In partial fulfillment of Task 400.3 of the Herrera contract with King County for analysis and design of the proposed White River Countyline Levee Setback project (Contract #E00187E10), this technical memorandum outlines the approach, analytical methods, and results of geotechnical-related evaluations for the setback levee. This memo furthermore presents recommendations regarding geotechnical design and construction aspects of the project.

1.0 PROJECT DESCRIPTION

1.1 SETBACK LEVEE ALIGNMENT

The White River at Countyline Levee Setback (Countyline) project is a salmon recovery and flood risk reduction project located on the left (east) bank of the White River between river mile (RM) 5.00 and RM 6.33. Implementation of the Countyline project will reconnect approximately 124 acres of forested wetland and historical floodplain to the main stem of the White River by removing most of an existing left bank levee and constructing a new setback levee and biorevetment along the eastern edge of the project boundary. The site location is shown on Figure 1. The proposed setback levee alignment and locations of subsurface investigation borings are shown on Figure 2. Figure 2 also shows the locations of Sections AA’, BB’, CC’, and DD’ that are discussed repeatedly in this memo, as representative locations for the geotechnical analyses conducted.

1.2 SETBACK LEVEE CROSS SECTION

URS and King County agreed upon the following proposed general levee configuration for the cross sections evaluated in detail:

- Levee top width 15 feet.
- Levee side slopes 2.5H:1V (horizontal to vertical).
- River-side water level is 3 feet below the levee crest.
The proposed levee consists of a zoned embankment consisting of the following materials:

- Core – low permeability fill material.
- Shell – native alluvium surrounding the core.
- Outer surface - topsoil.
- Top – gravel driving surface.

2.0 SCOPE OF SERVICES

The scope of services for the analyses presented in this memo is described in the December 6, 2010 Professional Services Agreement signed between Herrera Environmental Consultants and URS Corporation, which includes providing geotechnical services for levee setback seepage analysis. Specific elements of this scope of services are:

- Compare river stages to measured groundwater level data to assess the linkage between river water level and the groundwater elevation response to it, using river stage data from the USGS gauging station at the A Street Bridge in Auburn and groundwater data loggers deployed by King County in the wetland on-site.
- Characterize the general foundation conditions along the setback levee alignment and provide concept level and design-level geotechnical analysis of the proposed levee, and provide construction recommendations addressing compaction; preload requirements; and potential modes of failure, including slope stability, settlement, levee underseepage, and seismic considerations in general accordance with the following: US Army Corps of Engineers (USACE) Design and Construction of Levees Manual EM 1110-2-1913, dated April 30, 2000, USACE Slope Stability Manual EM 1110-2-1902, dated October 31, 2003, and ETL 1110-2-569 Design Guidance for Levee Underseepage, dated May 1, 2005.
- Prepare a geotechnical analysis technical memorandum (this memo) that documents water level monitoring in wells along the setback levee alignment, addresses the static stability and settlement of the new setback levee, the need for seepage cutoff within and below the new levee, erosion protection of the new levee, use of on-site soils (if available) for construction of the new levee, and seepage cutoff key (if required).
- Provide geotechnical analyses using SLOPE/W and SEEP/W, including design recommendations, for up to two setback levee footprints and up to 3 levee cross-section configurations prepared by King County.

3.0 SITE CONDITIONS

3.1 SURFACE DESCRIPTION

The proposed setback levee site is on the perimeter of active farmland with a small area of commercial/industrial property along the southern 1,500 lineal feet of the setback alignment. The ground surface in the setback levee project area is relatively flat and gently sloping upward from the southwest to the northeast end, with a mean surface elevation of approximately 70 to 80 feet (NAVD 88). The setback floodplain area west of the setback levee alignment encompasses approximately 124 acres of forested wetland and upland wetland buffer.
3.2 GEOLOGIC SETTING

The valley of the White River is underlain by Holocene alluvium (USGS, 1995). During the Holocene Epoch, erosion and deposition occurred primarily along major river valleys and marine embayments. Holocene deposits include peat, mass wasting debris, mudflow sediments generated on the volcanic peaks of the Cascade Range, and fluvial and deltaic sediments. Alluvium found in the valley of the White River is designated as geologic unit “Qal”, and this unit is considered to be an important aquifer. Few wells fully penetrate the Qal unit in the study area, so the thickness of the unit generally is not known. Near the steep slopes of each valley, Qal is interbedded with and sometimes overlain by mass-wasting debris (USGS, 1995). The liquefaction potential of the area is indicated as “moderate to high” in the most recent liquefaction susceptibility mapping (Palmer et al, 2004).

The project area is part of the alluvial fan laid down over the past 5,000 years by the erosion and deposition of lahar (volcaniclastic mudflow, such as the 5,700-year-old Osceola mudflow) sediment deposited in the White River canyon. The river was historically considered the Stuck River, an overflow distributary channel of the White River. Prior to a major flood in 1906, most of the White River water and sediment exited the White River canyon near RM 8 and flowed north to join the present-day Green River near Auburn (Herrera, 2012). During the 1906 flood, the main flow of the White River was diverted down the old Stuck River channel. The construction of the Auburn Wall in 1915 made the change permanent.

3.3 SUBSURFACE CONDITIONS

Subsurface conditions at the project site were investigated by King County by drilling 16 soil borings, excavating six test pits and excavating three shallow surface scrapings on the waterward face of the existing levee, performing laboratory testing of selected soil samples, and performing conductivity testing at two wells at the locations indicated on Figure 2. A list of the borings and a brief summary of soil layers encountered are presented in Table 2 below. It should be noted that when a water level monitoring well was installed in the boring, an additional name was assigned to the boring to reflect the presence of the well. For example a monitoring well was installed in boring KCB-2, so the boring is also designated as KCMW-2. Boring logs and laboratory data are provided in Appendix A, and are also in Appendix A of the County Line to A Street Geotechnical Investigation memo prepared by the King County Department of Transportation (2012).

STRATIGRAPHY

The general stratigraphy along the proposed setback levee alignment as indicated by the subsurface descriptions in the boring logs is roughly illustrated on Figure 3. The figure reflects the substantial variation of subsurface conditions in this alluvial fan setting and may not accurately portray the stratigraphy at locations between borings. About one foot of cultivated sandy topsoil was encountered at the surface along the proposed setback levee alignment at borings KCB-1 and KCB-2 and in borings KCB-4 to KCB-9. Uncontrolled fill (mixed natural and man-made materials without obvious compaction controls) and road fill were encountered at the surface in borings KCB-16 and KCB-3 in thicknesses of about 11 feet and 1 foot, respectively. In general, the native stratigraphy below the topsoil or fill surface is poorly graded fine to medium sand to silty sand interbedded with silt and scattered lenses of peat and organics. In the upper 25 feet, the granular material zones tend to be medium dense to occasionally loose, while the fine grained material zones (silt, clay, and peat) tend to be medium stiff to soft.
GROUNDWATER

Groundwater was encountered in all of the borings drilled for this project at depths ranging from 1.6 to 6 feet below the ground surface (see Figure 3 and Appendix A). Water level measurements from six (6) shallow groundwater monitoring wells installed for this project were provided by King County. Of the six groundwater wells installed for the project, four are located in the wetland area on the landward side of the existing levee, and two are located in borings drilled on the floodplain surface above the wetland along the alignment of the proposed setback levee. The locations of the wells (Figure E-1) and the associated water level data are included in Appendix E. A summary of the wells is shown in Table 1.

Groundwater levels generally follow the slope of the river and alluvial fan surface and are higher in the northeast and lower in the southwest (see Figures 3 and E-2). The time-series plots for the wells shown on Figure E-2 illustrate that the upper wetland in the vicinity of groundwater wells GW1, GW2, and GW3 is hydraulically disconnected from the river (USGS gage #12100496 – White River near Auburn, WA, located at the A Street bridge crossing). King County personnel have reportedly observed static water levels in the wetland several feet lower than the river stage even when the river level is near the top of the existing left bank levee. In contrast, groundwater at GW4, KCMW-2, and KCMW-4 in the lower portion of the wetland is hydraulically connected to the river and responds to water entering the wetland near the county line (for flows greater than 3,500 cfs) and returning back to the river near GW4. The two-foot drop in water levels at GW4 between September and October 2011 corresponds to repair work performed on the culvert at the wetland outlet, whereby a beaver dam was dismantled, the culvert unclogged, and a ford cut in the access road. Reconstruction of the beaver dam restored groundwater levels at GW4 by spring 2012.

Table 1: Summary of Groundwater Well Measurements

<table>
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<tr>
<th>GROUNDWATER WELLS</th>
<th>GW1</th>
<th>GW2</th>
<th>GW3</th>
<th>GW4</th>
<th>KCMW-2</th>
<th>KCMW-4</th>
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<td>66.19</td>
<td>71.57</td>
<td>59.32</td>
<td>61.99</td>
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<td>5/23/12</td>
<td>5/23/12</td>
<td>5/23/12</td>
<td>5/23/12</td>
<td>5/9/12</td>
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<td>71.57</td>
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Figure E-2 and Table 1 also show that groundwater levels measured in KCM-2 were higher than the ground surface at the well location during peaks in the White River hydrograph. This indicates groundwater movement originating from upland areas on the alluvial fan in addition to the shallow groundwater connection with the river described above. This interpretation is consistent with saturated ground observed by King County personnel in the fields near KCM-2 during periods of low river levels in July 2012.
LABORATORY TESTING
To aid in classifying the subsurface materials and to estimate general material characteristics, laboratory tests were performed on selected representative samples. The following tests were performed by the King County Materials Laboratory: moisture content, grain size distribution, fines content and Atterberg limits. The results of the laboratory testing are presented in Appendix A and on the boring logs.

4.0 METHODS AND RESULTS

4.1 SOIL PROFILES AND SOIL PARAMETERS FOR DESIGN

Figure 3 shows a conceptual stratigraphic profile along the proposed setback levee alignment based on an interpretation of the boring logs. The estimated material parameters for each of the soil strata encountered at the site are provided in Table 2 for use in the levee seepage and stability analyses. The values provided in the table have been estimated using a combination of field and laboratory data together with published data on similar materials. It should be noted that in most cases the values listed in Table 2 are intended to represent average or slightly conservative field conditions.

The estimated material parameters for the proposed setback levee core fill material are also listed in Table 2. Topsoil is not specifically listed but the value for permeability used in the seepage modeling was 0.02 centimeters per second (cm/sec). The permeability value of 0.10 cm/sec was used to model alluvium.

Natural variations in stratigraphy and soil parameters are expected throughout the site, and thus the values listed in Table 2 may not be strictly representative of all locations. The definitions of the soil types used in Table 2 are listed in ASTM D-2487 Classification of Soils for Engineering Purposes (Unified Soil Classification System).
<table>
<thead>
<tr>
<th>Section * or Boring No.</th>
<th>Fill or Stratum Modeled **</th>
<th>Top Depth (ft)</th>
<th>Thickness (ft)</th>
<th>Raw SPT (blows per foot)</th>
<th>Unit Weight (lbs/ft³)</th>
<th>Friction Angle (degrees)</th>
<th>Cohesion (lbs/ft²)</th>
<th>Permeability (cm/s)</th>
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<td>ML</td>
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</tbody>
</table>

* Sections as shown on Figures 4 and 5
** 20% or 25 % fines is that percentage of fill material that passes the #200 sieve
SPT – standard penetration test
4.2 LEVEE CROSS SECTIONS

Several different setback levee cross-section configurations were modeled (simulated). Section 1 and Section 2 are shown on Figure 4. Sections 3a and 3b are preferred by King County and are shown on Figure 5.

Section 1 was analyzed at locations AA’, CC’, and DD’ shown on Figure 2. Section 1 was assumed applicable for all portions of the setback levee except where the levee encroaches into the wetland. This section consists entirely of imported low permeability material with a top width of 15 feet and 2.5H:1V side slopes (Figure 4).

Section 2 is located in the area where the levee encroaches on the wetland as shown at cross-section BB’ on Figure 2 (approximately Station 12+00 to 16+50 as shown on the 60% Plans). Section 2 is shown on Figure 4 and is similar to Section 1 except that it has a 3-foot layer of heavy loose riprap with a filter layer on the riverward side and an engineered logjam with wood piles built into the levee toe on the river side.

Sections 3a and 3b have a smaller impermeable core, and were evaluated at locations AA’ and DD’ shown on Figure 2. These sections include an outer shell of gravelly material representative of on-site alluvium. Section 3a consists of a core of imported low permeability material with the top at the future 100-year recurrence interval water surface elevation, 2.5H:1V side slopes, and on-site alluvium for the outer shell around the core ranging in thickness from 18 inches on the slopes to 3 feet on the top of the levee. The shell is covered with 18 inches of topsoil on both slopes of the levee. Section 3b is similar to Section 3a, with a narrower core constructed to the same height as section 3a but with 1H:1V side slopes. On-site alluvium was assumed for the outer shell around the core ranging in thickness from 3 feet on the top of the levee to approximately 5 feet on the side slopes. Both slopes of the levee in Section 3b are covered with 18 inches of topsoil.

