GEODESIGN INC

REPORT OF GEOTECHNICAL ENGINEERING SERVICES

Wayland Arms Apartments
307 South Division Street
Auburn, Washington

For
King County Housing Authority
November 3, 2009

GeoDesign Project: KCHA-13-01

FOR WAYLAND ARMS SLAB REPAIR & SEISMIC UPGRADE RFQ

Site Observations and Review
First Floor Concrete Slab Repair Recommendations
Wayland Arms Apartments
307 South Division Street
Auburn, Washington

Prepared for

KING COUNTY HOUSING AUTHORITY

JRP ENGINEERING, INC.

JRP ENGINEERING, INC.

December 10, 2009

KING COUNTY HOUSING AUTHORITY
625 Andover Park West, Suite 107
Seattle, Washington 98188-3326

Attn: Mr. Steve Jefferis, Project Manager

Consulting Architectural and Engineering Services

Subject: Site Observations and Review
First Floor Concrete Slab Repair Recommendations
Wayland Arms Apartments
307 South Division Street
Auburn, Washington

Dear Mr. Jefferis:

Scope of Services:

As requested have made site visits and performed a vertical control survey of the first floor of the above referenced building to document the extent of vertical displacement resulting from subsidence of the concrete first floor slab that has reportedly occurred over many years. We performed a vertical control survey at the common area corridors on the first floor, and using the survey points in the corridors, the survey extended into individual apartment units in order to determine the relative elevations of the floor slab throughout the common areas and non-public first floor areas of the building.

An initial site visit was performed on September 8, 2009 by Mr. Don C. Nelson, P.E., of this company, when he met with you to make a visual review of the conditions at the building. The vertical control survey was performed during site visits that were made on October 14 and 16, 2009 by myself and Mr. Nelson.

Photographs were taken during the site visits and reproductions of several of these photographs are bound in Appendix A. We have received several documents regarding the subject building. These documents include:

a) Copies of the original architectural and structural plans of the building. The architectural plans were prepared by Carlson-Eley-Grevstad, AIA, Architects and are dated May 25, 1966. The structural plans were prepared by Chalmers O. Ekness and

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have the same date as the architectural drawings. The original plans were prepared for the "Housing Authority of the County of King, Washington".

b) Copies of a geotechnical engineering report prepared by GeoEngineers dated February 9, 1999 for the construction of the C Street interchange project located directly north of the Wayland Arms building.

c) A copy of a geotechnical engineering report prepared by GeoDesign, Inc. for the proposed repairs to the first floor of the Wayland Arms building dated November 3, 2009.

Description of Building:

The Wayland Arms Apartment building is a four-story concrete and steel frame structure that is situated at the southwest corner of the intersection of 3rd Street S.W. and South Division Street in the downtown area of Auburn, Washington (refer Photograph 1). The building is situated on a level site and has an L-shape configuration. The building has overall plan dimensions of 111'-5" x 186'-11" with the long dimension oriented in the north-south direction. The building has a centrally located entry lobby that adjoins to north and south wings of the building to give the building an L-shape configuration. The south wing has the long dimension oriented in the north-south direction extending south from the entry lobby. The north wing has the long dimension oriented in the east-west direction. The east end of the south wall of the north wing connects to the entry lobby and extends to the west. The building was constructed in 1967.

At the time of original construction, the building was designed under the 1961 Edition of the Uniform Building Code. The building is constructed to comply with Group H Occupancy and Type II Construction. The total floor area of the building is 45,056 square feet. The building contains a total of 67 apartment units, with 10 units on the first floor and 19 units each on the second, third and fourth floors. There are offices, craft room, kitchen and community lounge located on the first floor, all in the south wing. The entry lobby between the north and south wings faces east toward South Division Street. The entry also has a door on the west side to provide access to an exterior courtyard that occupies the outside space to the south of the north wing and west of the south wing. Along the west side of the south wing, the first floor wall is recessed back to the east underneath the building above to create a covered patio area alongside the community lounge (refer Photographs 2 and 3).

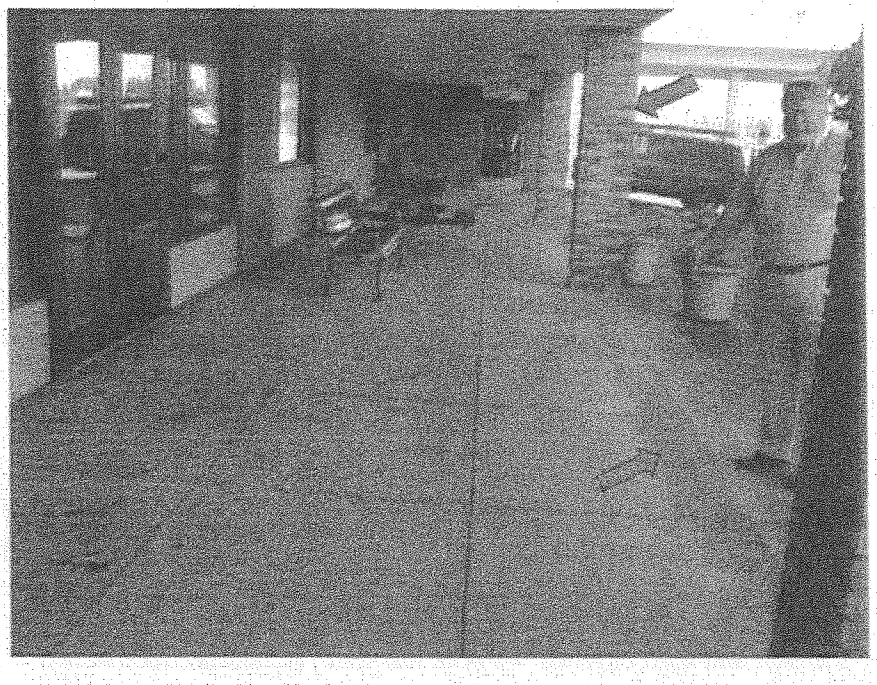
The original building plans indicate that the roof of the building consists of the built-up roof membrane placed over a layer of rigid insulation board that is placed over corrugated metal roof decking. The roof decking spans over 14" deep open web steel bar joists. The bar joist span in the east-west direction in the north wing and north-south direction in the south wing from a ridgeline to the side walls at an approximately ¼" per foot slope.

There is a gypsum ceiling that follows the slope of the roof attached to steel resilient channels that are in turn, attached to the bottom chord of the bar joists. The second, third and fourth floors of the building consist of a 2½" thick concrete slab that spans over 14" deep open web steel bar joists that span in the east-west direction in the north wing and north-south direction in the south wing. The joists are supported by steel beam lines that align with the party walls separating apartment units. The steel beam lines are supported by three steel columns, one at each side wall, and one at one of the interior corridor walls. The steel columns that support the second, third and fourth floors as well as the roof are supported by concrete pile caps. The pile caps are typically supported on two piles at the exterior wall column locations and three piles at the columns at the corridor wall in each wing. The original plans indicate that the piles are 40 Ton capacity pressure-treated timber piles. There are concrete grade beams that connect the pile caps. The first floor slab throughout the building is a 4" thick concrete slab that is ground supported. The first floor slab spans directly concrete pile caps and footing at the exterior wall lines.

The exterior wall construction of the building consists of steel stud framework with areas of brick veneer and areas of cement plaster (stucco) as the exterior finish. The exterior wall cladding material is placed over a weather-resistive barrier and gypsum sheathing that is attached to the steel stud framing. The windows are aluminum frame window units.

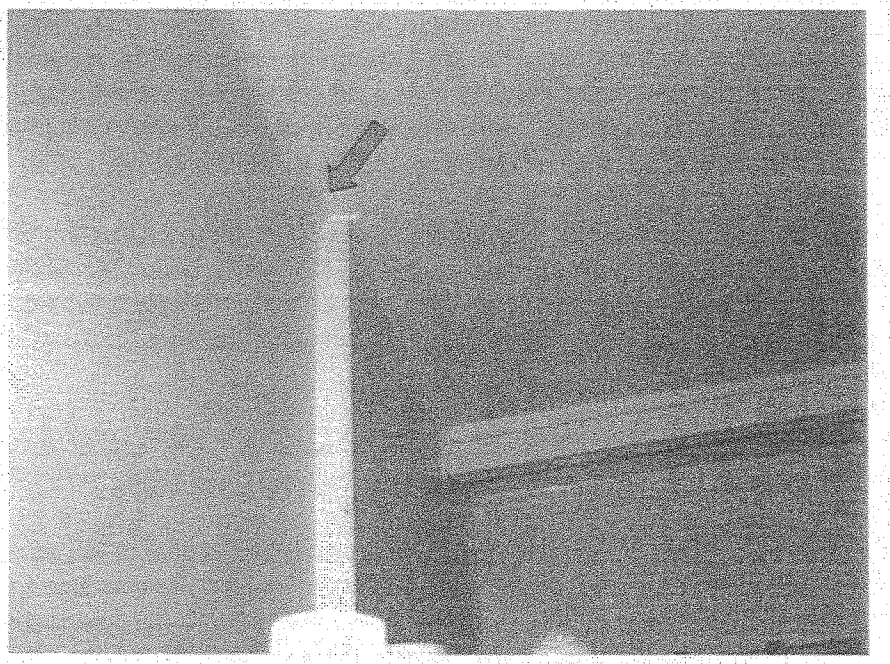
Observations:

During our first site visit on September 8, 2009, we were able to access the building and observe and document conditions at the first floor. It was noted that at the first floor, there are noticeable undulations in the surface of the floor. Cracks and gaps have formed where the first floor slab has subsided with respect to the wall base, bottom of door frames, or at wall intersections at many locations at the first floor area. The cracks and gaps indicate that subsidence of the first floor has occurred at many places (refer Photographs 4, 5 and 6). Also, the wall base along the corridor walls in the north wing had been installed along the slopes in the floor indicating the floor was undulated in the corridor when the wall base was installed (refer Photograph 7). It was reported that numerous repairs including realigning doors at the first floor and repairing wall cracks and distress has occurred over a number of years as a result of the uneven floor condition at the first floor. Along the concrete patio along the west side of the south wing, and along the concrete walkways poured on grade along the west side of the property, there are numerous areas where the slabs have subsided and cracked. Some areas have been patched in to prevent trip hazards for people walking on the patio or walkways. At the location where the driveway meets the patio near the south end of the south wing, a small section concrete was placed over the asphalt to create a ramp driveway between the patio and asphalt pavement (refer Photograph 8).



HOW THIS BUM GET HERE?

3. This photograph was taken looking south along the patio located along the west side of the community lounge. The upper arrow points to a support column. The lower arrow points to a prior repair made to the patio slab.



4. This photograph was taken in apartment Unit 104 in the north wing. The arrow points to separation between the second floor ceiling and interior wall due to downward displacement of the first floor below.

It was decided that it would be appropriate to perform a vertical control survey in the first floor area of the building in order to develop accurate floor elevations throughout the first floor. A vertical control survey was performed on October 14 and 16, 2009 by JRP Engineering personnel. King County Housing Authority provided access to the first floor apartment units and common area spaces so that a comprehensive vertical control survey could be performed in both common area and private areas of the first floor. The results of the vertical control survey are shown with relative floor elevations at the surveyed locations on a first floor plan drawing that is bound in Appendix B. Generally, the results of the survey are as follows:

1. In the south wing, the survey results indicate that there is undulation in the floor slab at survey points taken over pile caps are in a range within of less than ¾" differential. It should be noted that the first floor slab is placed directly on top of the pile caps.

