



**King County
Road Services Division**

Department of Transportation
Engineering Services Section
Materials Laboratory
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Renton, WA 98056-4199

June 8, 2006

TO: Don Althausser, P.E., Supervising Engineer, Water and Land Resources Division,
Department of Natural Resources

Jon Hansen, Senior Ecologist, Water and Land Resources Division,
Department of Natural Resources

FM: Alan D. ^{all}Corwin, P.E., Materials Engineer, Materials Laboratory, Road Services
Division, Department of Transportation

RE: North Wind Weir Intertidal Restoration Project; Preliminary Slope Stability Evaluation

Ref: *Environmental Site Assessment Report, North Wind Weir Intertidal Restoration Project
Site; Draft Report from CDM dated June 2004.*

General

The North Wind Weir intertidal habitat site will require significant permanent excavations in close proximity to both public and private facilities. As such, the design team has requested a slope stability evaluation to insure that the proposed excavations do not adversely impact the neighboring properties.

Subsurface Information

The consulting firm of CDM completed an environmental assessment of the project site in 2004. As part of their field investigation, several soil borings were drilled throughout the property to identify and assess the near surface soil and groundwater conditions. The borings were advanced to a maximum depth of about 25 feet below ground level using a truck mounted hollow stem auger drill rig. At each testing location, generally non-standard penetration tests were completed at five foot maximum vertical intervals as the auger was advanced. Disturbed, but representative soil samples were collected at each testing interval for identification and environmental testing. Although the penetration testing was not generally standard, the data provides some insight as to the relative density or consistency of the in place soils.

Our office completed a single groundwater monitoring boring (KCB-1) at the northwest end of the property, near the riverbank. The boring was advanced to a depth of 25 feet below ground level using a truck mounted CME 850 drill rig equipped with a hollow stem auger. Standard penetration tests (SPT) were taken at five-foot maximum vertical intervals as the boring was

advanced below ground level. The SPT provides a measure of compaction or relative density of granular soils and consistency or stiffness of cohesive fine-grained soils. In addition, disturbed but representative soil samples were collected at each testing interval and returned to our laboratory for analysis. The SPT values obtained from KCB-1 appear to correlate well with the non-standard penetration values obtained by others at this site.

Based on the information available, similar and relatively uniform near surface soil conditions are anticipated throughout the site. In general, loose to medium dense sand and silty sands were intercepted in the site borings to the testing limits. Groundwater was intercepted in all test holes at depths ranging from 7.5 feet to 15 feet below ground level. For your reference, the general boring locations are provided on the general site plan, Figure 1. The soil logs and applicable laboratory test results are attached in Appendix A at the conclusion of the text.

Static Slope Stability Model

We reviewed the proposed site excavation plan, Figure 2, and selected two critical cross sections (D & F) for preliminary modeling of the site slope stability under both static and seismic conditions. Based on the relatively uniform soil conditions encountered in the borings, a single soil-type was selected to represent the near surface soil conditions within each cross section analyzed. For the static analyses, a soil angle of internal friction of 30 degrees and unit weight of 115 pounds per cubic foot (pcf) were approximated based on empirical correlations with the corrected SPT values obtained in the site borings. The same soil parameters were assumed for both high water and drawdown models. In our opinion, the site soils are generally granular and effective stress (drained) soil parameters will apply. The analyses were completed using the computer program Galena, developed by Clover Technologies, utilizing the Simplified Bishop Method of slices, circular failure technique. Analyses were completed for the two slope configurations for the following static conditions:

Static Mean High High Water

Static Mean High High Water w/ 5 feet drawdown

For each condition noted above, multiple analyses with range constraints were selected for evaluating the respective cross section critical slope stability. For the static analyses, a safety factor of 1.3 is generally considered adequate. Based on our static analysis with range constraints, the critical slope sections generally have minimum safety factors above the minimum required. Plates 1 through 4, in Appendix B, show the general critical failure surfaces and associated safety factors for the above static conditions. It should be noted that

shallow failures remaining at or below the cross section crest were ignored in our analyses, as these would not impact surrounding properties.