4.3 SEEPAGE ANALYSES

Seepage analyses were performed using the computer program SEEP/W (2007) to obtain pore water pressures in the soil elements for both steady state and transient state flow conditions. The steady state pore pressures are used for the evaluation of exit hydraulic gradients at the toe of the levee for long-term conditions. Similarly, the transient pore pressures are used to evaluate hydraulic gradients for rapid drawdown conditions. The pore pressure values were also used in the slope stability analyses using SLOPE/W (2007).

SEEP/W is a commercially available (Geo-Slope International Ltd) finite element software product for analyzing groundwater seepage and excess pore-water pressure dissipation problems within porous materials such as soil and rock. SEEP/W provides analyses and results that comply with the USACE guidelines in EM 1110-2-1913 and ETL 1110-2-569. SEEP/W can model both saturated and unsaturated flow, a feature that greatly broadens the range of problems that can be analyzed. In addition to traditional steady-state saturated flow analysis, the saturated/unsaturated formulation of SEEP/W makes it possible to analyze seepage as a function of time and to consider such processes as the infiltration of precipitation.
The seepage models were developed for the proposed setback levee using soil conditions encountered at borings KCB-1, KCB-2/KCMW-2, KCB-7 and KCB-9, and assumed material properties for the imported material to be used in the proposed levee. These borings were considered the most critical for seepage considerations because of the presence of relatively higher permeability materials directly beneath the ground surface under the proposed embankment compared to the other borings. Seepage analyses were conducted for the steady state condition and for a transient rapid drawdown condition. A total head boundary condition was applied for the seepage model cases discussed below.

URS used available King County hydraulic modeling data showing the timing of flood water rise and fall (see Appendix B) to develop a rapid drawdown rate for the seepage analysis. A drawdown rate of 0.42 feet per hour (ft/hr) was calculated from the drawdown curves provided by the County for the future conditions scenario. This value was conservatively rounded up to 0.50 ft/hr for the seepage analysis.

The phreatic surface across the levee was developed based on the following total head boundary conditions for the following model cases:

- **Long-term Condition:**
  - Riverward side of the levee – 100-year flood peak water surface elevation (Section AA’ - EL. 80 feet, Section BB’- EL. 80 feet, Section CC’ - EL. 82 feet, Section DD’ - EL. 85 feet),
  - Landward side of the levee – ground surface elevation (Section AA’ - EL. 72 feet, Section BB’ - EL. 73 feet, Section CC’ - EL. 79 feet, Section DD’ - EL. 81 feet).

- **Rapid Drawdown Condition:**
  - Riverward side of the levee – drop from 100-year flood level elevation to landward side ground elevation at a rate of 0.5 inches per hour in 6 to 12 hours;
  - Landward side of the levee - ground surface elevation.

For underseepage conditions, the current USACE criterion for the average vertical exit hydraulic gradient through a levee’s landward side blanket was used. This criterion is to be less than or equal to 0.5 for the design floodwater level condition (see USACE, 2000 and USACE, 2005).

Table 3 shows results of the seepage analyses for long-term steady seepage conditions. An exit vertical gradient contour output figure was generated using SEEP/W for each case as shown on Figures C1 to C5 included in Appendix C. The results of the seepage analysis are summarized in Table 3. The analyses were performed on the four different sections with different core fill soil types as follows:

- Fill with an estimated 25 percent fines with a conservative estimate of permeability equal to 0.003 cm/sec (Section 1 at locations AA’, CC’, and DD’; Section 2 at location BB’). In this case a “conservative” permeability is one that is in the high end of the expected range.
- Fill with an estimated 25 percent fines with typical estimate of permeability equal to 0.003 cm/sec (Sections 3a and 3b).
- Fill with an estimated 20 percent fines passing the #200 sieve and higher permeability of 0.020 cm/sec (Section 1 at Location AA; Section 2 at BB).

Topsoil was not modeled as a separate layer from the levee fill in Section 1 and Section 2. However, both of these sections were modeled using permeability of 0.02 cm/sec for the levee
fill, which is the same permeability used in modeling topsoil in Sections 3a and 3b. Therefore, 12 inches of topsoil placed as part of the section at AA and BB would not be inconsistent with the modeled results.

It should be noted that the estimates of permeability for levee core material having 20 to 25 percent fines were made assuming that these fines are non-plastic to low plasticity silt and/or clay to account for the potential difficulty in obtaining borrow fill containing higher plasticity fines that would also have lower permeabilities.

<table>
<thead>
<tr>
<th>Analyzed Location</th>
<th>Levee Core Material</th>
<th>Maximum Vertical Exit Gradient ($i_{max}$)</th>
<th>Figure No.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Passing #200 Sieve (%)</td>
<td>Permeability (cm/sec)</td>
<td></td>
</tr>
<tr>
<td><strong>SECTION 1</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AA’</td>
<td>25</td>
<td>0.003</td>
<td>0.38</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>0.020</td>
<td>0.43</td>
</tr>
<tr>
<td>CC’</td>
<td>25</td>
<td>0.003</td>
<td>0.35</td>
</tr>
<tr>
<td>DD’</td>
<td>25</td>
<td>0.003</td>
<td>0.35</td>
</tr>
<tr>
<td><strong>SECTION 2</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BB’</td>
<td>25</td>
<td>0.003</td>
<td>0.45</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>0.020</td>
<td>0.46</td>
</tr>
<tr>
<td><strong>SECTION 3a</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AA’</td>
<td>25</td>
<td>0.003</td>
<td>0.40</td>
</tr>
<tr>
<td><strong>SECTION 3b</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AA’</td>
<td>25</td>
<td>0.003</td>
<td>0.41</td>
</tr>
<tr>
<td>DD’</td>
<td>25</td>
<td>0.003</td>
<td>0.39</td>
</tr>
</tbody>
</table>

Table 3: Summary of Seepage Gradient Estimates at Setback Levee Toe

* Percent fines passing the #200 sieve.

The vertical exit gradients listed in Table 3 are less than the maximum acceptable value of 0.5 that is the current USACE criterion for the levee design floodwater level condition (see USACE, 2000 and USACE, 2005). The results of the seepage analysis indicate that the exit gradients are considered acceptable according to USACE criteria, and therefore a seepage cutoff trench, core or blanket is not required if soils encountered during construction are consistent with the values used in the analysis.

The analysis of core material with an estimated 20 percent fines was performed only at location AA’ for Section 1 and location BB’ for Section 2 to show the relative difference if fill is imported with lesser fines than assumed for the modeling.

The results of this comparative analysis show that soils with higher permeability consistent with lesser fines content (assumed 20 percent) would have greater exit gradients than soils with permeability corresponding to 25 percent fines. However, the difference in exit gradients for location BB’ and Section 2 is insignificant, which may be related to the thinner impermeable section with the rock face on the waterward side of levee in this section.
A transient analysis was performed to simulate the phreatic surface (including groundwater levels on the landward side of the proposed levee) during a 100-year flood event in the White River. The results of the transient analysis indicate that groundwater is high enough to be at or above the ground surface during extreme flood events with associated high river stages lasting 48 hours or more. The high groundwater levels would not be from seepage through the levee but would occur from the surcharge of deeper pervious layers that would transmit groundwater to shallower alluvium near the surface. This is in contrast to existing conditions during moderate flood flows less than the 100-year flood event, in which the field areas south of the proposed setback levee would be inundated with floodwaters. Although the proposed setback levee will provide protection from flood inundation, the high groundwater levels that currently exist in the field areas south of the proposed setback levee will not be alleviated by the levee. The presence of near-surface moisture for 48 hours or more under existing and proposed conditions could have adverse impacts on the existing pavements near the toe of the future levee at the south end of the alignment. With or without the setback levee, consideration should be given to adding fill in areas where roads and buildings will be constructed immediately adjacent to the proposed setback levee toe.

4.4 STABILITY ANALYSES

URS performed a static slope stability analysis for long-term conditions and for rapid drawdown conditions using SLOPE/W (2007), a commercially available computer program for the general solution of slope stability problems by two-dimensional limit equilibrium methods. SLOPE/W provides analyses and results that comply with the USACE guidelines in EM 1110-2-1913 and ETL 1110-2-1902. The calculation of the factor of safety (FS) against instability of a slope can be performed using one of the following methods: Bishop Simplified Method (applicable to circular shaped failure surfaces), Ordinary Method, Janbu Simplified Method (applicable to failure surfaces of general shape), or Spencer's Method (applicable to any type of surface).

SLOPE/W features unique random techniques for generation of potential failure surfaces for subsequent determination of the more critical surfaces and their corresponding factors of safety. These techniques generate circular failure surfaces, surfaces of sliding block character, or more general irregular surfaces of random shape. For the purposes of these analyses, URS utilized Spencer’s Method. The pore pressure generated in the SEEP/W model run was used in the SLOPE/W program during stability analysis. The analysis incorporated the following options:

1. Analysis method: Spencer
2. Slip surface option: entry and exit
3. Directions of movement: left to right for landward side of levee; right to left for riverward side of levee
4. Tension crack option: no tension crack
5. Minimum slip surface depth: 5 feet

The minimum FS for static conditions required by the USACE (2000) are shown in Table 4.

Table 4: Minimum Factors of Safety Required by the USACE (2000) for Levees under Static Conditions

<table>
<thead>
<tr>
<th>Design Condition</th>
<th>Minimum FS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rapid Drawdown</td>
<td>1.0 to 1.2 *</td>
</tr>
<tr>
<td>Long Term (Steady Seepage)</td>
<td>1.4**</td>
</tr>
</tbody>
</table>
Sudden drawdown analysis. F.S. = 1.0 applies to pool levels prior to drawdown conditions where these water levels are unlikely to persist for long periods preceding drawdown. F.S. = 1.2 applies to pool level likely to persist for long periods prior to drawdown.

For existing slopes where either sliding or large deformation have occurred previously and back analyses have been performed to establish design shear strengths, lower factors of safety may be used. In such cases probabilistic analyses may be useful in supporting the use of lower factors of safety for design.

Cross sections for evaluation were selected based on levee height and the presence of the most critical foundation soil conditions and strata depths. Selected locations for stability analyses are as follows:

- Location AA’ (near KCB-1).
- Location BB’ (near KCB-2/KCMW-2).
- Location CC’ (near KCB-7).
- Location DD’ (near KCB-9).

*Note that KCB-2 and KCMW-2 are the same boring with different names to designate that the boring is also used as groundwater monitoring well.

Static factors of safety were estimated for long-term and rapid drawdown conditions.

The results of the long-term and rapid drawdown stability analyses are summarized in Tables 5 and 6, respectively. These tables show that the calculated FS met the minimum acceptable FS specified by the USACE (2000) in all cases. The stability calculation output figures are attached in Appendix D.

### Table 5: Summary of Simulated Long-term Condition Factors of Safety

<table>
<thead>
<tr>
<th>Analyzed Locations</th>
<th>Levee Core Material</th>
<th>FS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Passing #200 Sieve (%)</td>
<td>Friction Angle (degrees)</td>
</tr>
<tr>
<td>AA’</td>
<td>20</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td>25</td>
<td>35</td>
</tr>
<tr>
<td>BB’</td>
<td>20</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td>25</td>
<td>35</td>
</tr>
<tr>
<td>CC’</td>
<td>20</td>
<td>37</td>
</tr>
<tr>
<td>DD’</td>
<td>20</td>
<td>37</td>
</tr>
</tbody>
</table>

### Table 6: Summary of Simulated Rapid Drawdown Condition Factors of Safety

<table>
<thead>
<tr>
<th>Analyzed Sections</th>
<th>FS*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Landward Side</td>
</tr>
<tr>
<td>Section AA’</td>
<td>1.62</td>
</tr>
<tr>
<td>Section BB’</td>
<td>1.56</td>
</tr>
<tr>
<td>Section CC’</td>
<td>1.91</td>
</tr>
<tr>
<td>Section DD’</td>
<td>1.74</td>
</tr>
</tbody>
</table>

* φ = 37°, c = 0 lbs/ft², permeability = 0.02 cm/s, assumed 20% fines passing the #200 sieve for the modeled fill.
As in the seepage analyses, the stability analyses were performed for two separate hypothetical levee fill soil types, one having 20 percent fines and an assumed zero cohesion value but higher friction angle than a fill having 25 percent fines. In general, the use of the higher fines fill resulted in a slightly higher long-term factor of safety. The rapid drawdown case was only examined with 20 percent fines in the fill soil (zero cohesion), because the likelihood of obtaining a factor of safety less than the required 1.2 value was judged to be remote for the higher fines fill.