2. Along the east and west exterior walls of the south wing, the floor between pile caps is as much as 2-3/8" lower than the elevation of the floor at pile caps located along the corridor wall. The floor slab elevation at the east exterior wall is as much as 2¾" lower than the floor slab elevation at the pile cap along the same exterior wall line.

3. Along the west side of the south wing, the upper floors of the building project out over an exterior patio that borders the craft room, kitchen and community lounge. The support for the upper floors is located along the outer edge of this patio. The survey points taken at the slab directly above the pile caps at the outer edge of this patio slab are as much as 2-1/8" higher than the low point. Between two adjacent pile caps, the floor slab elevation between pile caps is at most 1-1/8".

4. At the exterior wall line of the south wing along the craft room, kitchen and community lounge, the exterior wall is supported by the ground slab of the first floor and not by pile caps or grade beams. The floor elevations along this exterior wall line are all between 1¾" and 2¼" lower than the floor slab elevation at the pile caps in the center of the building.

5. In the north wing, the floor slab elevation is as much as 3-3/8" higher at the pile caps than the readings taken mid-way between pile caps in the corridor.

6. Floor elevations taken along the exterior walls in the apartment units, most of which were located between pile caps, the relative floor elevations are between 1-1/8" and 2-1/2" lower than the elevations recorded at the floor slab at the center corridor that is directly over or adjacent to pile caps. Due to the configuration of the apartment units, readings directly over pile caps along the north and south exterior walls of the north wing were not recorded.

Review of GeoDesign, Inc. Report:

The November 3, 2009 report prepared by GeoDesign, Inc. provides a through description of the subsurface soil conditions encountered at this site. The report indicates that for the first floor slab has undergone differential settlement over the years and will continue to do so in the future due to the decomposition of underlying organic matter in the subsurface soils. In order to prevent future settlements from causing downward displacements (differential settlements) of the first floor slab from occurring, it is necessary to remove the existing slab and provide a new slab that would be supported by small diameter steel pin piles. The report indicates that the floor slab should be supported by 3" diameter pin piles. Each pin pile would have a capacity of 12,000 pounds if driven to refusal, which is defined as 1" of penetration over a period of time depending on the size of hammer used to install the piles. The report indicates that the piles would have between 45' and 65' penetration into the ground below the slab.

Opinions and Recommendations:

Based on the observations made during the site visits, the results of the vertical control survey, and our review of the GeoDesign, Inc. geotechnical report, it is necessary for us to recommend that the first floor slab throughout both wings of the building be removed and a new floor slab supported by steel pin piles be installed. Although differential floor settlements are not as severe in the south wing of the building, future settlements could occur that will ultimately be severe. The floor in the entry lobby should remain in place as long as possible during the course of the work to allow access to the elevator and one (1) stair tower for exiting of the occupants that reside on the second, third and fourth floors, unless it is deemed more appropriate to vacate the building during the course of the work.

At all slab areas that it is decided to remove the slab, the existing slab should be removed and replaced with a new slab supported on 3" diameter pin piles having the required spacing to support the code required loads as recommended by GeoDesign, Inc. This will require that the first floor be vacated, temporary access be provided to the upper floors of the building while the work is being performed, or the building vacated, and the first floor areas reconstructed with the new pin pile supported slab including having the interiors built back to their original configuration. The interior walls, which are non-bearing walls, can be temporarily supported off the second floor while the concrete floor slab is removed and replaced.

Based on a preliminary design, we project that the new first floor slab would be 6" thick and would contain two mats of reinforcing steel. The mats of reinforcing steel would be placed near the top and bottom of the slab. The slab would be placed on grade but would span between the 3" diameter pin piles that would be spaced at approximately 8' on center in each direction.

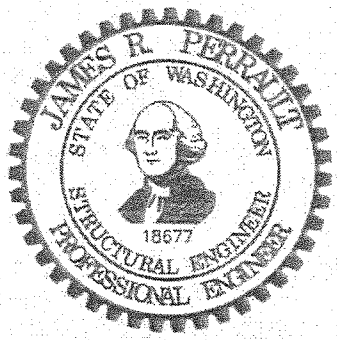
It is necessary that the new first floor slab be supported on new pin piles rather than be supported on the existing pile caps and timber piles. We have performed a preliminary structural analysis of the existing piles to determine if the piles have the capacity to support a structural slab at the first floor level that would span between the existing grade beams and/or pile caps. The existing timber piles are loaded to near their maximum capacity so providing a new structural slab at the first floor spanning between the existing pile caps would overload the existing piles. Also, the existing grade beams do not have adequate additional capacity to support a new structural slab at the first floor level. Therefore, the first floor slab must be entirely supported on new 3" diameter steel pin piles.

Please call if you have any questions or require additional information.

Very truly yours,

JRP Engineering, Inc.

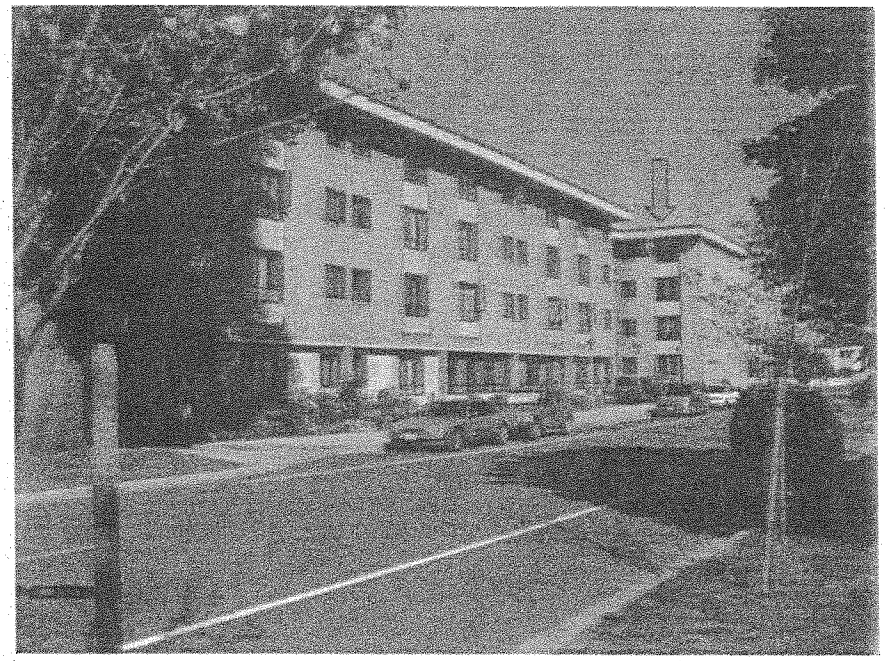
James R. Perrault, P.E., S.E.
President



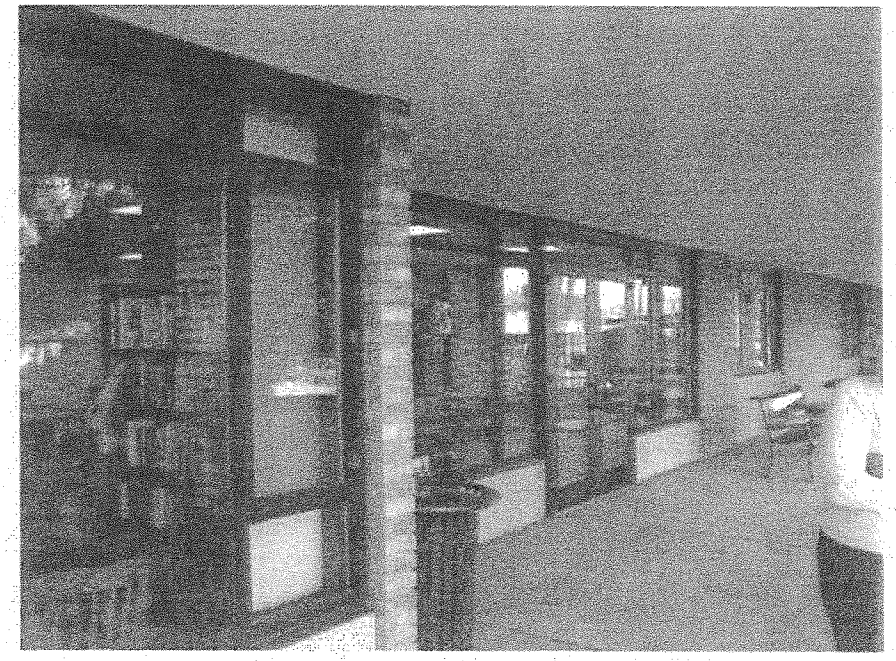
DISCLAIMER: The information observations, opinions and recommendations in this report are the exclusive use of King County Housing Authority. JRP Engineering, Inc. assumes no liability or responsibility in the event that any other party uses this report. The opinions and recommendations presented in the report are based on limited visual observations at the site. No destructive testing or monitoring was performed. The design or detailing of any recommended repairs to repair the structure exceeds the scope of this report and the services authorized.

APPENDIX A

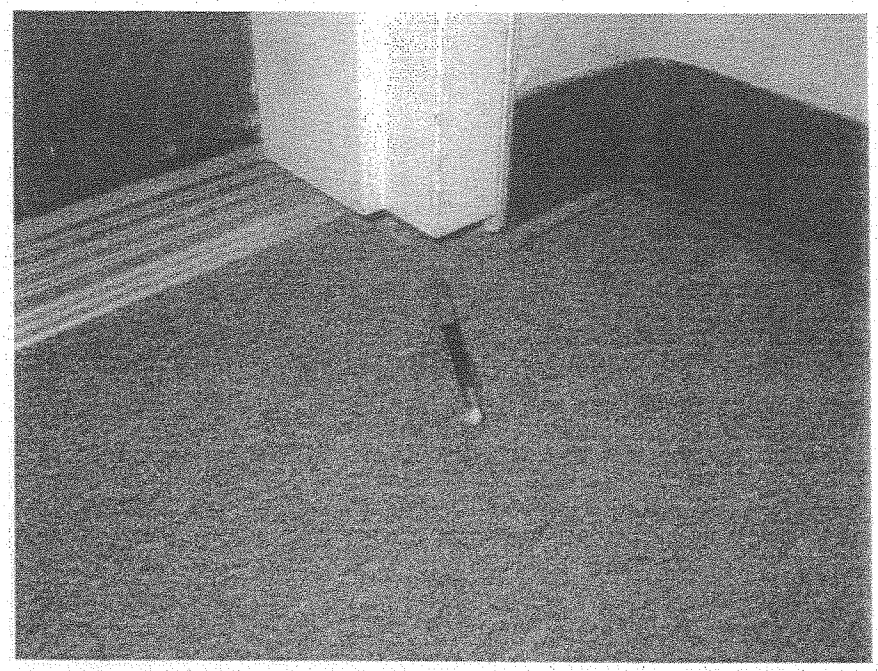
PHOTOGRAPHS



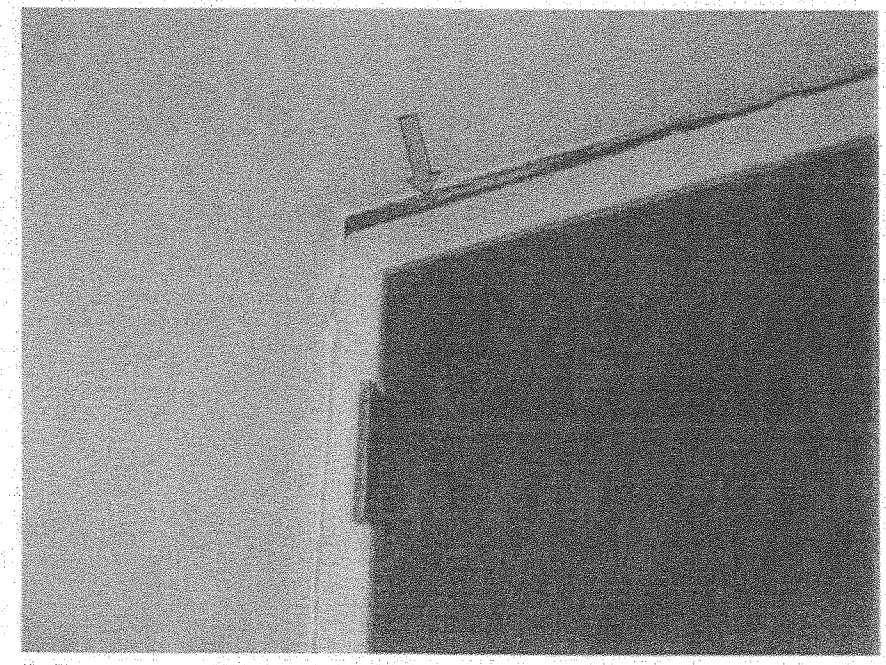
1. This is a photograph of the Wayland Arms Apartments as viewed from across South Division Street. The south wing appears in the foreground. The north wing is identified by the arrow.



