Associated Earth Sciences, Inc.

Celebrating 25 Years of Service

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CITY OF SULTAN

August 23, 2006
Project No. KE01638A

INOV8 Real Estate, Inc.
1304 Skywall Drive
Sultan, Washington 98294

Attention: Ms. Kay George

Subject: Addendum to Geotechnical Report
High Street Station
701 High Street
Sultan., Washington

Reference: Associated Earth Sciences, Inc
Geotechnical Engineering Report
November 14, 2001
Project No. KE01638A

Dear Ms. George:

It is our understanding that the subject project has been expanded to include an additional 5,165 square feet of land area. The new site area consists of a 10 foot wide strip located along the west perimeter of Parcels A and B, as indicated with slash marks on the attached site plan provide by you.

Our review indicates that the proposed 6-plex building is located outside and east of the addition areas. Thus, the 6-plex should not be affected by the soils located within the addition areas, and in our opinion, a new geotechnical report would not be necessary.

If you have any questions or require additional information, please feel free to contact our office.

Sincerely,
ASSOCIATED EARTH SCIENCES, INC.
Kirkland, Washington

G. Aaron McMichael

G. Aaron McMichael, P.E.
Associate Engineer

Attachments: Site Plan

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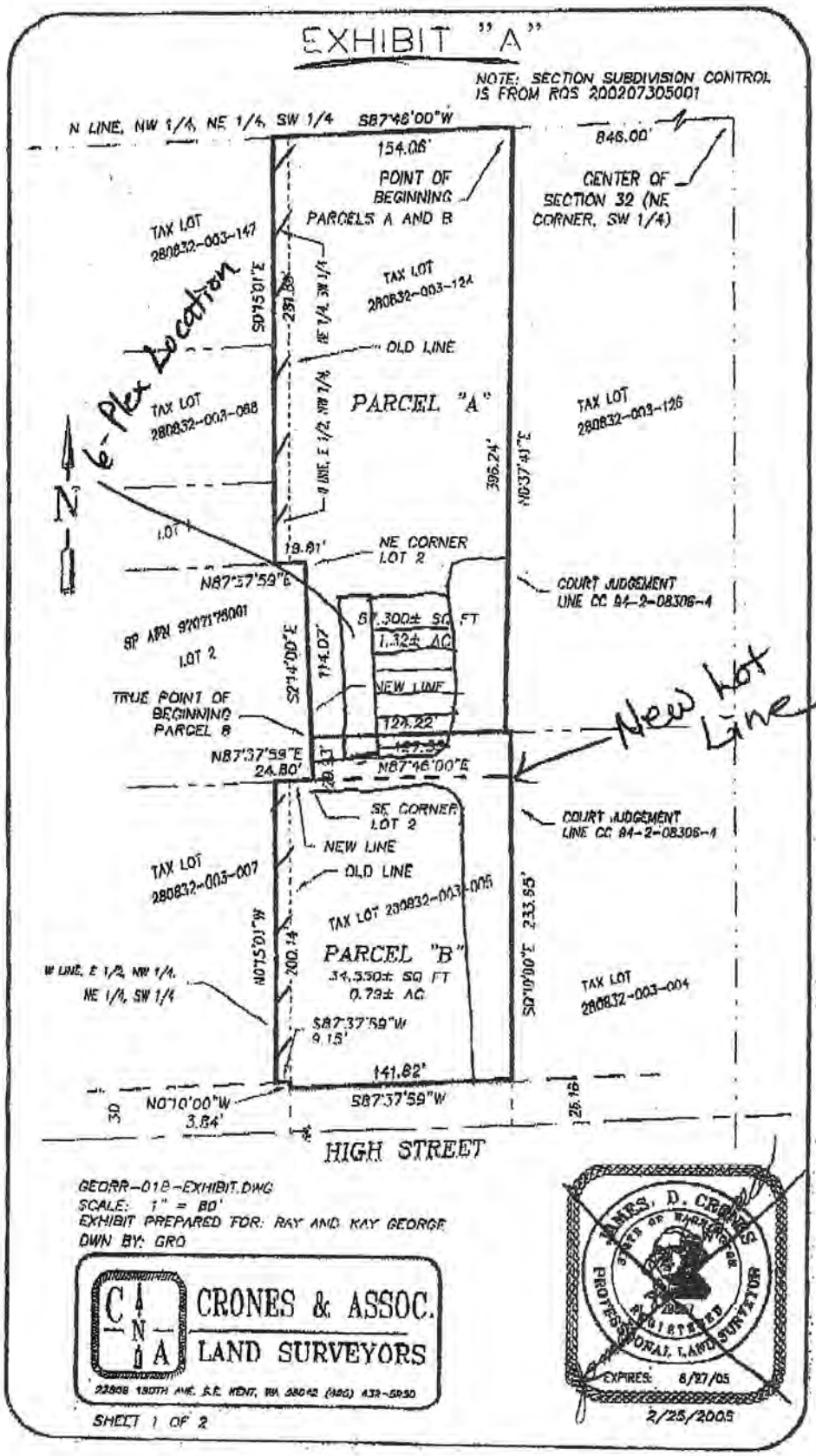
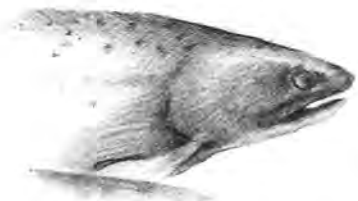


EXHIBIT "A"
NOTE: SECTION SUBDIVISION CONTROL IS FROM ROS 200207305001
N LINE, NW 1/4, NE 1/4, SW 1/4 S87°48'00"W
154.06'
846.00'
POINT OF BEGINNING
CENTER OF SECTION 32 (NE CORNER, SW 1/4)
PARCELS A AND B
TAX LOT 280832-003-147
TAX LOT 280832-003-124
S01°51'01"E 291.86'
NE 1/4, SW 1/4
OLD LINE
6-Plex Location
PARCEL "A"
TAX LOT 280832-003-068
TAX LOT 280832-003-126
N
W LINE, E 1/2, NW 1/4
396.24'
N00°37'41"E
LOT 1
19.81'
NE CORNER LOT 2
N87°37'59"E
COURT JUDGEMENT LINE CC 94-2-08306-1
SP APN 920717B001
LOT 2
67,300± SQ FT
1.32± AC
S2°14'00"E 114.07'
NEW LINE
TRUE POINT OF BEGINNING PARCEL B
124.22'
New Lot Line
N87°37'59"E 24.80'
N87°46'00"E
SE CORNER LOT 2
COURT JUDGEMENT LINE CC 94-2-08306-1
NEW LINE
OLD LINE
TAX LOT 280832-003-007
TAX LOT 280832-003-005
N01°51'01"W 200.14'
PARCEL "B"
34,350± SQ FT
0.79± AC
S02°10'00"E 233.85'
TAX LOT 280832-003-004
W LINE, E 1/2, NW 1/4, NE 1/4, SW 1/4
S87°37'59"W 9.15'
141.82'
N01°10'00"W 3.84'
S87°37'59"W
30
25.16'
HIGH STREET
GEORR-01B-EXHIBIT.DWG
SCALE: 1" = 80'
EXHIBIT PREPARED FOR: RAY AND KAY GEORGE
DWN BY: GRO
CRONES & ASSOC.
LAND SURVEYORS
22908 130TH AVE. S.E. KENT, WA 98042 (425) 432-5950
SHEET 1 OF 2
JAMES, D. CRONES
STATE OF WASHINGTON
PROFESSIONAL LAND SURVEYOR
EXPIRES: 8/27/05
2/25/2005

Geotechnical Engineering

Water Resources

Solid and Hazardous Waste



Ecological/Biological Sciences

Geologic Assessments

Associated Earth Sciences, Inc.

Subsurface Exploration, Geologic Hazard, and Geotechnical Engineering Report

PROPOSED HIGH STREET STATION

Sultan, Washington

Prepared for

Ms. Kay George
INOV8 Real Estate, Inc.

