Chapter 5: Results - Streams

LUC 20.25H075 through 20.25H.090 defines Streams as: "*An aquatic area where surface water produces a channel, not including a wholly artificial channel, unless the artificial channel is 1). Used by salmonids; or 2) Used to convey a stream that occurred naturally before construction of the artificial channel*."

5.1 Stream and Buffers in the Study Area

The project area is located in the Kelsey Creek Basin of the Lake Washington Watershed (Water Resource Inventory Area 8). The Kelsey Creek basin consists of nine drainage basins with more than 19 miles of streams, encompassing 10,870 acres (Kerwin 2001). The project is located within the West Tributary drainage basin. In general, the drainage basin contains a high level of impervious area with moderate levels of length in culverts and modified riparian conditions (Kerwin 2001).

West Tributary

The West Tributary is the only stream located within the study area. The stream originates in a wetland located west of 120th Avenue NE between the WW Gainger facility and Lowe's Hardware and generally flows east for approximately 2,000 feet before it crosses 124th Avenue NE in a 48-inch circular petal pipe (CMP) culvert. A flow control structure maintained by King County Metro is attached to the inlet of the 48-inch culvert. The flow control structure was installed to provide flow control for stormwater from the King County Metro property and consists of a 60-inch by 30-inch slide gate that is manually operated by King County Metro. The slide gate appears to remain half open for most of the time according to the sign posted by the flow control structure. The channel width in the upstream reach of the project area ranges from 7 feet to 20 feet wide. The channel substrate is dominated by silt.

Downstream of the project area, the West Tributary flows southeast through Wetland 1, and water exits through a dam and a flow control structure located at the southeastern end of the wetland. The stream then flows south for approximately 350 feet and enters a culvert where it is conveyed below ground for approximately 1,300 feet until the channel opens up again in a wetland south of Bel-Red Road (Figure 2). Approximately 800 feet downstream of Bel-Red Road, Goff Creek enters the West Tributary. The West Tributary continues to flow south and eventually drains into Kelsey Creek at Kelsey Creek Farm Park.

The West Tributary within the project area is rated as a fish-bearing stream (Type F) per the City of Bellevue Land Use Code (LUC 20.25H.075). More specific information about fish use in the West Tributary is described in Chapter 8. Open stream segments of the West Tributary require 50-foot buffer. However, the segment within the project area is entirely conveyed through the culvert; therefore, no stream buffer width is applied within the project area. Outside of the project area, a standard 50-foot buffer will apply. Table 5 summarizes the size, rating,

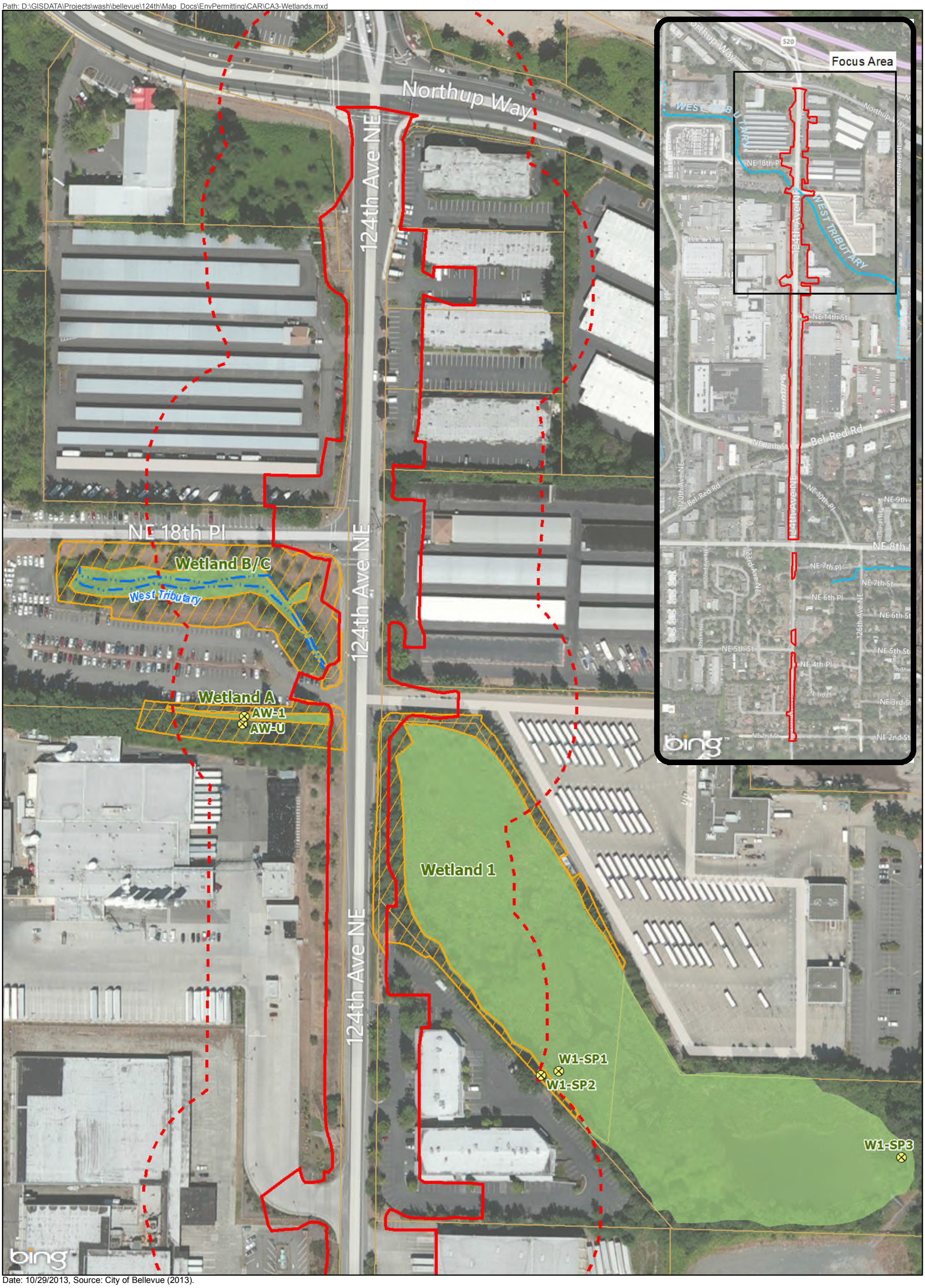
and classification of the West Tributary in the project area, and Figure 2 shows the location of the West Tributary. Photographs of the stream are provided in Appendix C.

Table 5. Summary of Streams in the Study Area

Stream Characteristics	
Stream Name	West Tributary
Tributary to	Kelsey Creek
Bellevue Stream Type[a]	F
Buffer Width (ft)	N/A (within the project area) 50 (upstream and downstream of the project area)
Setback width (ft)[a]	10 (within the project area) 20 (upstream and downstream of the project area)
USACE Jurisdiction[b]	RPW
Average Width in Study Area (ft)[c]	14
Approximate Length in Study Area (ft)[c]	160

[a] LUC 20.25H.075
[b] RPW = Relatively Permanent Water
[c] Average widths and approximate lengths were determined based on existing survey data and field observations.

Path: D:\GISDATA\Projects\wash\bellevue\124th\Map_Docs\EnvPermitting\CAR\CA3-Wetlands.mxd



Date: 10/29/2013, Source: City of Bellevue (2013).

Legend

- Study Area
- Construction Limit
- Delineated Stream
- Sample Plot
- Wetland
- Wetland Buffer
- Parcel

0 50 100 150 200 Feet

Figure 2
Streams, Wetlands, and Wetland Buffers in the Study Area

This page intentionally left blank.

5.1.1 Stream Impacts

No permanent impacts to the West Tributary would occur as a result of this project because there is no open stream channel located within the project footprint. Construction of the culvert replacement would not directly affect the West Tributary because the proposed project would result in the existing culvert being removed and being replaced with a shorter box culvert. Overall, there would be a net benefit to the aquatic habitat for the West Tributary. The total length of the open stream would increase by 33 feet.

Replacing the pipe culvert with a box culvert would also be a substantial net gain of open channel within the West Tributary to restore natural channel conditions of the West Tributary. The replacement of culvert would incorporate well-graded stream bed cobbles that are approximately 12 inches in diameter (HDR 2013a). As a result, the proposed project will daylight a portion of the West Tributary, which would be a significant benefit to aquatic habitat.

Construction activities associated with removal of the existing culvert and installation of the new box culvert would occur within or directly adjacent to the West Tributary and could include bank disturbance and dewatering activities. These construction impacts are expected to be minimal and limited to short-term activities. The new culvert would be self-mitigating for the temporary disturbance during the construction by providing for improved fish passage, habitat and water quality benefits, and scour and sedimentation control.

In-stream construction activities will occur in summer during the WDFW in-water work window (August 1 through August 31 for Lake Washington tributaries) and the federal in-water work window (July 1 through August 31). The reduced and diverted stream flow will minimize increases in turbidity. Best management practices (BMPs) and temporary erosion control measures will also be implemented to minimize sediment entering the channel during construction.

5. 1.1 Stream Buffer Impacts

No impacts to stream buffers would occur as a result of the proposed project. A portion of the stream that would be affected is completely within the closed segment; therefore, no stream buffer is present within the project area.

5. 1.2 Cumulative Impacts

According to the Bel-Red Subarea Plan (2008), surrounding areas around 124th Avenue NE are planned to be redeveloped to higher densities to accommodate the growing population and to provide housing and employment opportunities. However, these planned development activities are not expected to increase impervious surface area since most of the surrounding area has already been developed with a high degree of impervious surface and have few stormwater treatment facilities. For public and private projects in the Bel-Red corridor, the City would encourage natural drainage practices where feasible (City of Bellevue 2008). The City's development standards also require developers to prepare plans for erosion and sediment

control before construction. The developers must specify specific BMPs to prevent sediment and other pollutants from entering streams. As a result, the proposed project is not expected to have a substantial cumulative effect on surface water resources.

5.2 Structure Setback

LUC 20.25H.075(D) requires that projects provide structure setbacks that are additional area outside of the prescribed stream buffers and provides a description of the structural setbacks from streams. The structure setback for the West Tributary in the project area is 10 feet based on application of LUC 20.25H.075(D) for Closed Stream Segments.

5.3 Streams Performance Standards

Below is a description of performance standards required for a new culvert in the City of Bellevue.

The LUC 20.25H. 055(C)(3e) notes:

> *3e. New or Expanded Bridges and Culverts. New culverts shall be designed in accordance with the Washington State Department of Fish and Wildlife "Design of Road Culverts for Fish Passage" now or as hereafter amended. Culvert expansions shall be considered new culverts and be required to be designed in accordance with "Design of Road Culverts for Fish Passage" now or as hereafter amended when the expansion is associated with a project increasing vehicular capacity and (i) there are fish present downstream; (ii) there is potential fish habitat upstream; and (iii) the benefits of so designing the culvert are substantial when compared to expanding the culvert based on its then-existing design.*
>
> *Applicant's Response:*
>
> The proposed culvert will be designed in accordance with the WDFW "Design of Road Culverts for Fish Passage" for a project that will increase vehicular capacity, there are fish present downstream, and there is potential fish habitat upstream.

The LUC 20.25H. 080(A) notes:

> *A. Development on sites with a type S or F stream or associated critical area buffer shall incorporate the following performance standards in design of the development, as applicable*
>
> > *1. Lights shall be directed away from the stream*
> >
> > *Applicant's Response:*
> >
> > LED lighting will be used in the replacement lighting for 124th Avenue NE. This lighting has a narrower bandwidth and is expected to result in less disturbance to nearby wildlife.

In addition, all lighting will be directed towards the roadway and pedestrian ways to limit light pollution in the West Tributary.

2. Activity that generates noise such as parking lots, generators, and residential uses, shall be located away from the stream, or any noise shall be minimized through use of design and insulation techniques.

Applicant's Response:

The improved roadway will have the same speed as currently posted for 124th Avenue NE. The project will add sidewalks and planting strips that will increase the distance between vehicles on the roadway and the stream. As a result, the impact of sound near the West Tributary is expected to be slightly reduced compared to the current conditions.

3. Toxic runoff from new impervious area shall be routed away from the stream.

4. Treated water may be allowed to enter the stream critical area buffer.

Applicant's Response

Stormwater runoff resulting from the existing and new impervious surface will be treated fully for water quality and quantity and then discharged into Wetland 1 on the east side of 124th Avenue NE. This discharge is consistent with the use of Wetland 1 as a regional stormwater detention facility and in keeping with the performance standards.

5. The outer edge of the stream critical area buffer shall be planted with dense vegetation to limit pet or human use.

Applicant's Response:

The project will include dense planting near the roadway to reduce the potential for intrusion by people and pets.

6. Use of pesticides, insecticides and fertilizers within 150 feet of the edge of the stream critical area buffer shall be in accordance with the City of Bellevue's "Environmental Best Management Practices", now or as hereafter amended.

Applicant's Response:

City staff will provide maintenance for 124th Avenue NE, and it is assumed that any use of pesticide, insecticide, or fertilizers within 150 feet of the stream will follow the City's BMPs.

B. Modification of Stream Channel

Applicant's Response:

No modifications to the channel of the West Tributary are proposed. The proposed project will replace the existing culvert with a new box culvert; however, the project will not relocate the open channel segment of the West Tributary, close the channel through culverts, or relocate the closed stream channel.

5.4 Stream Mitigation and Monitoring

The project does not require stream or stream buffer mitigation because there are no permanent stream or stream buffer impacts associated with this project. Replacing the existing culvert with a new larger culvert would provide enhanced fish habitat in the form of improved passage.

Chapter 6: Results -Wetlands

LUC 20.25H.095 defines wetlands as: *"Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas. Wetlands do not include those artificial wetlands intentionally created from nonwetland sites, including, but not limited to, irrigation and drainage ditches, grass-lined swales, canals, detention facilities, wastewater treatment facilities, farm ponds, and landscape amenities, or those wetlands created after July 1, 1990, that were unintentionally created as a result of the construction of a road, street, or highway. Wetlands may include those artificial wetlands intentionally created from nonwetland areas to mitigate the conversion of wetlands."*

6.1 Wetlands and Buffers in the Study Area

Three wetlands have been identified in the project area. HDR biologists verified the extent and location of one previously-identified wetland and delineated two additional wetlands. Wetlands were distinguished from adjoining uplands by the presence of indicators for wetland hydrology, hydric soils, and hydrophytic vegetation. The locations of wetlands are shown in Figure 2. Table 6 summarizes the size, rating, classification, and buffer width of wetlands found within the project area. Wetland delineation data sheets are provided in Appendix B, and photographs are provided in Appendix C. Wetlands delineated by Parametrix are included in Appendix E.

Table 6. Wetland Size, Rating, Classification, and Buffer Width for Wetlands in the Study Area

Wetland Name	Delineated Area (overall wetland size)[a]	Hydrogeomorphic (HGM) Classification	Cowardin Classification[c]	Score for Water Quality	Score for Hydrologic Functions	Score for Habitat Functions	Total Score for Functions	Wetland Rating City of Bellevue[b]	Buffer Width[b]
A	0.07 acre (0.07 acre)	Depressional	PFO	10	14	5	29	IV	40
B/C	0.42 acre (0.42 acre)	Riverine	PSS	16	16	11	43	III	60
1	6 acres (6 acres)	Riverine/Depressional	PEM/PFO	22	24	17	63	II	75

[a] Overall wetland size is the total area of wetland delineated or estimated based on aerial photograph interpretation and field reconnaissance. Area of delineated portions of the wetlands is based on the survey data.
[b] Wetland ratings and buffer widths are based on LUC 20.25H.095.
[c] Cowardin et al. (1979). All wetlands are palustrine. PSS = palustrine, scrub-shrub; PFO = palustrine forested; PEM = palustrine emergent.

6. 1.1 Wetland A

- Palustrine forested
- Category IV
- 0.07 acre overall

Description

Wetland A is a depressional wetland located west of 124th Avenue NE between the Metro parking lot and the Safeway distribution center (Figure 2).

Vegetation

Wetland A is a palustrine forested wetland and is primarily dominated by Red alder (*Alnus rubra*) with an understory of Giant horsetail (*Equisetum telmateia*). The presence of these species meets the wetland vegetation criteria.

Soils

Soils in Wetland A are mapped as Seattle muck and Urban land (USDA NRCS 2013). The observed soils in Wetland A consist of 5 inches of very dark grayish brown (2.5Y 3/2) gravelly silt loam and dark grayish brown (2.5Y 4/2) gravelly sandy clay loam with redoximorphic features. Sulfidic odor was also present in the soil profile. As a result, soils in Wetland A meet the hydric soil indicators for Hydrogen Sulfide and Depleted Matrix.

Hydrology

Primary indicators of hydrology include surface water present at the sample plot location, saturated soils present at the surface, and a shallow water table present at the surface. Surface water flows eastward through Wetland A and likely drains into an eight-inch CMP culvert located at the east end of the wetland boundary.

Wetland Rating and Buffer Width

Wetland A is rated as a Category IV wetland in the Ecology rating system. Wetland A scores low for water quality (10/32 points), hydrologic (14/32 points), and habitat (5/36 points) functions. Wetland A has low potential to provide water quality, hydrologic, and habitat functions because the wetland lacks dense vegetation, is partially inundated throughout the year, and does not provide substantial live storage of stormwater. However, surrounding developments provide an opportunity for Wetland A to perform water quality functions. Wetland A has minimal habitat diversity and interspersion and is isolated from other habitat types. The City requires a 40-foot buffer for Category IV wetlands with less than 30 habitat points (LUC 20.25H.095(C)).

Buffer Conditions

The vegetated buffer of Wetland A primarily consists of red alder, Himalayan blackberry (*Rubus armeniacus*), and Giant horsetail. Small amounts of Salmonberry (*Rubus spectabilis*) were also present. The King County Metro parking lot cuts off the buffer on the north side of the wetland; therefore, the northern portion of the buffer widths average 10 to 20 feet instead of the standard 40-foot buffer width.

6. 1.2 Wetland B/C

- Palustrine scrub-shrub
- Category III
- 0.42 acre overall

Description

Wetland B/C is a riverine wetland located west of 124th Avenue NE along the banks of the West Tributary (Figure 2). Wetland B/C is located in a depression where topography of the surrounding area slopes down to Wetland B/C and the West Tributary.

Vegetation

Wetland B/C is a palustrine scrub-shrub wetland (Cowardin et al. 1979). Dominant vegetation observed in the wetland includes White willow (*Salix* alba), Cascara False Buckthorn (*Frangula purshiana*), Red-osier dogwood (*Cornus* alba), Four-Line Honeysuckle (*Lonicera involucrate*), Reed canarygrass (*Phalaris arundinacea*), Giant horstail, and Himalayan blackberry. The presence of these species meets the wetland vegetation criteria.

Soils

Soils in Wetland B/C are mapped as Seattle muck (USDA NRCS 2013). Soils in Wetland B/C are mapped as Seattle muck and Urban land (USDA NRCS 2013). The observed soils in Wetland B/C consist of 5 inches of very dark brown (10YR 2/2) fine sandy loam, 5 inches of very dark grayish brown (2.5Y 3/2) loamy sand with redoximorphic features over 6 inches of dark grayish and dark grayish brown (2.5Y 4/2.5) gravelly loamy sand with redoximorphic features. Soils in Wetland B/C meet the hydric soils indicators for Redox Dark Surface

Hydrology

The primary source of wetland hydrology for Wetland B/C is the West Tributary. Saturated soils were present at 10 inches below the surface in the soil pit.

Wetland Rating and Buffer Width

Wetland B/C is rated as a Category III wetland in the Ecology rating system with a moderate score for water quality (16/32 points) and low scores for hydrologic (16/32 points) and habitat

(11/36 points) functions. Wetland B/C provides some water quality and hydrologic functions as the shrub and emergent vegetation covers in the wetland help filter and trap sediments, and surrounding developments provide an opportunity for Wetland B/C to perform water quality and hydrologic functions. Wetland B/C has some potential for habitat function since it has some vegetation and hydrologic diversity, as well as habitat features; however, Wetland B/C has low opportunity to provide habitat functions since its connection to other habitat types are limited. The City requires a 60-foot buffer for Category III wetlands with less than 20 habitat points.

Buffer Conditions

The vegetated buffer of Wetland B/C primarily consists of mowed grasses and Himalayan blackberry. Wetland B/C is bounded by the Metro parking lot to the south and west, NE 18th Place to the north, and 124th Avenue NE to the east. As a result, buffer widths of Wetland B/C average 30 to 40 feet instead of the standard 60-foot buffer width.

6. 1.3 Wetland 1

- Palustrine emergent/forested
- Category II
- 6 acres overall

Description

Wetland 1 is a riverine/depressional wetland associated with the West Tributary located east of 124th Avenue NE and north of NE 14th Street. Wetland 1 is bounded by fill from the King County Metro parking lot to the north, Mid-Mountain Equipment Yard and Evans Industrial Park to the east, and the former Safeway Bottling Plant parking lot to the south (Figure 2). Wetland 1 is also referred as the West Tributary Regional Detention Pond which was constructed by the City of Bellevue in 1982 to treat runoff from 445 acres of primarily industrial and commercial development, as well as associated roads (SAIC 2012).

Vegetation

Wetland 1 primarily consists of a palustrine emergent community with a forested community along its edge. The emergent community in Wetland 1 is primarily dominated by Reed canarygrass. Other vegetation observed in Wetland 1 includes Common cattail (*Typha latifolia*), Douglas spirea (*Spiraea douglasii*), Pacific willow (*Salix lasiandra*), Sitka willow (*Salix sitchensis*), Small-fruited bulrush (*Scirpus microcarpus*), Red-osier dogwood (*Cornus alba*), and Common rush (*Juncus effusus*). In general, the wetland edges contain more plant diversity whereas the northwestern and southwestern ends of the wetland are primarily dominated by Reed canarygrass and Common cattail (Parametrix 2012). The presence of these species meets the wetland vegetation criteria.

Soils

Soils in Wetland 1 are mapped as Everett gravelly sandy loam, 5 to 15 percent slopes (USDA NRCS 2013). The observed soils in Wetland 1 consist of 12 inches of black (10YR 2/1) silty muck over at least 7 inches of dark gray (2.5Y 4/1) silt loam or 5 inches of very dark gray (10YR 3/1) loam with 4 inches of dark gray (2.5Y 4/1) sandy loam and at least 9 inches of gray (5Y 5/1) gravelly sandy loam with redoximorphic features (Parametrix 2012). The soils observed in Wetland 1 do not technically meet any of the standard hydric soil indicators; however, hydric soils were assumed to be present based on the presence of saturated soils and a shallow water table at the site during the field investigation conducted by Parametrix.

Hydrology

Primary indicators of hydrology include saturated soils present at the surface and a shallow water table at 3 inches below the surface in the soil pit. The primary source of wetland hydrology for Wetland 1 is the West Tributary; however, the water level in the wetland is controlled by a flow control structure located at the southeastern end of the wetland (Parametrix 2012).

Wetland Rating and Buffer Width

Wetland 1 is rated as a Category II wetland in the Ecology rating system with moderate scores for water quality (22/32 points) and hydrologic (24/32 points) and habitat (17/36 points) functions. Wetland 1 has high potential for water quality function because it contains dense ungrazed vegetation and areas of seasonal ponding. Untreated stormwater from surrounding development provides an opportunity to perform this function. Wetland 1 also provides moderate hydrologic function due to its relatively large size in relation to the watershed and potential for additional storage. Wetland 1 also has some potential and opportunity to provide habitat functions because it has some habitat diversity and structural complexity, as well as some connectivity to other wetlands. The City requires a 75-foot buffer for Category II wetlands with less than 20 habitat points (LUC 20.25H.095(C)).

Buffer Conditions

The vegetated buffer of Wetland 1 primarily consists of forested slopes and is dominated by Red alder, Big leaf maple (*Acer macrophyllum*), Indian plum (*Oemleria cerasiformis*), Himalayan blackberry, and English ivy (*Hedera helix*) (Parametrix 2012). Wetland 1 is surrounded by developed areas; therefore, the vegetated buffer is relatively narrow. The buffer on the north side of the wetland also contains Douglas fir (*Pseudotsuga menziesii*) and Western red cedar (*Thuja plicata*). Yard waste, trash, and minor erosion from stormwater outfalls were observed within the buffer of the wetland during the field investigation conducted by Parametrix in December 2011.

6. 1.4 Wetland Impacts

Construction of the 124th Avenue NE project will not result in direct effects to wetlands in the project area. There are no permanent wetland impacts anticipated to occur as a result of this project.

Construction of the project would result in disturbance to Wetland 1 from culvert replacement activities in the immediate vicinity of the work area including, but not limited to, clearing and grading. Grading would occur within Wetland 1 to create a new submerged channel of the West Tributary as the new culvert would be located slightly south of the existing channel. Approximately 220 cubic yards of material will be excavated for the new channel, which is composed primarily of silt materials. The new channel would be approximately 20 feet wide at the top and 52 feet long until it matches with the existing channel contour downstream of the culvert. As a result, approximately 1,040 square feet (0.02 acre) of Wetland 1 would be temporarily disturbed during the construction. However, the new channel would be stabilized with engineered stream bed material and would not lose any functions that the wetland was providing. The current submerged channel of the West Tributary in Wetland 1 would be left as-is. It is anticipated that temporary disturbance to the wetland would be minimal and short in duration.

6. 1.5 Wetland Buffer Impacts

Project construction is expected to have permanent and temporary impacts to vegetated buffers of Wetland A, B/C, and 1. Permanent buffer impacts include clearing buffer vegetation and permanent filling of these areas from the construction of paved surfaces. These activities would affect approximately 0.28 acres of wetland buffers within the project area. Table 7 summarizes the acreage of wetland buffer impacts within the project area, and the affected areas are shown in Figure 3.

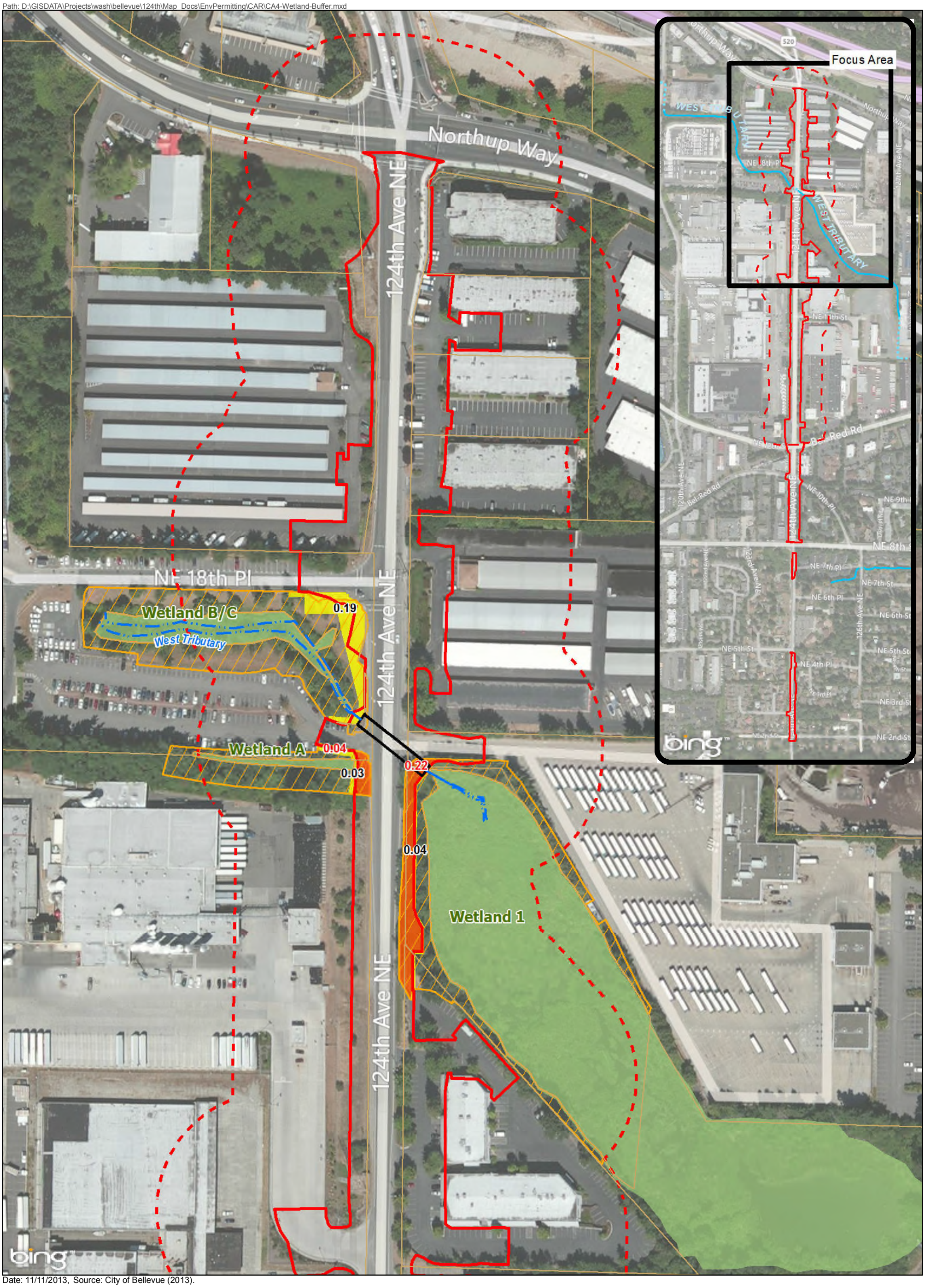
Table 7. Summary of Wetland Buffer Impacts in the 124th Avenue NE Study Area

Wetland	Affected Vegetation	Area of Impact[a]
		Acres
1	Dominated by big-leaf maple, red alder, and Himalayan blackberry	0.22
A	Dominated by mowed grasses in the row, Himalayan blackberry, red alder and big-leaf maple	0.04
B/C	Dominated by mowed grasses in the row, Himalayan blackberry on the interior of the site	0.02
Total		**0.28**

[a] Impacts are based on 60 percent project designs, and are current as of October, 2013.

The affected buffers in these areas are already disturbed by mowing activities within the existing right-of-way and by the indirect effects from the existing roadway (light spillover, traffic noise, potential intrusion by humans and pets, and invasive species). Although these wetland buffer areas have limited habitat, they still provide some habitat for birds and small mammals. Because these wetlands are located in an urban setting, they also provide some protective screening for wildlife from the disturbances of adjacent human disturbance, especially for the buffers of Wetlands 1 and A. Furthermore, the affected buffers of Wetland 1 also help moderate water level fluctuations in Wetland 1 during and after large storm events.

Path: D:\GISDATA\Projects\wash\bellevue\124th\Map_Docs\EnvPermitting\CAR\CA4-Wetland-Buffer.mxd



Date: 11/11/2013, Source: City of Bellevue (2013).

Legend

- Study Area
- Permanent Buffer Impact
- Temporary Buffer Impact
- Wetland
- Wetland Buffer
- Parcel
- Construction Limit
- Delineated Stream
- Proposed Box Culvert

0 50 100 150 200 Feet

Figure 3
Wetland Buffer Impacts at the Project Site

124th Avenue NE | Bellevue, Washington

This page intentionally left blank.

Approximately 0.26 acres of temporary buffer impacts would occur where construction work will extend beyond the permanent footprint of the project. Temporary buffer impacts would mostly result from vegetation removal throughout the project area. Following construction, these temporarily disturbed buffer areas will be replanted with native plant species. The affected buffer areas are primarily dominated by Himalayan blackberry and mowed lawn providing lower levels of habitat benefits. Revegetating disturbed areas with native woody vegetation would result in a long-term increase in plant species diversity and general habitat support to their adjoining wetlands.

6. 1.6 Cumulative Impacts

As described in Section 5.1.1, the Bel-Red Subarea Plan identifies the surrounding areas around 124th Avenue NE for redevelopment to higher densities with a mixed use of commercial and residential development (City of Bellevue 2008). However, these planned development activities are not expected to affect wetlands since the City's goal is to protect and enhance the existing wetlands in the Bel-Red corridor as a part of the plan. As a result, the proposed project is not expected to have a substantial cumulative effect on wetlands.

6.2 Wetland Structure Setback

Structure setbacks associated with wetland buffers were assigned to wetlands in the project area according to LUC.20.25.095(D)(2). Minimum widths of structure setback required for Category II and III wetlands are 20 feet and 15 feet. Other wetlands to be retained on site are Category IV, and additional setbacks are not required under LUC 20.25.095(D)(2).

6.3 Wetland Performance Standards

The LUC 20.25H.100 notes:

> *Development on sites with a wetland or wetlands critical area buffer shall incorporate the following performance standards in design of the development, as applicable:*
>
> *A. Lights shall be directed away from the wetland*
>
> *<u>Applicant's Response</u>:*
>
> LED lighting will be used in the replacement lighting for 124th Avenue NE. The lighting has a narrower bandwidth and is expected to result in less disturbance to nearby wildlife. In addition, all lighting will be directed towards the roadway and pedestrian paths to limit light pollution in nearby critical areas.
>
> *B. Activity that generates noise such as parking lots, generators, and residential uses, shall be located away from the wetland, or any noise shall be minimized through use of design and insulation techniques.*

Applicant's Response:

The improved roadway for the proposed project will have the same speed as currently posted for 124th Avenue NE. The project will add sidewalks and planting strips that will increase the distance between vehicles on the roadway and the natural areas. As a result, the impact of sound on wetlands is expected to be slightly reduced versus current conditions.

C. *Toxic runoff from new impervious area shall be routed away from wetlands.*

Applicant's Response:

The 124th Avenue NE project will result in an additional 2.85 acres of impervious surface. The permanent stormwater BMPs proposed for the project include on-site stormwater management, flow control, and water quality treatment facilities. Stormwater runoff resulting from the existing and new impervious surface will be treated fully for quantity and quality using bioretention swales and a detention vault located beneath 124th Avenue NE south of the West Tributary crossing. Bioretention swales will be located behind the curb and gutter of 124th Avenue NE for sections on the west and east sides of the road. The bioretention facilities will provide the required water quality treatment for the project.

D. *Treated water may be allowed to enter the wetland critical area buffer.*

Applicant's Response:

Discharge from bioretention swales will be conveyed to the proposed detention vault beneath 124th Avenue NE south of the West Tributary crossing then discharged into Wetland 1 and its buffer on the east side of 124th Avenue NE. This discharge is consistent with the use of Wetland 1 in this location as a regional stormwater detention facility and in keeping with the performance standards.

E. *The outer edge of the wetland critical area buffer shall be planted with dense vegetation to limit pet or human use.*

Applicant's Response:

The proposed project will comply with the provisions in LUC 20.25H.100(E). The proposed project will include dense planting in the remaining buffers to reduce the potential for intrusion by people and pets.

F. *Use of pesticides, insecticides and fertilizers within 150 feet of the edge of the stream buffer shall be in accordance with the City of Bellevue's "Environmental Best Management Practices", now or as hereafter amended.*

Applicant's Response:

City staff will provide maintenance for 124th Avenue NE, and it is assumed that any use of pesticide, insecticide, or fertilizers within 150 feet of the wetland or stream will follow the City's environmental BMPs.

6.4 Wetlands Mitigation and Monitoring

LUC 20.25.105 identifies additional provisions for wetland mitigation plans beyond the criteria in LUC 20.25.210. All of these criteria have been consolidated into a single section in Chapter 9. The reader is referred to this section for all information regarding mitigation actions proposed for the project.

Geotechnical Engineering Services

124th Avenue NE Corridor Improvements
NE 12th Street to Northup Way
Bellevue, Washington

for
City of Bellevue and
HDR Engineering, Inc.

April 30, 2014

GeoEngineers
Earth Science + Technology

Geotechnical Engineering Services

124th Avenue NE Corridor Improvements
NE 12th Street to Northup Way
Bellevue, Washington

for
City of Bellevue and
HDR Engineering, Inc.

April 30, 2014

GeoEngineers

8410 154th Avenue NE
Redmond, Washington 98052
425.861.6000

Geotechnical Engineering Services

124th Avenue NE Corridor Improvements
NE 12th Street to Northup Way
Bellevue, Washington

File No. 0526-177-01

April 30, 2014

Prepared for:

City of Bellevue
c/o HDR Engineering, Inc.
500 108th Avenue NE, Suite 1200
Bellevue, Washington 98004

Attention: Paul Ferrier, PE

Prepared by:

GeoEngineers, Inc.
8410 154th Avenue NE
Redmond, Washington 98052
425.861.6000

Timothy D. Bailey, PE
Senior Geotechnical Engineer

Shaun D. Stauffer, PE, LEED AP
Principal

SHAUN D. STAUFFER
STATE OF WASHINGTON
33250
REGISTERED
PROFESSIONAL ENGINEER
4/30/14

TDB:SDS:nld

Disclaimer: Any electronic form, facsimile or hard copy of the original document (email, text, table, and/or figure), if provided, and any attachments are only a copy of the original document. The original document is stored by GeoEngineers, Inc. and will serve as the official document of record.

Copyright© 2014 by GeoEngineers, Inc. All rights reserved.

GeoEngineers

Table of Contents

INTRODUCTION AND PROJECT DESCRIPTION **1**
FIELD EXPLORATIONS AND LABORATORY TESTING **2**
Field Explorations 2
Laboratory Testing 2
Geotechnical 2
Environmental 2
PREVIOUS STUDIES **2**
SITE CONDITIONS **3**
Setting 3
Geology 3
Critical Areas Delineation 4
Surface Conditions 4
Subsurface Conditions 4
General 4
Soil Conditions 4
Groundwater Conditions 5
Pavement Conditions 6
CONCLUSIONS AND RECOMMENDATIONS **7**
Summary of Geotechnical Considerations 7
Earthquake Engineering 8
Design Earthquake Parameters 8
Seismic Hazards 9
Sound Transit East Link Bridge Structure 9
General 9
Bridge Structure Recommendations 9
Construction Considerations 11
Cut Slope Retaining Walls 12
General 12
Soldier Pile Walls 12
Gravity Walls 15
Rockeries 16
Fill Embankment Retaining Walls 17
General 17
Cast-in-Place Concrete Walls 17
Structural Earth Walls 20
Gravity Walls 22
Wall Drainage 23
General 23
Soldier Pile Walls 23
Gravity Walls 24
SE Walls 24
Rockeries 24

Table of Contents (continued)

West Tributary Creek Culvert 24
Culvert Design Recommendations 24
Lock Block Wall Recommendations 25
Stormwater Vault 26
SCL Monopole Drilled Shaft Foundations 27
Axial Capacity 27
Lateral Capacity 28
Construction Considerations 28
Earthwork 29
Earthwork Considerations 29
Clearing and Grubbing 29
Subgrade Preparation 29
Structural Fill Materials 30
Underground Utilities 31
Temporary Slopes 32
Benching 33
Permanent Slopes 33
Site Drainage 33
Traffic Signal and Luminaire Foundations 33
General 33
Design Considerations 33
Construction Considerations 34
Infiltration Evaluation 34
Empirical Correlations 34
Rain Garden Site Preparation 37
Pavement Design 37
Subgrade Preparation 37
New Hot Mix Asphalt Pavements 38
ADDITIONAL GEOTECHNICAL SERVICES 38
LIMITATIONS 39
REFERENCES 39

Table of Contents (continued)

LIST OF FIGURES

Figure 1. Vicinity Map
Figures 2A and 2B. Site Plan
Figure 3. Geologic Map
Figure 4. Slope Categories within Project Area
Figure 5. Active Earth Pressure Diagrams - Cantilever Secant Pile Wall
Figure 6. At-Rest Earth Pressure Diagrams – Cantilever Secant Pile Wall
Figure 7. Earth Pressure Diagrams – Cantilever Soldier Pile Wall
Figure 8. Shallow Foundation Design
Figure 9. Drilled Shaft Axial Capacity, GEI-16
Figure 10. Drilled Shaft Axial Capacity, GEI-18
Figure 11. Cross Section A-A' – Retaining Wall 9 Subsurface Profile

APPENDICES

Appendix A. Field Explorations
    Figure A-1 – Key to Exploration Logs
    Figures A-2 through A-22 – Log of Explorations
Appendix B. Laboratory Testing
    Figures B-1 through B-7 – Sieve Analysis Results
    Figures B-8 and B-9 – Atterberg Limits Test Results
Appendix C. Previous Explorations
Appendix D. Environmental Screening
Appendix E. Report Limitations and Guidelines for Use

INTRODUCTION AND PROJECT DESCRIPTION

This report presents the results of our geotechnical engineering services for the 124th Avenue NE Corridor Improvements project in Bellevue, Washington. The project consists of three segments along an approximately ⅔-mile stretch of 124th Avenue NE. The project begins just north of the intersection of 124th Avenue NE with NE 12th Street and continues north to the intersection with Northup Way. The site is shown relative to surrounding physical features on the Vicinity Map, Figure 1, and the Site Plan, Figures 2A and 2B.

Our understanding of the project is based on discussions with HDR Engineering, Inc. (HDR) and the City of Bellevue. This project design will be completed in three segments:

- CIP# PW-R-169, 12th Street to 14th Street: 30 percent preliminary engineering;
- CIP# PW-R-166, 14th Street to 18th Street: Full Implementation of design engineering, plans, specifications, and estimates;
- CIP # PW-R-166, 18th Street to Northup Way: 100 percent (shelf-ready) design engineering, plans, specifications, and estimates.

As currently envisioned, the overall project will widen 124th Avenue NE to a four lane arterial with a two-way left turn, landscape strips and sidewalks between NE 12th Street and Northup Way. We understand that the roadway will be designed to consider the Sound Transit (ST) East Link light rail transit project (LRT) which calls for a grade separated facility where LRT will cross below 124th Avenue NE. Improvements will be designed to address an at-grade or grade-separated open-space trail connection and crossing at the West Tributary to Kelsey Creek, and provide fish passable enhancements compliant with endangered species. Other improvements will include underground utilities, street lighting, new traffic signals and existing traffic signal modifications, landscaping, urban design treatments, provisions for gateways, relocation of Seattle City Light (SCL) transmission towers, and compatibility with existing overhead Puget Sound Energy (PSE) transmission and distribution facilities.

The current plan includes multiple retaining walls along both sides of and throughout the corridor to accommodate road widening. The proposed wall types include structural earth (SE) walls, cast-in-place (CIP) concrete walls and soldier pile walls. The West Tributary Creek that passes through an existing culvert under 124th Avenue NE will be realigned to include passage via a three-sided bridge or culvert beneath the roadway. A portion of the fish passage will require a gravity block wall as part of the flow control structure.

The purpose of this study was to complete subsurface explorations along the project alignment and to provide geotechnical engineering conclusions and recommendations for the design and construction of the proposed improvements. Our geotechnical engineering services were completed in general accordance with the subconsultant agreement executed August 29, 2011 and amendments dated January 17, 2013 and July 31, 2013. The recommendations in this report incorporate and supersede the draft reports dated September 11, 2012 and October 31, 2013.

FIELD EXPLORATIONS AND LABORATORY TESTING

Field Explorations

The subsurface soil and groundwater conditions were evaluated by drilling 21 borings (GEI-1 through GEI-21). Borings GEI-1 through GEI-15 were completed in 2011 and borings GEI-16 through GEI-21 were completed in 2013. The borings were completed using, continuous-flight, hollow-stem auger drilling equipment. Borings GEI-8, GEI-12, GEI-15, GEI-17, and GEI-18 were completed with monitoring wells. The approximate locations of the explorations are shown on the Site Plan, Figures 2A and 2B. Details of the field exploration program and logs of the explorations including details of the monitoring well installations are presented in Appendix A.

Laboratory Testing

Geotechnical

Soil samples were obtained during drilling and taken to GeoEngineers' laboratory for further evaluation. Selected samples were tested for the determination of moisture content, grain size distribution, and Atterberg limits (plasticity characteristics). A description of the laboratory testing and the test results are presented in Appendix B.

Environmental

The soil samples obtained from the borings were field screened (visual, water sheen screening and headspace vapor screening) for evidence of contamination. Field screening showed no evidence of contamination in the borings; therefore, no follow-up chemical analytical analyses were performed on the soil samples obtained from the borings. Field screening methods are summarized in Appendix D.

PREVIOUS STUDIES

In addition to the explorations completed as part of this study, we reviewed the logs of explorations completed as part of previous studies in the project vicinity. The existing geotechnical information reviewed by GeoEngineers consists mostly of geotechnical studies for the development of properties alongside the roadway. The existing information was obtained largely through the Pacific Northwest Center for Geologic Mapping Studies (GeoMapNW), which is a collaborative effort to develop a database of geologic information that is being compiled by the United States Geological Survey (USGS), the University of Washington, and others.

The previous studies reviewed include:

- Draft logs of borings completed by ST for the East Link LRT project.
- Logs of a boring and a test pit completed by GeoEngineers for the 15th/16th project.
- Kleinfelder, Inc. report titled, "Geotechnical Engineering Report, Proposed Improvements, Safeway Distribution Center, Bellevue, Washington 98005," prepared for Safeway, Inc., dated November 11, 2005.

The locations of useful explorations in the immediate vicinity of the project corridor are shown approximately on the Site Plan, Figures 2A and 2B. The corresponding exploration logs and supporting laboratory data are included in Appendix C. We reviewed additional reports from nearby projects, including the logs of other previous studies, which are not included in this report.

SITE CONDITIONS

Setting

The project is located on the east side of the new Spring District neighborhood in the northwest portion of Bellevue. SR 520 runs east-west north of the project segment. Most of the adjacent property is currently developed, although redevelopment was recently started at the south end of the project as part of the Spring District project. The adjacent property usage includes warehouse, distribution, transit, and retail developments. The West Tributary Creek passes under the road surface via a culvert which connects to a large stormwater pond just east of the roadway at NE 18th Street. ST East Link rail will pass under the project at approximately NE 16th Street. There are two existing SCL lattice power transmission towers located on the west side of the road south of NE 15th Street.

Geology

Published geologic information for the project vicinity includes a Pacific Northwest Center for Geologic Mapping Studies map, "Geologic Map of King County, Washington". The geology in the project vicinity is presented on the Geology Map, Figure 3. Mapped soils along the project corridor generally consist of recessional outwash and glacial till. Advance outwash deposits are mapped near the north end of the corridor and transitional bed deposits are mapped in the middle portion of the project corridor. Fill soils associated with roadway construction, site development, and utilities are also anticipated.

Recessional outwash deposits in the region are described as consisting of stratified sand and gravel, moderately to well sorted, and well-bedded silty sand to silty clay deposited in proglacial and ice-marginal environments.

Glacial till typically consists of a dense to very dense heterogeneous mixture of sand, gravel, cobbles and occasional boulders in a silt and clay matrix that were deposited beneath a glacier. A zone of weathered till typically overlies the glacial till to depths of several feet below the ground surface. This weathered zone is somewhat drained, whereas the unweathered till is a barrier to vertical drainage. Water percolating into the weathered till will usually pond and migrate laterally between the weathered and unweathered layers.

Advance outwash is described as well-bedded sand and gravel deposited by streams and rivers issuing from advancing ice sheets and typically almost de-void of silt or clay, except near the base of the unit and as discontinuous beds within the unit.

Transitional bed deposits are described as laminated to massive silt, clayey silt, and silty clay deposited in lowland or proglacial lakes and mark the transition from nonglacial to glacial time/deposits.

Critical Areas Delineation

As part of our services, we reviewed King County's online service for critical and sensitive areas within the project site and vicinity, including maps of seismic areas, erosion areas, coal mine and landslide hazard areas. Based on our review of King County maps, geologic hazards are not mapped in the project area.

Bellevue Land Use Code Part 20.25H regulates land development within and adjacent to areas defined by the ordinance as critical areas. Geologic critical areas defined by the ordinance include landslide, steep slope and coal mine hazard areas. Based on the requirements of critical areas defined by the ordinance and our assessment of the project area slopes, it is our opinion that the project areas generally do not meet the designations for landslide or coal mine critical areas. However, steep slopes are defined by the ordinance as slopes greater than 40 percent that are taller than 10 feet and exceed 1,000 square feet in area. As such, project area slopes in some instances are classified as steep slopes in accordance with the Bellevue ordinance, as shown on Figure 4.

Based on our observations and explorations, it appears the mapped geology and critical areas along the project corridor have generally been portrayed accurately in the published maps as described herein.

Surface Conditions

The ground surface along the existing roadway alignment slopes from about Elevation 200 feet at Northup Way to about Elevation 140 feet near the West Tributary Creek. The ground surface slopes both up and down to the east and west, and the project slopes are shown on Figure 4.

The existing roadway is generally two lanes wide with additional turn lanes at the north and south ends of the project. Paved shoulders border much of the existing alignment and are in large part currently used for off-street parking. The alignment currently has sidewalks near Northup Way and near NE 12th Street.

Vegetation along the project segment varies from trees, brush and grass to landscaping depending on the adjacent property use.

Subsurface Conditions

General

The subsurface soil and groundwater conditions at the site were evaluated by drilling 21 borings (GEI-1 through GEI-21), and reviewing historical exploration data from available sources, including data from numerous development and capital improvement projects in the area. Soil and groundwater conditions are described below.

Soil Conditions

The available data indicates that soils generally consist of fill overlying glacially consolidated soils. Based on the explorations, the fill generally consists of loose to dense sand with variable silt and gravel content and ranges up to 15 feet thick along the project alignment. Cobbles were also encountered in the fill soils. The glacially consolidated soils generally consist of medium dense to

very dense sand and gravel with variable silt content and medium stiff to hard silt and clay. While not encountered in the explorations, cobbles and boulders are frequently encountered in the glacially deposited soils.