Seismic Slope Stability Model

The North Wind Weir project is located in a seismically sensitive area. Consequently, the completed facility may be subjected to considerable earthquake shaking. Such shaking will impose dynamic lateral pressures on the exposed side slopes. In addition, the underlying loose to medium dense saturated sands and silty sands could undergo liquefaction. Liquefaction is a phenomenon in which saturated soil deposits temporarily lose strength and behave as a liquid in response to the ground-shaking event.

Analyses were completed utilizing the Simplified Bishop method of slices, circular failure technique. The following seismic conditions were analyzed for cross sections D & F:

Pseudostatic Mean High High Water

Post-Liquefaction Mean High High Water

To simulate seismic loading conditions on the selected cross sections, a pseudostatic approach was utilized with a seismic coefficient of .17g (17 percent of gravity). This value is one half of the approximate peak ground acceleration (PGA) of .34g anticipated for the area during the design earthquake event. The PGA of .34 was obtained from the United States Geologic Survey seismic hazard website for the project site zip code and represents an earthquake event with a 10 percent probability of exceedance in a 50 year period. For the pseudostatic analysis, static soil parameters described previously were applied to the respective slope models. For the post-liquefaction event, a residual shear strength of 300 pounds per square foot (psf) was assigned to the loose to medium dense sand and silty sand present below the respective model's groundwater table. For the conditions noted, multiple analyses with range constraints were applied for evaluating the critical slope cross section impacting the design. For the pseudo-static analysis, a minimum safety factor of 1.1 is considered acceptable. For the post liquefaction event, a minimum factor of safety of 1.0 is generally sought. Plates 5 through 8, in Appendix B, show the general critical failure surfaces and associated safety factors for the seismic conditions described above.

Based on our analyses, section D meets the minimum safety factor requirements for the pseudo-static conditions (Plate 5). The section F critical slope, however, was found to be marginally stable with a minimum safety factor of .98 (Plate 6).

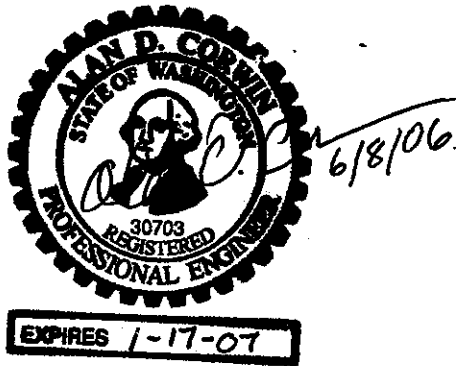
In our opinion, the site soils probably have a minor cohesive component not taken into account in the analysis. In an effort to better bracket the slope condition at section F under pseudo-static conditions, we initiated a back calculation for the critical slip circle to determine the cohesive strength necessary to attain a safety factor of 1.1. Based on our back calculation analysis, a safety factor of 1.1 can be attained with a cohesion component to the soil of only 20

pounds per square foot (psf) and an angle of internal friction of 30 degrees (Plate 6B). This level of cohesion is reasonable for the near surface soil types noted in the soil borings.

As we discussed during our meeting on May 18, 06, post liquefaction analyses for both sections D and F show critical slip circles deeper than the soils information available (Plates 7 and 8). Consequently, additional drilling and analysis will be required to define the actual soil and groundwater conditions for post liquefaction analyses.

I hope this general information is of assistance to you. If you have any questions or require clarification, don't hesitate to contact me at 296-7711.