Project No. KE01638A
November 14, 2001

SUBSURFACE EXPLORATION, GEOLOGIC HAZARD, AND GEOTECHNICAL ENGINEERING REPORT

PROPOSED HIGH STREET STATION

Sultan, Washington

Prepared for:
Ms. Kay George
INOV8 Real Estate, Inc.
1304 Skywall Drive
Sultan, Washington 98294

Prepared by:
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Kirkland, Washington 98033
425-827-7701
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November 14, 2001
Project No. KE01638A

I. PROJECT AND SITE CONDITIONS

1.0 INTRODUCTION

This report presents the results of our subsurface exploration, geologic hazard, and geotechnical engineering study for the proposed High Street Station in Sultan, Washington. The location of the property is shown on the Vicinity Map, Figure 1. The proposed building townhouse locations and approximate locations of the explorations we accomplished for this study are presented on the Site and Exploration Plan, Figure 2. In the event that any changes in the nature, design, or location of the new structures are planned, the conclusions and recommendations contained in this report should be reviewed and modified, or verified, as necessary.

1.1 Purpose and Scope

The purpose of this study was to provide subsurface data to be utilized in the design and development of the above-mentioned project. We performed geologic studies to assess the type, thickness, distribution, and physical properties of the subsurface sediments and shallow ground water conditions. Geotechnical engineering studies were also conducted to determine the type of suitable foundation, allowable foundation soil bearing pressures, anticipated foundation settlements, floor support recommendations, and drainage considerations. Pavement design recommendations are not a part of our current scope of services. However, Associated Earth Sciences, Inc. (AESI) is available to assist INOV8 Real Estate, Inc. and your planner/civil engineer in developing pavement design criteria and other appropriate geotechnical recommendations.

This report summarizes our current fieldwork and offers development recommendations based on our present understanding of the project.

1.2 Authorization

Written authorization to proceed with this study was granted by Ms. Kay George of INOV8 Real Estate, Inc. on October 1, 2001. This report has been prepared for the exclusive use of INOV8 Real Estate, Inc. and their agents, for specific application to this project. Within the limitations of scope, schedule, and budget, our services have been performed in accordance with generally accepted geotechnical engineering and engineering geology practices in effect in this area at the time our report was prepared. No other warranty, expressed or implied, is made. Our observations, findings, and opinions are a means to identify and reduce the inherent risks to the owner.

2.0 PROJECT AND SITE DESCRIPTION

This report was completed with an understanding of the project based on a Record of Survey prepared for Ray Edward George and Belinda Kay George (of INOV8 Real Estate, Inc.) by R.L. McDuffy & Associates, Inc., dated July 2, 2001.

Present plans call for construction of five, two-story, wood-frame townhouse structures on the approximately 2-acre property, which is located at 701 High Street in the north portion of the City of Sultan. Ms. George provided AESI with sketches showing the approximate locations of the new buildings (as hand drawn on the survey). She also provided AESI with sketches of the townhouse models as prepared by Building Designs by Stockton (undated). The sketches indicate that two basic models will be built: three of the new structures will consist of two back-to-back model No. 2-2011 buildings in three groups (totaling six separate townhouses) and two separate model No. 4-2110 buildings (totaling two townhouses). Thus, eight new townhouses, each with two separate living units (16 total units) are to be constructed on the property. Model No. 2-2110 units will have 745 to 780 square-feet (sf) each, and model No. 2-2011 units will have 1,291 sf per unit. Site development will also include construction of asphalt-paved access and parking areas. Finish floor and parking grades were not available at the time of this report. However, existing site grades are relatively level and we anticipate minimal site grading with finish floor and parking lot elevations close to existing grade.

The subject property consists of two parcels (Parcel A is north and Parcel B is to the south) as shown on Figure 2. The site is bordered to the north by Willow Avenue and Sultan High School, and High Street to the south. Developed single-family, residential properties are adjacent to the east and west sides of the site.

At the time of our explorations, there was an existing single-story, wood-frame house (rental) and wood shed (old garage) on the property (see Figure 2). We noted portions of a concrete driveway extending along the east side of the house that turns west between the house and shed. A grass covered gravel driveway was discovered during our explorations along the west side of the house.

Parcel B is mostly covered with grass. Parcel A is covered with grass and dense blackberry vines, along with scattered other shrubs and brush. Trash is scattered about the surface of Parcel A, and the north part of Parcel B. The blackberry vines on Parcel A are underlain by trash piles in several locations.

The project site is situated in a relatively level portion of Sultan. The nearly level topography represents past meanders of the Sultan River that included many episodes of scouring and deposition of sediments since de-glaciation of the Skykomish River valley perhaps 13,000 to 15,000 years ago. The site is part of an abandoned oxbow of the Sultan River that has been

partially filled with sediments over perhaps hundreds or maybe thousands of years. Traces of old drainage patterns still exist on the site based on our observation of shallow drainage swales that extend generally southeast-northwest across the south and north ends of Parcel A. The larger drainage swale at the extreme northeast corner of the site represents the alignment of the old Sultan River oxbow; the smaller swale near the south end of Parcel A may also represent a smaller oxbow or meander.

3.0 SUBSURFACE EXPLORATION

Review

Prior to starting our field study, we reviewed the following geologic maps and associated reports:

- *Surficial Geologic Map of the Skykomish and Snoqualmie Rivers Area, Snohomish and King Counties, Washington,* by Derek B. Booth, U.S. Geological Survey Map I-1745, dated 1990; and

- *Geologic Map of the Skykomish River 30-by60-minute Quadrangle, Washington,* by R.W. Tabor, V.A. Frizzell, Jr., D.B. Booth, et al, U.S. Geological Survey Miscellaneous Investigation Series Map I-1963, dated 1993.

The geologic conditions as described in the maps and reports we reviewed are generally consistent with our field observations, as described below.

Field Study

Our field study included excavating a series of backhoe-excavated exploration pits and performing a geologic reconnaissance to gain information about the site. The various types of sediments, as well as the depths where characteristics of the sediments changed, are indicated on the exploration logs presented in the Appendix. The depths indicated on the logs where conditions changed may represent gradational variations between sediment types in the field. Our explorations were approximately located in the field by measuring from the existing site features shown on the July 2, 2001, Record of Survey.

The conclusions and recommendations presented in this report are based on five exploration pits that we completed for this study. The approximate locations of the exploration pits are shown in Figure 2.

The number, location, and depth of the explorations were completed within site and budgetary constraints. Because of the nature of exploratory work below ground, extrapolation of subsurface conditions between and beyond field explorations is necessary. It should be noted that differing subsurface conditions might sometimes be present due to the random nature of fluvial (water) deposition and the alteration of topography by past grading, filling or construction on the site. This is especially true of the alluvial deposits that underlie the site, which can vary considerably in color, strength, gradation, and soil type over very short horizontal and vertical distances. As such, the nature and extent of any variations between the field explorations may not become fully evident until construction. If variations are observed at that time, it may be necessary to re-evaluate specific recommendations in this report and make appropriate changes.

3.1 Exploration Pits

Five exploration pits were excavated with a track-mounted backhoe (excavator). The exploration pits permitted direct, visual observation of subsurface conditions, especially the variation of the underlying alluvial deposits, and the presence of some old fill with trash on the site (as described below). Materials encountered in the exploration pits were studied and classified in the field by an engineering geologist from our firm. Selected samples of the soils encountered in the exploration pits were then transported to our laboratory for further visual classification and testing, as necessary.

All exploration pits were backfilled immediately after examination and logging. The backfill soil was tamped with the bucket of the backhoe to a relatively firm condition. The top of each exploration pit was then track-rolled by the backhoe to a nearly level condition. However, the contractor for the new buildings should know that the backfilled exploration pits are considered very loose/soft. As such, when these exploration pits are encountered during construction, they should be overexcavated and backfilled with compacted structural fill (as defined later in this report).

