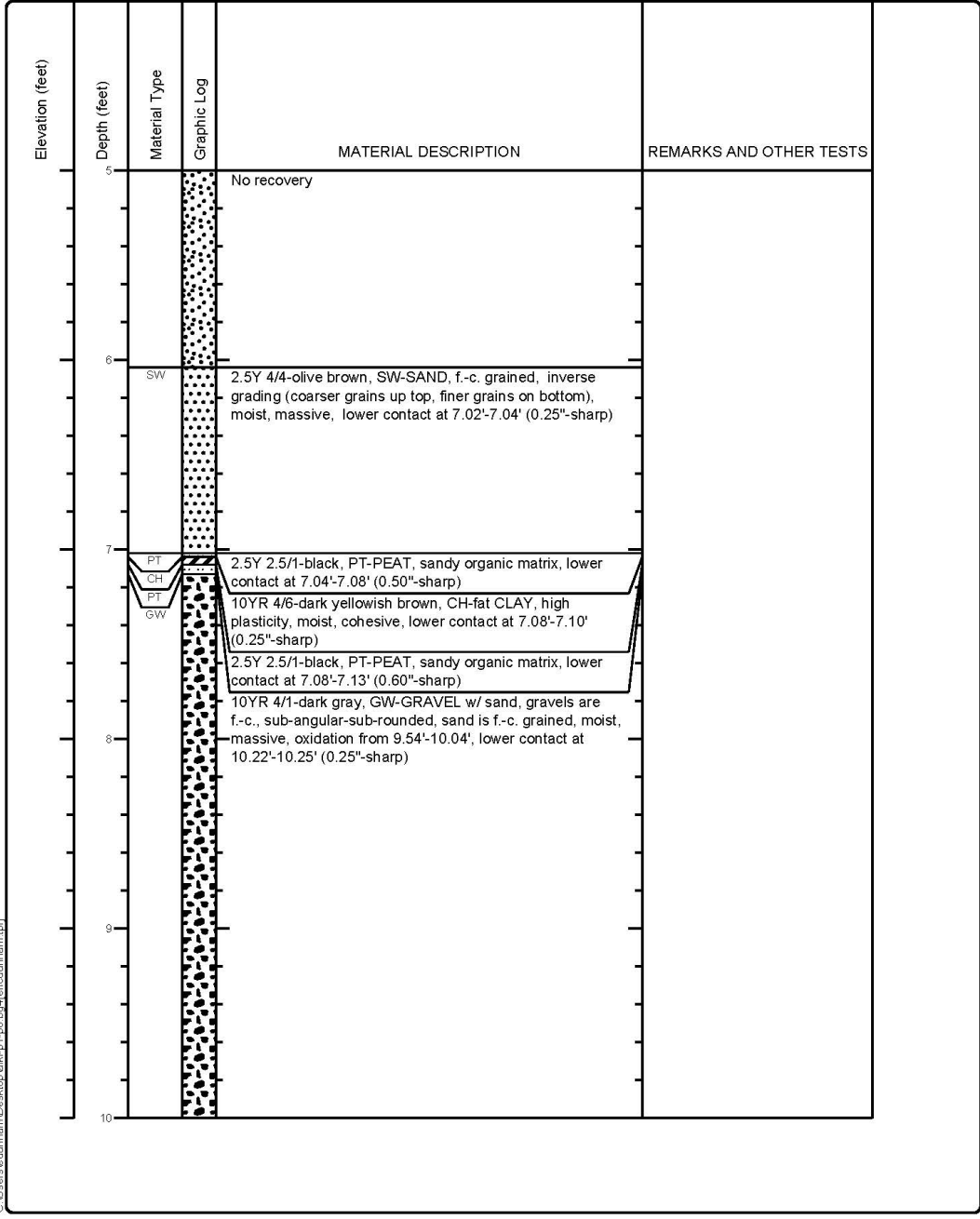


Figure 21.2. Boring log descriptions of P5 from Alki Playground.

Project: **Paleoseismic Studies in the Seattle Fault Zone**  
 Project Location: **Alki Playground & Whale Tail Park**  
 Project Number: **N/A**

**Log of Boring P5**  
**Sheet 3 of 4**

| Elevation (feet) | Depth (feet) | Material Type | Graphic Log | MATERIAL DESCRIPTION  | REMARKS AND OTHER TESTS |
|------------------|--------------|---------------|-------------|---|-------------------------|
|                  | 10           | GW            |             | 10YR 4/1-dark gray, GW-GRAVEL w/ sand, gravels are f.-c., sub-angular-sub-rounded, sand is f.-c. grained, moist, massive, oxidation from 9.54'-10.04', lower contact at 10.22'-10.25' (0.25"-sharp) |                         |
|                  |              | SP            |             | 10YR 4/1-dark gray, SP-SAND, f.-m. grained (mostly med. grained), moist, massive, lower contact at 10.68'-10.7' (0.25"-sharp)   |                         |
|                  | 11           | GW            |             | 10YR 4/1-dark gray, GW-GRAVEL w/ sand, gravels are f.-c., sub-rounded, sands are f.-c. grained, moist, massive, lower contact at 11.68'-11.71' (0.30"-sharp)  |                         |
|                  |              | SP            |             | 10YR 4/1-dark gray, SP-SAND, f.-m. grained (mostly med. grained), moist, massive, lower contact at 11.89'-11.92' (0.45"-sharp)  |                         |
|                  | 12           | GW            |             | 10YR 4/1-dark gray, GW-GRAVEL w/ sand, gravel is fine, sub-angular-sub-rounded, sand is f.-c. grained, lower contact at 12.50'-12.67' (2"-gradational)  |                         |
|                  |              | SW            |             | 10YR 4/1-dark gray, SW-SAND w/ gravel, sand is f.-c. grained, gravel is fine, sub-angular-sub-rounded, moist, massive, lower contact at 14.29'-14.35' (0.75")                                       |                         |
|                  | 13           |               |             |   |                         |
|                  | 14           |               |             |   |                         |
|                  |              | SP            |             | 10YR 4/1-dark gray, SP-SAND, f.-m. grained, moist, massive, lower contact at 14.54'-14.56' (0.25"-sharp)  |                         |
|                  |              | SM            |             | 10YR 5/2-grayish brown, SM-silty SAND, sand is fine grained, one 1" coarse gravel that is highly oxidized, moist, massive, lower contact at 14.68'-14.69' (0.05"-sharp)                             |                         |
|                  |              | SP            |             | 10YR 4/1-dark gray, SP-SAND, fine grained, moist, massive, core ends at 14.79'  |                         |
|                  | 15           |               |             |   |                         |

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Figure 21.3. Boring log descriptions of P5 from Alki Playground.

|  |  |
|--|--|
| Project: <b>Paleoseismic Studies in the Seattle Fault Zone</b><br>Project Location: <b>Alki Playground &amp; Whale Tail Park</b><br>Project Number: <b>N/A</b> | <b>Log of Boring P5</b><br><b>Sheet 4 of 4</b> |
|--|--|

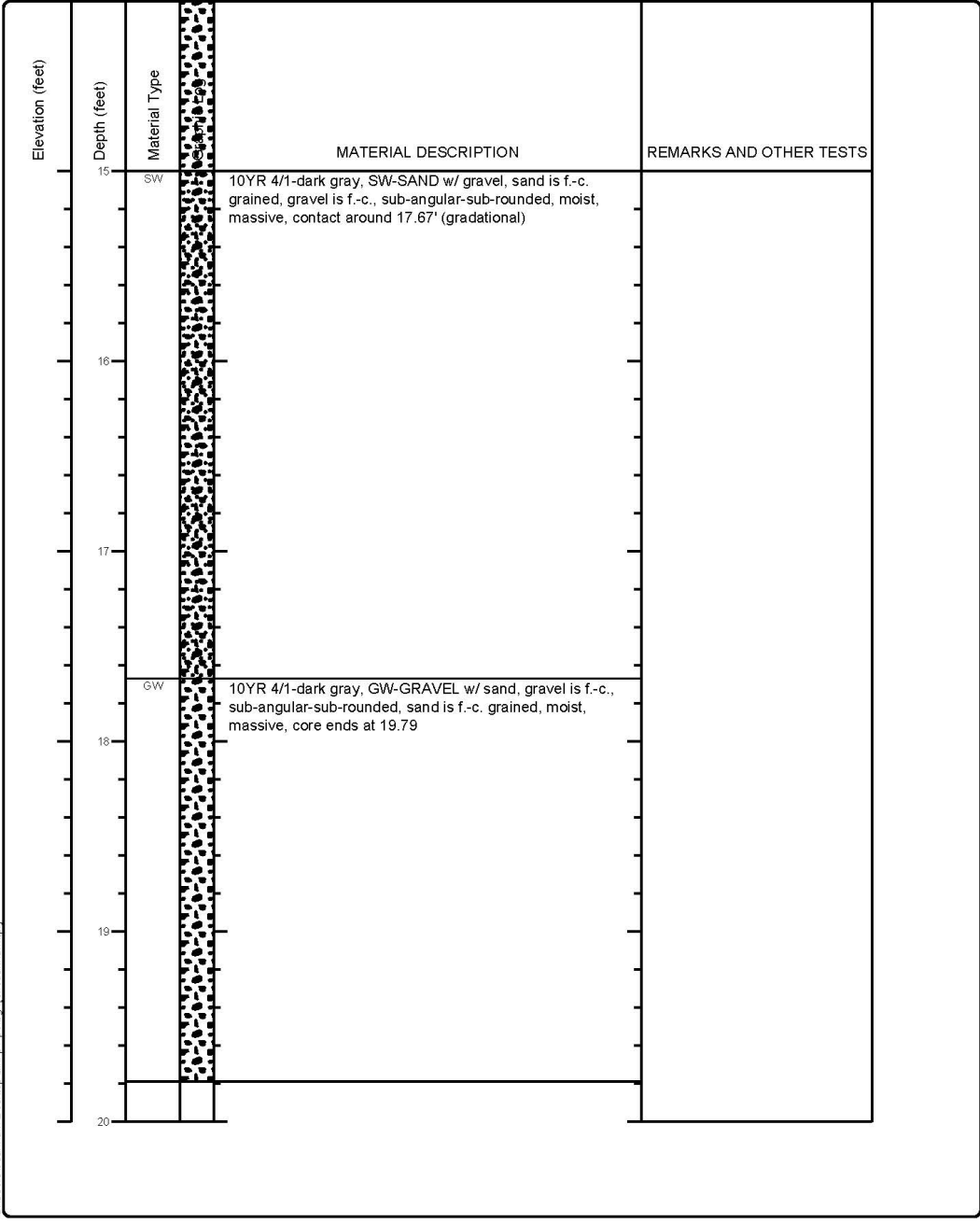


Figure 21.4. Boring log descriptions of P5 from Alki Playground.