King County Materials Laboratory



Alan D. Corwin, P.E.
Materials Engineer

General References

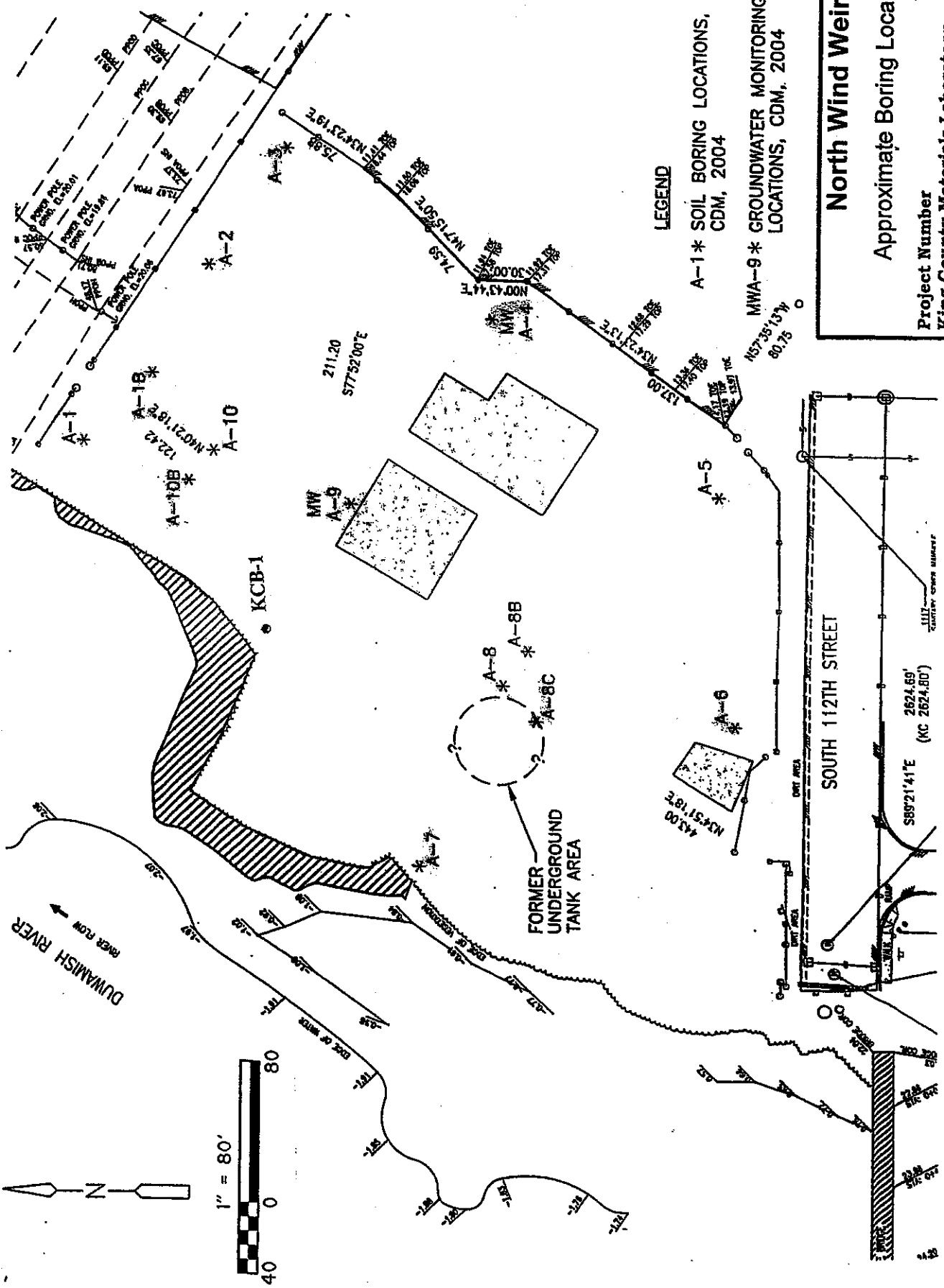
Das, B.M. (1999). Principles of Foundation Engineering. PWS Publishers

Galena Version 4 (1982-2003). A Slope Stability System. Clover Associates

US Army Corps. of Engineers; Department of Army (2003). Engineering and Design; Slope Stability; Engineering Manual No. 1110-2-1902.