2. This photograph was taken along the west side of the building from the patio area outside the community lounge.

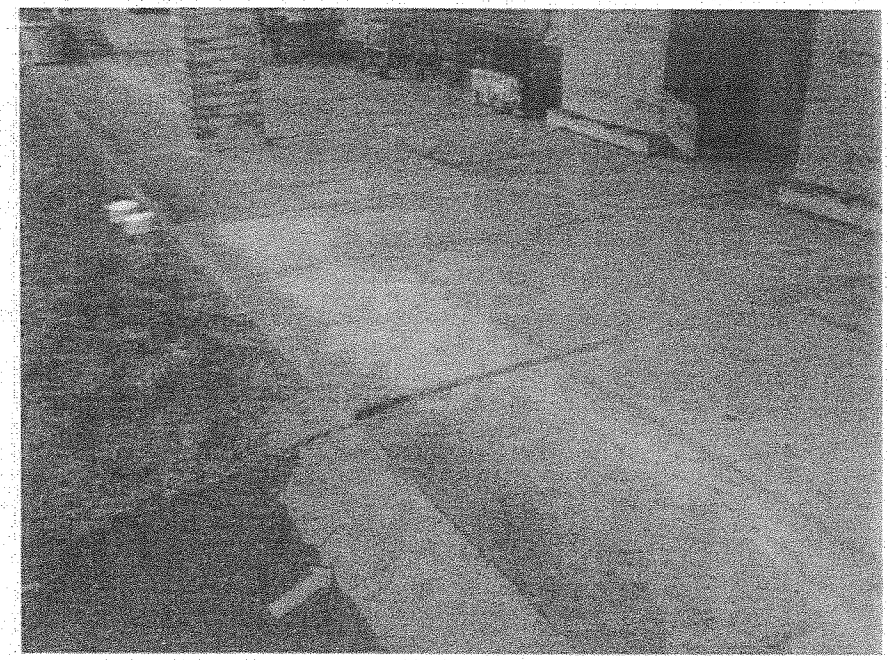


5. The pencil in this photograph points to a separation between the base of the door jamb where an approximately ¾" high gap has developed. The floor slab has subsided away from the door jamb at this location.



6. This photograph was taken at one of the doors to an apartment unit in the north wing at the first floor. The arrow points to downward displacement of the door frame with respect to the ceiling.

7. This photograph was taken looking west along the corridor at the first floor in the north wing. The arrows point to where the wall base follows the slope of the floor likely when new carpet was added to the corridor floor in past years.

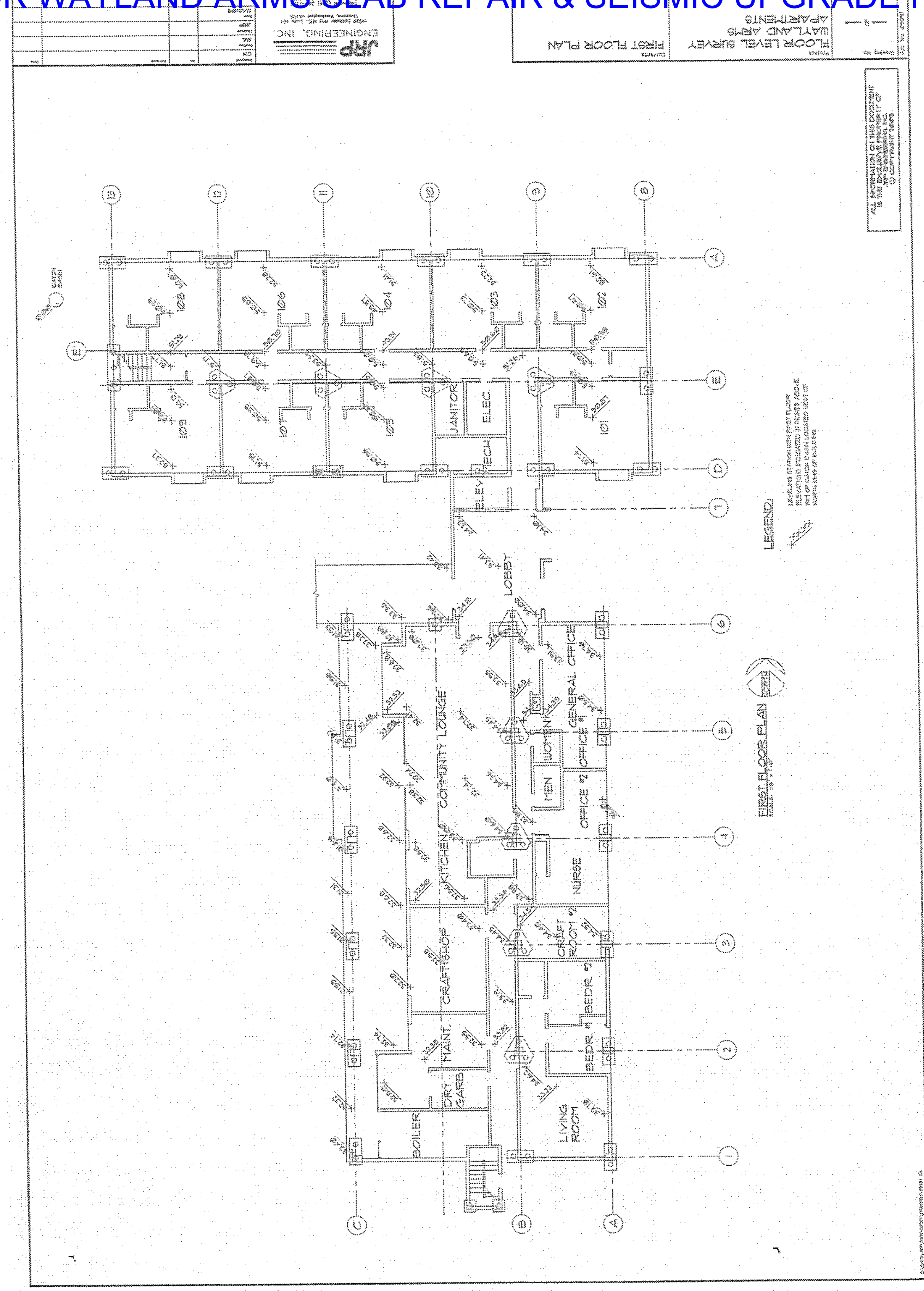


8. This photograph was taken along the west side of the south wing looking at the patio. The arrow points to where concrete was placed over asphalt to provide a better transition between the patio and asphalt driveway.

APPENDIX B

SURVEY RESULTS

FOR WAYLAND ARMS SLAB REPAIR & SEISMIC UPGRADE RFQ



GeoDesign Inc

November 3, 2009

King County Housing Authority
Capital Construction Department
625 Andover Park West, Suite 107
Tukwila, WA 98188

Attention: Mr. Steve Jefferis

Report of Geotechnical Engineering Services
Wayland Arms Apartments
307 South Division Street
Auburn, Washington
GeoDesign Project: KCHA-13-01

GeoDesign, Inc. is pleased to submit this report summarizing our geotechnical engineering services to address differential settlement of buildings, utilities, and hardscape areas at the Wayland Arms Apartment complex at 302 South Division Street in Auburn, Washington. This report has been prepared in accordance with our proposal dated August 19, 2009.

We appreciate the opportunity to be of continued service to you. Please call if you have questions regarding this report.

Sincerely,

GeoDesign, Inc.

Kevin J. Lamb, P.E.
Senior Associate Engineer

George Saunders, P.E.
Principal Engineer

KJL:GPS:sms
Attachments
Two copies submitted
Document ID: KCHA-13-01-110309-geor

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1.0 INTRODUCTION

GeoDesign, Inc. is pleased to submit this report summarizing our geotechnical engineering services for the proposed improvement project at King County Housing Authority's Wayland Arms Apartments in Auburn, Washington. The apartment building is located at 307 South Division Street in Auburn, Washington (Figure 1). For your reference, definitions of all acronyms used are attached at the end of this document.

The Wayland Arms Apartment complex is a four-story, L-shaped, masonry apartment building located at the southwest corner of S Division Street and 3rd Avenue SE in Auburn, Washington. The building was constructed in 1967 and is approximately 45,500 square feet in size. Original plans for the apartment building indicate that the building is supported on 40-ton, creosote-treated timber piles tipped at an elevation of 40 feet above MSL and that the floor slabs are supported on grade with a finish floor elevation of 85.25 feet. Based on this information, the existing piles are anticipated to be a minimum of 45 feet in length.

We understand that differential settlement of floor slabs within the facility has been observed and that the proposed improvements include replacing the on-grade floor slabs with pile-supported floor slabs. Other improvements include a new entrance canopy on the east side of the building.

We have reviewed logs of nearby borings that were completed for the "C" Street overcrossing. The "C" Street overcrossing was constructed a few years ago and is supported on driven pile foundations. The logs indicate the area is underlain by fine-grain alluvium composed of loose sand and soft silt deposits that extend 40 to 50 feet BGS. The fine-grain alluvium is underlain by coarse-grain alluvium composed of dense sand gravel deposits.

2.0 PURPOSE AND SCOPE

The purpose of this study was to provide geotechnical recommendations for use in design and construction of additional foundation support in areas where excessive differential settlement have occurred and the location of the proposed addition, to identify and evaluate the cause of the settlement, and to provide recommendations to stabilize the area. Additionally our scope was expanded to provide geotechnical recommendations for supporting a one-story canopy at the front entry area on the east side of the building. Specifically, we completed the following scope of services:

- Reviewed the readily available geotechnical and geologic information in the site area from our in-house files.
- Completed a field investigation, including locating utilities and advancing four borings to depths ranging from 46.5 to 51.5 feet BGS.
- Prepared this report that documents our geotechnical findings, conclusions, and recommendations.

3.0 SITE CONDITIONS

Surficial conditions were determined from observations during two visits to the site. Subsurface conditions were evaluated by completing four borings and reviewing available geotechnical and geologic information.