|  |  |
|--|--|
| Project: <b>Paleoseismic Studies in the Seattle Fault Zone</b> | <b>Log of Boring P6</b><br><b>Sheet 1 of 3</b> |
| Project Location: <b>Alki Playground &amp; Whale Tail Park</b> |  |
| Project Number: <b>N/A</b>                                     |  |

|  |   |                                |
|--|---|--------------------------------|
| Date(s) Drilled: <b>2/8/2019</b>                 | Logged By: <b>Eric Dunham</b>   | Checked By:                    |
| Drilling Method: <b>Direct Push</b>              | Drill Bit Size/Type: <b>2.25"</b>   | Total Depth of Borehole:       |
| Drill Rig Type: <b>7822DT Geoprobe</b>           | Drilling Contractor: <b>Cascade</b>   | Approximate Surface Elevation: |
| Groundwater Level and Date Measured: <b>7.5'</b> | Sampling Method(s):   | Hammer Data:                   |
| Borehole Backfill: <b>Bentonite</b>              | Location: <b>10' W of western edge of the middle of mini bleachers on concrete pad (middle eastern edge of grass field)</b> |                                |

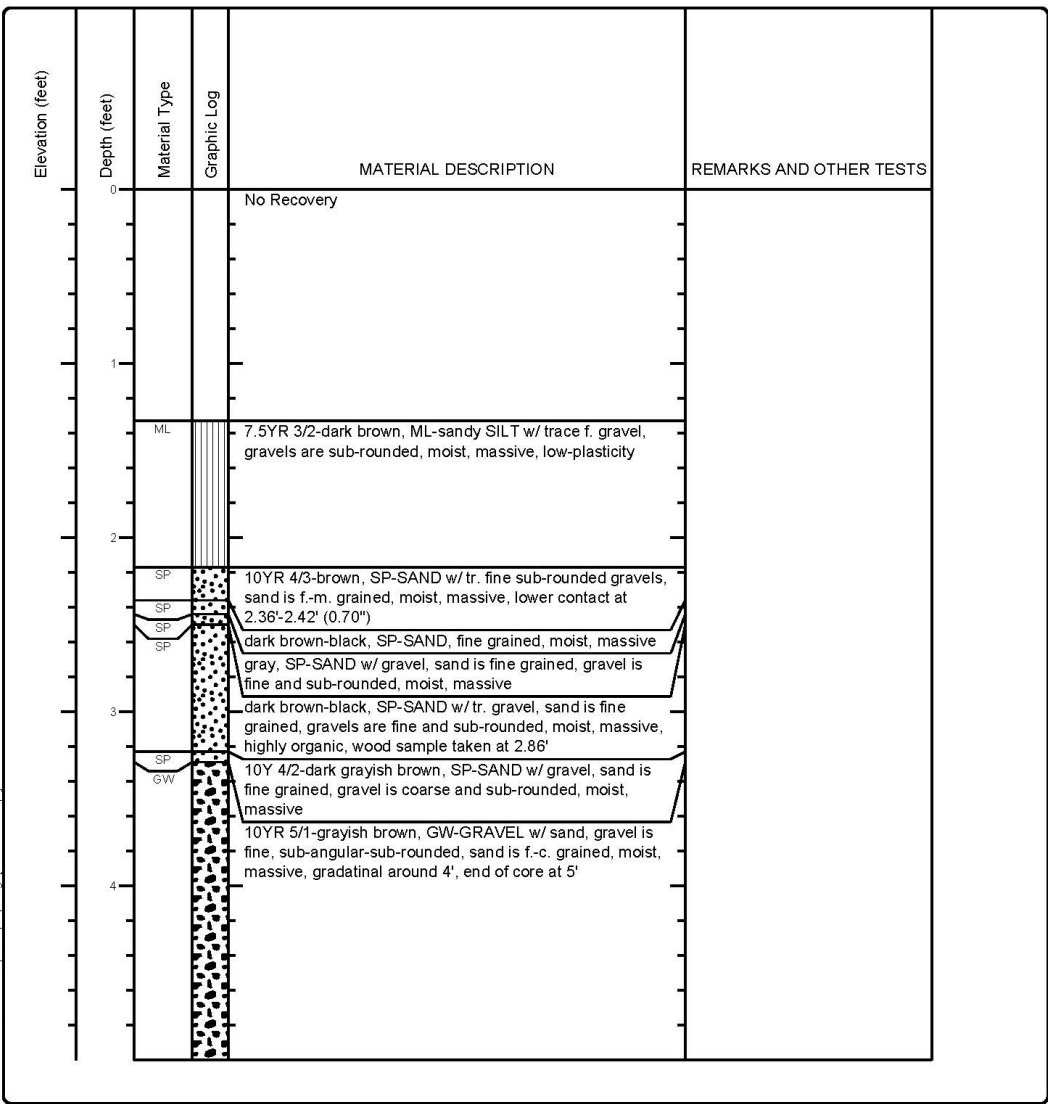


Figure 22.1. Boring log descriptions of P6 from Alki Playground.

| Elevation (feet) | Depth (feet) | Material Type | Graphic Log | MATERIAL DESCRIPTION  | REMARKS AND OTHER TESTS |
|------------------|--------------|---------------|-------------|---|-------------------------|
|                  | 5            |               |             | No Recovery   |                         |
|                  | 6            | GW            |             | 10YR 4/2-dark grayish brown, GW-GRAVEL w/ sand, gravels are f.-c., sub-angular-sub-rounded, sand is f.-c. grained                           |                         |
|                  | 6.5          | SP-SM         |             | 10YR 2/2-very dark brown, SP-SM-SAND w/ silt and tr. fine gravels that are sub-rounded, sand is f.-m. grained, tr. organics, moist, massive |                         |
|                  | 7            | GW            |             | 10YR 4/2-dark grayish brown, GW-GRAVEL w/ sand, gravels are f.-c., sub-angular-sub-rounded, sand is f.-c. grained, moist, massive           |                         |
|                  | 8            | SW            |             | 5Y 3/2-dark olive gray, SW-SAND w/ gravel, sand is f.-c. grained, gravels are fine at sub-rounded, moist, massive                           |                         |
|                  | 8.5          | GW            |             | 5Y 3/2-dark olive gray, GW-GRAVEL w/ sand, gravels are f.-c., sub-angular-sub-rounded, sand is f.-c. grained, moist, massive                |                         |
|                  | 9            | SW            |             | 5Y 3/2-dark olive gray, SW-SAND w/ gravel, sand is f.-c. grained, gravels are fine at sub-rounded, moist, massive                           |                         |
|                  | 9.5          | GW            |             | 5Y 3/2-dark olive gray, GW-GRAVEL w/ sand, gravels are f.-c., sub-angular-sub-rounded, sand is f.-c. grained, moist, massive                |                         |
|                  | 10           | SW            |             | 5Y 3/2-dark olive gray, SW-SAND, sand is f.-c. grained, tr. gravels that are fine and sub-rounded, moist, massive                           |                         |

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Figure 22.2. Boring log descriptions of P6 from Alki Playground.

Project: **Paleoseismic Studies in the Seattle Fault Zone**  
 Project Location: **Alki Playground & Whale Tail Park**  
 Project Number: **N/A**

**Log of Boring P6**  
**Sheet 3 of 3**

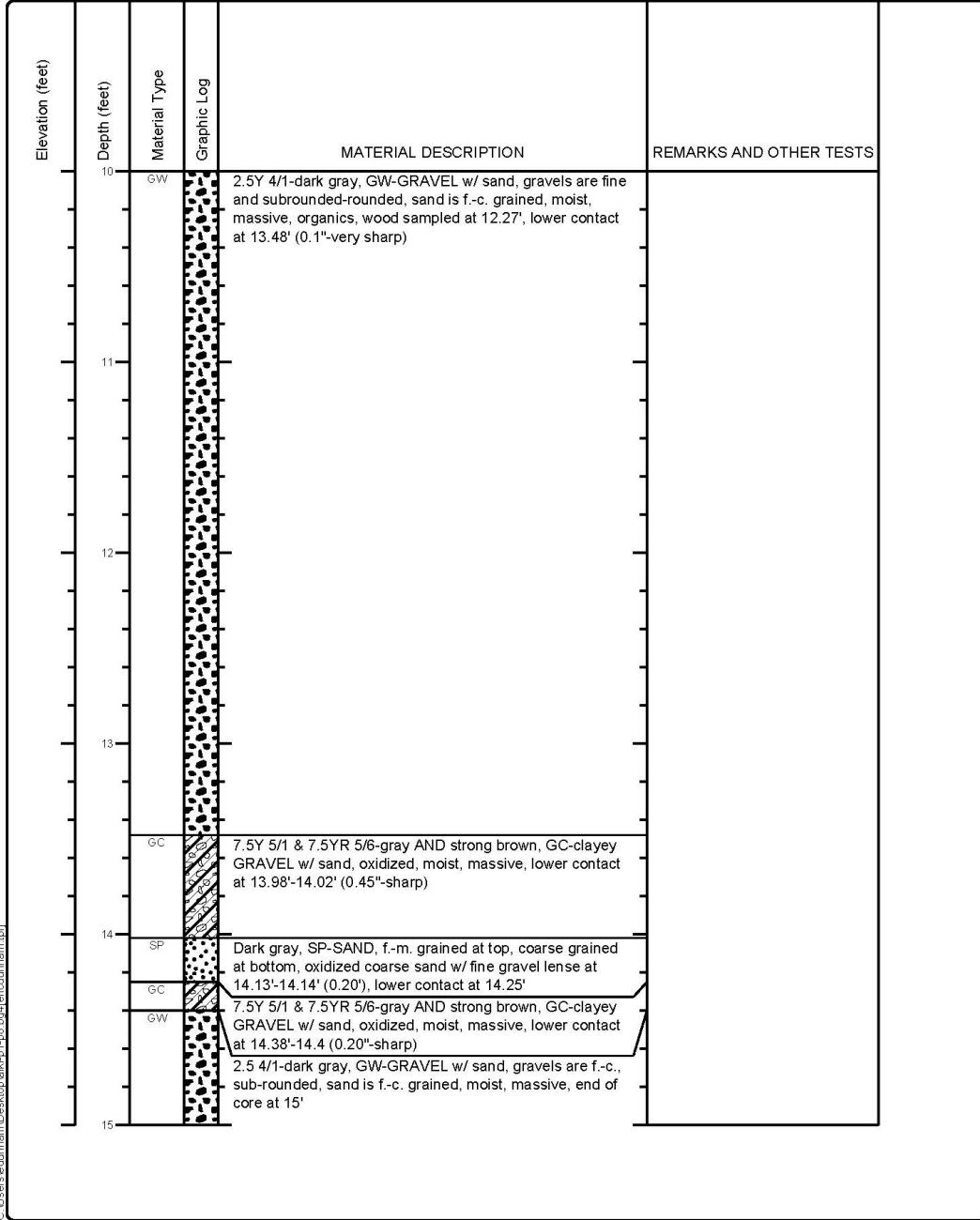


Figure 22.3. Boring log descriptions of P6 from Alki Playground.

|  |  |
|--|--|
| Project: <b>Paleoseismic Studies in the Seattle Fault Zone</b> | <b>Log of Boring P7</b><br><b>Sheet 1 of 3</b> |
| Project Location: <b>Alki Playground &amp; Whale Tail Park</b> |  |
| Project Number: <b>N/A</b>                                     |  |

|  |  |                                |
|--|--|--------------------------------|
| Date(s) Drilled: <b>2/8/2019</b>                 | Logged By: <b>Eric Dunham</b>  | Checked By:                    |
| Drilling Method: <b>Direct Push</b>              | Drill Bit Size/Type: <b>2.25"</b>  | Total Depth of Borehole:       |
| Drill Rig Type: <b>7822DT Geoprobe</b>           | Drilling Contractor: <b>Cascade</b>  | Approximate Surface Elevation: |
| Groundwater Level and Date Measured: <b>7.5'</b> | Sampling Method(s):  | Hammer Data:                   |
| Borehole Backfill: <b>Bentonite</b>              | Location <b>28'</b> west of western edge of sidewalk in line with mid lot 2742 58th St |                                |