US Army Corps of Engineers; Department of Army (2000). Engineering and Design; Design And Construction of Levees; Engineering Manual No. 1110-2-1913.

USGS Earthquake Hazards Program. <http://eqint.cr.usgs/eq-men/html/zipcode-06.html>



LEGEND

A-1 * SOIL BORING LOCATIONS,
CDM, 2004

MWA-9 * GROUNDWATER MONITORING WELL
LOCATIONS, CDM, 2004

North Wind Weir

Approximate Boring Locations

Project Number 1A1647
King County Materials Laboratory Figure 1

Appendix A

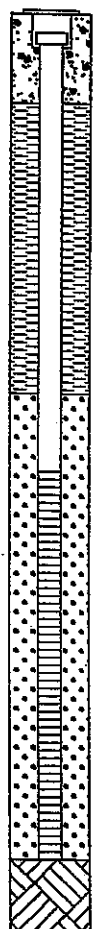
Soil Logs and Laboratory Test Results

LOG OF MONITOR WELL INSTALLATION

WELL NO. KCB-1

PROJECT: North Winds Weir
BORING LOCATION: West end of site
DRILL METHOD: Hollow Stem Auger
DRILLER: Gregory Drilling
DEPTH TO - Water: 12.6 ft

DATE: February 13, 2006
START: N/A
FINISH: n/A
LOGGER: D. Armstrong
DATE CHECKED: After Drilling

ELEVATION/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	Description	Moist (%)	-200 (%)	Remarks	Monitor Well Construction Schematic
0		SM	Brown silty sand with traces of gravel and building debris, moist, medium dense. (Fill)				
7.7, 9		GP	Brown poorly graded gravel with silt and sand, moist, medium dense. (fill)				
7.9, 8		SM	Brown silty sand, moist, medium dense.				
3.1, 2		SP	Black poorly graded sand, wet, loose.	33.3	26.4		
0.2, 3				28.5	3.3		
2.3, 5							
25							
-10							
-30							
-15							
-35							

The KCB-3 Observation Well is located west of existing well A-9 drilled by others. Groundwater was encountered during drilling.

KEY TO SYMBOLS

Symbol Description

Symbol Description

Strata symbols



Silty sand



slotted pipe w/ sand



Poorly graded gravel



no pipe, filler material



Poorly graded sand

Misc. Symbols



Water table during drilling



Bottom of Boring

Soil Samplers



Standard penetration test

Monitor Well Details



flush-mount cover



recessed cover set in concrete



concrete seal



bentonite pellets



silica sand, blank PVC

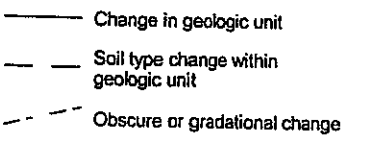
Notes:

1. KCB-1 was drilled February 13, 2006, using a track mounted CME 850 drill. The boring was advanced and supported with hollow stem auger.
2. Groundwater was encountered in the boring during drilling.
3. The boring were located by the DNR Survey department. Boring elevations were also determined by the DNR Survey Department.
4. These logs are subject to the limitations, conclusions, and recommendations in this report.