All FS values listed in Table 5 and Table 6 are greater than or equal to the minimum for static conditions \( (FS = 1.4) \) and rapid drawdown conditions \( (FS = 1.2) \) required by the USACE (2000), as shown in Table 4.

5.0 CONCLUSIONS

The analyses conducted for the proposed setback levee along the alignment shown in Figure 2 indicate that all configurations modeled will meet the requirements of the USACE for slope stability. The analyses also indicate that the sections modeled meet the USACE seepage guidelines at the locations as follows:

- The proposed sections using a narrow core as shown for Sections 3a and 3b on Figure 5 can be used for the entire proposed setback levee except near location BB’.
- Location BB’ requires a core section with rock riprap facing on the waterward side as shown in Section 2 on Figure 4.

Calculations indicate that for soil conditions at most borings, the estimated settlement magnitude for the new levee embankments is relatively small at 2 to 4 inches, most of which is expected to occur during construction. At a few locations where peat or organic silt have been encountered, such as at borings KCB-6 and KCB-7, the settlement could increase to as much as approximately 6 inches, and could occur over an extended period of time.

Existing groundwater levels will not be lowered by installation of the setback levee. The transient modeling predicts that there may be low-gradient seepage beneath the levee during prolonged periods of high river flows that could result in shallow groundwater conditions landward of the setback levee that would otherwise be inundated with flood water if the project was not constructed. With or without the setback levee, roads or structures may experience saturated subgrades due to existing shallow groundwater conditions.

6.0 RECOMMENDATIONS AND CONSTRUCTION CONSIDERATIONS

The soil encountered within the area to be occupied by the new levee is suitable as a foundation for the new levee fills without preload or extensive modification. Total settlements ranging up to 6 inches could occur at the center of the levee during and after construction in locations overlying peat deposits. The settlement will be generated by consolidation of the silt and peat zones under the weight of the new embankment fill.

The permeability of potential on-site or imported embankment fill could vary naturally by a substantial amount. Accordingly, URS is recommending minimum fines content of 25 percent for the levee core so that portions of the fill that do not meet the assumed permeability will still meet the requirement for the maximum allowable seepage gradient.
Recommended fill materials for the core of the levee embankment are silts, clays, sands with silt, sands with clay, or a mixture thereof. The plasticity of the fines content of levee fill materials should be as high as possible to decrease permeability. The fill material should have a maximum particle size of 3 inches with a minimum of 25 percent of the material passing the #200 sieve (considering only material less than 3 inches) measured in accordance with ASTM D-1140. Organic and foreign substances should not be allowed in the earthfill material. URS recognizes that the minimum fines recommendation may be difficult to achieve given the available borrow sources, and accordingly has examined the seepage and stability assuming a coarser levee fill.

Zoned fills as shown on Figure 5 meet minimum seepage and stability guidelines as described in the Conclusions section above. The existing levee materials (alluvium) are gravels with minimal fines and are not acceptable for the core of the setback levee. For the zoned levee section, the core should contain soils with a minimum of 25 percent of the material passing the #200 sieve and it should be constructed up to the future 100-year flood peak water surface elevation. The portion of the levee above the 100-year flood level (freeboard) may be constructed of fill having less than 25 percent fines, including on-site alluvium.

The impervious core of the levee embankment fill should be placed in continuous, homogenous lifts with a maximum layer thickness of 8 inches before compaction. The alluvium may be placed with a maximum layer thickness of 12 inches before compaction. The recommendations for the degree of compaction made here consider that no specific numerical compaction requirement is contained in the latest guidance on levee construction (EM 1110-2-1913, Design and Construction of Levees) published by the USACE (2000). Given the above considerations, URS recommends that fill placed for construction of the setback levee be compacted to a minimum density of 95 percent of the maximum dry density as measured using ASTM Test Method D-698.

The moisture content of the fine-grained fill matrix should not be less than 2 percent below the optimum moisture content, and no more than 3 percent above optimum moisture content as determined by ASTM D-698.

The fill in the wetland (location DD’) can be started by removing fine and organic material and filling with approved riprap as a base within the footprint of the riprap as shown in the design drawings. Levee fill behind the riprap should be placed in the dry, meeting all levee criteria described above, after the foundation has been stripped and proof rolled (compact foundation layer prior to initial fill placement).

A clubfoot or sheepsfoot roller is recommended for foundation subgrade preparation and levee compaction for fine-grained soils (e.g., silts, clay, sandy silt, and sandy clay) or soils that have a high fines component (e.g., silty sand), to be used for construction of the new levee. This type of roller is expected to minimize the potential for creating a preferred pathway for seepage at the interface between lifts of fill soil. If a smooth surface occurs during placement, the top of each lift should be scarified to a depth of approximately 1 inch before placement of the next lift to avoid development of a preferred pathway for seepage. If rainfall is expected during the construction period, the levee surface should be sloped to drain and “sealed” with a smooth drum roller to allow surface water runoff. The smooth surface should be scarified when fill placement is resumed. Vibratory compaction should be avoided for fine-grained soils or soils with high fines content. Rubber tire or smooth drum vibratory compactors can be used on coarser soils used in the zone identified as alluvium.
Fill soils immediately below the riprap blanket placed on the waterward face of the setback levee may be susceptible to erosion and washing from behind the riprap unless a filter is placed between the riprap blanket and the levee fill. The filter should consist of a 9-inch minimum thickness of well-graded sand and gravel meeting the gradation requirements in Appendix D of EM 1110-2-1913.

Before starting earthwork, site preparation should begin with stripping any surficial grass, roots, and topsoil from within the limits of fill placement. URS expects surface stripping will be necessary to a minimum depth of 1 foot.

One typically adverse existing soil condition that was not encountered in the soil borings, but if encountered during construction would likely result in an unacceptable seepage exit gradient is the presence of a clean sand (SP or SW) at the subgrade level of the new setback levee embankment. While it appears that the possibility of encountering such a condition is low, URS recommends that if the clean sand is present for a distance of at least 15 feet along the setback levee alignment, the low permeability core soil should be extended downward in the form of a keyway into the foundation to a depth of at least 4 feet. The final dimensions should be assessed according to the nature of conditions encountered.

Topsoil obtained from the foundation preparation may be stockpiled and placed on the setback levee prior to revegetation of the levee slopes. Prior to placing topsoil, the setback levee should be constructed to its full cross section using approved levee fill material. The setback levee side slopes should be “track-walked” by a tracked vehicle running up and down the slopes of the fill. The topsoil should be compacted by the same track-walking method leaving the final surface with horizontal indents from the tracks to collect rain and prevent erosion of the newly completed levee.

The soils expected to be exposed at the subgrade level for the setback levee are considered moderately to highly erodible in a disturbed condition. Erosion control efforts during construction should be diligently implemented in this large area of disturbance, and Best Management Practices (BMPs) applied as necessary to protect the nearby wetlands and river. Protection of compacted soil embankment slopes should be selected considering the velocity of the water that may be flowing towards or along the sloping surface.

### 7.0 LIMITATIONS

The recommendations and descriptions presented in this report are based on the soil conditions encountered in the field exploration conducted by King County at the site in 2010. The subsurface information referred to herein does not constitute a direct or implied warranty that the soil conditions between boring locations can be directly interpolated or extrapolated or that subsurface conditions and soil variations different from those encountered in the County’s explorations will not be revealed. If, during construction, subsurface conditions different from those described herein are observed, or if the structures and loading conditions described here are modified, URS Corporation should review such conditions and the recommendations given herein should be revised, as necessary.
REFERENCES


King County Department of Natural Resources and Parks, Water and Land Resources Division, March 29, 2012. County Line to A Street, White River, River Mile 4.92 – 6.05 Levee Modification, Draft CADD/40% Drawing, Project No. 111417. Seattle, WA.

King County Department of Transportation, June 2012. County Line to A Street Geotechnical Investigation Project No. 1112049. Renton, WA.


Washington State Department of Transportation (WSDOT), November 2011. Geotechnical Design Manual, M46-03.06.

APPENDICES

Appendix A - Logs of Borings, Results of Laboratory Testing
Appendix B - King County Modeling Data for Drawdown Analysis
Appendix C - Vertical Exit Gradient SEEP/W Output
Appendix D - Stability Analyses SLOPE/W Output
Appendix E - King County Groundwater Well Data
Figure 1
Site Location

Source: King County, Department of Natural Resources and Parks, Water and Land Resources Division

Job No. 33762798

White River Countyline Levee Project
King County, Washington
Source: King County, Department of Natural Resources and Parks, Water and Land Resources Division

Site Plan, Boring Locations and Cross Sections

White River Countyline Levee Project
King County, Washington

Job No. 33762798
Figure 3

Estimated Soil Profile Along Proposed Levee

The soil conditions are known only at the boring locations and are therefore accurate only at these points. The profile is based on interpolation or extrapolation between conditions observed at the boring locations and should be considered approximate.
Appendix A: Borings and Laboratory Test Results
**BORING LOG**
**BORING KCB-1**

**PROJECT:** Countyline to A-Street Geotechnical Study  
**BORING LOCATION:** Setback Levee Location 1  
**DRILL METHOD:** Mud Rotary  
**DRILLER:** Holocene Drilling Inc.  
**DEPTH TO:** Water: 6 ft  
**Caving:** N. A.  
**DATE:** September 28, 2010  
**START:** 12:00 PM 9/28/2010  
**FINISH:** 2:00 PM 9/28/2010  
**LOGGER:** DA  
**DATE CHECKED:** During

<table>
<thead>
<tr>
<th>ELEVATION/DEPTH</th>
<th>SOIL SYMBOLS</th>
<th>USCS</th>
<th>Description</th>
<th>Moist (%)</th>
<th>-200 (%)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>SP</td>
<td></td>
<td>Sod and sandy topsoil. Dark brown poorly graded fine to medium grained sand with silt, gravel, and occasional cobbles, moist, medium dense. (Fill)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>90</td>
<td>ML</td>
<td></td>
<td>Gray silt with sand, moist, loose. The silt contains a few fragments of decaying vegetation.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>85</td>
<td>SP</td>
<td></td>
<td>Black poorly graded fine to medium sand, wet, loose. Peat. Black poorly graded fine to medium grained sand with silt, wet, loose to dense.</td>
<td>168.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>80</td>
<td>PT</td>
<td></td>
<td>Black silt, wet, medium dense. Peat.</td>
<td></td>
<td>26.4</td>
<td>7.9</td>
</tr>
<tr>
<td>75</td>
<td>ML</td>
<td></td>
<td>Dark gray sandy silt, wet, medium dense.</td>
<td>168.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>70</td>
<td>SP</td>
<td></td>
<td>Black poorly graded fine to medium grained sand, wet, medium dense to dense.</td>
<td>35.4</td>
<td>61.7</td>
<td></td>
</tr>
<tr>
<td>65</td>
<td></td>
<td></td>
<td>The sample contained scattered tephra granules.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Boring KCB-1 was located in the field by GPS. The approximate boring location is provided in Figure 2.

---

KING COUNTY MATERIALS LABORATORY
# Log of Monitor Well Installation

**Well No. KCB-2**

**Project:** Countyline to A-Street Geotechnical Study  
**Boring Location:** Setback Levee Location 2  
**Drill Method:** Mud Rotary  
**Driller:** Holocene Drilling Inc.  
**Depth to Water:** 1.62 ft  
**Date:** September 22, 2010  
**Start:** 12:00 PM 9/22/2010  
**Finish:** 2:00 PM 9/22/2010  
**Logger:** DA  
**Date Checked:** 7:30 AM 9/30/  

<table>
<thead>
<tr>
<th>Elevation/Depth</th>
<th>Soil Symbols</th>
<th>Description</th>
<th>Moist (%)</th>
<th>-200 (%)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>ML</td>
<td>Cultivated sandy topsoil.</td>
<td>53.0</td>
<td>80.6</td>
<td>The silt was found to be non-plastic.</td>
</tr>
<tr>
<td>95</td>
<td>SM</td>
<td>Gray mottled silt with sand, moist to wet, very loose. Sample also contained scattered organic material.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>90</td>
<td>ML</td>
<td>Black silty sand, wet, medium dense. The sand contains thin lenses of fine sand and silt. Black silt with sand, wet, loose to medium dense.</td>
<td>31.6</td>
<td>72.2</td>
<td>The silt was found to be non-plastic.</td>
</tr>
<tr>
<td>85</td>
<td>ML</td>
<td>Gray silt, wet, very loose. The sample also contained a 6 inch thick lense of peat. Black poorly graded fine to medium sand with silt, wet, medium dense.</td>
<td>29.5</td>
<td>5.5</td>
<td></td>
</tr>
<tr>
<td>80</td>
<td>SP-SM</td>
<td>Poorly graded gravel with sand, wet, medium dense.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>75</td>
<td>SP</td>
<td>Black poorly graded fine to medium grained sand, wet, medium dense to dense.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>70</td>
<td>ML</td>
<td>Dark gray sandy silt, wet, dense.</td>
<td>30.0</td>
<td>56.6</td>
<td>The silt was found to be non-plastic.</td>
</tr>
</tbody>
</table>