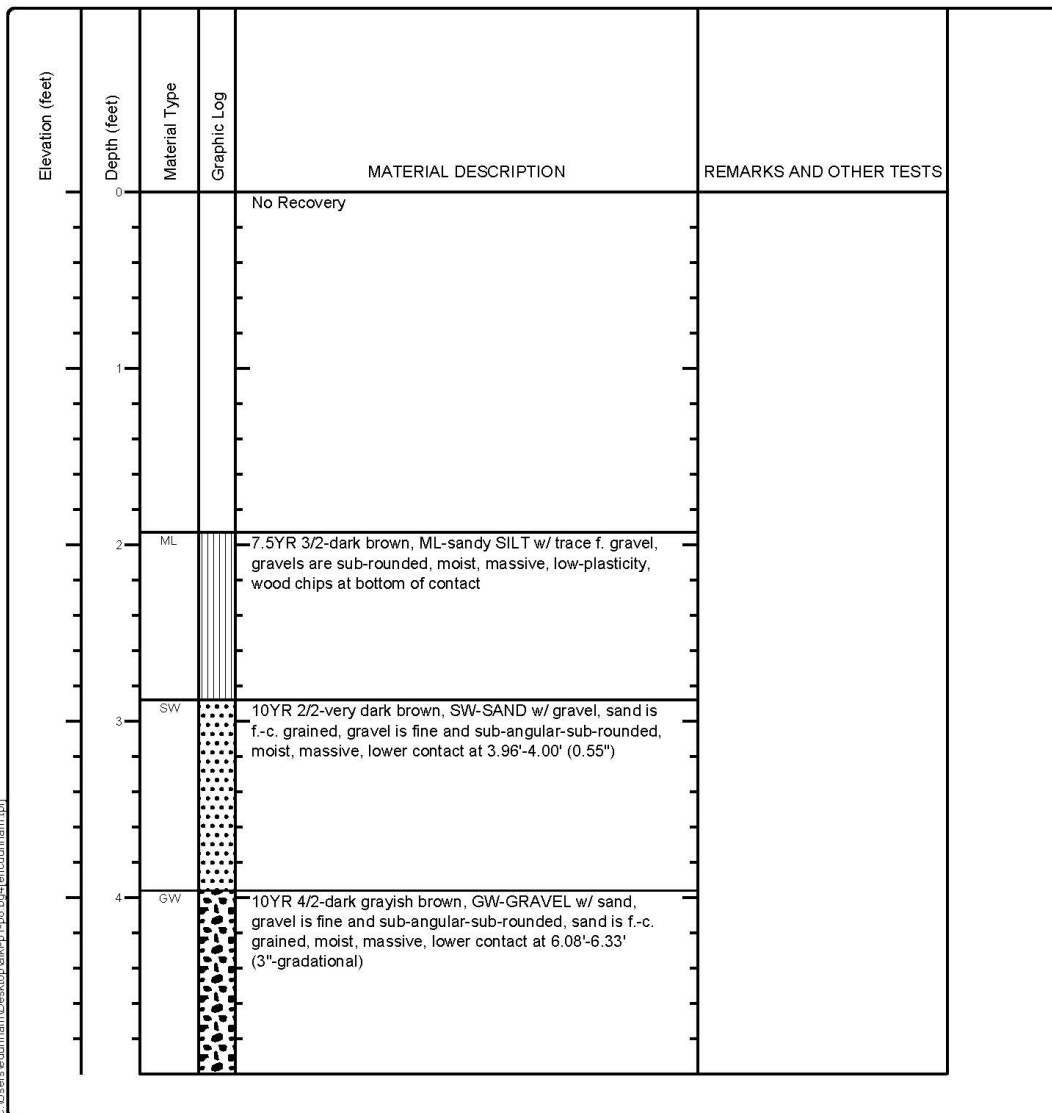







Figure 23.1. Boring log descriptions of P7 from Alki Playground.

Project: **Paleoseismic Studies in the Seattle Fault Zone**  
 Project Location: **Alki Playground & Whale Tail Park**  
 Project Number: **N/A**

**Log of Boring P7**  
**Sheet 2 of 3**

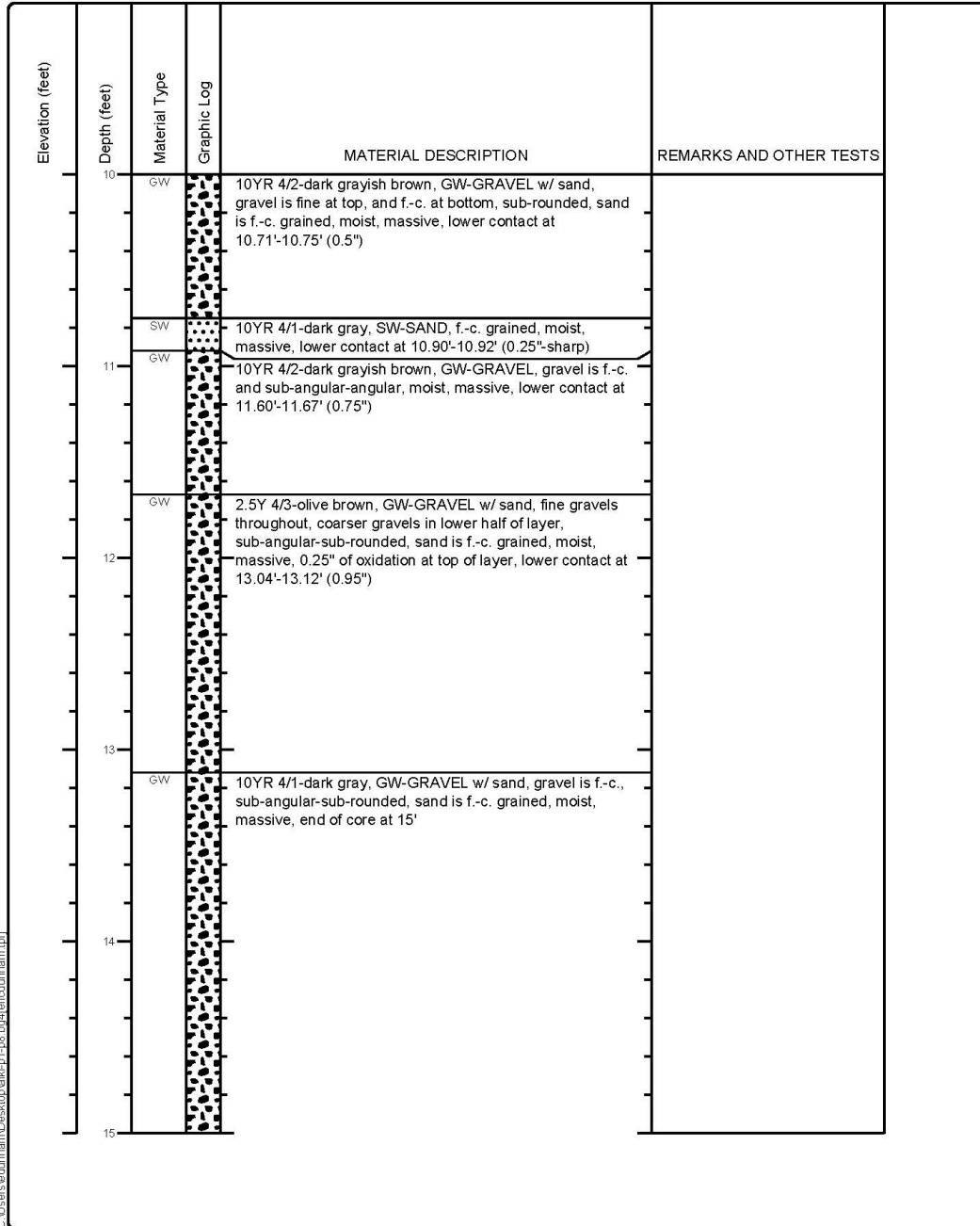
| Elevation (feet) | Depth (feet) | Material Type | Graphic Log   | MATERIAL DESCRIPTION  | REMARKS AND OTHER TESTS |
|------------------|--------------|---------------|---|---|-------------------------|
|                  | 5            | GW            |    | 10YR 4/2-dark grayish brown, GW-GRAVEL w/ sand, gravel is fine and sub-angular-sub-rounded, sand is f.-c. grained, moist, massive, lower contact at 6.08'-6.33' (3"-gradational)      |                         |
|                  | 6            | GW            |   | 10YR-yellowish brown, GW-GRAVEL w/ sand, gravel is f.-c., sub-rounded-sub-angular, sand is f.-c. grained, moist, massive, lower contact at 8.29'-8.38' (1")                           |                         |
|                  | 7            |               |   |   |                         |
|                  | 8            | SW            |  | 10YR 5/2- grayish brown, SW-SAND w/ gravel, sand is f.-c. grained, gravel is fine and subrounded, moist, massive, lower contact at 8.87'-8.93' (0.80")                                |                         |
|                  | 9            | SW            |  | 10YR 4/2-dark grayish brown, SW-SAND, f.-c. grained, moist, massive, lower contact at 9.21'-9.29' (1")  |                         |
|                  | 10           | GW            |  | 10YR 4/2-dark grayish brown, GW-GRAVEL w/ sand, gravel is fine at top, and f.-c. at bottom, sub-rounded, sand is f.-c. grained, moist, massive, lower contact at 10.71'-10.75' (0.5") |                         |

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Figure 23.2. Boring log descriptions of P7 from Alki Playground.