Soft organic soils (organic silt and/or or peat) were likely deposited by West Tributary Creek and the creek's historical channels and these soft soils may be encountered in the vicinity of the creek. Organic silt was encountered in boring GEI-7 between about 11½ and 14½ feet below the ground surface (bgs) and in boring GEI-9 between about 16 and 17 feet bgs.

Groundwater Conditions

Table 1 presents groundwater levels observed at the time of drilling for our current borings and levels measured in the installed groundwater monitoring wells. The depths to groundwater noted at the time of drilling represent conditions observed during the exploration and may not represent the true static groundwater level because it can take hours or even days for the groundwater level observed in a boring to reach equilibrium. Groundwater levels are expected to fluctuate as a result of season and precipitation, and other factors.

TABLE 1. GROUNDWATER LEVELS

Exploration	Approximate Surface Elevation (feet)	Date	Approximate Depth to Groundwater (feet)	Approximate Groundwater Elevation (feet)	Groundwater Observations
GEI-1	199.5	9/29/2011	28.5	171.0	ATD
GEI-2	182	9/26/2011	25.0	157.0	ATD
GEI-3	160	9/26/2011	7.5	152.5	ATD
GEI-4	150	9/29/2011	9.5	140.5	ATD
GEI-5	143	9/26/2011	7.0	136.0	ATD
GEI-6	140	9/29/2011	6.5	133.5	ATD
GEI-7	141.5	9/26/2011	14.0	127.5	ATD
GEI-8	145	9/29/2011	21.0	124.0	ATD
		12/5/2011	4.6	140.4	RIP
		2/16/2012	4.2	140.8	RIP
		9/11/2012	5.2	139.8	RIP
		10/18/2013	4.9	140.1	RIP
		4/20/2014	3.5	141.5	RIP
GEI-9	151	9/26/2011	19.5	131.5	ATD
GEI-10	160	9/28/2011	16.5	143.5	ATD
GEI-11	160	9/26/2011	NE	NE	ATD

Exploration	Approximate Surface Elevation (feet)	Date	Approximate Depth to Groundwater (feet)	Approximate Groundwater Elevation (feet)	Groundwater Observations
GEI-12	165	9/28/2011	26.8	141.2	ATD
		12/5/2011	23.6	141.4	RIP
		2/16/2012	23.4	141.6	RIP
		9/11/2012	23.8	141.2	RIP
		10/18/2013	23.5	141.5	RIP
		4/30/2014	22.6	142.4	RIP
GEI-13	168	9/26/2011	6.5	161.5	ATD
GEI-14	173	9/26/2011	NE	NE	NE
GEI-15	184	9/27/2011	NE	NE	ATD
		12/5/2011	41.1	142.9	RIP
		2/16/2012	41.2	142.8	RIP
		9/11/2012	41.3	142.7	RIP
		10/18/2013	41.5	142.5	RIP
GEI-16	166.5	7/31/2013	22.0	144.5	ATD
GEI-17	168.5	7/29/2013	25.6	142.9	RIP
		10/18/2013	27.8	140.7	RIP
		4/30/2014	26.8	141.7	RIP
GEI--18	183	7/30/2013	42.5	140.5	RIP
		10/18/2013	43.2	139.8	RIP
		4/30/2014	41.0	142.0	RIP
GEI-19	181	7/29/2013	NE	NE	NE
GEI-20	187	7/29/2013	NE	NE	NE
GEI-21	183.5	7/29/2013	NE	NE	NE

Notes:

NE = not encountered

ATD = at time of drilling

RIP = reading in piezometer (monitoring well)

Pavement Conditions

The existing pavement along NE 124th Street consists of asphalt concrete (AC). The thickness of the AC pavement was 3 inches at exploration GEI-1 and 6 inches at exploration GEI-4. The remaining explorations were not completed in the paved surface of the roadway.

CONCLUSIONS AND RECOMMENDATIONS

Summary of Geotechnical Considerations

We conclude that the planned improvements can be successfully completed from a geotechnical perspective, provided the considerations presented in this report are incorporated into the project planning and design. A summary of the primary geotechnical considerations is provided below. The summary is presented for introductory purposes only and should be used in conjunction with the complete recommendations presented in this report.

- Cut slopes may be supported with soldier piles walls or gravity wall systems. Some short cut slopes may be faced with rockeries, with certain limitations.
- New fill embankments may be supported with SE walls, gravity wall systems, CIP concrete walls, or soldier pile walls.
- Wall 3, located north of NE 15th Street on the east side of 124th Avenue, is planned as a SE fill wall.
- Wall 4, located north of the East Link light rail and east of 124th Avenue, is planned as a CIP concrete fill wall.
- Wall 7, located north of NE 16th Street on the east side of 124th Avenue, is planned as a SE fill wall.
- Wall 9, located south of NE 18th Street on the east side of 124th Avenue, is planned as a CIP concrete fill wall. Overexcavation is required to remove soft, compressible soils present below the foundation level. Overexcavation recommendations are described further below.
- The ST East Link LRT Bridge may be supported on secant pile walls.
- The fish passage flow control structure may be constructed with a Lock-Block wall and geomembrane.
- The proposed SCL monopoles to replace the existing lattice towers may be supported on drilled shafts.
- Most of the on-site soils observed in the explorations generally contain a high percentage of fines (silt and clay). On-site soils may be suitable for reuse as fill during dry weather, provided they can be moisture-conditioned. Imported gravel borrow may be necessary during wet weather.
- Based on the laboratory data, we anticipate the on-site soils are suitable for slow to moderate stormwater infiltration.
- Overexcavation of unsuitable organic silt and/or peat soils will likely be required to properly support the planned structures for the West Tributary Creek improvements (which includes Wall 9 as discussed above).

These and other geotechnical considerations are discussed further, and recommendations pertaining to the geotechnical aspects of the project are presented in the following sections of this report.

Earthquake Engineering

Design Earthquake Parameters

The seismic design of the proposed improvements should be completed using the design criteria presented in the Washington State Department of Transportation (WSDOT) Geotechnical Design Manual (GDM) and the AASHTO Guide Specifications for Load and Resistance Factor Design (LRFD) Seismic Bridge Design. The ST East Link LRT Bridge should be designed using these criteria as well as the ST Design Criteria Memo (DCM). Based on these documents, there are three seismic events that need to be considered in the design of the proposed improvements:

- Operating Design Earthquake (ODE) – 150-year return period, no significant damage or loss of operation (ST East Link LRT Bridge only).
- Maximum Design Earthquake (MDE) – 2,500-year return period, no collapse (ST East Link LRT Bridge only).
- AASHTO/WSDOT – 1,000-year return period, no collapse (all structures).

For all three of these design seismic events, the design guidelines reference the 2002 USGS National Seismic Hazards Mapping project for determining the peak ground (bedrock) acceleration (PGA) and the spectral accelerations. The local site effects for all three of these design seismic events were calculated using the AASHTO site adjustment factors for Site Class D. The seismic horizontal acceleration coefficient, k_h, used for design for each of the seismic events was calculated based on the design criteria in the design guidelines. Our recommended seismic design parameters are presented in Tables 2 through 4 below.

TABLE 2. ODE SEISMIC PARAMETERS

ODE Seismic Parameter	Recommended Value	k_h (design)
Effective Peak Ground Acceleration Coefficient $A_S = F_{pga}PGA = (1.44)(0.18)$	0.259	0.259 (no reduction of A_s)
Design Spectral Acceleration Coefficient at 0.2-second period $SD_S = F_aS_s = (1.49)(0.39)$	0.581	
Design Spectral Acceleration Coefficient at 1.0-second period $SD_1 = F_vS_1 = (2.28)(0.13)$	0.296	

TABLE 3. MDE SEISMIC PARAMETERS

MDE Seismic Parameter	Recommended Value	k_h (design)
Effective Peak Ground Acceleration Coefficient $A_S = F_{pga}PGA = (1.0)(0.592)$	0.592	0.296 (50 percent reduction of A_s)
Design Spectral Acceleration Coefficient at 0.2-second period $SD_S = F_aS_s = (1.0)(1.336)$	1.336	
Design Spectral Acceleration Coefficient at 1.0-second period $SD_1 = F_vS_1 = (1.55)(0.452)$	0.700	

TABLE 4. AASHTO/WSDOT SEISMIC PARAMETERS

AASHTO/WSDOT Seismic Parameter	Recommended Value	k_h (design)
Effective Peak Ground Acceleration Coefficient $A_S = F_{pga}PGA = (1.07)(0.425)$	0.454	0.227 (50 percent reduction of A_s)
Design Spectral Acceleration Coefficient at 0.2-second period $SD_S = F_aS_s = (1.12)(0.951)$	1.065	
Design Spectral Acceleration Coefficient at 1.0-second period $SD_1 = F_vS_1 = (1.76)(0.316)$	0.556	

Seismic Hazards

Based on USGS maps of active faults in the Puget Sound region, the site is located approximately 3 miles north of the Seattle Fault Zone, approximately 20 miles south-southeast of the Southern Whidbey Island Fault Zone, and approximately 28 miles north-northeast of the Tacoma Fault Zone. Because the thickness of Quaternary sediments below the site, which are commonly more than 1,000 feet thick in the region, and lack of fault displacement evidence in the area, the potential for surface fault rupture is considered remote.

We evaluated the site conditions for seismic hazards including liquefaction, lateral spreading and seismically induced landsliding. Our evaluation indicates the site has low risk of liquefaction because of the presence of dense glacially consolidated soils below the site. Because there is a low risk of liquefaction, the site has a low risk of liquefaction-induced ground disturbance including lateral spreading. Our evaluation of seismically induced landsliding indicates that there is also a low risk for seismically induced landsliding; however, localized sloughing and minor instability may occur during a large seismic event.

Sound Transit East Link Bridge Structure

General

We understand that the ST East Link LRT corridor will be constructed in a retained cut where it will cross below 124th Avenue NE. Our understanding of the proposed bridge is based on discussions with HDR. We understand the bridge will be supported on secant pile walls, which will form the north and south abutment walls. The bridge will be constructed as part of the interim project (14th Street to 18th Street, CIP # PW-R-166), and the excavation and construction of the ST East Link LRT project will be constructed under the bridge after the bridge is complete. Based on our review of the subsurface information, we concur with the selection of secant pile walls as the preferred approach for support of the bridge.

Bridge Structure Recommendations

LATERAL EARTH PRESSURES

We recommend the secant pile walls be designed using the following earth pressure diagrams:

- Figure 5 - Earth Pressure Diagrams, Cantilever Secant Pile Wall (Active).
- Figure 6 - Earth Pressure Diagrams, Cantilever Secant Pile Wall (At Rest).

These earth pressures were developed using the LRFD approach in accordance with the criteria of WSDOT GDM M 46-03.03 in conjunction with the AASHTO LRFD Bridge Design Specifications. The earth pressures were estimated using a spreadsheet developed by GeoEngineers (based on Rankine and Mohr-Coulomb earth pressure theory). The earth pressure diagrams are for permanent full-height secant pile walls for the Strength Limit and Extreme I Limit States. The Extreme Limit I Limit State loads for the retained soils include combined seismic and static earth pressures. The seismic earth pressures are based on the Mononobe-Okabe method set forth in the AASHTO LRFD Bridge Design Manual and recommended in Section 15.4.29 of the GDM, using the k_h values presented in Tables 2 through 4 for the three seismic events. We have presented all three seismic earth pressures in the diagrams, as well as traffic surcharge loads.

Other surcharge loads, such as foundations, construction equipment, or construction staging should also be considered on a case-by-case basis for the Strength Limit State loading, if applicable.

DRAINAGE

Although the groundwater level appears to be located below the base of the wall, due to the silty nature of the existing soils behind the wall, it is our opinion hydrostatic pressures could develop behind the walls without drainage. The secant pile wall design should include permanent drainage systems to prevent hydrostatic pressures from building up behind the walls. The system should maintain the groundwater level below the lowest finish grade elevation in front of the wall.

Drainage can be provided by installing vertical drains/wells behind the wall at approximately 15 foot on center. The vertical drains would need to be connected into the footing drain when the wall is completed at a later date by Sound Transit.

AXIAL PILE CAPACITY

The axial capacity of the secant piles must resist the downward component of vertical loads from the bridge. We recommend evaluating the axial capacities of the secant piles using an ultimate end-bearing value of 60 kips per square foot (ksf) for piles supported on the dense to very dense gravel and sand. The ultimate end bearing value should be applied to the base area of the secant pile. Secant piles used for end bearing must have the shaft bottom cleaned out immediately prior to concrete placement. If necessary, an ultimate shaft skin friction of 1 ksf may be used on the portion of the secant piles embedded into the very stiff silt and clay (above Elevation 147 feet) and 2 ksf may be used for piles embedded into the dense to very dense gravel and sand (below Elevation 147 feet).

We recommend the following resistance factors, presented in Table 5, be used to evaluate the different limit states:

TABLE 5. LRFD SECANT PILE FOUNDATION RESISTANCE FACTORS

Limit State	Resistance Factor ϕ		
	Passive Earth Pressure	End Bearing	Shaft Friction
Strength	0.75	0.5	0.55
Service	1.0	1.0	1.0
Extreme	1.0	1.0	1.0

Cobbles and boulders are not noted in the explorations but are commonly encountered in the dense to very dense gravel and sand deposits. The contractor should be prepared to address the presence of cobbles and boulders during construction.

LATERAL ANALYSIS

We understand the lateral capacity and performance of the secant piles will be evaluated by HDR using CT Shoring. We recommend the CT Shoring analysis be completed using the earth pressure diagrams (Figures 5 and 6). If lateral soil springs are required, we recommend using LPILE to develop those springs.

The recommended LPILE parameters are presented in Table 6 below. We recommend the lateral pile capacity be reduced for the planned secant pile spacing using a P-multiplier of 0.5. The P-multiplier is needed for the secant piles because the structural secant piles are installed at a center-to-center spacing of 2B, where B is the pile diameter. This P-multiplier was developed using the relationships presented in Table 10.7.2.4-1 of the 2012 AASHTO LRFD Bridge Design Specifications.

TABLE 6. LPILE PARAMETERS

Soil Unit	Elevation (feet)	Soil Type	Effective Unit Weight (pounds per cubic inch)	Friction Angle (degree)	Soil Modulus (pounds per cubic inch)
Fill/Silt and Clay	Top of pile to 147	Sand	0.0723	34	90
Sand and Gravel	147 to 142	Sand	0.0781	40	225
Sand and Gravel	142 to 127	Sand	0.0434	40	125

Construction Considerations

Groundwater is expected to be encountered during excavation of the secant piles. The contractor should be prepared to deal with groundwater seepage and potential caving during drilling, particularly the sand and gravel soils encountered below the groundwater level. The contractor should plan on using “wet” construction methods using drilling slurry to maintain sidewall stability.

Secant piles should be excavated with equipment that reduces the amount of loose cuttings or slough at the bottom of the drilled hole. Slough and loose cuttings should be removed from the hole prior to placing the concrete. Since “wet” construction methods will likely be used, it will be necessary to use tremie methods for placement of concrete. Nondestructive testing of secant piles using Cross-Hole Sonic Logging (CSL) should be considered if the secant piles are constructed using “wet” methods.

Cobbles and boulders are frequently encountered in glacially deposited soils. The contractor should be prepared to remove cobbles and boulders during secant pile construction.

Cut Slope Retaining Walls

General

We understand that cut slope retaining walls are currently planned at various locations along the project corridor. Where cut slope walls are in close proximity to upslope properties and/or where existing slope geometry is relatively steep, wall construction requiring temporary backcuts to install reinforcing materials will likely not be feasible, especially for the taller wall sections. Additionally, walls in close proximity to upslope improvements should be designed to control deformation that could result in subsidence and/or movement of the retained slope, which could adversely affect the upslope properties. Because of site constraints, soldier pile wall construction is often the most feasible wall type for the taller cut wall segments.

Depending on the final configuration of the cut slope retaining walls, gravity type (such as block walls, crib walls, gabion walls and bin walls) or rockery wall construction could be used as an alternative to or in conjunction with a soldier pile wall (i.e. a hybrid system), especially in the shorter wall segments. The following sections present our recommendations for these wall types.

Soldier Pile Walls

SOLDIER PILES

We recommend that permanent soldier pile walls be designed using the earth pressure diagrams presented in Figure 7. These earth pressures are developed using WSDOT LRFD approach in accordance with the criteria of the WSDOT GDM M 46-03.06 in conjunction with the AASHTO LRFD Bridge Design Specifications. The earth pressures presented in Figure 7 are for permanent full-height soldier pile walls for the Strength Limit and Extreme I Limit States. The Extreme Limit I Limit State loads for the retained soils include combined seismic and static earth pressures.

Traffic surcharge loads and other surcharge loads, such as foundations, construction equipment, or construction staging should also be considered on a case-by-case basis for the Strength Limit and Service Limit State loading, if applicable.

We recommend that the embedded portion of the soldier piles be at least 2 feet in diameter and extend a minimum distance of 10 feet below the base of the slope to resist “kick-out.” The axial capacity of the soldier pile must resist the downward component of any vertical loads, as appropriate. We recommend evaluating the axial capacities of the soldier pile shafts using an ultimate end-bearing value of 60 ksf for piles supported on the dense to very dense glacially consolidated soils.

The ultimate end bearing value should be applied to the base area of the drilled hole into which the soldier pile is concreted. This value is unfactored. Soldier piles used for end bearing must have the shaft bottom cleaned out immediately prior to concrete placement. If necessary, an ultimate shaft skin friction of 2 ksf may be used on the embedded portion of the soldier piles to help resist the vertical loads. This value is also unfactored. Only the portions of the shafts below the base of the excavation should be considered for vertical support.

The recommended resistance factors are presented in Table 7.

TABLE 7. LRFD SOLDIER PILE/SHAFT FOUNDATION RESISTANCE FACTORS

Limit State	Resistance Factor ϕ		
	Passive Earth Pressure	End Bearing	Shaft Friction
Strength	0.75	0.5	0.55
Service	1.0	1.0	1.0
Extreme	1.0	1.0	1.0

Wall drainage should be incorporated into the construction as described in the "Wall Drainage" section of this report, including a perforated drain at the base of the wall.

Both cobbles and boulders are known to exist in glacial soils, especially in glacial till. The contractor should be prepared to address the presence of cobbles and/or boulders during construction.

LAGGING

Permanent lagging may consist of timber, CIP concrete or pre-cast concrete. If timber is used for the permanent lagging, it must be adequately treated for protection against water and decay. We recommend that the permanent lagging be designed for uniform pressures equal to one-half the full static earth pressure (Strength Limit) or one-half the full combined active and seismic earth pressure (Extreme I Limit) depicted in Figure 7. This pressure reduction is based on a maximum center-to-center pile spacing of 8 feet. If a wider spacing is desired, GeoEngineers should provide guidance on modifying the lagging pressures.

The space behind the lagging should be packed full with soil as soon as practical. Placement of this material will help reduce the risk of voids developing behind the wall. The workmanship associated with lagging installation is important for maintaining the integrity of the excavation. Lagging should be installed promptly after excavation, especially in areas where perched groundwater is present or where clean sand and gravel soils are present and caving soils conditions are likely.

If a permanent facing is constructed in front of the soldier piles that is designed to resist the lagging pressures described above and timber lagging is used for temporary support, then we recommend that the temporary timber lagging be sized using the procedures outlined in the Federal Highway Administration's Geotechnical Engineering Circular No. 4. The site soils are best described as competent soils. The recommended lagging thicknesses (rough-cut) are presented in Table 8 below as a function of soldier pile clear span and depth.

TABLE 8. TEMPORARY TIMBER LAGGING THICKNESS (ROUGH-CUT) FOR SOLDIER PILE WALLS

Height (feet)	Recommended Lagging Thickness (rough-cut) for Clear Spans of:					
	5 feet	6 feet	7 feet	8 feet	9 feet	10 feet
0 to 25 (competent soils)	2 inches	3 inches	3 inches	3 inches	4 inches	4 inches

GROUND ANCHORS

Ground anchors can be used for wall heights where cantilever soldier pile walls are not cost effective. Ground anchors should extend far enough behind the wall to develop anchorage beyond the "no-load" zone and within a stable soil mass. The "no load" zone is defined from the base of the wall as a horizontal distance equal to H/4, where H is the wall height, then upward and away from the wall at a 60 degree angle measured from the horizontal. The anchors should be inclined downward at 15 to 25 degrees below the horizontal. We recommend that the ground anchors be double-corrosion protected because they will support loads on a permanent basis.

Centralizers should be used to keep the ground anchor in the center of the hole during grouting. Structural grout or concrete should be used to fill the bond zones of the ground anchors. The no-load zone of the ground anchor should be filled with a non-cohesive material such as sand slurry. Alternatively, a bond breaker, such as plastic sheathing, can be placed around the portion of the ground anchor located within the no-load zone.

Loose soil and slough should be removed from the holes drilled for ground anchors prior to installing the anchors. The contractor should take necessary precautions to minimize loss of ground and prevent disturbance to previously installed anchors and existing improvements in the site vicinity. Holes drilled for ground anchors should be grouted/filled promptly to reduce the potential for loss of ground.

Ground anchors should develop anchorage in glacially consolidated soils. We recommend that spacing between ground anchors be at least three times the anchor hole diameter to minimize group interaction. We recommend an ultimate adhesion value between the anchor and soil of 4 ksf in the glacially consolidated soils. The design anchor resistance can be evaluated using a resistance factor of 0.65 to determine the Factored Design Loads (FDLs) for the anchors.

Higher adhesion values may be developed depending on the anchor installation technique. The contractor should be given the opportunity to use higher adhesion values by conducting a performance test prior to the start of the production ground anchor installation. If post-grouting or pressure grouting is used, no post-grouting or pressure grouting should take place within the no-load zone of the ground anchors. Caution should be exercised when post-grouting or pressure grouting to prevent deflection of the shoring system or damage to existing improvements, such as utilities.

The anchors should be tested to confirm that the anchors have adequate pullout capacity. The pullout resistance should be verified by completing at least two successful verification tests in each soil type. Each anchor should be proof tested to 115 percent of the FDL. Additionally, 5 percent of the anchors should be subjected to performance tests. Anchor tests should be completed using the criteria outlined in Section 15.5.2.3 of the WSDOT GDM.

The ground anchor layout and inclination should be checked by GeoEngineers and the contractor to confirm that the ground anchors do not interfere with foundation elements for adjacent structures or other existing improvements such as buried utilities.

Gravity Walls

DESIGN CRITERIA

Gravity walls may be used for cut slope wall segments where the wall configuration (height, width, temporary backcut, etc.) can be feasibly constructed. These wall systems act as gravity retaining structures. Construction of this type of wall requires a base width approximately equal to 60 percent of the wall height, and this type of wall usually has a slight face batter. The units are backfilled with compacted granular soil. Gravity walls should be designed with back drainage as discussed in the "Wall Drainage" section below. Because the proposed cut slope retaining walls will be constructed into existing slopes, wall construction requiring significant temporary backcut will likely not be practical. The required temporary cut slope and width of the structures should be considered in planning and design. All temporary backcuts should be made in accordance with the "Temporary Slopes" section of this report.

Gravity walls should be designed in accordance with the AASHTO LRFD Bridge Design Manual and the GDM. The design parameters presented in Table 9 may be used for design of gravity walls.

TABLE 9. LATERAL EARTH PRESSURES AND SOIL PARAMETERS FOR CUT SLOPE GRAVITY WALLS

Parameter	Value [2]		
Backfill Soil Unit Weight, γ	125 pcf		
Backfill Soil Friction Angle, ϕ	36°		
Foundation Soil Unit Weight, γ	135 pcf		
Foundation Soil Friction Angle, ϕ	38°		
Allowable Bearing Capacity – AASHTO Group I	4,000 psf		
Allowable Bearing Capacity – AASHTO Group VII	6,000 psf		
Wall Foundation Coefficient of Sliding – Unfactored	0.78		
Back Slope:	2H:1V	3H:1V	Level
Active Earth Pressure Coefficient, K_a	0.35	0.30	0.24
Active Earth Pressure [1]	44 pcf	38 pcf	30 pcf
Combined Active and Seismic Earth Pressure Coefficient, K_{ae}	0.78	0.56	0.37
Combined Active and Seismic Earth Pressure [2,3]	49H psf	35H psf	23H psf
Passive Earth Pressure Coefficient, K_p	4.20		
Passive Earth Pressure [1] – Unfactored (Level Toe Slope)	550 psf		

Notes:

[1] Equivalent Fluid Density – triangular pressure distribution

[2] H equals the retained wall height

[3] Rectangular pressure distribution

psf – pounds per square foot

pcf – pounds per cubic foot

The design height of the gravity walls should include the aboveground wall height as well as the full embedment depth of the wall below the toe of the wall. We recommend that the wall foundations be supported on shallow foundations bearing on properly compacted structural fill or on undisturbed glacially consolidated soils. For foundations supported on structural fill, the zone of

structural fill should extend laterally beyond the footing edges a horizontal distance at least equal to the thickness of the fill.

The minimum embedment depth for walls founded on sloping ground should be provided as described in Table 10 below. In addition, the minimum embedment depth should be provided below a theoretical 4-foot-wide horizontal bench that extends from the face of the wall and intersects the sloping ground in front of the wall.

TABLE 10. MINIMUM EMBEDMENT DEPTHS FOR RETAINING WALLS

Slope in Front of Wall	Minimum Embedment Depth (feet) [1]
Horizontal	H/20 or 2 feet, whichever is greater
3H:1V	H/10 or 2 feet, whichever is greater
2H:1V	H/7 or 2 feet, whichever is greater

Notes:

[1] H equals the retained wall height

We recommend that the footing excavations be examined by a representative of our firm prior to forming footings or placing structural steel.

Gravity walls should be designed with a factor of safety of 1.5 for sliding and 2 for overturning. We recommend that the wall designs be reviewed by GeoEngineers to verify that valid assumptions were made relative to material properties and other factors.

SETTLEMENT

Provided all loose soil is removed and the subgrade is prepared as recommended in the "Earthwork" section of this report, we estimate the total settlement of wall foundations will be on the order of 1 inch. The settlements will occur rapidly, essentially as loads are applied. Differential settlements over 100 feet of wall length are expected to be on the order of one-half the total settlement.

CONSTRUCTION CONDITIONS

Unsuitable subgrade soils consisting of soft silt, organic silt, and/or peat, may be encountered during wall construction near the West Tributary Creek as discussed in the "Subsurface Conditions" section of this report. The discussions and recommendations for gravity wall design presented above assume that gravity walls are supported on shallow foundations bearing on properly compacted structural fill or on undisturbed glacially consolidated soils.

Rockeries

In our opinion, cuts made in dense soils may be faced with rockeries, provided certain limitations are understood as discussed below. It is important to realize that rockeries provide only limited soil retention and are not intended as structural retaining walls. The primary purpose of a rockery is to protect the slope face from erosion and raveling, while providing limited soil retention. Rockeries are an alternative wall type which is usually less costly than structural walls but involve more risk of slope failure. There is always some risk of rockery movement or failure even when the foundation and retained material are satisfactory and the rockery materials and construction are satisfactory.

We recommend that rockery wall height be limited to 6 feet and constructed using rock weights and sizes as specified in Sections 8-24 and 9-13.7(1) of the WSDOT Standard Specifications. The rockery face should be constructed with a batter of between 1H:5V (horizontal:vertical) and 1H:6V. Rock courses should be gradational in size from top to bottom with the largest rocks of uniform size being placed for the lowest course. Wall drainage should be incorporated into the construction as described in the "Wall Drainage" section including a perforated drain at the base of the wall.

Fill Embankment Retaining Walls

General

We understand that fill embankment retaining walls are currently planned at various locations along the project corridor. For the fill embankment retaining walls, we recommend using conventional CIP concrete walls, SE walls or gravity walls (such as block walls, crib walls, gabion walls and bin walls). The following sections provide recommendations for these wall types.

Cast-in-Place Concrete Walls

GENERAL

CIP concrete walls are retaining structures frequently used in fill conditions that are economical for walls up to about 15 feet in height and use readily available construction equipment. CIP retaining walls taller than about 15 feet become less economical than other retaining systems because they require large amounts of reinforcing steel and concrete to support the earth pressures of the retained soil. CIP retaining walls typically have a heel that extends on the order of one-half the wall height behind the wall.

This type of retaining structure is relatively settlement-sensitive, and suitable foundation support is important. We anticipate that some overexcavation of loose fill soils will be required to achieve suitable foundation support for concrete cantilever retaining walls for this project. Specific recommendations for overexcavation of soft, compressible soils for Wall 9 are discussed below.

WALL 9 RECOMMENDATIONS

We understand Wall 9 will be a CIP wall based on aesthetic, staging, and performance requirements. Wall 9 is underlain by potentially compressible soils and we recommend overexcavation as illustrated in Figure 11. Provided overexcavation is completed as recommended, the following are our settlement and performance estimates for this wall. Design recommendations for Wall 9 and other CIP retaining walls are provided in subsequent sections of this report

- Wall Station 0+00 to 1+21: Settlement is expected to be ½ to 1 inch, with differential settlement less than ¾ inch over 100 feet, if compressible soils are encountered (conventional CIP per GDM Table 15-2). Less settlement is expected if compressible soils are not present. Settlements are tolerable for a CIP wall in this area without the need for overexcavation.
- Wall Station 1+21 to 1+56: This area has the potential for large differential settlement because the footing steps down and is likely underlain by compressible soils. Overexcavation is recommended as shown on Figure 11. With overexcavation, settlement is anticipated to be less than ½ inch (conventional CIP per GDM Table 15-2), with differential settlement less than ½ inch over 100 feet.

- Wall Station 1+56 to 2+30: Settlement is expected to be ½ to 1 inch because the compressible soils will be removed to complete the foundation excavation (conventional CIP per GDM Table 15-2).
- Wall Station 2+30 to 3+79: Settlement is expected to be between 1 to 2 inches without overexcavation, with differential settlement equal to total settlement. In order to meet the differential settlement requirements of the WSDOT GDM (Table 15-2), we recommend that overexcavation be a minimum of 2 feet at Station 2+30 transitioning to a minimum of 5 feet at Station 3+79. Some compressible soil will remain below the wall with this scenario. With the recommended partial overexcavation, we estimate that total settlement will be on the order of 1 inch, with differential settlement of about 1 inch over 100 feet (designer to check that structure can tolerate this amount of settlement per GDM Table 15-2).
- Wall Station 3+79 to 4+68. Foundation excavation will likely extend to the bottom of the compressible soils. Limited overexcavation (less than 2 feet) will be necessary if compressible soils are encountered at foundation elevation. Overexcavation should remove all soft, compressible soils from below the foundation. Settlement is expected to be less than ½ inch because the compressible soils will be removed (conventional CIP per GDM Table 15-2).

Overexcavated areas should be backfilled with crushed rock over a geotextile separator fabric (width of excavation extending beyond the edge of the footing a distance equal to the depth of overexcavation). If controlled density fill (CDF) is used to backfill the overexcavation, the overexcavation may be neat-cut to reduce potential impacts to the adjacent wetlands.

STANDARD PLAN WALLS

WSDOT has developed Standard Plans for CIP retaining walls. These walls are acceptable for this project site, in our opinion. The CIP retaining walls are designed in accordance with the criteria of AASHTO LRFD Bridge Design Specifications. In our opinion, the standard plan walls will exhibit adequate factors of safety with respect to global stability, provided the walls are designed and constructed in accordance with the applicable WSDOT standards.

Retaining wall backfill materials should consist of gravel backfill for walls as described in Section 9-03.12(2) of the WSDOT Standard Specifications. Placement and compaction of fill behind the walls should be in accordance with Section 2-09.3(1)E. Drainage behind the walls should be designed and constructed in accordance with WSDOT Standard Plan Sheet D-4.

We recommend that standard plan walls be supported on shallow foundations, which are discussed below in the “Shallow Foundations” section.

NON-STANDARD PLAN WALLS

Non-standard plan walls will need to be designed using the WSDOT LRFD approach in accordance with the criteria of the WSDOT GDM in conjunction with the AASHTO LRFD Bridge Design Specifications. Non-standard plan walls with level backslopes should be designed using the parameters shown in Table 11. We can provide earth pressures for other backslope configurations, if necessary.

TABLE 11. LATERAL EARTH PRESSURES AND SOIL PARAMETERS FOR NON-STANDARD PLAN WALLS

Parameter	Value
Backfill and Foundation Soil Unit Weight, γ	125 pcf
Backfill and Foundation Soil Friction Angle, ϕ	36°
Active Earth Pressure Coefficient , K_a	0.26
Active Earth Pressure [1]	32 pcf
Passive Earth Pressure Coefficient, K_p	3.85
Passive Earth Pressure [1] – Unfactored – Level Toe Slope	481 pcf
Active Seismic Earth Pressure Coefficient K_{ae}	0.37
Total Combined Active plus Seismic Earth Pressure [2,3]	23H psf
Traffic Surcharge Pressure [3]	65 psf
Concrete Wall Foundation Coefficient of Sliding – Unfactored	0.72

Notes:

[1] Equivalent Fluid Density – triangular pressure distribution

[2] H equals the retained wall height

[3] Rectangular pressure distribution

Where large surcharge loads (such as from nearby retaining walls within a horizontal distance equal to the height of the wall, or from heavy trucks, cranes or other construction equipment) are anticipated in close proximity to the retaining walls, the walls should also be designed to accommodate the additional lateral pressures resulting from these concentrated loads.

If soils adjacent to footings are disturbed during construction, the disturbed soils must be recompacted; otherwise, the lateral passive resistance value must be reduced. Recommendations for wall drainage are given in "Wall Drainage" section.

We recommend that non-standard plan walls be supported on shallow foundations, which are discussed below in the "Shallow Foundations" section.

SHALLOW FOUNDATIONS

The bearing capacity for shallow foundations for Strength, Service and Extreme Limit loading states are presented in Figure 8. We recommend that the LRFD resistance factors listed in Table 12 be used when evaluating the three limit states for spread footings. Footing design parameters are provided above in Table 11.

TABLE 12. LRFD SPREAD FOOTING RESISTANCE FACTORS

Limit State	Resistance Factor ϕ		
	Shear Resistance to Sliding	Bearing	Passive Pressure Resistance to Sliding
Strength	0.8	0.45	0.5
Service	1.0	1.0	1.0
Extreme	0.9	0.9	0.9

We estimate that postconstruction settlement of footings that are underlain by competent fill or glacially consolidated soil, and are designed and constructed as recommended will be on the order of 1 inch or less, with differential settlement on the order of half that amount (½ inch). Most of this settlement will occur rapidly as loads are applied. Settlement and performance expectations for Wall 9 located in soft ground areas are discussed above.

Lateral loads acting on structures supported by shallow foundations may be resisted by passive earth pressure against the embedded portion of the foundation, as well as friction along the base of the foundation. Unless covered by pavement or slabs, the passive resistance in the upper 12 inches of soil should be ignored.

The foundation subgrade for the shallow foundations should be prepared in accordance with the recommendations provided in the "Earthwork" section of this report. We recommend that the condition of all shallow foundation excavations be observed by a representative of GeoEngineers to evaluate whether the work is completed in accordance with our recommendations and whether the subsurface conditions are as expected.

FOUNDATION EMBEDMENT

CIP retaining walls should be supported on undisturbed native sand or structural fill. Both standard plan and non-standard plan concrete cantilever retaining walls should be embedded a minimum depth of 2 feet below final grades.

Structural Earth Walls

GENERAL

SE retaining walls are often a cost-effective method for support of fill embankments, provided sufficient space is available for placement of the reinforcing materials. Design of such a wall system must be based on site-specific conditions and geotechnical parameters. Precast concrete members (panels or blocks) are widely used as facing elements. Principal advantages of SE walls include relatively low unit cost and tolerance of relatively large differential settlements.

SE walls consist of alternating layers of backfill soil and reinforcing material with facing elements. Commonly used reinforcing elements include steel strips and various geosynthetic products such as geogrid and geotextile sheets. The vertical spacing of the reinforcing elements is typically on the order of 1 to 3 feet, depending on the type of wall, the reinforcing material specified and other parameters. If geosynthetic products are selected, long-term creep characteristics should be taken into consideration in product selection.

Many proprietary SE wall systems are available. The design procedures and wall details of several proprietary wall systems have been evaluated by WSDOT, which has resulted in a preapproved status for certain walls. An agreement between WSDOT and the proprietary wall manufacturer exists for preapproved systems, which allows the proprietary wall manufacturer to competitively bid a particular project without having to provide a detailed wall design in the contract plans. Preapproved proprietary wall systems with specific requirements and details are available in the Appendix of Chapter 15 of the WSDOT GDM. WSDOT should be contacted for a current list of the preapproved proprietary systems prior to selection of a system.

If a non-preapproved wall system is chosen, it will be necessary for the wall supplier to completely design the wall in accordance with the AASHTO Standard Specifications for Highway Bridges LRFD approach as modified in the WSDOT GDM.

We recommend that proprietary wall system designs be reviewed by the geotechnical engineer to confirm that valid assumptions were made relative to material properties, site conditions and other factors.

DESIGN PARAMETERS

SE walls should be designed in accordance with the AASHTO LRFD Bridge Design Manual and the WSDOT GDM. We recommend the design parameters summarized in Table 13 for use in design of SE walls. The values shown in Table 13 assume that the backfill soil is compacted as recommended in the "Earthwork" section of this report.

TABLE 13. RECOMMENDED DESIGN PARAMETERS FOR SE WALLS

Soil Properties	Reinforced Zone Soil	Retained Soil	Foundation Bearing Soil
	Gravel Borrow WSDOT 9-03.14(1)	Native Soils/ Common Borrow WSDOT 9-03.14(3)	Native Soils (Glacially Consolidated)
Unit Weight (pcf)	135	125	130
Friction Angle (degrees)	36	34	38
Cohesion (psf)	0	0	0
Allowable Bearing Capacity (psf) – AASHTO Group I	N/A	N/A	4,000
Allowable Bearing Capacity (psf) – AASHTO Group VII	N/A	N/A	6,000

The design heights of the SE walls should include the aboveground wall heights as well as the full embedment depths of the walls below the toes of the walls. Recommendations for wall embedment depths are based on the descending slope inclination in front of the walls as a function of overall wall height, as discussed below.

The SE walls should be designed for seismic loading as discussed in the "Earthquake Engineering" section of this report. In accordance with the WSDOT GDM, SE walls that are free to translate or move during a seismic event should be designed with a reduced coefficient of horizontal acceleration (k_h) of approximately one-half of the PGA for the site. This corresponds to a coefficient of horizontal acceleration of 0.227g. Alternatively, the value of the horizontal coefficient of acceleration can be calculated using the Mononobe-Okabe method specified in Article 11.6.5 of the AASHTO LRFD Bridge Design Specifications. The vertical coefficient of acceleration (k_v) will be set to 0 for the analysis. For internal stability, the SE wall design for pullout, reinforcement capacity, connection, and overturning should consider a PGA of 0.454g.

SE walls should be designed with a factor of safety of 1.5 for sliding and pullout of reinforcing elements and a factor of safety of 2 for overturning. If proprietary wall systems are used, the wall supplier is responsible for evaluating these items. However, we recommend that proprietary wall

system designs be reviewed by a qualified geotechnical engineer, to verify that valid assumptions were made relative to material properties and other factors.

The minimum embedment depth of the SE retaining walls will be a function of the height of the wall and the slope in front of the wall. We recommend that the permanent slopes in front of and above the SE walls be inclined no steeper than the existing topography. Temporary cut slopes to install the SE walls should be inclined no steeper than 1½H:1V.

The minimum embedment depth for walls founded on sloping ground should be provided as previously presented in Table 10. In addition, the minimum embedment depth should be provided below a theoretical 4-foot-wide horizontal bench that extends from the face of the wall and intersects the sloping ground in front of the wall.

If the SE walls will be subjected to the influence of surcharge loading from traffic or nearby retaining walls within a horizontal distance equal to the height of the SE wall, the walls should be designed for the additional horizontal pressure using an appropriate design method. A common practice is to assume a surcharge loading equivalent to 2 feet of additional fill to simulate traffic loading; we consider this method appropriate for typical situations. Where large surcharge loads (such as from nearby retaining walls, heavy trucks, cranes or other construction equipment) are anticipated in close proximity to the SE retaining walls, the walls should also be designed to accommodate the additional lateral pressures resulting from these concentrated loads.

The foundation subgrade for the SE walls should be prepared in accordance with the recommendations provided in the "Earthwork" section of this report. We recommend that the condition of all SE wall foundation excavations be observed by GeoEngineers to evaluate whether the work is completed in accordance with our recommendations and whether the subsurface conditions are as expected. Recommendations for wall drainage are given in the "Wall Drainage" section.

If the foundation subgrade for the SE walls is adequately prepared, we anticipate that differential settlement along 100 linear feet of the SE wall will be less than about ¾ inch.

Gravity Walls

Gravity walls, which were discussed in the previous section, can be used to support fill embankments. Table 14 presents the recommended design soil parameters for fill walls per AASHTO LRFD Bridge Design Manual and the GDM.

TABLE 14. LATERAL EARTH PRESSURES AND SOIL PARAMETERS FOR FILL EMBANKMENT GRAVITY WALLS

Parameter	Value
Backfill Soil Unit Weight, γ	125 pcf
Backfill Soil Friction Angle, ϕ	36°
Foundation Soil Unit Weight, γ	125 pcf
Foundation Soil Friction Angle, ϕ	36°
Allowable Bearing Capacity – AASHTO Group I	3,000 psf

Parameter	Value		
Allowable Bearing Capacity – AASHTO Group VII	4,000 psf		
Wall Foundation Coefficient of Sliding – Unfactored	0.72		
Traffic Surcharge Lateral Pressure [3]	65 psf		
Active Earth Pressure Coefficient, K_a	0.26		
Active Earth Pressure [1]	32 pcf		
Combined Active and Seismic Earth Pressure Coefficient, K_{ae}	0.37		
Combined Active and Seismic Earth Pressure [2, 3]	23H psf		
Foreslope:	Level	3H:1V	2H:1V
Passive Earth Pressure Coefficient, K_p	3.85	2.03	1.45
Passive Earth Pressure [1] – Unfactored	481 pcf	254 pcf	181 pcf

Notes:

[1] Equivalent Fluid Density – triangular pressure distribution

[2] H equals the retained wall height

[3] Rectangular pressure distribution

The design height of the gravity walls should include the aboveground wall height as well as the full embedment depth of the wall below the toe of the wall. We recommend that the wall foundations be supported on shallow foundations bearing on properly compacted structural fill or on undisturbed glacially consolidated soils.

The minimum embedment depth for walls founded on level ground should be provided as described previously in Table 10.

Wall Drainage

General

Permanent drainage system should intercept surface water runoff at the top of cut and fill walls to prevent it from flowing in an uncontrolled manner across the wall face.

For all wall backdrains we recommend using either heavy-wall pipe (SDR-35) or rigid corrugated polyethylene pipe (ADS N-12, or equivalent) for wall drainage collector pipes. We recommend against using flexible tubing for wall drainpipe. The pipes should be laid with a minimum slope of ½ percent and discharge into the stormwater collection system to convey the water to a suitable disposal location. The pipe installations should include cleanouts to allow for future maintenance.

Soldier Pile Walls

Wall drainage for soldier pile walls can be completed by allowing seepage to pass through the lagging or drain behind the lagging to the bottom of the wall. We recommend a vertical spacing between the timber lagging boards of approximately ⅜ inch. We also recommend the installation of a full-coverage prefabricated drainage board, such as MiraDrain™. The drainage board should be located behind the lagging unless the wall incorporates a relatively impermeable facing, in which case the drainage board should be installed in front of the lagging. Seepage flows at the base of the wall should be contained and controlled with the installation of a collector drain.

The drain should consist of 4-inch-diameter perforated collector pipe enveloped within a minimum thickness of 6 inches of gravel backfill for drains conforming to Section 9-03.12(4) of the WSDOT Standard Specifications. A construction geotextile for underground drainage, moderate survivability, conforming to Section 9-33 of the WSDOT Standard Specifications should be placed between the gravel backfill and the native soils to prevent movement of the soils into the drainage backfill.

Gravity Walls

Positive drainage should be provided behind gravity walls by backfilling the wall with gravel backfill for walls (WSDOT Standard Specifications Section 9-03.12(2)) and installing weepholes in accordance with the WSDOT Standard Plans and WSDOT Standard Specifications Section 6-02.3(21).

Alternatively, a collector drain can be installed behind the wall. The drain should consist of 4-inch-diameter perforated collector pipe enveloped within a minimum thickness of 6 inches of gravel backfill for drains conforming to Section 9-03.12(4) of the WSDOT Standard Specifications. A construction geotextile for underground drainage, moderate survivability, conforming to Section 9-33 of the WSDOT Standard Specifications should be placed between the gravel backfill and the native soils to prevent movement of the soils into the drainage backfill.

SE Walls

Wall drainage for SE walls constructed using gravel borrow (WSDOT Standard Specifications Section 9-03.14(1)) in the reinforced zone can be completed by placing a perforated drainpipe with a minimum diameter of 4 inches at the back of the reinforced zone enveloped within a minimum thickness of 6 inches of gravel backfill for drains (WSDOT Standard Specifications Section 9-03.12(4)).

Rockeries

Seepage flows at the base of rockeries should be contained and controlled with the installation of a collector drain. The drain should consist of 4-inch-diameter perforated collector pipe enveloped within a minimum thickness of 6 inches of gravel backfill for drains conforming to Section 9-03.12(4) of the WSDOT Standard Specifications. A construction geotextile for underground drainage, moderate survivability, conforming to Section 9-33 of the WSDOT Standard Specifications should be placed between the gravel backfill and the native soils to prevent movement of the soils into the drainage backfill.

West Tributary Creek Culvert

Culvert Design Recommendations

The project includes removal of an existing 48-inch corrugated metal pipe (CMP) below 124th Avenue NE (below the proposed intersection with NE 18th Street and 124th Avenue NE) and replacing the CMP with a three-sided box culvert structure to improve fish passage through West Tributary Creek.

Based on our understanding of the site soil conditions, as described in the “Subsurface Conditions” of this report, we anticipate that organic silt and/or peat soils may be encountered

near the West Tributary Creek. We recommend that the proposed foundations be founded on native dense soils below organic silt and/or peat soils, if present, or on structural fill bearing directly on the dense soils. In either case, the overexcavation of several feet of unsuitable organic silt and/or peat soils is likely to properly support the planned structures. We recommend that the structures be designed using the parameters discussed for shallow footings in the "Fill Embankment Retaining Wall" section of this report.

The creek conveyance structures should be designed to resist buoyancy uplift considering the dead weight of the structures, weight of soil above structures and portions that protrude beyond the perimeter of the structures, and soil shear resistance on the buried walls. We can assist with these analyses if requested.

Lock Block Wall Recommendations

GENERAL

We understand the existing Metro flow control structure needs to remain in place and functional after replacement of the CMP with the box culvert structure. Based on our discussions with HDR, the preferred alternative is to construct a concrete block wall with a geomembrane liner to maintain the current overflow elevation of 138.5 feet on the flow control structure. The downstream side of the blocks will be covered with a 2H:1V soil slope, which will be vegetated.

FOUNDATION SUBGRADE PREPARATION

The foundation subgrade for support of the Lock Block wall should consist of firm, undisturbed native soils (stiff silt). Based on boring GEI-6, the elevation of these soils is anticipated to be close to the base of the proposed gravel layer at the base of the channel. Loose, sandy soils should be overexcavated to support the wall on the stiff silt, to limit seepage below the wall. The blocks may be supported directly on the silt or on CDF placed over the silt to provide a leveling pad and flow barrier layer. Granular material should not be used below the base of the wall, since this material would provide a preferential flow path for seepage below the wall.

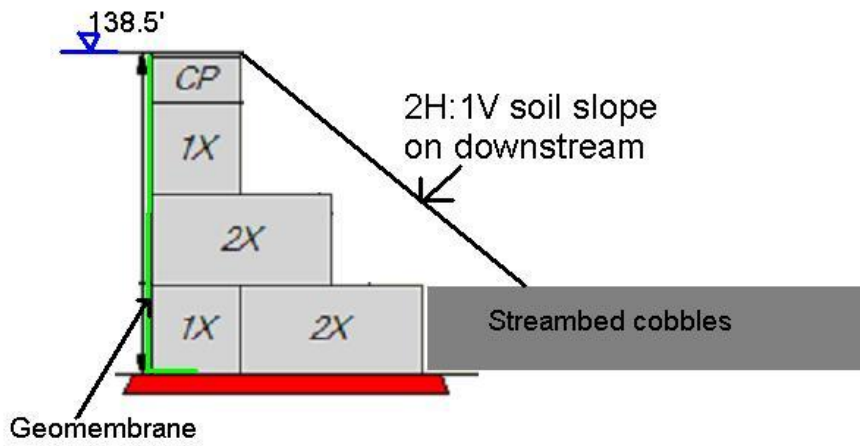
GLOBAL STABILITY ANALYSIS

Because the wall will be supported on stiff silt, it is our opinion it will have adequate global stability, provided the wall is properly designed for external stability, as discussed below.