Well KCB-2 was located in the field by GPS. The approximate well location is provided in Figure 2. Well KCB-2 is identified by Washington State Department of Ecology discrete well tag number BCJ 225.
Boring KCB-3 was located in the field by GPS. The approximate boring location is provided in Figure 2.
### LOG OF Boring
#### BORING KCB-3
(continued)

<table>
<thead>
<tr>
<th>ELEVATION/DEPTH</th>
<th>SOIL SYMBOLS</th>
<th>U.S.C.S.</th>
<th>Description</th>
<th>Moist (%)</th>
<th>-200 (%)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>SM</td>
<td>Brown silt, wet, loose. A 1 inch thick peat lens was found on the surface of the silt. Black silty fine to medium grained sand, wet, loose to medium dense. The soil zone from 38 to 54 feet also contains scattered thin silt and peat lenses with occasional decomposed wood.</td>
<td>45.9</td>
<td>98.5</td>
<td>Liquid Limit 35 Plastic Index 2. The testing at 40 feet was performed on one of the intermittent silt lenses. A sampler containing rings was pushed at this elevation resulting in no sample recovery.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ML</td>
<td>Peat and dark brown silt, wet, loose.</td>
<td>51.3</td>
<td>92.7</td>
<td>Liquid Limit 42 Plastic Index 8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SP</td>
<td>Black poorly graded fine to medium sand, wet, medium dense.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>CL</td>
<td>Gray silty lean clay, wet, stiff.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>PT</td>
<td>Peat</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>SP</td>
<td>Black poorly graded fine to medium sand, wet, medium dense.</td>
<td>112.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>SM</td>
<td>Dark gray silty fine grained sand, wet, medium dense.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

KING COUNTY MATERIALS LABORATORY
### LOG OF MONITOR WELL INSTALLATION

**WELL NO. KCB-4**

<table>
<thead>
<tr>
<th>ELEVATION/DEPTH</th>
<th>SOIL SYMBOLS</th>
<th>SAMPLER SYMBOLS AND FIELD TEST DATA</th>
<th>USCS</th>
<th>Description</th>
<th>Moist (%)</th>
<th>-200 (%)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>ML</td>
<td>Pushed</td>
<td></td>
<td>Cultivated sandy topsoil.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>95</td>
<td>SP</td>
<td></td>
<td>26.7</td>
<td>Gray mottled sandy silt, moist to wet, very loose. The sample also contained scattered organic material.</td>
<td></td>
<td>4.5</td>
<td>Brown fine sand observed in the tip of the Shelby.</td>
</tr>
<tr>
<td>90</td>
<td>SM</td>
<td></td>
<td>28.3</td>
<td>Black poorly graded fine to medium grained sand, wet, medium dense.</td>
<td></td>
<td>26.1</td>
<td></td>
</tr>
<tr>
<td>85</td>
<td>ML</td>
<td></td>
<td>62.5</td>
<td>Brown poorly graded fine grained sand, wet, medium dense.</td>
<td></td>
<td>89.8</td>
<td></td>
</tr>
<tr>
<td>80</td>
<td>SP</td>
<td></td>
<td>26.7</td>
<td>Black poorly graded fine to medium grained sand with 1 to 2 inch thick lenses of fine sand and silt, wet, medium dense.</td>
<td></td>
<td>11.8</td>
<td></td>
</tr>
<tr>
<td>75</td>
<td>ML</td>
<td></td>
<td></td>
<td>Dark gray silty sand, wet, medium dense. Slight bedding visible.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>70</td>
<td>SP,SM</td>
<td></td>
<td></td>
<td>Gray silt, wet, very loose. The sample also contained a 3 inch thick lens of peat at the bottom of the silt.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>65</td>
<td></td>
<td></td>
<td></td>
<td>Black poorly graded fine to medium grained sand, wet, medium dense.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35</td>
<td></td>
<td></td>
<td></td>
<td>Gray silt, wet, very loose. The sample also contained a 3-inch thick lens of peat at the bottom of the silt.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td></td>
<td></td>
<td></td>
<td>Black poorly graded fine to medium grained sand with silt, wet, medium dense to dense.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Well KCB-4 was located in the field by GPS. The approximate well location is provided in Figure 2. Well KCB-4 is identified by Washington State Department of Ecology discrete well tag number BCJ 226.
BORING LOG
BORING KCB-5

PROJECT: Countyline to A-Street Geotechnical Study
BORING LOCATION: Setback Levee Log Jam Location 5
DRILL METHOD: Mud Rotary
DRILLER: Holocene Drilling Inc.
DEPTH TO - Water: 4.5 ft
Caving: N.A.

<table>
<thead>
<tr>
<th>ELEVATION/DEPTH</th>
<th>SOIL SYMBOLS</th>
<th>USCS</th>
<th>Description</th>
<th>Moist (%)</th>
<th>-200 (%)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td></td>
<td></td>
<td>Cultivated sandy topsoil.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>95</td>
<td>ML</td>
<td></td>
<td>Gray brown mottled silt, wet, loose. The sample contained scattered root</td>
<td>49.0</td>
<td>87.9</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>fragments.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>90</td>
<td>SM</td>
<td></td>
<td>Dark gray silty sand, wet, loose.</td>
<td>29.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>90</td>
<td>ML</td>
<td></td>
<td>Black fine to medium grained sandy silt, wet, medium dense.</td>
<td>48.6</td>
<td>66.2</td>
<td></td>
</tr>
<tr>
<td>85</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>The silt was found to be non-plastic.</td>
</tr>
<tr>
<td>85</td>
<td>ML</td>
<td></td>
<td>Brown silt, wet, medium dense.</td>
<td>52.6</td>
<td>98.6</td>
<td>The silt was found to be non-plastic.</td>
</tr>
<tr>
<td>80</td>
<td>ML</td>
<td></td>
<td>Gray silt, wet, medium stiff to stiff.</td>
<td>49.6</td>
<td>99.6</td>
<td>Liquid Limit 44 Plastic Index 10 The silt was found to be non-plastic.</td>
</tr>
<tr>
<td>80</td>
<td>ML</td>
<td></td>
<td>Black sandy silt, wet, medium dense.</td>
<td>36.4</td>
<td>59.0</td>
<td></td>
</tr>
<tr>
<td>75</td>
<td>SM</td>
<td></td>
<td>Dark gray silty sand, wet, medium dense.</td>
<td>29.1</td>
<td>23.0</td>
<td>The mud level in the boring at 7:45 AM on 9/24/10 was 4 feet below the surface.</td>
</tr>
<tr>
<td>70</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Scattered decomposed wood debris observed in the drill fluid. The silt was found to be non-plastic.</td>
</tr>
<tr>
<td>70</td>
<td>ML</td>
<td></td>
<td>Dark gray silt with a 4-inch thick peat lens, wet, loose. The silt also</td>
<td>40.2</td>
<td>71.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>contained scattered decomposed wood debris.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>65</td>
<td>SP</td>
<td></td>
<td>Black poorly graded fine to medium grained sand, wet, medium dense to</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>dense.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>65</td>
<td>SM</td>
<td></td>
<td>Dark gray silty sand, wet, medium dense.</td>
<td></td>
<td></td>
<td>Silt noted in the drill cuttings</td>
</tr>
</tbody>
</table>

Boring KCB-5 was located in the field by GPS. The approximate boring location is provided in Figure 2.
<table>
<thead>
<tr>
<th>ELEVATION/DEPTH</th>
<th>SOIL SYMBOLS</th>
<th>USCS</th>
<th>Description</th>
<th>Moist (%)</th>
<th>-200 (%)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td></td>
<td></td>
<td>to dense.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>55</td>
<td></td>
<td></td>
<td>ML Dark gray sandy silt, wet, medium dense.</td>
<td>32.3</td>
<td>33.6</td>
<td>between 38 and 40 feet below the surface.</td>
</tr>
<tr>
<td>50</td>
<td></td>
<td></td>
<td>SP Black poorly graded fine to medium sand, wet, medium dense to very dense.</td>
<td>29.1</td>
<td>52.1</td>
<td>Sloping thin lenses of fine sand in the sample.</td>
</tr>
<tr>
<td>45</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>A thin volcanic ash lens was found overlying a minor layer of peat in the tip of the sampler. The silt was found to be non-plastic.</td>
</tr>
<tr>
<td>40</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Silt was observed in cuttings during drilling.</td>
</tr>
<tr>
<td>35</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

KING COUNTY MATERIALS LABORATORY
BORING LOG
BORING KCB-6

PROJECT: Countyline to A-Street Geotechnical Study
BORING LOCATION: Setback Levee Location 6
DRILL METHOD: Mud Rotary
DRILLER: Holocene Drilling Inc.
DEPTH TO Water: 5 ft
Caving: N.A.

<table>
<thead>
<tr>
<th>ELEVATION/DEPTH</th>
<th>SOIL SYMBOLS</th>
<th>SAMPLER SYMBOLS AND FIELD TEST DATA</th>
<th>USCS</th>
<th>Description</th>
<th>Moist (%)</th>
<th>Plasticity (%)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 0</td>
<td></td>
<td></td>
<td></td>
<td>Cultivated sandy topsoil.</td>
<td>35.3</td>
<td>86.4</td>
<td>The silt was found to be non-plastic.</td>
</tr>
<tr>
<td>95 5</td>
<td>ML</td>
<td></td>
<td></td>
<td>Brown mottled poorly graded fine grained sand with silt, wet, loose.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>90 10</td>
<td>ML</td>
<td></td>
<td></td>
<td>Tan mottled silt, wet, loose. The sample also contained a few iron stained joints.</td>
<td>26.1</td>
<td>8.5</td>
<td>Sample contained scattered decomposed wood fragments.</td>
</tr>
<tr>
<td>85 15</td>
<td>SP</td>
<td></td>
<td></td>
<td>Black poorly graded fine to medium grained sand with silt, wet, medium dense. Lenses of fine sand and silt are 1 to 2 inches thick.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>80 20</td>
<td>SM</td>
<td></td>
<td></td>
<td>Dark gray silty sand, wet, loose.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>75 25</td>
<td>ML</td>
<td></td>
<td></td>
<td>Gray silt with sand, wet, loose.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>70 30</td>
<td>PT</td>
<td></td>
<td></td>
<td>Peat.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>65 35</td>
<td>SM</td>
<td></td>
<td></td>
<td>Dark gray silty sand, wet, loose.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ML</td>
<td></td>
<td></td>
<td>Gray silt, wet, loose.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PT</td>
<td></td>
<td></td>
<td>Tan sedimentary peat, wet, soft.</td>
<td>134.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SM</td>
<td></td>
<td></td>
<td>Peat with alternating layers of organic silt and sand, wet, loose.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SM</td>
<td></td>
<td></td>
<td>Dark gray silty sand, wet, loose.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ML</td>
<td></td>
<td></td>
<td>Black silty sand, wet, medium dense. Tephra pebbles noted in the cuttings.</td>
<td>24.0</td>
<td>18.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CL</td>
<td></td>
<td></td>
<td>Dark gray silt with sand and a thin lens of sedimentary peat, wet, loose.</td>
<td>88.9</td>
<td>74.2</td>
<td>The silt was found to be non-plastic.</td>
</tr>
</tbody>
</table>

Boring KCB-6 was located in the field by GPS. The approximate boring location is provided in Figure 2.

PLATE NUMBER A6

KING COUNTY MATERIALS LABORATORY
Green lean clay, wet, soft.

SM
Black silty fine to medium grained sand, wet, medium dense to very dense.

Sloping thin lenses of fine sand in the sample.

36.7
49.7
Scattered decomposed wood in the sample.

ML
Dark gray silt, wet, medium dense.

Silt observed in the drill cuttings between 56 and 59 feet below the surface.

SP
Black poorly graded fine to medium sand, wet, dense.

Material composition based on drill cuttings.

PT
Peat and organic silt, wet, loose.

ML
Decomposed wood.