4.0 SUBSURFACE CONDITIONS

Subsurface conditions on the site were inferred from the field explorations accomplished for this study, visual reconnaissance of the site, and review of a geologic map of the area. As shown on the field logs, the exploration pits generally encountered minor amounts of fill and topsoil over old river alluvial deposits. The following section presents more detailed subsurface information organized from the upper (youngest) to the lower (oldest) sediment types.

4.1 Stratigraphy

Fill

Fill soil (material not naturally placed) was encountered in the two exploration pits we completed in Parcel B. The fill consists of about 3 to 6 inches of loose 5/8-inch minus crushed rock as encountered in Exploration Pit 1 (EP-1). This grass lawn-covered material indicates the presence of an abandoned gravel driveway that extended along the west side of the existing rental house on Parcel B. Fill soil was also observed in EP-2 and consists of trash (electrical wire, wire fencing, wood, plastic) in nearly a foot of dark brown to black organic silt and topsoil that mantles the native soils in the northeast corner of Parcel B. Other fill zones of varying depth/consistency may also occur at random locations on both Parcels A and B.

The existing fill is very soft and, in our opinion, is not suitable for foundation or floor slab support for this project and should be removed.

Topsoil

The site is mantled by a roughly 1-foot-thick layer of very soft to soft, very moist to moist, organic, silt topsoil (sometimes mixed with fill as described above). These soils are highly compressible, highly water sensitive (easily disturbed when wet) and possess little bearing strength. In our opinion, the topsoil is not suitable for foundation or floor slab support for this project and should be removed.

Alluvium

Beneath the fill and topsoil layers on the site, we observed in all explorations the presence of alluvial soils representing old floodplain, overbank, and channel deposits from past meanders of the Sultan River. The alluvium exhibits a downward coarsening of sediments, from silt-sized material in the upper portions, to gravel- and cobble-sized material in the lower portions of our explorations. The downward coarsening indicates that the upper finer constituents were likely deposited in gently flowing water or in fairly shallow lake or pond areas, whereas the coarser deposits indicate fast moving, high flow water deposition of gravel and cobble-size materials.

Except for the upper silt portions, the underlying sandy and gravely constituents are fairly well drained and exhibit "dry" caving (caving without the presence of water) when not confined (such as occurs in excavations or trenches). Caving of the alluvium prevented excavation of our explorations deeper than about 13 feet. Please note that the contractor must be aware of soil caving during construction, particularly in utility trenches and footing excavations, and should be prepared to deal with caving soils.

Although the lower, coarser portions of the alluvium (sandy gravel, gravelly sand, silty gravel constituents) are in a loose to medium dense condition, these soils have moderate compressive strength that provides adequate foundation support for light to moderately-loaded buildings when prepared as described in Section 9.0 below.

We have described the various portions of alluvium in the attached exploration logs based on their gradation (size of soil particles). Table 1, presented below, indicates the approximate depth and thickness of the major constituents of the alluvium encountered at the site. Additionally, Table 1 indicates the approximate depth of the recommended removal and replacement of those constituents not capable of providing suitable support for proposed new buildings at the site.

Table 1
Major Constituents and Approximate Thickness of Alluvial Soils

Constituents	EP-1	EP-2	EP-3	EP-4	EP-5
Approx. Elevation (ft)	127	126	126	127	128
Topsoil and Organic Silt	0.0' – 1.0'	0.0' – 1.0'	0.0' – 1.0'	0.0' – 0.5'	0.0' – 0.5'
Organic Silt	1.0' – 2.0'	1.0' – 2.0'	1.0' – 2.0'	0.5' – 1.0'	NP
Sandy Silt	2.0' – 4.5'	2.0' – 3.5'	2.0' – 3.0'	1.0' – 2.5'	NP
Fine Sand	NP	3.5' – 5.0'	3.0' 5.5'	NP	NP
Silty Sand	NP	5.0' – 8.0'	NP	NP	0.5' – 1.0'
Gravelly Sand/ Sandy Gravel/ Silty Gravel	4.5' – 12.7'	8.0' – 13.0'	5.5' – 13.5'	2.5' – 10.0'	1.0' – 11.5'

2.0' – 4.5' Numbers indicate approximate depth and thickness of soil constituent.
NP = Not Present
Shaded areas indicate that soils are not capable of providing adequate support of building loads and should be removed and replaced with compacted, structural fill.

4.2 Hydrology

Ground Water

We did not observe ground water seepage in any of our explorations because the coarse portions of the alluvium beneath the site are well drained. However, the surficial soils consist of fill, topsoil, and weathered soil materials that contain a significant amount of fine soil particles (silt and clay-sized particles that pass through a U.S. Standard No. 200 sieve). As such, the surficial soils may restrict the downward infiltration of surface water into the underlying coarse alluvium. This may lead to some temporary ponding of water at the surface,

or perhaps the development of some minor subsurface seepage (as locally perched ground water) in the surficial soils during particularly wet periods.

Although none of our explorations encountered ground water (to the maximum depths explored, which was about 13.5 feet below the ground surface), it is possible and likely that the ground water elevation beneath the site will rise during wet weather conditions. Wet weather conditions occur after prolonged rainstorms, or in fall, winter, and spring months. The rise in ground water elevation is likely tied to the level of water in Sultan River, which we believe is hydraulically connected to the coarse alluvium beneath the site. Thus, as the river rises, so does the ground water beneath the site.

We believe that an established ground water table exists at some depth below the site, likely within the coarse gravelly portions of the underlying alluvium. We suspect that the static ground water elevation is perhaps at a depth of about 20 feet below existing grades (based on the observation of wet cobbles and gravel below 13 feet in our explorations on October 19, 2001).

AESI is currently assessing the property for possible on-site disposal of storm water. Further discussion of the ground water conditions and our assessment of possible storm water infiltration will be provided to INOV8 Real Estate, Inc. in our separate infiltration memorandum.

Surface Water Pattern

As mentioned above, the site is situated on the Sultan River flood plain, which is nearly flat, and includes an abandoned oxbow of the river. Traces of old drainage patterns still exist on the site based on our observation of shallow drainage swales that extend generally southeast-northwest across the south and north ends of Parcel A. The larger drainage swale at the extreme northeast corner of the site represents the alignment of the old Sultan River oxbow; the smaller swale near the south end of Parcel A may also represent a smaller oxbow or meander.

Surface water on the site appears to currently flow towards the existing drainage swales on Parcel A, and where fairly flat, spreads out over the surface of both Parcels A and B, leading to infiltration, as inferred by the topography shown in Figure 3.

II. GEOLOGIC HAZARDS AND MITIGATIONS

The following discussion of potential geologic hazards is based on the geologic, slope, and surface and ground water conditions as observed and discussed herein.

5.0 SEISMIC HAZARDS AND RECOMMENDED MITIGATIONS

Earthquakes occur in the Puget Lowland with great regularity. The vast majority of these events are small and are usually not felt by people. However, large earthquakes do occur as evidenced by the 1949, 7.2 magnitude event, the February 2001, 6.8 magnitude event, and the 1965, 6.5 magnitude event. The 1949 earthquake is the largest in this area during recorded history and was centered in the Olympia area. The 2001, 6.8-magnitude earthquake was also centered in the Olympia. Evaluation of earthquake return rates of the Puget Sound region indicates that an earthquake of the magnitude between 5.5 and 6.0 is likely to occur within a given 20-year period.

Generally, there are four types of potential geologic hazards associated with large seismic events: 1) surficial ground rupture; 2) seismically induced landslides; 3) liquefaction; and 4) ground motion. The potential for each of these hazards to adversely impact the proposed project is discussed below.