Project: **Paleoseismic Studies in the Seattle Fault Zone**  
 Project Location: **Alki Playground & Whale Tail Park**  
 Project Number: **N/A**

**Log of Boring P7**  
**Sheet 3 of 3**



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Figure 23.3. Boring log descriptions of P7 from Alki Playground.

|  |  |
|--|--|
| Project: <b>Paleoseismic Studies in the Seattle Fault Zone</b> | <b>Log of Boring P8</b><br><b>Sheet 1 of 3</b> |
| Project Location: <b>Alki Playground &amp; Whale Tail Park</b> |  |
| Project Number: <b>N/A</b>                                     |  |

|  |   |                                |
|--|---|--------------------------------|
| Date(s) Drilled: <b>2/8/2019</b>                 | Logged By: <b>Eric Dunham</b>   | Checked By:                    |
| Drilling Method: <b>Direct Push</b>              | Drill Bit Size/Type: <b>2.25"</b>   | Total Depth of Borehole:       |
| Drill Rig Type: <b>7822DT Geoprobe</b>           | Drilling Contractor: <b>Cascade</b>   | Approximate Surface Elevation: |
| Groundwater Level and Date Measured: <b>7.5'</b> | Sampling Method(s):   | Hammer Data:                   |
| Borehole Backfill: <b>Bentonite</b>              | Location: <b>35 east of FNC in line with NE corner of property 2749 59th St</b> |                                |

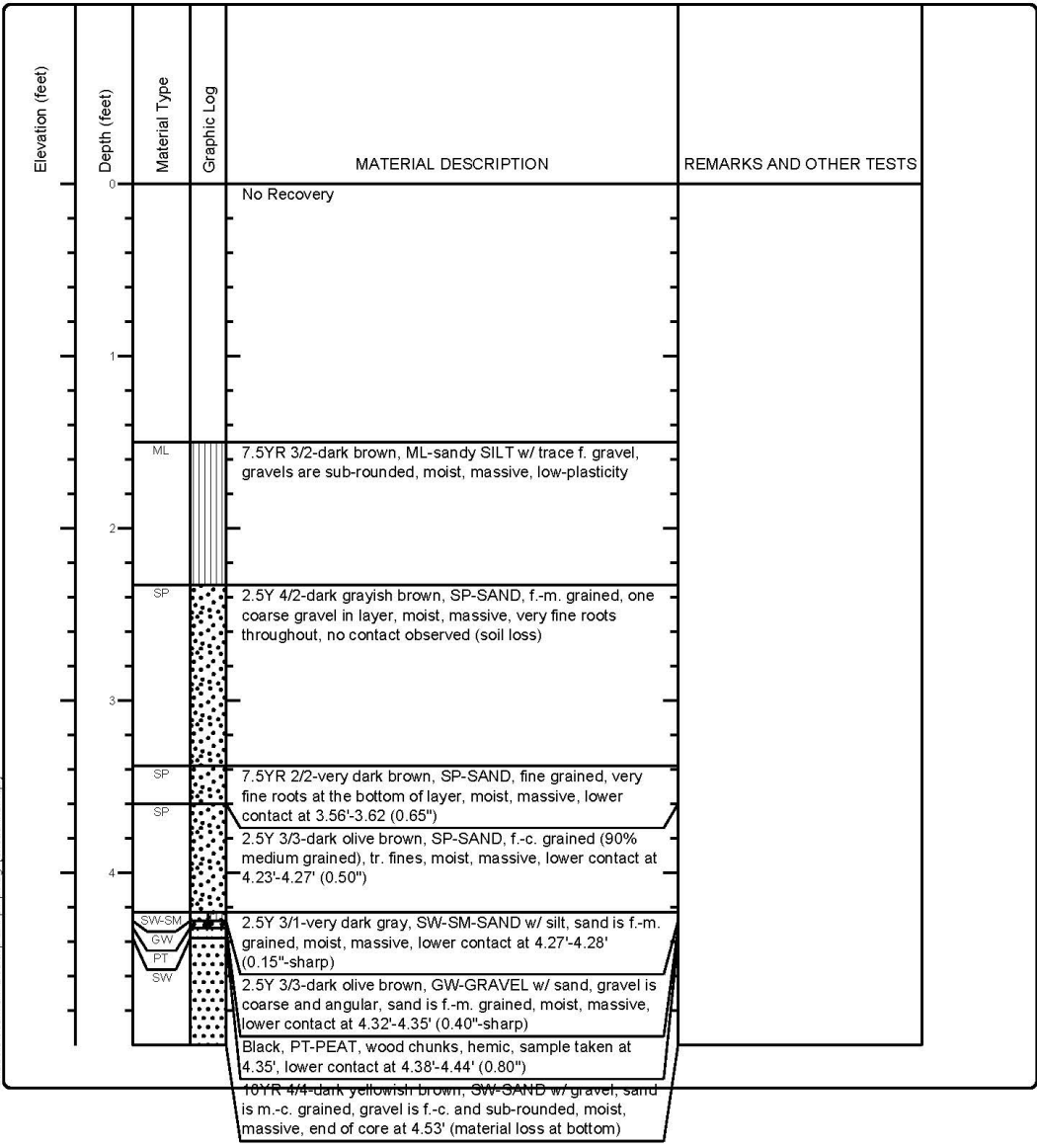


Figure 24.1. Boring log descriptions of P8 from Alki Playground.

|  |  |
|--|--|
| Project: <b>Paleoseismic Studies in the Seattle Fault Zone</b> | <b>Log of Boring P8</b><br><b>Sheet 2 of 3</b> |
| Project Location: <b>Alki Playground &amp; Whale Tail Park</b> |  |
| Project Number: <b>N/A</b>                                     |  |

| Elevation (feet) | Depth (feet) | Material Type | Graphic Log | MATERIAL DESCRIPTION   | REMARKS AND OTHER TESTS |
|------------------|--------------|---------------|-------------|--|-------------------------|
|                  | 5            |               |             | No Recovery/Compaction   |                         |
|                  |              | SP            |             | 10YR 3/2- very dark grayish brown, SP-SAND w/ gravel, sand is medium grained, gravel is fine and sub-rounded, moist, massive, lower not observable (too loose) |                         |
|                  |              | SM            |             | 10YR 2/2-very dark brown, SM-silty SAND, sand is fine, very fine roots, moist, massive, lower contact at 6.69' (0.04"-very sharp)                              |                         |
|                  |              | GW            |             | 10YR 5/1-gray, GW-GRAVEL w/ sand, gravel is f.-c., sub-angular-sub-rounded, sand is f.-c. grained, moist, massive, lower contact at 7.88'-7.96' (1.0")         |                         |
|                  |              | SW            |             | 10YR 4/2-dark grayish brown, SW-SAND w/ gravel, sand is f.-c. grained, gravel is fine and sub-rounded, moist, massive, lower contact at 8.04'-8.17' (1.5")     |                         |
|                  |              | SW            |             | 10YR 5/1-gray, SW-SAND, f.-c. grained, moist, massive, lower contact at 8.29'  |                         |
|                  |              | GW            |             | 10YR 5/1-gray, GW-GRAVEL w/ sand, sand is f.-c. grained, gravel is fine and sub-rounded, moist, massive, lower contact at 8.46'-8.54' (1.0")                   |                         |
|                  |              | GW            |             | Gray-dark brown, GW-GRAVEL w/ sand, gravel is f.-c. and sub-angular-sub-rounded, moist, massive, lower contact at 9.33'-9.40' (0.75")                          |                         |
|                  |              | SW            |             | 2.5Y 4/2-dark grayish brown, SW-SAND w/ gravel, sand is f.-c. grained, gravel is fine and sub-rounded, moist, massive, material ends at bottom of core         |                         |
|                  | 10           |               |             |  |                         |

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Figure 24.2. Boring log descriptions of P8 from Alki Playground.



|  |  |
|--|--|
| Project: <b>Paleoseismic Studies in the Seattle Fault Zone</b> | <b>Log of Boring P9</b><br><b>Sheet 1 of 2</b> |
| Project Location: <b>Alki Playground &amp; Whale Tail Park</b> |  |
| Project Number: <b>N/A</b>                                     |  |

|  |   |                                |
|--|---|--------------------------------|
| Date(s) Drilled: <b>2/8/2019</b>                 | Logged By: <b>Eric Dunham</b>                                   | Checked By:                    |
| Drilling Method: <b>Direct Push</b>              | Drill Bit Size/Type: <b>2.25"</b>                               | Total Depth of Borehole:       |
| Drill Rig Type: <b>7822DT Geoprobe</b>           | Drilling Contractor: <b>Cascade</b>                             | Approximate Surface Elevation: |
| Groundwater Level and Date Measured: <b>7.5'</b> | Sampling Method(s):   | Hammer Data:                   |
| Borehole Backfill: <b>Bentonite</b>              | Location: <b>37' E of FNC perpendicular to lot 2753 59th St</b> |                                |

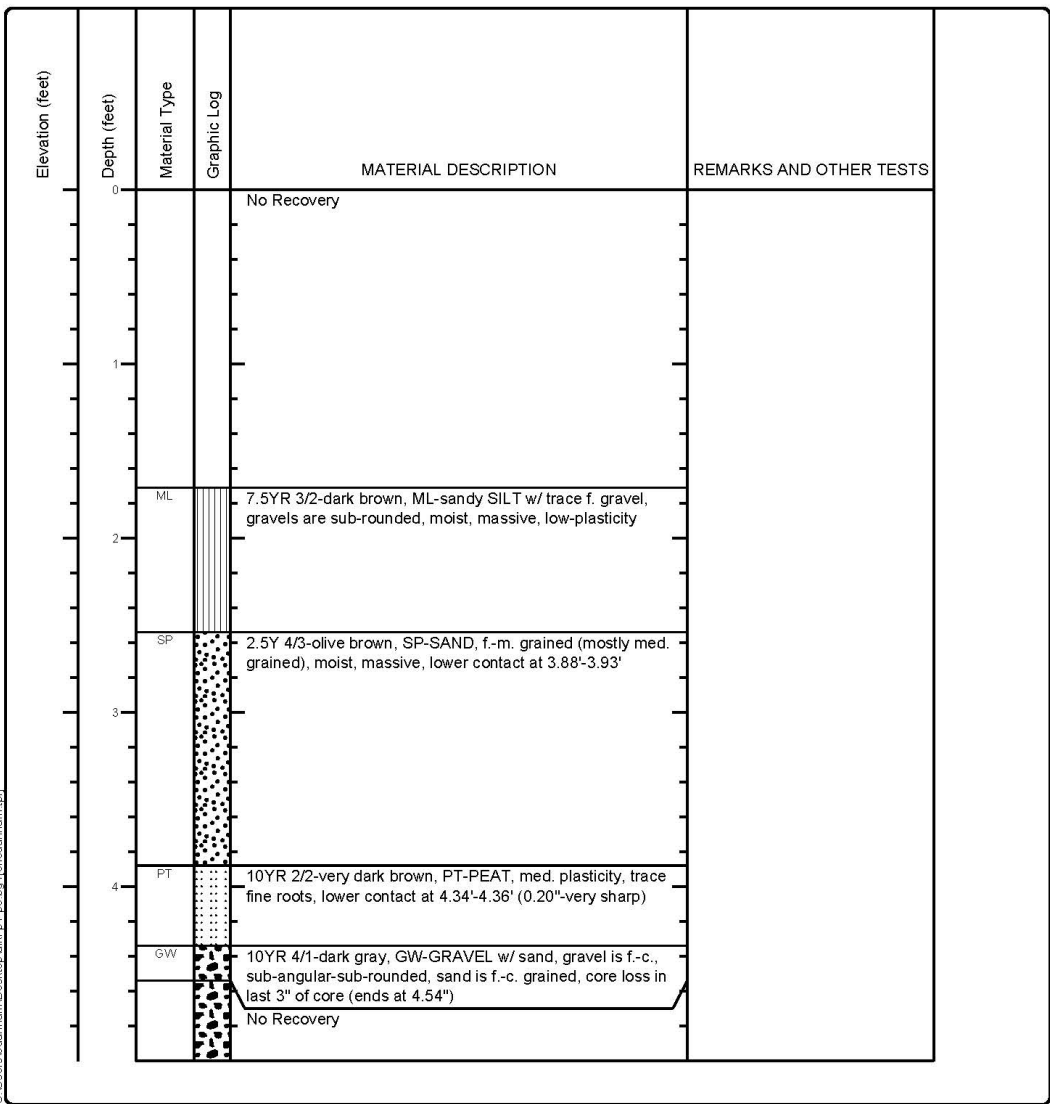


Figure 25.1. Boring log descriptions of P9 from Alki Playground.