Dark gray silt with scattered wood debris, wet, medium dense.
Boring KCB-7 was located in the field by GPS. The approximate boring location is provided in Figure 2.
<table>
<thead>
<tr>
<th>ELEVATION/DEPTH</th>
<th>SOIL SYMBOLS</th>
<th>SAMPLER SYMBOLS AND FIELD TEST DATA</th>
<th>USCS</th>
<th>Description</th>
<th>Moist (%)</th>
<th>-200 (%)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>60 40</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>55 45</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50 50</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>45 55</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40 60</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35 65</td>
<td>ML</td>
<td></td>
<td></td>
<td>Dark gray silt with scattered wood debris, wet, medium dense.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30 70</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25 75</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 80</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Scattered decomposed wood in the sample.
**BORING LOG**

**BORING LOG**

**BORING LOCATION:** Countyline to A-Street Geotechnical Study

**DATE:** September 27, 2010

**START:** 11:30 AM 9/27/2010

**FINISH:** 3:30 PM 9/27/2010

**DRILL METHOD:** Mud Rotary

**DRILLER:** Holocene Drilling Inc.

**DEPTH TO:** Water: 5 ft

**Caving:** N.A.

**DATE CHECKED:** During

---

<table>
<thead>
<tr>
<th>ELEVATION/DEPTH</th>
<th>SOIL SYMBOLS</th>
<th>USCS</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 0</td>
<td></td>
<td></td>
<td>Cultivated sandy topsoil.</td>
</tr>
<tr>
<td>95 5</td>
<td>ML</td>
<td></td>
<td>Tan mottled silt, moist, loose.</td>
</tr>
<tr>
<td>90 10</td>
<td>ML</td>
<td></td>
<td>Dark gray silt with scattered organic material, wet, loose.</td>
</tr>
<tr>
<td>85 15</td>
<td>SP</td>
<td></td>
<td>Brown mottled poorly graded fine grained sand, wet, loose to medium dense.</td>
</tr>
<tr>
<td>80 20</td>
<td>SP</td>
<td></td>
<td>Gray mottled sandy silt, wet, loose.</td>
</tr>
<tr>
<td>75 25</td>
<td>ML</td>
<td></td>
<td>Black poorly graded fine to medium grained sand with 1 to 2 inch thick silt and fine grained sand lenses, wet, medium dense.</td>
</tr>
<tr>
<td>70 30</td>
<td>ML</td>
<td></td>
<td>Gray mottled silt with scattered organic material, wet, loose.</td>
</tr>
<tr>
<td>65 35</td>
<td>ML</td>
<td></td>
<td>Dark gray sandy silt, wet, loose.</td>
</tr>
<tr>
<td></td>
<td>SP</td>
<td></td>
<td>Black poorly graded fine to medium sand, wet, medium dense.</td>
</tr>
<tr>
<td></td>
<td>SM</td>
<td></td>
<td>Green silt, wet, loose.</td>
</tr>
</tbody>
</table>

---

The following soil types were encountered:

- **Cultivated sandy topsoil**
- **Tan mottled silt**
- **Dark gray silt with scattered organic material**
- **Brown mottled poorly graded fine grained sand**
- **Gray mottled sandy silt**
- **Black poorly graded fine to medium grained sand**
- **Gray mottled silt with scattered organic material**
- **Dark gray sandy silt**
- **Dark gray silty sand**
- **Green silt**

---

**Remarks**

- The silt was found to be non-plastic.
- The silt was found to be non-plastic.
- The silt was found to be non-plastic.
- The silt was found to be non-plastic.

---

*Boring KCB-8 was located in the field by GPS. The approximate boring location is provided in Figure 2.*
<table>
<thead>
<tr>
<th>ELEVATION/DEPTH</th>
<th>SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA</th>
<th>USCS</th>
<th>Description</th>
<th>Moist (%)</th>
<th>-200 (%)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>SP</td>
<td>Black poorly graded fine to medium grained sand, wet, loose to very dense.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>The fine sand and silt is in the form of 1 to 2 inch to thick lenses throughout out this section.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>55</td>
<td></td>
<td>ML</td>
<td>Gray sandy silt, wet, dense to very dense.</td>
<td>33.2</td>
<td>66.7</td>
<td>The silt was found to be non-plastic.</td>
</tr>
<tr>
<td>45</td>
<td></td>
<td>SP</td>
<td>Black poorly graded fine to medium grained sand, wet, loose to very dense.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>The fine sand and silt is in the form of 1 to 2 inch to thick lenses throughout out this section.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35</td>
<td></td>
<td>ML</td>
<td>Dark gray silt with scattered wood debris, wet, dense.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

KING COUNTY MATERIALS LABORATORY
**BORING LOG**
**BORING KCB-9**

**PROJECT:** Countyline to A-Street Geotechnical Study  
**BORING LOCATION:** Setback Levee Log Jam Location 9  
**DRILL METHOD:** Mud Rotary  
**DRILLER:** Holocene Drilling Inc.  
**DEPTH TO Water:** 4.5 ft  
**Caving:** N.A.  
**DATE:** September 28, 2010  
**START:** 8:00 AM 9/28/2010  
**FINISH:** 10:30 AM 9/28/2010  
**LOGGER:** D. A.  
**DATE CHECKED:** During

<table>
<thead>
<tr>
<th>ELEVATION/DEPT</th>
<th>SOIL SYMBOLS</th>
<th>SAMPLER SYMBOLS AND FIELD TEST DATA</th>
<th>USCS</th>
<th>Description</th>
<th>Moist (%)</th>
<th>-200 (%)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 0</td>
<td>SM</td>
<td></td>
<td></td>
<td>Cultivated sandy topsoil.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>95 5</td>
<td>SM</td>
<td></td>
<td></td>
<td>Brown mottled poorly graded fine to medium grained sand, moist, loose.</td>
<td>32.6</td>
<td>47.1</td>
<td></td>
</tr>
<tr>
<td>90 10</td>
<td>PT</td>
<td></td>
<td></td>
<td>Brown peat.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>85 15</td>
<td>SP</td>
<td></td>
<td></td>
<td>Gray mottled silt with scattered organic material, wet, loose.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>80 20</td>
<td>SP</td>
<td></td>
<td></td>
<td>Black poorly graded fine to medium grained sand with 1 to 2 inch thick silt and fine grained sand lenses, wet, medium dense.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>75 25</td>
<td>ML</td>
<td></td>
<td></td>
<td>Dark gray silt with scattered organic material, wet, loose.</td>
<td></td>
<td></td>
<td>A thin peat lens was found at the base of the silt in the sampler.</td>
</tr>
<tr>
<td>70 30</td>
<td>SM</td>
<td></td>
<td></td>
<td>Dark gray silty fine grained sand, wet, loose.</td>
<td>39.2</td>
<td>48.2</td>
<td></td>
</tr>
<tr>
<td>65 35</td>
<td>SP</td>
<td></td>
<td></td>
<td>Dark gray silt with thin fine sand lenses, wet, loose. A thin peat lens 1/4 inch thick was found on the surface of the silt.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Black silty fine to medium grained sand, wet, medium dense to dense. Silt and fine sand are in the form of 1 to 2 inch thick lenses throughout this section.</td>
<td>26.6</td>
<td>24.6</td>
<td></td>
</tr>
</tbody>
</table>

Boring KCB-9 was located in the field by GPS. The approximate boring location is provided in Figure 2.

**PLATE NUMBER** A9

**KING COUNTY MATERIALS LABORATORY**
<table>
<thead>
<tr>
<th>ELEVATION/DEPTH</th>
<th>SOIL SYMBOLS</th>
<th>USCS</th>
<th>Description</th>
<th>Moist (%)</th>
<th>-200 (%)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>60 - 40</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>55 - 45</td>
<td></td>
<td>14,11,6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50 - 50</td>
<td></td>
<td>15,14,10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>45 - 55</td>
<td></td>
<td>20,22,27</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40 - 60</td>
<td></td>
<td>5,6,23</td>
<td>Dark gray silt with sand, wet, medium dense to dense.</td>
<td>30.3</td>
<td>75.3</td>
<td>The silt was found to be non-plastic.</td>
</tr>
<tr>
<td>35 - 65</td>
<td></td>
<td>5,6,26</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30 - 70</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
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<td>25 - 75</td>
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<tr>
<td>20 - 80</td>
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</tr>
</tbody>
</table>
### BORING LOG

#### BORING KCB-16

**PROJECT:** Countyline to A-Street Geotechnical Study  
**BORING LOCATION:** Fairweather Property  
**DRILL METHOD:** Mud Rotary  
**DRILLER:** Holocene Drilling Inc.  
**DEPTH TO - Water:** N/A  
**Caving:** N/A

<table>
<thead>
<tr>
<th>ELEVATION/DEPTH</th>
<th>SOIL SYMBOLS</th>
<th>SAMPLER SYMBOLS AND FIELD TEST DATA</th>
<th>USCS</th>
<th>Description</th>
<th>Moist (%)</th>
<th>-200 (%)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>SM</td>
<td></td>
<td>Brown silty sand with gravel, occasional cobble, scattered concrete debris, moist to wet, medium dense. (Fill)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>70</td>
<td>GP</td>
<td></td>
<td>Black poorly graded gravel with sand and cobble, scattered concrete debris, trace paper, moist to wet, medium dense to dense. (Fill)</td>
<td></td>
<td></td>
<td></td>
<td>Dames and Moore sample.</td>
</tr>
<tr>
<td>56</td>
<td>SM</td>
<td>11,16,24</td>
<td>Brown silty sand with gravel, trace concrete debris, moist to wet, medium dense. (Fill)</td>
<td></td>
<td></td>
<td>26.2</td>
<td>29.6</td>
</tr>
<tr>
<td>60</td>
<td>LP</td>
<td>10,6,5</td>
<td>Black poorly graded gravel with sand, wet, medium dense. (Native contact?)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>ML</td>
<td>0,0,0</td>
<td>Gray sandy silt, wet, very loose?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>ML</td>
<td>1,2,1</td>
<td>Wood debris with gray sandy silt, wet, very loose?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>GP</td>
<td>2,1,1</td>
<td>Black poorly graded gravel with sand, occasional cobble, wet, dense.</td>
<td></td>
<td></td>
<td>39.0</td>
<td>3.8</td>
</tr>
<tr>
<td>10</td>
<td>SP</td>
<td>17,10,18</td>
<td>Black poorly graded sand with gravel, wet, dense.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**DATE:** October 4, 2011  
**START:** 7:45 AM 10/4/2011  
**FINISH:** 2:15 PM 10/4/2011  
**LOGGER:** DW  
**DATE CHECKED:** N/A

---

Boring KCB-16 was drilled in the Fairweather Property south of the wetland. The boring location is provided in Figure 2. No water level was determined for the boring due to use of mud rotary methodology. However, the water level is anticipated to be at the approximate depth of the adjacent wetland.
<table>
<thead>
<tr>
<th>Depth</th>
<th>USCS</th>
<th>Description</th>
<th>Moist (%)</th>
<th>-200 (%)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>SM</td>
<td>Gray silty sand to sandy silt, scattered organics and wood debris, wet, loose.</td>
<td>69.3</td>
<td>49.2</td>
<td>LL=29, PL=29, PI=0, KCB-16 terminated at 76.5 feet.</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td></td>
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<tr>
<td>20</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>ML</td>
<td>Dark gray sandy silt, wet, medium dense to dense.</td>
<td>19.2</td>
<td>11.0</td>
<td></td>
</tr>
<tr>
<td>45</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>SP-SM</td>
<td>Black poorly graded fine to medium sand with silt, wet, dense.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>55</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>60</td>
<td></td>
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<tr>
<td>65</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>70</td>
<td>ML</td>
<td>Gray sandy silt, wet, medium dense.</td>
<td>28.9</td>
<td>10.8</td>
<td></td>
</tr>
<tr>
<td>75</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>80</td>
<td></td>
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</tr>
</tbody>
</table>

KING COUNTY MATERIALS LABORATORY
KEY TO SYMBOLS

**Strata symbols**
- Silty sand
- Silt
- Poorly graded sand
- Poorly graded gravel
- Low plasticity clay
- Topsoil
- Peat
- Poorly graded sand with silt
- Decomposed wood
- Poorly graded gravel with silt
- Elastic silt

**Soil Samplers**
- Standard penetration test
- No recovery
- Undisturbed thin wall Shelby tube
- Dutch cone test

**Monitor Well Details**
- Riser with cover and protective casing
- Protective casing set in concrete
- Bentonite pellets
- Silica sand, blank PVC
- Slotted pipe w/ sand
- No pipe, filler material

**Misc. Symbols**
- Water table during drilling
- End of boring

**Notes:**

1. KCB-1 through KCB-12 were drilled between September 22, 2010 and October 1, 2010. KCB-13 through KCB-16 were drilled between September 28, 2011 and October 4, 2011. All borings were drilled using a CME-850 track mounted drill utilizing mud rotary methodology.