DESIGN PARAMETERS

Design parameters used for design of the Lock Block wall are presented below:

- Foundation Soil: Native Stiff Silt, Unit Weight = 115 pounds per cubic foot (pcf), Friction Angle = 34 degrees, Soil/Block Friction Angle = 16.5 degrees; Unfactored Bearing Pressure = 4,000 pounds per square foot (psf)
- Wall supports 6 feet of water on upstream side (Elevation 138.5 feet at flow control structure, Elevation 132.5 feet at downstream side)
- 2.5-foot minimum embedment/ minimum bury depth at face of wall
- No wall batter (vertical)
- Safety Factors (Static): Sliding = 1.5, Overturning = 2.0, Bearing Capacity = 3.0



WALL DESIGN

We completed analysis for the required wall height using the design parameters presented above. Our analysis was completed using the UltraWall version 1.0.24 software. The anticipated gravity block wall geometry is illustrated to the right. We also checked the sliding and overturning and confirmed this wall geometry is adequate for external stability.

GEOMEMBRANE

We recommend the upstream side of the block wall be covered with a geomembrane to reduce seepage between the individual. We recommend at a minimum that the membrane consist of a 30-mil-thick product.

CONSTRUCTION CONSIDERATIONS

We recommend the soil slope on the downslope side of the block be compacted to at least 90 percent of the maximum dry density (MDD) estimated in general accordance with American Society for Testing and Materials (ASTM) D 1557. The slope should be overbuilt slightly (1 to 2 feet) and subsequently cut back to expose properly compacted fill.

To reduce erosion, newly constructed slopes should be planted or hydroseeded shortly after completion of grading. Until the vegetation is established, some sloughing and raveling of the slopes should be expected. This may require localized repairs and reseeding. Temporary covering, such as clear heavy plastic sheeting, jute fabric, loose straw or excelsior matting should be used to protect the slopes during periods of rainfall.

Stormwater Vault

We understand a large precast concrete stormwater detention vault will be constructed below the roadway south of NE 18th Street. We recommend the design parameters presented in Table 15 for design of the vault.

TABLE 15. LATERAL EARTH PRESSURES AND SOIL PARAMETERS FOR DETENTION VAULT

Parameter	Value
Backfill and Foundation Soil Unit Weight (above groundwater), γ	125 pcf
Backfill and Foundation Soil Unit Weight (below groundwater), γ'	62.4 pcf
Backfill and Foundation Soil Friction Angle, ϕ	36°
At Rest Earth Pressure Coefficient , K_o	0.41
At Rest Earth Pressure (above groundwater) [1]	52 pcf
At Rest Earth and Water Pressure (below groundwater) [1]	(26 + 62.4) = 88.4 pcf
Passive Earth Pressure Coefficient, K_p	3.85
Passive Earth Pressure (below groundwater) [1] – Unfactored – Level Toe Slope	241 pcf
Seismic Earth Pressure [2,3]	11H psf
Traffic Surcharge Pressure [3]	65 psf
Concrete Wall Foundation Coefficient of Sliding – Unfactored	0.72

Notes:

[1] Equivalent Fluid Density – triangular pressure distribution

[2] H equals the retained wall height

[3] Rectangular pressure distribution

SCL Monopole Drilled Shaft Foundations

Axial Capacity

We understand that large diameter drilled shaft foundations are planned for support of the monopoles that will replace the existing SCL lattice transmission towers. We evaluated the axial capacity of 7-foot-diameter shafts in accordance with the methods presented in the AASHTO LRFD Bridge Design Specifications. The axial shaft capacities for Service, Strength and Extreme Limit loading states are provided in the following figures:

- Figure 9 – Drilled Shaft Axial Capacity, GEI-16 (Northern SCL Structure)
- Figure 10 – Drilled Shaft Axial Capacity, GEI-18 (Southern SCL Structure)

We recommend the resistance factors presented in Table 16 be used when evaluating the three limit states for the drilled shaft foundations. The capacity plots presented in Figures 9 and 10 incorporate the appropriate resistance factors. The service limit condition assumes 1 inch of settlement.

TABLE 16. LRFD DRILLED SHAFT FOUNDATION RESISTANCE FACTORS

Limit State	Resistance Factor ϕ	
	Skin Friction	End Bearing
Strength	0.55	0.5
Service	1.0	1.0
Extreme	1.0	1.0

Lateral capacity and not axial capacity typically governs the design of drilled shaft foundations for steel monopole structures.

Lateral Capacity

LATERAL ANALYSIS

We understand the lateral capacity and performance of the drilled shafts will be evaluated by HDR using LPILE. The recommended LPILE parameters are presented in Tables 17 and 18 below.

TABLE 17. LPILE PARAMETERS FOR GEI-16 (NORTHERN SCL STRUCTURE)

Soil Unit	Elevation (feet)	Soil Type	Effective Unit Weight (pounds per cubic inch)	Friction Angle (degree)	Soil Modulus (pounds per cubic inch)
Fill/Silt and Clay	166.5 to 158.5	Sand	0.0723	34	90
Sand and Gravel	158.5 to 144.5	Sand	0.0781	40	225
Sand and Gravel	144.5 to 75	Sand	0.0434	40	125

TABLE 18. LPILE PARAMETERS FOR GEI-18 (SOUTHERN SCL STRUCTURE)

Soil Unit	Elevation (feet)	Soil Type	Effective Unit Weight (pounds per cubic inch)	Friction Angle (degree)	Soil Modulus (pounds per cubic inch)
Fill/Silt and Clay	183 to 175	Sand	0.0723	34	90
Sand and Gravel	175 to 139.8	Sand	0.0781	40	225
Sand and Gravel	139.8 to 101	Sand	0.0434	40	125

Construction Considerations

Groundwater is expected to be encountered during excavation of the drilled shafts. A monitoring well was installed in GEI-18 that may be used by the contractor to measure groundwater levels prior to construction. The contractor should be prepared to deal with groundwater seepage and potential caving during drilling, particularly of the sand and gravel soils encountered in the borings below the groundwater level. The contractor should plan on using “wet” construction methods using drilling slurry to maintain sidewall stability.

Drilled shafts should be excavated with equipment that reduces the amount of loose cuttings or slough at the bottom of the drilled hole. Slough and loose cuttings should be removed from the hole prior to placing the concrete. Since “wet” construction methods will be used, it will be necessary to use tremie methods for placement of concrete. Nondestructive testing of shafts using CSL is required for all drilled shafts constructed using “wet” methods.

Cobbles and boulders are frequently encountered in glacially deposited soils. The contractor should be prepared to remove cobbles and boulders during drilled shaft construction.

Earthwork

Earthwork Considerations

Fill and glacially consolidated soils were observed in the explorations. We anticipate that these soils can be excavated with conventional excavation equipment, such as trackhoes or dozers. Cobbles and boulders are frequently encountered in glacially consolidated soils. Larger horsepower excavators will be more efficient for excavating the very dense, native soils, or if large cobbles and boulders are encountered in the deeper excavations. The contractor should be prepared to deal with debris in the fill and cobbles and boulders in the native soils.

Clearing and Grubbing

The existing ground surface along the project corridor is typically vegetated or paved as discussed in the "Surface Conditions" section of this report. Embankment areas covered with vegetation should be cleared and grubbed in accordance with Section 2-01 of the WSDOT Standard Specifications.

Subgrade Preparation

Prior to placing new fill, subbase or base course materials, subgrade areas should be proof-rolled to locate areas of loose, soft or pumping soils. Proof-rolling can be completed using a piece of heavy tire-mounted equipment or a loaded dump truck. If soft or pumping soils are observed, such unsuitable subgrade soils should be recompacted or overexcavated and replaced. The depth of overexcavation should be determined by GeoEngineers.

We recommend overexcavation to remove potentially compressible soils below Wall 9 as presented in Figure 11. Overexcavated areas should be backfilled with crushed rock over a Geotextile for Separation or Soil Stabilization (WSDOT Standard Specification 9-33.2), with the width of excavation extending beyond the edge of the footing a distance equal to the depth of overexcavation. If CDF is used to backfill the overexcavation, the overexcavation may be neat-cut to reduce potential impacts to the adjacent wetlands

If deep pockets of soft or pumping soils are encountered, it may be possible to limit the depth of overexcavation by placing a Geotextile for Separation or Soil Stabilization (WSDOT Standard Specification 9-33.2) on the overexcavated subgrade and covering the geotextile with structural fill. We recommend using the specified woven fabric for soil stabilization. The geotextile will provide additional support by bridging over the soft material, and will help reduce fines contamination into the structural fill. The need for geotextile fabric and overexcavation should be evaluated by GeoEngineers during construction.

GeoEngineers should monitor the subgrade preparation operations to help determine the depth of removal of soft or pumping soils, and to evaluate whether subgrade disturbance or progressive deterioration is occurring. Subgrade disturbance or deterioration could occur if the subgrade is wet and cannot be dried. If the subgrade deteriorates during proof-rolling or compaction, it may become necessary to modify the proof-rolling or compaction criteria or methods.

Backfill in old utility trenches or previously placed to construct the existing road prism that exhibit surface settlement or pavement distress should be tested and recompacted if necessary.

The uppermost 2 feet supporting the pavement structure should be compacted to at least 95 percent of the MDD estimated in general accordance with ASTM D 1557. Material below this level should be compacted to at least 90 percent.

Structural Fill Materials

GENERAL

Materials used to construct roadways, placed to support retaining structures or foundations, or placed behind retaining structures is classified as structural fill for the purpose of this report. Structural fill material quality varies depending upon its use, as described below:

1. As a minimum, structural fill placed to construct embankments and roadways, to backfill utility trenches and to support foundations should meet the criteria for common borrow, WSDOT 9-03.14(3). Common borrow will be suitable for use as structural fill during dry weather conditions only. If structural fill is placed during wet weather, the structural fill should consist of gravel borrow, WSDOT 9-03.14(1).
2. Structural backfill for walls should meet the criteria for gravel backfill for walls, WSDOT 9-03.12(2).
3. Structural fill placed to surround collector pipe (drain rock) should meet the criteria for gravel backfill for drains, WSDOT 9-03.12(4).
4. Structural fill placed as crushed surfacing base course below pavements should conform to WSDOT 9-03.9(3).

ON-SITE SOILS

The soils observed in the explorations generally contain a high percentage of fines (silt and clay) and are moisture-sensitive. Some of the on-site soils may meet the criteria for common borrow and may be suitable for use during dry weather construction only, provided the soil has a moisture content near optimum. Fine-grained soils (silt and clay) do not meet the criteria for common borrow and should not be used. Peat and organic silt soils are unsuitable for use as structural fill.

FILL PLACEMENT AND COMPACTION CRITERIA

Structural fill should be mechanically compacted to a firm, non-yielding condition. Structural fill should be placed in loose lifts not exceeding 1 foot in thickness. Each lift should be conditioned to the proper moisture content and compacted to the specified density before placing subsequent lifts. Structural fill should be compacted to the following criteria:

1. Structural fill placed behind retaining walls should be compacted to at least 90 percent of the MDD in general accordance with ASTM D 1557. Care should be taken when compacting fill near the face of retaining walls to avoid overcompaction and hence overstressing the walls.
2. Structural fill in embankment and new pavement areas, including utility trench backfill, should be compacted to 90 percent of the MDD (ASTM D 1557), except that the upper 2 feet of fill below final subgrade should be compacted to 95 percent of the MDD (ASTM D 1557).
3. Structural fill placed below foundations should be compacted to 95 percent of the MDD (ASTM D 1557).
4. Structural fill placed as crushed rock base course below pavements should be compacted to 95 percent of the MDD (ASTM D 1557).

We recommend that a representative of GeoEngineers be present during proof-rolling and/or probing of the exposed subgrade and pavement subgrade soils, and during placement of structural fill. GeoEngineers will evaluate the adequacy of the subgrade soils and identify areas needing further work, perform in-place moisture-density tests in the fill to evaluate whether the work is being done in accordance with the compaction specifications, and advise on any modifications to procedure that may be appropriate for the prevailing conditions.

WEATHER CONSIDERATIONS

The on-site soils generally contain a high percentage of fines (silt and clay) and are moisture-sensitive. When the moisture content of these soils is more than a few percent above the optimum moisture content, these soils become muddy and unstable, operation of equipment on these soils will be difficult, and it will be difficult or impossible to meet the required compaction criteria. Additionally, disturbance of near-surface soils should be expected if earthwork is completed during periods of wet weather. The contractor will need to take precautions to protect the subgrade during periods of wet weather.

The wet weather season in western Washington generally begins in October and continues through May; however, periods of wet weather may occur during any month of the year. The optimum earthwork period for these types of soils is typically June through September. If wet weather earthwork is unavoidable, we recommend that:

- The ground surface in and around the work area should be sloped so that surface water is directed away from the work area. The ground surface should be graded such that areas of ponded water do not develop. The contractor should take measures to prevent surface water from collecting in excavations and trenches. Measures should be implemented to remove surface water from the work area.
- Erosion control techniques should be implemented to prevent sediment from leaving the site.
- Earthwork activities should not take place during periods of heavy precipitation.
- Slopes with exposed soils should be covered with plastic sheeting.
- The contractor should take necessary measures to prevent on-site soils and soils to be used as fill from becoming wet or unstable. These measures may include the use of plastic sheeting, sumps with pumps, and grading. The site soils should not be left uncompacted and exposed to moisture. Sealing the surficial soils by rolling with a smooth-drum roller prior to periods of precipitation will help reduce the extent that these soils become wet or unstable.
- Construction activities should be scheduled so that the length of time that soils are left exposed to moisture is reduced to the extent practical.

Underground Utilities

TEMPORARY SHORING

The installation of the new underground utilities may require some type of shoring system to support the temporary excavations and maintain the integrity of the surrounding undisturbed soils, to reduce disruption of adjacent improvements and to protect the personnel working within the excavations.

Because of the diversity of available shoring systems and construction techniques, the design of temporary shoring is most appropriately left up to the contractor proposing to complete the installation. The following paragraphs present recommendations for the type of shoring system and design parameters that we conclude are appropriate for the subsurface conditions at the project.

The soils within the project area can be retained using conventional trench shoring systems such as trench boxes. The design of temporary shoring should allow for lateral pressures exerted by the adjacent soil, surcharge loads from traffic, construction equipment and temporary stockpiles adjacent to the excavation, etc. Temporary shoring used to support trench excavations typically uses internal bracing such as hydraulic or fixed braces.

Temporary trench shoring using internal bracing can be designed using active soil pressures. We recommend that temporary shoring be designed using a lateral pressure equal to an equivalent fluid density of 35 pcf, for conditions with horizontal backfill adjacent to the excavation. If the ground within 5 feet of the excavation rises at an inclination of 1½H:1V or steeper, the shoring should be designed using an equivalent fluid density of 75 pcf. For adjacent slopes flatter than 1½H:1V, soil pressures can be interpolated between this range of values. Other conditions should be evaluated on a case-by-case basis.

These lateral soil pressures do not include traffic or construction surcharges, which should be added separately, if appropriate. Shoring should be designed for a traffic influence equal to a uniform lateral pressure of 100 psf acting over a depth of 10 feet from the ground surface. More conservative pressure values should be used if the designer deems them appropriate. These soil pressure recommendations are predicated upon the construction being essentially dewatered; therefore, hydrostatic water pressures are not included.

DEWATERING CONSIDERATIONS

Based on the available subsurface information, the proposed excavations will not likely extend below the regional groundwater table. However, perched groundwater will most likely be encountered throughout the site. In general, we anticipate that groundwater seepage in the proposed excavations can be controlled with in-trench pumping from sumps.

Temporary Slopes

We recommend that temporary unsupported cut slopes greater than 4 feet deep be inclined no steeper than 1½H:1V. This applies to fully dewatered conditions. Flatter slopes may be necessary if seepage is present on the cut face. Temporary cut slopes should encroach no closer than 5 feet laterally from roadways, pavements, structures or other improvements. Some sloughing and raveling of the cut slopes should be expected. Temporary covering, such as heavy plastic sheeting, should be used to protect these slopes during periods of rainfall. Surface water runoff from above cut slopes must be prevented from flowing over the slope face by using curbs, berms, drainage ditches, swales or other appropriate methods.

If temporary cut slopes experience excessive sloughing or raveling during construction, it may become necessary to modify the cut slopes to maintain safe working conditions and protect adjacent facilities or structures. Slopes experiencing excessive sloughing or raveling can be

flattened or can be regraded to add intermediate slope benches, or additional dewatering can be provided if the poor slope performance is related to groundwater seepage.

Benching

In area where fill will be placed against existing slopes, the fill should be effectively keyed into the existing slope as described in Section 2-03.3(14) of the WSDOT Standard Specifications.

Permanent Slopes

We recommend that permanent cut and fill slopes be constructed no steeper than 2H:1V. To achieve uniform compaction, we recommend that fill slopes be overbuilt slightly and subsequently cut back to expose properly compacted fill. We recommend that the finished slope faces be compacted by track walking with the equipment running perpendicular to the slope contours so that the track grouser marks help provide an erosion-resistant slope texture.

To reduce erosion, newly constructed slopes should be planted or hydroseeded shortly after completion of grading. Until the vegetation is established, some sloughing and raveling of the slopes should be expected. This may require localized repairs and reseeding. Temporary covering, such as clear heavy plastic sheeting, jute fabric, loose straw, or excelsior or straw/coconut matting, should be used to protect the slopes during periods of rainfall.

Site Drainage

Permanent drainage systems should intercept surface water runoff at the top and/or bottom of cut and fill slopes to prevent it from flowing in an uncontrolled manner across or off the site. The finished ground surface adjacent to new retaining walls should be sloped so that surface water runoff flows away from the structures.

Traffic Signal and Luminaire Foundations

General

We understand that new traffic signals and luminaires are planned for the project. Pole foundation dimensions and loading have not been finalized; however, we anticipate that all project poles and foundations will comply with WSDOT preapproved signal pole and foundation designs. The following recommendations are based on the WSDOT GDM.

Design Considerations

Drilled shaft foundations designed in accordance with the WSDOT Design Manual and WSDOT GDM, require a lateral-bearing pressure to determine the shaft depth required. The WSDOT design method to estimate lateral-bearing pressures is based on empirical correlations with blow count data and the angle of internal friction of the soil. Pole foundation may be designed using a soil unit weight of 125 pcf, a soil friction angle of 30 degrees, and an allowable lateral bearing pressure of 1,500 psf.

These recommendations assume that new pole foundations are founded in medium dense or denser native sand and gravel soils or properly compacted structural fill.

Construction Considerations

We recommend that drilled shaft foundations for the poles be installed using the WSDOT procedure. Concrete should be cast near against excavation sides. The use of temporary casing, drilling mud or other types of procedures should be used, as necessary, to control sloughing of sidewalls. However, any casing should be removed while the concrete is still fluid so that proper soil/cement contact is achieved. Sonotube casings should not be used. Slough should be removed from the bottom of the excavation prior to placement of concrete, as loose or disturbed soil in the excavation base could result in increased settlement.

Structures that require relatively short shafts (less than 9 feet deep) may be formed and constructed in an open excavation. The backfill placed around the foundation in the excavation must be compacted in accordance with the WSDOT Standard Specification M41-10, Section 2-09.3(1)E and as described in the "Earthwork" section of this report using high quality soil backfill. Foundation construction should be in accordance with WSDOT Standard Specifications M41-10, Sections 8-20.3(2) and 8-20.3(4). Following the removal of the concrete forms (the forms may be left in place ONLY if CMP is used), compacted backfill should be placed around the shaft to provide containment. CDF may be used as an alternative for structural backfill.

On the basis of our explorations and experience in the project vicinity, it is our opinion that perched groundwater could be encountered during construction. We recommend that casing and tremie or temporary dewatering methods be used to displace perched groundwater, if encountered, prior to the placement of concrete for pole foundations.

We recommend that GeoEngineers be present during foundation excavation and/or drilling. GeoEngineers will evaluate and confirm the adequacy of the subgrade soils with respect to the anticipated conditions based on the borings and foundation design recommendations presented in this report.

Infiltration Evaluation

Empirical Correlations

We understand that Natural Drainage Practices (NDP) improvements may be incorporated into the project including sidewalks designed as pervious pavements and/or bioretention (rain gardens) for stormwater management.

The design of pervious sidewalks for stormwater management depends on the storage capacity of the pervious sidewalk system (capacity of the pervious sidewalk and the capacity of the crushed rock subbase) and infiltration capacity of the subgrade soils. The effective porosity of the pervious concrete depends on the concrete mix design used. The effective porosity of the crushed rock subbase should be evaluated from laboratory tests, but is typically about 30 to 45 percent for clean crushed rock (negligible fines and sand content).

Pursuant to the City of Bellevue Storm and Surface Water Engineering Standards, dated January 2011, Section D4-06.7 - Infiltration Systems, Subsection D – Infiltration Test Requirement, design infiltration rates shall be determined using one of the three methods outlined in Volume III, Chapter 3 and Appendix C of the Department of Ecology Stormwater Management Manual

or Western Washington (SMMWW); USDA Textural Classification, ASTM Gradation, or In-Situ Infiltration Measurements.

Two methods were used to evaluate an appropriate design (long-term) infiltration rate for the various soils encountered at the site in the current explorations. The methods consist of correlations based on United States Department of Agriculture (USDA) soil textural classification and ASTM gradation testing, as discussed in Section 3.3.6 of the SMMWW (Ecology, 2005).

Table 19 presents a summary of the estimated infiltration rate based on the two methods for correlations infiltration rate with laboratory data: (1) USDA textural class and (2) ASTM laboratory gradation testing. Groundwater conditions at the site are summarized in the "Subsurface Conditions" section of this report.

TABLE 19. INFILTRATION RATE CORRELATIONS

Exploration	Depth (feet)	USDA Textural Class	Estimate of Short-Term Infiltration Rate (inches/hour)	Estimate of Long-Term Infiltration Rate (inches/hour)[1]	
				USDA	ASTM
GEI-1	5	sandy loam	1	0.25	< 0.8 (0.2 to 2)[2]
GEI-1	15	loamy sand	2	0.5	0.8 (0.2 to 2)[2]
GEI-2	5	loamy sand	2	0.5	0.8 (0.2 to 2)[2]
GEI-3	5	sandy loam	1	0.25	< 0.8 (0.2 to 2)[2]
GEI-5	5	silt loam	0.5	<0.25	< 0.8 (0.2 to 2)[2]
GEI-5	7.5	loamy sand	2	0.5	0.8 (0.2 to 2)[2]
GEI-6	5	sandy loam	1	0.25	< 0.8 (0.2 to 2)[2]
GEI-7	5	silt loam	0.5	<0.25	< 0.8 (0.2 to 2)[2]
GEI-7	7½	silt loam	0.5	<0.25	< 0.8 (0.2 to 2)[2]
GEI-8	5	silt loam	0.5	<0.25	< 0.8 (0.2 to 2)[2]
GEI-9	7½	sandy loam	1	0.25	< 0.8 (0.2 to 2)[2]
GEI-10	7½	loamy sand	2	0.5	0.8 (0.2 to 2)[2]
GEI-11	5	sandy loam	1	0.25	< 0.8 (0.2 to 2)[2]

Exploration	Depth (feet)	USDA Textural Class	Estimate of Short-Term Infiltration Rate (inches/hour)	Estimate of Long-Term Infiltration Rate (inches/hour)[1]	
				USDA	ASTM
GEI-13	5	sandy loam	1	0.25	< 0.8 (0.2 to 2)[2]
GEI-15	5	sandy loam	1	0.25	< 0.8 (0.2 to 2)[2]
GEI-16	15	sandy loam	1	0.25	< 0.8 (0.2 to 2)[2]
GEI-16	30	loamy sand	2	0.5	1 (0.2 to 2)[2]
GEI-16	55	silt loam	0.5	<0.25	< 0.8 (0.2 to 2)[2]
GEI-16	75	loamy sand	2	0.5	1 (0.2 to 2)[2]
GEI-17	25	silt loam	0.5	<0.25	< 0.8 (0.2 to 2)[2]
GEI-17	40	loamy sand	2	0.5	0.8 (0.2 to 2)[2]
GEI-18	30	sandy loam	1	0.25	< 0.8 (0.2 to 2)[2]
GEI-18	40	sandy loam	1	0.25	< 0.8 (0.2 to 2)[2]
GEI-18	55	loamy sand	2	0.5	0.8 (0.2 to 2)[2]
GEI-18	65	loamy sand	2	0.5	0.8 (0.2 to 2)[2]

Notes:

[1] Infiltration rates shown for two different methodologies per DOE simplified procedure. These values incorporate a correction factor as described in Volume III, Chapter 3 of the SWMWW.

[2] Recommend using 0.5 in/hr. (range dependent on influent control, long-term maintenance, soil layering, and groundwater separation). After Massmann, et al. 2003.

Based on the USDA textural and the ASTM Gradation methods of evaluating approximate design (long-term) infiltration rates, the near-surface on-site soils are generally suitable for slow to moderate stormwater infiltration.

For bioretention areas (rain gardens), Section 7.7 of Appendix C of the DOE Manual, Subsection 7.7.4 – Infiltration Rate Determinations, states that the assumed infiltration rate for the bioretention area must be the lower of the long-term rate of the imported soil (amended soil) or the initial (short-term) infiltration rate of the underlying (native) soil. This section also states that the underlying native soil does not need a (infiltration rate) correction factor because the overlying imported soil protects it. Accordingly, we recommend that NDP improvements which incorporate an amended soil layer be designed using the lower of the amended soil long-term infiltration rate or

the short-term infiltration rate of the native soil. The recommended design short-term infiltration rate of the native soils encountered in the borings are presented in the above table.

It should be noted that the infiltration rates presented herein are based on design guidelines that are intentionally conservative, not on actual on-site infiltration performance testing. We recommend completing on-site infiltration testing (Pilot Infiltration Tests) to establish more site-specific infiltration performance values. In our experience, site-specific testing often demonstrates higher infiltration performance than the values discussed above.

We recommend that the construction plans for this project include a note to require field verification during construction of the facility, of soil conditions, and infiltration rates by an engineer with experience in stormwater management and licensed in the State of Washington. The engineer shall provide a written statement to the City related to the field verification of the design parameters.

Rain Garden Site Preparation

In addition to the recommendations presented in the "Earthwork" section of this report, we recommend the following site preparation recommendations for rain gardens and other NDP facilities.

Rain gardens should be excavated to final depth and configuration using equipment that operates outside the footprint of the rain garden. Under no circumstances should equipment be allowed with the footprint of the rain garden; otherwise the native soil subgrade could be compacted by the weight of the equipment and possibly reduce the infiltration performance of the soil. Consideration should be given to hand raking the final subgrade to help scarify the subgrade.

We recommend placing either a non-woven geotextile separator fabric or a layer of sand filter on the native soil subgrade prior to placing the retention zone gravel (if used) or amended soil in the rain garden. We understand the sand filter layer is the preferred alternative, and we recommend the sand filter layer meet the requirements of WSDOT Standard Specification 9-03.13.

Stormwater runoff should not be allowed to enter the rain garden until the vegetation is established. This is particularly critical during the construction phase when stormwater runoff can be very silty.

Pavement Design

Subgrade Preparation

We recommend that the subgrade soils in new pavement areas be prepared and evaluated as described in the "Earthwork" section of this report. We recommend that the subgrade be compacted to at least 95 percent of the MDD per ASTM D 1557 prior to placing pavement section materials. If the subgrade soils are loose or soft, it may be necessary to excavate the soils and replace them with structural fill. A layer of suitable woven geotextile fabric may be placed over soft subgrade areas to limit the thickness of structural fill required to bridge soft, yielding areas.

New Hot Mix Asphalt Pavements

At a minimum we recommend that new pavement sections be designed for "Public Street (Arterial)" in accordance with City of Bellevue Transportation Design Manual drawing DEV-9. The City of Bellevue minimum requirements for hot mix asphalt (HMA) pavement sections are presented below in Table 20. We recommend that these values be checked against calculated sections based upon an appropriate pavement design procedure using actual traffic data such as the AASHTO Guide for Design of Pavement Structures.

TABLE 20. RECOMMENDED MINIMUM PAVEMENT SECTION

Material	Pavement Section Thickness (inches)
Hot Mix Asphalt Class ½-inch PG 70-22 or PG 64-22	4
Hot Mix Asphalt Class 1-inch PG 64-22	6

We also recommend that the pavement section be placed on a 6-inch-thick layer of crushed surfacing base course as specified previously in the Earthwork section of this report. The base course should be compacted to at least 95 percent of the MDD per ASTM D 1557. Crushed surfacing top course may be substituted for crushed surfacing top course for trafficability during construction.

Alternatively, we recommend that new pavement sections be designed in accordance with the WSDOT Pavement Policy. The following table, Table 21, presents the WSDOT minimum requirements for HMA and Portland cement concrete (PCC) pavement sections for Design Period ESALs less than 5,000,000. We recommend that these values be checked against calculated sections based upon an appropriate pavement design procedure using actual traffic data such as the AASHTO Guide for Design of Pavement Structures.

TABLE 21. WSDOT RECOMMENDED MINIMUM PAVEMENT SECTION (DESIGN PERIOD ESALS < 5,000,000)

Flexible Pavement		Rigid Pavement	
HMA	CSBC	PCC Slab	CSBC
6 inches	6 inches	8 inches	4 inches

ADDITIONAL GEOTECHNICAL SERVICES

Throughout this report, recommendations are provided where we consider additional geotechnical services to be appropriate. These additional services are summarized below:

- Plan and specification review. We recommend that we be given the opportunity to review the project plans and specifications prior to issuing the bid set to confirm the recommendations presented in this report have been implemented appropriately.
- During construction, a representative of GeoEngineers should evaluate the condition of retaining wall foundation subgrades, deep foundation (secant piles, drilled shafts, etc.)

installation activities, evaluate backfill compaction and observe installation of subsurface drainage measures. The purposes of GeoEngineers' construction phase services are to confirm that the subsurface conditions are consistent with those observed in the explorations and other reasons described in Appendix E, "Report Limitations and Guidelines for Use."

LIMITATIONS

We have prepared this report for the exclusive use of the City of Bellevue, HDR and other project team members for the 124th Avenue NE Corridor Improvements – 12th Street to Northup Way project in Bellevue, Washington. The data should be provided to prospective contractors for their bidding or estimating purposes, but our report and interpretations should not be construed as a warranty of the subsurface conditions.

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

Any electronic form, facsimile or hard copy of the original document (email, text, table, and/or figure), if provided, and any attachments are only a copy of the original document. The original document is stored by GeoEngineers, Inc. and will serve as the official document of record.

Please refer to Appendix E titled "Report Limitations and Guidelines for Use" for additional information pertaining to use of this report.

REFERENCES

American Association of State Highway and Transportation Officials, "LRFD Bridge Design Specifications, 5th Edition," 2010.

Bellevue, "City of Bellevue Transportation Design Manual drawing DEV-9," February 12, 2009.

Booth, D.B., Troost, K.A., and Wisher A.P., Pacific Northwest Center for Geologic Mapping Studies, "Geologic Map of King County, Washington." (available at http://geomapnw.ess.washington.edu/services/publications/map/data/KingCo_composite.pdf), 2007.

Federal Highway Administration, "Geotechnical Engineering Circular No. 4, Ground Anchors and Anchored Systems," 1999.

United States Geological Survey, "Earthquake Hazards Program, Interpolated Probabilistic Ground Motion for the Conterminous 48 States by Latitude Longitude, 2002 Data."

United States Geological Survey, "AASHTO Seismic Design Parameters CD," USGSSEIS-1-CD, 2008.

United States Geological Survey Website, Seattle fault zone, in Quaternary fault and fold database of the United States, http://earthquakes.usgs.gov/regional/qfaults.

Washington State Department of Ecology, 2005 Stormwater Management Manual for Western Washington: Volume II – Hydrologic Analysis and Flow Control Design/BMPs.

Washington State Department of Transportation, Design Manual M 22-01.08 (supplements issued August 2011 and March 2012), July 2011.

Washington State Department of Transportation, Geotechnical Design Manual, M 46-03.07, April 2012.

Washington State Department of Transportation, Standard Plans M 21-01, August 1, 2011.

Washington State Department of Transportation, Standard Specifications for Road, Bridge and Municipal Construction, 2012.

Washington State Department of Transportation, WSDOT Pavement Policy, June 2011.

FIGURES

Type Name of Services Here

Name of Project Here

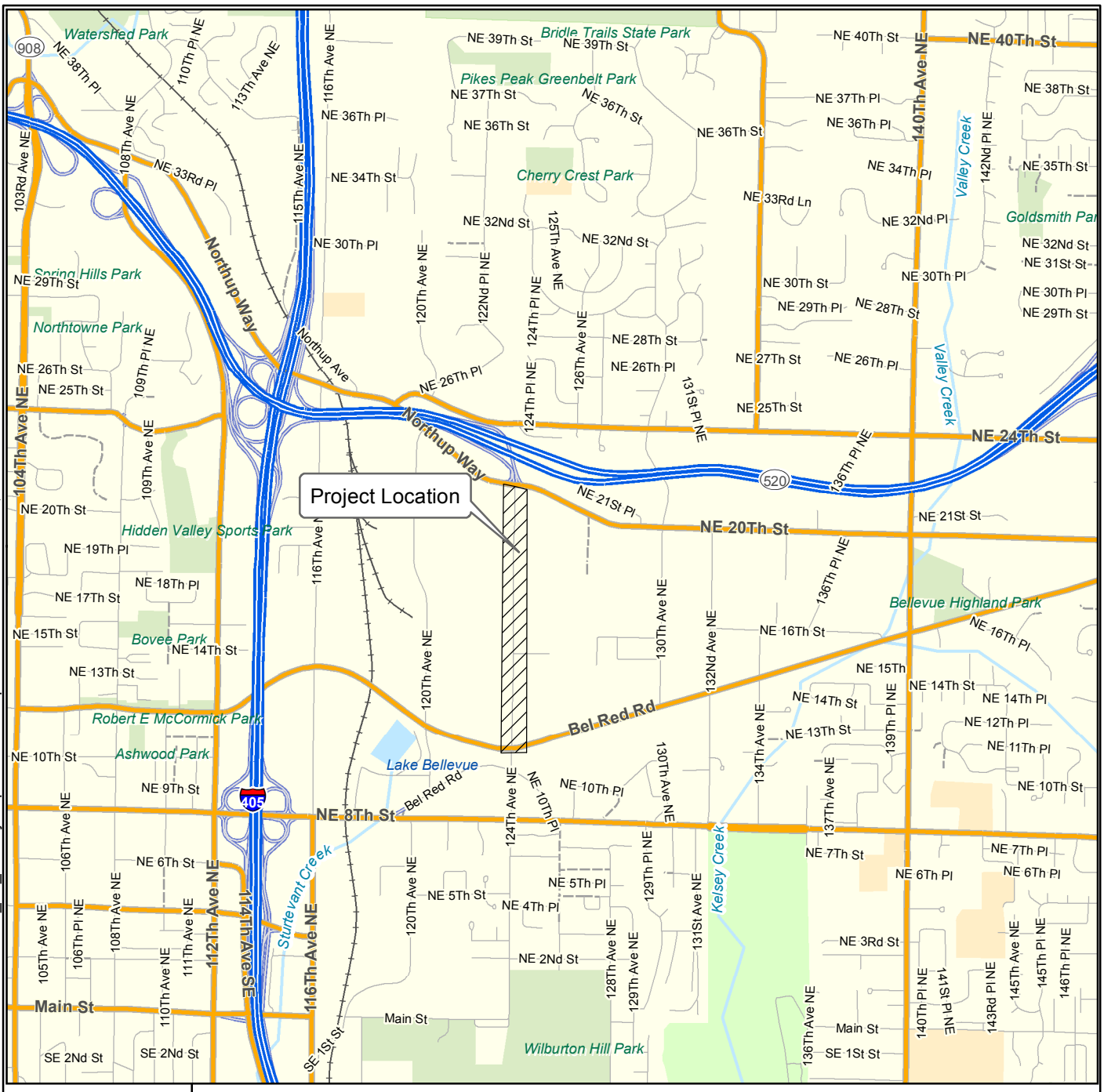
for

Type Client Name Here

Type Date of Report Here

GeoEngineers

Earth Science + Technology



N
W E
S

2,000 0 2,000
Feet

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.
3. It is unlawful to copy or reproduce all or any part thereof, whether for personal use or resale, without permission.

Data Sources: ESRI Data & Maps, Street Maps 2005

Transverse Mercator, Zone 10 N North, North American Datum 1983
North arrow oriented to grid north

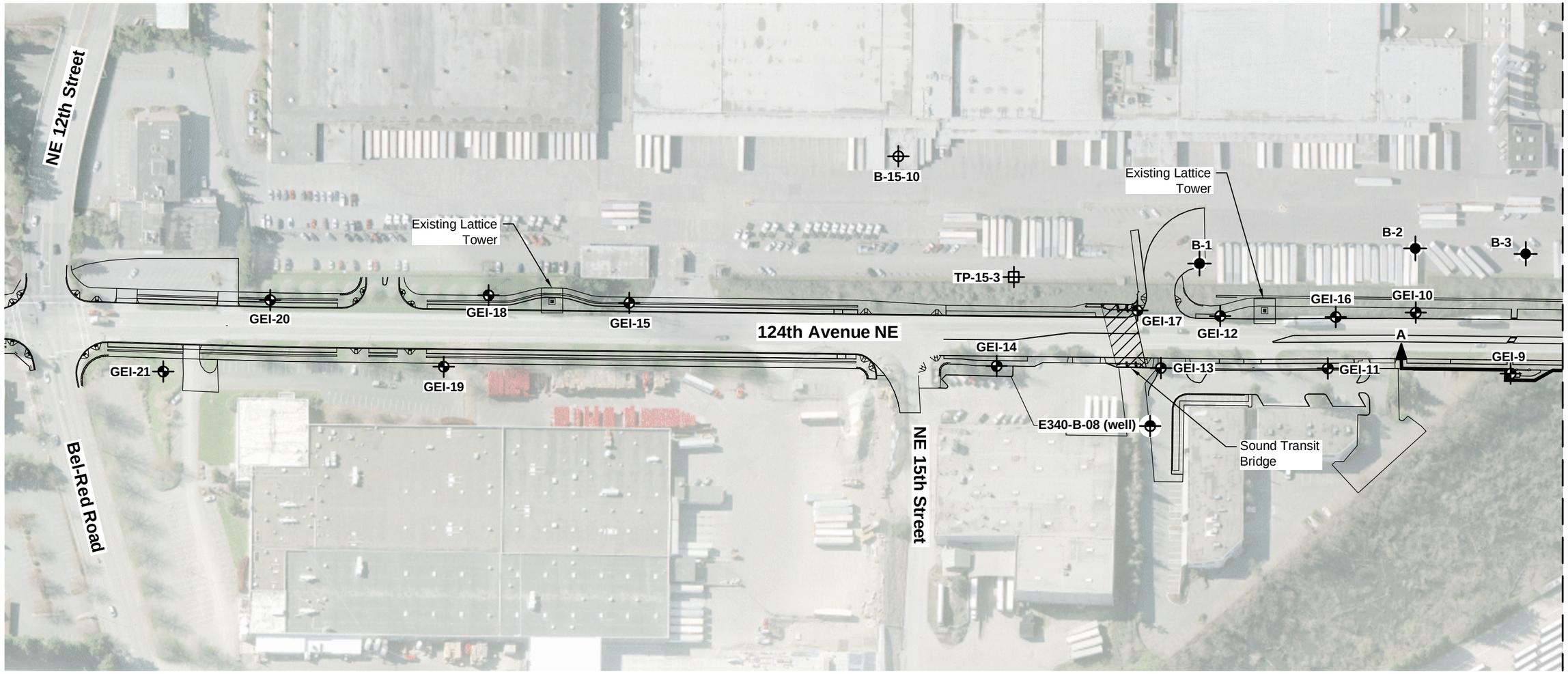
Vicinity Map

124th Avenue NE Corridor Improvements
NE 12th Street to Northup Way
Bellevue, Washington

GEOENGINEERS

Figure 1

Office: Redmond Path: W:\Redmond\Projects\0\0526177\GIS\052617700_F1_VicinityMap.mxd Map Revised: November 15, 2011 EL



150 0 150
FEET

Legend

- GEI-1 — Boring by GeoEngineers, 2011 & 2013
- B-15-10 — Boring for 15th/16th Project by GeoEngineers, 2011 &2013
- TP-15-3 — Test Pit for 15th/16th project by GeoEngineers, 2011 & 2013
- E340-B-08 — Boring by Sound Transit, 2012
- B-1 — Boring by Kleinfelder, 2005
- A — A' Cross Section Location

Notes

1. The locations of all features shown are approximate.
2. See subsurface profile, Figure 11.
3. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Reference: Base files provided by HDR on 10/01/13.

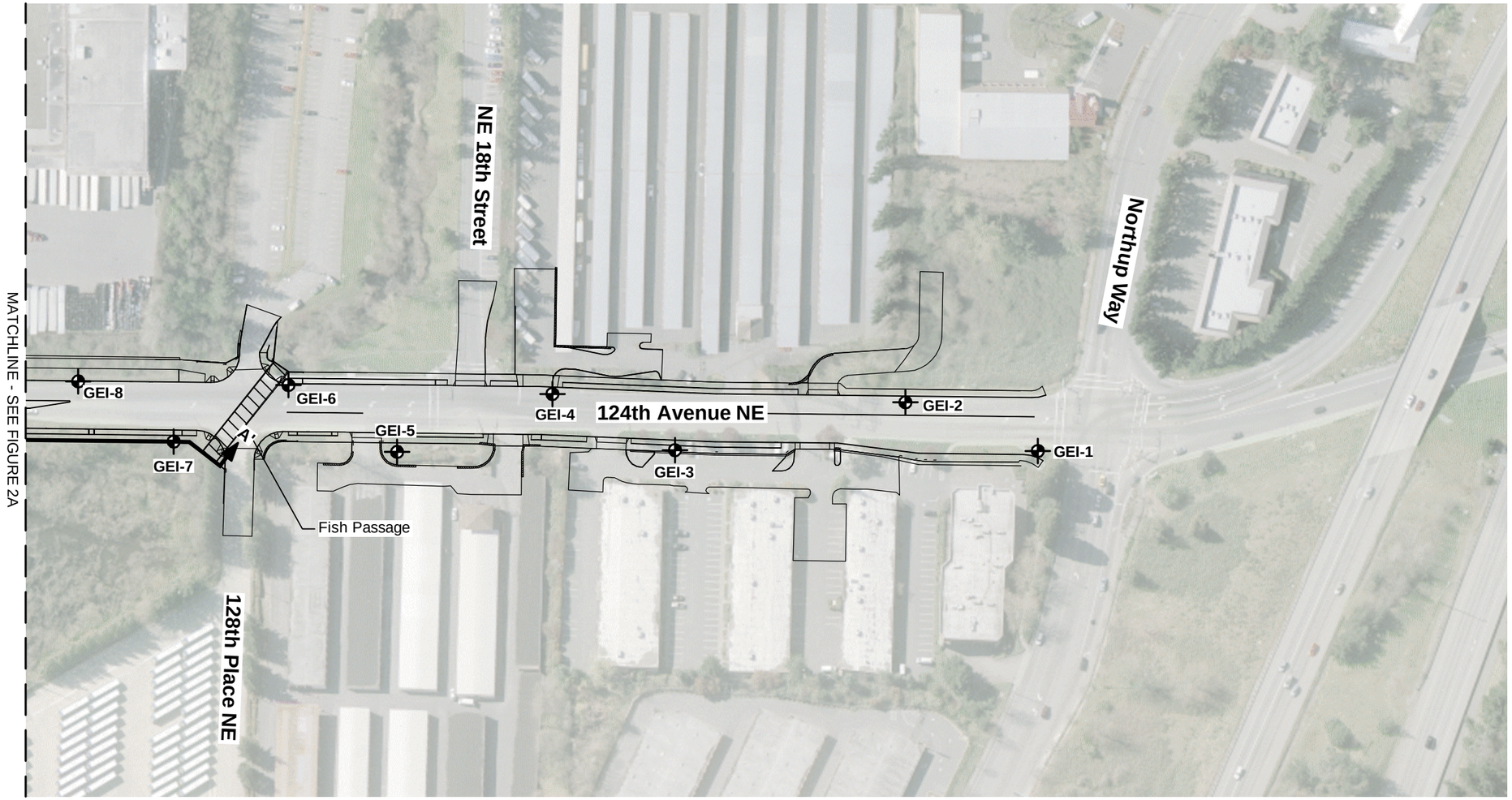
Site Plan

124th Avenue NE Corridor Improvements
NE 12th Street to Northup Way
Bellevue, Washington

GEOENGINEERS

Figure 2A

\\RED\PROJECTS\0\0526177\01\CAD\0526177-01_SITE PLANS.DWG\TAB:F2A MODIFIED BY MFORMOLO ON APR 11, 2014 - 14:21



150 0 150
FEET

Legend

- GEI-1 — Boring by GeoEngineers, 2011 & 2013
- B-15-10 — Boring for 15th/16th Project by GeoEngineers, 2011 &2013
- TP-15-3 — Test Pit for 15th/16th project by GeoEngineers, 2011 & 2013
- E340-B-08 — Boring by Sound Transit, 2012
- B-1 — Boring by Kleinfelder, 2005
- A — A' Cross Section Location

Notes

1. The locations of all features shown are approximate.
2. See subsurface profile, Figure 11.
3. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Reference: Base files provided by HDR on 10/01/13.

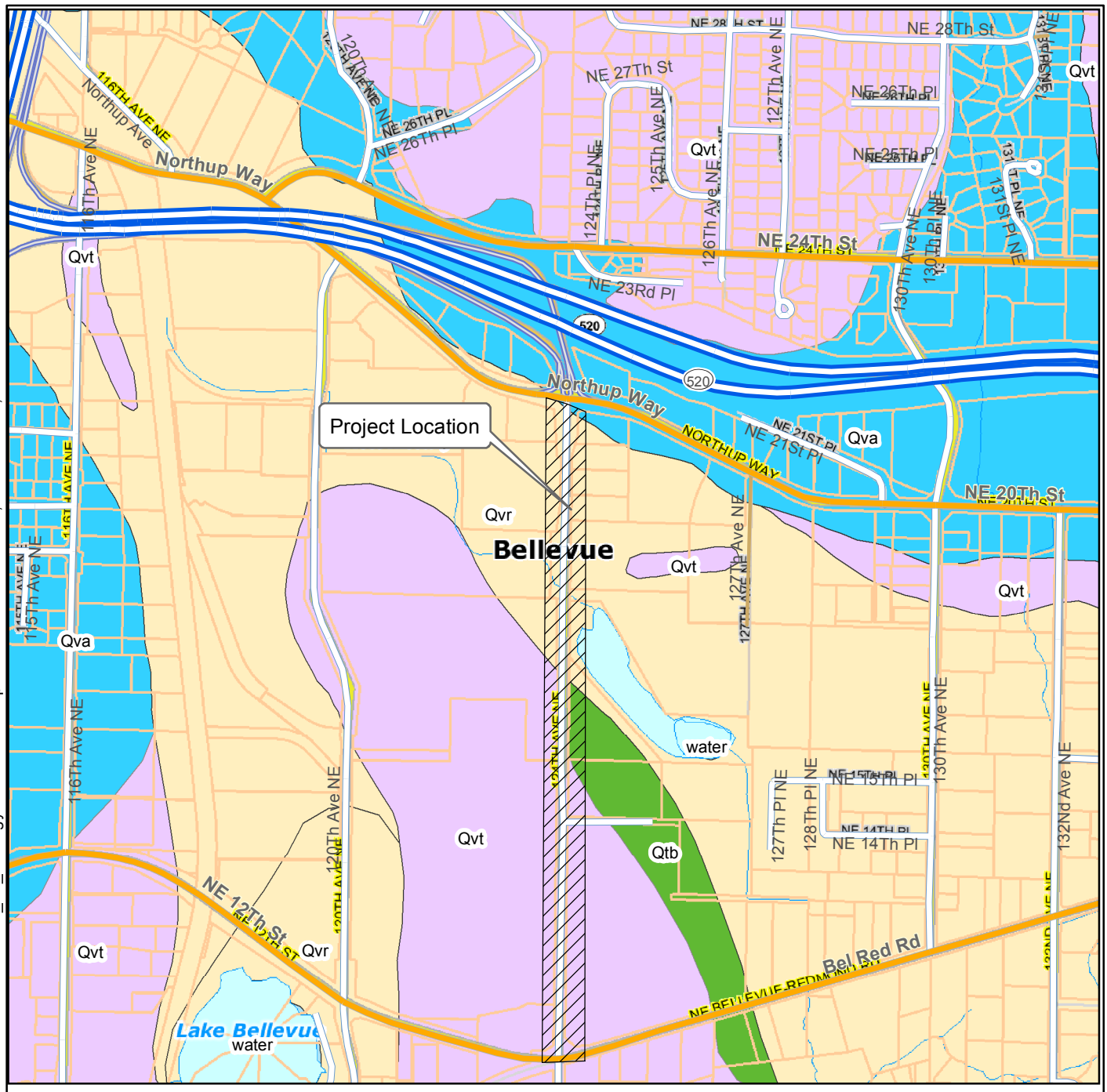
Site Plan

124th Avenue NE Corridor Improvements
NE 12th Street to Northup Way
Bellevue, Washington

GEOENGINEERS

Figure 2B

\\RED\PROJECTS\0\0526177\01\CAD\0526177-01_SITE PLANS.DWG\TAB:F2B MODIFIED BY MFORMOLO ON APR 11, 2014 - 14:20



Surface Geology

- water
- Qvr- Recessional Outwash
- Qvt Glacial Till
- Qva- Advance Outwash
- Qtb- Transitional Beds

N
W E
S

800 0 800
Feet

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.
3. It is unlawful to copy or reproduce all or any part thereof, whether for personal use or resale, without permission.