SOIL CLASSIFICATION LEGEND

MAJOR DIVISIONS		TYPICAL NAMES		SAMPLE TYPE SYMBOLS	
COARSE GRAINED SOILS More than half is larger than No. 200 sieve	GRAVELS More than half coarse fraction is larger than No. 4 sieve size	Clean gravels with little or no fines	GW Well graded gravels, gravel-sand mixtures	Disturbed bag or jar sample Std. Penetration Test (2.0" OD) Type U Ring Sampler (3.25" OD) California Sampler (3.0" OD) Undisturbed Tube Sample Grab Sample Core Run Non-standard Penetration Test (with split spoon sampler)	
		Gravel with over 12% fines	GP Poorly graded gravels, gravel-sand mixtures		
		Clean sands with little or no fines	GM Silty gravels, gravel-sand-silt mixtures		
			GC Clayey gravels, gravel-sand-clay mixtures		
	SANDS More than half coarse fraction is smaller than No. 4 sieve size	Clean sands with little or no fines	SW Well graded sands, gravelly sands		
			SP Poorly graded sands, gravelly sands		
		Sands with over 12% fines	SM Silty sand, sand-silt mixtures		
			SC Clayey sands, sand-clay mixtures		
			SILTS AND CLAYS Liquid limit less than 50		ML Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity
					CL Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
OL Organic clays and organic silty clays of low plasticity					
SILTS AND CLAYS Liquid limit greater than 50	MH Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts				
	CH Inorganic clays of high plasticity, fat clays				
	OH Organic clays of medium to high plasticity, organic silts				
	HIGHLY ORGANIC SOILS	PT Peat and other highly organic soils			

CONTACT BETWEEN UNITS



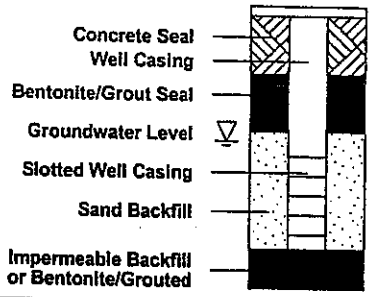
DESCRIPTORS FOR SOIL STRATA AND STRUCTURE (ENGLISH/METRIC)

General Thickness or Spacing	Structure		General Attitude
	Parting:	Pocket:	
less than 1/16 in. (1/8 cm)	Erratic, discontinuous deposit of limited extent	Near horizontal: 0 to 10 deg.	
1/16 to 1/2 in. (1/8 to 1 1/4 cm)	Lens: Lenticular deposit	Low angle: 10 to 45 deg.	
1/2 to 12 in. (1 1/4 to 30 1/2 cm)	Varved: Alternating seams of silt and clay	High angle: 45 to 80 deg.	
> 12 in. (30 1/2 cm)	Laminated: Alternating seams	Near Vertical: 80 to 90 deg.	
< 1 per ft. (30 1/2 cm)	Interbedded: Alternating layers		
> 1 per ft. (30 1/2 cm)			

MOISTURE DESCRIPTION

- Dry - Free of moisture, dusty
- Moist - Damp but no visible free water
- Wet - Visible free water, saturated

WELL COMPLETIONS



STRUCTURE DESCRIPTION (cont.)

Fractured	Breaks easily along definite fractured planes
Slickensided	Polished, glossy, fractured planes
Blocky, Diced	Breaks easily into small angular lumps
Sheared	Disturbed texture, mix of strengths
Homogenous	Same color and appearance throughout

RELATIVE DENSITY OR CONSISTENCY VS. SPT N-VALUE

COARSE GRAINED			FINE GRAINED		
Density	N (blows/ft)	Approx. Relative Density (%)	Consistency	N (blows/ft)	Approx. Undrained Shear Str. (psf)
Very Loose	0 to 4	0 - 15	Very Soft	0 to 2	<250
Loose	4 to 10	15 - 35	Soft	2 to 4	250 - 500
Medium Dense	10 to 30	35 - 65	Medium Stiff	4 to 8	500 - 1000
Dense	30 to 50	65 - 85	Stiff	8 to 15	1000 - 2000
Very Dense	Over 50	85 - 100	Very Stiff	15 to 30	2000 - 4000
			Hard	over 30	>4000