3.1 SURFACE CONDITIONS

The Wayland Arms Apartments property is approximately rectangular in shape with dimensions of about 350 feet by 150 feet (approximately 3,800 square feet or 0.88 acre). The building is bound on the north by a roadway ramp that extends 3rd Street SW over "A" Street SW, on the east by S Division Street, on the south by 4th Street SW, and on the west by neighboring properties. The area is relatively level. Landscaped areas are located adjacent to the south and west perimeter of the building. A parking area is located at the southern portion of the property. A stormwater detention pond is located adjacent to the northwest corner of the property.

3.2 SUBSURFACE CONDITIONS

The project is located in the Green River Valley, and the surficial geology of the site area is mapped as quaternary or recent alluvium (Schuster, 2005; Mullineaux, 1965). The alluvium in this part of the valley typically consists of unconsolidated or semi-consolidated alluvial clay, silt, sand, gravel, and/or cobble deposits.

We explored subsurface conditions within the project area by drilling four borings (B-1 through B-4) to depths ranging from 46.5 to 51.5 feet BGS. The borings were completed on the east, west, north, and south sides of the building. The approximate locations of the borings are shown on Figure 2. Boring B-1 was completed near the proposed canopy location at the front entrance of the building. Summary logs of the subsurface conditions encountered in the explorations are included in the Appendix.

Beneath the surficial fill, the subsurface conditions were generally consistent with the mapped surficial geology and geology encountered in other borings completed nearby. Fine-grain alluvium composed of interbedded sand, silty sand, sandy silt, and silt with organics was encountered extending to depths of 39.0 to 46.0 feet BGS. Coarse-grain alluvium composed of sand and gravel was encountered below the fine-grain alluvium. All of the borings were terminated within the coarse-grain alluvium.

The density of the fine-grain alluvium was typically loose or soft from the ground surface to a depth of 35.0 feet BGS at boring B-1 and a depth of 20.0 feet BGS at borings B-2, B-3, and B-4. Below these depths, the fine-grain alluvium graded to medium dense or stiff depending on composition. Within the fine-grain alluvium, organic materials consisting of wood debris and/or decomposed wood were encountered at depths of about 15.0 feet BGS in borings B-1 and B-3 and 35.0 feet BGS in boring B-2.

The fine-grain alluvium was underlain by coarse-grain alluvium varying in composition from sandy gravel to silty gravel. The coarse-grain alluvium is composed of fine to coarse sand or gravel with cobbles and a variable amount of silt. The coarse-grain alluvium generally was

encountered from 39.0 to 51.5 feet BGS in all borings. The gravel was typically dense to very dense, except in boring B-1, where the boring was terminated at 51.5 feet BGS in medium dense gravel.

3.3 GROUNDWATER

Groundwater was not observed during drilling due to mud rotary drilling techniques. However, based on nearby borings completed for the 3rd Street overpass, we anticipate that groundwater may be encountered at a depth as shallow at 6.0 feet BGS.

3.4 SEISMICITY

Washington State is situated at a convergent continental margin and is susceptible to subduction zone, intraplate, and shallow crustal source earthquakes. We reviewed published geologic maps for the site vicinity (Johnson, et al., 1996; Sherrod, et al., 2004) to evaluate seismic hazards. The site is located near the northern splay of the Tacoma Fault Zone and about 15 miles south of the Seattle Fault Zone, which is a result of shallow crustal faulting.

The Tacoma Fault Zone consists of several geophysical lineaments or splays that extend at least 50 km from Hood Canal through the city of Tacoma and areas to the north and northeast (Sherrod et al., 2004). Geologic evidence indicates that a large earthquake (M~7) occurred on the Tacoma Fault about 1,100 years ago, evidenced by changes in elevation coastal marshes surrounding the fault (USGS, 2009).

The Seattle Fault Zone to the north of the site represents a 2- to 4-mile-wide zone extending from the Kitsap Peninsula near Bremerton to the Sammamish Plateau. Within the zone are several east-west trending fault splays of the Seattle Fault (Johnson, et al. 1999). The Seattle Fault is considered an active major fault and is capable of producing earthquakes of Magnitude ~7 with associated surface rupture and ground motions, posing a significant hazard to the Puget Sound Region (Sherrod, et al., 2004). Geologic evidence indicates at least three episodes of movement on the fault within the last 10,000 years, with the most recent earthquake with surface rupture approximately 1,100 years ago (Nelson, et al. 2000).

Based on our subsurface exploration, literature review, and experience, a summary of the seismic hazards in the area and their associated impact at the site are as follows:

- Amplification - Areas subject to amplification are typically soft or loose soils overlying stiff soil or bedrock. Based on our explorations and available geologic maps, the fine-grain alluvium has a potential for amplifying ground motions.
- Liquefaction/Settlement - Groundwater is expected within a depth of 6.0 feet BGS based on explorations completed adjacent to the site. Soils within a depth of 40 feet BGS generally consisted of interbedded lenses to layers of loose to medium dense sand or silty sand and soft to firm sandy silt. In our opinion there is a relatively low potential for liquefaction to occur within the granular layers of the alluvium.

- Lateral Spreading – Areas subject to lateral spreading are typically gently sloping or flat sites underlain by liquefiable sediments adjacent to an open face (such as riverbanks or bay fronts). Liquefied soils adjacent to open faces may "flow" in that direction, resulting in lateral displacement and surface cracking. It is our opinion that the potential for lateral spreading is low.
- Fault surface rupture – The site is near the Tacoma Fault Zone for which the recurrence interval of activity appears to be on the order of thousands of years, with the most recent movement approximately 1,100 years ago. The potential for surface rupture at the site over the life of the structure is low.

4.0 PROJECT CONCLUSIONS AND RECOMMENDATIONS

Based on the conditions encountered in the borings and a review of the existing information, we believe that the differential settlement observed in the Wayland Arms Apartments building is due to consolidation and settlement of the loose and soft, fine-grain alluvium underlying the site and the decomposition of organic debris where it is present within the soil.

Construction-induced vibrations during construction of the 3rd Street ramp may also have caused the densification of loose, fine-grained alluvium at the north end of the building and resulted in additional settlement and consolidation of the very soft to soft silty soils.

Consolidation of the silt and decomposition of the organic matter within the fine-grain alluvium will continue to result in differential settlement of the building elements supported on grade. The magnitude of the future settlement is difficult to estimate because of the variable organic decomposition rate. Future differential settlement can be mitigated by supporting the building floor slab and other proposed improvements on pin piles. Pin piles driven to refusal in the coarse-grain alluvium will provide adequate support for the floor slab and the proposed canopy at the east entry.

Pin piles are small-diameter, steel pipe sections that are driven into the ground using a pneumatic or hydraulic impact hammer. We recommend installing 3-inch-diameter pin piles to support the floor slab and the new canopy foundation loads.

This size of pin pile is typically driven with a hydraulic hammer with a weight ranging from 650 to 1,100 pounds. We estimate an allowable capacity of 12 kips (6 tons) for 3-inch-diameter pin piles driven to refusal.

Refusal criteria to achieve the recommended allowable capacity are defined as 1 inch of penetration over a 12-second period for a 650-pound hammer, a 10-second period for an 850-pound hammer, and a 6-second period for a 1,100-pound hammer. We anticipate the piles will be driven and embedded into the underlying coarse-grain alluvium and anticipate pile lengths varying from 45 to 65 feet will be required to meet the refusal criteria. Based on the design criteria, the structural engineer can determine the number of piles required and provide a connection detail between the pile and existing foundations.

5.0 OBSERVATION OF CONSTRUCTION

Sufficient observation of the contractor's activities is a key part of determining that the work is completed in accordance with the construction drawings and specifications. Consequently, we recommend that GeoDesign be retained to observe all geotechnical construction, including the installation of the pin piles.

Installation of the piles should be observed by the geotechnical engineer of record to verify that the conditions are as expected. Subsurface conditions observed during construction should be compared with those assumed in our analysis. Recognition of changed conditions often requires experience; therefore, qualified personnel should visit the site with sufficient frequency to detect whether subsurface conditions change significantly from those anticipated.

6.0 LIMITATIONS

We have prepared this report for use by King County Housing Authority and members of the design and construction teams for the proposed project. The data and report can be used for bidding or estimating purposes, but our report, conclusions, and interpretations should not be construed as warranty of the subsurface conditions and are not applicable to other sites.

Exploration observations indicate soil conditions only at a specific location and only to the depth penetrated. They do not necessarily reflect soil strata or water level variations that may exist between exploration locations. If subsurface conditions differing from those described are noted during the course of excavation and construction, re-evaluation will be necessary.

The scope of our services does not include services related to construction safety precautions, and our recommendations are not intended to direct the contractor's methods, techniques, sequences, or procedures, except as specifically described in our report for consideration in design.

Within the limitations of scope, schedule, and budget, our services have been executed in accordance with generally accepted practices in this area at the time the report was prepared. No warranty, expressed or implied, should be understood.

♦ ♦ ♦

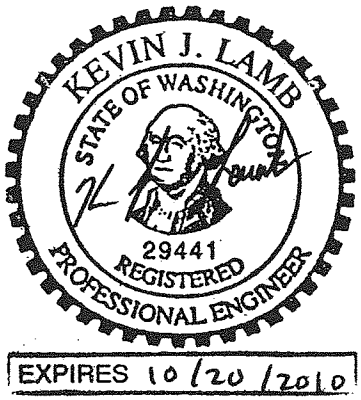
We appreciate the opportunity to be of continued service to you. Please call if you have questions concerning this report or if we can provide additional services.

Sincerely,

GeoDesign, Inc.