Data Sources: King County Surface Geology Digital Map, 2004, ESRI Data & Maps, Street Maps 2005

Transverse Mercator, Zone 10 N North, North American Datum 1983
North arrow oriented to grid north

Geologic Map

124th Avenue NE Corridor Improvements
NE 12th Street to Northup Way
Bellevue, Washington

GEOENGINEERS

Figure 3

Office: Redmond Path: W:\Redmond\Projects\0\0526177\GIS\052617700_F3_Geology.mxd Map Revised: December 1, 2011 ETB, EL

Data Source: Topography from City of Bellevue, 2013, Imagery from ESRI, 2013, Proposed Alignment from HDR Engineering Inc on 8/14/12, Parcel and Stream data from King County.

Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Slope Category

- 0-14.9%
- 15-39.9%
- =>40%

- Proposed Road Alignment
- Parcels
- Contours
- Stream

W S N E

250 0 250
Feet

Slope Categories within Project Area

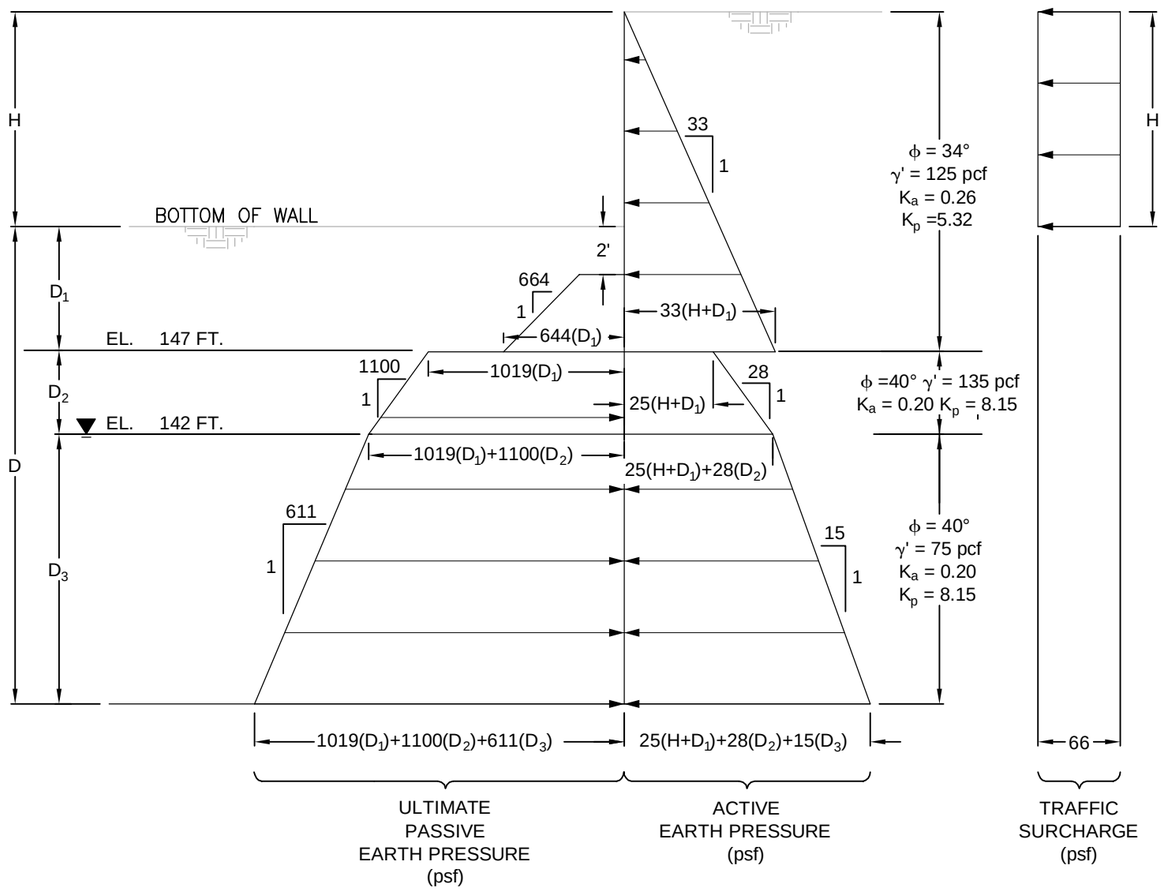
124th Avenue NE Corridor Improvements
NE 12th Street to Northup Way
Bellevue, Washington

GEOENGINEERS

Figure 4

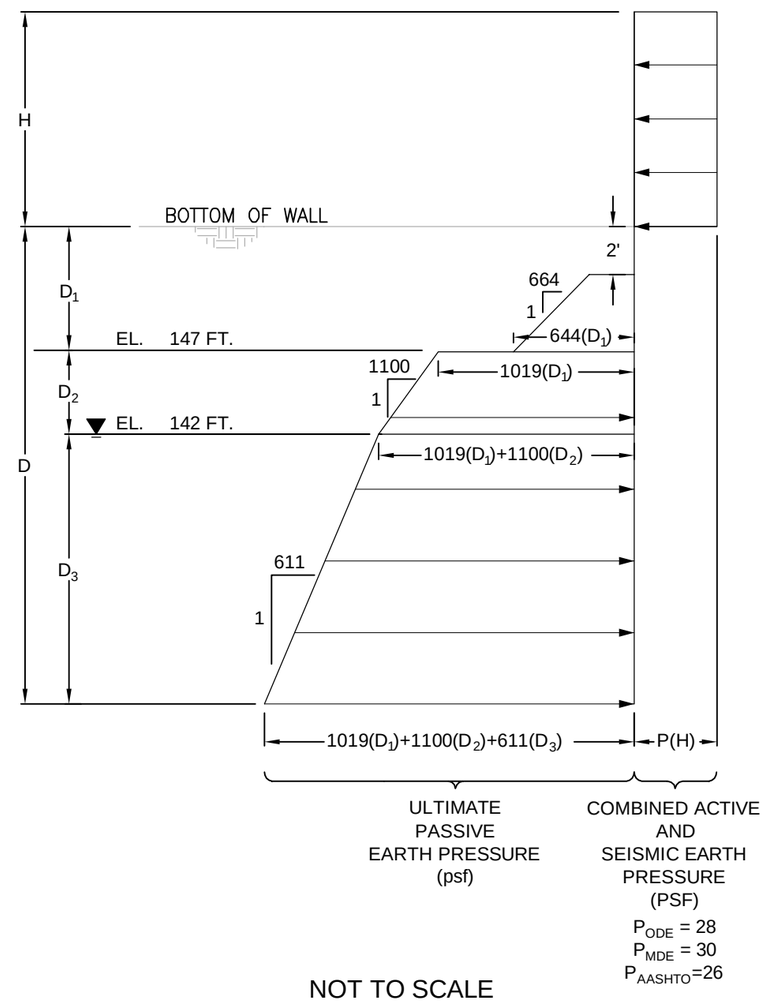
Office: SEA Path: W:\Redmond\Projects\0\0526177\GIS\052617000_F4_SlopeCat.mxd Map Revised: 21 October 2013 cgonzales

CANTILEVER SECANT PILE WALL
STRENGTH LIMIT STATE (ACTIVE)



NOT TO SCALE

CANTILEVER SECANT PILE WALL
EXTREME I LIMIT STATE (ACTIVE)



NOT TO SCALE

NOTES:

1. Active earth pressure below the base of the excavation acts over one structural secant pile diameter. Active earth pressure and traffic surcharge act over the structural secant pile spacing above the base of the excavation.
2. Combined active and seismic earth pressure acts over the structural secant pile spacing above the base of the excavation.
3. Passive earth pressure acts over 2 times the concreted diameter of structural secant pile, or the structural secant pile spacing, whichever is less.
4. Passive pressure does not include a factor of safety.
5. If additional surcharge loading (such as from soil stockpiles, excavators, dumptrucks, cranes, or concrete trucks) is anticipated, GeoEngineers should be consulted to provide revised surcharge pressures.
6. Secant piles shall extend to the elevation required for wall stability.

LEGEND:

H = HEIGHT OF WALL, FEET

D = SECANT PILE EMBEDMENT, FEET

Active Earth Pressure Diagrams
Cantilever Secant Pile Wall

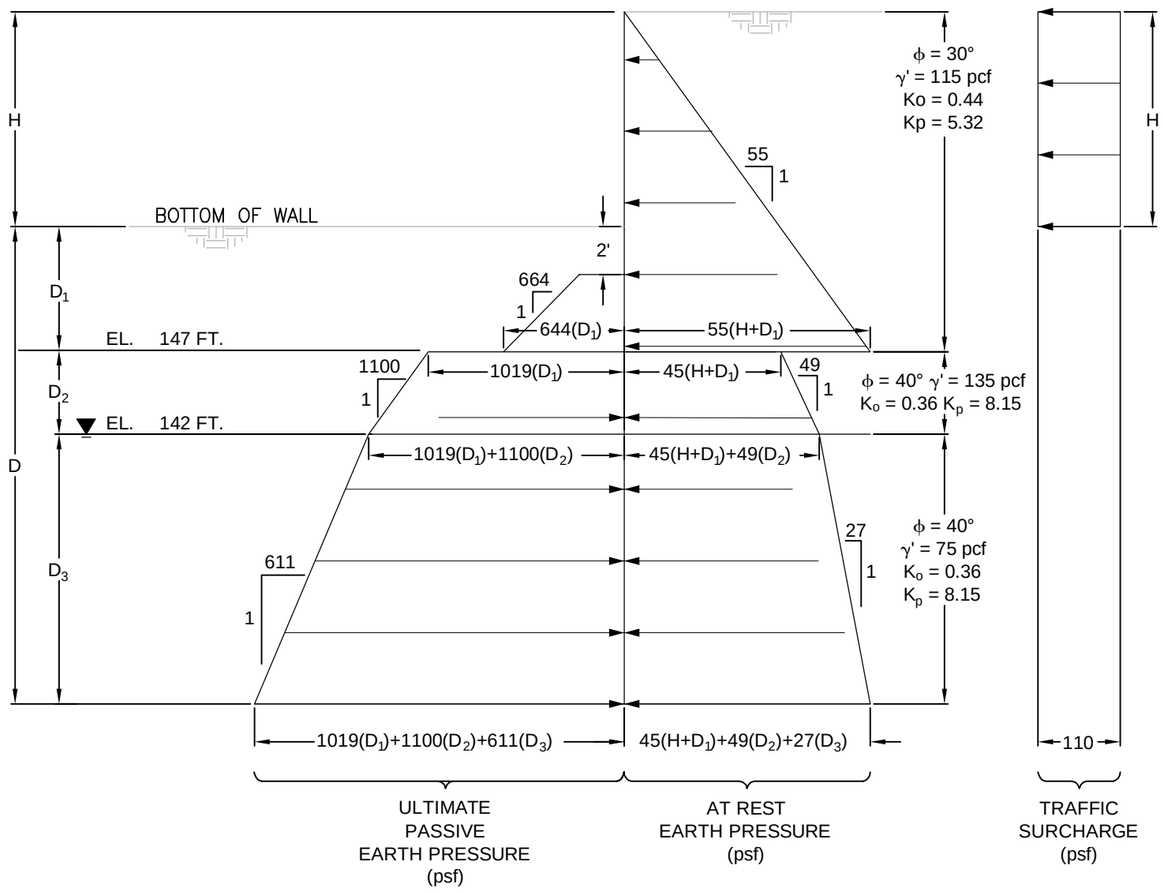
124th Avenue NE Corridor Improvements
NE 12th Street to Northup Way
Bellevue, Washington

GEOENGINEERS

Figure 5

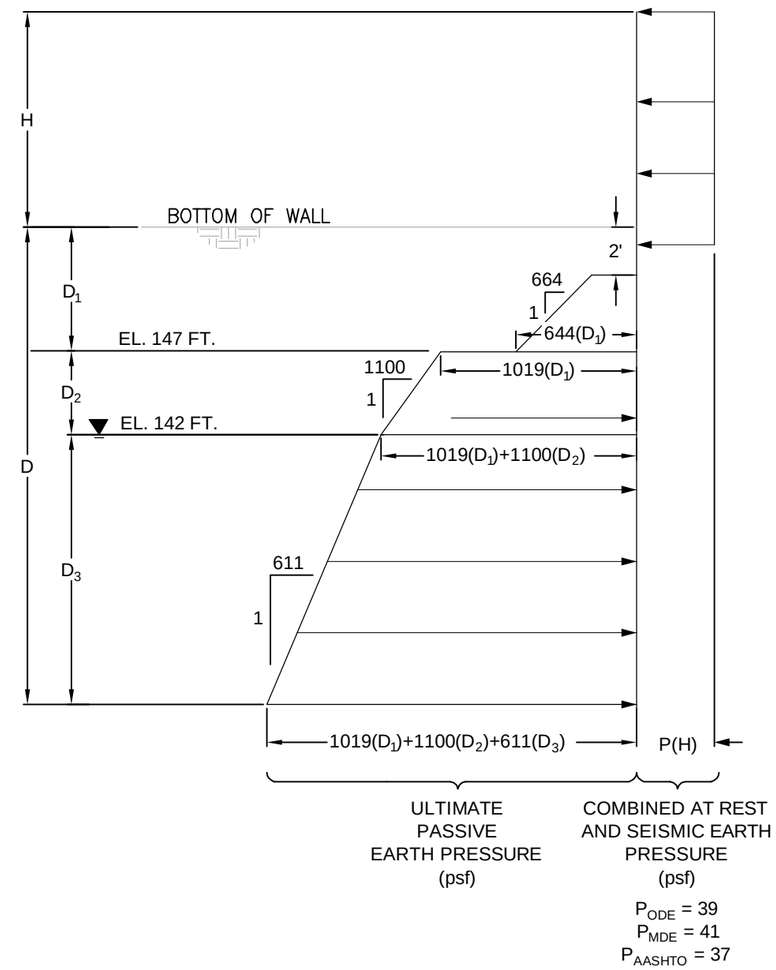
W:\Redmond\Projects\0\0526177\01\CAD\0526-177-01 EPDs.dwg\TAB:Fig 5 modified on Oct 21, 2013 - 10:31am
REDM:TB : SCY

CANTILEVER SECANT PILE WALL
STRENGTH LIMIT STATE (AT REST)



NOT TO SCALE

CANTILEVER SECANT PILE WALL
EXTREME I LIMIT STATE (AT REST)



NOT TO SCALE

NOTES:

1. At rest earth pressure below the base of the excavation acts over one structural secant pile diameter. At rest earth pressure and traffic surcharge act over the structural secant pile spacing above the base of the excavation."
2. Combined at rest and seismic earth pressure acts over the structural secant pile spacing above the base of the excavation.
3. Passive earth pressure acts over 2 times the concreted diameter of structural secant pile, or the structural secant pile spacing, whichever is less
4. Passive pressure does not include a factor of safety.
5. If additional surcharge loading (such as from soil stockpiles, excavators, dumptrucks, cranes, or concrete trucks) is anticipated, GeoEngineers should be consulted to provide revised surcharge pressures.
6. Secant piles shall extend to the elevation required for wall stability.

LEGEND:

H = HEIGHT OF WALL, FEET
D = SECANT PILE EMBEDMENT, FEET

At-Rest Earth Pressure Diagrams
Cantilever Secant Pile Wall

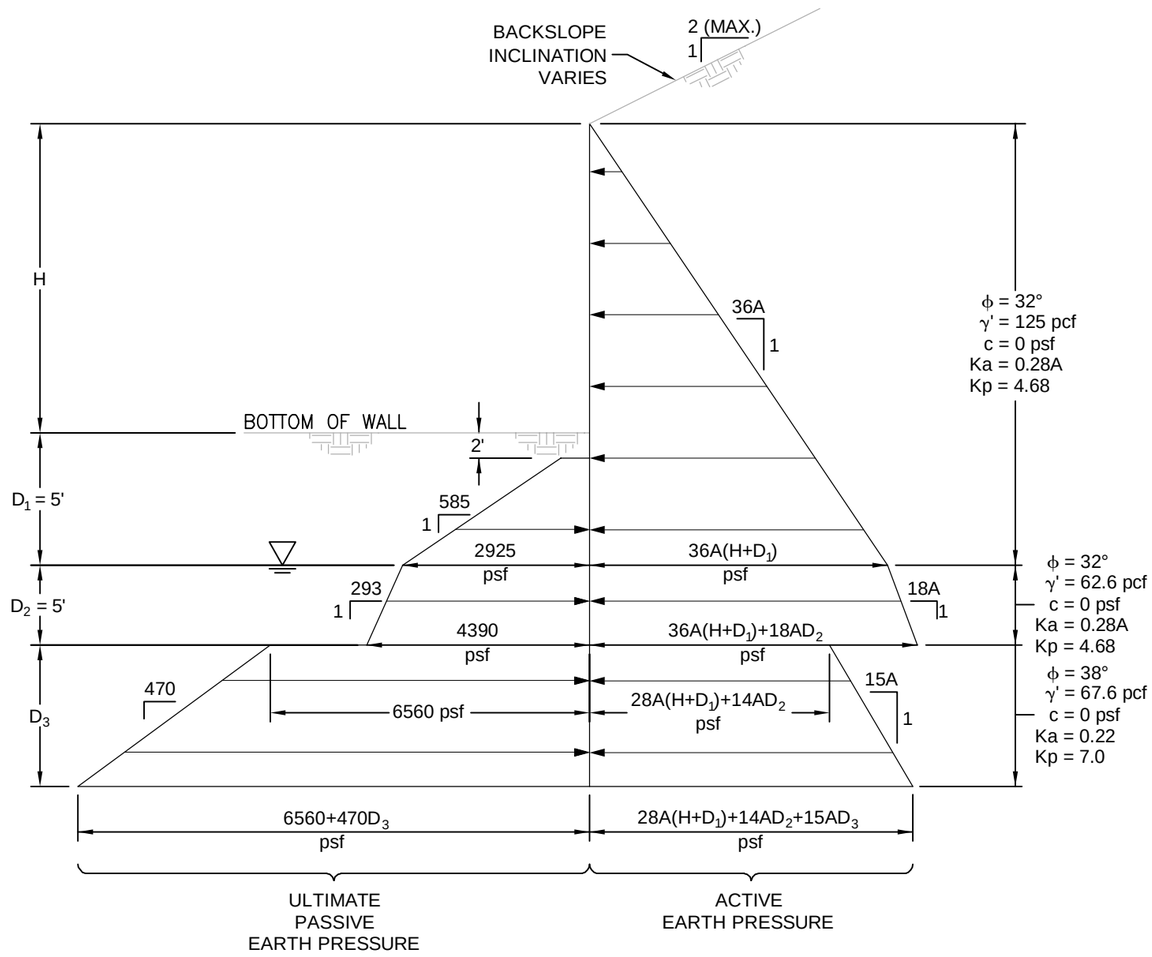
124th Avenue NE Corridor Improvements
NE 12th Street to Northup Way
Bellevue, Washington

GEOENGINEERS

Figure 6

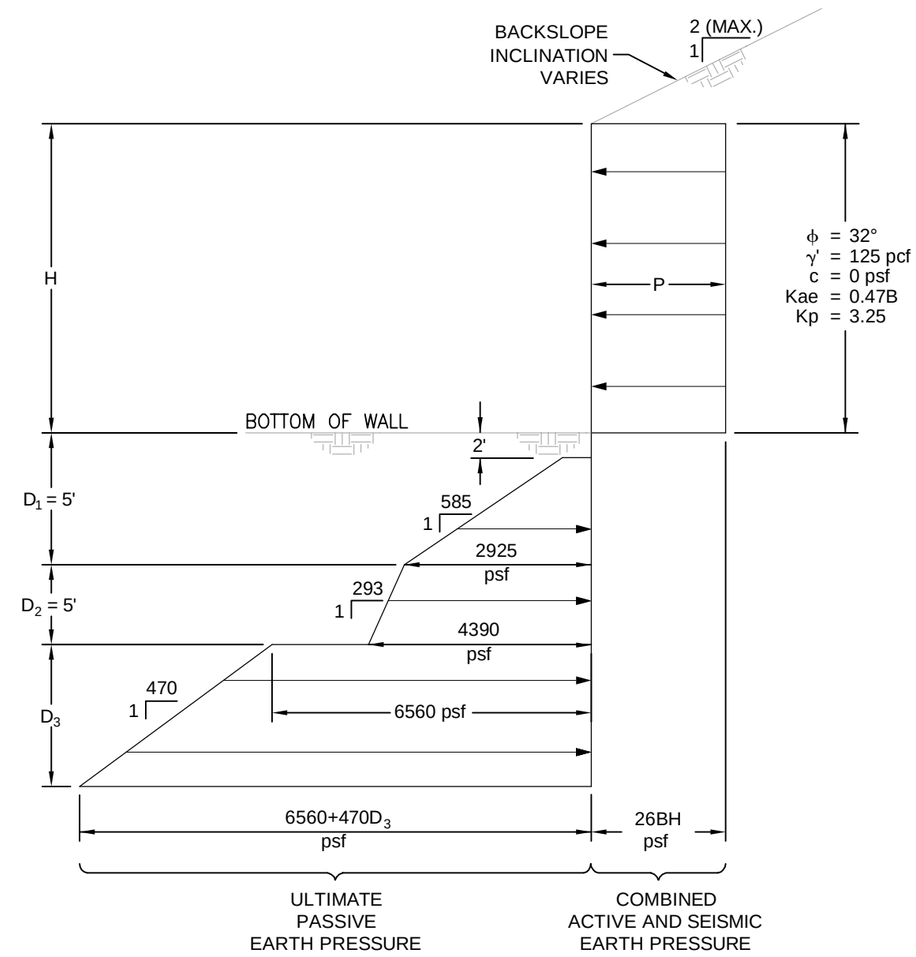
W:\Redmond\Projects\0\0526177\01\CAD\0526-177-01 EPDs.dwg\TAB:Fig 6 modified on Oct 21, 2013 - 10:33am
REDM:TB : SCY

CANTILEVER SOLDIER PILE WALL
STRENGTH LIMIT STATE



NOT TO SCALE

CANTILEVER SOLDIER PILE WALL
EXTREME I LIMIT STATE



NOT TO SCALE

NOTES:

1. Active earth pressure below the base of the excavation acts over one pile diameter.
2. Combined active and seismic earth pressure acts over the pile spacing above the base of the excavation.
3. Passive earth pressure acts over 3 times the concreted diameter of the soldier pile, or the pile spacing, whichever is less.
4. Passive pressure does not include a factor of safety.
5. If additional surcharge loading (such as from soil stockpiles, excavators, dumptrucks, cranes, or concrete trucks) is anticipated, GeoEngineers should be consulted to provide revised surcharge pressures.

LEGEND:

H = HEIGHT OF EXCAVATION, FEET
D = SOLDIER PILE EMBEDMENT, FEET
P = MAXIMUM APPARENT EARTH PRESSURE, POUNDS PER SQUARE FOOT

BACKSLOPE INCLINATION:	A	B
2 HORIZONTAL : 1 VERTICAL	1.61	2.1
3 HORIZONTAL : 1 VERTICAL	1.32	1.9
4 HORIZONTAL : 1 VERTICAL	1.21	1.5
HORIZONTAL	1.0	1.0

Earth Pressure Diagrams
Cantilever Soldier Pile Walls

124th Avenue NE Corridor Improvements
NE 12th Street to Northup Way
Bellevue, Washington

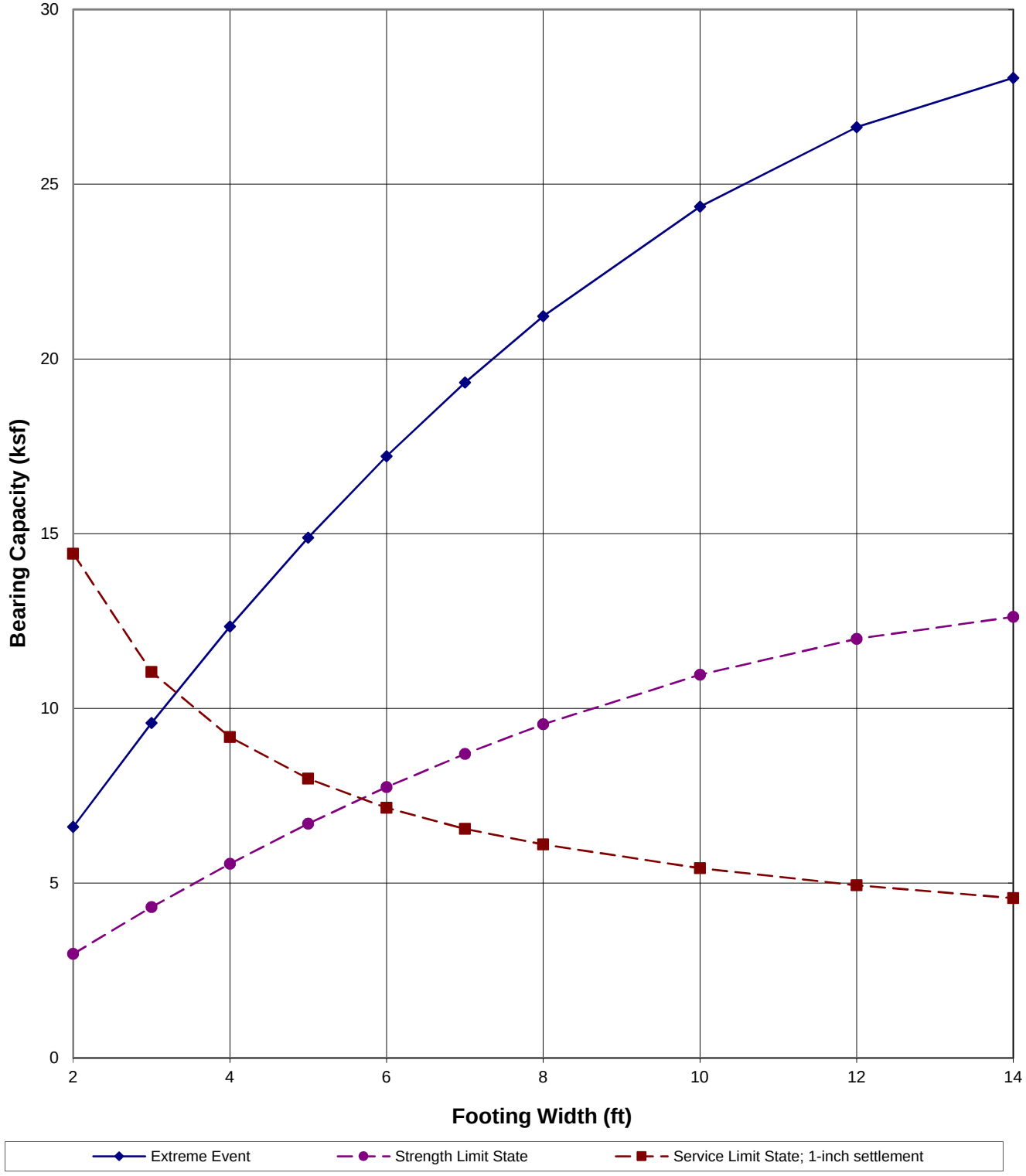
GEOENGINEERS

Figure 7

TDB : TJM
W:\Redmond\Projects\0\0526177\01\CAD\0526177-01_Fig_7 EPD.dwg\TAB:EPD modified on Oct 21, 2013 - 11:05am

TDB 0526-177-00 10-18-13 SharePoint\052617701\Working\ShallowFoundationCapacity-Elastic Settlement_Validated 2011.xlsx

Shallow Foundation Bearing Capacity



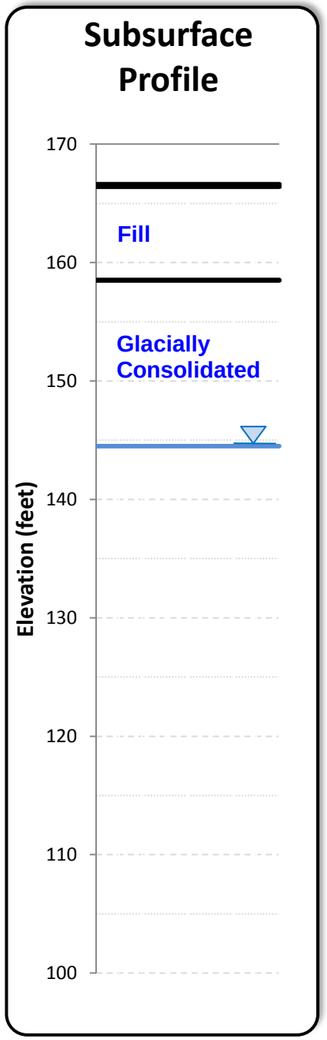
GeoEngineers
Earth Science + Technology

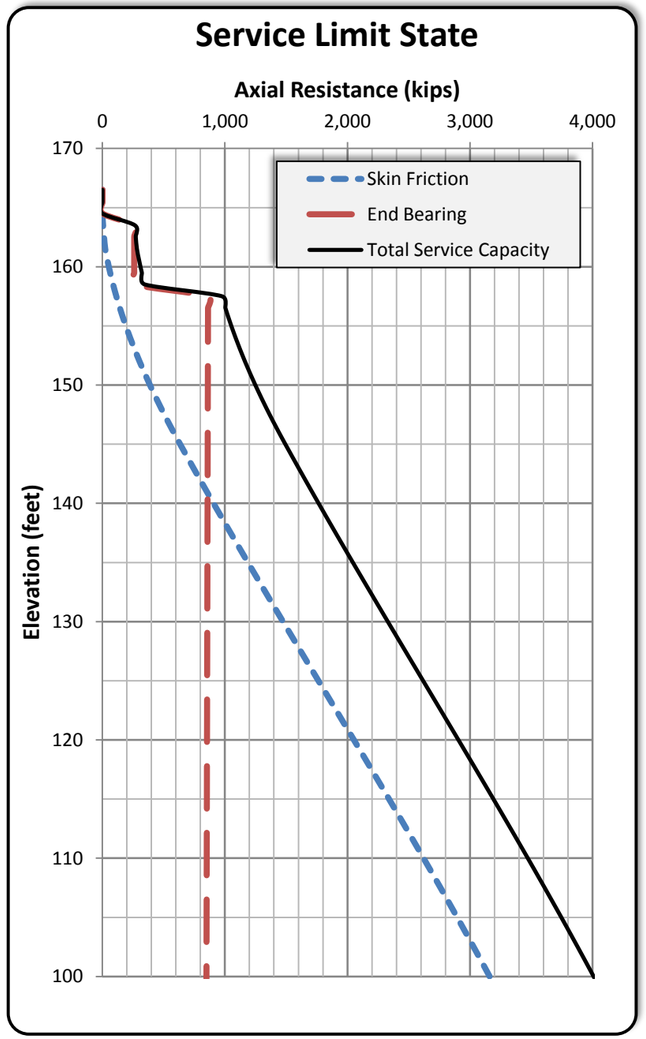
Shallow Foundation Design

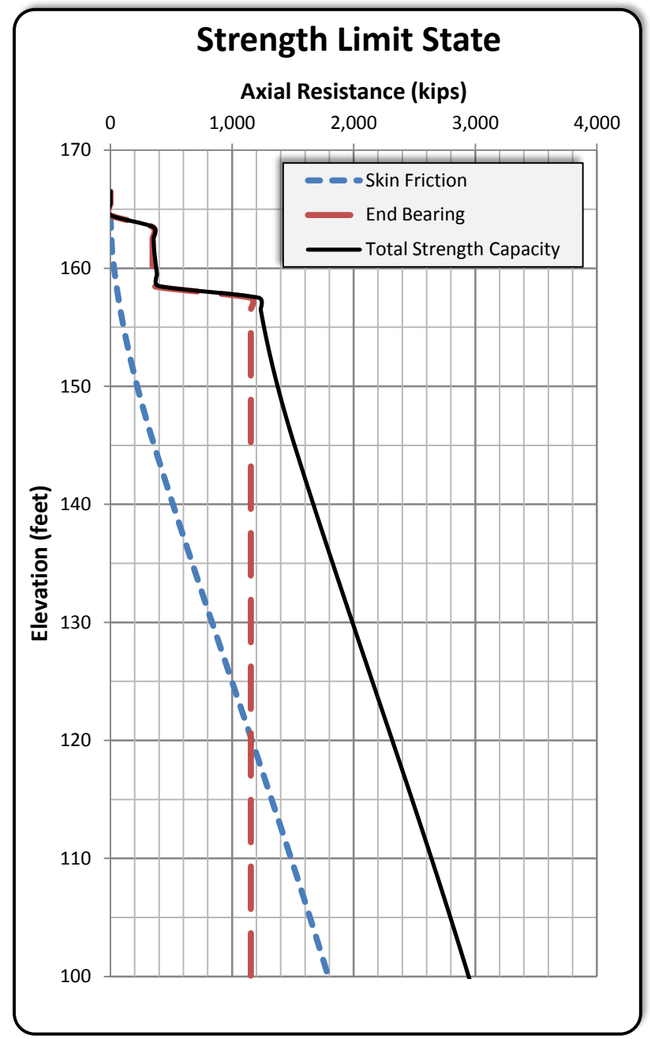
Figure 8

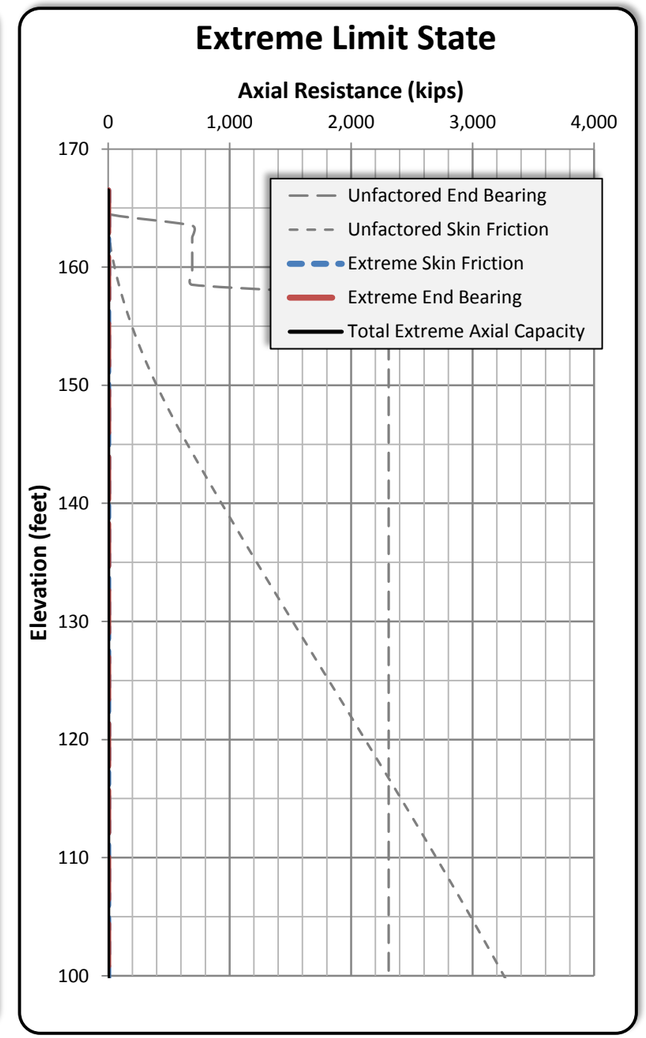
AASHTO Drilled Shaft Axial Capacity

7-foot Diameter Drilled Shaft









General Notes

1. The shaft capacities were developed in accordance with the 2010 AASHTO LRFD Bridge Design Manual and the 2010 WSDOT Geotechnical Design Manual (GDM).
2. The axial capacity plots assume a top of shaft Elevation of 164.5 feet. The geotechnical engineer should re-evaluate the axial shaft capacity if the top of shaft elevation changes.
3. The plots are based on a single shaft and do not consider group effects of closely spaced shafts.
4. The service case assumes 1 inch of shaft settlement.
5. The appropriate LRFD resistance factors, as presented in the "Resistance Factors" table are included in the plots presented above.
6. Since liquefiable soils are not present, the extreme and unfactored capacity values are the same value.

Resistance Factors		
	Skin	End
Sand	0.55	0.5
Clay	0.45	0.4
IGM	0.6	0.55

Drilled Shaft Axial Capacity, GEI-16

124th Ave NE Corridor Improvements
12th Street to Northup Way
Bellevue, Washington

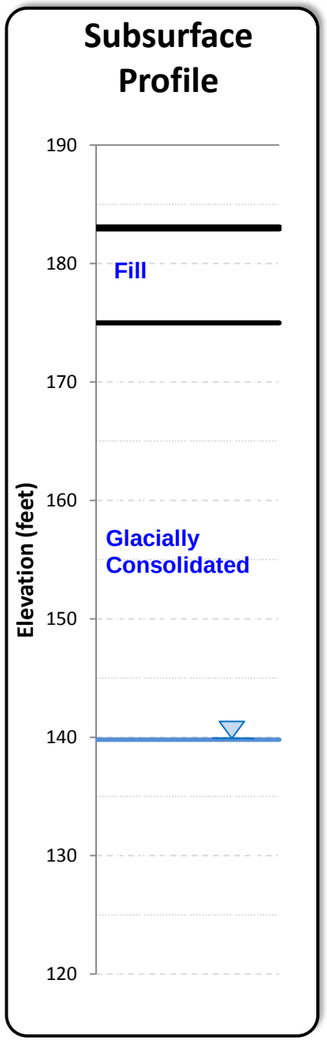
GeoEngineers

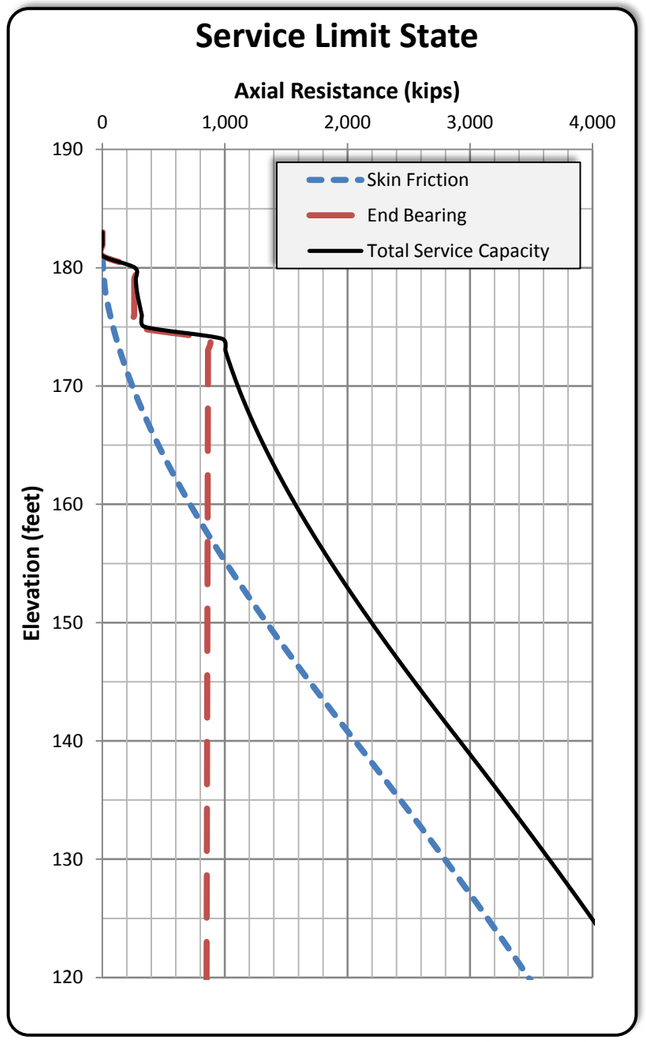
Figure 9

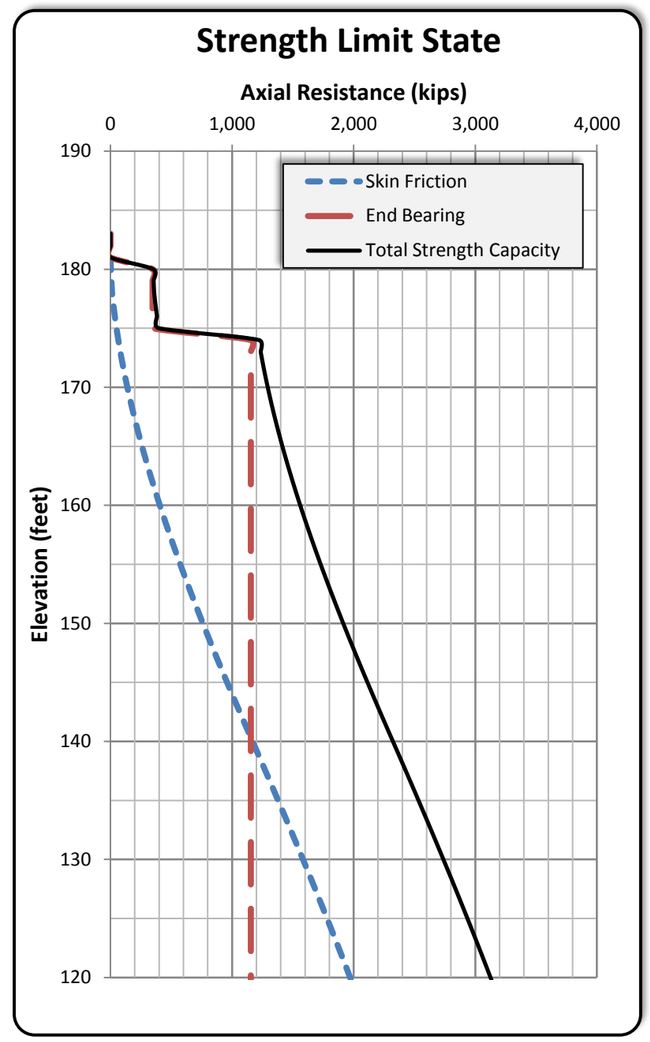
SharePoint: 0526-172-02\Technical Analysis\Pier 2 - AASHTO Drilled Shaft.xlsx 061013 TDB:SDS

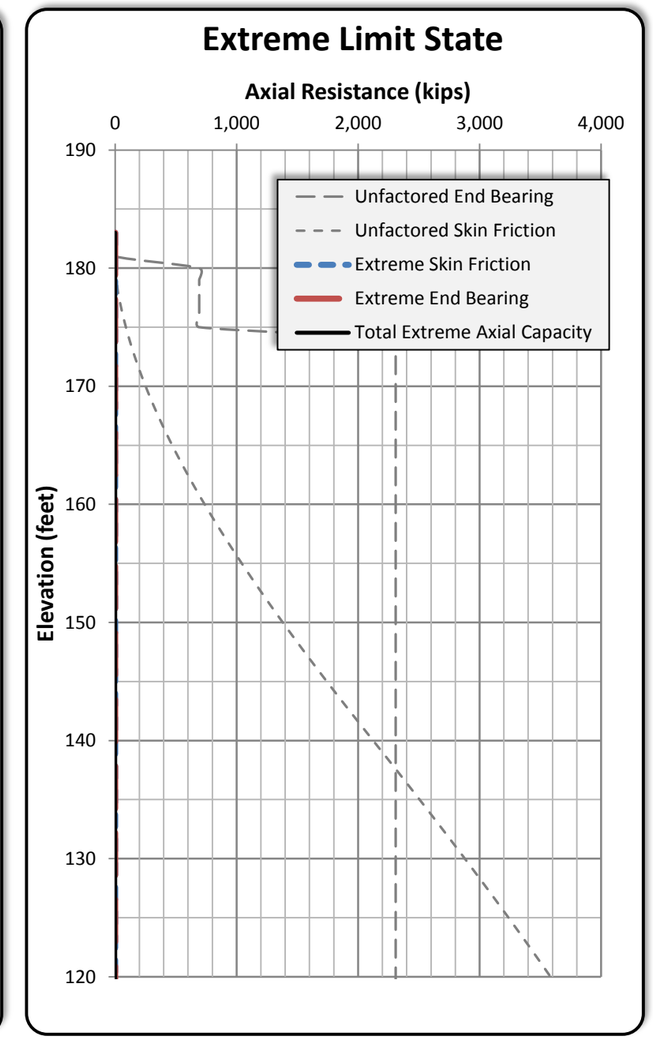
AASHTO Drilled Shaft Axial Capacity

7-foot Diameter Drilled Shaft









General Notes

1. The shaft capacities were developed in accordance with the 2010 AASHTO LRFD Bridge Design Manual and the 2010 WSDOT Geotechnical Design Manual (GDM).
2. The axial capacity plots assume a top of shaft Elevation of 163 feet. The geotechnical engineer should re-evaluate the axial shaft capacity if the top of shaft elevation changes.
3. The plots are based on a single shaft and do not consider group effects of closely spaced shafts.
4. The service case assumes 1 inch of shaft settlement.
5. The appropriate LRFD resistance factors, as presented in the "Resistance Factors" table are included in the plots presented above.
6. Since liquefiable soils are not present, the extreme and unfactored capacity values are the same value.

Resistance Factors		
	Skin	End
Sand	0.55	0.5
Clay	0.45	0.4
IGM	0.6	0.55

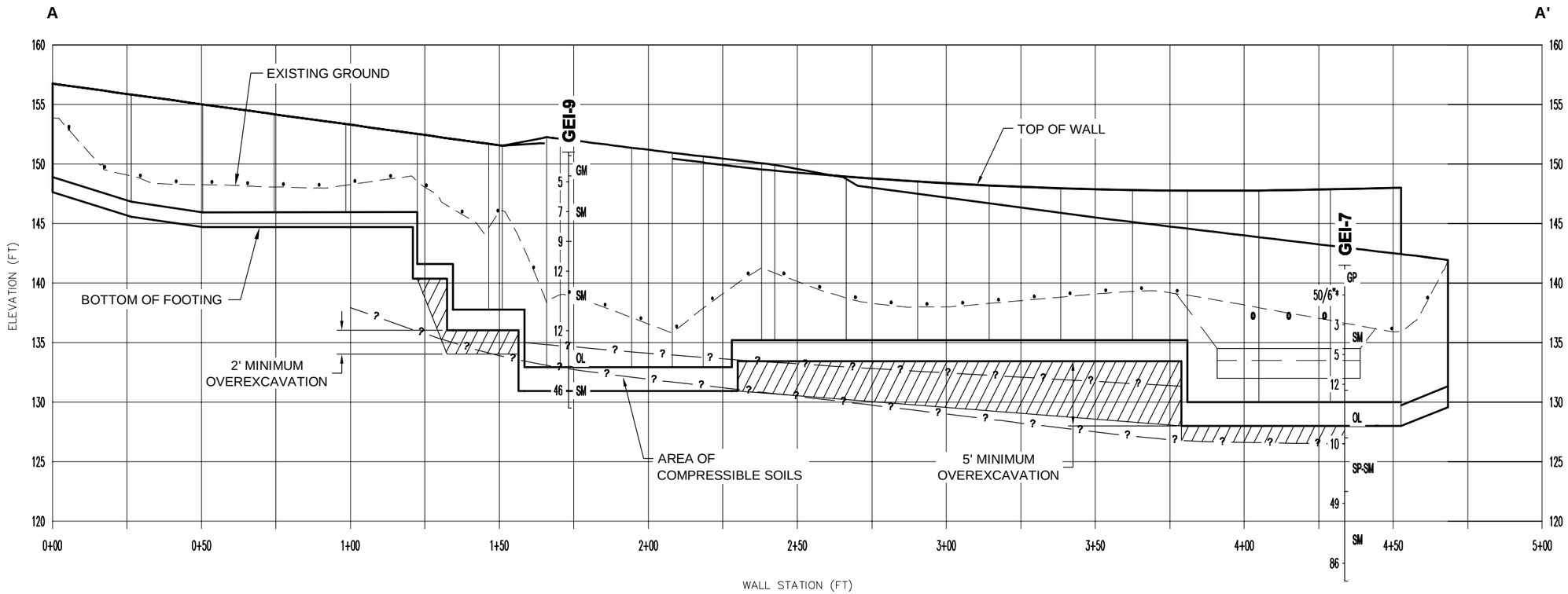
Drilled Shaft Axial Capacity, GEI-18

124th Ave NE Corridor Improvements
12th Street to Northup Way
Bellevue, Washington

GEOENGINEERS

Figure 10

SharePoint: 0526-172-02\Technical Analysis\Pier 2 - AASHTO Drilled Shaft.xlsx 061013 TDB:SDS



HORIZONTAL SCALE: 1"= 40'
VERTICAL SCALE: 1"= 10'
VERTICAL EXAGGERATION: 4X

40 0 40
FEET

Legend

Areas of Overexcavation

Boring Legend

B-1 — Number and location of boring

3 / 30 / 67 — Standard penetration number (Blows/foot) - N

Notes

1. The locations of all features shown are approximate.
2. See plan view, Figures 2A and 2B.
3. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Reference: Base files provided by HDR.

Cross Section A-A'
Retaining Wall 9 Subsurface Profile

124th Avenue NE Corridor Improvements
NE 12th Street to Northup Way
Bellevue, Washington

GEOENGINEERS

Figure 11

W:\REDMOND\PROJECTS\0\0526177\01\CAD\0526177-01_Fig_11 WALL PROFILE.DWG\TAB:F11 MODIFIED BY TMICHAUD ON APR 25, 2014 - 14:42

APPENDICES

Type Name of Services Here

Name of Project Here

for

Type Client Name Here

Type Date of Report Here

GeoEngineers

Earth Science + Technology

APPENDIX A
Field Explorations

APPENDIX A
FIELD EXPLORATIONS

General

Subsurface conditions were explored at the site by drilling twenty-one borings. The borings were completed to depths ranging from about 20½ to 91 feet below the existing ground surface. Borings GEI-1 through GEI-15 were performed by Geologic Drill, Inc. under subcontract to GeoEngineers on September 26 through 29, 2011. Borings GEI-16 through GEI-21 were performed by Boretec, Inc. under subcontract to GeoEngineers on July 29 through 31, 2013.