Project: **Paleoseismic Studies in the Seattle Fault Zone**  
 Project Location: **Alki Playground & Whale Tail Park**  
 Project Number: **N/A**

**Log of Boring P9**  
**Sheet 2 of 2**

| Elevation (feet) | Depth (feet) | Material Type | Graphic Log | MATERIAL DESCRIPTION   | REMARKS AND OTHER TESTS |
|------------------|--------------|---------------|-------------|--|-------------------------|
|                  | 5            |               |             | No Recovery  |                         |
|                  | 6            |               |             |  |                         |
|                  | 7            |               |             | 2.5Y 4/2-dark gray brown, SW-SAND w/ gravel, sand is f.-c. grained (mostly m.-c.), gravel is fine and sub-rounded, moist, massive, lower contact at 7.27'-7.29' (0.25"-sharp)            |                         |
|                  |              | SP            |             | 2.5Y 4/2-dark gray brown, SP-SAND, f.-m. grained (mostly fine grained), moist, massive, lower contact at 7.44'-7.46' (0.25"-sharp)   |                         |
|                  |              | GW            |             | 2.5Y 5/2-grayish brown, GW-GRAVEL w/ sand, gravel is f.-c., sub-angular-sub-rounded, sand is f.-c. grained (mostly coarse grained), moist, massive, lower contact at 7.87'-7.90' (0.40") |                         |
|                  | 8            |               |             | 2.5Y 5/2-grayish brown, SW-SAND w/ gravel, sand is f.-c. grained, gravel is f.-c., sub-angular-sub-rounded, moist, massive, lower contact at 8.96'-9.05' (1.15")                         |                         |
|                  |              | SW            |             |  |                         |
|                  | 9            |               |             | 2.5Y 5/2-grayish brown, SP-SAND, med. grained, moist, massive, lower contact at 9.55'-9.63' (1.0")   |                         |
|                  |              | SP            |             |  |                         |
|                  |              | SW            |             | 2.5Y 5/2-grayish brown, SW-SAND w/ gravel, sand is f.-c. grained, gravel is f.-c., sub-angular-sub-rounded, moist, massive, core ends at 10'   |                         |
|                  | 10           |               |             |  |                         |

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Figure 25.2. Boring log descriptions of P9 from Alki Playground.

|  |   |
|--|---|
| Project: <b>Paleoseismic Studies in the Seattle Fault Zone</b> | <b>Log of Boring P10</b><br><b>Sheet 1 of 2</b> |
| Project Location: <b>Alki Playground &amp; Whale Tail Park</b> |   |
| Project Number: <b>N/A</b>                                     |   |

|  |   |                                |
|--|---|--------------------------------|
| Date(s) Drilled: <b>2/8/2019</b>                 | Logged By: <b>Eric Dunham</b>   | Checked By:                    |
| Drilling Method: <b>Direct Push</b>              | Drill Bit Size/Type: <b>2.25"</b>   | Total Depth of Borehole:       |
| Drill Rig Type: <b>7822DT Geoprobe</b>           | Drilling Contractor: <b>Cascade</b>   | Approximate Surface Elevation: |
| Groundwater Level and Date Measured: <b>7.5'</b> | Sampling Method(s):   | Hammer Data:                   |
| Borehole Backfill: <b>Bentonite</b>              | Location <b>66' east of FNC in line with lot line 2753 (southern lot of lot line)</b> |                                |

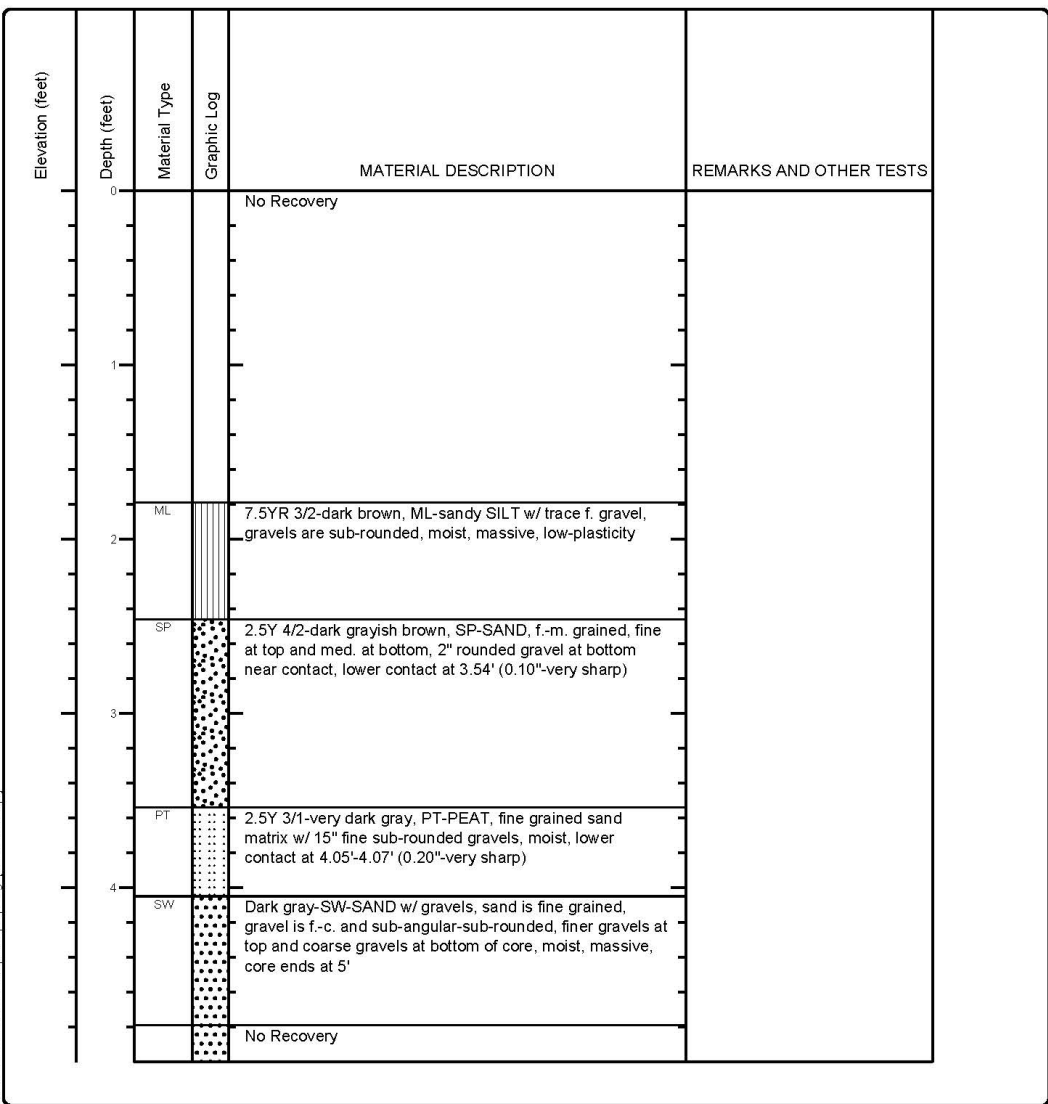


Figure 26.1. Boring log descriptions of P10 from Alki Playground.

|  |   |
|--|---|
| Project: <b>Paleoseismic Studies in the Seattle Fault Zone</b> | <b>Log of Boring P10</b><br><b>Sheet 2 of 2</b> |
| Project Location: <b>Alki Playground &amp; Whale Tail Park</b> |   |
| Project Number: <b>N/A</b>                                     |   |

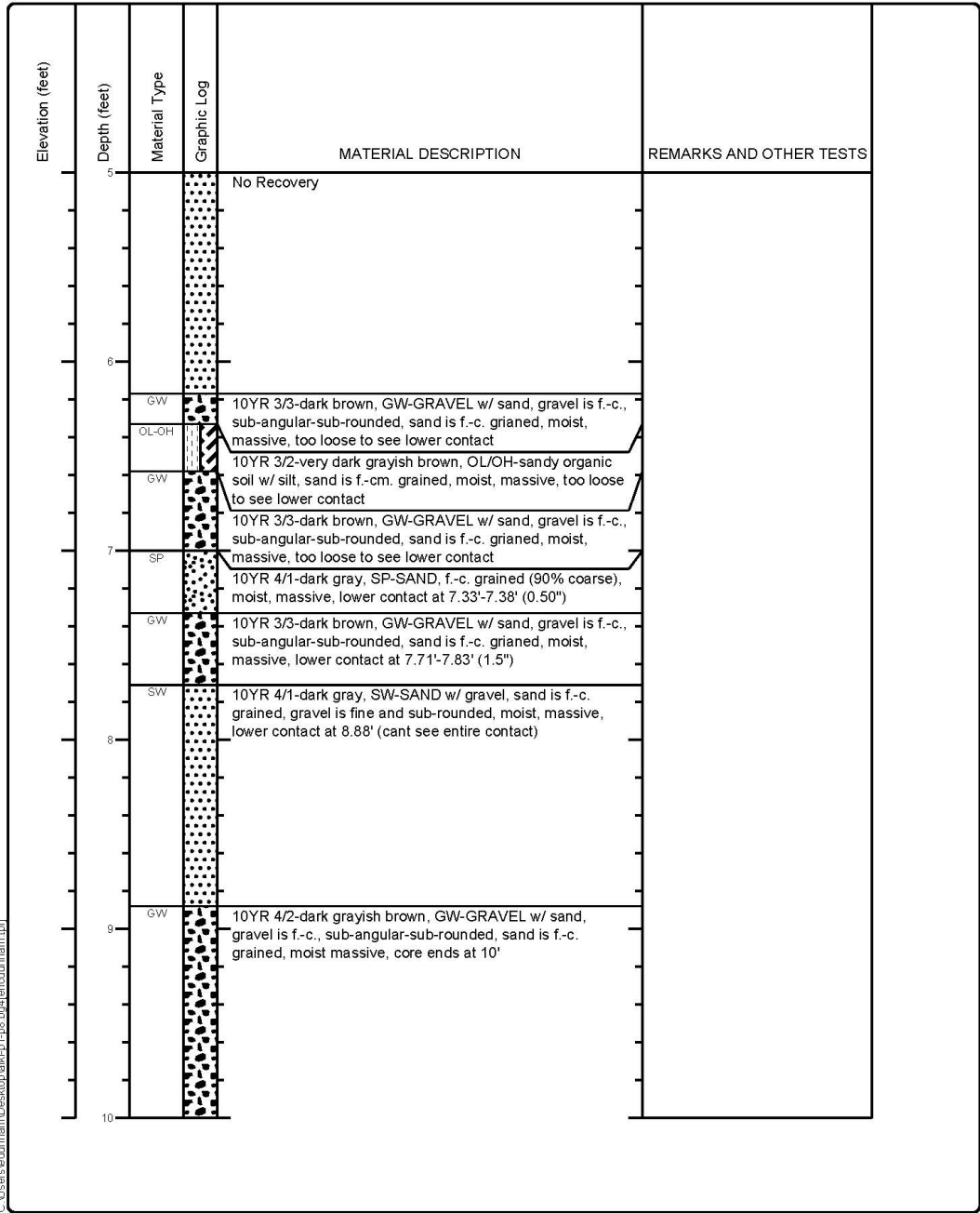


Figure 26.2. Boring log descriptions of P10 from Alki Playground.