5.1 Surficial Ground Rupture

Generally, the largest earthquakes that have occurred in the Puget Sound area are subcrustal events with epicenters ranging from 50 to 70 kilometers in depth. The 1949 and 2001 Olympia earthquakes are good examples of this type of seismic activity. Although the energy from deep subcrustal earthquakes does propagate up to the ground surface, actual surficial faulting and earth rupture features are rare. However, loose, wet soils may liquefy, move laterally, landslide, or otherwise settle or move, causing cracks and ruptures in the surficial soils during earthquakes. These types of damages are not related to actual fault rupture but are a result of ground shaking and liquefaction (see below). For this reason, we are not aware of surficial faulting, or earth rupture, as a result of deep, seismic activity in the immediate vicinity of the site. Therefore, it is our opinion, based on existing geologic data, that the risk of surface rupture impacting the proposed project is low. No mitigation measures are thus required.

5.2 Seismically Induced Landslides

The project site is located in an area of Sultan consisting of nearly flat ground. The site exhibits very gentle slopes on the flanks of the small drainage swales on Parcel A (less than 5

percent). As such, there is virtually no potential for seismically induced landslides on this site. No mitigation measures are thus required.

5.3 Liquefaction

Based on the observation of no ground water in our October 19, 2001 explorations, the encountered soils on this site are judged to have a fairly low potential for liquefaction during a seismic event. However, an established ground water table exists at some depth below the site, likely within the coarse gravelly portions of the underlying alluvium. We suspect that the static ground water elevation is perhaps at a depth of about 20 feet or more below existing grades (based on the observation of wet cobbles and gravel below 13 feet in our explorations on October 19). Because the ground water table likely does not rise into the upper, finer portions of the alluvium but stays within the well-drained gravel portions, these soils are not considered susceptible to liquefaction. No mitigation measures are thus required.

5.4 Ground Motion

We have observed the site stratigraphy in our explorations and completed a visual reconnaissance of the site and surrounding areas. As such, it is our opinion that potential earthquake damages to the proposed structures, when founded on a suitable bearing strata, and following the recommendations contained herein, would be caused by the intensity and acceleration associated with the event and not due to any of the above-discussed impacts. Design of the building should follow Uniform Building Code (UBC) standards (1997) for Seismic Zone 3, using 0.3g for maximum ground accelerations, soil profile S_D (stiff soil profile), seismic coefficient Ca of 0.36, seismic coefficient Cv of 0.54, seismic source A, and take into consideration stress caused by seismically induced earth shaking.

6.0 STEEP SLOPE AND LANDSLIDE HAZARDS AND RECOMMENDED MITIGATIONS

The site is essentially level with about 5 vertical feet of elevation change across the roughly 630-foot length (north-south) of the property. The flanks of the drainage swale on Parcel A are inclined at less than 5 percent. The slopes in the surrounding vicinity of the site are nearly flat. As such, it is our opinion that the site does not have steep slope or landslide hazards. No mitigation measures are thus required.

7.0 FLOOD HAZARDS AND RECOMMENDED MITIGATIONS

According to Federal Emergency Management Agency (FEMA) flood zone maps for the vicinity of the site, the subject property is in Flood Plain Zone "A", indicating that the site is within the old flood plain of the Sultan River. For more detail, AESI reviewed a map prepared by the City of Sultan showing the approximate 100-year recurrence flood zone for the site (as provided by Craig Bruner, City Engineer, on November 2, 2001). This map is based on flood elevation interpolation of Flood Zone A from the best available information provided on FEMA Map No. 53061C1406 E, effective November 8, 1999. The map, included in this report as Figure 3, shows that a potential 100-year flood hazard exists in the mid- to upper portions of Parcel A. However, we understand that the FEMA map was never ground verified or corrected for existing elevations. Thus, according to Mr. Bruner, the map incorrectly shows the alignment of the 100-year recurrence interval flood on this site. Based on our observations, the correct alignment of the potential 100-year flood zone should be within the previously described drainage swale in the north portion of Parcel A. This swale represents the alignment of the old Sultan River oxbow (abandoned portion of river old river alignment). It is likely that the applicant (INOV8 or their civil engineer or planner) will need to file an amendment with FEMA to move the alignment of the potential 100-year flood zone to the swale area.

We also noted during our review of the flood zone map from the City of Sultan and the topography shown on the R.L. McDuffy drawing that there may be a roughly 2-vertical-foot elevation difference between the two maps. This elevation difference could be significant relative to determining the proper elevations for flood hazard mitigation. As such, we recommend that R.L. McDuffy, Inc. review the map from the city and/or discuss with the city the elevation discrepancy, as it appears that different elevation benchmarks were used for each map. We also recommend that R.L. McDuffy, Inc. meet with the City to determine the true boundaries and elevations of the 100-year flood zone on this property because Figure 3 only presents a rough approximation of the location of the flood zone.

III. DESIGN RECOMMENDATIONS

8.0 INTRODUCTION

Our explorations indicate that, from a geotechnical standpoint, the property is suitable for the proposed construction of the High Street Station townhouse project provided the recommendations contained herein are properly followed. Suitable bearing soils are fairly close to the ground surface in most areas and conventional spread footing foundations may be used after proper subgrade preparation and soil replacement activities have been accomplished, as described below.

The site is covered with a thin layer of topsoil, fill in some areas, and up to 4.5 feet of compressible soils or soils subject to significant settlement. The surface of the site is also covered with rubble and trash, and is vegetated with grass and dense blackberry vines.

In our opinion, the existing topsoil, fill, and the upper, finer portions of the underlying alluvial soils may be susceptible to consolidation and/or settlement under building loads and are judged unsuitable for support of the new townhouse buildings. As such, we recommend that all of the existing topsoil, fill, and the upper portions of the alluvial soil materials be removed from the footing and floor slab areas and that the building be supported on new structural fill (see *Foundations* and *Slab Floor* Sections below).

Dry caving of the site soils should be expected. Therefore, the contractor should be prepared for dry caving during excavations for foundations and utilities.

9.0 SITE PREPARATION

Initial site preparation should include removal of any grass or vegetation that may exist at the time of construction and removal of all existing trash and rubble within the building envelopes, under any proposed new structures, or under new pavement areas. In addition, all existing topsoil, fill, and the upper, finer portions of the alluvial soils should be stripped from the building foundation areas, and up to 2-feet of soil removed from slab-on-grade floor areas. From our explorations, we estimate approximately 2- to 4.5-feet of unsuitable soil removal in most foundation areas. However, the actual depth of soil removal for foundation areas may be locally deeper or shallower, depending on fill depth and soil moisture conditions at the time of construction. The stripping area should extend outside of the building footprint a minimum distance equal to the removal depth or 3 feet, whichever is greater.

The resulting excavations should be recompacted, inspected by AESI, and then backfilled with new structural fill placed in 8-inch-thick lifts compacted to at least 95 percent of ASTM:D 1557 (modified Proctor maximum density), as described in the *Structural Fill* Section below.

10.0 STRUCTURAL FILL

All references to structural fill in this report refer to subgrade preparation, fill type, placement, and compaction of materials as discussed in this section. If a percentage of compaction is specified under another section of this report, the value given in that section should be used.

After overexcavation/stripping has been performed to the satisfaction of the geotechnical engineer, the upper 12 inches of exposed ground should be recompacted to at least 90 percent of the modified Proctor maximum density using ASTM:D 1557 as the standard. If construction occurs in wet weather conditions, and the subgrade contains too much moisture, adequate recompaction may be difficult or impossible to obtain and should probably not be attempted. In lieu of recompaction, the area to receive fill should be blanketed with 2- to 4-inch crushed quarry spalls (shot rock) to act as a capillary break between the new fill and the wet subgrade.

After recompaction of the exposed ground is tested and approved, or a free-draining rock course is laid, structural fill may be placed to attain desired grades. Structural fill is defined as non-organic soil, acceptable to the geotechnical engineer, placed in maximum 8-inch loose lifts with each lift being compacted to at least 95 percent of the modified Proctor maximum density using ASTM:D 1557 as the standard. Where applicable, the top of the compacted fill should extend horizontally outward a minimum distance of 3 feet beyond the location of the perimeter footings or pavement edges before sloping down at an angle of 2H:1V (Horizontal:Vertical).