The locations of the explorations were estimated by taping/pacing in the field from existing site features. The approximate locations of the explorations are shown on the Site Plan, Figures 2A and 2B.

Borings

Borings were completed using track-mounted or trailer-mounted, continuous-flight, hollow-stem auger drilling equipment. The borings were continuously monitored by a representative from our firm who examined and classified the soils encountered, obtained representative soil samples, observed groundwater conditions and prepared a detailed log of each exploration.

The soils encountered in the borings were sampled at 2½- or 5-foot vertical intervals with a 2-inch outside diameter split-barrel standard penetration test (SPT) sampler. The samples were obtained by driving the sampler 18 inches into the soil with a 140-pound hammer free-falling 30 inches. The number of blows required for each 6 inches of penetration was recorded. The blow count ("N-value") of the soil was calculated as the number of blows required for the final 12 inches of penetration. This resistance, or N-value, provides a measure of the relative density of granular soils and the relative consistency of cohesive soils. Where very dense soil conditions precluded driving the full 18 inches, the penetration resistance for the partial penetration was entered on the logs. The blow counts are shown on the boring logs at the respective sample depths.

Soils encountered in the borings were visually classified in general accordance with the classification system described in Figure A-1. A key to the boring log symbols is also presented in Figure A-1. The logs of the borings are presented in Figures A-2 to A-22. The boring logs are based on our interpretation of the field and laboratory data, and indicate the various types of soils and groundwater conditions encountered. The logs also indicate the depths at which these soils or their characteristics change, although the change may actually be gradual. If the change occurred between samples, it was interpreted. The densities noted on the boring logs are based on the blow count data obtained in the borings and judgment based on the conditions encountered.

Observations of groundwater conditions were made during drilling, and these observations represent a short-term condition and may or may not be representative of the long-term groundwater conditions at the site. Groundwater conditions observed during drilling should be considered approximate.

Monitoring Wells

Monitoring wells (2-inch-diameter) were constructed in five of the borings (GEI-8, GEI-12, GEI-14, GEI-17 and GEI-18) to allow for groundwater measurements. A representative of GeoEngineers observed the installation of monitoring wells. The monitoring wells were constructed using 2-inch-diameter polyvinyl chloride (PVC) casing and well screen. The depth to which the casing was installed was selected based on our understanding of subsurface soil and groundwater conditions in the project area.

The lower portion of the casing assembly included a machine-cut well screen that was slotted with 0.020-inch-wide slots to allow entry of water into each monitoring well. Medium sand was placed in the borehole annulus surrounding the well screen. A bentonite seal was placed above the well screen to form a surface seal. The monitoring well was protected by installing a flush-mount steel monument set in concrete at the ground surface. Details of the monitoring well installations are presented on the respective exploration logs in this Appendix.

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS MORE THAN 50% RETAINED ON NO. 200 SIEVE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS
				SP	POORLY-GRADED SANDS, GRAVELLY SAND
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% PASSING NO. 200 SIEVE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS, ROCK FLOUR, CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS AND SILTS OF MEDIUM TO HIGH PLASTICITY
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: Multiple symbols are used to indicate borderline or dual soil classifications

ADDITIONAL MATERIAL SYMBOLS

SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
	AC	Asphalt Concrete
	CC	Cement Concrete
	CR	Crushed Rock/ Quarry Spalls
	TS	Topsoil/ Forest Duff/Sod

Groundwater Contact

Measured groundwater level in exploration, well, or piezometer

Measured free product in well or piezometer

Graphic Log Contact

Distinct contact between soil strata or geologic units

Approximate location of soil strata change within a geologic soil unit

Material Description Contact

Distinct contact between soil strata or geologic units

Approximate location of soil strata change within a geologic soil unit

Sampler Symbol Descriptions

2.4-inch I.D. split barrel

Standard Penetration Test (SPT)

Shelby tube

Piston

Direct-Push

Bulk or grab

Blowcount is recorded for driven samplers as the number of blows required to advance sampler 12 inches (or distance noted). See exploration log for hammer weight and drop.

A "P" indicates sampler pushed using the weight of the drill rig.

Laboratory / Field Tests

%F	Percent fines
AL	Atterberg limits
CA	Chemical analysis
CP	Laboratory compaction test
CS	Consolidation test
DS	Direct shear
HA	Hydrometer analysis
MC	Moisture content
MD	Moisture content and dry density
OC	Organic content
PM	Permeability or hydraulic conductivity
PI	Plasticity index
PP	Pocket penetrometer
PPM	Parts per million
SA	Sieve analysis
TX	Triaxial compression
UC	Unconfined compression
VS	Vane shear

Sheen Classification

NS	No Visible Sheen
SS	Slight Sheen
MS	Moderate Sheen
HS	Heavy Sheen
NT	Not Tested

NOTE: The reader must refer to the discussion in the report text and the logs of explorations for a proper understanding of subsurface conditions. Descriptions on the logs apply only at the specific exploration locations and at the time the explorations were made; they are not warranted to be representative of subsurface conditions at other locations or times.

KEY TO EXPLORATION LOGS

GEOENGINEERS

FIGURE A-1

Drilled Start 9/29/2011	End 9/29/2011	Total Depth (ft) 35.5	Logged By PDR / Checked By HRP	Driller Geologic Drill, Inc.	Drilling Method Hollow-Stem Auger
Surface Elevation (ft) / Vertical Datum 199.5		Hammer Data Rope & Cathead 140 (lbs) / 30 (in) Drop		Drilling Equipment Trailer-mounted Deep Rock XL	
Easting (X) / Northing (Y)		System Datum		Groundwater: Date Measured / Depth to Water (ft) / Elevation (ft)	
Notes: Auger Data: 3¼-inch I.D., 7½-inch O.D.					

Elevation (feet)	Depth (feet)	Interval Recovered (in)	Blows/foot	Collected Sample / Sample Name Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)	REMARKS
	0						AC	6-inches asphalt concrete			
							SP	Brown fine to coarse sand with gravel (medium dense, moist) (base course)			
		12	10	1			SM	Brown silty fine to coarse sand with gravel (loose to medium dense, moist) (fill)	14		
195	5	16	20	2 SA					11		SA (%F = 27)
							SM	Orange-brown silty fine to medium sand with gravel (loose, moist) (fill)			
		16	7	3					11		
190	10	18	13	4			SP-SM	Light brown fine to medium sand with silt and gravel (medium dense, moist) (fill)	4		
185	15	18	41	5 SA			SM	Brown silty fine to coarse sand with gravel (dense, moist to wet)	4		SA (%F = 16)
											Drilling becomes harder
180	20	16	37	6							
175	25	18	44	7							
170								Grades to wet			Groundwater observed at time of drilling
	30	8	50/2"	8			ML	Brown silt with fine sand (hard, moist to wet)			
165	35	1	50/3"	9			GM	Gray silty fine to coarse gravel with sand and cobbles (very dense, moist)			Driling becomes harder

Note: See Figure A-1 for explanation of symbols. All samples were screened in the field for evidence of contamination (See Appendix D). Unless noted otherwise, evidence of contamination was not observed during drilling and sampling.

Log of Boring GEI-1

GeoEngineers

Project: 124th Avenue NE Corridor Improvements
Project Location: Bellevue, Washington
Project Number: 0526-177-01

Figure A-2
Sheet 1 of 1

Redmond: Date:10/21/13 Path:\\RED\PROJECTS\0\0526177\00\GINT\0526177\00.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_GEOTECH_STANDARD

Drilled Start 9/26/2011	End 9/26/2011	Total Depth (ft) 26.5	Logged By PDR / Checked By HRP	Driller Geologic Drill, Inc.	Drilling Method Hollow-Stem Auger
Surface Elevation (ft) / Vertical Datum 182		Hammer Data Rope & Cathead 140 (lbs) / 30 (in) Drop		Drilling Equipment Bobcat-mounted MT 52	
Easting (X) / Northing (Y)		System Datum		Groundwater: Date Measured / Depth to Water (ft) / Elevation (ft)	

Notes: Auger Data: 2¼-inch I.D., 6-inch O.D.

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name / Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)	REMARKS
	0								TS	3-inches sod and topsoil			
180									SM	Brown silty fine to medium sand with gravel (medium dense, moist) (fill)			
		■	12	19		1					6		
									SM	Brown silty fine to coarse sand with gravel (loose, moist) (fill)			
	5	■	12	7		2 SA					7		SA (%F = 13)
175		■	10	12		3							
	10	■	10	8		4			SM	Gray silty fine sand with gravel (loose, moist)	7		
170													Drilling becomes harder (gravel and cobbles)
									SP-SM	Orange-brown fine to medium sand with silt, gravel and cobbles (loose, moist)			
	15	■	12	5		5							
165									SM	Brown silty fine to medium sand with gravel (medium dense to dense, moist to wet)			
	20	■	12	17		6							
160													
	25	■	18	33		7				Grades to dense, wet			Groundwater observed at time of drilling

Note: See Figure A-1 for explanation of symbols. All samples were screened in the field for evidence of contamination (See Appendix D). Unless noted otherwise, evidence of contamination was not observed during drilling and sampling.

Log of Boring GEI-2

GeoEngineers

Project: 124th Avenue NE Corridor Improvements
Project Location: Bellevue, Washington
Project Number: 0526-177-01

Figure A-3
Sheet 1 of 1

Redmond: Date:10/21/13 Path:\\RED\PROJECTS\0\0526177\00\GINT\0526177\00.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_GEOTECH_STANDARD

Drilled	Start 9/26/2011	End 9/26/2011	Total Depth (ft) 21.5	Logged By PDR / Checked By HRP	Driller Geologic Drill, Inc.	Drilling Method Hollow-Stem Auger
Surface Elevation (ft) / Vertical Datum	160		Hammer Data	Rope & Cathead 140 (lbs) / 30 (in) Drop	Drilling Equipment	Bobcat-mounted MT 52
Easting (X) / Northing (Y)			System Datum		Groundwater: Date Measured	Depth to Water (ft) / Elevation (ft)

Notes: Auger Data: 2¼-inch I.D., 6-inch O.D.

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name / Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)	REMARKS
	0								TS	6-inches topsoil			
									SM	Brownish-gray silty fine to medium sand with gravel and occasional cobbles (medium dense, moist)			
			15	39*		1					4		*Blowcount may be overstated due to cobbles
155	5		12	14		2 SA					8		SA (%F = 26)
			18	2		3			SM	Gray silty fine to medium sand with gravel (loose, wet)	12		Groundwater observed at time of drilling
150	10		18	17		4			SM/ML	Gray silty fine sand interbedded with sandy silt (medium dense, wet)			
145	15		18	12		5 AL			CL-ML	Brownish-gray sandy silty clay (stiff to hard, wet)	18		AL (LL = 22, PI = 6)
140	20		18	44		6				Grades to hard			

Note: See Figure A-1 for explanation of symbols. All samples were screened in the field for evidence of contamination (See Appendix D). Unless noted otherwise, evidence of contamination was not observed during drilling and sampling.

Log of Boring GEI-3

GEOENGINEERS

Project: 124th Avenue NE Corridor Improvements
Project Location: Bellevue, Washington
Project Number: 0526-177-01

Figure A-4
Sheet 1 of 1

Redmond: Date:10/21/13 Path:\\RED\PROJECTS\0\0526177\00\GINT\0526177\00.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_GEOTECH_STANDARD

Drilled Start 9/29/2011 End 9/29/2011	Total Depth (ft) 26	Logged By PDR Checked By HRP	Driller Geologic Drill, Inc.	Drilling Method Hollow-Stem Auger
Surface Elevation (ft) Vertical Datum 150		Hammer Data Rope & Cathead 140 (lbs) / 30 (in) Drop		Drilling Equipment Trailer-mounted Deep Rock XL
Easting (X) Northing (Y)		System Datum		Groundwater Date Measured / Depth to Water (ft) / Elevation (ft)
Notes: Auger Data: 3¼-inch I.D., 7½-inch O.D.				

Elevation (feet)	Depth (feet)	FIELD DATA: Interval Recovered (in)	Blows/foot	Collected Sample	Sample Name Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)	REMARKS
	0							TS	6-inches topsoil			
								SM	Brown silty fine to medium sand with gravel (dense, moist)			
		6	47		1							
145	5	10	63		2					5		
		18	11		3			ML	Gray sandy silt (stiff, moist to wet)	21		
140	10	18	19		4			SM	Gray silty fine to medium sand (medium dense, wet)			Groundwater observed at time of drilling
135	15	18	30		5			ML	Gray silt with occasional sand and gravel (very stiff to hard, wet)			
130	20	18	67		6				Becomes moist			
125	25	0	50/5"		7							No recovery

Note: See Figure A-1 for explanation of symbols. All samples were screened in the field for evidence of contamination (See Appendix D). Unless noted otherwise, evidence of contamination was not observed during drilling and sampling.

Log of Boring GEI-4

GeoEngineers

Project: 124th Avenue NE Corridor Improvements
Project Location: Bellevue, Washington
Project Number: 0526-177-01

Figure A-5
Sheet 1 of 1

Redmond: Date:10/21/13 Path:\\RED\PROJECTS\0\0526177\00\GINT\0526177\00.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_GEOTECH_STANDARD

Drilled Start 9/26/2011 End 9/26/2011	Total Depth (ft) 21.5	Logged By PDR Checked By LCF	Driller Geologic Drill, Inc.	Drilling Method Hollow-Stem Auger
Surface Elevation (ft) Vertical Datum 143		Hammer Data Rope & Cathead 140 (lbs) / 30 (in) Drop		Drilling Equipment Bobcat-mounted MT 52
Easting (X) Northing (Y)		System Datum		Groundwater: Date Measured / Depth to Water (ft) / Elevation (ft)
Notes: Auger Data: 2¼-inch I.D., 6-inch O.D.				

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name / Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)	REMARKS
	0								TS	6-inches grass and topsoil			
140			12	2		1			SM	Gray silty fine to coarse sand with trace organic matter (very loose, moist) (fill?)			
	5		18	2		2 SA			ML	Gray sandy silt (soft, moist to wet)	21		SA (%F = 51)
135			18	12		3 SA			SM	Gray silty fine to medium sand (medium dense, wet)	22		Groundwater observed at time of drilling SA (%F = 17)
	10		18	14		4 AL			ML	Gray silt with sand and trace organic matter (stiff, wet)	37		AL (LL = 38, PI = 5)
130										Becomes sandy			
	15		18	28		5			SM	Gray silty fine sand (medium dense, moist to wet)			
125													Drilling becomes harder
	20		18	62		6			ML	Gray silt with occasional gravel (hard, moist)			

Note: See Figure A-1 for explanation of symbols. All samples were screened in the field for evidence of contamination (See Appendix D). Unless noted otherwise, evidence of contamination was not observed during drilling and sampling.

Log of Boring GEI-5

GeoEngineers

Project: 124th Avenue NE Corridor Improvements
Project Location: Bellevue, Washington
Project Number: 0526-177-01

Figure A-6
Sheet 1 of 1

Redmond: Date:10/21/13 Path:\\RED\PROJECTS\0\0526177\00\GINT\0526177\00.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_GEOTECH_STANDARD

Drilled Start 9/29/2011	End 9/29/2011	Total Depth (ft) 30.5	Logged By PDR / Checked By LCF	Driller Geologic Drill, Inc.	Drilling Method Hollow-Stem Auger
Surface Elevation (ft) / Vertical Datum 140		Hammer Data Rope & Cathead 140 (lbs) / 30 (in) Drop		Drilling Equipment Trailer-mounted Deep Rock XL	
Easting (X) / Northing (Y)		System Datum		Groundwater: Date Measured / Depth to Water (ft) / Elevation (ft)	

Notes: Auger Data: 3¼-inch I.D., 7½-inch O.D.

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name / Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)	REMARKS
	0								SM	Brown silty fine to coarse sand with organic matter (loose to medium dense, moist) (fill)			
									SM	Brown silty fine to medium sand with occasional gravel (medium dense, moist)			
			18	11		1							
135	5		15	18		2 SA			SM	Gray silty fine to coarse sand with occasional gravel (medium dense, moist)	15		SA (%F = 38)
													Groundwater observed at time of drilling
			0	12		3			SP	Gray fine to medium sand (medium dense, moist)			
130	10		18	9		4							
									ML	Gray silt with trace sand (stiff, moist)	25		
													No recovery, driller noted gravel
125	15		0	34		5							
													Drilling smooths out
120	20		12	64		6 AL			CL-ML	Gray silty clay with sand (hard, moist)	16		AL (LL = 22, PI = 5)
115	25		12	50/6"		7							
													Drilling becomes harder
									GM	Gray silty fine to coarse gravel (very dense, moist)			
110	30		3	50/5"		8							

Note: See Figure A-1 for explanation of symbols. All samples were screened in the field for evidence of contamination (See Appendix D). Unless noted otherwise, evidence of contamination was not observed during drilling and sampling.

Log of Boring GEI-6

GEOENGINEERS

Project: 124th Avenue NE Corridor Improvements
Project Location: Bellevue, Washington
Project Number: 0526-177-01

Figure A-7
Sheet 1 of 1

Redmond: Date:10/21/13 Path:\\RED\PROJECTS\0\0526177\00\GINT\0526177\00.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_GEOTECH_STANDARD

Drilled Start 9/26/2011	End 9/26/2011	Total Depth (ft) 26.5	Logged By PDR / Checked By LCF	Driller Geologic Drill, Inc.	Drilling Method Hollow-Stem Auger
Surface Elevation (ft) / Vertical Datum 141.5		Hammer Data Rope & Cathead 140 (lbs) / 30 (in) Drop		Drilling Equipment Trailer-mounted Deep Rock XL	
Easting (X) / Northing (Y)		System Datum		Groundwater: Date Measured / Depth to Water (ft) / Elevation (ft)	
Notes: Auger Data: 3¼-inch I.D., 7½-inch O.D.					

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name / Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)	REMARKS
	0								TS	6-inches topsoil with organic matter			
									GP	Gravel, asphalt pieces			
140			12	50/6"*		1			SM	Gray-brown silty fine to medium sand with gravel and cobbles (very dense, moist) (fill)			*Blowcount may be overstated due to cobbles
	5		12	3		2 SA; HA			SM	Brown silty fine to coarse sand with occasional gravel (very loose, moist) (fill)	12		SA (%F = 50) Iron oxide staining
135			10	5		3 SA			SM	Gray silty fine to medium sand with occasional gravel (loose, moist) (fill)	16		SA (%F = 49)
	10		12	12		4			OL	Brown organic silt with organic matter (decayed wood) (stiff, moist)	32		
130													Groundwater observed at time of drilling
	15		10	10		5			SP-SM	Gray fine sand with silt (loose, wet)			
125													
	20		18	49		6			SM	Gray silty fine to medium sand (dense to very dense, wet)			
120													
	25		18	86		7							
115													

Note: See Figure A-1 for explanation of symbols. All samples were screened in the field for evidence of contamination (See Appendix D). Unless noted otherwise, evidence of contamination was not observed during drilling and sampling.

Log of Boring GEI-7

GeoEngineers

Project: 124th Avenue NE Corridor Improvements
Project Location: Bellevue, Washington
Project Number: 0526-177-01

Figure A-8
Sheet 1 of 1

Redmond: Date:10/21/13 Path:\\RED\PROJECTS\0\0526177\00\GINT\0526177\00.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_GEOTECH_STANDARD

Drilled Start 9/29/2011	End 9/29/2011	Total Depth (ft) 30.5	Logged By PDR / Checked By HRP	Driller Geologic Drill, Inc.	Drilling Method Hollow-Stem Auger

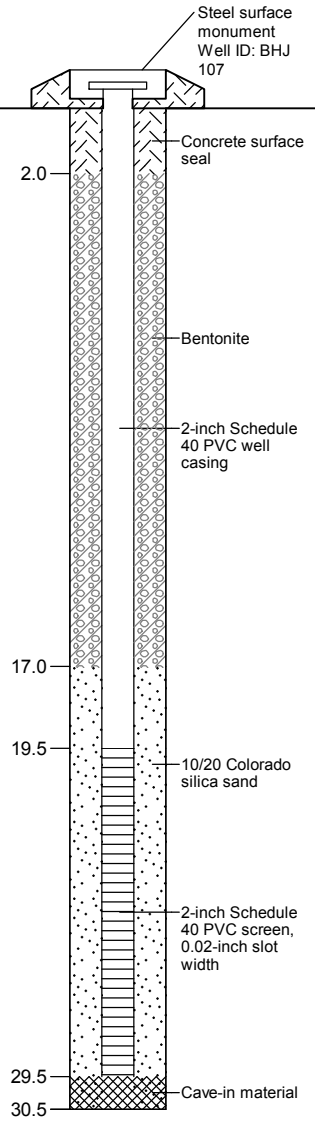
Hammer Data	Rope & Cathead 140 (lbs) / 30 (in) Drop	Drilling Equipment	Trailer-mounted Deep Rock XL
Surface Elevation (ft) Vertical Datum	145	Top of Casing Elevation (ft)	
Easting (X) Northing (Y)		Horizontal Datum	

A 2 (in) well was installed on 9/29/2011 to a depth of 52 (ft).

Groundwater Date Measured	Depth to Water (ft)	Elevation (ft)
12/5/2011	4.6	140.4

Notes: Auger Data: 3¼-inch I.D., 7½-inch O.D.

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)
	0								TS	3-inches topsoil		
									SM	Gray-brown silty fine to medium sand with occasional gravel (loose, moist) (fill)		
			15	10		1					6	
140	5		6	12		2 SA				SA; %F = 50	11	
			12	3		3			ML	Brown-gray sandy (stiff, moist)	18	
135	10		10	10		4			SM	Dark brown silty fine to medium sand (loose, moist)		
130	15		18	4		5			ML	Gray sandy silt (medium stiff, wet)		
125	20		18	48		6			SM	Gray silty fine sand with gravel (dense, wet)		
										Groundwater observed at time of drilling		
120	25		11	50/5"		7			SM	Gray silty fine to coarse sand with gravel (dense, wet)		
115	30		5	50/5"		8			SP-SM	Gray fine to coarse sand with silt and gravel (dense, wet)		



Note: See Figure A-1 for explanation of symbols. All samples were screened in the field for evidence of contamination (See Appendix D). Unless noted otherwise, evidence of contamination was not observed during drilling and sampling.

Log of Monitoring Well GEI-8

GeoEngineers

Project: 124th Avenue NE Corridor Improvements
Project Location: Bellevue, Washington
Project Number: 0526-177-01

Figure A-9
Sheet 1 of 1

Redmond: Date:10/21/13 Path:\\RED\PROJECTS\0\0526177\00\GINT\0526177\00.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_GEOTECH_WELL

Drilled Start 9/26/2011 End 9/26/2011	Total Depth (ft) 21.5	Logged By PDR Checked By HRP	Driller Geologic Drill, Inc.	Drilling Method Hollow-Stem Auger
Surface Elevation (ft) Vertical Datum 151		Hammer Data Rope & Cathead 140 (lbs) / 30 (in) Drop		Drilling Equipment Bobcat-mounted MT 52
Easting (X) Northing (Y)		System Datum		Groundwater Date Measured / Depth to Water (ft) / Elevation (ft)
Notes: Auger Data: 2¼-inch I.D., 6-inch O.D.				

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)	REMARKS
150	0								TS	3-inches topsoil			
									GM	Brown silty fine to coarse gravel with sand (medium dense, moist) (fill)			
			12	5		1			SM	Gray silty fine to medium sand with gravel and cobbles (loose, moist) (fill)			
145	5		2	7		2					5		
			6	9		3			SM	Gray-brown silty fine to medium sand with occasional gravel (loose to medium dense, moist) (fill)			
140	10		15	12		4							
135	15		10	12		5			OL	Dark brown organic silt with wood debris (stiff, moist)			
									SM	Gray silty fine to medium sand with gravel (dense, wet)			Drilling becomes harder
130	20		15	46		6							Groundwater observed at time of drilling

Note: See Figure A-1 for explanation of symbols. All samples were screened in the field for evidence of contamination (See Appendix D). Unless noted otherwise, evidence of contamination was not observed during drilling and sampling.

Log of Boring GEI-9

GEOENGINEERS

Project: 124th Avenue NE Corridor Improvements
Project Location: Bellevue, Washington
Project Number: 0526-177-01

Figure A-10
Sheet 1 of 1

Redmond: Date:10/21/13 Path:\\RED\PROJECTS\0\0526177\00\GINT\0526177\00.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_GEOTECH_STANDARD

Drilled Start 9/28/2011	End 9/28/2011	Total Depth (ft) 20.5	Logged By PDR / Checked By HRP	Driller Geologic Drill, Inc.	Drilling Method Hollow-Stem Auger
Surface Elevation (ft) / Vertical Datum 160		Hammer Data Rope & Cathead 140 (lbs) / 30 (in) Drop		Drilling Equipment Trailer-mounted Deep Rock XL	
Easting (X) / Northing (Y)		System Datum		Groundwater: Date Measured / Depth to Water (ft) / Elevation (ft)	
Notes: Auger Data: 3¼-inch I.D., 7½-inch O.D.					

Elevation (feet)	Depth (feet)	Interval Recovered (in)	Blows/foot	Collected Sample / Sample Name Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)	REMARKS
	0						GP-GM	Gray fine to coarse gravel with silt and sand (loose, moist) (fill)			
							SM	Brown silty fine to medium sand with gravel and cobbles (medium dense, moist)			
		12	50/6"	1			SM	Brown silty fine to coarse sand with gravel and cobbles (dense to very dense, moist)			
155	5	6	50/0"	2					5		
		6	64	3							
150	10	6	43	4					8		
145	15	6	50/3"	5			SM	Light brown silty fine to coarse sand with gravel (dense, wet)			Groundwater observed at time of drilling
							SP	Gray fine to coarse sand with gravel (very dense, wet)			
140	20	6	50/6"	6							

Note: See Figure A-1 for explanation of symbols. All samples were screened in the field for evidence of contamination (See Appendix D). Unless noted otherwise, evidence of contamination was not observed during drilling and sampling.

Log of Boring GEI-10

GeoEngineers

Project: 124th Avenue NE Corridor Improvements
Project Location: Bellevue, Washington
Project Number: 0526-177-01

Figure A-11
Sheet 1 of 1

Redmond: Date:10/21/13 Path:\\RED\PROJECTS\0\0526177\00\GINT\0526177\00.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_GEOTECH_STANDARD

Drilled Start 9/26/2011	End 9/26/2011	Total Depth (ft) 20.5	Logged By PDR / Checked By HRP	Driller Geologic Drill, Inc.	Drilling Method Hollow-Stem Auger
Surface Elevation (ft) / Vertical Datum 160		Hammer Data Rope & Cathead 140 (lbs) / 30 (in) Drop		Drilling Equipment Bobcat-mounted MT 52	
Easting (X) / Northing (Y)		System Datum		Groundwater: Date Measured / Depth to Water (ft) / Elevation (ft)	
Notes: Auger Data: 3¼-inch I.D., 7½-inch O.D.				Not Encountered	

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name / Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)	REMARKS
	0		0	10		1			SM	Brown silty fine to coarse sand with gravel, cobbles and trace organic matter (loose to medium dense, moist) (fill)			
155	5		12	65		2 SA			SM	Brown silty fine to medium sand with gravel (dense, moist)	6		SA (%F = 27)
			12	36		3				With cobbles			Driller noted cobbles
150	10		12	7		4			ML	Brown sandy silt (medium stiff, moist)	14		
145	15		5	50/5"		5			GM	Brown silty fine to coarse gravel with sand (very dense, moist)	4		Gravel in cuttings from 15 to 20 feet Very slow drilling
140	20		5	50/5"		6							

Note: See Figure A-1 for explanation of symbols. All samples were screened in the field for evidence of contamination (See Appendix D). Unless noted otherwise, evidence of contamination was not observed during drilling and sampling.

Log of Boring GEI-11

GeoEngineers

Project: 124th Avenue NE Corridor Improvements
Project Location: Bellevue, Washington
Project Number: 0526-177-01

Figure A-12
Sheet 1 of 1

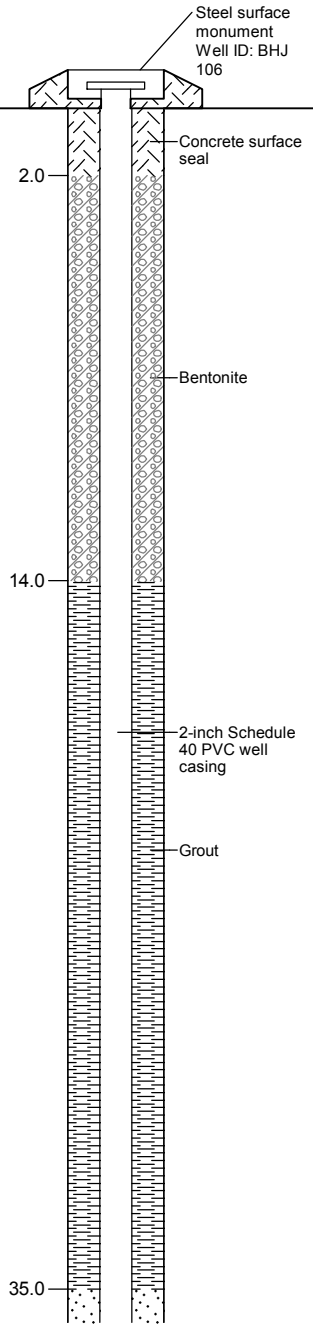
Redmond: Date:10/21/13 Path:\\RED\PROJECTS\0\0526177\00\GINT\0526177\00.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_GEOTECH_STANDARD

Drilled Start 9/28/2011	End 9/28/2011	Total Depth (ft) 52	Logged By PDR / Checked By HRP	Driller Geologic Drill, Inc.	Drilling Method Hollow-Stem Auger
Hammer Data	Rope & Cathead 140 (lbs) / 30 (in) Drop	Drilling Equipment	Trailer-mounted Deep Rock XL	A 2 (in) well was installed on 9/28/2011 to a depth of 42 (ft).	
Surface Elevation (ft) Vertical Datum	165	Top of Casing Elevation (ft)		Groundwater	
Easting (X) Northing (Y)		Horizontal Datum		Date Measured: 12/5/2011	Depth to Water (ft): 23.7 / Elevation (ft): 141.4

Notes: Auger Data: 3¼-inch I.D., 7½-inch O.D.

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)
	0								TS	6-inches topsoil		
									ML	Brown silt with fine sand (stiff, moist)		
			18	15		1					28	
160	5		6	42		2			ML	Brown silt with sand and gravel (hard, moist)		
			18	32		3						
155	10		18	33		4						
150	15		18	52		5						
									SM	Gray silty fine to coarse sand with gravel and cobbles (very dense, moist to wet)		
145	20		5	50/5"		6						
										Driller noted cobbles		
140	25		18	84		7				Groundwater observed at time of drilling	7	
									GP	Gray fine to coarse gravel with sand (very dense, wet)		
135	30		6	50/6"		8						
130	35		12	50/5"		9						

WELL LOG



Note: See Figure A-1 for explanation of symbols. All samples were screened in the field for evidence of contamination (See Appendix D). Unless noted otherwise, evidence of contamination was not observed during drilling and sampling.

Log of Monitoring Well GEI-12

GeoEngineers

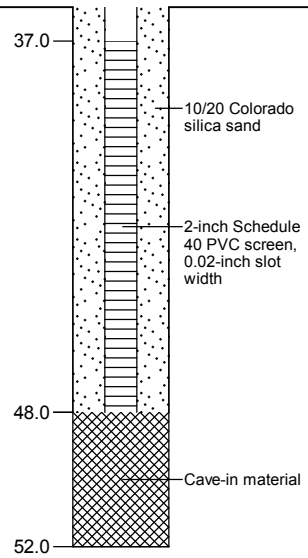
Project: 124th Avenue NE Corridor Improvements
Project Location: Bellevue, Washington
Project Number: 0526-177-01

Figure A-13
Sheet 1 of 2

Redmond: Date:10/21/13 Path:\\RED\PROJECTS\0\0526177\00\GINT\0526177\00.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_GEOTECH_WELL

Elevation (feet)	Depth (feet)	FIELD DATA: Interval Recovered (in)	Blows/foot	Collected Sample	Sample Name	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)
125	40	6	50/6"		10			GP	Gray fine to coarse gravel with sand (very dense, wet)		
120	45	18	83		11						
115	50										

WELL LOG



Note: See Figure A-1 for explanation of symbols. All samples were screened in the field for evidence of contamination (See Appendix D). Unless noted otherwise, evidence of contamination was not observed during drilling and sampling.

Log of Monitoring Well GEI-12 (continued)

GEOENGINEERS

Project: 124th Avenue NE Corridor Improvements
Project Location: Bellevue, Washington
Project Number: 0526-177-01

Figure A-13
Sheet 2 of 2

Redmond: Date:10/21/13 Path:\\RED\PROJECTS\0526177\00\GINT\0526177\00.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_GEOTECH_WELL

Drilled Start 9/28/2011	End 9/28/2011	Total Depth (ft) 23.5	Logged By PDR / Checked By HRP	Driller Geologic Drill, Inc.	Drilling Method Hollow-Stem Auger
Surface Elevation (ft) / Vertical Datum 168		Hammer Data Rope & Cathead 140 (lbs) / 30 (in) Drop		Drilling Equipment Bobcat-mounted MT 52	
Easting (X) / Northing (Y)		System Datum		Groundwater: Date Measured / Depth to Water (ft) / Elevation (ft)	
Notes: Auger Data: 3¼-inch I.D., 6-inch O.D.					

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name / Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)	REMARKS
	0								TS	6-inches topsoil			
									SM	Brown silty fine to coarse sand with occasional gravel and cobbles (loose to medium dense, moist to wet)			
165		■	18	18		1							
	5	■	18	7		2 SA					14		SA (%F = 38)
										Grades to wet			Groundwater observed at time of drilling
160		■	18	7		3			ML	Light brown silt with fine sand (medium stiff, wet)	23		
	10	■	2	39		4			ML	Light brown silt (hard, moist)			
155													
									ML	Gray silt (very stiff, moist)			
	15	■	18	21		5							
150									SM	Gray silty fine sand (dense, moist)			
	20	■	18	57		6					19		
145		■	2	50/5"		7			GM	Gray silty fine to coarse gravel with sand (dense, moist)			Refusal at 23½ feet

Note: See Figure A-1 for explanation of symbols. All samples were screened in the field for evidence of contamination (See Appendix D). Unless noted otherwise, evidence of contamination was not observed during drilling and sampling.

Log of Boring GEI-13

GeoEngineers

Project: 124th Avenue NE Corridor Improvements
Project Location: Bellevue, Washington
Project Number: 0526-177-01

Figure A-14
Sheet 1 of 1

Redmond: Date:10/21/13 Path:\\RED\PROJECTS\0\0526177\00\GINT\0526177\00.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_GEOTECH_STANDARD

Drilled	Start 9/28/2011	End 9/28/2011	Total Depth (ft) 21.5	Logged By PDR / Checked By HRP	Driller Geologic Drill, Inc.	Drilling Method Hollow-Stem Auger
Surface Elevation (ft) / Vertical Datum	173		Hammer Data	Rope & Cathead 140 (lbs) / 30 (in) Drop	Drilling Equipment	Bobcat-mounted MT 52
Easting (X) / Northing (Y)			System Datum		Groundwater: Date Measured / Depth to Water (ft) / Elevation (ft)	Not Encountered
Notes: Auger Data: 3¼-inch I.D., 7½-inch O.D.						

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name / Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)	REMARKS
	0								AC	3-inches asphalt concrete			
									GP	Brown fine to coarse gravel with sand (medium dense, moist) (base course)			
									ML	Gray silt (very stiff to hard, moist)			
170			18	31		1					23		
	5		18	34		2							
165			18	35		3					23		
	10		18	32		4							
160													
	15		18	59		5							
155													
	20		18	50/6"		6							

Note: See Figure A-1 for explanation of symbols. All samples were screened in the field for evidence of contamination (See Appendix D). Unless noted otherwise, evidence of contamination was not observed during drilling and sampling.

Log of Boring GEI-14

GeoEngineers

Project: 124th Avenue NE Corridor Improvements
Project Location: Bellevue, Washington
Project Number: 0526-177-01

Figure A-15
Sheet 1 of 1

Redmond: Date:10/21/13 Path:\\RED\PROJECTS\0\0526177\00\GINT\0526177\00.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_GEOTECH_STANDARD

Drilled Start 9/27/2011	End 9/27/2011	Total Depth (ft) 42	Logged By PDR / Checked By HRP	Driller Geologic Drill, Inc.	Drilling Method Hollow-Stem Auger
Hammer Data	Rope & Cathead 140 (lbs) / 30 (in) Drop	Drilling Equipment	Trailer-mounted Deep Rock XL	A 2 (in) well was installed on 9/27/2011 to a depth of 29.5 (ft).	
Surface Elevation (ft) Vertical Datum	184	Top of Casing Elevation (ft)	183.72	Groundwater	
Easting (X) Northing (Y)		Horizontal Datum		Date Measured / Depth to Water (ft) / Elevation (ft): Not Encountered	

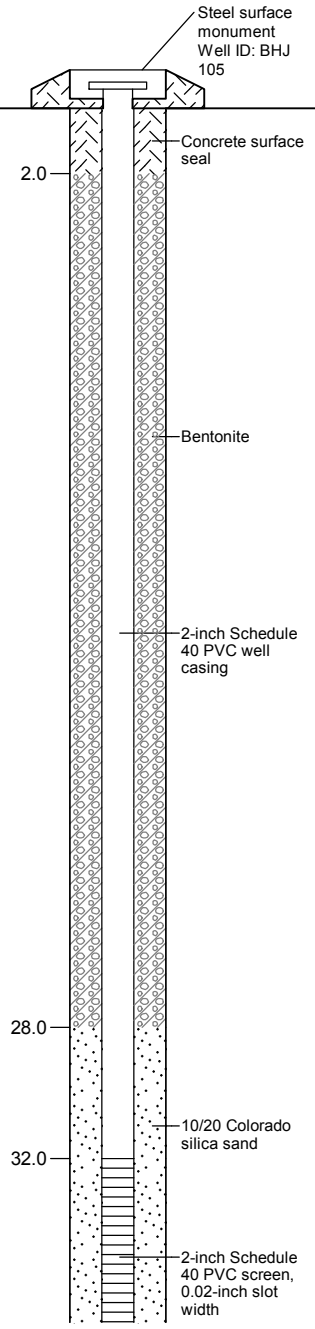
Notes: Auger Data: 3¼-inch I.D., 7½-inch O.D.

FIELD DATA

Depth (feet)	Interval Recovered (in)	Blows/foot	Collected Sample	Sample Name	Water Level	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)
0						TS	6-inches topsoil		
						SM	Brown silty fine to coarse sand (loose, moist) (fill)		
	15	24		1		SM	Brown silty fine to medium sand with gravel (medium dense, moist) (till)	11	
5	18	61		2 SA		SM	Gray silty fine to coarse sand with gravel (very dense, moist)	8	
	18	57		3					
10	18	85		4					
						ML	Gray silt with sand (hard, moist)		
15	11	50/5"		5				14	
						SM	Gray silty fine to medium sand with gravel (very dense, moist)		
20	6	50/6"		6					
25	4	50/4"		7					
30	4	50/4"		8					
35	3	50/2"		9					

Elevation (feet): 180, 175, 170, 165, 160, 155, 150

WELL LOG



Note: See Figure A-1 for explanation of symbols. All samples were screened in the field for evidence of contamination (See Appendix D). Unless noted otherwise, evidence of contamination was not observed during drilling and sampling.

Log of Monitoring Well GEI-15

GeoEngineers

Project: 124th Avenue NE Corridor Improvements
Project Location: Bellevue, Washington
Project Number: 0526-177-01

Figure A-16
Sheet 1 of 2

Redmond: Date:10/21/13 Path:\\RED\PROJECTS\0526177\00\GINT\0526177\00.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_GEOTECH_WELL

Elevation (feet)	Depth (feet)	FIELD DATA: Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)	WELL LOG
145	40	■	5	50/5"		10				Gray silty fine to medium sand with gravel (very dense, moist)			42.0
										Refusal at 42 feet			

Note: See Figure A-1 for explanation of symbols. All samples were screened in the field for evidence of contamination (See Appendix D). Unless noted otherwise, evidence of contamination was not observed during drilling and sampling.

Log of Monitoring Well GEI-15 (continued)

GeoEngineers

Project: 124th Avenue NE Corridor Improvements
Project Location: Bellevue, Washington
Project Number: 0526-177-01

Figure A-16
Sheet 2 of 2

Redmond: Date:10/21/13 Path:\\RED\PROJECTS\0\0526177\00\GINT\0526177\00.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_GEOTECH_WELL

Drilled Start 7/31/2013 End 7/31/2013	Total Depth (ft) 91.42	Logged By CW Checked By TDB	Driller Boretec, Inc.	Drilling Method Hollow-Stem Auger
Surface Elevation (ft) Vertical Datum 166.5		Hammer Data Rope & Cathead 140 (lbs) / 30 (in) Drop		Drilling Equipment EC-55 Track Rig
Easting (X) Northing (Y)		System Datum		Groundwater: Date Measured / Depth to Water (ft) / Elevation (ft) — Not Encountered
Notes:				

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name / Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)	REMARKS
165	0								TS	Topsoil			
160	5		18	24		1			ML	Brown with orange mottling sandy silt with occasional gravel (very stiff, moist)	20		Rough drilling
155	10		7	50/5"		2 AL			CL	Gray sandy clay with occasional gravel and occasional organic matter (very fine roots) (hard, wet)	25		AL (LL = 36, PI = 17) Rough drilling
150	15		5	50/5"		3 SA			GM	Gray/brown with orange mottling silty fine to coarse gravel with sand (very dense, wet)	10		SA (%F = 25) Rough drilling
145	20		5	50/5"		4					8		Water observed at time of drilling
140	25		10	50/4"		5 %F					10		%F = 9
135	30		12	50/6"		6 SA			GW-GM	Brown fine to coarse gravel with silt and sand (very dense, wet)	8		SA (%F = 7)
130	35		5	50/5"		7			SM/GM	Brown silty fine to coarse sand with gravel (very dense, wet)			
	40												

Note: See Figure A-1 for explanation of symbols. All samples were screened in the field for evidence of contamination (See Appendix D). Unless noted otherwise, evidence of contamination was not observed during drilling and sampling.

Log of Boring GEI-16

GEOENGINEERS

Project: 124th Avenue NE Corridor Improvements
Project Location: Bellevue, Washington
Project Number: 0526-177-01

Figure A-17
Sheet 1 of 3

Redmond: Date:10/21/13 Path:\\RED\PROJECTS\0526177\01\GINT\0526177\01.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_GEOTECH_STANDARD

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name / Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)	REMARKS
125	40	■	6	50/6"		8 / %F			SM	Brown silty fine to coarse sand with gravel (very dense, wet)	12		%F = 16
120	45	■	5	50/5"		9							Rough drilling
115	50	■	5	50/5"		10 / %F			GP	Gray fine to coarse gravel with sand (very dense, moist)	8		%F = 5
110	55	■		63		11A / 11B / SA			ML	Gray sandy silt (hard, wet)	18		SA (%F = 44)
									SM	Gray silty fine to coarse sand with gravel (very dense, wet)			
105	60	■	5	50/5"		12			GP-GM	Brown fine to coarse gravel with silt and sand (very dense, wet)			
100	65	■	5	50/5"		13 / %F				Becomes gray	14		%F = 5
95	70	■	10	50/4"		14							Rough drilling, driller noted gravel
90	75	■	5	50/5"		15 / SA			SP-SM	Brown fine to coarse sand with silt and gravel (very dense, wet)	14		SA (%F = 8)
85	80	■	5	50/5"		16 / %F			GM	Gray silty gravel (very dense, wet)	10		%F = 13
80	85	■	6	50/6"		17							Rough drilling

Note: See Figure A-1 for explanation of symbols. All samples were screened in the field for evidence of contamination (See Appendix D). Unless noted otherwise, evidence of contamination was not observed during drilling and sampling.

Log of Boring GEI-16 (continued)

GEOENGINEERS

Project: 124th Avenue NE Corridor Improvements
Project Location: Bellevue, Washington
Project Number: 0526-177-01

Figure A-17
Sheet 2 of 3

Redmond: Date:10/21/13 Path:\\RED\PROJECTS\0526177\01\GINT\0526177\01.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_GEOTECH_STANDARD

Elevation (feet)	Depth (feet)	FIELD DATA: Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name / Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)	REMARKS
	90		17	50/5"		18 / %F			SP-SM	Gray fine to medium sand with silt and gravel (very dense, wet)	11		%F = 12

Note: See Figure A-1 for explanation of symbols. All samples were screened in the field for evidence of contamination (See Appendix D). Unless noted otherwise, evidence of contamination was not observed during drilling and sampling.

Log of Boring GEI-16 (continued)

GeoEngineers

Project: 124th Avenue NE Corridor Improvements
Project Location: Bellevue, Washington
Project Number: 0526-177-01

Figure A-17
Sheet 3 of 3

Redmond: Date:10/21/13 Path:\\RED\PROJECTS\0\0526177\01\GINT\0526177\01.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_GEOTECH_STANDARD

Drilled	Start 7/29/2013	End 7/29/2013	Total Depth (ft)	50.5	Logged By / Checked By	CW / TDB	Driller	Boretec, Inc.	Drilling Method	Hollow-Stem Auger

Hammer Data	Rope & Cathead 140 (lbs) / 30 (in) Drop	Drilling Equipment	EC-55 Track Rig
Surface Elevation (ft) Vertical Datum	168.5	Top of Casing Elevation (ft)	
Easting (X) Northing (Y)		Horizontal Datum	

A 2 (in) well was installed on 7/29/2013 to a depth of 35 (ft).

Groundwater		
Date Measured	Depth to Water (ft)	Elevation (ft)
7/29/2013	25.6	142.9

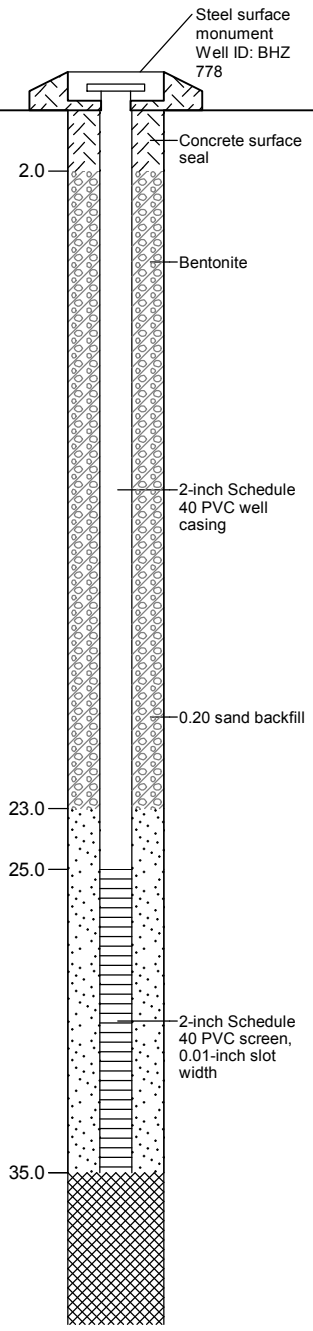
Notes:

FIELD DATA

Depth (feet)	Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name	Water Level	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)
0							TS	Topsoil		
							SM	Gray-brown silty fine to medium sand with occasional gravel (very dense, moist)		
5	■	12	69		1				6	
								No recovery		
10	■	0	53		2					
							CH	Gray sandy clay with gravel (hard, moist)		
15	■	16	97		3 AL			AL (LL = 54, PI = 26)	14	
							ML	Gray sandy silt (hard, moist)		
20	■	18	34		4					
							SM	Brown silty fine to medium sand with gravel and organics (very dense, moist to wet)		
25	■	5	50/5"		5 SA	▼		SA (%F = 37)	9	
							SM	Gray silt fine to coarse sand with gravel and brown sandy silt lenses (very dense, wet)		
30	■	3	50/3"		6 %F			%F = 22	21	
							GM	Brown silty fine to coarse gravel (dense, wet)		
35	■	10	50/4"		7					
40										

Elevation (feet): 165, 160, 155, 150, 145, 140, 135, 130

WELL LOG



Note: See Figure A-1 for explanation of symbols. All samples were screened in the field for evidence of contamination (See Appendix D). Unless noted otherwise, evidence of contamination was not observed during drilling and sampling.

Log of Boring GEI-17

GeoEngineers

Project: 124th Avenue NE Corridor Improvements
Project Location: Bellevue, Washington
Project Number: 0526-177-01

Figure A-18
Sheet 1 of 2

Redmond: Date:10/21/13 Path:\\RED\PROJECTS\0\0526177\01\GINT\0526177\01.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_GEOTECH_WELL

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)	WELL LOG
	40		18	48		8 SA			SW-SM	Brown fine to coarse sand with silt and gravel (dense, wet) SA (%F = 10)	19		
125									SM	Brown silty fine to coarse sand with gravel (dense, wet)			Cave-in material
	45		18	44		9 %F				%F = 7	9		
120									GM	Brown silty fine to coarse gravel (very dense, wet)			
	50		6	50/6"		10 %F				%F = 11	7		50.5

Note: See Figure A-1 for explanation of symbols. All samples were screened in the field for evidence of contamination (See Appendix D). Unless noted otherwise, evidence of contamination was not observed during drilling and sampling.