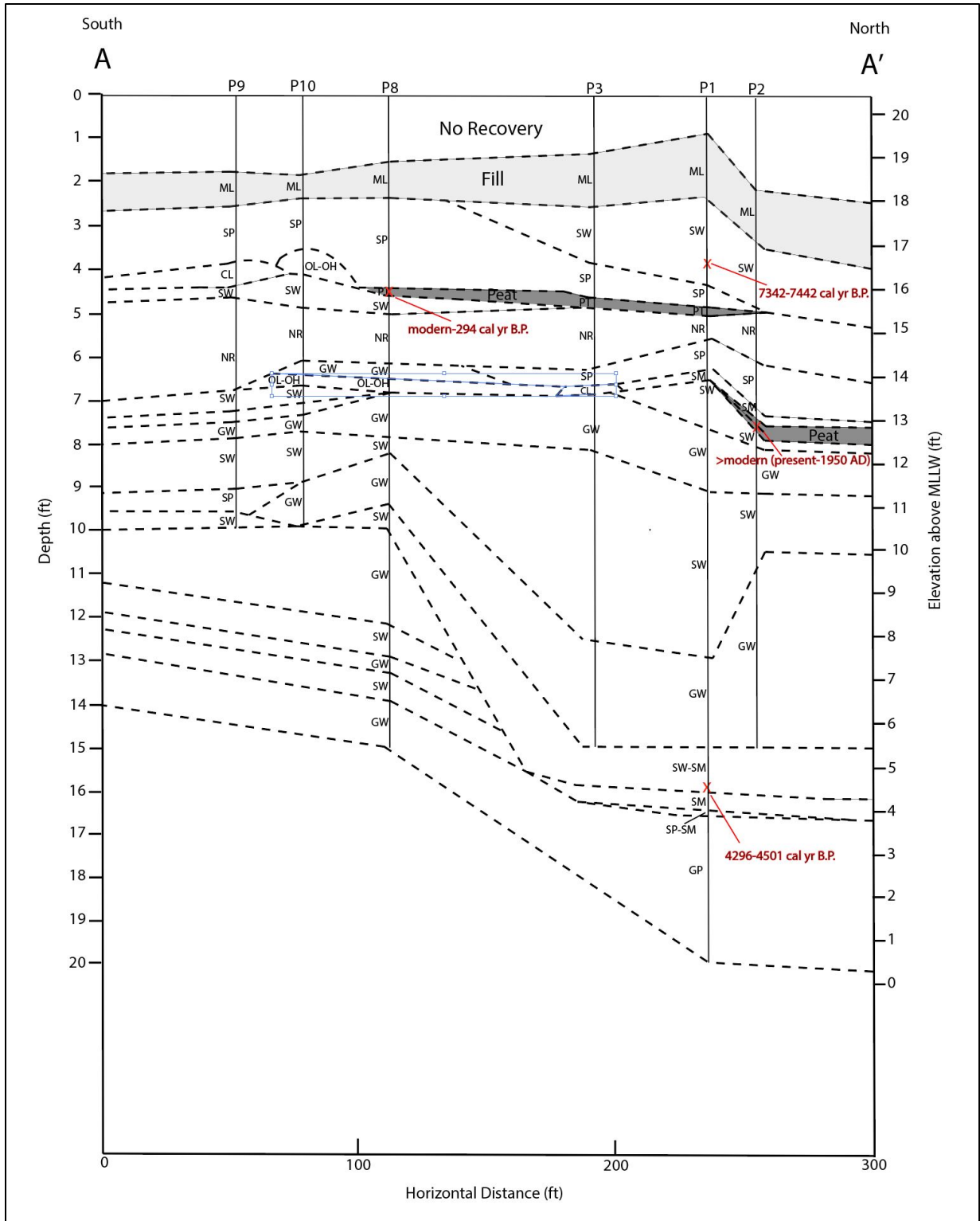


Figure 27. Cross-section A-A' for Alki Playground. Modern age refers to a range within 1950 A.D. Symbols are based on Unified Soil Classification System (ASTM D2488). NR-No Recovery, ML-sandy SILT, SP-poorly graded SAND, SW-well graded SAND, PT-PEAT, GP-poorly graded GRAVEL, GW-well graded GRAVEL, OL-OH-sandy organic soil, SM-silty

SAND, CL/CH-CLAY, SP-SM-poorly graded SAND with silt, SW-SM-well graded SAND with silt.

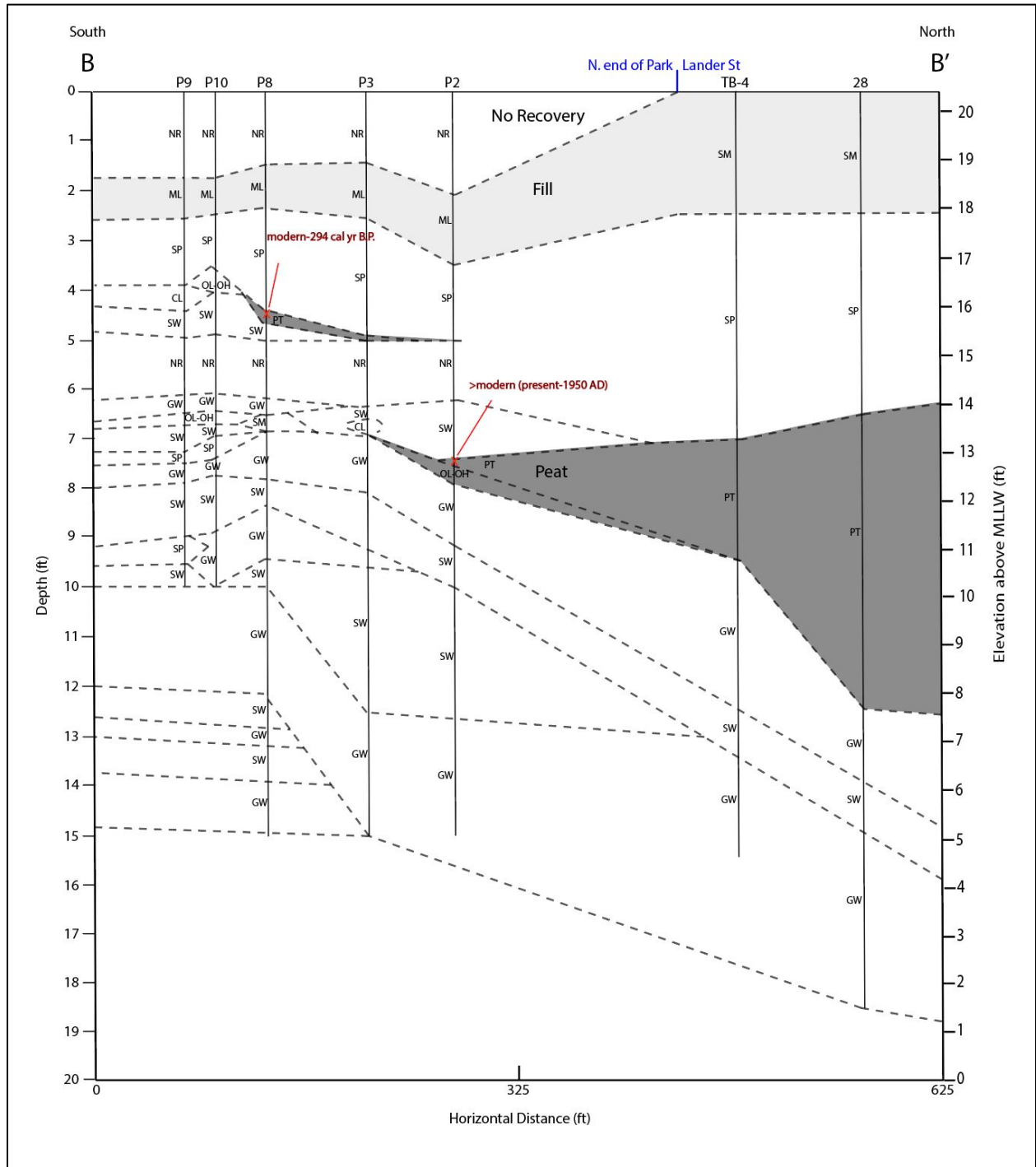


Figure 28. Cross-section B-B' for Alki Playground. Modern age refers to a range within 1950 A.D. Symbols are based on Unified Soil Classification System (ASTM D2488). NR-No Recovery, ML-sandy SILT, SP-poorly graded SAND, SW-well graded SAND, PT-PEAT, GP-poorly graded GRAVEL, GW-well graded GRAVEL, OL-OH-sandy organic soil, SM-silty SAND, CL/CH-CLAY, SP-SM-poorly graded SAND with silt, SW-SM-well graded SAND with silt.

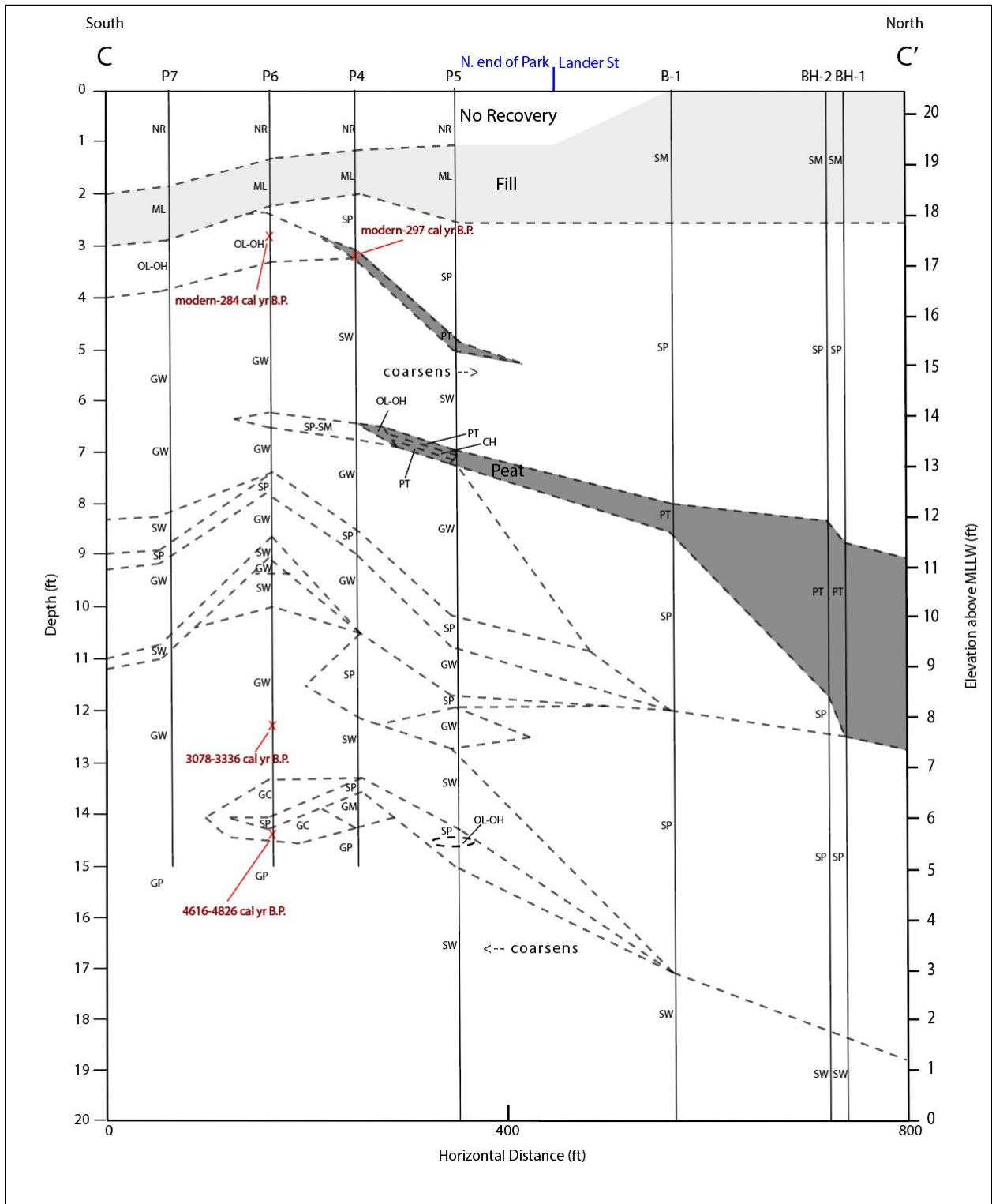


Figure 29. Cross-section C-C' for Alki Playground. Modern age refers to a range within 1950 A.D. Symbols are based on Unified Soil Classification System (ASTM D2488). NR-No Recovery, ML-sandy SILT, SP-poorly graded SAND, SW-well graded SAND, PT-PEAT, GP-poorly graded GRAVEL, GW-well graded GRAVEL, OL-OH-sandy organic soil, SM-silty

SAND, CL/CH-CLAY, SP-SM-poorly graded SAND with silt, SW-SM-well graded SAND with silt.