Kevin J. Lamb, P.E.
Senior Associate Engineer

George Saunders, P.E.
Principal Engineer



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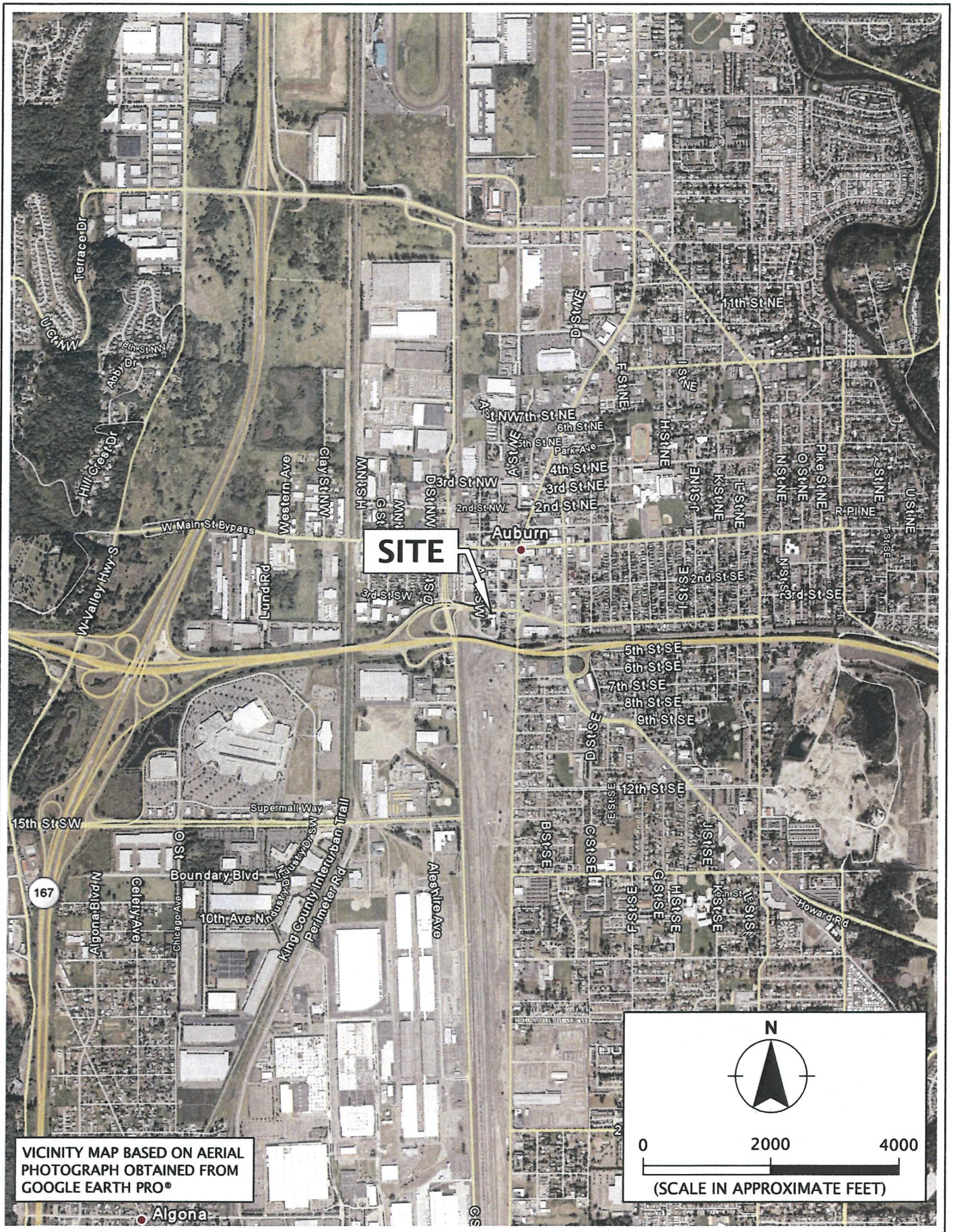

GEODESIGN INC 10700 Meridian Avenue North - Suite 210 Seattle, WA 98133 Off 206.838.9900 Fax 206.838.9901	KCHA-13-01	**VICINITY MAP**
	NOVEMBER 2009	WAYLAND ARMS APARTMENTS AUBURN, WA — **FIGURE 1**

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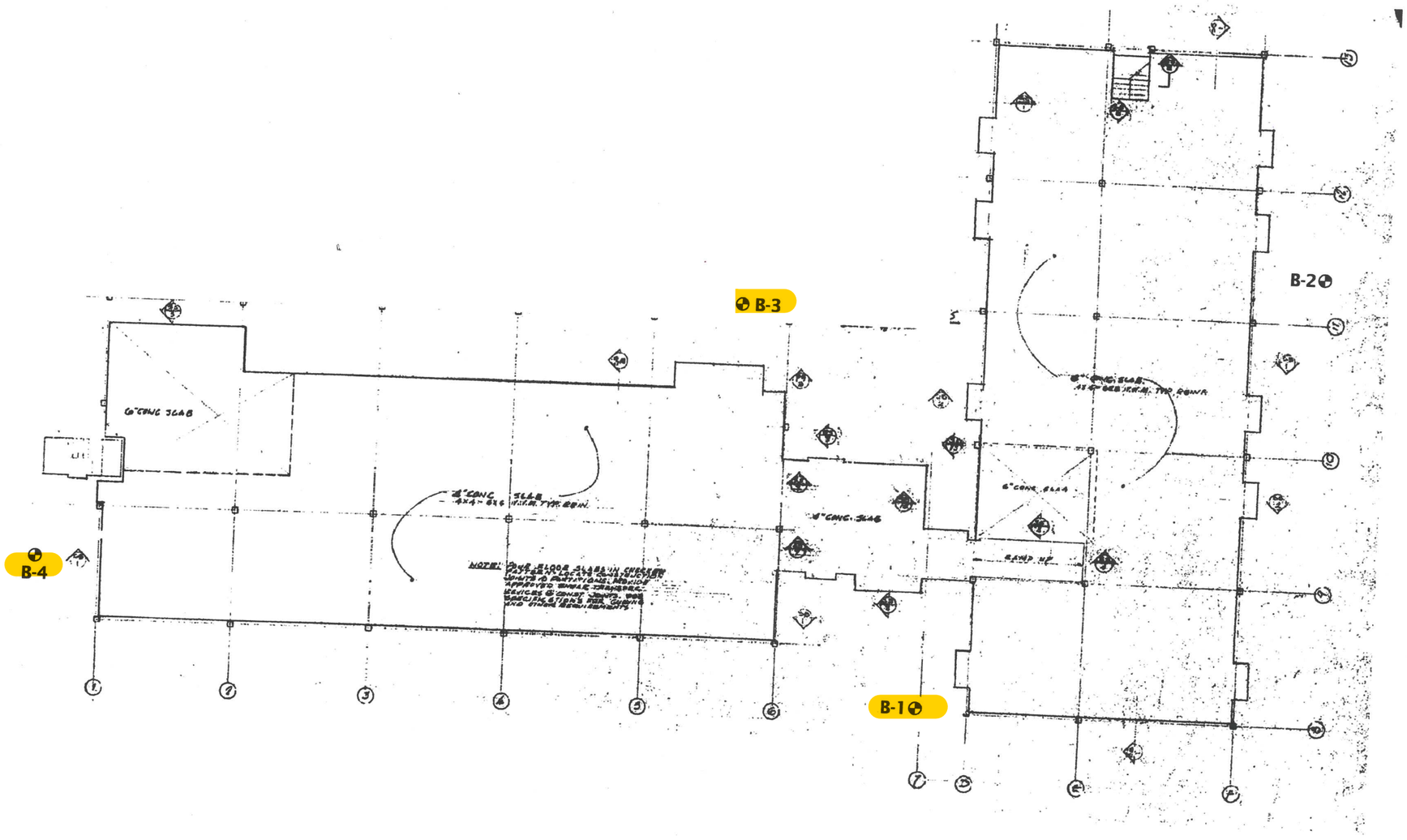

LEGEND:

B-1 ⊕ BORING

(NOT TO SCALE)

SITE PLAN BASED ON CARSON-ELEY-GREVSTAD A.I.A. ARCHITECTS MISCELLANEOUS FOUNDATION AND FRAMING DETAILS, MAY 25, 1966, PROVIDED BY KING COUNTY HOUSING AUTHORITIES ON OCTOBER 8, 2009

SITE PLAN

WAYLAND ARMS APARTMENTS
AUBURN, WA

FIGURE 2

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APPENDIX

FIELD EXPLORATIONS

GENERAL

We explored subsurface conditions at the site by completing four borings (B-1 through B-4) to depths ranging from 46.5 to 51.5 feet BGS. The borings were drilled on October 15 and 16, 2009 by Boart Longyear of Fife, Washington using a truck-mounted drill rig. Mud rotary method was used to drill the borings. The approximate locations of the explorations are shown on Figure 2. Logs of the explorations are included in this appendix.

SOIL SAMPLING

A member of our geotechnical staff observed the exploration. SPTs were performed in general conformance with ASTM D 1586. At isolated locations, a Dames and Moore large diameter, spilt spoon sampler (U-Type) was used to collect samples. Both the SPT and U-Type sampler were driven with a 140-pound hammer free-falling 30 inches. The number of blows required to drive the sampler 1 foot, or as otherwise indicated, into the soils is shown adjacent to the sample symbols on the exploration logs. Disturbed soil samples were obtained from the samplers for classification and laboratory testing.

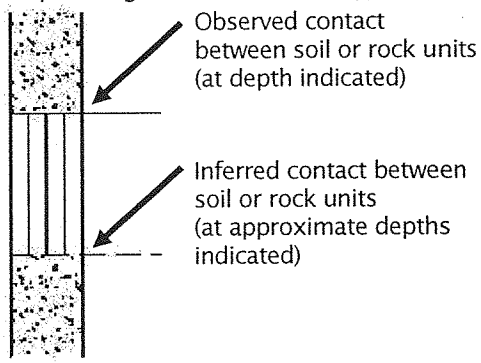
Soil classifications, sampler and hammer types, and sampling intervals are presented on the exploration logs included in this appendix.

SOIL CLASSIFICATION

The soil samples were classified in accordance with the "Exploration Key" (Table A-1) and "Soil Classification System" (Table A-2), copies of which are included in this appendix. The exploration logs indicate the depths at which the soils or their characteristics change, although the change actually could be gradual. Classifications and sampling intervals are presented on the exploration logs included in this appendix.

SYMBOL	SAMPLING DESCRIPTION
	Location of sample obtained in general accordance with ASTM D 1586 Standard Penetration Test with recovery
	Location of sample obtained using thin-wall Shelby tube or Geoprobe® sampler in general accordance with ASTM D 1587 with recovery
	Location of sample obtained using Dames & Moore sampler and 300-pound hammer or pushed with recovery
	Location of sample obtained using Dames & Moore or 3-inch-O.D. split-spoon sampler and 140-pound hammer or pushed with recovery
	Location of grab sample
	Rock coring interval
	Water level during drilling
	Water level taken on date shown

Graphic Log of Soil and Rock Types



GEOTECHNICAL TESTING EXPLANATIONS

ATT	Atterberg Limits	P	Pushed Sample
CBR	California Bearing Ratio	PP	Pocket Penetrometer
CON	Consolidation	P200	Percent Passing U.S. Standard No. 200 Sieve
DD	Dry Density	RES	Resilient Modulus
DS	Direct Shear	SIEV	Sieve Gradation
HYD	Hydrometer Gradation	TOR	Torvane
MC	Moisture Content	UC	Unconfined Compressive Strength
MD	Moisture-Density Relationship	VS	Vane Shear
OC	Organic Content	kPa	Kilopascal

ENVIRONMENTAL TESTING EXPLANATIONS

CA	Sample Submitted for Chemical Analysis	ND	Not Detected
P	Pushed Sample	NS	No Visible Sheen
PID	Photoionization Detector Headspace Analysis	SS	Slight Sheen
ppm	Parts per Million	MS	Moderate Sheen
		HS	Heavy Sheen

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EXPLORATION KEY

TABLE A-1

RELATIVE DENSITY - COARSE-GRAINED SOILS

Relative Density	Standard Penetration Resistance	Dames & Moore Sampler (140-pound hammer)	Dames & Moore Sampler (300-pound hammer)
Very Loose	0 – 4	0 - 11	0 - 4
Loose	4 – 10	11 - 26	4 - 10
Medium Dense	10 – 30	26 - 74	10 - 30
Dense	30 – 50	74 - 120	30 - 47
Very Dense	More than 50	More than 120	More than 47

CONSISTENCY - FINE-GRAINED SOILS

Consistency	Standard Penetration Resistance	Dames & Moore Sampler (140-pound hammer)	Dames & Moore Sampler (300-pound hammer)	Unconfined Compressive Strength (tsf)
Very Soft	Less than 2	Less than 3	Less than 2	Less than 0.25
Soft	2 - 4	3 – 6	2 - 5	0.25 - 0.50
Medium Stiff	4 - 8	6 – 12	5 - 9	0.50 - 1.0
Stiff	8 - 15	12 – 25	9 - 19	1.0 - 2.0
Very Stiff	15 - 30	25 – 65	19 – 31	2.0 - 4.0
Hard	More than 30	More than 65	More than 31	More than 4.0