Log of Boring GEI-17 (continued)

GEOENGINEERS

Project: 124th Avenue NE Corridor Improvements
Project Location: Bellevue, Washington
Project Number: 0526-177-01

Figure A-18
Sheet 2 of 2

Redmond: Date:10/21/13 Path:\\RED\PROJECTS\0526177\01\GINT\0526177\01.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_GEOTECH_WELL

Drilled Start 7/30/2013	End 7/30/2013	Total Depth (ft) 81	Logged By CW / Checked By TDB	Driller Boretec, Inc.	Drilling Method Hollow-Stem Auger

Hammer Data	Rope & Cathead 140 (lbs) / 30 (in) Drop	Drilling Equipment	EC-55 Track Rig
Surface Elevation (ft) Vertical Datum	183	Top of Casing Elevation (ft)	
Easting (X) Northing (Y)		Horizontal Datum	

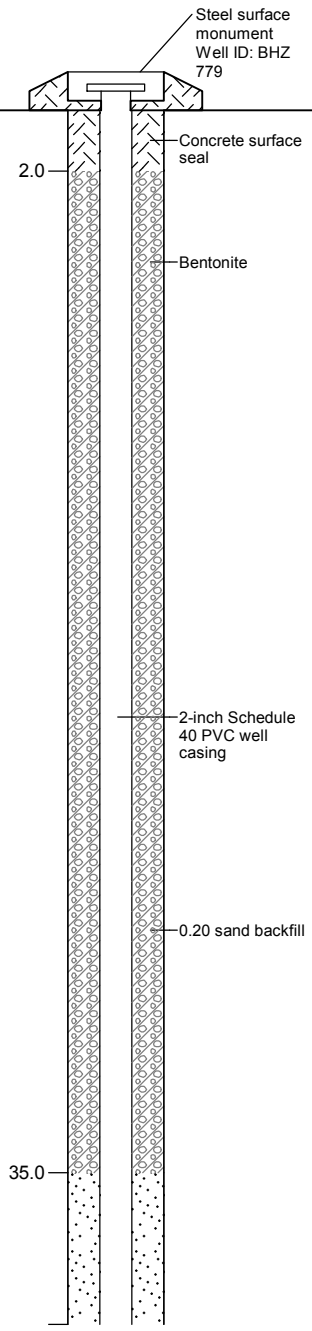
A 2 (in) well was installed on 7/31/2013 to a depth of 50 (ft).

Groundwater Date Measured	Depth to Water (ft)	Elevation (ft)
7/31/2013	42.5	140.5

Notes:

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)
	0								TS	Topsoil		
									SM	Brown silty fine to medium sand with gravel (dense, moist)		
180												
	5		3	39		1						
175									SM	Brown silty fine to medium sand with occasional gravel (very dense, moist)		
	10		12	50/6"		2					6	
170												
	15		3	50/3"		3					7	
165												
	20		4	50/4"		4 %F				%F = 28	5	
160												
	25		3	50/3"		5						
155												
	30		3	50/3"		6 SA				SA (%F = 32)	5	
150												
	35		1	50/1"		7 %F			SM	Brown silty fine to medium sand with gravel and occasional organics (very dense, moist) %F = 34	2	
145												
	40											

WELL LOG



Note: See Figure A-1 for explanation of symbols. All samples were screened in the field for evidence of contamination (See Appendix D). Unless noted otherwise, evidence of contamination was not observed during drilling and sampling.

Log of Boring GEI-18

GEOENGINEERS

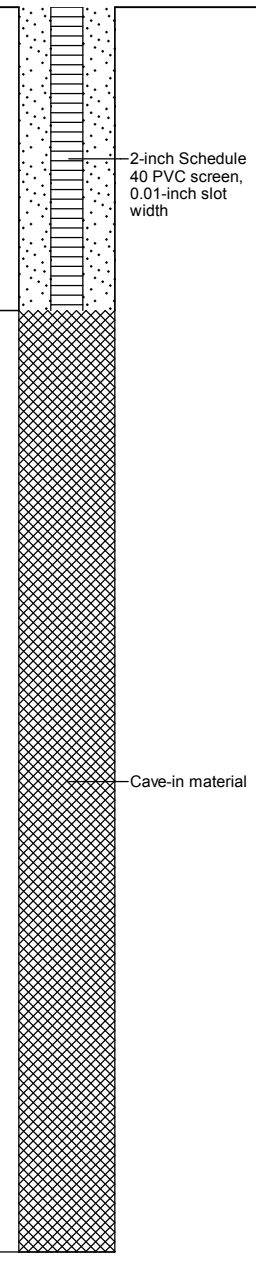
Project: 124th Avenue NE Corridor Improvements
Project Location: Bellevue, Washington
Project Number: 0526-177-01

Figure A-19
Sheet 1 of 2

Redmond: Date:10/21/13 Path:\\RED\PROJECTS\0\0526177\01\GINT\0526177\01.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_GEOTECH_WELL

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)
	40		1	50/1"		8 SA			SM	Brown silty fine to coarse sand with gravel (very dense, moist) SA (%F = 22)	5	
140									SP-SM	Brown with orange mottling fine to medium sand with silt and gravel (very dense, moist to wet) %F = 12		
	45		18	94		9 %F					15	
135												
	50		5	50/5"		10 %F				%F = 10	10	
130												
	55		5	50/5"		11 SA			SM	Brown silty fine to coarse sand with gravel (very dense, wet) SA (%F = 15)	15	
125												
	60		3	50/3"		12 %F					9	
120												
	65		3	50/3"		13 SA				SA (%F = 14)	11	
115									GP-GM	Brown with orange mottling fine to coarse gravel with silt and sand (very dense, wet) %F = 13		
	70		3	50/3"		14 %F				%F = 10	10	
110												
	75		3	50/3"		15						
105												
	80		2	50/2"		16 %F				%F = 12	25	

WELL LOG



Note: See Figure A-1 for explanation of symbols. All samples were screened in the field for evidence of contamination (See Appendix D). Unless noted otherwise, evidence of contamination was not observed during drilling and sampling.

Log of Boring GEI-18 (continued)

GEOENGINEERS

Project: 124th Avenue NE Corridor Improvements
Project Location: Bellevue, Washington
Project Number: 0526-177-01

Figure A-19
Sheet 2 of 2

Redmond: Date:10/21/13 Path:\\RED\PROJECTS\0526177\01\GINT\0526177\01.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_GEOTECH_WELL

Drilled Start 7/29/2013 End 7/29/2013	Total Depth (ft) 20.25	Logged By CW Checked By TDB	Driller Boretec, Inc.	Drilling Method Hollow-Stem Auger
Surface Elevation (ft) Vertical Datum 181		Hammer Data Rope & Cathead 140 (lbs) / 30 (in) Drop		Drilling Equipment EC-55 Track Rig
Easting (X) Northing (Y)		System Datum		Groundwater Date Measured / Depth to Water (ft) / Elevation (ft)
Notes:				Not Encountered

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)	REMARKS
180	0								TS	Topsoil			
									SM	Brown silty fine to medium sand with gravel and organics (very dense, moist)			
175	5		18	66		1					8		Rough drilling
									SM	Brown silty fine to medium sand with gravel (very dense, moist)			
170	10		15	75		2 %F					7		%F = 32 Rough drilling
165	15		3	50/3"		3							
	20		5	50/5"		4							

Note: See Figure A-1 for explanation of symbols. All samples were screened in the field for evidence of contamination (See Appendix D). Unless noted otherwise, evidence of contamination was not observed during drilling and sampling.

Log of Boring GEI-19

GeoEngineers

Project: 124th Avenue NE Corridor Improvements
Project Location: Bellevue, Washington
Project Number: 0526-177-01

Figure A-20
Sheet 1 of 1

Redmond: Date:10/21/13 Path:\\RED\PROJECTS\0\0526177\01\GINT\0526177\01.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_GEOTECH_STANDARD

Drilled Start 7/29/2013 End 7/29/2013	Total Depth (ft) 20.42	Logged By CW Checked By TDB	Driller Boretec, Inc.	Drilling Method Hollow-Stem Auger
Surface Elevation (ft) Vertical Datum 187		Hammer Data Rope & Cathead 140 (lbs) / 30 (in) Drop		Drilling Equipment EC-55 Track Rig
Easting (X) Northing (Y)		System Datum		Groundwater Date Measured / Depth to Water (ft) / Elevation (ft)
Notes:				Not Encountered

Elevation (feet)	Depth (feet)	FIELD DATA: Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)	REMARKS
	0								SM	Brown with orange mottling silty fine to medium sand with gravel and organic matter (fine roots) (dense, moist)			
185													
	5		18	33		1					9		Rough drilling
180									SM	Brown silty fine to medium sand with gravel and organics (very dense, moist)			
	10		6	50/6"		2							Rough drilling
175									SM	Brown silty fine to medium sand with gravel (very dense, moist)			
	15		5	50/5"		3							Rough drilling
170													
	20		5	50/5"		4							Rough drilling

Note: See Figure A-1 for explanation of symbols. All samples were screened in the field for evidence of contamination (See Appendix D). Unless noted otherwise, evidence of contamination was not observed during drilling and sampling.

Log of Boring GEI-20

GeoEngineers

Project: 124th Avenue NE Corridor Improvements
Project Location: Bellevue, Washington
Project Number: 0526-177-01

Figure A-21
Sheet 1 of 1

Redmond: Date:10/21/13 Path:\\RED\PROJECTS\0\0526177\01\GINT\0526177\01.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_GEOTECH_STANDARD

Drilled Start 7/29/2013	End 7/29/2013	Total Depth (ft) 16.5	Logged By CW / Checked By TDB	Driller Boretec, Inc.	Drilling Method Hollow-Stem Auger
Surface Elevation (ft) / Vertical Datum 183.5		Hammer Data Rope & Cathead 140 (lbs) / 30 (in) Drop		Drilling Equipment EC-55 Track Rig	
Easting (X) / Northing (Y)		System Datum		Groundwater: Date Measured / Depth to Water (ft) / Elevation (ft)	
Notes:				Not Encountered	

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name / Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)	REMARKS
	0								SM	Brown with orange mottling silty fine to medium sand with gravel and organics (dense to very dense, moist)			
180													
	5		18	36		1							
175													
									SM	Brown with orange mottling silty fine to medium sand with gravel (dense, moist)			
	10		10	37		2					11		
170													
										Grades to very dense			
	15		18	52		3							

Note: See Figure A-1 for explanation of symbols. All samples were screened in the field for evidence of contamination (See Appendix D). Unless noted otherwise, evidence of contamination was not observed during drilling and sampling.

Log of Boring GEI-21

GeoEngineers

Project: 124th Avenue NE Corridor Improvements
Project Location: Bellevue, Washington
Project Number: 0526-177-01

Figure A-22
Sheet 1 of 1

Redmond: Date:10/21/13 Path:\\RED\PROJECTS\0\0526177\01\GINT\0526177\01.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_GEOTECH_STANDARD

APPENDIX B
Laboratory Testing

APPENDIX B
LABORATORY TESTING

General

Soil samples obtained from the explorations were transported to our laboratory and examined to confirm or modify field classifications, as well as to evaluate index properties of the soil samples. Representative samples were selected for laboratory testing consisting of the determination of the moisture content, grain size distribution (sieve and hydrometer analysis), and plasticity characteristics (Atterberg limits). The tests were performed in general accordance with test methods of the American Society for Testing and Materials (ASTM) or other applicable procedures.

Moisture Content Testing

Moisture content tests were completed in general accordance with ASTM D 2216 for representative samples obtained from the explorations. The results of these tests are presented on the exploration logs in Appendix A at the depths at which the samples were obtained.

Sieve Analyses

Sieve analyses were performed on selected samples in general accordance with ASTM D 422 to determine the sample grain size distribution. The wet sieve analysis method was used to determine the percentage of soil greater than the U.S. No. 200 mesh sieve. The distribution of the percentage of soil smaller than the U.S. No. 200 mesh sieve (e.g. silt and clay) was determined for select samples by hydrometer analysis in accordance with ASTM D 4221. The results of the sieve analyses were plotted, classified in general accordance with the Unified Soil Classification System (USCS), and are presented in Figures B-1 through B-7.

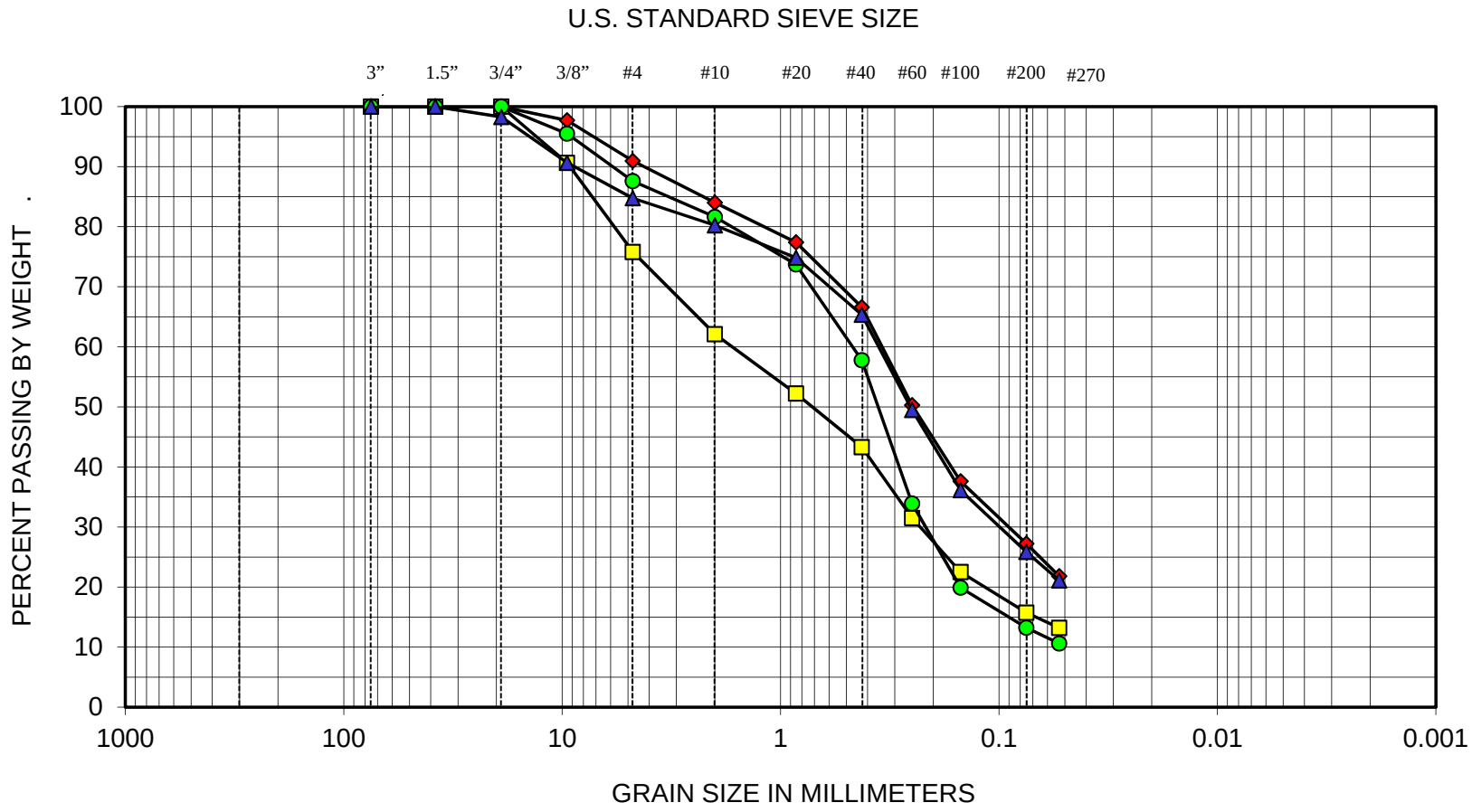
It should be noted that the sieve analyses were performed on soils obtained from samplers that have an opening size of 1½ inches so larger sized particles can't be obtained by the samplers. Therefore, the sieve results do not account for soil particles that are larger than 1½ inches. Soils with larger sized materials are described in this report qualitatively based on visual observations and experience on projects where excavations were made into similar formations.

Atterberg Limits Testing

Atterberg limits testing was performed on a selected fine-grained soil samples. The tests were used to classify the soil as well as to evaluate index properties. The liquid limit and the plastic limit were estimated through a procedure performed in general accordance with ASTM D 4318. The results of the Atterberg limits testing are summarized in Figures B-8 and B-9.

0526-177-00 SAS: SAS 11-11-2011

GEOENGINEERS



BOULDERS	COBBLES	GRAVEL		SAND			SILT OR CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE	

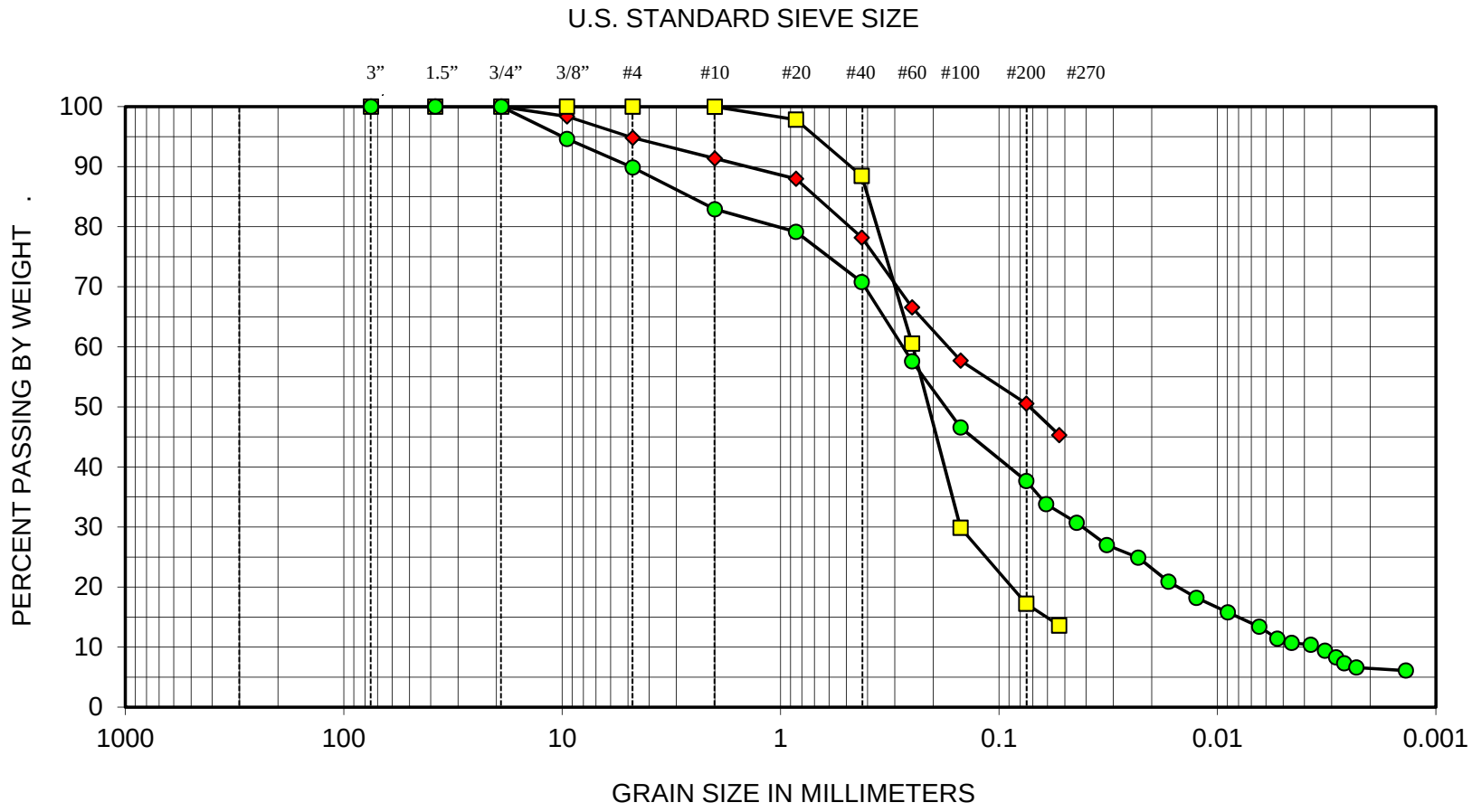
SYMBOL	EXPLORATION NUMBER	DEPTH (ft)	SOIL CLASSIFICATION
◆	GEI-1	5	Brown silty fine to coarse sand with gravel (SM)
■	GEI-1	15	Brown silty fine to coarse sand with gravel (SM)
●	GEI-2	5	Brown silty fine to coarse sand with gravel (SM)
▲	GEI-3	5	Brownish gray silty fine to medium sand with gravel (SM)

SIEVE ANALYSIS RESULTS

FIGURE B-1

0526-177-00 SAS: SAS 11-11-2011

GEOENGINEERS



BOULDERS	COBBLES	GRAVEL		SAND			SILT OR CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE	

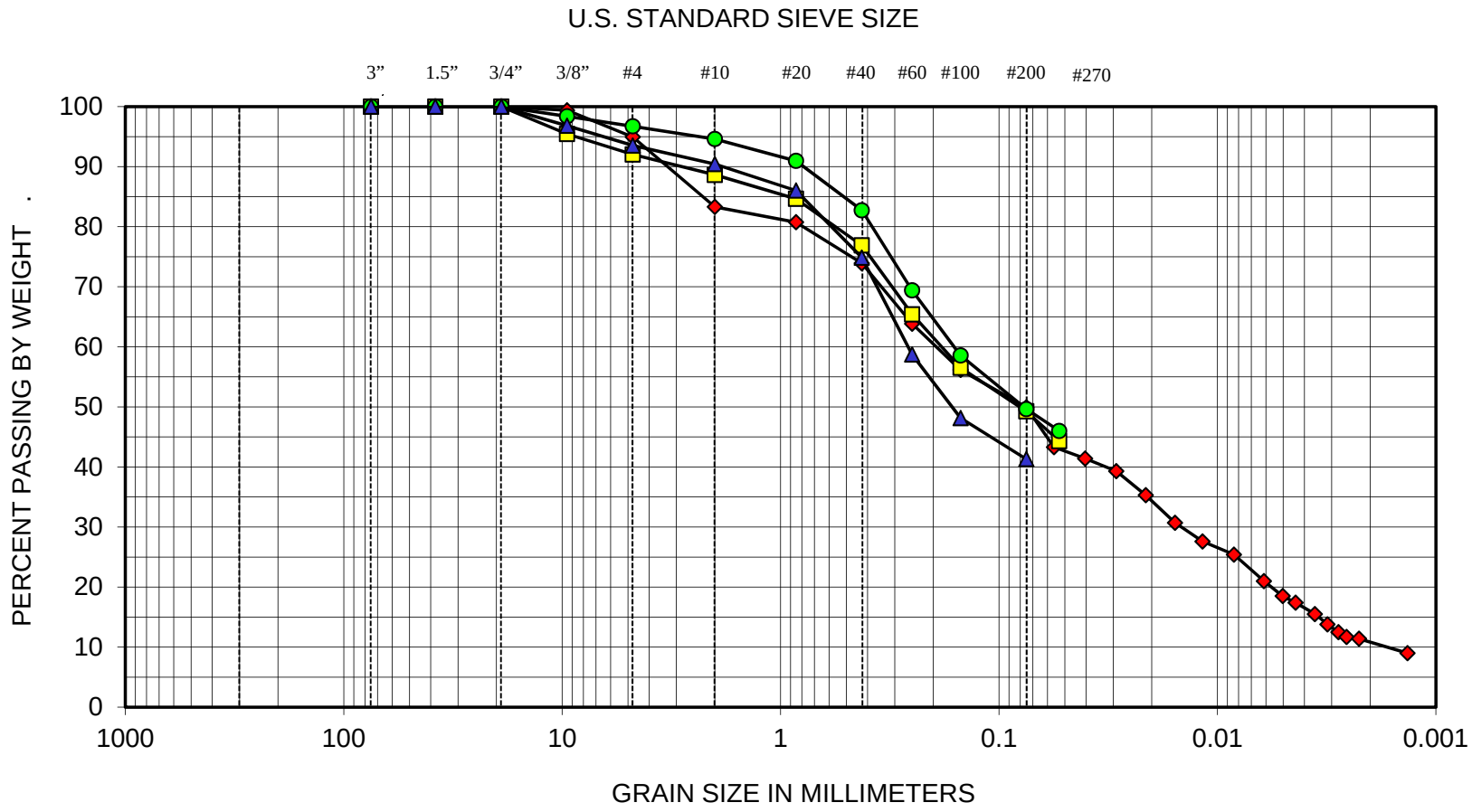
SYMBOL	EXPLORATION NUMBER	DEPTH (ft)	SOIL CLASSIFICATION
◆	GEI-5	5	Gray sandy silt (ML)
□	GEI-5	7½	Gray silty fine to medium sand (SM)
○	GEI-6	5	Gray silty fine to coarse sand with occasional gravel (SM)

SIEVE ANALYSIS RESULTS

FIGURE B-2

0526-177-00 SAS: SAS 11-11-2011

GEOENGINEERS



BOULDERS	COBBLES	GRAVEL		SAND			SILT OR CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE	

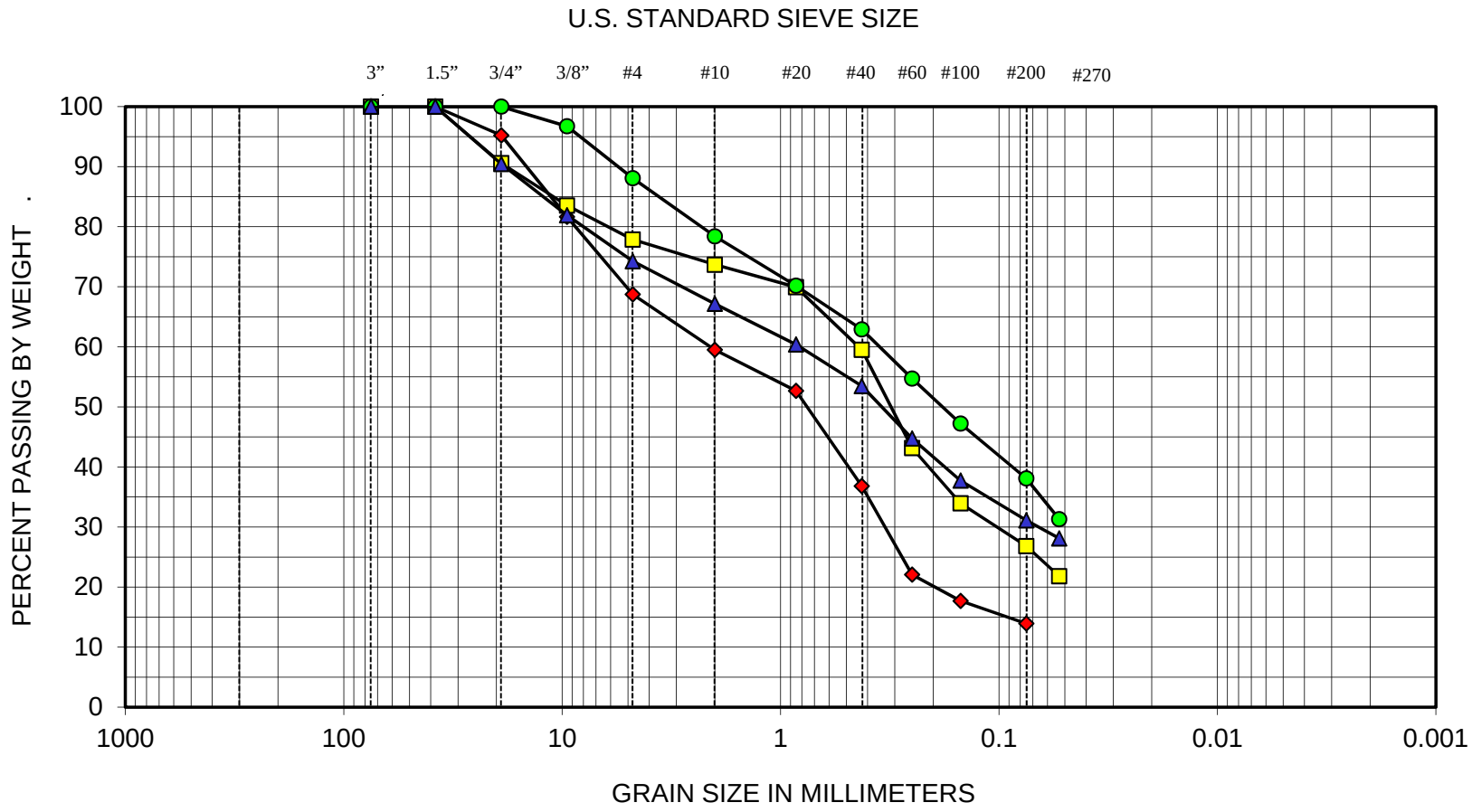
SYMBOL	EXPLORATION NUMBER	DEPTH (ft)	SOIL CLASSIFICATION
◆	GEI-7	5	Brown silty fine to coarse sand with occasional gravel (SM)
■	GEI-7	7½	Gray silty fine to medium sand with occasional gravel (SM)
●	GEI-8	5	Gray-brown silty fine to medium sand with occasional gravel (SM)
▲	GEI-9	7½	Gray-brown silty fine to medium sand with occasional gravel (SM)

SIEVE ANALYSIS RESULTS

FIGURE B-3

0526-177-00 SAS: SAS 11-11-2011

GEOENGINEERS



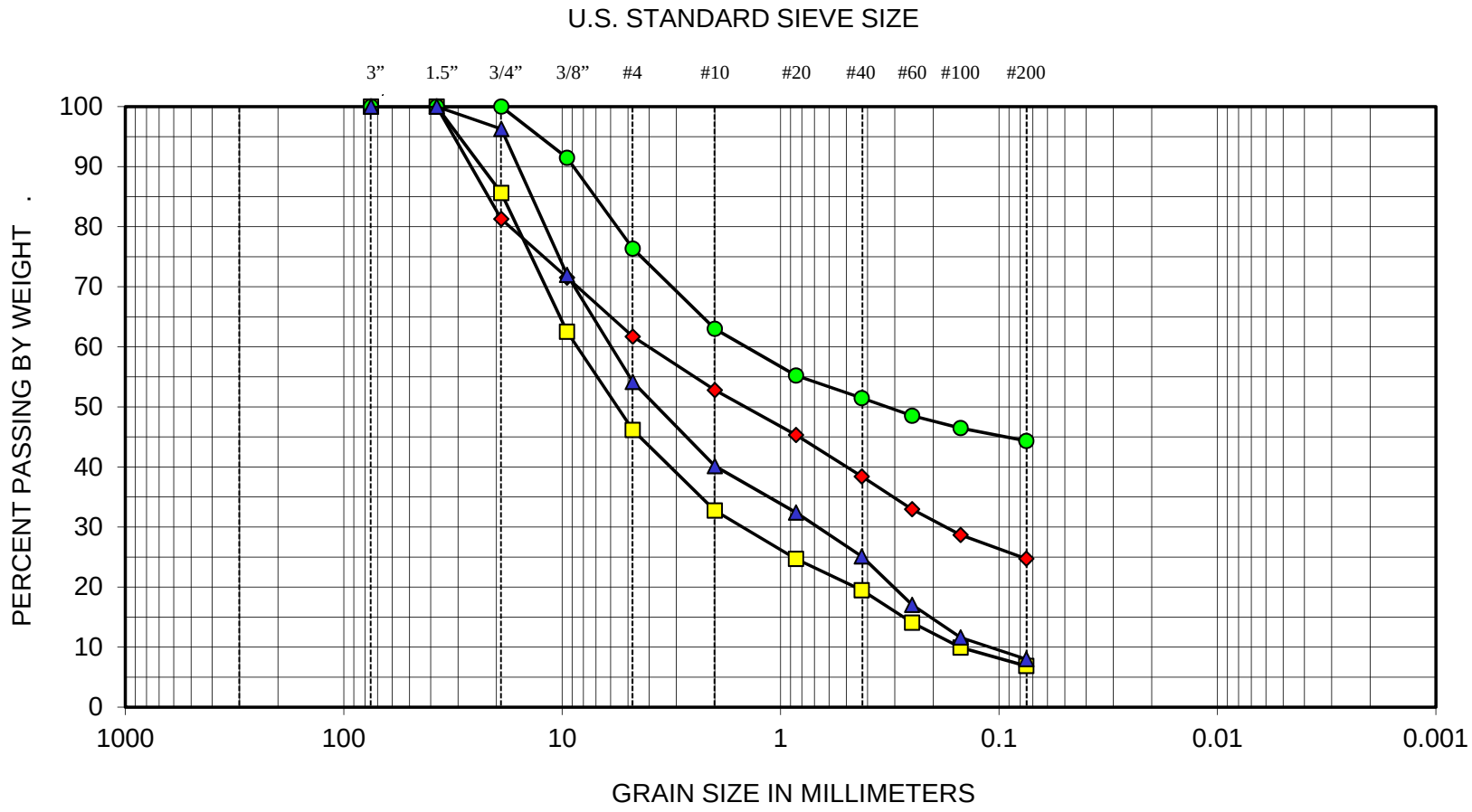
BOULDERS	COBBLES	GRAVEL		SAND			SILT OR CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE	

SYMBOL	EXPLORATION NUMBER	DEPTH (ft)	SOIL CLASSIFICATION
◆	GEI-10	7½	Brown silty fine to coarse sand with gravel (SM)
■	GEI-11	5	Brown silty fine to medium sand with gravel (SM)
●	GEI-13	5	Brown silty fine to coarse sand with occasional gravel (SM)
▲	GEI-15	5	Gray silty fine to coarse sand with gravel (SM)

SIEVE ANALYSIS RESULTS

FIGURE B-4

0526-077-01 CWM: SAS 08-07-2013



BOULDERS	COBBLES	GRAVEL		SAND			SILT OR CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE	

SYMBOL	EXPLORATION NUMBER	DEPTH (ft)	SOIL CLASSIFICATION
◆	GEI-16	15	Silty fine to coarse gravel with sand (GM)
□	GEI-16	30	Brown fine to coarse gravel with silt and sand (GW-GM)
○	GEI-16	55	Gray silty fine to coarse sand with gravel (SM)
▲	GEI-16	75	Brown fine to coarse sand with silt and gravel (SP-SM)

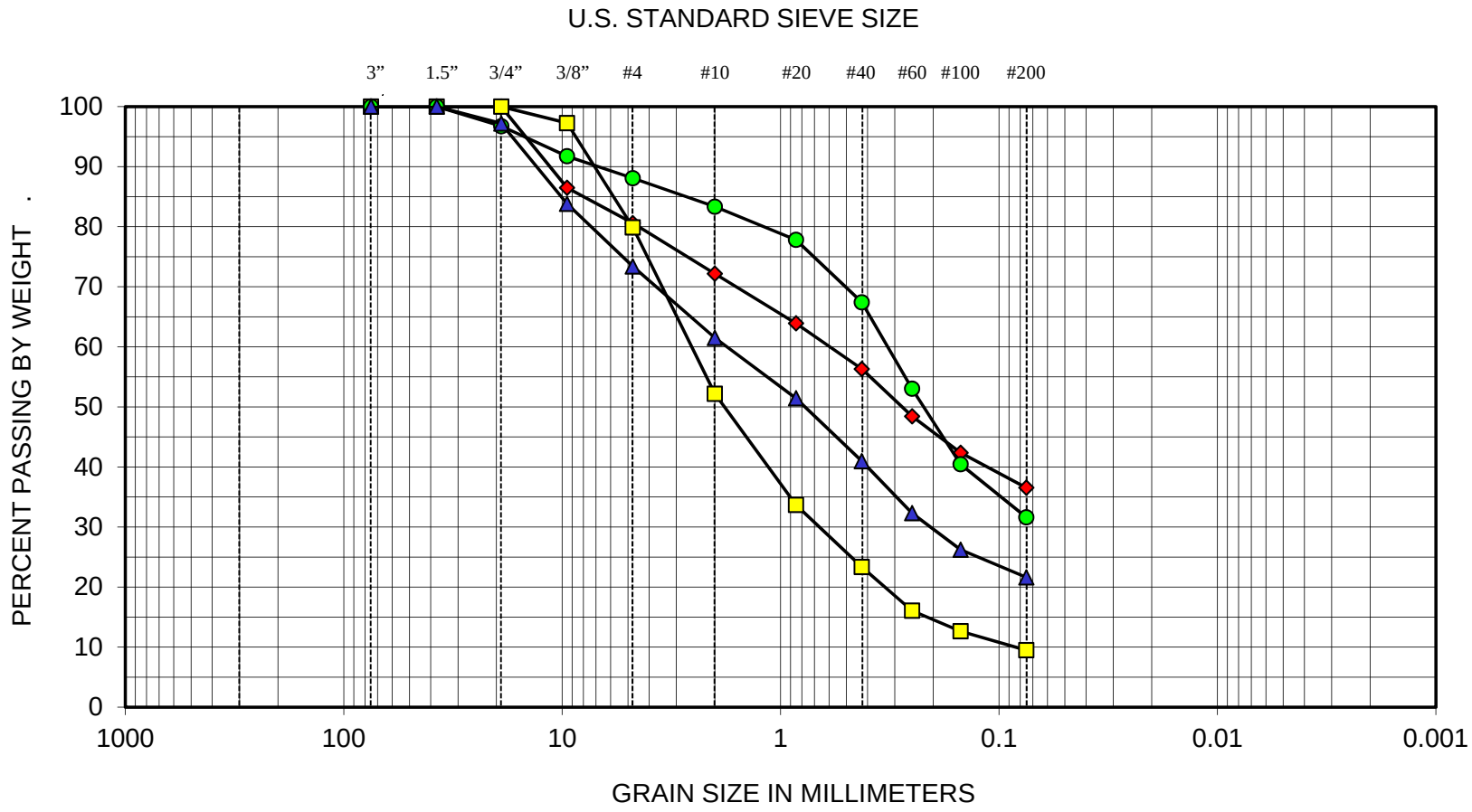
GEOENGINEERS

SIEVE ANALYSIS RESULTS

FIGURE B-5

0526-077-01 CWM: SAS 08-07-2013

GEOENGINEERS



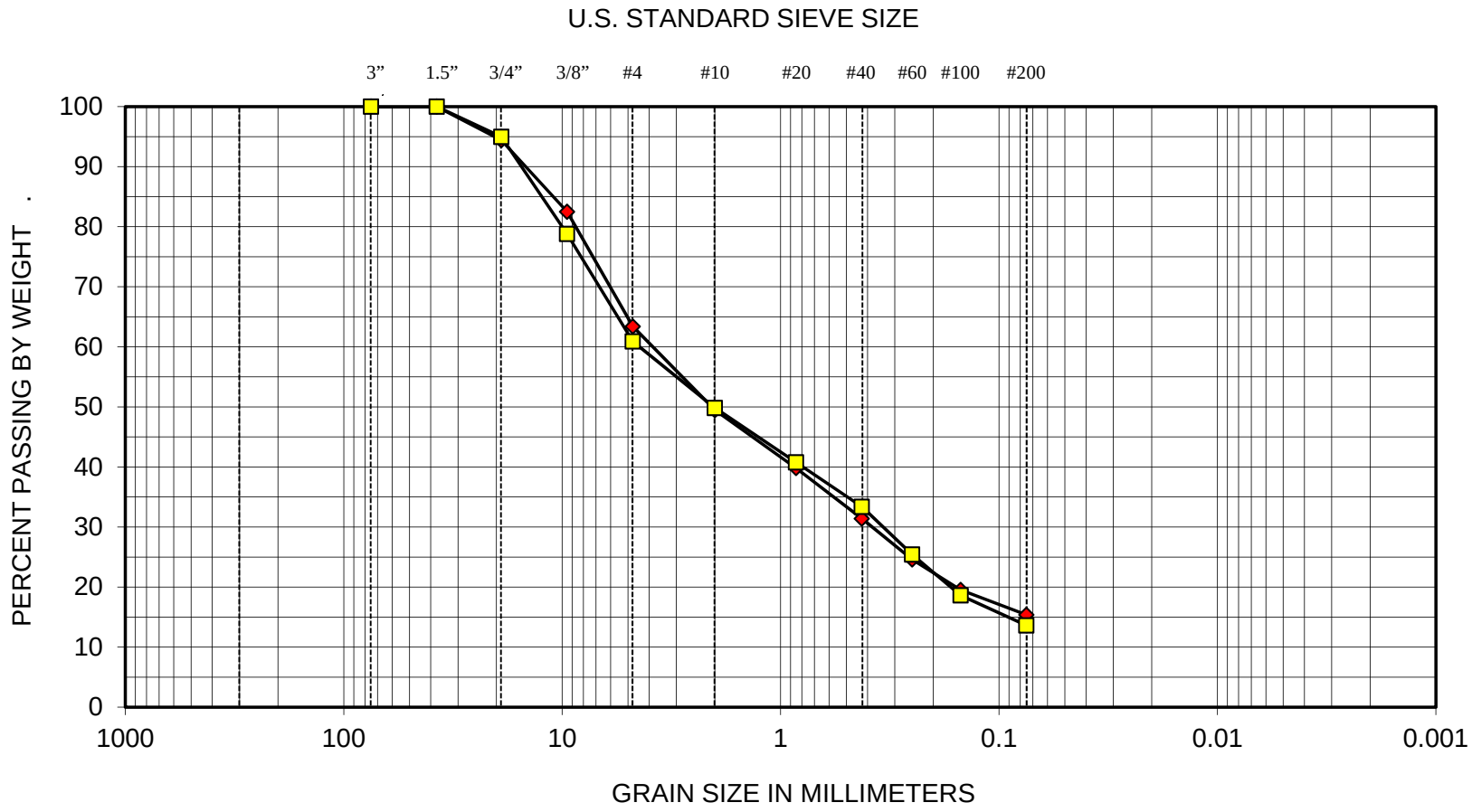
BOULDERS	COBBLES	GRAVEL		SAND			SILT OR CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE	

SYMBOL	EXPLORATION NUMBER	DEPTH (ft)	SOIL CLASSIFICATION
◆	GEI-17	25	Brown silty fine to medium sand with gravel (SM)
■	GEI-17	40	Gray fine to coarse sand with silt and gravel (SW-SM)
●	GEI-18	30	Brown silty fine to medium sand with occasional gravel (SM)
▲	GEI-18	40	Brown silty fine to coarse sand with gravel (SM)

SIEVE ANALYSIS RESULTS

FIGURE B-6

0526-077-01 CWM: SAS 08-07-2013



BOULDERS	COBBLES	GRAVEL		SAND			SILT OR CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE	

SYMBOL	EXPLORATION NUMBER	DEPTH (ft)	SOIL CLASSIFICATION
◆	GEI-18	55	Brown silty fine to coarse sand with gravel (SM)
■	GEI-18	65	Brown silty fine to coarse sand with gravel (SM)

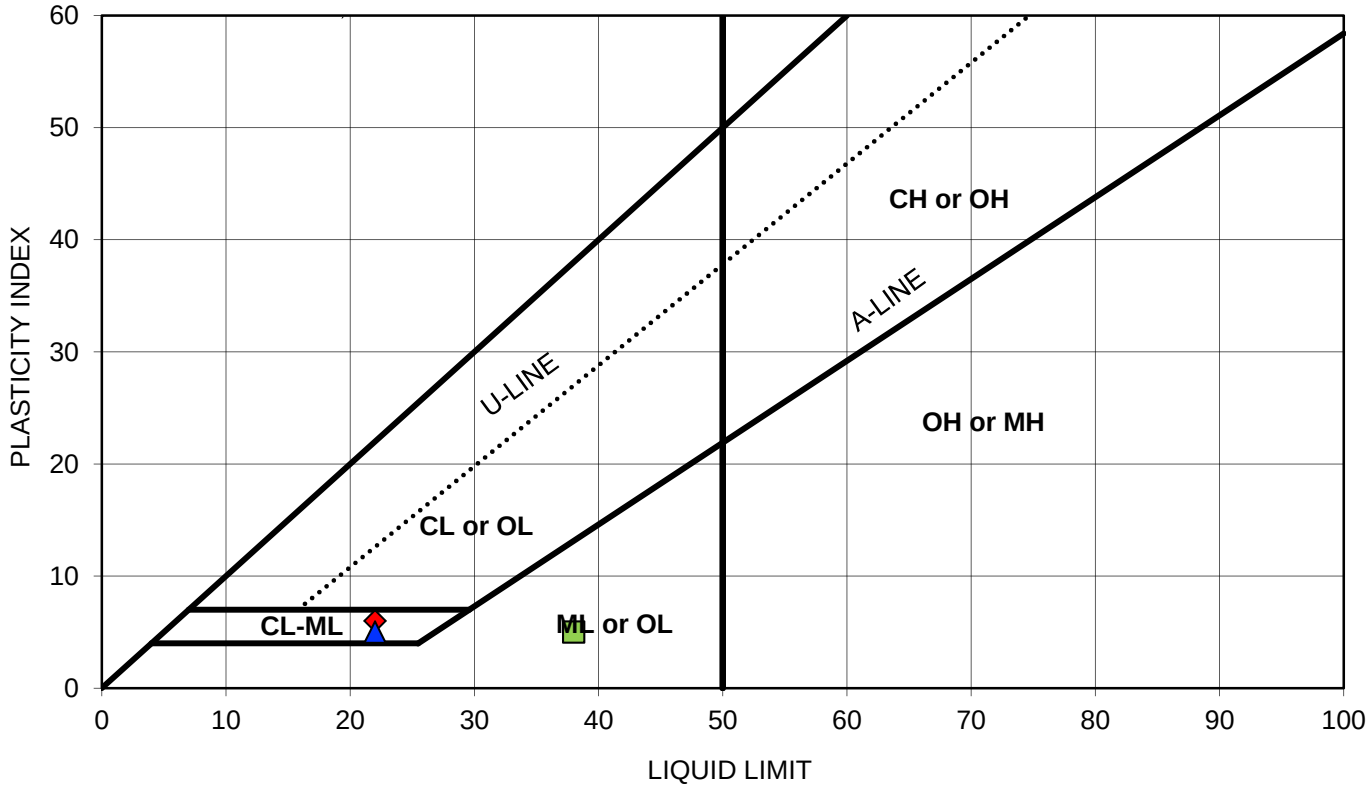
GEOENGINEERS

SIEVE ANALYSIS RESULTS

FIGURE B-7

GEOENGINEERS

PLASTICITY CHART



SYMBOL	EXPLORATION NUMBER	SAMPLE DEPTH (ft)	MOISTURE CONTENT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	SOIL DESCRIPTION
◆	GEI-3	15	18	22	6	Brownish-gray sandy silty clay (CL-ML)
■	GEI-5	10	37	38	5	Gray silt with sand and trace organic matter (ML)
▲	GEI-6	20	16	22	5	Gray silty clay with sand (CL-ML)

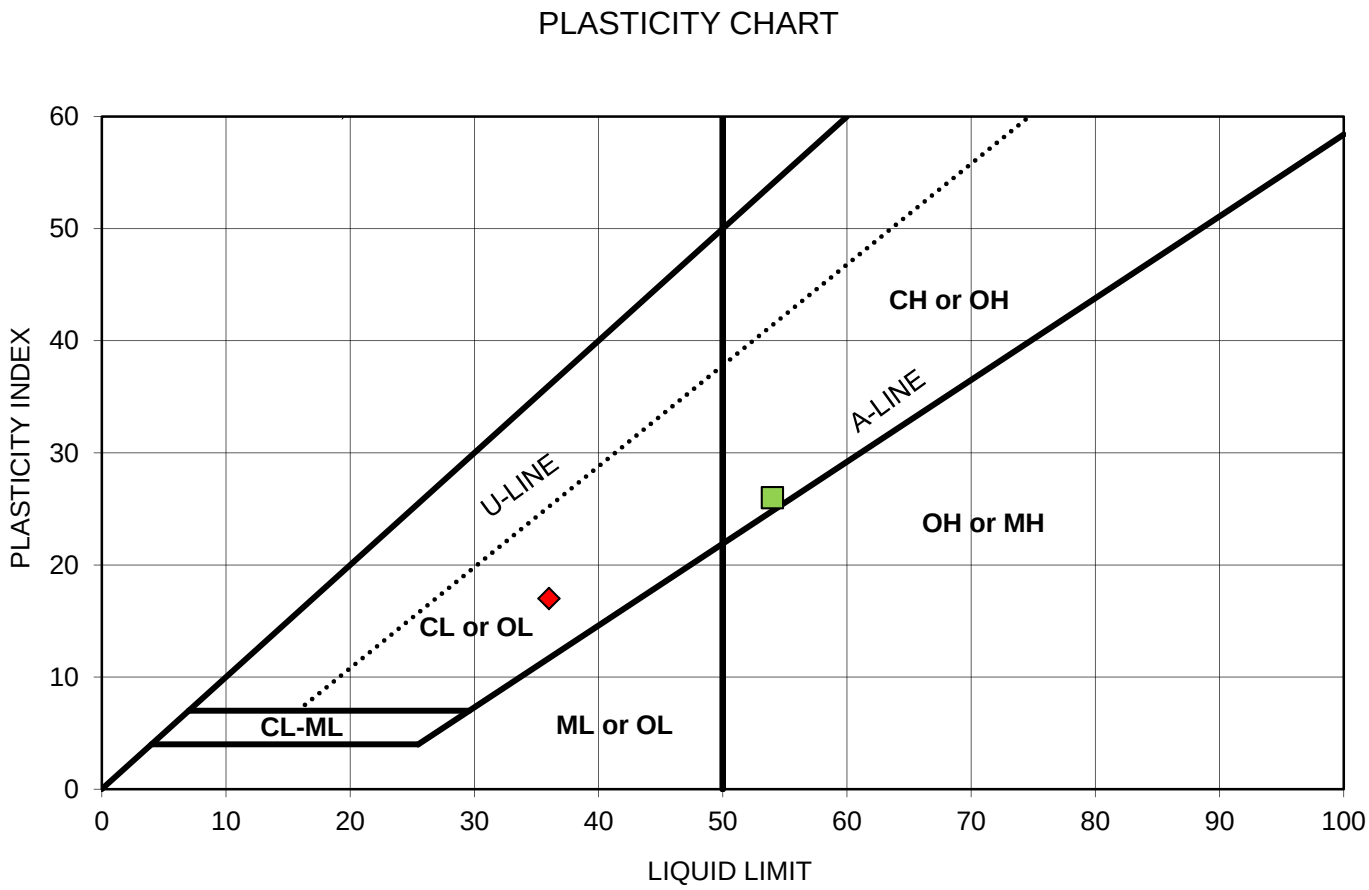
ATTERBERG LIMITS TEST RESULTS

FIGURE B-8

GEOENGINEERS

FIGURE B-9

ATTERBERG LIMITS TEST RESULTS



SYMBOL	EXPLORATION NUMBER	SAMPLE DEPTH (ft)	MOISTURE CONTENT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	SOIL DESCRIPTION
◆	GEI-16	10	25	36	17	Gray sandy clay with occasional gravel (CL)
■	GEI-17	15	14	54	26	Gray sandy clay with gravel (CH)

APPENDIX C
Previous Explorations

APPENDIX C
PREVIOUS EXPLORATIONS

This appendix includes the logs of previous explorations in the project vicinity:

- The log of one boring completed by Sound Transit in 2012 for the East Link light rail transit project (E340-B-008) and supporting laboratory data.
- The log of one boring and one test pit completed by GeoEngineers in 2013 for the 15th/16th roadway project and supporting Pilot Infiltration Test (PIT) data.
- The log of four borings completed by Kleinfelder in 2005 for Proposed Improvements to Safeway Distribution Center (B-1 through B-4) and supporting laboratory data.