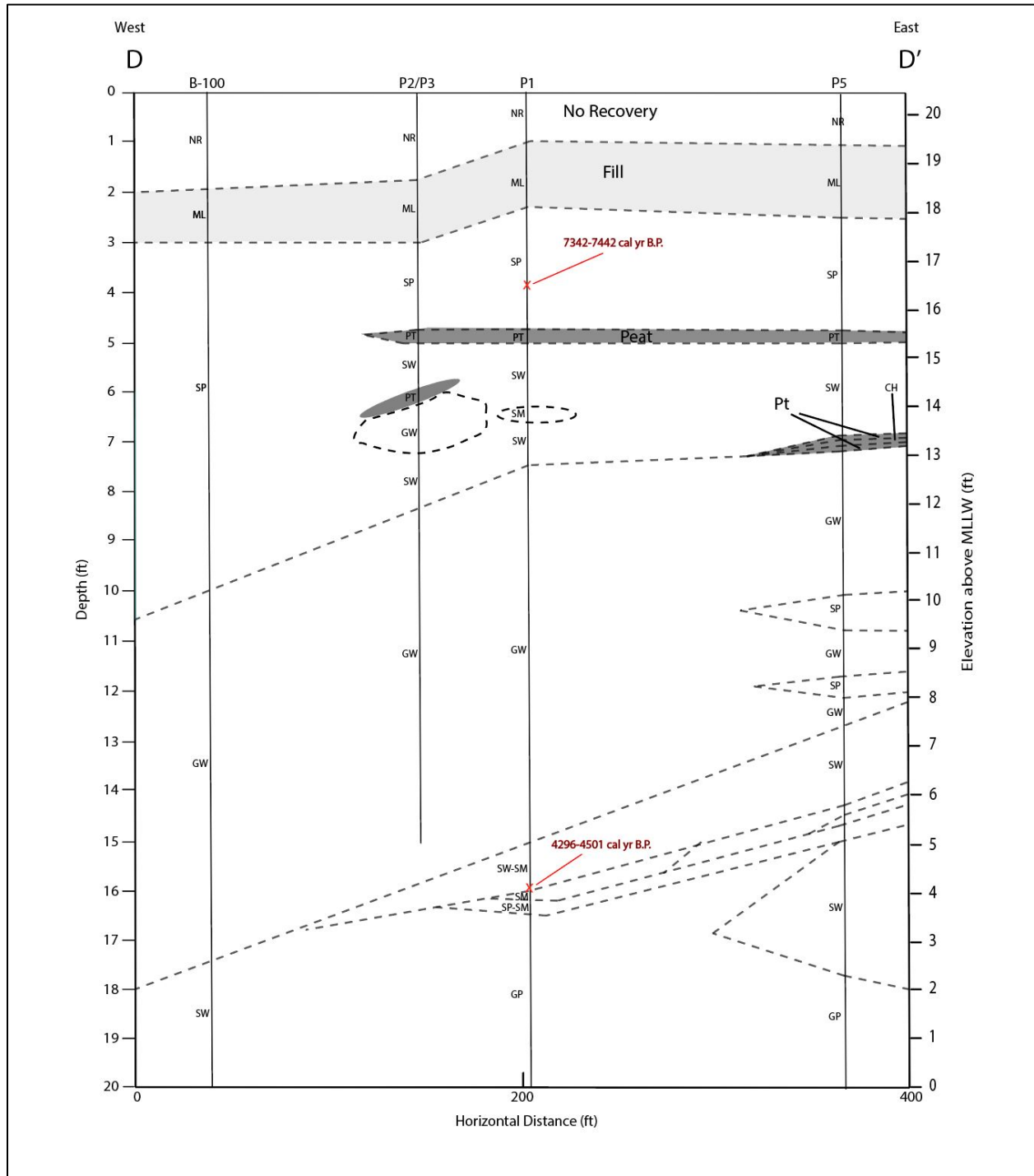


Figure 30. Cross-section D-D' for Alki Playground. Modern age refers to a range within 1950 A.D. Symbols are based on Unified Soil Classification System (ASTM D2488). NR-No Recovery, ML-sandy SILT, SP-poorly graded SAND, SW-well graded SAND, PT-PEAT, GP-poorly graded GRAVEL, GW-well graded GRAVEL, OL-OH-sandy organic soil, SM-silty SAND, CL/CH-CLAY, SP-SM-poorly graded SAND with silt, SW-SM-well graded SAND with silt.

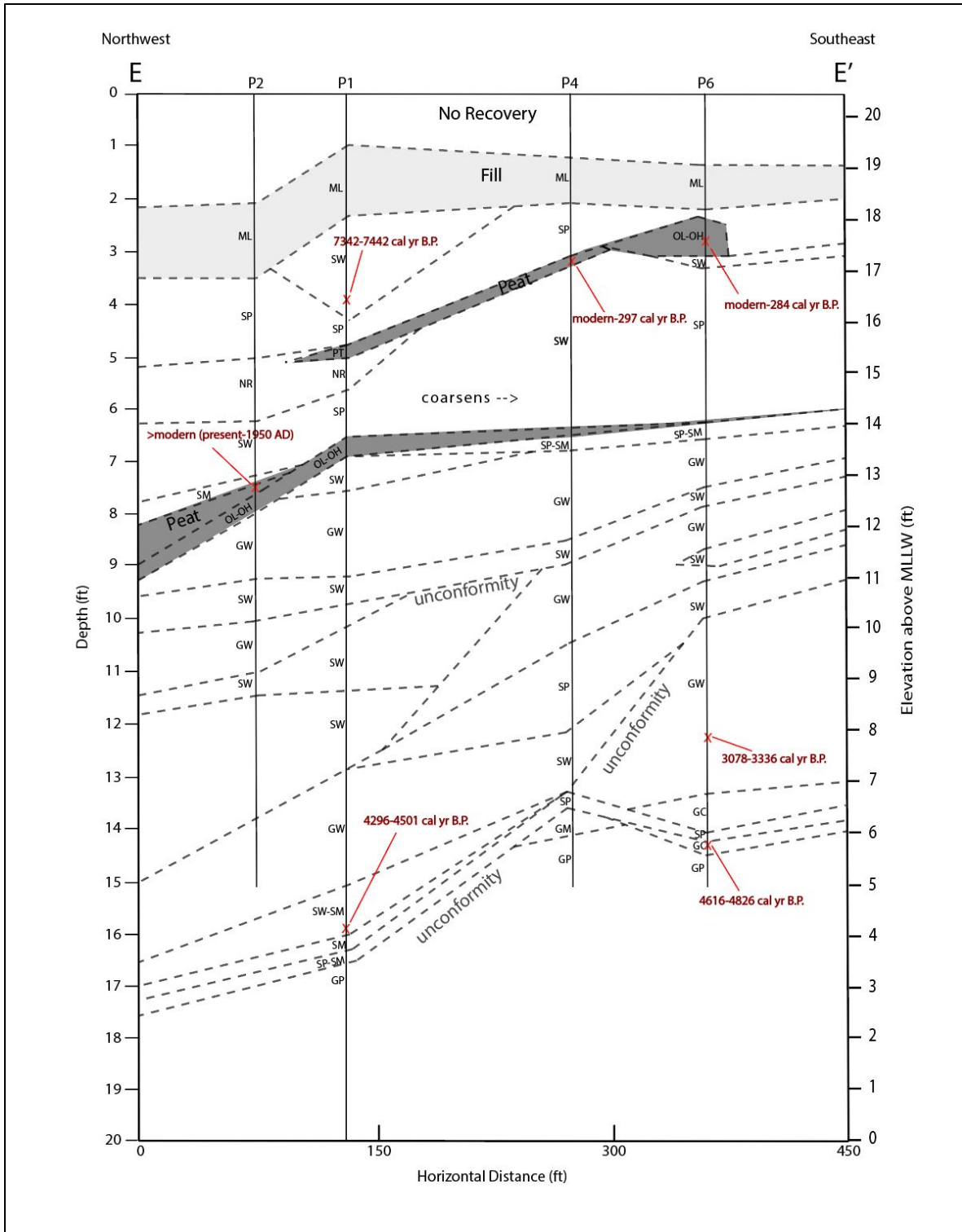


Figure 31. Cross-section E-E' for Alki Playground. Modern age refers to a range within 1950 A.D. Symbols are based on Unified Soil Classification System (ASTM D2488). NR-No Recovery, ML-sandy SILT, SP-poorly graded SAND, SW-well graded SAND, PT-PEAT, GP-poorly graded GRAVEL, GW-well graded GRAVEL, OL-OH-sandy organic soil, SM-silty SAND, CL/CH-CLAY, SP-SM-poorly graded SAND with silt, SW-SM-well graded SAND with silt.