PHYSICAL PROPERTY TEST

- AL - Atterberg Limits
- FC - Fines Content
- GSD - Grain Size Distribution
- MC - Moisture Content
- MD - Moisture Content/Dry Density
- Comp - Compaction Test (Proctor)
- SG - Specific Gravity
- CBR - California Bearing Ratio
- RM - Resilient Modulus
- Perm - Permeability
- TXP - Triaxial Permeability
- Cons - Consolidation
- Chem - Analytical Chemical Analysis
- Corr - Corrosion
- VS - Vane Shear
- DS - Direct Shear
- UC - Unconfined Compression
- TX - Triaxial Compression
- UU - Unconsolidated, Undrained
- CU - Consolidated, Undrained
- CD - Consolidated, Drained

Notes:

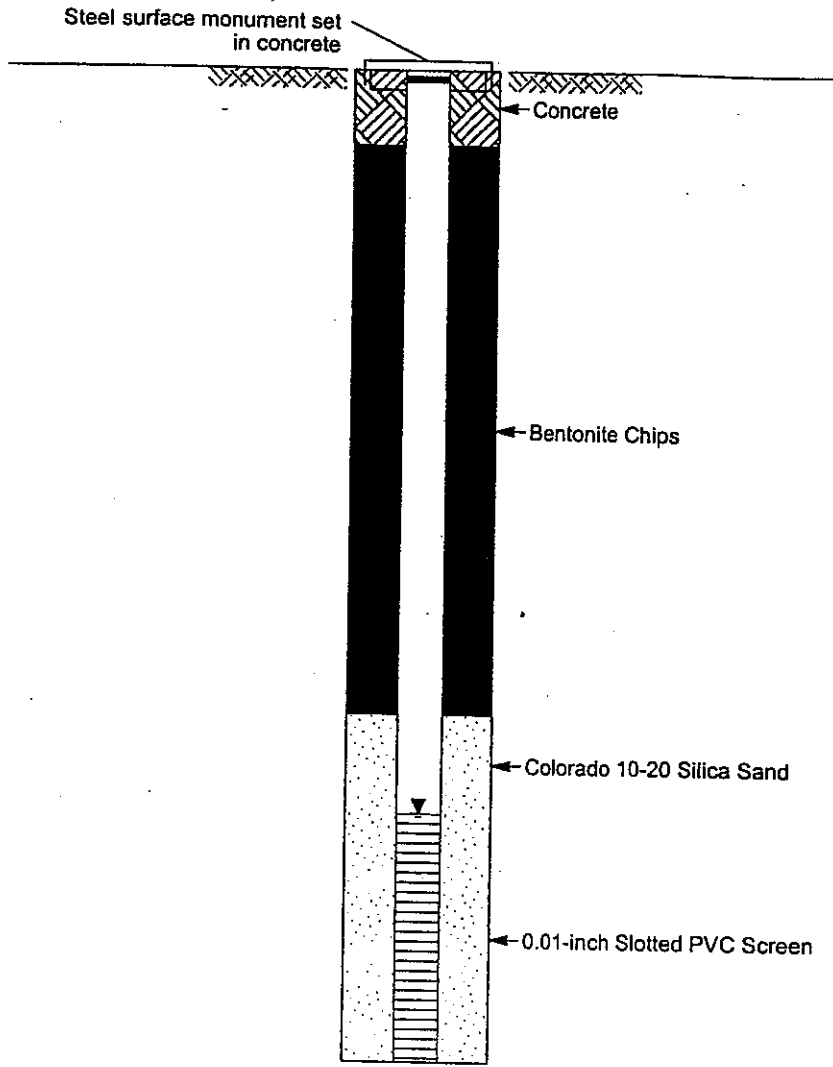
- Sample descriptions in this report are based on visual field and laboratory observations, which include density/consistency, moisture condition, grain size, and plasticity estimates, and should not be construed to imply field or laboratory testing unless presented herein. Visual-manual classification methods in accordance with ASTM D 2488 were used as an identification guide. Where laboratory data are available, soil classifications are in general accordance with ASTM D 2487.
- Dual symbols are used to indicate gravel and sand units with 5 to 12 percent fines.
- WOR = weight of rod.