The contractor should note that any proposed fill soils must be evaluated by AESI prior to their use in fills. This would require that we have a sample of the material 48 hours in advance to perform a Proctor test and determine its field compaction standard. Soils in which the amount of fine-grained material (smaller than U.S. Standard No. 200 sieve) is greater than approximately 5 percent (measured on the minus U.S. Standard No. 4 sieve size) should be considered moisture-sensitive. Use of moisture-sensitive soil in structural fills should be limited to favorable dry weather and dry subgrade conditions.

The existing on-site topsoil, fill, and the upper alluvial soils (organic silt, silty sand, sandy silt) contains significant amounts of silt and are considered very moisture-sensitive. The underlying mid- to lower portions of the alluvium (fine sand, sandy gravel, gravelly sand, and silty sand) can be used as new fill if prepared as described in this section. Thus, the cleaner portions of the mid- to lower portions of the alluvium (fine sand, sandy gravel, gravelly sand) may be suitable for reuse as structural fill in most weather conditions.

Construction equipment traversing the site when the soils are wet can cause considerable disturbance. If structural fill is placed during wet weather or if proper compaction cannot be obtained, a select import material consisting of clean, free-draining gravel and/or sand should be used. Free-draining fill consists of non-organic soil with the amount of fine-grained material (amount passing the U.S. Standard No. 200 sieve) limited to 5 percent by weight.

10.1 Fill Inspections

A representative from our firm should inspect the stripped subgrade and be present during placement of structural fill to observe the work and perform a representative number of in-place density tests. In this way, the adequacy of the earthwork may be evaluated as filling progresses and any problem areas may be corrected at that time.

11.0 FOUNDATIONS

11.1 Subgrade Preparation and Structural Fill for Foundations

Conventional concrete spread footings may be used for building support when founded on approved structural fill or recompacted natural soils as herein described.

Structural Fill Prism

It is our experience that the mid- to lower portions of the alluvium in the Sultan area can support light to moderately loaded structures when their foundations bear on a structural fill prism placed over the mid- to lower portions of the alluvium. We recommend a minimum of 2 feet of unsuitable soil removal, and replacement of a minimum of 2 vertical feet of compacted structural fill. Again, the 2-foot depth/thickness is a *minimum* depth of excavation and replacement. We recommend that the topsoil and upper zone of alluvium be removed from foundation areas (down to the fine sand or silty sand layer, or if absent, the gravelly layers beneath). We have estimated the approximate depth of unsuitable soil removal based on soils observed in our explorations, as shown in Table 1. Thus, the estimated amount of soil removal ranges from 2 feet (the minimum) to as deep as 4.5 feet (or perhaps deeper). At least

2 feet of compacted structural fill may be placed upon the excavated and compacted subgrade to bring these areas back up to footing subgrade elevation.

The townhouse structures can optionally be directly supported on the recompacted, firm, and unyielding mid- to lower portions of the underlying alluvium. Any yielding, highly organic, uncompactable or otherwise unsuitable portion of the alluvium should also be removed, based on inspection of our field engineer. The footings may then be *directly* placed on the recompacted natural subgrade. This would entail the bottom of foundations being deeper than if fill is used to bring the foundation subgrades back up to their planned elevations.

11.2 Allowable Foundation Soil Bearing Pressure and Anticipated Settlement

Bearing Pressure

We recommend that an allowable foundation soil bearing pressure of 2,000 pounds per square foot (psf) be utilized for foundation footing design purposes including both dead and live loads. This value assumes that all footing excavations penetrate to the prescribed stratums, no footings are founded in or above existing soft/loose fill or organic soils, and that the footings are placed on structural fill or firm, unyielding natural soil (mid- to lower portions of the alluvium). An increase of one-third may be used for short-term wind or seismic loading. All footings should have a minimum width of 14 inches for the one-story structures, 18 inches for two-story structures, and 21 inches for three-story structures. All footing areas should be inspected by AESI prior to placing concrete to verify that the design bearing capacity of the soils has been attained and that construction conforms with the recommendations contained in this report. The governing municipality (City of Sultan or Snohomish County) may require such inspections. Perimeter footing drains should be provided as discussed under the section on *Drainage Considerations*.

Anticipated Settlements

Anticipated differential settlement of footings founded on approved structural fill placed on the prescribed bearing layer, or on undisturbed, compacted mid- to lower alluvial soils, should be on the order of 1 inch. Differential settlements are anticipated to be approximately ½ inch.

11.3 Passive Resistance and Friction Factor

Footings and stem walls cast directly on and backfilled against compacted structural fill or compacted mid- to lower alluvial soil may be designed for passive resistance against lateral translation using an equivalent fluid equal to 250 pounds per cubic foot (pcf). This passive resistance value includes a factor of safety of 3 to reduce the amount of movement necessary to generate passive resistance.

The friction coefficient for footings cast directly on compacted structural fill or approved natural soil may be taken as 0.35. This is also an allowable value and includes a safety factor of at least 1.5.

11.4 Minimum Foundation Depth for Frost Protection

All foundations must be placed at least 18 inches below ground surface for frost protection in accordance to the 1997 UBC.

12.0 FLOOR SUPPORT

For concrete slab-on-grade floors, we recommend that the existing topsoil, fill, and organic silt layers be removed and the exposed grade compacted to a firm, unyielding condition and to a density of at least 90 percent of the modified Proctor maximum density using ASTM:D 1557 as the standard. We recommend a minimum of 2 feet of overexcavation to remove the topsoil, fill, and organic silt layers. Any yielding areas should be overexcavated and filled with approved compacted structural fill or 2- to- 4-inch-diameter crushed rock or rock spalls. Once compacted, the exposed grade should be raised back up to planned floor subgrade elevation using structural fill compacted to 95 percent of the modified Proctor maximum density using the ASTM:D 1557 standard.

A capillary break layer consisting of 4 inches of washed pea gravel or washed (no fines) 5/8- to 1¼-inch crushed rock should be placed. A heavy-duty polyethylene plastic vapor barrier should be provided under the floor slab. Based on American Concrete Institute recommendations, we also suggest placing a 2- to 3-inch layer of clean sand over the vapor barrier to protect the vapor barrier and to allow some moisture loss through the bottom of the slab to aid in the curing process. This sand may be used to aid in fine-grading the subgrade to provide uniform support under the slab.

13.0 DRAINAGE CONSIDERATIONS

All perimeter footing walls should be provided with a drain at the footing level. Drains should consist of rigid, perforated, PVC pipe surrounded by washed drain rock (typically 1-inch-diameter washed, rounded rock is used for this purpose). The level of the perforations in the pipe should be set approximately 2 inches below the bottom of the footing and the drains should be constructed with sufficient gradient to allow gravity discharge away from the building. Roof and surface runoff water should not discharge into the footing drain system but should be handled by a separate, rigid, tightline drain. All collected storm water should be

tightlined to an approved storm water drainage system. In planning, exterior grades adjacent to walls should be sloped downward away from the structure to achieve surface drainage.

All site foundations should be above any potential 100-year flood elevation.

14.0 PAVEMENT RECOMMENDATIONS

Specific pavement design recommendations are not a part of our current scope of services. However, AESI is available to assist INOV8 Real Estate, Inc. and your planner/civil engineer in developing pavement design criteria and appropriate geotechnical recommendations.

However, we can provide some general guidelines for new pavements. We suggest that the new pavements utilize a flexible pavement design. This would include:

- Removal of soft/loose unsuitable soils to a specified depth;
- Placement of a subgrade aggregate, i.e., pit run fill to planned subgrade elevation;
- Placement of a crushed rock base course and the leveling course; and
- Placement of the recommended flexible pavement for this site (typically a specified thickness of Washington State Class "B" asphalt concrete pavement).

15.0 PROJECT DESIGN AND CONSTRUCTION MONITORING

We recommend that AESI perform a geotechnical review of the townhouse development and construction plans prior to final design completion. In this way, our earthwork and foundation recommendations may be properly interpreted and implemented in the design.