PRIMARY SOIL DIVISIONS			GROUP SYMBOL	GROUP NAME
COARSE-GRAINED SOILS (more than 50% retained on No. 200 sieve)	GRAVEL (more than 50% of coarse fraction retained on No. 4 sieve)	CLEAN GRAVELS (< 5% fines)	GW or GP	GRAVEL
		GRAVEL WITH FINES (≥ 5% and ≤ 12% fines)	GW-GM or GP-GM	GRAVEL with silt
			GW-GC or GP-GC	GRAVEL with clay
		GRAVELS WITH FINES (> 12% fines)	GM	silty GRAVEL
			GC	clayey GRAVEL
			GC-GM	silty, clayey GRAVEL
	SAND (50% or more of coarse fraction passing No. 4 sieve)	CLEAN SANDS (<5% fines)	SW or SP	SAND
		SANDS WITH FINES (≥ 5% and ≤ 12% fines)	SW-SM or SP-SM	SAND with silt
			SW-SC or SP-SC	SAND with clay
		SANDS WITH FINES (> 12% fines)	SM	silty SAND
			SC	clayey SAND
			SC-SM	silty, clayey SAND
FINE-GRAINED SOILS (50% or more passing No. 200 sieve)	SILT AND CLAY	Liquid limit less than 50	ML	SILT
			CL	CLAY
			CL-ML	silty CLAY
			OL	ORGANIC SILT or ORGANIC CLAY
		Liquid limit 50 or greater	MH	SILT
			CH	CLAY
			OH	ORGANIC SILT or ORGANIC CLAY
HIGHLY ORGANIC SOILS			PT	PEAT

MOISTURE CLASSIFICATION

Term	Field Test
dry	very low moisture, dry to touch
moist	damp, without visible moisture
wet	visible free water, usually saturated

ADDITIONAL CONSTITUENTS

Secondary granular components or other materials such as organics, man-made debris, etc.

Percent	Silt and Clay In: Fine-Grained Soils	Silt and Clay In: Coarse-Grained Soils	Percent	Sand and Gravel In: Fine-Grained Soils	Sand and Gravel In: Coarse-Grained Soils
< 5	trace	trace	< 5	trace	trace
5 – 12	minor	with	5 – 15	minor	minor
> 12	some	silty/clayey	15 – 30	with	with
			> 30	sandy/gravelly	sandy/gravelly

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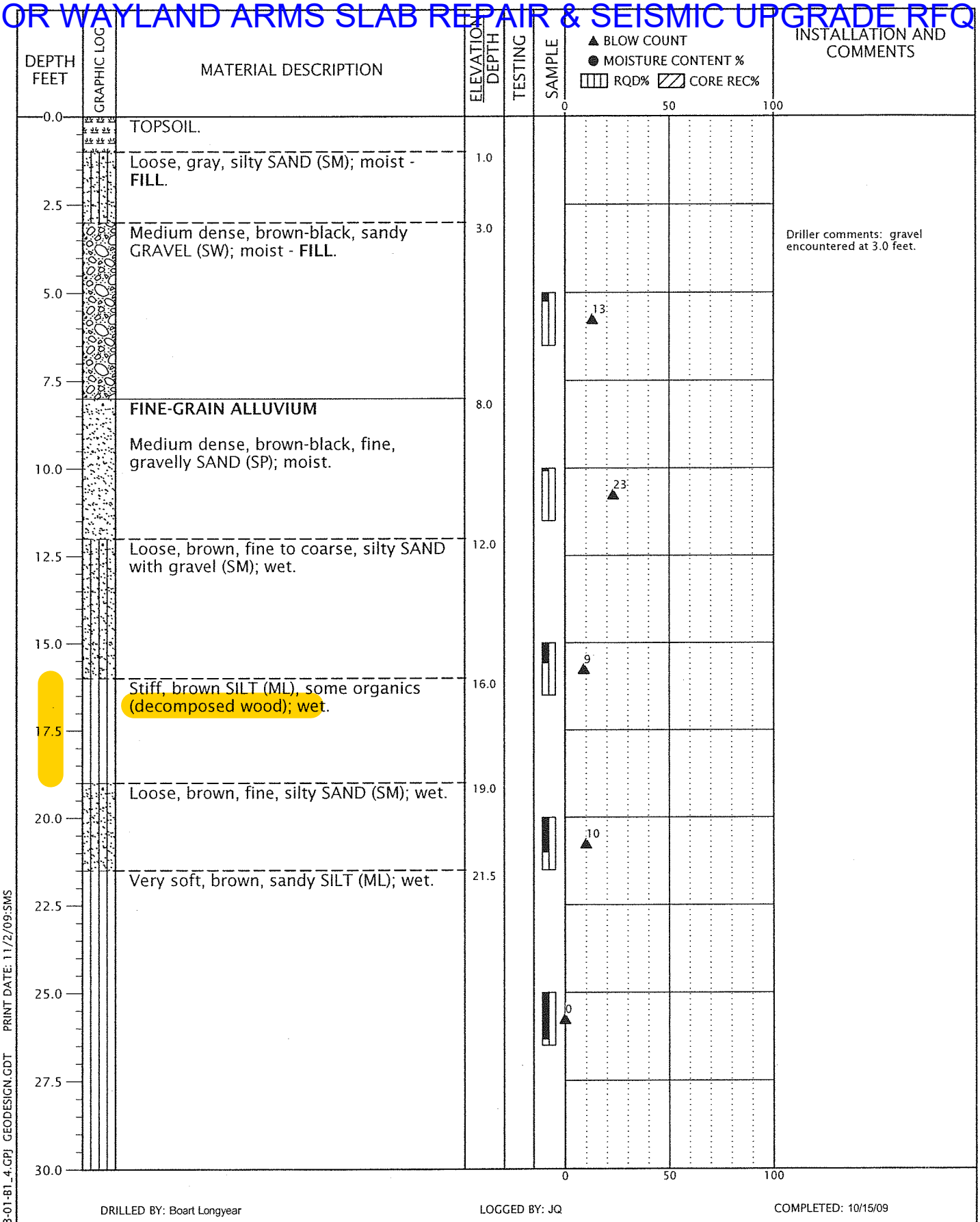
SOIL CLASSIFICATION SYSTEM

TABLE A-2



DRILLED BY: Boart Longyear | LOGGED BY: JQ | COMPLETED: 10/15/09

BORING METHOD: mud rotary (see report text) | BORING BIT DIAMETER: 4 7/8-inch

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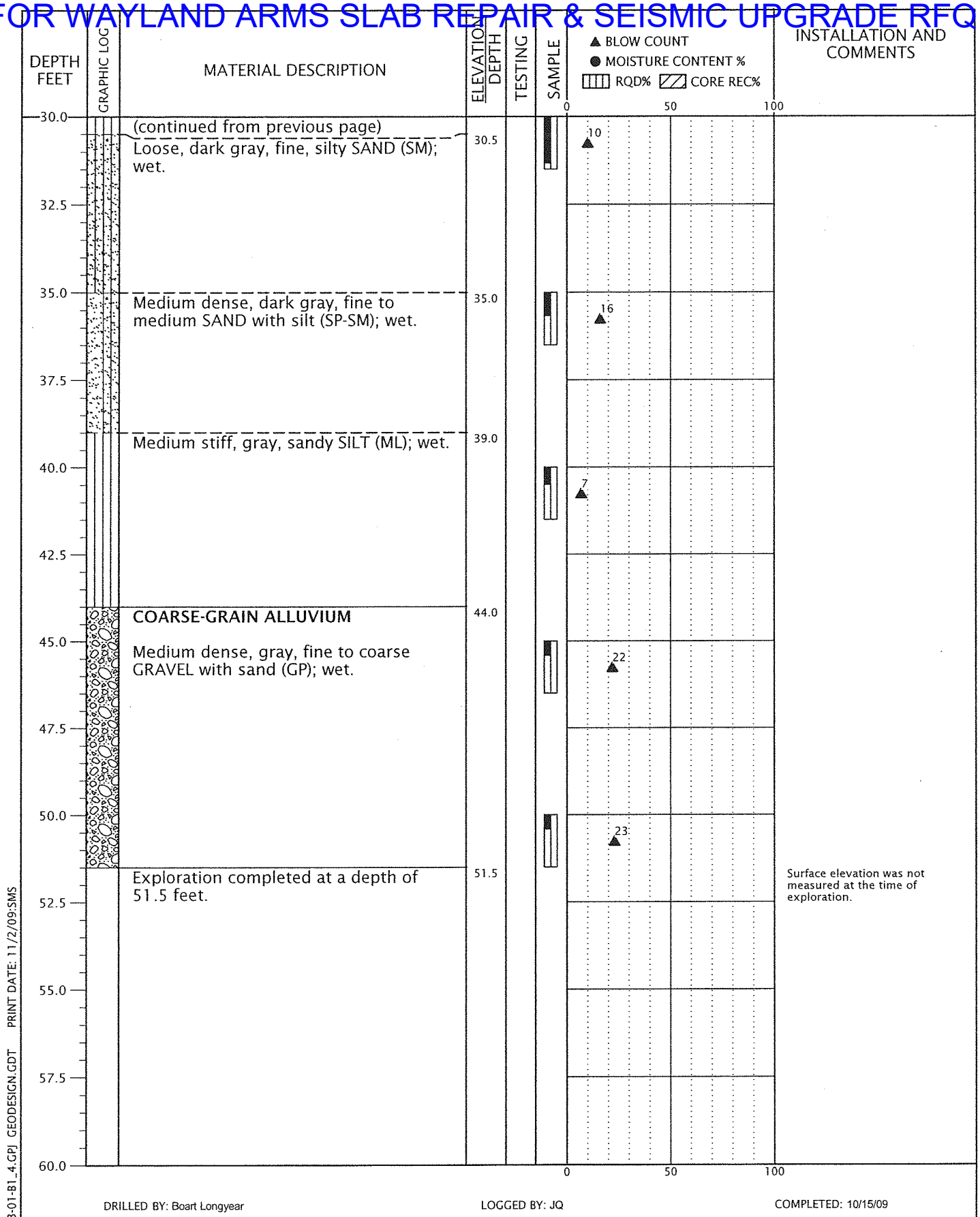
BORING B-1