2. Results of tests conducted on samples recovered are reported on the logs.

3. These logs are subject to the limitations, conclusions, and recommendations in this report.
### Particle Size Distribution Report

#### U.S. SIEVE OPENING IN INCHES
- 6 in.
- 3 in.
- 2 in.
- 1 in.
- ½ in.
- ¼ in.
- 3/8 in.

#### U.S. STANDARD SIEVE NUMBERS
- #10
- #20
- #30
- #40
- #60
- #100
- #200

#### HYDROMETER

<table>
<thead>
<tr>
<th>GRAIN SIZE - mm.</th>
<th>% +3*</th>
<th>% Gravel</th>
<th>% Sand</th>
<th>% Fines</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Coarse</td>
<td>Medium</td>
<td>Silt</td>
</tr>
<tr>
<td>% Gravel</td>
<td>Coarse Fine</td>
<td>Coarse Medium</td>
<td>Fine</td>
<td>Silt</td>
</tr>
<tr>
<td>O</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.5</td>
</tr>
<tr>
<td>D</td>
<td>0.0</td>
<td>0.0</td>
<td>0.1</td>
<td>0.7</td>
</tr>
<tr>
<td>A</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Source</th>
<th>Sample #</th>
<th>Depth/Elev.</th>
<th>Date Sampled</th>
<th>USCS</th>
<th>Material Description</th>
<th>NM %</th>
<th>LL</th>
<th>PL</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>KCB-3</td>
<td>KC-10-978</td>
<td>2.5</td>
<td>10/8/10</td>
<td>ML</td>
<td>Silt with sand</td>
<td>42.9</td>
<td>NV</td>
</tr>
<tr>
<td>D</td>
<td>KCB-3</td>
<td>KC-10-979</td>
<td>5</td>
<td>10/8/10</td>
<td>ML</td>
<td>Silt with sand</td>
<td>36.5</td>
<td>NV</td>
</tr>
<tr>
<td>A</td>
<td>KCB-3</td>
<td>KC-10-980</td>
<td>10</td>
<td>10/8/10</td>
<td>ML</td>
<td>Silt</td>
<td>45.5</td>
<td>NV</td>
</tr>
</tbody>
</table>

**Client:** WLRD  
**Project:** Countyline to A-Street Geotechnical Study  
**Project No.:** FL9001  
**Figure:** A4
# Particle Size Distribution Report

## GRAIN SIZE - mm.

<table>
<thead>
<tr>
<th>% +3</th>
<th>% Gravel</th>
<th>% Sand</th>
<th>Silt</th>
<th>% Fines</th>
<th>Clay</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coarse</td>
<td>Fine</td>
<td>Coarse</td>
<td>Medium</td>
<td>Fine</td>
</tr>
<tr>
<td>D</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.1</td>
<td>10.1</td>
</tr>
<tr>
<td>D</td>
<td>0.0</td>
<td>3.8</td>
<td>7.1</td>
<td>2.1</td>
<td>6.6</td>
</tr>
<tr>
<td>A</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.3</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Source</th>
<th>Sample #</th>
<th>Depth/Elev.</th>
<th>Date Sampled</th>
<th>USCS</th>
<th>Material Description</th>
<th>NM %</th>
<th>LL</th>
<th>PL</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>KCB-3</td>
<td>KC-10-981</td>
<td>15</td>
<td>10/8/10</td>
<td>Silty sand</td>
<td>28.4</td>
<td>NV</td>
<td>NP</td>
</tr>
<tr>
<td>D</td>
<td>KCB-3</td>
<td>KC-10-982</td>
<td>30</td>
<td>10/8/10</td>
<td>Silty sand</td>
<td>26.2</td>
<td>NV</td>
<td>NP</td>
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<tr>
<td>A</td>
<td>KCB-3</td>
<td>KC-10-983</td>
<td>40</td>
<td>10/8/10</td>
<td>Silt</td>
<td>45.9</td>
<td>35</td>
<td>33</td>
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</table>

Client: WLRD
Project: Countyline to A-Street Geotechnical Study

KING COUNTY

MATERIALS LABORATORY

Tested By: vw
## Particle Size Distribution Report

### GRAIN SIZE - mm.

<table>
<thead>
<tr>
<th>% +3&quot;</th>
<th>% Gravel</th>
<th>% Sand</th>
<th>Silt</th>
<th>% Fines</th>
<th>Clay</th>
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<tr>
<td></td>
<td>Coarse</td>
<td>Fine</td>
<td>Coarse</td>
<td>Medium</td>
<td>Fine</td>
</tr>
<tr>
<td>O</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.4</td>
<td>34.3</td>
</tr>
<tr>
<td>D</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>4.3</td>
<td>44.9</td>
</tr>
<tr>
<td>A</td>
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<td>0.0</td>
<td>0.0</td>
<td>0.5</td>
<td>28.6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Source</th>
<th>Sample #</th>
<th>Depth/Elev.</th>
<th>Date Sampled</th>
<th>USCS</th>
<th>Material Description</th>
<th>NM %</th>
<th>LL</th>
<th>PL</th>
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</thead>
<tbody>
<tr>
<td>O</td>
<td>KCB-7</td>
<td>KC-10-1002</td>
<td>3</td>
<td>10/8/10</td>
<td>Sandy silt</td>
<td>29.8</td>
<td>NV</td>
<td>NP</td>
</tr>
<tr>
<td>D</td>
<td>KCB-7</td>
<td>KC-10-1003</td>
<td>12.5</td>
<td>10/8/10</td>
<td>Sandy silt</td>
<td>27.4</td>
<td>NV</td>
<td>NP</td>
</tr>
<tr>
<td>A</td>
<td>KCB-7</td>
<td>KC-10-1004</td>
<td>45</td>
<td>10/8/10</td>
<td>Poorly graded sand with silt</td>
<td>39.3</td>
<td>NV</td>
<td>NP</td>
</tr>
</tbody>
</table>

**Client:** WLRD  
**Project:** Countyline to A-Street Geotechnical Study  

**KING COUNTY**  
**MATERIALS LABORATORY**  

Tested By: vw
### Particle Size Distribution Report

#### GRAIN SIZE - mm.

<table>
<thead>
<tr>
<th>% +3*</th>
<th>% Gravel</th>
<th>% Sand</th>
<th>% Fines</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Coarse</td>
<td>Fine</td>
<td>Coarse</td>
</tr>
<tr>
<td>0.0</td>
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<td>0.0</td>
</tr>
<tr>
<td>0.0</td>
<td>0.0</td>
<td>0.1</td>
<td>0.2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Source</th>
<th>Sample #</th>
<th>Depth/Elev.</th>
<th>Date Sampled</th>
<th>USCS</th>
<th>Material Description</th>
<th>NM %</th>
<th>LL</th>
<th>PL</th>
</tr>
</thead>
<tbody>
<tr>
<td>KCB-10</td>
<td>KC-10-1018</td>
<td>40</td>
<td>10/8/10</td>
<td>ML</td>
<td>Silt with sand</td>
<td>46.6</td>
<td>NV</td>
<td>NP</td>
</tr>
<tr>
<td>KCB-10</td>
<td>KC-10-1019</td>
<td>55</td>
<td>10/8/10</td>
<td>SM</td>
<td>Silty sand</td>
<td>36.1</td>
<td>NV</td>
<td>NP</td>
</tr>
</tbody>
</table>

Client: WLRD  
Project: Countyline to A-Street Geotechnical Study

KING COUNTY  
MATERIALS LABORATORY

Tested By: vw
Particle Size Distribution Report

PERCENT FINER

GRAIN SIZE - mm.

% +3" | % Gravel | % Sand | % Fines
---|---|---|---
| Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
O | 0.0 | 58.4 | 21.1 | 5.2 | 7.9 | 5.4 | 2.0 |
D | 0.0 | 44.3 | 1.7 | 0.6 | 8.8 | 40.9 | 3.7 |
A | 0.0 | 0.0 | 0.1 | 0.2 | 2.3 | 66.7 | 30.7 |

Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL
---|---|---|---|---|---|---|---|---
O | KCB-15 | KC-11-1370 | 10.0-11.5 | 10/6/11 | GP | Poorly graded gravel with sand | 8.9 |
D | KCB-15 | KC-11-1371 | 20.0-21.5 | 10/6/11 | SP | Poorly graded sand with gravel | 17.4 |

Client: King County
Project: County Line Levee Relocation
Project No.: FL9001

KING COUNTY
MATERIALS LABORATORY

Tested By: vw
Particle Size Distribution Report

U.S. SIEVE OPENING IN INCHES  U.S. STANDARD SIEVE NUMBERS  HYDROMETER

PERCENT FINER

GRAIN SIZE - mm.

% +3  % Gravel  % Sand  % Fines  Clay
<table>
<thead>
<tr>
<th>%</th>
<th>Coarse</th>
<th>Fine</th>
<th>Coarse</th>
<th>Medium</th>
<th>Fine</th>
<th>Silt</th>
<th>Clay</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>0.0</td>
<td>12.2</td>
<td>21.3</td>
<td>8.1</td>
<td>17.2</td>
<td>11.6</td>
<td>17.5</td>
</tr>
<tr>
<td>D</td>
<td>0.0</td>
<td>33.1</td>
<td>12.9</td>
<td>2.6</td>
<td>16.5</td>
<td>31.1</td>
<td>3.8</td>
</tr>
<tr>
<td>A</td>
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<td>0.0</td>
<td>0.1</td>
<td>1.5</td>
<td>49.0</td>
<td>38.4</td>
<td>11.0</td>
</tr>
</tbody>
</table>

Source  Sample #  Depth/Elev.  Date Sampled  USCS  Material Description  NM %  LL  PL
| KCB-16 | KC-11-1375 | 10.0-11.5 | 10/6/11 | SM    | Silty sand with gravel | 26.2 |
| KCB-16 | KC-11-1376 | 30.0-31.5 | 10/6/11 | SP    | Poorly graded sand with gravel | 39.0 |
| KCB-16 | KC-11-1377 | 45.0-46.5 | 10/6/11 | SP-SM | Poorly graded sand with silt | 19.2 |

Client  King County
Project  County Line Levee Relocation

Project No.  FL9001  Figure  A30

KING COUNTY
MATERIALS LABORATORY

Tested By:  vw
### Particle Size Distribution Report

#### U.S. Sieve Opening in Inches
- 6 in
- 3 in
- 2 in
- 1 1/4 in
- 1 1/8 in
- 3/8 in

#### U.S. Standard Sieve Numbers
- #4
- #10
- #20
- #30
- #40
- #60
- #100
- #140
- #200

#### Hydrometer

---

<table>
<thead>
<tr>
<th>GRAIN SIZE - mm.</th>
<th>% +3&quot;</th>
<th>% Gravel</th>
<th>% Sand</th>
<th>% Fines</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Coarse</td>
<td>Fine</td>
<td>Coarse</td>
</tr>
<tr>
<td>%</td>
<td></td>
<td></td>
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<td>0.0</td>
<td></td>
<td>0.0</td>
<td>0.1</td>
<td>0.5</td>
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<td></td>
<td>0.0</td>
<td>9.2</td>
<td>3.3</td>
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</table>

#### Source
- KCB-16
  - Sample #: KC-11-1378
  - Depth/Elev.: 60.0-61.5
  - Date Sampled: 10/6/11
  - USCS: SP-SM
  - Material Description: Poorly graded sand with silt
  - NM %: 28.9
  - LL: 69.3
  - PL: 29

- KCB-16
  - Sample #: KC-11-1379
  - Depth/Elev.: 75.0-76.5
  - Date Sampled: 10/6/11
  - USCS: SM
  - Material Description: Silty sand
  - NM %: 69.3
  - LL: 29
  - PL: 29

---

**Client:** King County  
**Project:** County Line Levee Relocation  
**Project No.:** FL9001  
**Figure:** A31  

**Tested By:** vw
## Particle Size Distribution Report

### Table

<table>
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<tr>
<th>% +3&quot;</th>
<th>% Gravel</th>
<th>% Sand</th>
<th>% Fines</th>
<th>Silt</th>
<th>Clay</th>
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<td>Fine</td>
<td>Coarse</td>
<td>Medium</td>
<td>Fine</td>
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<td>0.0</td>
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<td>21.3</td>
<td>8.1</td>
<td>17.2</td>
<td>11.6</td>
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<tr>
<td>0.0</td>
<td>33.1</td>
<td>12.9</td>
<td>2.6</td>
<td>16.5</td>
<td>31.1</td>
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<tr>
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<td>0.0</td>
<td>0.1</td>
<td>1.5</td>
<td>49.0</td>
<td>38.4</td>
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<table>
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<tr>
<th>Source</th>
<th>Sample #</th>
<th>Depth/Elev.</th>
<th>Date Sampled</th>
<th>USCS</th>
<th>Material Description</th>
<th>NM %</th>
<th>LL</th>
<th>PL</th>
</tr>
</thead>
<tbody>
<tr>
<td>KCB-16</td>
<td>KC-11-1375</td>
<td>10.0-11.5</td>
<td>10/6/11</td>
<td>SM</td>
<td>Silty sand with gravel</td>
<td>26.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>KCB-16</td>
<td>KC-11-1376</td>
<td>30.0-31.5</td>
<td>10/6/11</td>
<td>SP</td>
<td>Poorly graded sand with gravel</td>
<td>39.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>KCB-16</td>
<td>KC-11-1377</td>
<td>45.0-46.5</td>
<td>10/6/11</td>
<td>SP-SM</td>
<td>Poorly graded sand with silt</td>
<td>19.2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