We are also available to provide geotechnical engineering and monitoring services during construction. The integrity of the foundation depends on proper site preparation and construction procedures. In addition, engineering decisions may have to be made in the field in the event that variations in subsurface conditions become apparent.

16.0 CLOSURE

We have enjoyed working with you on this study and are confident that these recommendations will aid in the successful completion of your project. If you should have any questions, or require further assistance, please do not hesitate to call.

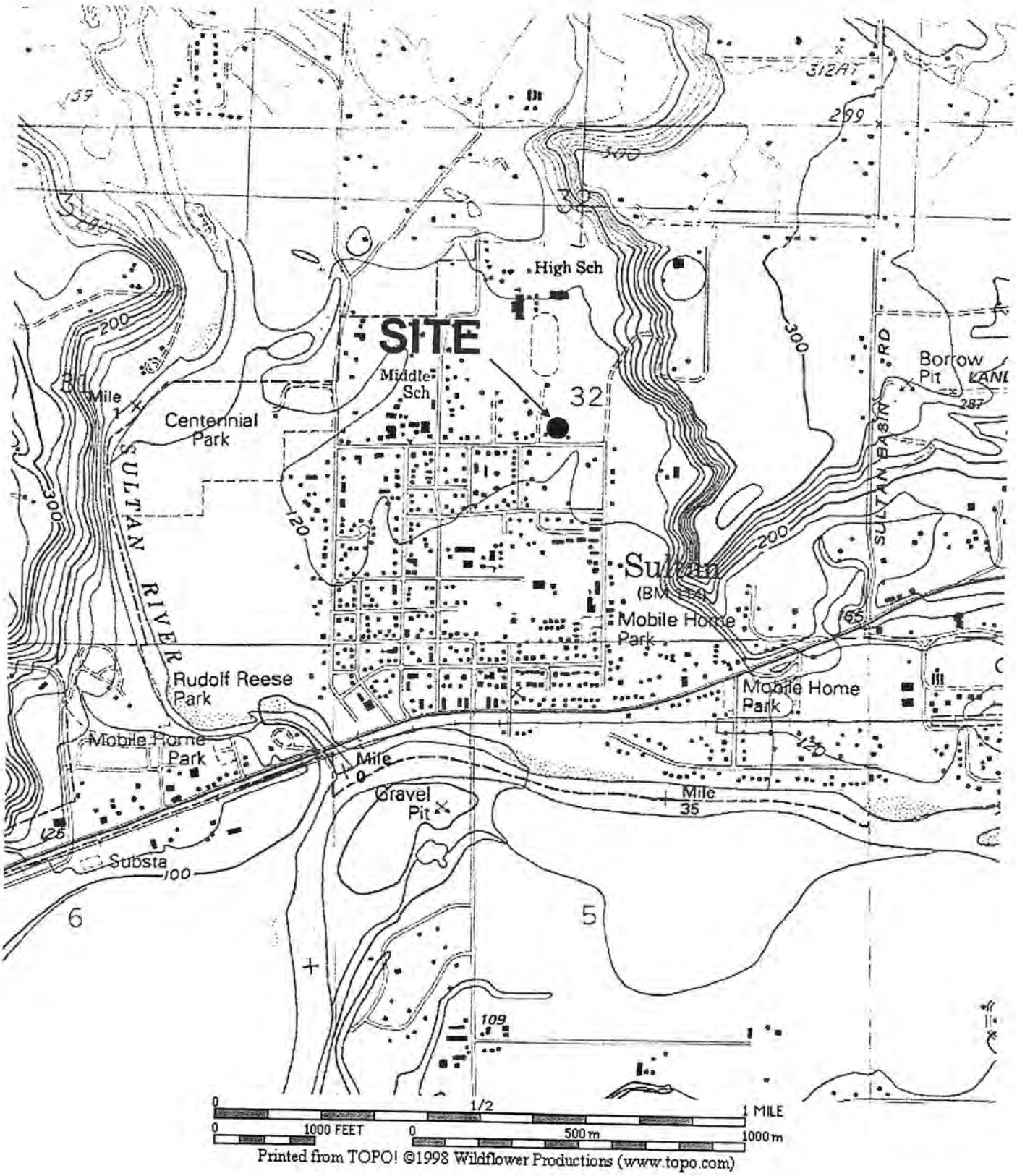
Sincerely,
ASSOCIATED EARTH SCIENCES, INC.
Kirkland, Washington

Gary D. Beckham, P.G.
Senior Engineering Geologist

Ronald A. Parker, P.G.
Principal

Bruce L. Blyton, P.E.
Principal Engineer

Attachment:
Figure 1: Vicinity Map
Figure 2: Site and Exploration Plan
Figure 3: Flood Zone "A" Map
Appendix: Exploration Logs



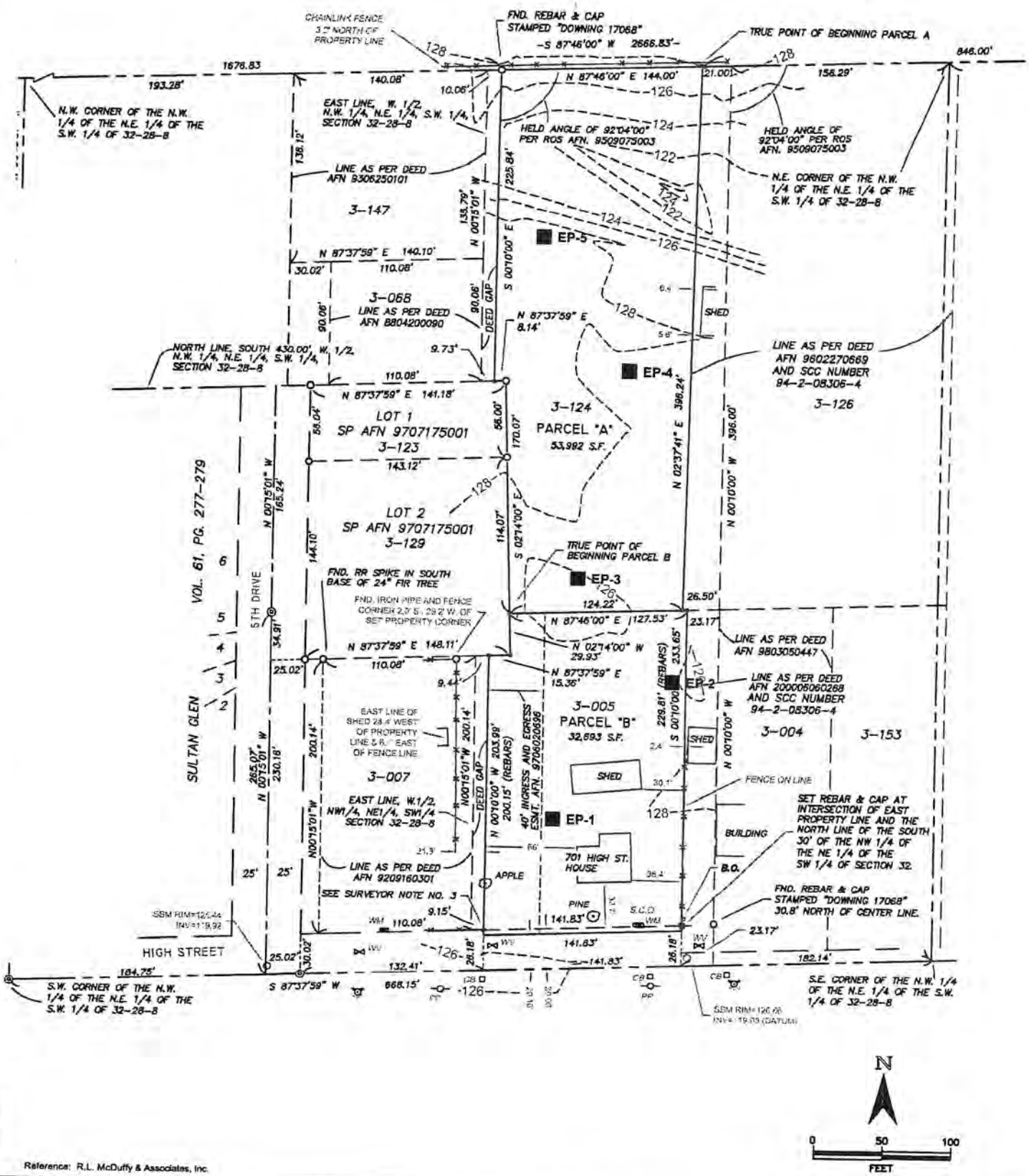
Associated Earth Sciences, Inc.