WAYLAND ARMS APARTMENTS
AUBURN, WA

FIGURE A-1



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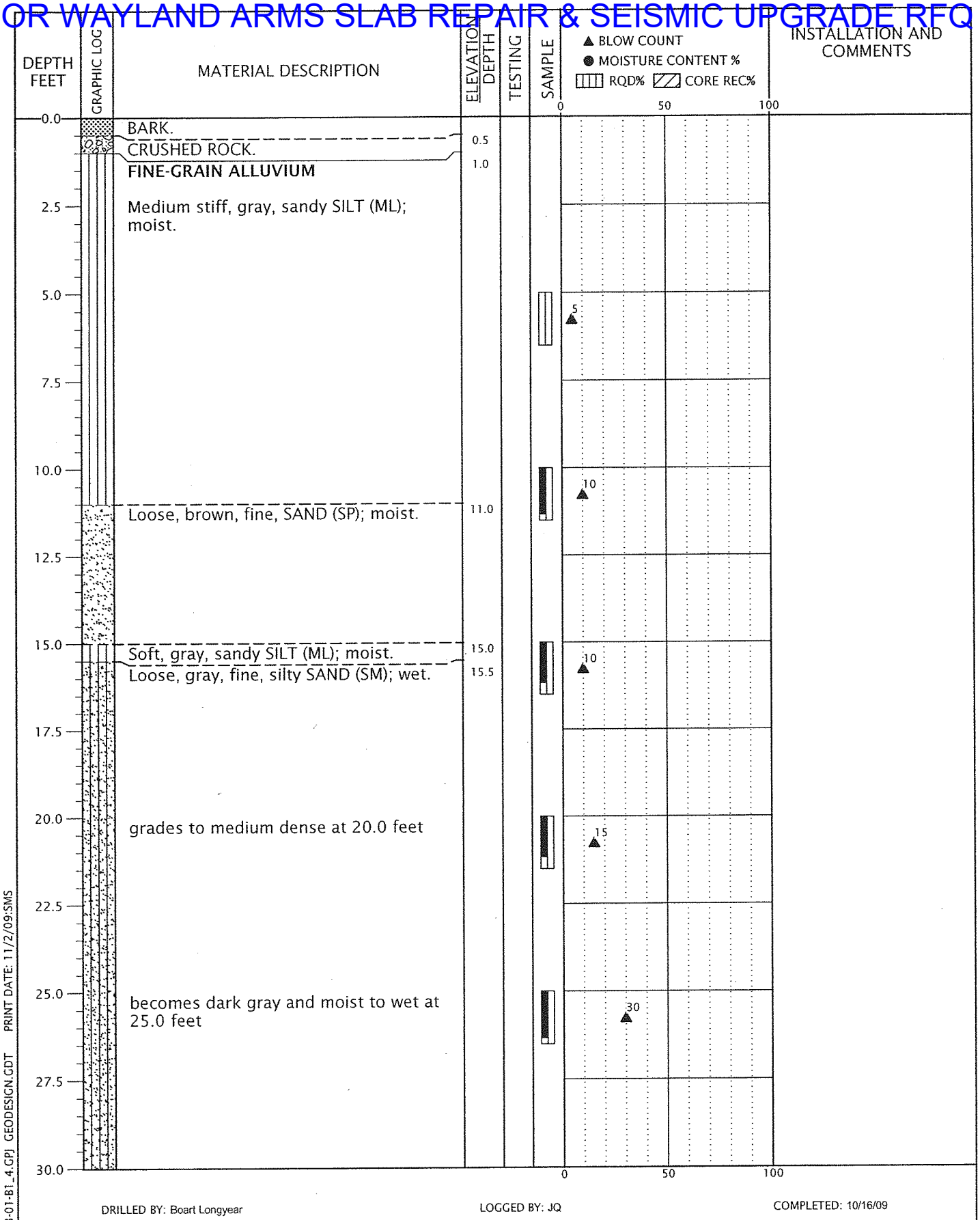
WAYLAND ARMS APARTMENTS
AUBURN, WA

FIGURE A-1



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WAYLAND ARMS APARTMENTS
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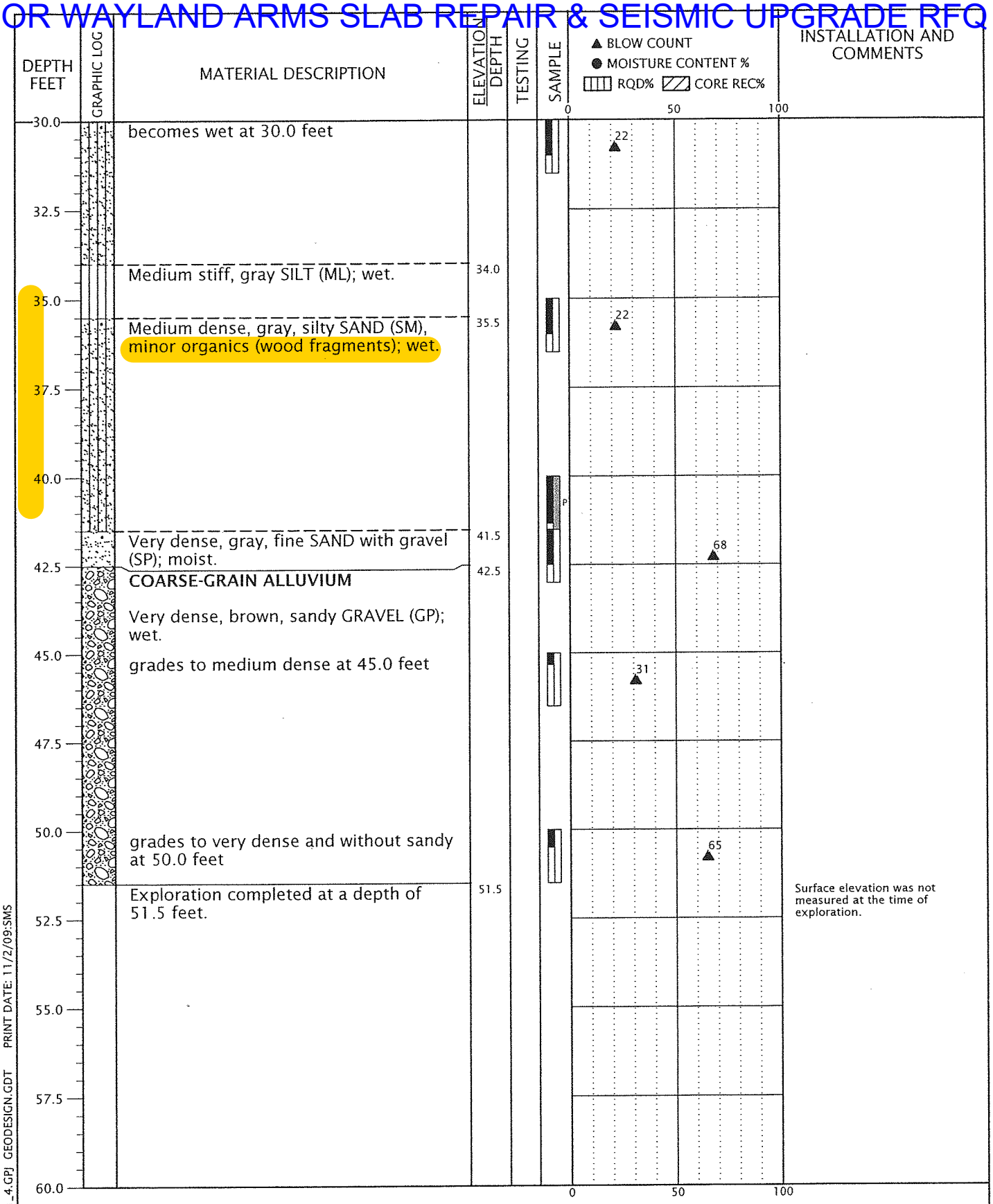
FIGURE A-2



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BORING METHOD: mud rotary (see report text) | BORING BIT DIAMETER: 4 7/8-inch

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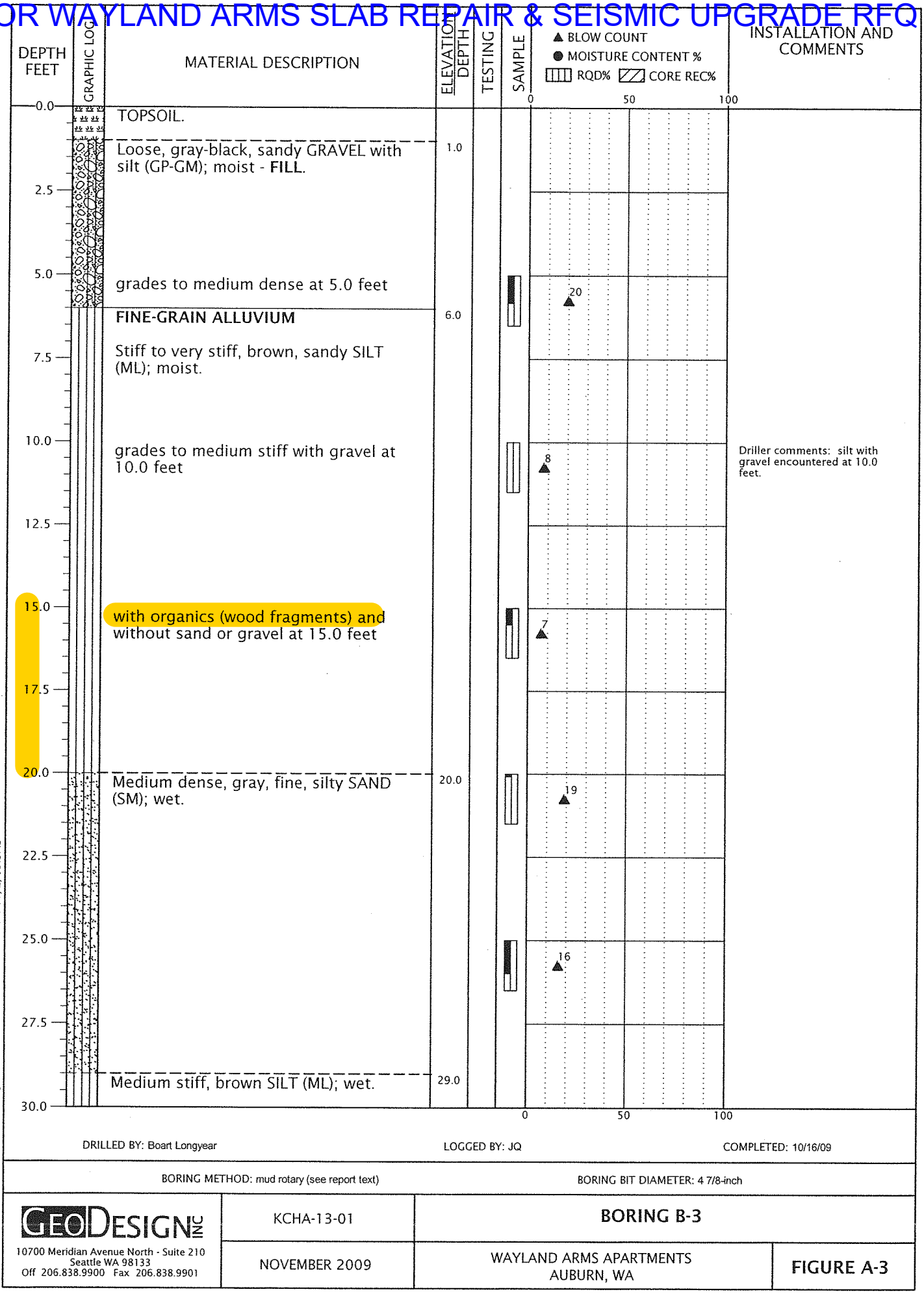
FIGURE A-2