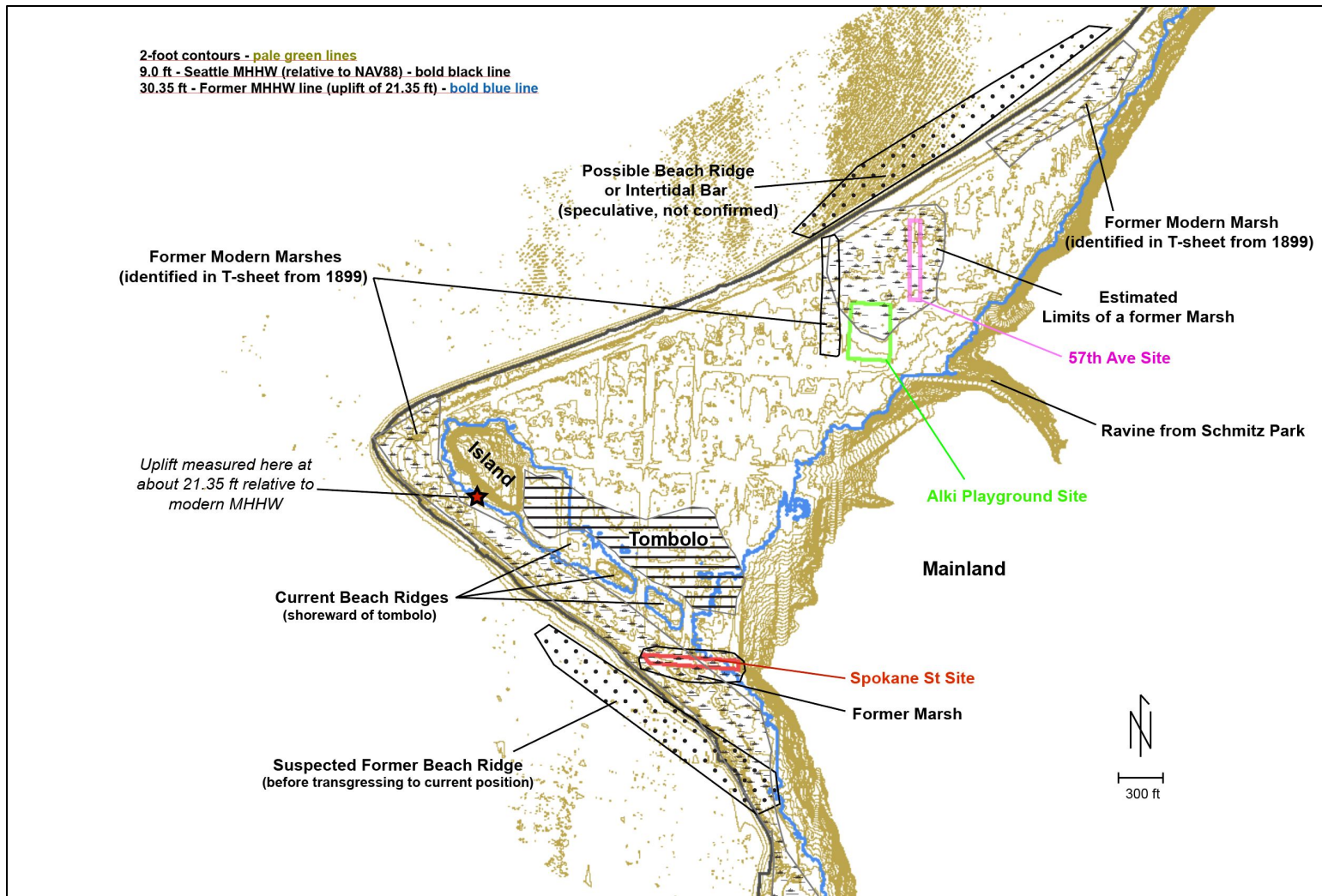


Figure 32. Two-foot contour map of Alki Point showing current landforms and potential landforms prior to uplift ~1000 cal yr B.P. A tombolo between the bedrock knoll at the western tip of Alki may have connected Alki point to the mainland. One or more beach ridges parallel to the tombolo are still preserved shoreward. Based on borings, the approximate extent of the marsh by Alki Playground and 57<sup>th</sup> Ave may have been protected by one or more beach ridges or intertidal bars in addition to the tombolo.

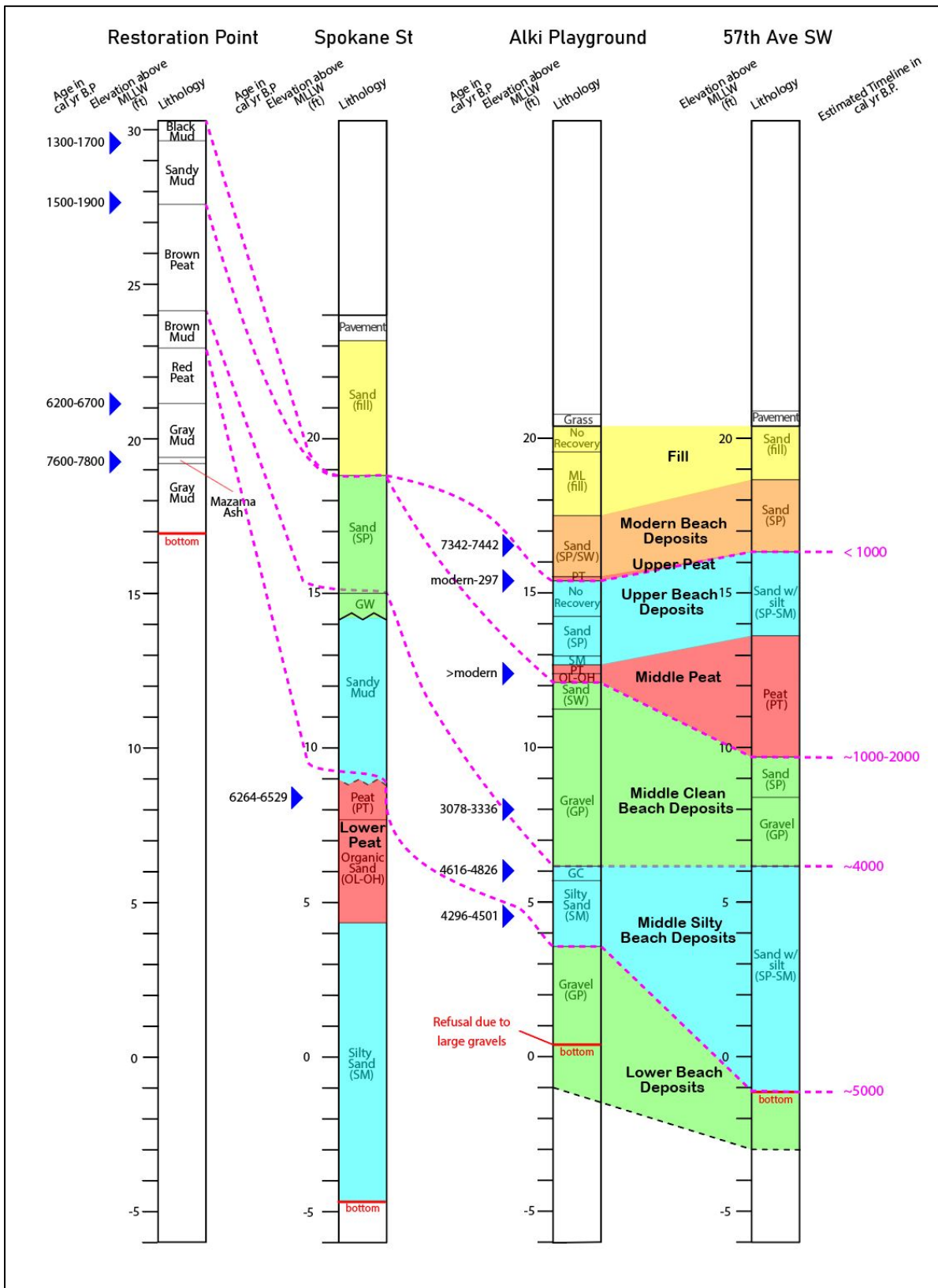


Figure 33. Conceptual chronostratigraphic model of all four sites. The white space between Spokane St and Alki Playground represents a geomorphic break from the suspected tombolo. There is also a geographic break between Restoration Point and the Alki Point sites, which limits stratigraphic correlations.

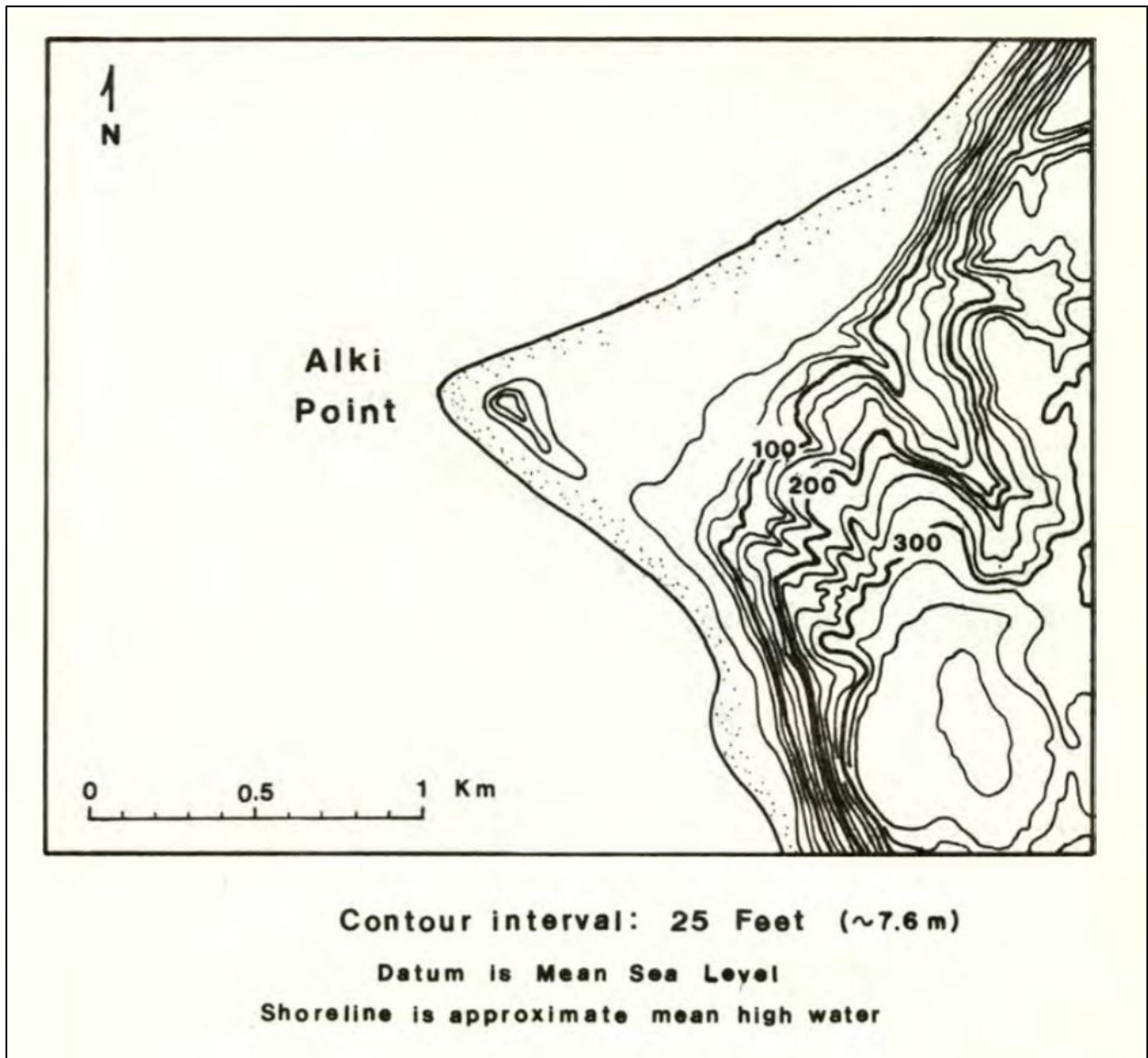


Figure 34. Topographic map of Alki Point showing the steep hillslopes to the east, the ravine in Schmitz Park oriented northwest towards the shore, and the bedrock knoll near the western tip of the point (contours from U. S. Geological Survey, 1949).