RECORD OF BOREHOLE E340-B-008

PROJECT: Sound Transit East Link/WA
PROJECT NUMBER: 113-93533.0320
LOCATION: 124th Ave. NE, Bellevue WA

DRILLING METHOD: Hollow Stem Auger
DRILLING DATE: 12/28/12
DRILL RIG: B-60 Mobile Drill Truck

DATUM: Sound Transit East Coordinate System
COORDINATES: not surveyed

ELEVATION: 170
INCLINATION: -90
WELL TAG#:BHU567

BORING METHOD: 4.25-inch Inner Diameter Hollow Stem Auger

DEPTH (Ft)	SOIL PROFILE DESCRIPTION	USCS	ELEV. / DEPTH (Ft)	SAMPLE NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	PENETRATION RESISTANCE BLOWS / ft ◆ (PL–MC–LL)	NOTES WATER LEVELS / GRAPHIC
0	0.0 - 0.7 Asphalt Pavement, [FILL, Hf].		169.3							8-inch diameter flush mount steel monument cemented in place to 1 ft bgs. 2 inch diameter PVC riser from 0.3 to 24 ft bgs. Backfilled with drill cuttings from 1.5 to 2 ft bgs. Backfilled with 3/8 inch "Holeplug" bentonite Chips from 2 to 22 ft bgs. Soft sediment deformation observed in Sample S-2 at 2.5 ft bgs. likely slough at top of Sample S-3 at 5 ft bgs.
	0.7 - 1.7 Compact, Light brown, (SP), dam to moist, fine to medium SAND, some fine to coarse gravel, occasional lenses (~1 inch thick) of silty fine to medium SAND , some fine to coarse gravel, [FILL, Hf].	SP	0.7 168.3	S-1	SS	14-14-11	25	1.5 / 1.5		
	1.7 - 23.0 Very stiff, light gray, light yellowish brown, and white, (CL/ML), moist, low plasticity to non-plastic SILT and CLAY , rhythmic subhorizontal laminations, [LACUSTRINE DEPOSITS, Hl].	CL/ML	1.7	S-2	SS	5-8-12	20	0.8 / 1.5		
5				S-3	SS	3-5-10	15	1.2 / 1.5		
				S-4	SS	4-8-12	20	1.0 / 1.5		
10				S-5	SS	5-10-12	22	1.5 / 1.5		
				S-6	SS	4-5-16	21	1.5 / 1.5		
15				S-7	SS	2-4-12	16	1.0 / 1.5		
20				S-8	SS	10-13-20	33	1.5 / 1.5		Backfilled with 10x20 silica sand filter Driller's Note: Gravel encountered at about 23 ft bgs. 2 inch diameter 0.020 machine
	23.0 - 38.0 Very dense, brown to gray, (GP/GP-GM), moist, fine to coarse GRAVEL, some fine to coarse sand, little to trace silt, [PRE-VASHON FLUVIAL DEPOSITS, Qpnf].	GP	147.0 23.0							
25										

Log continued on next page

DRAFT

1 in to 3 ft
DRILLING CONTRACTOR: Holt Services Inc
DRILLER: Todd Knipschield

LOGGED: Jeff Schwartz
CHECKED:
DATE:

FINAL DESIGN PARTNERS.

RECORD OF BOREHOLE E340-B-008

PROJECT: Sound Transit East Link/WA
PROJECT NUMBER: 113-93533.0320
LOCATION: 124th Ave. NE, Bellevue WA

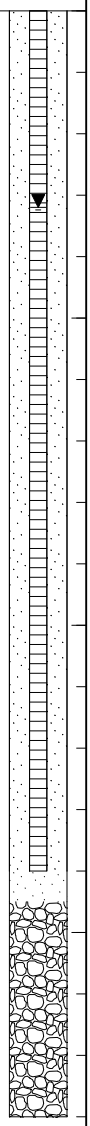
DRILLING METHOD: Hollow Stem Auger
DRILLING DATE: 12/28/12
DRILL RIG: B-60 Mobile Drill Truck

DATUM: Sound Transit East Coordinate System
COORDINATES: not surveyed

ELEVATION: 170
INCLINATION: -90
WELL TAG#:BHU567

BORING METHOD: 4.25-inch Inner Diameter Hollow Stem Auger

DEPTH (Ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (Ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	PENETRATION RESISTANCE BLOWS / ft ◆ (10 20 30 40; PL MC LL 20 40 60 80)	NOTES WATER LEVELS / GRAPHIC
25	23.0 - 38.0 Very dense, brown to gray, (GP/GP-GM), moist, fine to coarse GRAVEL, some fine to coarse sand, little to trace silt, [PRE-VASHON FLUVIAL DEPOSITS, Qpnf].	GP			S-9	SS	50/5"	>50	0.4 / 0.4		>> slotted PVC from 24 to 39 ft, cap at 39 ft bgs. Faceted gravel observed in sample S-9 at 25 ft bgs.
											Driller's Note: Groundwater encountered at about 29 ft bgs.
30	Becomes gray and wet, fine to medium sand.				S-10	SS	30-50/5"	>50	0.8 / 0.9		>>
35					S-11	SS	21-50/5"	>50	0.9 / 0.9		>>
	38.0 - 43.0 Dense to very dense, gray, (SP), wet, fine to coarse SAND, trace silt, trace gravel. Sand grades coarser from 40.0 to 41.5, [PRE-VASHON FLUVIAL DEPOSITS, Qpnf].			132.0 / 38.0							Driller's Note: Smoother drilling (less gravel) at about 38 ft bgs. Slough to bottom of hole.
40		SP			S-12	SS	5-18-32	50	1.5 / 1.5	●	S-12@40ft %G-1.6 %S-95.3 %F-3.1
	Becomes dense, fine to medium SAND, trace silt.				S-13	SS	12-16-22	38	1.0 / 1.5	◆	
	Boring completed at 43.0 ft.			127.0 / 43.0							
45											
50											



DRAFT

1 in to 3 ft
DRILLING CONTRACTOR: Holt Services Inc
DRILLER: Todd Knipschield

LOGGED: Jeff Schwartz
CHECKED:
DATE:

FINAL DESIGN PARTNERS.

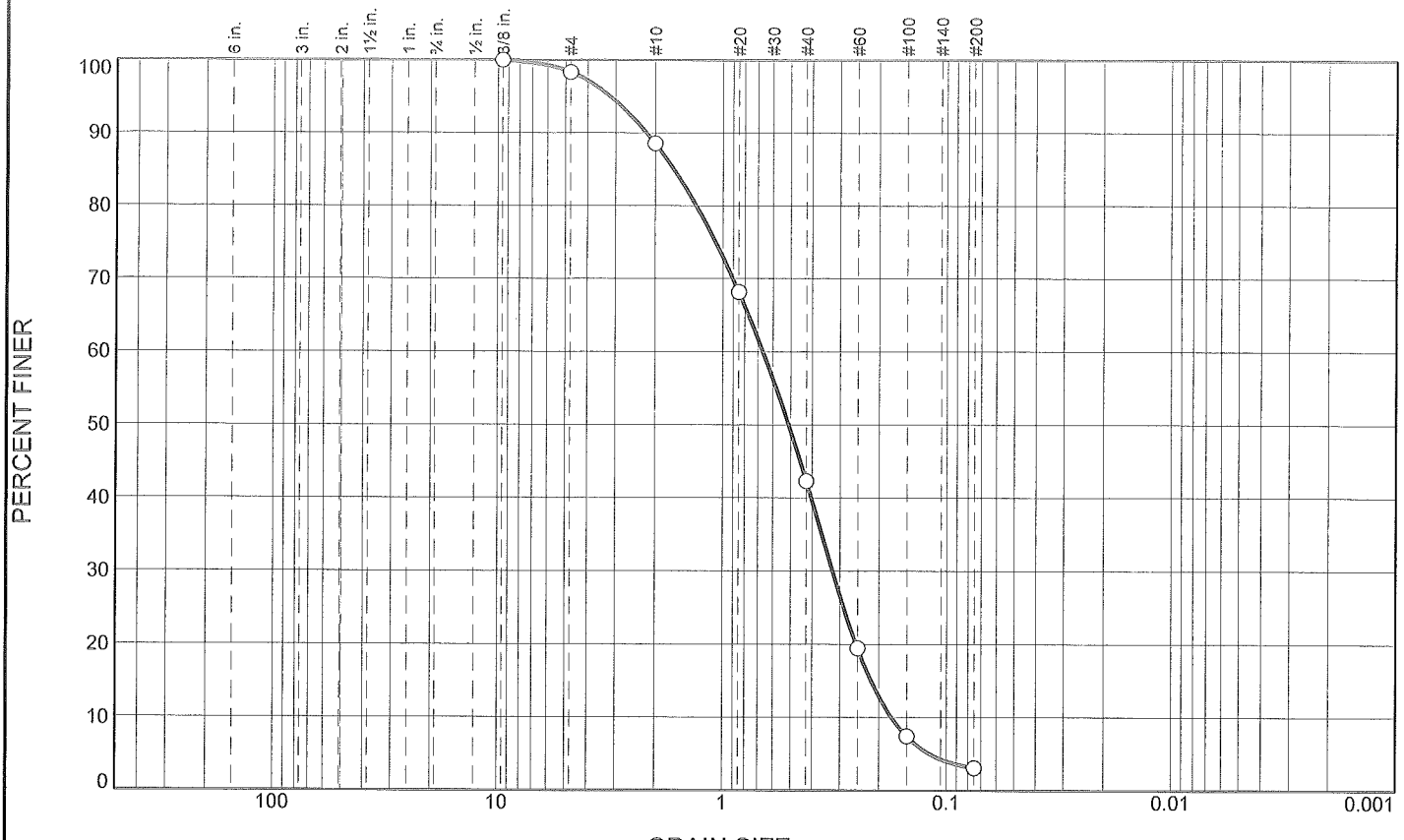
Hayre McElroy & Associates, LLC

Moisture Contents

Sound Transit East Link - Golder Asociates

HMA Sample #	Golder Sample #	Location	Date Received	Date of Test	Tare #	Wt of Tare	Tare+ Wet	Tare+ Dry	Moisture %
7494a	S-12	B-08/40'-41.5'	1/25/2013	1/28/2013	X6	196.4	590.5	518.2	22.5
7494b	S-8	B-08/20'-21.5'	1/25/2013	1/28/2013	12	31.0	90.5	79.3	23.2
7494c	S-5	B-08/10'-11.5'	1/25/2013	1/28/2013	83	35.1	117.5	103.4	20.6
7494d	S-2	B-08/2.5'-4'	1/25/2013	1/28/2013	81	36.7	114.4	100.8	21.2
7494e	S-1	B-09/0.8'-2.3'	1/25/2013	1/29/2013	X5	198.2	745.4	726.6	3.6
7494f	S-6	B-09/12.5'-14'	1/25/2013	1/29/2013	X8	194.2	685.1	632.1	12.1
7494g	S-10	B-09/30'-30.8'	1/25/2013	1/29/2013	AB	157.5	434.1	403.6	12.4
7494h	S-10	B-03/24.5'-25'	1/25/2013	1/30/2013	AJ	165.0	559.3	524.9	9.6
7494i	S-16	B-03/39'-40'	1/25/2013	1/30/2013	X7	193.10	869.20	819.90	7.9
7494j	S-21	B-03/52'-52.5'	1/25/2013	1/30/2013	9A	162.20	650.30	612.60	8.4
7494k	S-25	B-03/62'-62.5'	1/25/2013	1/30/2013	X10	234.80	781.80	739.80	8.3
7494l	S-14	B-01/34'-35'	1/25/2013	1/30/2013	X9	230.80	1135.00	1069.10	7.9
7494m	S-18	B-01/44'-45'	1/25/2013	1/30/2013	S1	118.30	912.00	861.40	6.8
7494n	S-21	B-01/52'-53'	1/25/2013	1/30/2013	S8	113.30	782.40	722.60	9.8

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.6	9.9	46.2	39.2	3.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8"	100.0		
#4	98.4		
#10	88.5		
#20	68.2		
#40	42.3		
#60	19.5		
#100	7.4		
#200	3.1		

* (no specification provided)

Material Description

Poorly Graded Sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{90}= 2.1839 D_{85}= 1.6544 D_{60}= 0.6640
D_{50}= 0.5100 D_{30}= 0.3237 D_{15}= 0.2171
D_{10}= 0.1756 C_u= 3.78 C_c= 0.90

Classification

USCS= SP AASHTO= A-1-b

Remarks

Source of Sample: Boring E340 - B-08 **Depth:** 40'-41.5'
Sample Number: HMA-7494a/Golder S12 **Date:** 2/1/2013

Hayre McElroy & Associates, LLC

Redmond, WA

Client: Golder Associates
Project: Sound Transit East Link
Project No: 12-450 **Figure**

Tested By: Tara Pfaff **Checked By:** JAM

GRAIN SIZE DISTRIBUTION TEST DATA

2/4/2013

Client: Golder Associates
Project: Sound Transit East Link
Project Number: 12-450
Location: Boring E340 - B-08
Depth: 40'-41.5'
Sample Number: HMA-7494a/Golder S12
Material Description: Poorly Graded Sand
Date: 2/1/2013 **PL:** NP **LL:** NP **PI:** NP
USCS Classification: SP
AASHTO Classification: A-1-b
Tested by: Tara Pfaff
Checked by: JAM

Sieve Test Data

Post #200 Wash Test Weights (grams): Dry Sample and Tare = 507.60
Tare Wt. = 196.40
Minus #200 from wash = 3.3%

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer
518.20	196.40	3/8"	0.00	0.00	100.0
		#4	1362.90	1357.60	98.4
		#10	1205.20	1173.60	88.5
		#20	1133.80	1068.30	68.2
		#40	1029.00	945.70	42.3
		#60	952.20	878.80	19.5
		#100	882.60	843.80	7.4
		#200	1034.40	1020.40	3.1

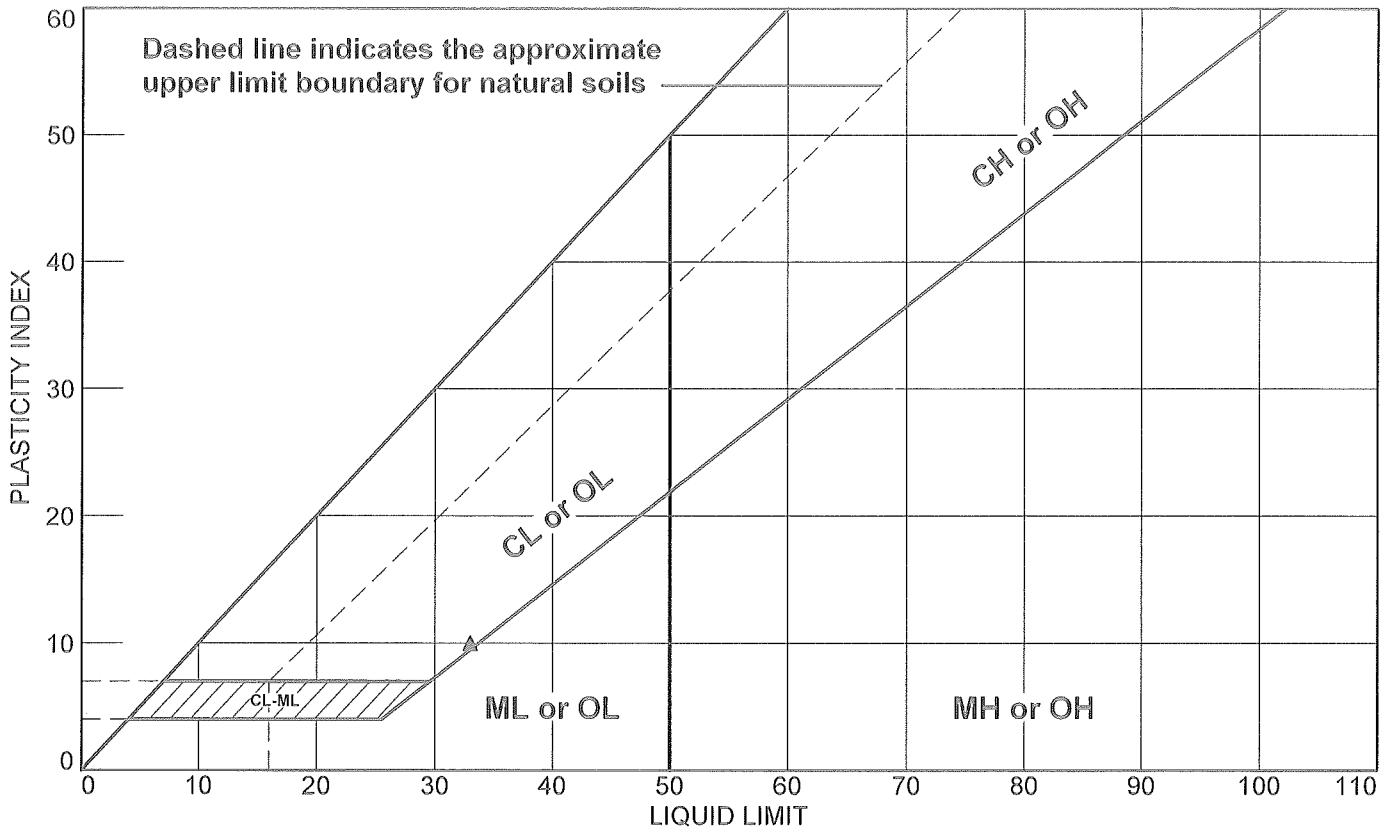
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	1.6	1.6	9.9	46.2	39.2	95.3			3.1

D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
0.1756	0.2171	0.2536	0.3237	0.5100	0.6640	1.3144	1.6544	2.1839	3.1607

Fineness Modulus	C_u	C_c
2.43	3.78	0.90

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA

	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	Boring E340 - B-08	HMA-7494b/ Golder S-8	20'-21.5'	23.2	21	21	NP	
■	Boring E340 - B-08	HMA-7494c/ Golder S-5	10'-11.5'	20.6	24	23	NP	
▲	Boring E340 - B-08	HMA-7494d/ Golder S-2	2.5'-4'	21.2	23	33	10	

Hayre McElroy & Associates, LLC **Redmond, WA**	**Client:** Golder Associates **Project:** Sound Transit East Link **Project No.:** 12-450 **Figure**

Tested By: Tara Pfaff **Checked By:** JAM

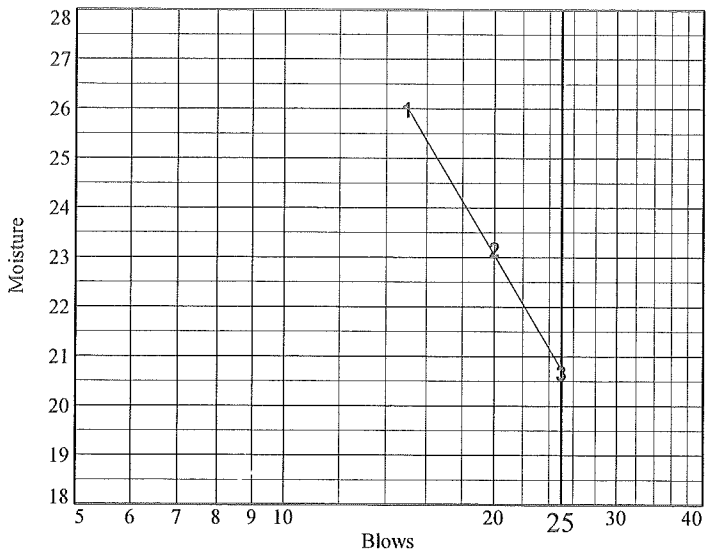
LIQUID AND PLASTIC LIMIT TEST DATA

2/1/2013

Client: Golder Associates
Project: Sound Transit East Link
Project Number: 12-450
Location: Boring E340 - B-08
Depth: 20'-21.5'
Sample Number: HMA-7494b/Golder S-8
Tested by: Tara Pfaff
Checked by: JAM

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	27.2	32.9	35.0			
Dry+Tare	23.9	28.8	31.3			
Tare	11.2	11.1	13.4			
# Blows	15	20	25			
Moisture	26.0	23.2	20.7			



Liquid Limit= 21
Plastic Limit= 21
Plasticity Index= NP
Natural Moisture= 23.2

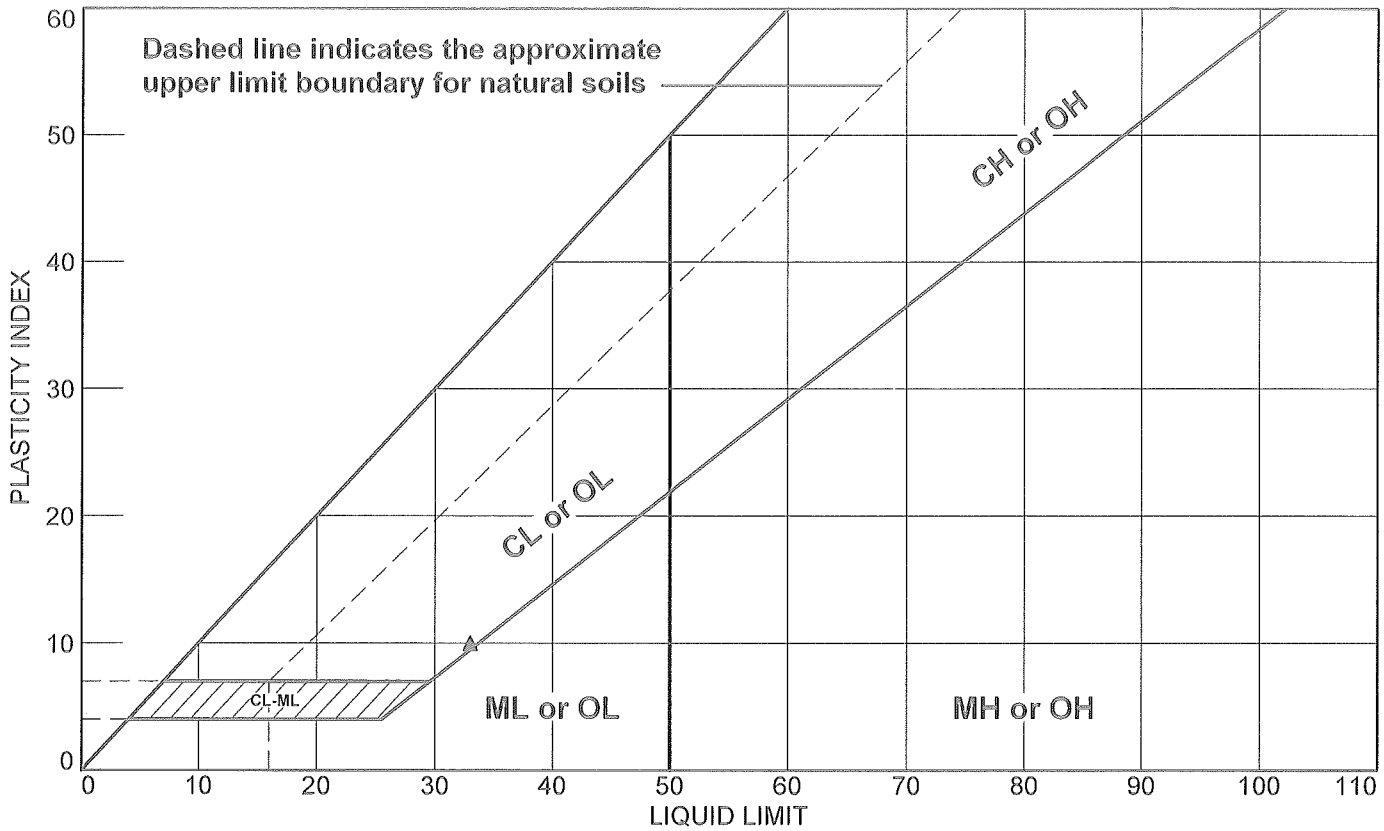
Plastic Limit Data

Run No.	1	2	3	4	
Wet+Tare	18.0	18.9	20.2		
Dry+Tare	16.8	17.4	18.8		
Tare	11.0	11.1	11.1		
Moisture	20.7	23.8	18.2		

Natural Moisture Data

Wet+Tare	Dry+Tare	Tare	Moisture
90.5	79.3	31.0	23.2

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA

	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	Boring E340 - B-08	HMA-7494b/ Golder S-8	20'-21.5'	23.2	21	21	NP	
■	Boring E340 - B-08	HMA-7494c/ Golder S-5	10'-11.5'	20.6	24	23	NP	
▲	Boring E340 - B-08	HMA-7494d/ Golder S-2	2.5'-4'	21.2	23	33	10	

Hayre McElroy & Associates, LLC **Redmond, WA**	**Client:** Golder Associates **Project:** Sound Transit East Link **Project No.:** 12-450 **Figure**

Tested By: Tara Pfaff **Checked By:** JAM

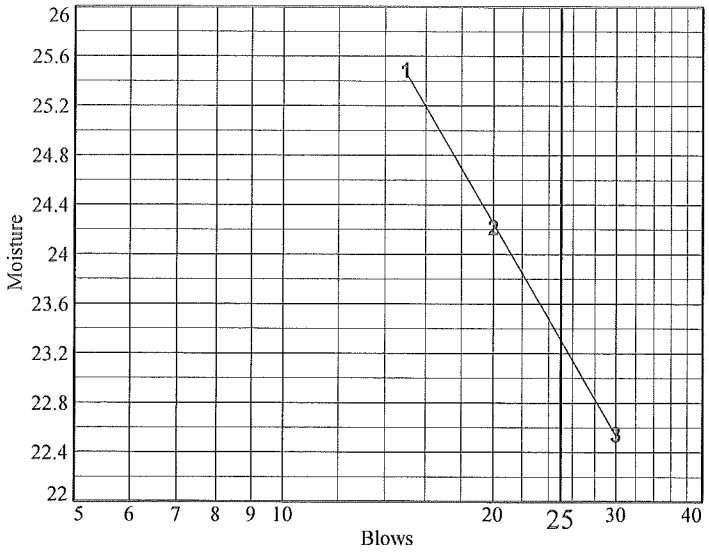
LIQUID AND PLASTIC LIMIT TEST DATA

2/1/2013

Client: Golder Associates
Project: Sound Transit East Link
Project Number: 12-450
Location: Boring E340 - B-08
Depth: 10'-11.5'
Sample Number: HMA-7494c/Golder S-5
Tested by: Tara Pfaff
Checked by: JAM

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	26.4	29.6	36.2			
Dry+Tare	23.8	26.5	31.6			
Tare	13.6	13.7	11.2			
# Blows	15	20	30			
Moisture	25.5	24.2	22.5			



Liquid Limit= 23
Plastic Limit= 24
Plasticity Index= NP
Natural Moisture= 20.6

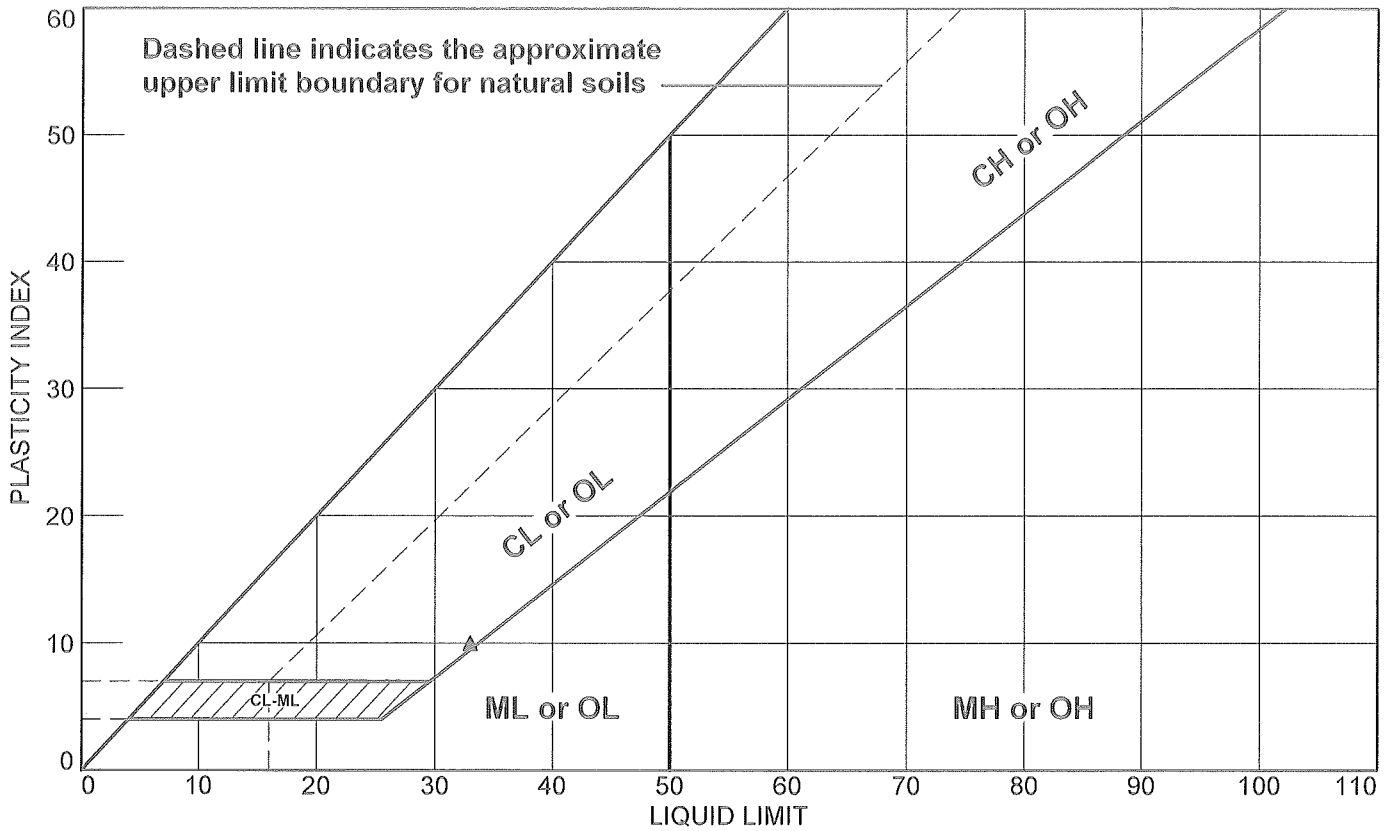
Plastic Limit Data

Run No.	1	2	3	4	
Wet+Tare	22.1	20.3	21.2		
Dry+Tare	20.0	18.6	19.3		
Tare	11.3	11.2	11.3		
Moisture	24.1	23.0	23.7		

Natural Moisture Data

Wet+Tare	Dry+Tare	Tare	Moisture
117.5	103.4	35.1	20.6

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA

	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	Boring E340 - B-08	HMA-7494b/ Golder S-8	20'-21.5'	23.2	21	21	NP	
■	Boring E340 - B-08	HMA-7494c/ Golder S-5	10'-11.5'	20.6	24	23	NP	
▲	Boring E340 - B-08	HMA-7494d/ Golder S-2	2.5'-4'	21.2	23	33	10	

Hayre McElroy & Associates, LLC **Redmond, WA**	**Client:** Golder Associates **Project:** Sound Transit East Link **Project No.:** 12-450 **Figure**

Tested By: Tara Pfaff **Checked By:** JAM

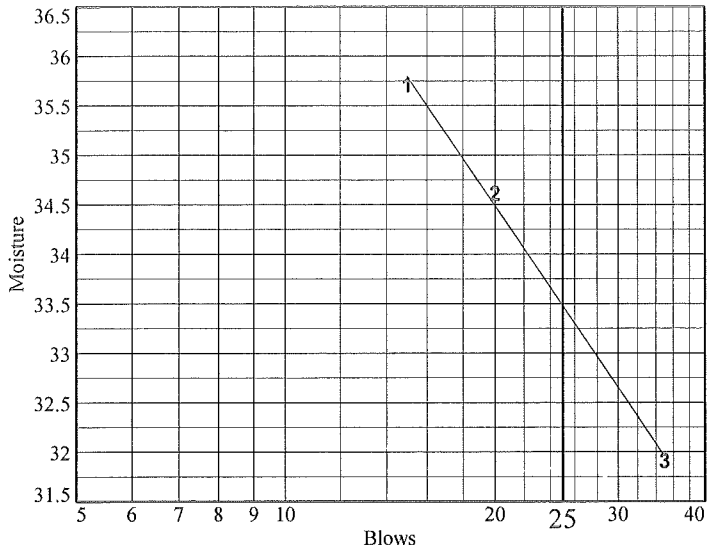
LIQUID AND PLASTIC LIMIT TEST DATA

2/1/2013

Client: Golder Associates
Project: Sound Transit East Link
Project Number: 12-450
Location: Boring E340 - B-08
Depth: 2.5'-4'
Sample Number: HMA-7494d/Golder S-2
Tested by: Tara Pfaff
Checked by: JAM

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	35.8	45.1	29.7			
Dry+Tare	29.3	37.0	25.2			
Tare	11.1	13.6	11.1			
# Blows	15	20	35			
Moisture	35.7	34.6	31.9			



Liquid Limit= 33
Plastic Limit= 23
Plasticity Index= 10
Natural Moisture= 21.2
Liquidity Index= -0.2

Plastic Limit Data

Run No.	1	2	3	4	
Wet+Tare	19.9	21.8	17.9		
Dry+Tare	18.7	20.3	16.6		
Tare	13.6	13.6	11.0		
Moisture	23.5	22.4	23.2		

Natural Moisture Data

Wet+Tare	Dry+Tare	Tare	Moisture
114.4	100.8	36.7	21.2

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS MORE THAN 50% RETAINED ON NO. 200 SIEVE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS
				SP	POORLY-GRADED SANDS, GRAVELLY SAND
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% PASSING NO. 200 SIEVE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS, ROCK FLOUR, CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS AND SILTS OF MEDIUM TO HIGH PLASTICITY
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: Multiple symbols are used to indicate borderline or dual soil classifications

ADDITIONAL MATERIAL SYMBOLS

SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
	AC	Asphalt Concrete
	CC	Cement Concrete
	CR	Crushed Rock/ Quarry Spalls
	TS	Topsoil/ Forest Duff/Sod

Groundwater Contact

Measured groundwater level in exploration, well, or piezometer

Measured free product in well or piezometer

Graphic Log Contact

Distinct contact between soil strata or geologic units

Approximate location of soil strata change within a geologic soil unit

Material Description Contact

Distinct contact between soil strata or geologic units

Approximate location of soil strata change within a geologic soil unit

Sampler Symbol Descriptions

2.4-inch I.D. split barrel

Standard Penetration Test (SPT)

Shelby tube

Piston

Direct-Push

Bulk or grab

Blowcount is recorded for driven samplers as the number of blows required to advance sampler 12 inches (or distance noted). See exploration log for hammer weight and drop.

A "P" indicates sampler pushed using the weight of the drill rig.

Laboratory / Field Tests

%F	Percent fines
AL	Atterberg limits
CA	Chemical analysis
CP	Laboratory compaction test
CS	Consolidation test
DS	Direct shear
HA	Hydrometer analysis
MC	Moisture content
MD	Moisture content and dry density
OC	Organic content
PM	Permeability or hydraulic conductivity
PI	Plasticity index
PP	Pocket penetrometer
PPM	Parts per million
SA	Sieve analysis
TX	Triaxial compression
UC	Unconfined compression
VS	Vane shear

Sheen Classification

NS	No Visible Sheen
SS	Slight Sheen
MS	Moderate Sheen
HS	Heavy Sheen
NT	Not Tested

NOTE: The reader must refer to the discussion in the report text and the logs of explorations for a proper understanding of subsurface conditions. Descriptions on the logs apply only at the specific exploration locations and at the time the explorations were made; they are not warranted to be representative of subsurface conditions at other locations or times.

KEY TO EXPLORATION LOGS

GEOENGINEERS

FIGURE A-1

Drilled	Start 9/19/2013	End 9/19/2013	Total Depth (ft) 30.5	Logged By CEW / Checked By CEW	Driller Boretec, Inc.	Drilling Method Hollow-Stem Auger
Surface Elevation (ft) / Vertical Datum	Undetermined		Hammer Data	Rope & Cathead 140 (lbs) / 30 (in) Drop	Drilling Equipment	Track/Trailer
Easting (X) / Northing (Y)			System Datum		Groundwater: Date Measured	Depth to Water (ft) / Elevation (ft)
Notes:						

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name / Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)	REMARKS
	0								CC	8½- to 9-inches concrete			
									SM	Gray silty fine to coarse sand with occasional gravel (very dense, moist)			
	5		9	50/5"		1 SA					9		NS SA (%F = 47)
	10		8	50/5"		2							NS
	15		18	90		3 AL			ML	Gray silt with sand (hard, moist)	25		NS AL (LL = 36; PI = 10) Rough drilling
	20		18	90		4			CL	Gray sandy clay with lenses of sand (hard, moist)			NS Rough drilling
	25		18	83		5 AL					24		AL (LL = 36; PI = 13)
	30		4	/4"		6 %F			SM	Gray silty fine to coarse sand with gravel (very dense, moist) (till-like)	8		NS %F = 30

Note: See Figure A-1 for explanation of symbols.

Log of Boring B-15-10

GEOENGINEERS

Project: Proposed NE 15th/16th Street Corridor
Project Location: Bellevue, Washington
Project Number: 0526-161-01

Figure A-11
Sheet 1 of 1

Redmond: Date:12/16/13 Path:\\RED\PROJECTS\0\0526161\01\GINT\0526161\01.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_GEOTECH_STANDARD

Date Excavated: 9/18/2013 | Logged By: CEW

Equipment: Backhoe | Total Depth (ft) 3.5

Elevation (feet)	Depth (feet)	SAMPLE Testing Sample	SAMPLE Sample Name / Testing	Graphic Log	Group Classification	Encountered Water	MATERIAL DESCRIPTION	Moisture Content, %	REMARKS
					AC		4-inches asphalt concrete		
		X	1		SM		Brown silty fine to medium sand with gravel and organic matter (roots) (dense, moist)		
	1				SM		Brown silty fine to medium sand with occasional gravel (dense, moist)		
		X	2 / SA					12	SA (%F = 34)
	2				SM		Brown silty fine to medium sand with gravel (very dense, moist)		
		X	3						
	3		4 / SA		SM		Brown silty fine to medium sand with occasional gravel and silt lenses (very dense, wet)	18	SA (%F = 20) Groundwater observed

Note: See Figure A-1 for explanation of symbols.

Log of Test Pit TP-15-3

GEOENGINEERS

Project: Proposed NE 15th/16th Street Corridor

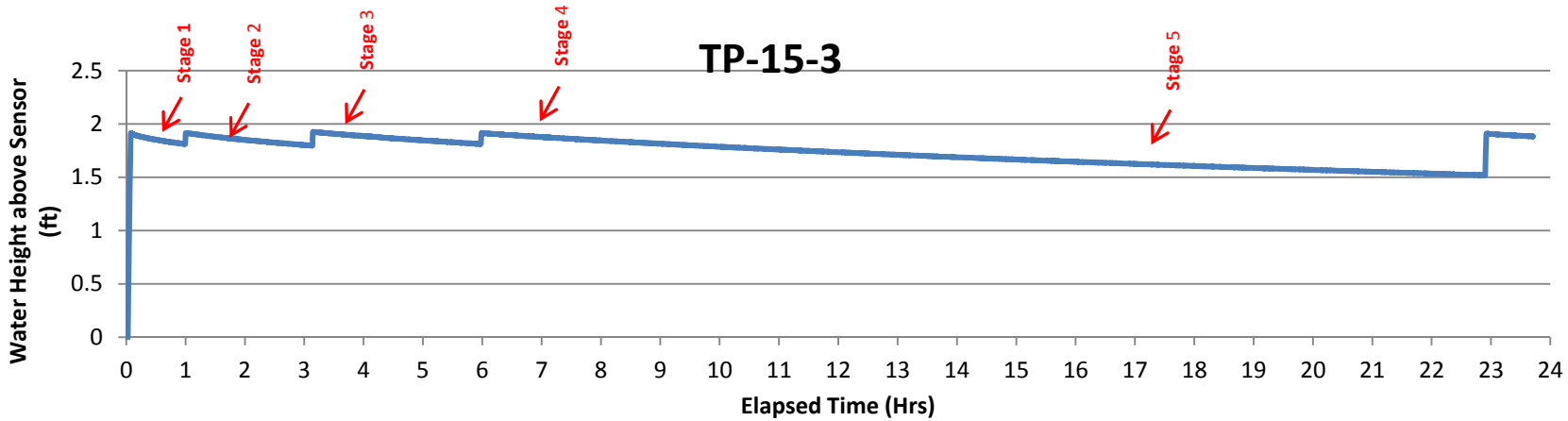
Project Location: Bellevue, Washington

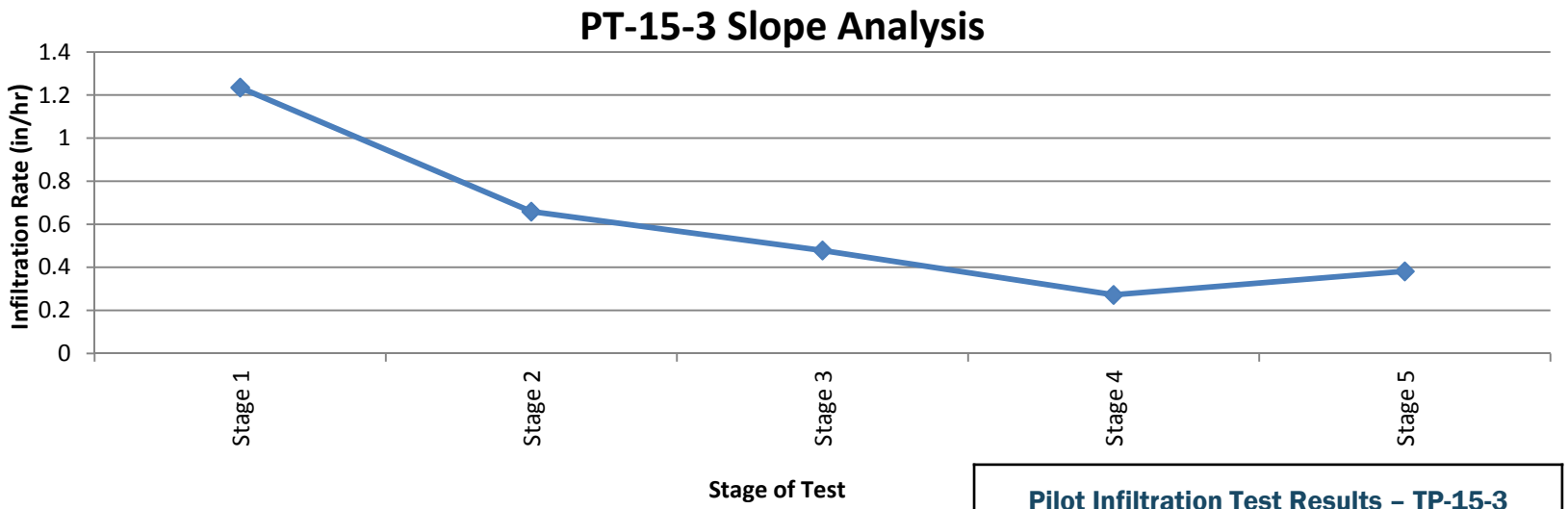
Project Number: 0526-161-01

Figure A-14

Sheet 1 of 1

Redmond: Date: 12/16/13 Path:\\RED\PROJECTS\0\0526161\01\GINT\0526161 01.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_TESTPIT_1P_GEOTEC





Pilot Infiltration Test Results – TP-15-3	
Proposed NE 15th/16th Street Corridor Bellevue, Washington	
GEOENGINEERS	**Figure 7**

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOIL MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, 0% TO 15% FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES, 0% TO 15% FINES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, SILTY GRAVEL-SAND MIXTURES
				GC	CLAYEY GRAVELS, CLAYEY GRAVEL-SAND MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, 0% TO 15% FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SAND, 0% TO 15% FINES
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SILTY SAND-GRAVEL MIXTURES
				SC	CLAYEY SANDS, CLAYEY SAND-GRAVEL MIXTURES
FINE GRAINED SOIL MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

Copyright © 2005 Kleinfelder, Inc., All rights reserved.

KLEINFELDER

Safeway Distribution Center
1274 124th Avenue NE
Bellevue, Washington

Project: 63172 November 2005

Soil Classification Legend

Appendix
A-1

DEPTH (feet)	WELL/PIEZO CONSTRUCTION	WATER LEVEL	MOISTURE CONTENT(%)	PLASTIC LIMIT(%)	LIQUID LIMIT(%)	% PASSING No. 200 SIEVE	OTHER TESTS	PID (ppm)	BLOWS/6 in** (uncorrected)	SAMPLER *	SAMPLE NUMBER	U.S.C.S. NAME	U.S.C.S. SYMBOL	SOIL DESCRIPTION
														Surface conditions: asphalt
0														2 inches asphalt.
												SM		SILTY SAND (SM): brown, moist, medium dense, fine to medium-grained sand, some fine to coarse gravel. (FILL)
												ML		CLAYEY SILT (ML): dark gray, moist, very stiff, non-plastic, trace fine-grained sand, trace fine-grained gravel. (LACUSTRINE DEPOSITS)
5			21.8						7, 10, 15		1			
10			20.2	23	31				8, 12, 15		2			- as above, frequent seams of fine-grained sand.
												SM		SILTY SAND (SM): dark grey, moist, dense, fine-grained sand, some cross-bedding.
15			19.2						11, 17, 29		3			
20			22.9						8, 14, 27		4			- as above.
												ML		CLAYEY SILT (ML): dark gray, moist, hard, non-plastic.
21														Boring terminated at 21 feet below ground surface. No groundwater seepage observed at time of exploration.

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

DATE DRILLED: 11-4-05
LOGGED BY: S. Darst
REVIEWED BY: K. Roth

SURFACE ELEVATION (feet): 176.0
TOTAL DEPTH (feet): 21.0
DIAMETER OF BORING (in): 8

DRILLING METHOD: HSA
DRILLER: Cascade
CASING SIZE: N/A

APPROV: ____

BY: ____

KLEINFELDER
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS
SOILS AND MATERIALS TESTING

PROJECT NUMBER: 63172

Safeway Bellevue
Bellevue, WA

BORING LOG
B-1

Appendix
A - 2

2002 STAN. INPUT/ALL OUTPUT 63172.GPJ 2000REV.GDT 11/11/05

DEPTH (feet)	WELL/PIEZO CONSTRUCTION	WATER LEVEL	TESTING PROGRAM: LABORATORY: MOISTURE CONTENT(%)	PLASTIC LIMIT(%)	LIQUID LIMIT(%)	% PASSING No. 200 SIEVE	OTHER TESTS	FIELD: PID (ppm)	BLOWS/6 in** (uncorrected)	SAMPLER *	SAMPLE NUMBER	U.S.C.S. NAME	U.S.C.S. SYMBOL	SOIL DESCRIPTION
														Surface conditions: asphalt
0														5 inches asphalt.
												SM		SILTY SAND (SM): brown, moist, medium dense, fine to medium-grained sand, some fine to coarse-grained gravel. (FILL)
5			8.8			29			7, 13, 17	X	1			SILTY SAND (SM): dark gray, moist, dense, fine to medium-grained and, some fine to coarse-grained gravel, trace coarse-grained gravel.
10			19.8						5, 7, 14	X	2			- as above.
												ML		CLAYEY SILT (ML): dark gray, moist, very stiff, non-plastic, trace fine-grained sand. (LACUSTRINE DEPOSITS)
														- as above, grades hard.
15			19.9						8, 15, 22	X	3			
												SM		SILTY SAND (SM): dark gray, moist, dense, fine-grained sand.
20			20.2						10, 15, 17	X	4			
21														Boring termintated at 21 feet below ground surface. No groundwater seepage observed at time of exploration.