Client: King County  
Project: County Line Levee Relocation  
Project No: FL9001  
Tested By: vw

KING COUNTY  
MATERIALS LABORATORY
Appendix B: King County Rapid Drawdown Data
Rapid Drawdown Rate
= (78' - 74.4')/(56.25 hrs - 48.25 hrs)
= 0.42 ft/hr
Use 0.5 ft/hr
Appendix C: Vertical Exit Gradient SEEP/W Output
Name: 2-Silt, Peat  Model: Saturated Only  K-Sat: 3.281e-007  Volumetric Water Content: 0  Mv: 0  K-Ratio: 1  K-Direction: 0
Name: 3-Sand, Silty Sand  Model: Saturated Only  K-Sat: 9.8425e-008  Volumetric Water Content: 0  Mv: 0  K-Ratio: 0.25  K-Direction: 0
Name: 4-Silt  Model: Saturated Only  K-Sat: 9.8425e-008  Volumetric Water Content: 0  Mv: 0  K-Ratio: 1  K-Direction: 0

Max. vertical exit gradient = 0.38
Fermeability for Proposed Fill is 0.02 cm/s = 6.5616798E-4 ft/s

Name: 2-Silt, Peat  Model: Saturated Only  K-Sat: 3.281e-007  Volumetric Water Content: 0  Mv: 0  K-Ratio: 1  K-Direction: 0
Name: 3-Sand, Silty Sand  Model: Saturated Only  K-Sat: 9.8425e-008  Volumetric Water Content: 0  Mv: 0  K-Ratio: 0.25  K-Direction: 0
Name: 4-Silt  Model: Saturated Only  K-Sat: 8.8425e-008  Volumetric Water Content: 0  Mv: 0  K-Ratio: 1  K-Direction: 0

Max. vertical exit gradient = 0.43

Vertical Gradient Contours, Section AA'

Figure C1a

White River Countyline Levee Project
King County, Washington
Vertical Gradient Contours, Section BB’

Job No. 33762798

White River Countyline Levee Project
King County, Washington

Figure C2

1-Existing Fill
Model: Saturated / Unsaturated
K-Function: Stratum 1-Fill
Vol. WC. Function: Sand
K-Ratio: 0.25
K-Direction: 0

3-Silty Sand, Sand
Model: Saturated Only
K-Sat: 9.84252e-006
Volumetric Water Content: 0
Mv: 0
K-Ratio: 0.25
K-Direction: 0

4-Silt
Model: Saturated Only
K-Sat: 9.84252e-008
Volumetric Water Content: 0
Mv: 0
K-Ratio: 1
K-Direction: 0

5-Sand, Silty Sand
Model: Saturated Only
K-Sat: 9.84252e-006
Volumetric Water Content: 0
Mv: 0
K-Ratio: 0.25
K-Direction: 0

Name: Proposed Fill
Model: Saturated / Unsaturated
K-Function: Proposed Fill
Vol. WC. Function: Sand
K-Ratio: 1
K-Direction: 0

Name: Riprap
Model: Saturated / Unsaturated
K-Function: Riprap
Vol. WC. Function: Sand
K-Ratio: 1
K-Direction: 0

Name: 3-Sand, Silty Sand
Model: Saturated Only
K-Sat: 9.84252e-006
Volumetric Water Content: 0
Mv: 0
K-Ratio: 0.25
K-Direction: 0

Name: 4-Silt
Model: Saturated Only
K-Sat: 9.84252e-008
Volumetric Water Content: 0
Mv: 0
K-Ratio: 1
K-Direction: 0

Name: 5-Sand, Silty Sand
Model: Saturated Only
K-Sat: 9.84252e-006
Volumetric Water Content: 0
Mv: 0
K-Ratio: 0.25
K-Direction: 0

Name: 1-Existing Fill
Model: Saturated / Unsaturated
K-Function: Stratum 1-Fill
Vol. WC. Function: Sand
K-Ratio: 0.25
K-Direction: 0

Max. vertical exit gradient = 0.45
Permeability for Proposed Fill is 0.02 cm/s = 6.65616798E-4 ft/s

Name: 3-Sand, Silty Sand     Model: Saturated Only     K-Sat: 9.84252e-006     Volumetric Water Content: 0     Mv: 0     K-Ratio: 0.25     K-Direction: 0
Name: 4-Silt     Model: Saturated Only     K-Sat: 9.84252e-008     Volumetric Water Content: 0     Mv: 0     K-Ratio: 1     K-Direction: 0
Name: 5-Sand, Silty Sand     Model: Saturated Only     K-Sat: 9.84252e-006     Volumetric Water Content: 0     Mv: 0     K-Ratio: 0.25     K-Direction: 0
Job No. 33762798

White River Countyline Levee Project
King County, Washington

Figure C3

Vertical Gradient Contours, Section CC’
Vertical Gradient Contours, Section DD'
Job No. 33762798

Vertical Gradient Contours, Section AA'
White River Countyline Levee Project
King County, Washington

Figure C5

Name: 2-Silt,Peat     Model: Saturated Only     K-Sat: 3.281e-007     Volumetric Water Content: 0     Mv: 0     K-Ratio: 1     K-Direction: 0
Name: 3-Sand, Silty Sand     Model: Saturated Only     K-Sat: 9.8425e-006     Volumetric Water Content: 0     Mv: 0     K-Ratio: 0.25     K-Direction: 0
Name: 4-Silt     Model: Saturated Only     K-Sat: 9.8425e-008     Volumetric Water Content: 0     Mv: 0     K-Ratio: 1     K-Direction: 0

Max. vertical exit gradient = 0.40
Name: Proposed Imported Fill (Fines.=25%)  
Model: Saturated / Unsaturated  
K-Function: Proposed Fill  
Vol. WC. Function: Silty Sand  
K-Ratio: 1  
K-Direction: 0

Name: 2-Silt, Peat  
Model: Saturated Only  
K-Sat: 3.281e-007  
Volumetric Water Content: 0  
Mv: 0  
K-Ratio: 1  
K-Direction: 0

Name: 3-Sand, Silty Sand  
Model: Saturated Only  
K-Sat: 9.8425e-006  
Volumetric Water Content: 0  
Mv: 0  
K-Ratio: 0.25  
K-Direction: 0

Name: 4-Silt  
Model: Saturated Only  
K-Sat: 9.8425e-008  
Volumetric Water Content: 0  
Mv: 0  
K-Ratio: 1  
K-Direction: 0

Name: 1-Existing Fill  
Model: Saturated / Unsaturated  
K-Function: Stratum 1-Fill  
Vol. WC. Function: Sand  
K-Ratio: 0.25  
K-Direction: 0

Name: On-Site Alluvium  
Model: Saturated / Unsaturated  
K-Function: On-Site Alluvium  
Vol. WC. Function: Sand  
K-Ratio: 1  
K-Direction: 0

Name: Topsoil  
Model: Saturated / Unsaturated  
K-Function: Topsoil  
Vol. WC. Function: Sand  
K-Ratio: 1  
K-Direction: 0

Max. vertical exit gradient = 0.41
Vertical Gradient Contours, Section DD'

Max. vertical exit gradient = 0.39
Appendix D: Stability Analyses SLOPE/W Output
**Slip Surface Option: Entry and Exit**

**Analyses State: Static**

**Factor of Safety: 1.52**

- **Name:** Proposed Fill  
  **Model:** Mohr-Coulomb  
  **Unit Weight:** 130  
  **Cohesion:** 0  
  **Phi:** 37

- **Name:** 2-Silt, Peat  
  **Model:** Mohr-Coulomb  
  **Unit Weight:** 110  
  **Cohesion:** 50  
  **Phi:** 28

- **Name:** 3-Sand, Silty Sand  
  **Model:** Mohr-Coulomb  
  **Unit Weight:** 125  
  **Cohesion:** 0  
  **Phi:** 35

- **Name:** 4-Silt  
  **Model:** Mohr-Coulomb  
  **Unit Weight:** 115  
  **Cohesion:** 200  
  **Phi:** 30

- **Name:** 1-Existing Fill  
  **Model:** Mohr-Coulomb  
  **Unit Weight:** 128  
  **Cohesion:** 0  
  **Phi:** 33

---

**Figure D1**

**Slope Stability – Static, Steady State, Land Side, Section AA’**

White River Countyline Levee Project
King County, Washington

Job No. 33762798

[Image of the figure showing the slope stability analysis with relevant elevation and distance details.]
Slip Surface Option: Entry and Exit
Analyses State: Static
Factor of Safety: 1.64

Name: Proposed Fill   Model: Mohr-Coulomb   Unit Weight: 130  Cohesion: 50  Phi: 35
Name: 2-Silt, Peat   Model: Mohr-Coulomb   Unit Weight: 110  Cohesion: 50  Phi: 28
Name: 3-Sand, Silty Sand   Model: Mohr-Coulomb   Unit Weight: 125  Cohesion: 0  Phi: 35
Name: 4-Silt   Model: Mohr-Coulomb   Unit Weight: 115  Cohesion: 200  Phi: 30
Name: 1-Existing Fill   Model: Mohr-Coulomb   Unit Weight: 128  Cohesion: 0  Phi: 33

Figure D1a

Slope Stability – Static, Steady State, Land Side, Section AA’

White River Countyline Levee Project
King County, Washington
**Slip Surface Option: Entry and Exit**

Analyses State: Static

Factor of Safety: 1.96

- **Name:** Proposed Fill     **Model:** Mohr-Coulomb     **Unit Weight:** 130     **Cohesion:** 0     **Phi:** 37
- **Name:** 2-Silt, Peat     **Model:** Mohr-Coulomb     **Unit Weight:** 110     **Cohesion:** 50     **Phi:** 28
- **Name:** 3-Sand, Silty Sand     **Model:** Mohr-Coulomb     **Unit Weight:** 125     **Cohesion:** 0     **Phi:** 35
- **Name:** 4-Silt     **Model:** Mohr-Coulomb     **Unit Weight:** 115     **Cohesion:** 200     **Phi:** 30
- **Name:** 1-Existing Fill     **Model:** Mohr-Coulomb     **Unit Weight:** 128     **Cohesion:** 0     **Phi:** 33

**Slope Stability** – Static, Steady State, River Side, Section AA’

**Job No. 33762798**

**URS**

White River Countyline Levee Project

King County, Washington
Slip Surface Option: Entry and Exit
Analyses State: Static
Factor of Safety: 2.15

Name: Proposed Fill    Model: Mohr-Coulomb    Unit Weight: 130    Cohesion: 50    Phi: 35
Name: 2-Silt, Peat    Model: Mohr-Coulomb    Unit Weight: 110    Cohesion: 50    Phi: 28
Name: 3-Sand, Silty Sand    Model: Mohr-Coulomb    Unit Weight: 125    Cohesion: 0    Phi: 35
Name: 4-Silt    Model: Mohr-Coulomb    Unit Weight: 115    Cohesion: 200    Phi: 30
Name: 1-Existing Fill    Model: Mohr-Coulomb    Unit Weight: 128    Cohesion: 0    Phi: 33

Slope Stability – Static, Steady State, River Side, Section AA'
Slip Surface Option: Entry and Exit
Analyses State: Static
Factor of Safety: 1.62

Name: Proposed Fill  Model: Mohr-Coulomb  Unit Weight: 130  Cohesion: 0  Phi: 37
Name: 2-Silt, Peat  Model: Mohr-Coulomb  Unit Weight: 110  Cohesion: 50  Phi: 28
Name: 3-Sand, Silty Sand  Model: Mohr-Coulomb  Unit Weight: 125  Cohesion: 0  Phi: 35
Name: 4-Silt  Model: Mohr-Coulomb  Unit Weight: 115  Cohesion: 200  Phi: 30
Name: 1-Existing Fill  Model: Mohr-Coulomb  Unit Weight: 128  Cohesion: 0  Phi: 33

Figure D3
Slope Stability – Static, Transient Seepage at 43200 Sec, Land Side, Section AA’
**Slip Surface Option: Entry and Exit**

**Analyses State: Static**

**Factor of Safety: 1.52**

- **Name:** Proposed Fill  
  **Model:** Mohr-Coulomb  
  **Unit Weight:** 130  
  **Cohesion:** 0  
  **Phi:** 37

- **Name:** 2-Silt, Peat  
  **Model:** Mohr-Coulomb  
  **Unit Weight:** 110  
  **Cohesion:** 50  
  **Phi:** 28

- **Name:** 3-Sand, Silty Sand  
  **Model:** Mohr-Coulomb  
  **Unit Weight:** 125  
  **Cohesion:** 0  
  **Phi:** 35

- **Name:** 4-Silt  
  **Model:** Mohr-Coulomb  
  **Unit Weight:** 115  
  **Cohesion:** 200  
  **Phi:** 30