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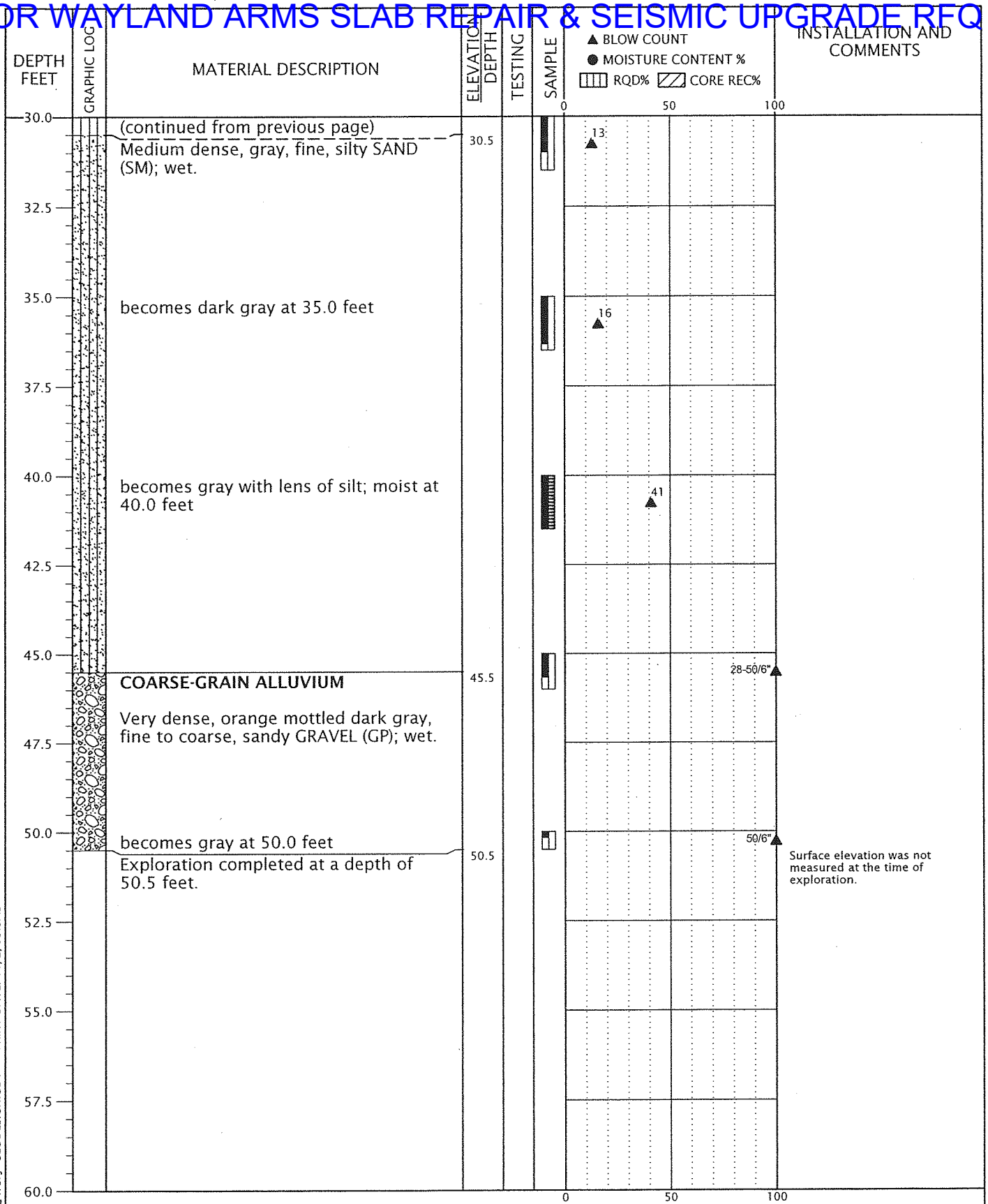
NOVEMBER 2009	WAYLAND ARMS APARTMENTS AUBURN, WA

FIGURE A-3



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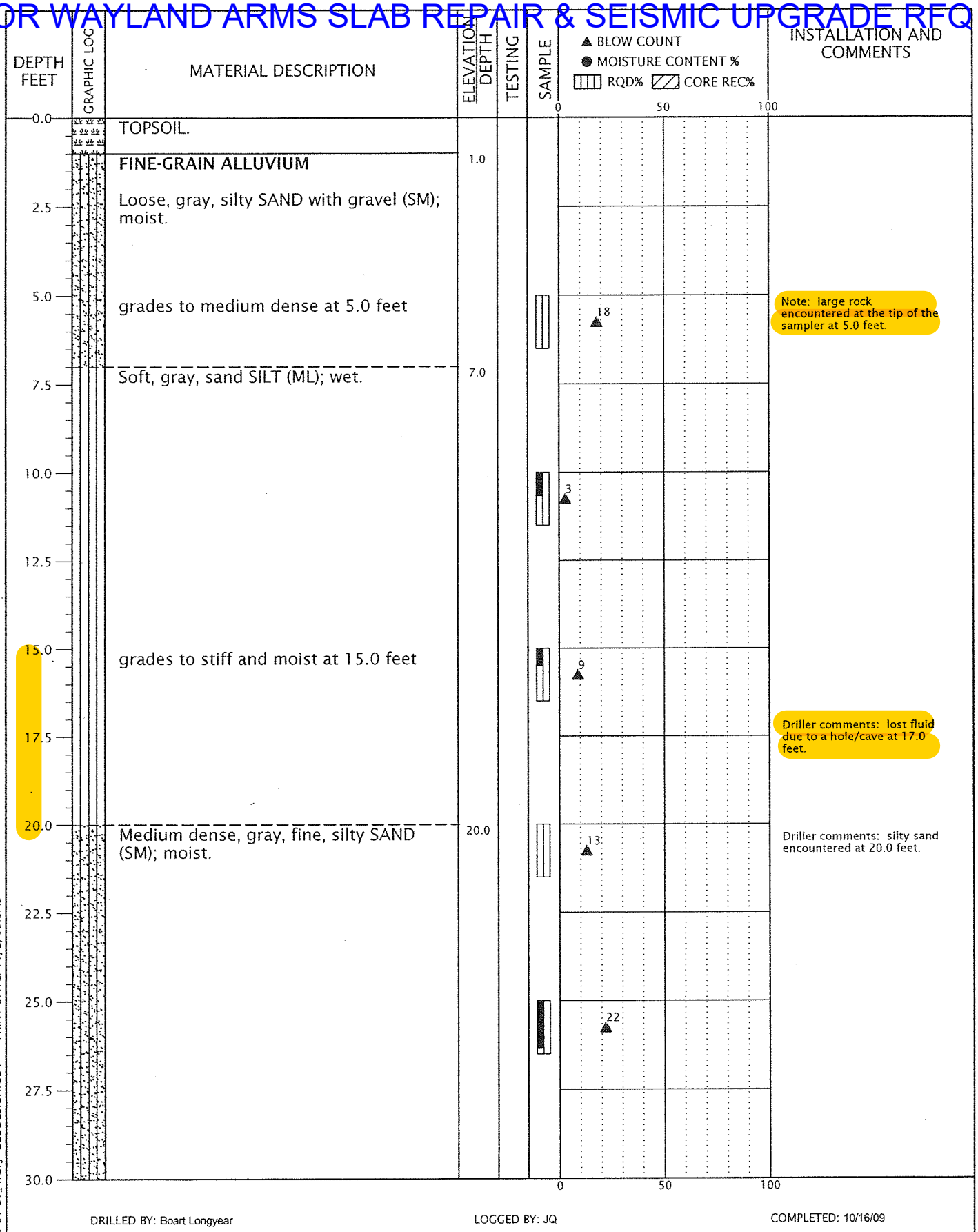
WAYLAND ARMS APARTMENTS
AUBURN, WA

FIGURE A-3



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WAYLAND ARMS APARTMENTS
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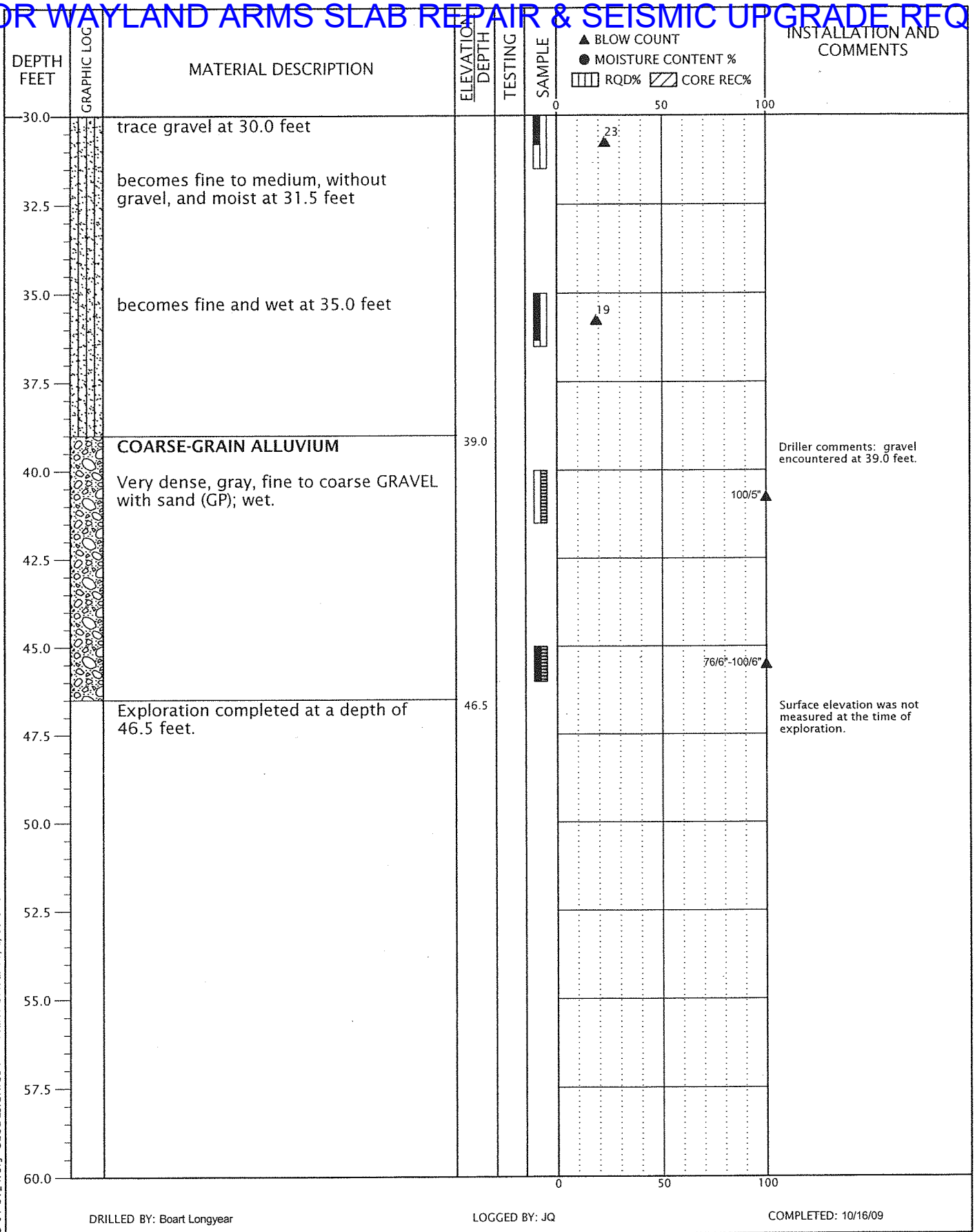
FIGURE A-4



DRILLED BY: Boart Longyear | LOGGED BY: JQ | COMPLETED: 10/16/09

BORING METHOD: mud rotary (see report text) | BORING BIT DIAMETER: 4 7/8-inch

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WAYLAND ARMS APARTMENTS
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FIGURE A-4

BORING LOG KCHA-13-01-B1_4.GPJ GEODESIGN.GDT PRINT DATE: 11/2/09:SMS

ACRONYMS

ASTM	American Society for Testing and Materials
BGS	below ground surface
KCHA	King County Housing Authority
km	kilometers
MSL	mean sea level
SPT	standard penetration test
USGS	U.S. Geological Survey