VICINITY MAP
HIGH STREET STATION
SULTAN, WASHINGTON

FIGURE 1

DATE 11/01

PROJ. NO. KE01638A



Reference: R.L. McDuffy & Associates, Inc.

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Associated Earth Sciences, Inc.

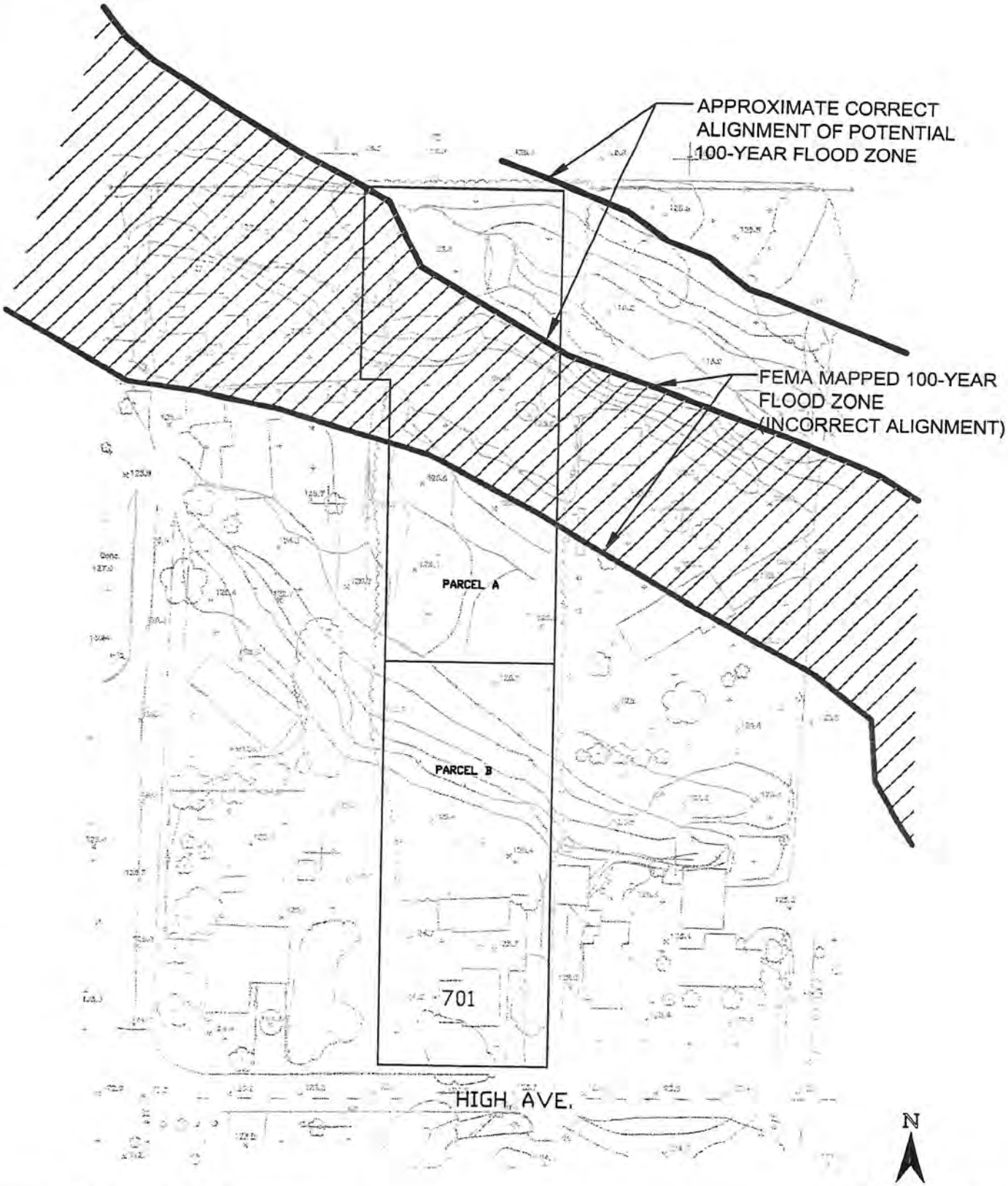
SITE AND EXPLORATION PLAN

HIGH STREET STATION
SULTAN, WASHINGTON

FIGURE 2

DATE 11/01

PROJECT NO. KE01638A



Reference: R.L. McDuffy & Associates, Inc.

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FLOOD ZONE "A" MAP

HIGH STREET STATION
SULTAN, WASHINGTON

FIGURE 3

DATE 11/01

PROJECT NO. KE01638A

01638 high street station\01638 floodzone.dwg

APPENDIX

Coarse-Grained Soils - More than 50%[1] Retained on No. 200 Sieve	Gravels - More than 60%[1] of Coarse Fraction Retained on No. 4 Sieve	≤6% Fines[5]	GW	Well-graded gravel and gravel with sand, little to no fines
			GP	Poorly-graded gravel and gravel with sand, little to no fines
		≥15% Fines[5]	GM	Silty gravel and silty gravel with sand
			GC	Clayey gravel and clayey gravel with sand
	Sands - 50%[1] or More of Coarse Fraction Passes No. 4 Sieve	≤5% Fines[5]	SW	Well-graded sand and sand with gravel, little to no fines
			SP	Poorly-graded sand and sand with gravel, little to no fines
		≥15% Fines[5]	SM	Silty sand and silty sand with gravel
			SC	Clayey sand and clayey sand with gravel
Fine-Grained Soils - 50%[1] or More Passes No. 200 Sieve	Silts and Clays Liquid Limit Less than 50		ML	Silt, sandy silt, gravelly silt, silt with sand or gravel
			CL	Clay of low to medium plasticity; silty, sandy, or gravelly clay, lean clay
			OL	Organic clay or silt of low plasticity
	Silts and Clays Liquid Limit 50 or More		MH	Elastic silt, clayey silt, silt with micaceous or diatomaceous fine sand or silt
			CH	Clay of high plasticity, sandy or gravelly clay, fat clay with sand or gravel
			OH	Organic clay or silt of medium to high plasticity
Highly Organic Soils			PT	Peat, muck and other highly organic soils

Terms Describing Relative Density and Consistency

	Density	SPT[2] blows/foot
Coarse-Grained Soils	Very Loose	0 to 4
	Loose	4 to 10
	Medium Dense	10 to 30
	Dense	30 to 50
	Very Dense	>50
	Consistency	**SPT[2] blows/foot**
Fine-Grained Soils	Very Soft	0 to 2
	Soft	2 to 4
	Medium Stiff	4 to 8
	Stiff	8 to 15
	Very Stiff	15 to 30
	Hard	>30

Test Symbols

G = Grain Size
M = Moisture Content
A = Atterberg Limits
C = Chemical
DD = Dry Density
K = Permeability

Component Definitions

Descriptive Term	Size Range and Sieve Number
Boulders	Larger than 12"
Cobbles	3" to 12"
Gravel	3" to No. 4 (4.75 mm)
Coarse Gravel	3" to 3/4"
Fine Gravel	3/4" to No. 4 (4.75 mm)
Sand	No. 4 (4.75 mm) to No. 200 (0.075 mm)
Coarse Sand	No. 4 (4.75 mm) to No. 10 (2.00 mm)
Medium Sand	No. 10 (2.00 mm) to No. 40 (0.425 mm)
Fine Sand	No. 40 (0.425 mm) to No. 200 (0.075 mm)
Silt and Clay	Smaller than No. 200 (0.075 mm)