- **Name:** 1-Existing Fill  
  **Model:** Mohr-Coulomb  
  **Unit Weight:** 128  
  **Cohesion:** 0  
  **Phi:** 33

---

**Figure D4**

**Slope Stability – Static, Transient Seepage at 43200 Sec, River Side, Section AA’**

White River Countyline Levee Project  
King County, Washington
Slip Surface Option: Entry and Exit
Analyses State: Static
Factor of Safety: 1.40

Name: Proposed Fill  Model: Mohr-Coulomb  Unit Weight: 130  Cohesion: 0  Phi: 37
Name: 2-Silt, Peat  Model: Mohr-Coulomb  Unit Weight: 110  Cohesion: 50  Phi: 28
Name: Riprap  Model: Mohr-Coulomb  Unit Weight: 140  Cohesion: 0  Phi: 40
Name: 3-Sand, Silty Sand  Model: Mohr-Coulomb  Unit Weight: 125  Cohesion: 0  Phi: 35
Name: 4-Silt  Model: Mohr-Coulomb  Unit Weight: 115  Cohesion: 200  Phi: 30
Name: 5-Sand, Silty Sand  Model: Mohr-Coulomb  Unit Weight: 130  Cohesion: 0  Phi: 35

Job No. 33762798
Slope Stability – Static, Steady State, Land Side, Section BB'
White River Countyline Levee Project
King County, Washington
Slip Surface Option: Entry and Exit
Analyses State: Static
Factor of Safety: 1.46

Name: Proposed Fill  Model: Mohr-Coulomb  Unit Weight: 130  Cohesion: 50  Phi: 35
Name: 2-Silt, Peat  Model: Mohr-Coulomb  Unit Weight: 110  Cohesion: 50  Phi: 28
Name: Riprap  Model: Mohr-Coulomb  Unit Weight: 140  Cohesion: 0  Phi: 40
Name: 3-Sand, Silty Sand  Model: Mohr-Coulomb  Unit Weight: 125  Cohesion: 0  Phi: 35
Name: 4-Silt  Model: Mohr-Coulomb  Unit Weight: 115  Cohesion: 200  Phi: 30
Name: 5-Sand, Silty Sand  Model: Mohr-Coulomb  Unit Weight: 130  Cohesion: 0  Phi: 35
Slip Surface Option: Entry and Exit

Analyses State: Static

Factor of Safety: 2.00

Name: Proposed Fill  Model: Mohr-Coulomb  Unit Weight: 130  Cohesion: 0  Phi: 37
Name: 2-Silt, Peat  Model: Mohr-Coulomb  Unit Weight: 110  Cohesion: 50  Phi: 25
Name: Riprap  Model: Mohr-Coulomb  Unit Weight: 140  Cohesion: 0  Phi: 40
Name: 3-Sand, Silty Sand  Model: Mohr-Coulomb  Unit Weight: 126  Cohesion: 0  Phi: 35
Name: 4-Silt  Model: Mohr-Coulomb  Unit Weight: 115  Cohesion: 200  Phi: 30
Name: 5-Sand, Silty Sand  Model: Mohr-Coulomb  Unit Weight: 130  Cohesion: 0  Phi: 35
Slip Surface Option: Entry and Exit

Analyses State: Static
Factor of Safety: 2.19

Name: Proposed Fill  Model: Mohr-Coulomb  Unit Weight: 130  Cohesion: 50  Phi: 35
Name: 2-Silt, Peat  Model: Mohr-Coulomb  Unit Weight: 110  Cohesion: 50  Phi: 28
Name: Riprap  Model: Mohr-Coulomb  Unit Weight: 140  Cohesion: 0  Phi: 40
Name: 3-Sand, Silty Sand  Model: Mohr-Coulomb  Unit Weight: 125  Cohesion: 0  Phi: 35
Name: 4-Silt  Model: Mohr-Coulomb  Unit Weight: 115  Cohesion: 200  Phi: 30
Name: 5-Sand, Silty Sand  Model: Mohr-Coulomb  Unit Weight: 130  Cohesion: 0  Phi: 35
Slip Surface Option: Entry and Exit
Analyses State: Static
Factor of Safety: 1.56
Name: Proposed Fill, Model: Mohr-Coulomb, Unit Weight: 130, Cohesion: 0, Phi: 37
Name: 2-Silt, Peat, Model: Mohr-Coulomb, Unit Weight: 110, Cohesion: 20, Phi: 30
Name: Riprap, Model: Mohr-Coulomb, Unit Weight: 140, Cohesion: 0, Phi: 40
Name: 3-Sand, Silty Sand, Model: Mohr-Coulomb, Unit Weight: 125, Cohesion: 0, Phi: 35
Name: 4-Silt, Model: Mohr-Coulomb, Unit Weight: 115, Cohesion: 200, Phi: 30
Name: 5-Sand, Silty Sand, Model: Mohr-Coulomb, Unit Weight: 130, Cohesion: 0, Phi: 35

Figure D7
Slope Stability – Static, Transient Seepage at 43200 Sec, Land Side, Section BB'
**Slip Surface Option: Entry and Exit**
**Analyses State: Static**
**Factor of Safety: 1.91**

- **Name: Proposed Fill**  Model: Mohr-Coulomb  Unit Weight: 130  Cohesion: 0  Phi: 37
- **Name: 2-Silt. Peat**  Model: Mohr-Coulomb  Unit Weight: 110  Cohesion: 50  Phi: 28
- **Name: Riprap**  Model: Mohr-Coulomb  Unit Weight: 140  Cohesion: 0  Phi: 40
- **Name: 3-Sand, Silt Sand**  Model: Mohr-Coulomb  Unit Weight: 125  Cohesion: 0  Phi: 26
- **Name: 4-Silt**  Model: Mohr-Coulomb  Unit Weight: 115  Cohesion: 200  Phi: 30
- **Name: 5-Sand, Silt Sand**  Model: Mohr-Coulomb  Unit Weight: 130  Cohesion: 0  Phi: 26

---

**Figure D8**

**Slope Stability – Static, Transient Seepage at 43200 Sec, River Side, Section BB’**

**Job No. 33762798**

*URS*

White River Countyline Levee Project
King County, Washington
Figure D9

Slope Stability – Static, Steady State, Land Side, Section CC'

White River Countyline Levee Project
King County, Washington

Job No. 33762798

URS
Slip Surface Option: Entry and Exit
Analyses State: Static
Factor of Safety: 2.13

Name: Proposed Fill   Model: Mohr-Coulomb   Unit Weight: 130   Cohesion: 0   Phi: 37
Name: 4-Silt   Model: Mohr-Coulomb   Unit Weight: 115   Cohesion: 200   Phi: 30
Name: 5-Sand, Silty Sand   Model: Mohr-Coulomb   Unit Weight: 130   Cohesion: 0   Phi: 35
Name: 1-Existing Fill   Model: Mohr-Coulomb   Unit Weight: 128   Cohesion: 0   Phi: 33

White River Countyline Levee Project
King County, Washington

Figure D10
Slope Stability – Static, Steady State, River Side, Section CC’
White River Countyline Levee Project
King County, Washington

Job No. 33762798

0:\King County White River\04 - Calculations\SlopeW\Final\Rev 1\Section KCB-7.qgz
Slip Surface Option: Entry and Exit
Analyses State: Static
Factor of Safety: 1.91

Name: Proposed Fill     Model: Mohr-Coulomb     Unit Weight: 130     Cohesion: 0     Phi: 37
Name: 4-Silt     Model: Mohr-Coulomb     Unit Weight: 115     Cohesion: 200     Phi: 30
Name: 5-Sand, Silty Sand     Model: Mohr-Coulomb     Unit Weight: 130     Cohesion: 0     Phi: 35
Name: 1-Existing Fill     Model: Mohr-Coulomb     Unit Weight: 128     Cohesion: 0     Phi: 33

Figure D11

G:\King County White River\04 - Calculations\SeepW, SlopeW\Final\Rev 1\Section KCB-7.gza
Slip Surface Option: Entry and Exit
Analyses State: Static
Factor of Safety: 1.90

Name: Proposed Fill  Model: Mohr-Coulomb  Unit Weight: 130  Cohesion: 0  Phi: 37
Name: 4-Silt  Model: Mohr-Coulomb  Unit Weight: 115  Cohesion: 200  Phi: 30
Name: 5-Sand, Silty Sand  Model: Mohr-Coulomb  Unit Weight: 130  Cohesion: 0  Phi: 35
Name: 1-Existing Fill  Model: Mohr-Coulomb  Unit Weight: 128  Cohesion: 0  Phi: 33

Slope Stability – Static, Transient Seepage at 21600 Sec, River Side, Section CC’
White River Countyline Levee Project
King County, Washington
Slip Surface Option: Entry and Exit
Analyses State: Static
Factor of Safety: 1.68

Name: Proposed Fill  Model: Mohr-Coulomb  Unit Weight: 130  Cohesion: 0  Phi: 37
Name: 2-Silt, Peat  Model: Mohr-Coulomb  Unit Weight: 110  Cohesion: 50  Phi: 28
Name: 3-Sand, Silty Sand  Model: Mohr-Coulomb  Unit Weight: 125  Cohesion: 0  Phi: 35
Name: 4-Silt  Model: Mohr-Coulomb  Unit Weight: 115  Cohesion: 200  Phi: 30
Name: 5-Sand, Silty Sand  Model: Mohr-Coulomb  Unit Weight: 130  Cohesion: 0  Phi: 35
Name: 1-Existing Fill  Model: Mohr-Coulomb  Unit Weight: 128  Cohesion: 0  Phi: 33

Distance (feet)

Distance (feet)

Elevation (feet)
Slip Surface Option: Entry and Exit
Analyses State: Static
Factor of Safety: 2.03

Name: Proposed Fill     Model: Mohr-Coulomb     Unit Weight: 130     Cohesion: 0     Phi: 37
Name: 2-Silt, Peat     Model: Mohr-Coulomb     Unit Weight: 110     Cohesion: 50     Phi: 28
Name: 3-Sand, Silty Sand     Model: Mohr-Coulomb     Unit Weight: 125     Cohesion: 0     Phi: 35
Name: 4-Silt     Model: Mohr-Coulomb     Unit Weight: 115     Cohesion: 200     Phi: 30
Name: 5-Sand, Silty Sand     Model: Mohr-Coulomb     Unit Weight: 130     Cohesion: 0     Phi: 35
Name: 1-Existing Fill     Model: Mohr-Coulomb     Unit Weight: 128     Cohesion: 0     Phi: 33
Slip Surface Option: Entry and Exit
Analyses State: Static
Factor of Safety: 1.74

Name: Proposed Fill     Model: Mohr-Coulomb     Unit Weight: 130     Cohesion: 0     Phi: 37
Name: 2-Silt,Peat     Model: Mohr-Coulomb     Unit Weight: 110     Cohesion: 50     Phi: 28
Name: 3-Sand, Silty Sand     Model: Mohr-Coulomb     Unit Weight: 125     Cohesion: 0     Phi: 35
Name: 4-Silt     Model: Mohr-Coulomb     Unit Weight: 115     Cohesion: 200     Phi: 30
Name: 5-Sand, Silty Sand     Model: Mohr-Coulomb     Unit Weight: 130     Cohesion: 0     Phi: 35
Name: 1-Existing Fill     Model: Mohr-Coulomb     Unit Weight: 128     Cohesion: 0     Phi: 33

Figure D15
Slope Stability – Static, Transient Seepage at 28800 Sec, Land Side, Section DD’

Job No. 33762798

URS
White River Countyline Levee Project
King County, Washington
Slip Surface Option: Entry and Exit
Analyses State: Static
Factor of Safety: 1.74

Name: Proposed Fill  Model: Mohr-Coulomb  Unit Weight: 130  Cohesion: 0  Phi: 37
Name: 2-Silt, Peat  Model: Mohr-Coulomb  Unit Weight: 110  Cohesion: 50  Phi: 28
Name: 3-Sand, Silty Sand  Model: Mohr-Coulomb  Unit Weight: 125  Cohesion: 0  Phi: 35
Name: 4-Silt  Model: Mohr-Coulomb  Unit Weight: 115  Cohesion: 200  Phi: 30
Name: 5-Sand, Silty Sand  Model: Mohr-Coulomb  Unit Weight: 130  Cohesion: 0  Phi: 35
Name: 1-Existing Fill  Model: Mohr-Coulomb  Unit Weight: 128  Cohesion: 0  Phi: 33

Figure D16
Slope Stability – Static, Transient Seepage at 28800 Sec, River Side, Section DD'
Appendix E: Groundwater Analysis
Figure E-1: Groundwater Well Location Map

See Figure 2 for location of proposed setback levee and drill holes.
Figure E-2: River and Groundwater Levels

White River at Auburn A-Street Gage
- GS Elevation KCMW-2
- KCMW-2
- GS Elevation KCMW-4
- KCMW-4
- GW1
- GW2
- GW3
- GW4