DATE DRILLED: 11-4-05
LOGGED BY: S. Darst
REVIEWED BY: K. Roth

SURFACE ELEVATION (feet): 176.0
TOTAL DEPTH (feet): 21.0
DIAMETER OF BORING (in): 8

DRILLING METHOD: HSA
DRILLER: Cascade
CASING SIZE: N/A

KLEINFELDER
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS
SOILS AND MATERIALS TESTING

PROJECT NUMBER: 63172

Safeway Bellevue
Bellevue, WA

BORING LOG
B-2

Appendix
A - 3

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

APPROV: ____

BY: ____

2002 STAN. INPUT/ALL OUTPUT 63172.GPJ 2000REV.GDT 11/11/05

DEPTH (feet)	WELL/PIEZO CONSTRUCTION	WATER LEVEL	TESTING PROGRAM: LABORATORY: MOISTURE CONTENT(%)	PLASTIC LIMIT(%)	LIQUID LIMIT(%)	% PASSING No. 200 SIEVE	FIELD: OTHER TESTS	PID (ppm)	BLOWS/6 in** (uncorrected)	SAMPLER *	SAMPLE NUMBER	U.S.C.S. NAME	U.S.C.S. SYMBOL	SOIL DESCRIPTION
														Surface conditions: asphalt
0												SM		4 inches asphalt. SILTY SAND (SM): dark brown, moist, medium dense, fine to medium-grained sand, some fine to medium-grained gravel, subrounded. (FILL)
5			11.8			33			5 8 9		1			SILTY SAND (SM): gray-brown mottled, medium dense, fine to medium-grained sand, trace coarse-grained sand, trace fine-grained gravel, trace organics.
10			6.3						8 12 8		2			- as above, olive brown, some fine grained gravel.
15			9.6						3 8 16		3			- as above, wet, some fine to coarse-grained gravel. - color change from olive-brown to dark gray at 15 feet.
20			16.4						5 4 5		4			- as above, grades brown-gray mottled, moist, loose, numerous organic roots, charcoal.
21														Boring termintated at 21 feet below ground surface. No groundwater seepage observed at time of exploration.

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

APPROV: _____

BY: _____

DATE DRILLED: 11-4-05
LOGGED BY: S. Darst
REVIEWED BY: K. Roth

SURFACE ELEVATION (feet): 176.0
TOTAL DEPTH (feet): 21.0
DIAMETER OF BORING (in): 8

DRILLING METHOD: HSA
DRILLER: Cascade
CASING SIZE: N/A

KLEINFELDER
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS
SOILS AND MATERIALS TESTING

PROJECT NUMBER: 63172

Safeway Bellevue
Bellevue, WA

BORING LOG
B-3

Appendix
A - 4

2002 STAN. INPUT/ALL OUTPUT 63172.GPJ 2000REV.GDT 11/11/05

DEPTH (feet)	WELL/PIEZO CONSTRUCTION	WATER LEVEL	TESTING PROGRAM: LABORATORY: MOISTURE CONTENT(%)	PLASTIC LIMIT(%)	LIQUID LIMIT(%)	% PASSING No. 200 SIEVE	FIELD: OTHER TESTS	PID (ppm)	BLOWS/6 in** (uncorrected)	SAMPLER *	SAMPLE NUMBER	U.S.C.S. NAME	U.S.C.S. SYMBOL	SOIL DESCRIPTION
														Surface conditions: concrete
0														8 inches concrete.
												SM		SILTY SAND (SM): olive-brown, dry, medium dense, fine to medium-grained sand, some fine- grained, subrounded gravel. (FILL)
5			6.5						50		1			- as above, very dense. NOTE: sample driven on a cobble, blow counts overstated.
												ML		CLAYEY SILT (ML): dark gray, moist, very hard, non-plastic to low plasticity. (LAUCUSTRINE DEPOSITS)
10			21.6						8 16 22		2			
												SM		SILTY SAND (SM): dark grey, wet, very dense, fine-grained sand with frequent seams of medium to coarse-grained sand. (GLACIAL TILL)
15			9.5						17 50		3			
20			4.8						27 50/3"		4			- as above, some coarse-grained gravel (subrounded) and rock fragments.
20.3														Boring terminated at 20.3 feet below ground surface. No groundwater seepage observed at time of exploration.

DATE DRILLED: 11-4-05
LOGGED BY: S. Darst
REVIEWED BY: K. Roth

SURFACE ELEVATION (feet): 178.0
TOTAL DEPTH (feet): 20.3
DIAMETER OF BORING (in): 8

DRILLING METHOD: HSA
DRILLER: Cascade
CASING SIZE: N/A

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

APPROV: _____

BY: _____

KLEINFELDER
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS
SOILS AND MATERIALS TESTING

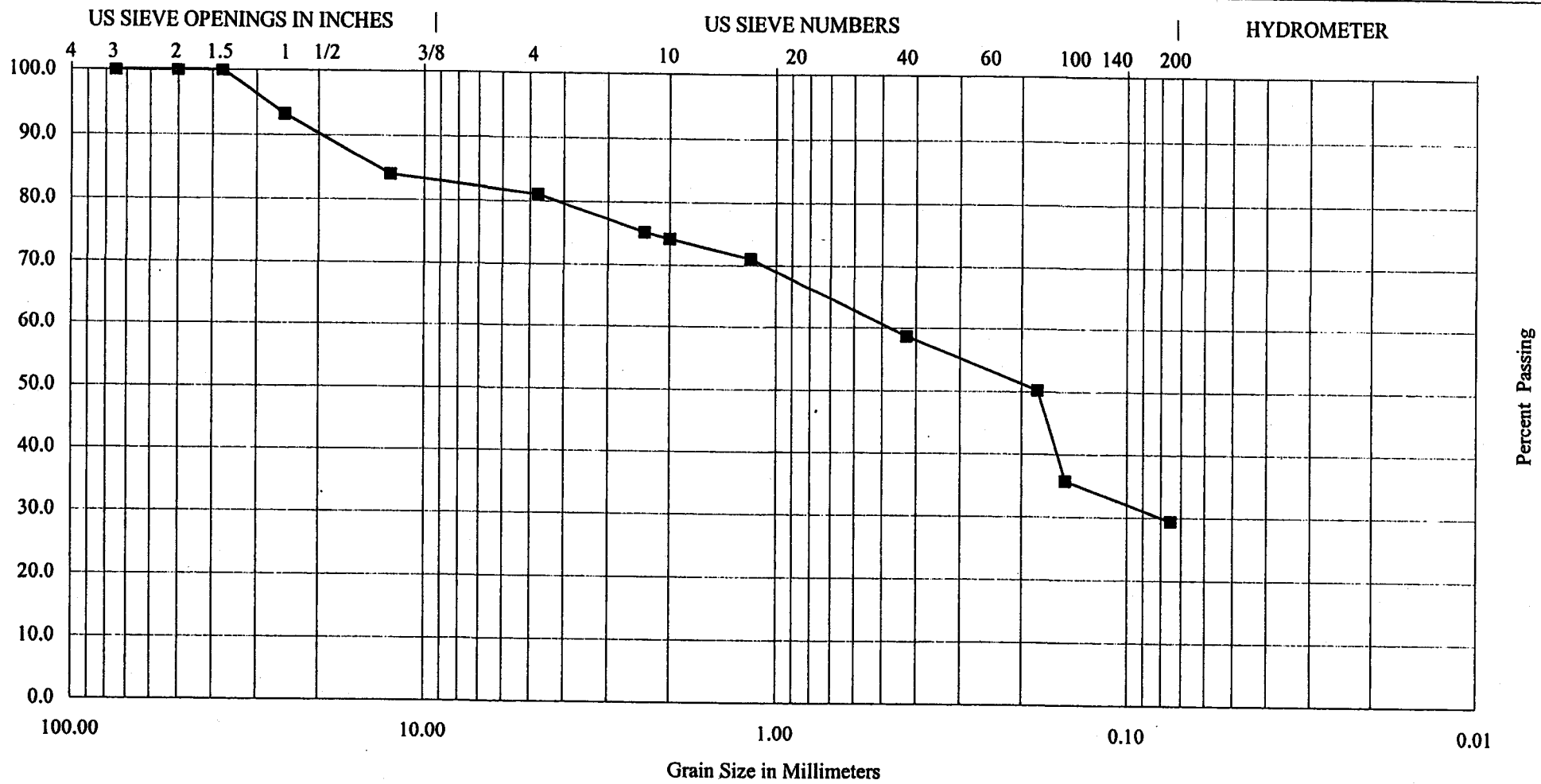
PROJECT NUMBER: 63172

Safeway Bellevue
Bellevue, WA

BORING LOG
B-4

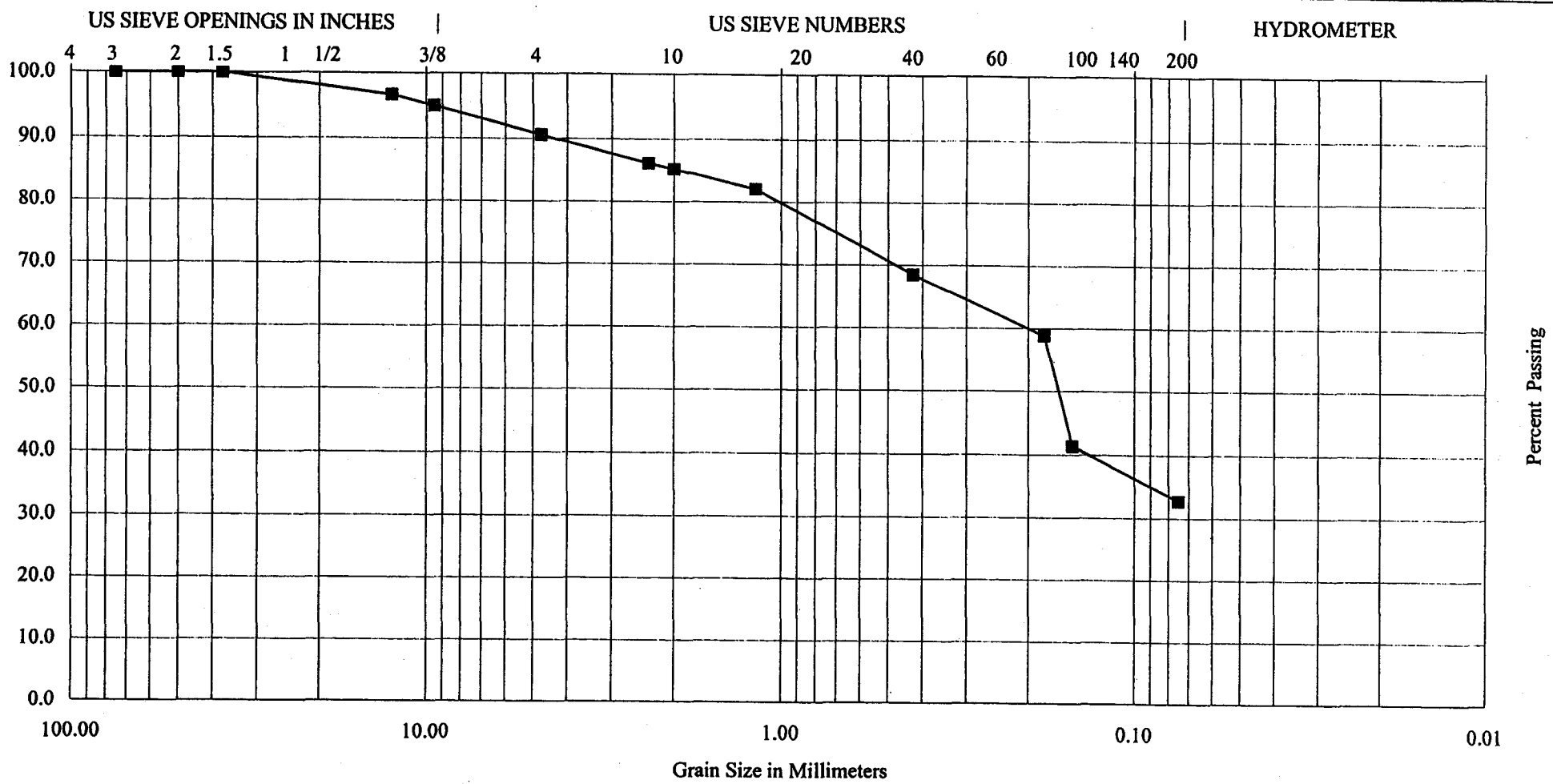
Appendix
A - 5

2002 STAN. INPUT/ALL OUTPUT 63172.GPJ 2000REV.GDT 11/11/05



GRAVEL		SAND			FINES (SILTS OR CLAYS)
coarse	fine	coarse	medium	fine	

Sa. No.	27-14	2405 140th Ave. NE Suite A 101 Bellevue, WA 98005 (452) 562-4200	**Sieve Analysis** **Safeway** Bellevue, WA				**L01S**
Loc.	B-2 / S1						
Desc.	SM						
Silty Sand with Gravel		Project Number 63172	Technician S. Flowers	Approved	Date 11/8/2005	Revised NA	Date NA



GRAVEL		SAND			FINES (SILTS OR CLAYS)
coarse	fine	coarse	medium	fine	

Sa. No.	27-14	2405 140th Ave. NE Suite A 101 Bellevue, WA 98005 (452) 562-4200	**Sieve Analysis** **Safeway** Bellevue, WA				**L02S**
Loc.	B-3 / S1						
Desc.	SM						
Silty Sand		Project Number 63172	Technician S. Flowers	Approved	Date 11/8/2005	Revised NA	Date NA

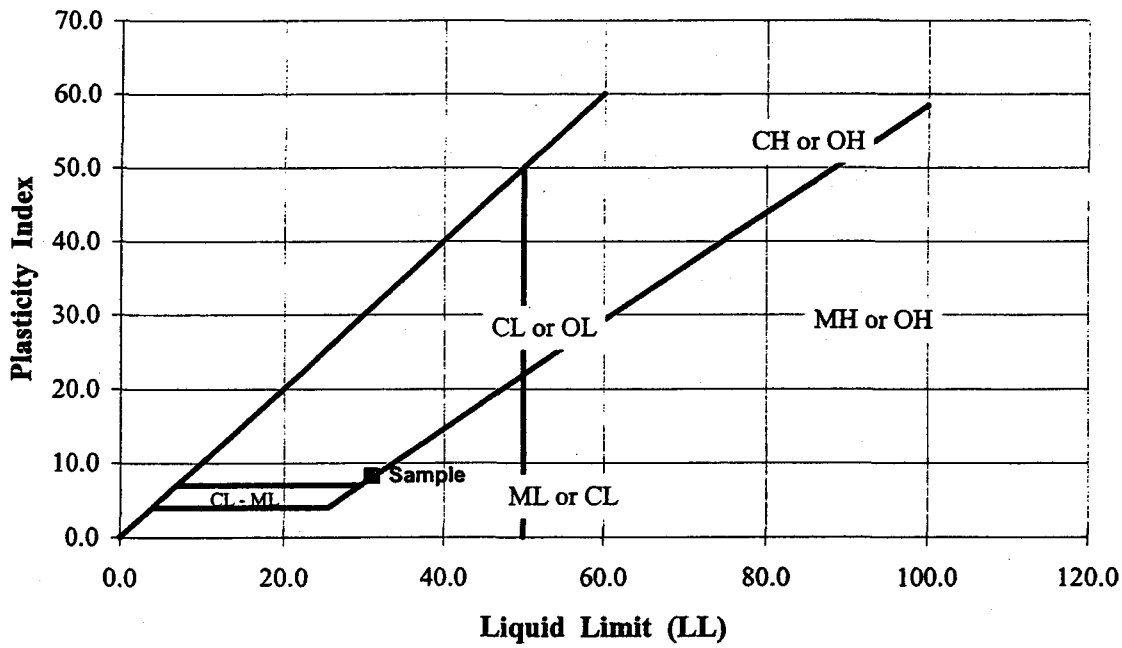
LIQUID LIMIT			
Trial No.	1	2	3
Tare No.	73	56	17
Wt. Tare & Wet Soil	73.6	73.9	75.2
Wt. Tare & Dry Soil	70.6	70.9	72.0
Wt. Water (Ww)	3.0	2.9	3.2
Wt. Tare	60.4	61.3	62.0
Wt. Dry Soil (Ws)	10.2	9.6	10.0
Moisture Content (MC), %	29.8%	30.6%	31.6%
No. of Blows	33	27	23
Adj. MC for 25 Blows, %	30.9%	30.9%	31.3%

NATURAL M.C.	
Trial No.	1
Tare No.	AA
Wt. Tare & Wet Soil	204.4
Wt. Tare & Dry Soil	186.6
Wt. Water (Ww)	17.9
Wt. Tare	18.0
Wt. Dry Soil (Ws)	88.6
Moisture Content (MC), %	20.2%

SAMPLE DATA	
Sampled Location	B-1 / S2
Sample No.	27-14
Depth	9.5'
Soil Description	N/A
USCS	N/A
Specific Gravity	N/A

PLASTIC LIMIT			
Trial No.	1	2	3
Tare No.	50	61	67
Wt. Tare & Wet Soil	21.8	22.4	22.7
Wt. Tare & Dry Soil	20.6	21.0	21.3
Wt. Water (Ww)	1.2	1.3	1.4
Wt. Tare	15.3	15.2	15.2
Wt. Dry Soil (Ws)	5.3	5.9	6.1
Moisture Content (MC), %	22.2%	22.9%	23.1%

Plasticity Chart for Classification



SUMMARY
Plastic Limit
22.7%
Liquid Limit
31.0%
Natural MC
20.2%
Plasticity Index
8.3%

Ref: ASTM D 4318-84
D 2487-90

Note: All weights in grams (g) unless stated.

Kleinfelder Materials Testing Bellevue, Washington	**Atterberg Limits** Safeway Bellevue, WA	**L01A**

Project Number	Technician	Approved	Date	Revised	Date
63172	S. Flowers	G 11.09.05	11/7/2005	NA	NA

APPENDIX D
Environmental Screening

APPENDIX D
ENVIRONMENTAL SCREENING

Soil Sampling

The soil samples obtained from the borings were field screened (visual, water sheen screening and headspace vapor screening) for evidence of contamination. Field screening methods are described below. The sampling equipment was decontaminated before each sampling attempt with a Liqui-Nox® solution wash and a distilled water rinse.

Field screening showed no evidence of contamination in the borings; therefore, no follow-up chemical analytical analyses were performed on the soil samples obtained from the borings.

Field Screening of Soil Samples

Soil samples were obtained in the field for screening of potential petroleum-related contamination using visual examination and sheen screening. Visual screening consists of observing the soil for stains indicative of petroleum-related contamination. Visual screening generally is more effective when contamination is present in high concentrations or when it is related to heavy petroleum hydrocarbons. Water sheen screening involves placing soil in water and observing the water surface for signs of sheen. Sheen classifications are as follows:

- **No Sheen (NS)** — No visible sheen on water surface.
- **Slight Sheen (SS)** — Light, colorless, dull sheen; spread is irregular, not rapid; sheen dissipates rapidly. Natural organic matter in the soil may produce a slight sheen.
- **Moderate Sheen (MS)** — Light to heavy sheen; may have some color/iridescence; spread is irregular to flowing, may be rapid; few remaining areas of no sheen on water surface.
- **Heavy Sheen (HS)** — Heavy sheen with color/iridescence; spread is rapid; entire water surface may be covered with sheen.

Field screening results are site-specific. The effectiveness of field screening results will vary with temperature, moisture content, organic content, soil type, and type and age of contaminant. The presence or absence of sheen does not necessarily indicate the presence or absence of petroleum hydrocarbons.

APPENDIX E
Report Guidelines and Limitations for Use

APPENDIX E
REPORT LIMITATIONS AND GUIDELINES FOR USE[1]

This appendix provides information to help you manage your risks with respect to the use of this report.

Geotechnical Services Are Performed for Specific Purposes, Persons and Projects

This report has been prepared for the exclusive use of the City of Bellevue, HDR Engineering, Inc., and other project team members for the 124th Avenue NE Corridor Improvements – 12th Street to Northup Way project in Bellevue, Washington. This report is not intended for use by others, and the information contained herein is not applicable to other sites.

GeoEngineers structures our services to meet the specific needs of our clients. For example, a geotechnical or geologic study conducted for a civil engineer or architect may not fulfill the needs of a construction contractor or even another civil engineer or architect that are involved in the same project. Because each geotechnical or geologic study is unique, each geotechnical engineering or geologic report is unique, prepared solely for the specific client and project site. Our report is prepared for the exclusive use of our Client. No other party may rely on the product of our services unless we agree in advance to such reliance in writing. This is to provide our firm with reasonable protection against open-ended liability claims by third parties with whom there would otherwise be no contractual limits to their actions. Within the limitations of scope, schedule and budget, our services have been executed in accordance with our Agreement with the Client and generally accepted geotechnical practices in this area at the time this report was prepared. This report should not be applied for any purpose or project except the one originally contemplated.

A Geotechnical Engineering or Geologic Report Is Based on a Unique Set of Project-Specific Factors

This report has been prepared for the 124th Avenue NE Corridor Improvements – 12th Street to Northup Way project in Bellevue, Washington. GeoEngineers considered a number of unique, project-specific factors when establishing the scope of services for this project and report. Unless GeoEngineers specifically indicates otherwise, do not rely on this report if it was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

For example, changes that can affect the applicability of this report include those that affect:

- the function of the proposed structure;
- elevation, configuration, location, orientation or weight of the proposed structure;
- composition of the design team; or
- project ownership.

[1] Developed based on material provided by ASFE, Professional Firms Practicing in the Geosciences; www.asfe.org .

If important changes are made after the date of this report, GeoEngineers should be given the opportunity to review our interpretations and recommendations and provide written modifications or confirmation, as appropriate.

Subsurface Conditions Can Change

This geotechnical or geologic report is based on conditions that existed at the time the study was performed. The findings and conclusions of this report may be affected by the passage of time, by manmade events such as construction on or adjacent to the site, or by natural events such as floods, earthquakes, slope instability or groundwater fluctuations. Always contact GeoEngineers before applying a report to determine if it remains applicable.

Most Geotechnical and Geologic Findings Are Professional Opinions

Our interpretations of subsurface conditions are based on field observations from widely spaced sampling locations at the site. Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. GeoEngineers reviewed field and laboratory data and then applied our professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ, sometimes significantly, from those indicated in this report. Our report, conclusions and interpretations should not be construed as a warranty of the subsurface conditions.

Geotechnical Engineering Report Recommendations Are Not Final

Do not over-rely on the preliminary construction recommendations included in this report. These recommendations are not final, because they were developed principally from GeoEngineers' professional judgment and opinion. GeoEngineers' recommendations can be finalized only by observing actual subsurface conditions revealed during construction. GeoEngineers cannot assume responsibility or liability for this report's recommendations if we do not perform construction observation.

Sufficient monitoring, testing and consultation by GeoEngineers should be provided during construction to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes should the conditions revealed during the work differ from those anticipated, and to evaluate whether or not earthwork activities are completed in accordance with our recommendations. Retaining GeoEngineers for construction observation for this project is the most effective method of managing the risks associated with unanticipated conditions.

A Geotechnical Engineering or Geologic Report Could Be Subject to Misinterpretation

Misinterpretation of this report by other design team members can result in costly problems. You could lower that risk by having GeoEngineers confer with appropriate members of the design team after submitting the report. Also retain GeoEngineers to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering or geologic report. Reduce that risk by having GeoEngineers participate in pre-bid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Exploration Logs

Geotechnical engineers and geologists prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering or geologic report should never be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, but recognize that separating logs from the report can elevate risk.

Give Contractors a Complete Report and Guidance

Some owners and design professionals believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering or geologic report, but preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with GeoEngineers and/or to conduct additional study to obtain the specific types of information they need or prefer. A pre-bid conference can also be valuable. Be sure contractors have sufficient time to perform additional study. Only then might an owner be in a position to give contractors the best information available, while requiring them to at least share the financial responsibilities stemming from unanticipated conditions. Further, a contingency for unanticipated conditions should be included in your project budget and schedule.

Contractors are Responsible for Site Safety on Their Own Construction Projects

Our geotechnical recommendations are not intended to direct the contractor's procedures, methods, schedule or management of the work site. The contractor is solely responsible for job site safety and for managing construction operations to minimize risks to on-site personnel and to adjacent properties.

Read These Provisions Closely

Some clients, design professionals and contractors may not recognize that the geoscience practices (geotechnical engineering or geology) are far less exact than other engineering and natural science disciplines. This lack of understanding can create unrealistic expectations that could lead to disappointments, claims and disputes. GeoEngineers includes these explanatory "limitations" provisions in our reports to help reduce such risks. Please confer with GeoEngineers if you are unclear how these "Report Limitations and Guidelines for Use" apply to your project or site.

Geotechnical, Geologic and Environmental Reports Should Not be Interchanged

The equipment, techniques and personnel used to perform an environmental study differ significantly from those used to perform a geotechnical or geologic study and vice versa. For that reason, a geotechnical engineering or geologic report does not usually relate any environmental findings, conclusions or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. Similarly, environmental reports are not used to address geotechnical or geologic concerns regarding a specific project.

Biological Pollutants

GeoEngineers' Scope of Work specifically excludes the investigation, detection, prevention or assessment of the presence of Biological Pollutants. Accordingly, this report does not include any interpretations, recommendations, findings, or conclusions regarding the detecting, assessing, preventing or abating of Biological Pollutants and no conclusions or inferences should be drawn regarding Biological Pollutants, as they may relate to this project. The term "Biological Pollutants" includes, but is not limited to, molds, fungi, spores, bacteria, and viruses, and/or any of their byproducts.

If Client desires these specialized services, they should be obtained from a consultant who offers services in this specialized field.

Environmental Regulations Are Always Evolving

Some substances may be present in the vicinity of the subject property in quantities or under conditions that may have led, or may lead, to contamination of the subject property, but are not included in current local, state or federal regulatory definitions of hazardous substances or do not otherwise present current potential liability. GeoEngineers cannot be responsible if the standards for appropriate inquiry, or regulatory definitions of hazardous substances, change or if more stringent environmental standards are developed in the future.

Uncertainty May Remain Even After This Environmental Soil Sampling Is Completed

Performance of environmental soil sampling is intended to reduce uncertainty regarding the potential for contamination in connection with a property, but no environmental sampling can wholly eliminate that uncertainty. Our interpretation of subsurface conditions in this study is based on field observations and chemical analytical data from widely spaced sampling locations. It is always possible that contamination exists in areas that were not explored, sampled or analyzed.

Soil and Groundwater End Use

The cleanup levels referenced in this report are site- and situation-specific. The cleanup levels may not be applicable for other properties or for other on-site uses of the affected soil and/or groundwater. Note that hazardous substances may be present in some of the on-site soil and/or groundwater at detectable concentrations that are less than the referenced cleanup levels. GeoEngineers should be contacted prior to the export of soil or groundwater from the subject property or reuse of the affected soil or groundwater on-site to evaluate the potential for associated environmental liabilities. We are unable to assume responsibility for potential environmental liability arising out of the transfer of soil and/or groundwater from the subject property to another location or its reuse on-site in instances that we did not know or could not control.

APPENDICES

Type Name of Services Here

Name of Project Here

for

Type Client Name Here

Type Date of Report Here

GeoEngineers

Earth Science + Technology

Chapter 9: Mitigation

This chapter describes the proposed mitigation for impacts to critical areas affected by the project. It outlines impact avoidance and minimization (including BMPs), and describes mitigation goals, objectives, and performance standards, as well as proposed monitoring and maintenance efforts at the mitigation site.

9.1 Mitigation Sequencing

The City of Bellevue requires that mitigation for impacts to wetland buffer follow this approved order (LUC 20.25H.210):

1. Avoiding the impact altogether by not taking a certain action or parts of an action
2. Minimizing the impacts by limiting the degree or magnitude of the action and its implementation with appropriate technology or by taking affirmative steps, such as project redesign, relocation or timing, to avoid or reduce the impacts
3. Rectifying the impact by repairing, rehabilitating or restoring the affected environment
4. Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action
5. Compensating for the impact by replacing, enhancing, or providing substitute resources or environments
6. Monitoring the hazard or other required mitigation and taking remedial action when necessary.

Avoidance and Minimization

The project has been designed to avoid or minimize impacts to critical areas and buffers wherever feasible. Project impacts to critical areas will be avoided or minimized using the following design and construction methods:

- Considerable efforts have been made for this project to limit disturbance to all the wetlands, and no wetland fill is proposed for this corridor project.
- To the extent practicable, work will be performed during the dry season in the stream to limit potential sedimentation effects and interruptions in surface and subsurface flows.
- Exposed soils will be stabilized with a vegetative cover or other erosion control treatment immediately following construction. Landscaping in compliance with City of Bellevue standards would be installed to control erosion.
- During construction, erosion control BMPs would be employed. The BMPs include use of mulch, silt barriers, containment systems, and cover measures (straw or plastic), as well as reseeding of areas temporarily disturbed by construction.
- Oil, fuels, or chemicals will not be discharged to surface waters or onto land where there is a potential for reentry into surface waters.
- Removal of riparian vegetation will be minimized as much as possible.

- Temporarily graded and cleared areas will be restored to appropriate grades and revegetated with appropriate native vegetation.
- BMPs will be used to minimize effects during and after construction.
- The project will comply with water quality conditions identified by Ecology.

9.2 Buffer Mitigation

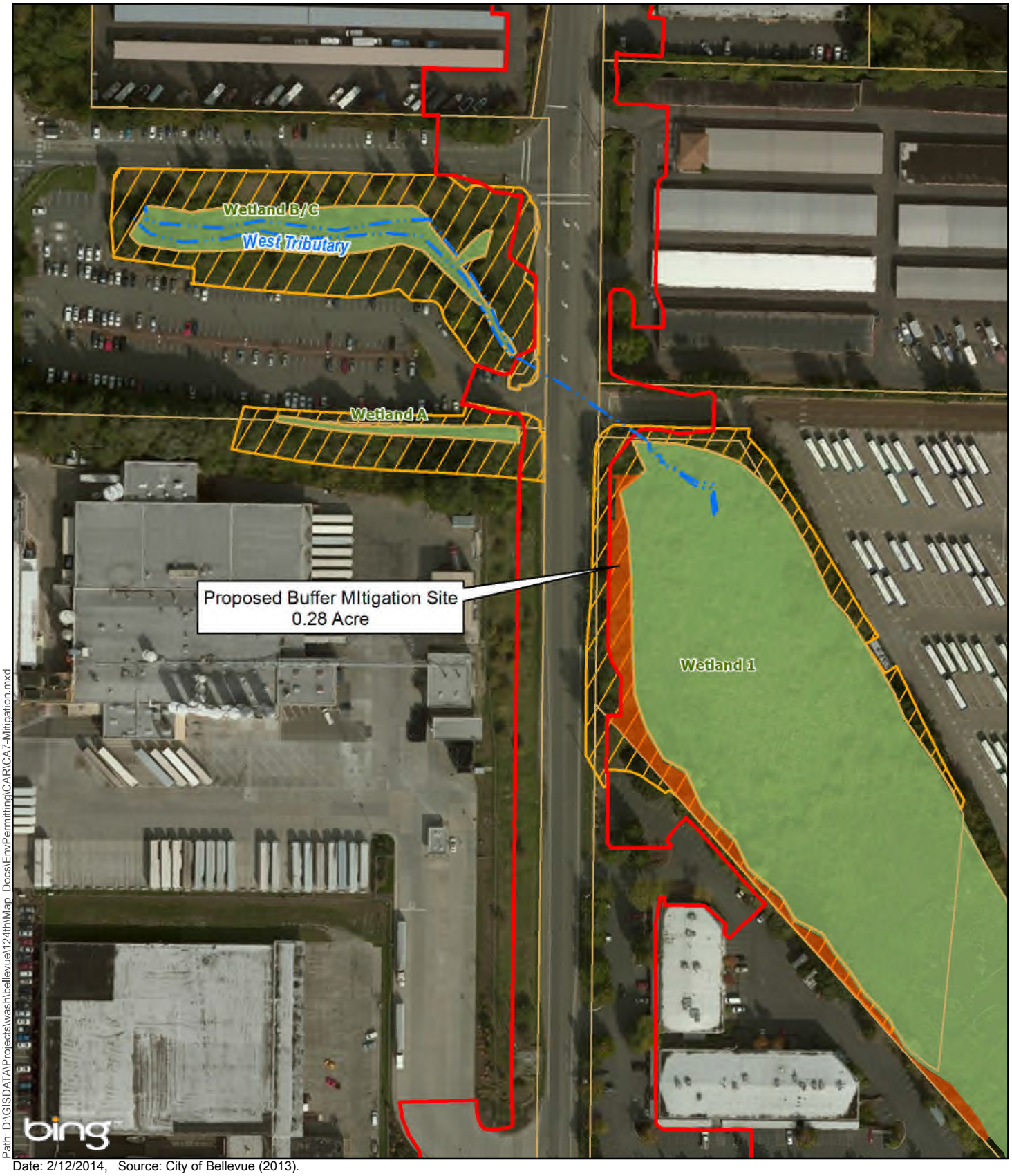
Buffer mitigation will be provided for permanent and temporary wetland buffer impacts for this project. Enhancement will be at 1:1 ratio for impacts to the buffer of Category II, III, and IV wetlands (LUC 20.25H.105).

For 0.28 acres of unavoidable impacts to the wetland buffers within the project corridor, approximately 0.28 acres of degraded wetland buffer of Wetland 1 would be enhanced (Figure 6). The proposed buffer mitigation area is located on the east of 124th Avenue and the north end of Wetland 1. The establishment of native woody vegetation in the degraded wetland buffer would increase buffer functions by slowing down water flow, limiting erosion, and providing vegetative screening and wildlife cover for Wetland 1. Table 8 presents proposed plant species to be infilled into the existing wetland buffer areas of Wetland 1. This planting palette will also be used in temporarily disturbed wetland buffer areas.

Table 8. Proposed Planting Palette for the Proposed Buffer Mitigation Area

Common Name	Latin Name	Percentage of Community Composition	Typical Plant Spacing(On Center)	Size
Oregon Ash	*Fraxinus latifolia*	5%	8’ OC	2 gallon/4’
Sitka Spruce	*Picea sitchensis*	5%	8’ OC	2 gallon/4’
Western Red Cedar	*Thuja plicata*	5%	4’ OC	2 gallon/8’
Pacific Willow	*Salix lucida*	10%	4’ OC	Live Stake
Sitka Willow	*Salix sitchensis*	10%	4’ OC	Live Stake
Vine Maple	*Acer circinatum*	5%	4’ OC	2 gallon
Beaked Hazelnut	*Corylus cornuta*	10%	4’ OC	2 gallon
Red-flowering Currant	*Ribes sanguineum*	10%	4’ OC	1 gallon
Pacific Ninebark	*Physocarpus capitatus*	10%	4’ OC	1 gallon
Baldhip Rose	*Symphoricarpos albus*	10%	4’ OC	1 gallon
Salmonberry	*Rubus spectabilis*	10%	4’ OC	1 gallon
Tall Oregon Grape	*Mahonia aquifolium*	10%	4’ OC	1 gallon
Soft Rush	*Juncus effusus*	--	Seed	Hydroseed

This page intentionally left blank



Path: D:\GISDATA\Projects\wash\bellevue\124th\Map_Docs\EnvPermitting\CAR\CA7-Mitigation.mxd

Date: 2/12/2014, Source: City of Bellevue (2013).

Legend

- Proposed Buffer Mitigation Site
- Wetland
- Wetland Buffer
- Parcel
- Construction Limit
- Delienated Stream

0 100 200 Feet

Figure 6
Proposed Buffer Mitigation Area at the Project Site

124th Avenue NE | Bellevue, Washington

This page intentionally left blank

Mitigation Goals

The goal of the proposed buffer mitigation is to replace the functions that are provided by the wetland buffer through enhancement. Enhancement activities will consist of improving water quality, hydrologic, and habitat functions that were observed at the site by removing non-native species such as Himalayan blackberry and English ivy and planting with native woody species.

Mitigation Objectives

The objective of the proposed mitigation is to establish a diverse plant community in the proposed buffer mitigation area and improve system complexity by increasing the structural diversity of the native plant community, which should improve wildlife habitat.

Performance Standards

Performance standards are measurable, quantifiable indicators of mitigation performance relative to the mitigation objectives and goals. The following minimum performance standards are proposed for the buffer enhancement areas and apply to all the objectives listed above:

1. The project biologists shall supervise the installation of plantings and verify that plants have been installed in quantities and species specified in plans.
2. Monitor plants to ensure appropriate survival rates:

   Areas shall meet the performance standards for plants as noted below:

   - Year 1: 100% survival of planted stock
   - Desirable native volunteers may be included in plant counts.
3. Buffer plantings shall demonstrate sufficient cover to provide wildlife habitat function:

   Areas shall meet the performance standards for shrub cover as noted below:

   - Year 1: 25 % cover
   - Year 2: 60% cover
   - Year 3: 70% cover
   - Year 5: 75% cover
   - Desirable native volunteers may be included in plant counts.

9.3 Monitoring Plan

The buffer mitigation area would be monitored to demonstrate compliance with applicable permit conditions and to evaluate the establishment and maintenance of the plant community within the planted area. The monitoring phase of the project is expected to consist of iterative and corrective measures, such as removing invasive species and is expected to occur up until a point when planted native species appear to be established. This goal would be initiated by careful plant selection, established by monitoring for plant health and survival, and then ensured by documenting progress.

Monitoring would continue at the buffer mitigation area up to five years after construction or until the City of Bellevue concurs that the plants have established at the site. The mitigation goal would be considered achieved when the project team and the City of Bellevue agree that plants have become established and can be expected to survive and self-maintain the area. If the area becomes covered with native plants and there are no foreseeable issues from invasive plants and human disturbance, monitoring would become unnecessary.

The monitoring period would commence from the month that the installation is completed. Overview photos would be taken from the same vantage points each year to document overall appearance of the buffer mitigation area before, during, and after construction. Plant survivorship would be defined as fully healthy and thriving. Plants would be considered "dead" when more than 50% of the plant is decadent. Monitoring field visits would take place during the growing season of each monitoring year, and a monitoring report would be submitted to the City of Bellevue by the end of each calendar year.

9.4 Contingency Plan

The purpose of the contingency plan is to identify the need for maintenance or corrective action if the monitoring indicates that any of the performance standards are not met. These actions will be documented in the monitoring reports. Contingency measures are provided in Table 9.

Table 9. Contingency Measures

Problem	Contingency Measures
Site does not meet plant survivorship requirements	• Evaluate reasons for mortality (e.g., poor soil conditions, insufficient moisture, incorrect planting, browsing by wildlife, vandalism). • Address cause for mortality and replant to exceed survivorship requirements (contractor is responsible for replacing plant materials that die in the first year). • Provide protective measures (e.g., rodent fencing, deer repellent, weeding, etc.), if appropriate. • Initiate or modify irrigation practices, if necessary.
Over-competition by invasive species (more than 30% cover in the mitigation area)	• Evaluate predominant invasive species in the restoration areas. • Initiate invasive species control protocols appropriate to species type, conditions of infestation area (wetland or buffer), and level of infestation (e.g., herbicide application, mowing, etc.).

9.5 Additional Mitigation requirements for Streams

The LUC 20.25H. 085 notes:

In addition to the provisions of LUC 20.25H.210, mitigation plans designed to mitigate impacts to streams and stream critical area buffers shall meet the requirements of this section.

A. Mitigation Preference.

Mitigation plans for streams and stream critical area buffers shall provide mitigation for impacts to critical area functions and values in the following order of preference:

1. On-site, through replacement of lost critical area buffer;

2. On-site, through enhancement of the functions and values of remaining critical area buffer;

3. Off-site, through replacement or enhancement, in the same sub-drainage basin;

4. Off-site, through replacement or enhancement, out of the sub-drainage basin but in the same drainage basin.

Mitigation off-site and out of the drainage basin shall be permitted only through a critical areas report.

B. Buffer Mitigation Ratio.

Critical area buffer disturbed or impacted under this part shall be replaced at a ratio of one-to-one. (Ord. 5680, 6-26-06, § 3)

Applicant's Response:

No permanent impacts to the West Tributary would occur as a result of this project. Construction of the culvert replacement would not directly or indirectly affect the West Tributary or its buffer because the proposed project will result in replacement of the existing culvert with a shorter box culvert. Overall, there will be a net benefit to the aquatic habitat for the West Tributary.

20.25H.090 Critical areas report – Additional provisions.

A. Limitation on Modifications.

A stream critical area buffer shall not be modified below the widths set forth in this section, measured from the top-of-bank:

Type S waters	*25 feet*
Type F waters	*25 feet*
Type N waters	*10 feet*
Type O waters	*10 feet*

Applicant's Response:

The West Tributary is a Type F stream, and the proposed project will not modify the critical area buffer below 25 feet from the top-of-bank.

B. Additional Content - Closed Stream Segments

Any critical areas report proposing a modification to the structure setbacks required for closed stream segments shall be based on a consideration of the impact of the modification on the feasibility of reopening the closed stream segment in the future, when compared with the feasibility of reopening the closed stream segment without the proposed modification. Where the proposed modification significantly decreases the feasibility of a future reopening, such modification shall be denied, unless the proposal includes mitigation for the functions and values that could have been achieved by reopening the stream segment. (Ord. 5680, 6-26-06, § 3)

Applicant's Response:

The project is not proposing a modification to the structure setbacks required for closed stream segments. The structure setback for the West Tributary in the project area is 10 feet, based on application of LUC 20.25H.075(D) for Closed Stream Segments.

9.6 Additional Mitigation requirements for Wetlands

The LUC 20.25H.105 notes:

In addition to the provisions of LUC 20.25H.210, mitigation plans designed to mitigate impacts to wetlands and wetland critical area buffers shall meet the requirements of this section.

A. Preference of Mitigation Actions.

2. Mitigation for Impacted Wetland Critical Area Buffer. Mitigation actions that require compensation of impacted critical area buffer shall occur in the following order of preference and in the following locations:

a. On-site, through replacement of lost critical area buffer;

b. On-site, through enhancement of the functions and values of remaining critical area buffer;

c. Off-site, through replacement or enhancement, in the same sub-drainage basin;

d. Off-site, through replacement or enhancement, out of the sub-drainage basin but in the same drainage basin.

Applicant's Response:

Mitigation for impacts to wetland critical area buffers from the proposed project will be located on-site, through enhancement of Wetland 1 buffer.

B. Type and Location of Mitigation for Wetland Critical Area.

Compensatory mitigation for critical areas functions and values shall be either in-kind and on-site, or in-kind and within the same drainage sub-basin. Mitigation actions may be conducted off-site and outside of the drainage sub-basin when all of the following are demonstrated through a critical areas report:

1. *There are no reasonable on-site or in-sub-drainage basin opportunities or on-site and in-sub-drainage basin opportunities do not have a high likelihood of success, after a determination of the natural capacity of the site to mitigate for the impacts. Consideration should include: anticipated wetland mitigation replacement ratios, buffer conditions and proposed widths, hydrogeomorphic classes of on-site wetlands when restored, proposed flood storage capacity, and potential to mitigate stream fish and wildlife impacts (such as connectivity);*

2. *Off-site mitigation has a greater likelihood of providing equal or improved wetland functions than the impacted wetland; and*

3. *Off-site locations shall be in the same sub-drainage basin unless established watershed goals for water quality, flood or conveyance, habitat, or other wetland functions have been established and strongly justify location of mitigation at another site.*

Applicant's Response:

Several options for wetland buffer mitigation were evaluated for the project. With this project, on-site wetland buffer mitigation is considered feasible on the north end of Wetland 1 and to provide similar types of buffer functions as those areas that would be affected. As a result, the mitigation proposed for impacts to wetland critical area buffers will be located on-site in Wetland 1.

C. Mitigation Ratios.

3. Critical Area Buffer Mitigation Ratio. Critical area buffer disturbed or impacted under this part shall be replaced at a ratio of one-to-one.

Applicant's Response:

Buffer mitigation for this project will be provided for 0.3 acre of unavoidable permanent wetland buffer impacts. Enhancement is required at a 1:1 ratio for impacts to the buffer of Category II, III, and IV wetlands (LUC 20.25H.105). Approximately 0.28 acres of degraded Wetland 1 buffer would be enhanced.

D. Wetlands Enhancement as Mitigation.

Impacts to wetland critical area functions may be mitigated by enhancement of existing significantly degraded wetlands. Applicants proposing to enhance wetlands must produce a critical areas report meeting the requirements of LUC 20.25H.110 and 20.25H.230 that identifies how enhancement will increase the functions of the degraded wetland and how this increase will adequately mitigate for the loss of wetland area and function at the impact site. An enhancement proposal must also show whether existing wetland functions will be reduced by the enhancement actions. (Ord. 5680, 6-26-06, § 3)

Applicant's Response:

The project is not proposing to mitigate by enhancing degraded wetlands for wetland buffer impacts.

20.25H.110 Critical areas report – Additional provisions.

A. Limitation on Modification.

A critical areas report may not be used to fill a wetland critical area, except where filling is required to allow a use set forth in LUC 20.25H.055.

Applicant's Response:

The project does not propose filling of wetlands beyond what is an allowed use under 20.25H.055.

B. Additional Content.

In addition to the general requirements of LUC 20.25H.230, a critical areas report for wetlands shall include a written assessment and accompanying maps of the wetlands and buffers within 300 feet of the project area, including the following information at a minimum:

1. A discussion of measures, including avoidance, minimization, and mitigation, proposed to preserve existing wetlands and restore any wetlands that were degraded prior to the current proposed land use activity.

2. A habitat and native vegetation conservation strategy that addresses methods to protect and enhance on-site habitat and wetland functions.

3. Functional evaluation for the wetland and adjacent buffer using a local or state agency staff-recognized method and including the reference of the method and all data sheets. (Ord. 5680, 6-26-06, § 3)

Applicant's Response:

The Critical Areas Report provides a discussion of all wetlands in the immediate vicinity of the site in the narrative discussion in Section 6.1. Information regarding avoidance and

minimization are provided in Section 9.1. Additional information on wetland preservation and enhancement on-site are provided in Section 9.2. This section also provides a discussion of native vegetation enhancement and preservation on the site.

9.7 Functional Lift Analysis

As described in the previous chapters, the proposed project is expected to improve the overall functions the critical areas provide on-site by replanting the existing wetland buffer areas. Additionally, replacing the existing culvert with a box culvert would provide improved fish passage and create a wildlife corridor. Table 10 provides an analysis of the specific functions of the critical areas provided by the existing site and the post-project site.

Through the proposed wetland buffer mitigation activities, functional attributes that will be improved in the wetland buffers include reduced prevalence of invasive species, increased plant diversity by replanting with native species, increased food sources for wildlife, increased vertical and horizontal habitat complexity, and improved stream bank protection.

Table 10. Functional Lift Resulting from the Proposed Project/Wetland Buffer Mitigation

Critical Area/Buffer Functions	Existing Conditions	Proposed Conditions	Change In Function
Wetland			
Water Quality	Existing wetlands (Wetlands 1 and B/C) along the West Tributary provide moderate levels of water quality functions.	Treat all stormwater on-site along 124th Avenue NE.	On-site stormwater treatment will increase pathogen removal of stormwater from 124th Avenue NE that will eventually discharge into Wetland 1. Planting in the buffer area of Wetland 1 with native vegetation will also help filter and trap sediments.
Hydrologic	Wetlands 1 and B/C have potential to reduce peak flows and retain water.	Planting 0.28 acres of native woody vegetation in Wetland 1 buffer.	Replanting 0.28 acres of the wetland buffer has the potential to reduce velocity of peak stream flows.
Habitat	Existing vegetation in the wetland buffer areas lacks native vegetation necessary to provide forage and cover opportunities for wildlife. Although disturbed, these wetland buffer areas still provide some habitat for birds and small mammals. In urban setting, these vegetated buffer areas, especially with trees and tall shrubs, also provide screening for wildlife.	Invasive species such as Himalayan blackberry and English ivy will be removed within the wetland buffer. Approximately 0.28 acres of the wetland buffer area will be replanted, and lawn and invasive species will be replaced with native plant species.	Replanting 0.28 acres of the wetland buffer with native plant species will increase plant diversity and complexity of the buffer areas. New native plantings will provide foraging opportunities for birds and small mammals. Planting native shrubs along the roadway would still provide screening for wildlife.
Stream			
In-Stream Habitat	The West Tributary currently crosses 124th Avenue NE in a 48-inch CMP culvert	The project is proposing to replace the existing culvert with a 10-foot-wide and 20-foot-long box culvert.	Approximately 33 feet of the channel would open up by the project, as well as restoring natural channel conditions by placing well-graded stream bed cobbles in the channel.
Riparian Condition	Riparian habitat is limited along the stream on the west side of 124th Avenue NE. The existing buffer area is dominated by mowed grass and Himalayan blackberry	Himalayan blackberry will be removed, and mowed grass will be replaced with native shrub communities.	Riparian habitat will be restored with an increase in native woody species, which would provide improvement of filtering stormwater, habitat structural complexity, and organic material to the food chain.