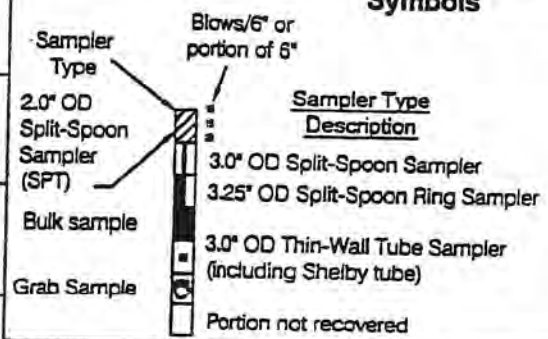
[3] Estimated Percentage

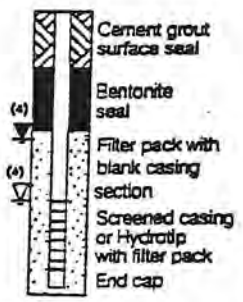
Component	Percentage by Weight
Trace	<5
Few	5 to 10
Little	15 to 25
With	- Non-primary coarse constituents: ≥ 15% - Fines content between 5% and 15%

Moisture Content

Dry - Absence of moisture, dusty, dry to the touch
Slightly Moist - Perceptible moisture
Moist - Damp but no visible water
Very Moist - Water visible but not free draining
Wet - Visible free water, usually from below water table

Symbols





(1) Percentage by dry weight
(2) (SPT) Standard Penetration Test (ASTM D-1586)
(3) In General Accordance with Standard Practice for Description and Identification of Soils (ASTM D-2488)
(4) Depth of groundwater
▼ ATD = At time of drilling
▽ Static water level (date)
(5) Combined USCS symbols used for fines between 5% and 15%

Classifications of soils in this report are based on visual field and/or laboratory observations, which include density/consistency, moisture condition, grain size, and plasticity estimates and should not be construed to imply field or laboratory testing unless presented herein. Visual-manual and/or laboratory classification methods of ASTM D-2487 and D-2488 were used as an identification guide for the Unified Soil Classification System.

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ASSOCIATED EARTH SCIENCES, INC

Exploration Log Key

FIGURE
A-1

LOG OF EXPLORATION PIT NO. EP-1

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.

Depth (ft)	DESCRIPTION
	Grass lawn over 5/8" diameter minus crushed rock road surface (old driveway).
1	Soft, very moist, dark black, SILTY TOPSOIL.
	Alluvium
2	Soft, very moist, dark brown, organic SILT with some charcoal. (OL)
	Soft, very moist, brown, fine SANDY SILT with occasional fine sand seams. (ML)
3	
4	
5	Loose, moist, brown, fine to coarse SAND with fine to coarse gravel and occasional cobbles. (SW)
	Grades to GRAVELLY SAND at 5'.
6	Grades to loose to medium dense, moist, tan-brown, SANDY fine to coarse GRAVEL with cobbles and occasional small boulders at 5.5'. (GW)
7	
8	
9	Becomes very moist at 9'.
10	Iron staining observed in gravel at 10'.
11	
12	
13	Bottom of exploration pit at depth 12.7 feet
	No ground water seepage observed on 10/19/01.
14	Slight "dry" caving from 4.5 feet-7 feet. Moderate to severe "dry" caving from 7 feet-12.7 feet.
	Exploration pit terminated at 12.7 feet because of caving.
15	
16	
17	
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KCTP3 01638.GPJ November 1, 2001

High Street Station
Sultan, WA

Logged by: GDB

Approved by: GDB

ASSOCIATED EARTH SCIENCES, INC

Project No. KE01638A

October 2001

LOG OF EXPLORATION PIT NO. EP-2

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.

Depth (ft)	DESCRIPTION
	Fill
1	Very soft, very moist, dark brown to black-brown, organic SILT and TOPSOIL with trash, wire, fencing wire, and wood. (OL)
	Alluvium
2	Soft, moist, dark brown, organic SILT with some charcoal. (OL)
3	Soft to medium stiff, moist, brown, fine SANDY SILT. (ML)
4	Loose, dry, gray-brown, fine SAND with occasional thin silt seams. (SP)
5	Loose, slightly moist, gray, SILTY fine to coarse SAND with fine gravel. (SM)
6	Gravel becomes fine to coarse with cobbles at 6'.
7	
8	Loose to medium dense, moist, brown, SANDY, SILTY GRAVEL with cobbles and occasional small
9	boulders. (GM)
10	Grades to interbedded wet, brown-gray, SANDY fine to coarse GRAVEL and SILTY fine to coarse
11	GRAVEL at 10'.
12	
13	
14	Bottom of exploration pit at depth 13 feet No ground water seepage observed on 10/19/01. Moderate to severe "dry" caving from surface to 13 feet. Exploration pit terminated at 13 feet because of caving.
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KCTP3 01638.GPJ November 1, 2001

High Street Station
Sultan, WA

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Project No. KE01638A

October 2001

LOG OF EXPLORATION PIT NO. EP-3

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.

Depth (ft)	DESCRIPTION
	Very soft, very moist, dark brown, organic SILT and TOPSOIL. (OL)
1	**Alluvium**
2	Soft, very moist, dark brown, organic SILT with some charcoal and burned tree roots. (OL)
	Soft, very moist, brown, fine SANDY SILT with occasional fine sand seams. (ML)
3	Loose, very moist, gray, fine to medium SAND with coarse sand and trace silt. (SP)
4	
5	
6	Loose, wet, gray, SANDY fine to coarse GRAVEL with cobbles. (GW)
7	Loose to medium dense, wet, gray, SANDY, SILTY fine to coarse GRAVEL with cobbles and occasional small boulders. (GM)
8	
9	
10	
11	
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14	Bottom of exploration pit at depth 13.5 feet
	No ground water seepage observed on 10/19/01.
15	Severe "dry" caving from surface to 5.5 feet. Moderate caving of wet gravel from 5.5 feet-7 feet; becomes severe from 7 feet-15.5 feet.
	Exploration pit terminated at 13.5 feet because of caving.
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October 2001

LOG OF EXPLORATION PIT NO. EP-4

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered. **DESCRIPTION**
	Very soft, very moist, dark brown, organic SILT and TOPSOIL (OL)
1	**Alluvium**
	Soft, very moist, dark brown, fine SANDY organic SILT. (OL)
2	Loose/soft, wet, tan-brown, SILTY fine SAND and fine SANDY SILT. (SM/ML)
3	Loose, wet, gray, SANDY fine to coarse GRAVEL with cobbles. (GW)
4	Gravel content increases; becomes medium dense at 3.5'.
5	
6	
7	
8	
9	
10	
11	Bottom of exploration pit at depth 10 feet No ground water seepage observed on 10/19/01. Severe "dry" caving from surface to 7 feet. Moderate "dry" caving from 7 feet-10 feet. Exploration pit terminated at 10 feet because of caving.
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Sultan, WA

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October 2001

LOG OF EXPLORATION PIT NO. EP-5

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.

Depth (ft)	DESCRIPTION
	Very soft, very moist, dark brown, organic SILT and TOPSOIL. (OL)
	Alluvium
1	Loose, very moist, brown, SILTY fine to medium SAND with fine to coarse gravel. (SM)
2	Loose, very moist, gray, SANDY fine GRAVEL and GRAVELLY fine to coarse SAND with coarse gravel and occasional cobbles. (SW/GP)
3	
4	
5	
6	Loose to medium dense, very moist to wet, gray, SANDY fine GRAVEL with some coarse gravel
7	and occasional cobbles. (GP)
8	Some silt in gravel at 8'.
9	
10	
11	
12	Bottom of exploration pit at depth 11.5 feet
13	No ground water seepage observed on 10/19/01. Severe "dry" caving observed from surface to 8 feet. Moderate caving from 8 feet-11.5 feet. Exploration pit terminated at 11.5 feet because of caving.
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