King County
North Wind Weir Site
Tukwila, Washington

Project No: 19897.52426.Task 1 Figure: B1



SOIL CLASSIFICATION LEGEND 42526 N WIND WEIR.GPJ CDM B.L.V.GDT 6/1/04 REV.



MONITORING WELL CONSTRUCTION 42528 N WIND WEIR.GPJ CDM, BLLV.GDT 6/1/04 REV.

TYPICAL MONITORING WELL CONSTRUCTION

King County
 North Wind Weir Site
 Tukwila, Washington

Project No: 19897.52426.Task 1 Figure: B2
 1 of 1



NEIS BORING LOG 42526 N WIND WEIR.GPJ CDM BLLV.GDT 6/1/04 REV.

Other Tests	Sample No.	Moisture Content (%)	Dry Density (pcf)	PTD (ppm) (reading/background)	Penetration Resistance (blows / 6 in.)	Depth (feet)	Sample	USCS	Symbol	Boring Log A-1 DESCRIPTION	Elev. (feet)
						0				BROWN SAND (SP) Dense, moist, with trace silt, some coarse-grained gravel and cobbles, pieces of brick and other misc. debris (concrete and rebar).	
				0/0	15 50/3"	2		SP			
				0/0	12 50/3"	4				LIGHT GRAY SILT (ML) Hard, moist, contains debris (brick, organics, and metal).	
						6		ML			
					100/3"	8				Encountered refusal at 7.7 ft bgs. No groundwater encountered during drilling.	
						10					
						12					
						14					
						16					
						18					
						20					
						22					
						24					

Latitude/Longitude: / Drill Rig: Mobile B-61
 Surface Elevation: Equipment/Hammer: D&M/140#/30"
 Logged By: K LW Date Completed: 4-19-04

King County
North Wind Weir Site
Tukwila, Washington



Boring Log A-1 Figure: B3
 Project No: 19897.52426.Task 1 1 of 1

NEIS BORING LOG 42526 N WIND WEIR.GPJ CDM_BLLV.GDT 6/1/04 REV.

Other Tests	Sample No.	Moisture Content (%)	Dry Density (pcf)	PIV (ppm) [reading/background]	Penetration Resistance (blows / 6 in.)	Depth (feet)	Sample	USCS	Symbol	DESCRIPTION	Elev. (feet)
						0				BROWN SILTY SAND (SM) Medium dense, moist, with some coarse-grained gravel.	
				0/0	20 26 50/2"	2					
				-	75/5"	4				No sample recovery.	
				-	50/3"	8				Becomes dense.	
				-		10		SM		No sample recovery.	
				0/0	20 23 43	12				Hard drilling until 11 ft bgs.	
						14				With some fine gravel.	
						16				Becomes saturated.	
				0/0	5 8 23	18		SP		DARK GRAY/BROWN SAND (SP) Medium dense, saturated, bottom 6 inches was solid wood.	
						20				Boring terminated at 19 ft bgs. Groundwater encountered at 15 ft bgs during drilling.	
						22					
						24					

Latitude/Longitude: / Drill Rig: Mobile B-61
 Surface Elevation: Equipment/Hammer: D&M/140#/30"
 Logged By: KLV Date Completed: 4-21-04

King County
 North Wind Weir Site
 Tukwila, Washington



Boring Log A-1b Figure: B4
 Project No: 19897.52426.Task 1 1 of 1

NEIS BORING LOG 42526 N WIND WEIR.GPJ CDM BLLV.GDT 6/1/04 REV.

Other Tests	Sample No.	Moisture Content (%)	Dry Density (pcf)	PIU (psf) (reading/background)	Penetration Resistance (blows / 6 in.)	Depth (feet)	Sample	USCS	Symbol	DESCRIPTION	Elev. (feet)
						0				BROWN SAND (SP) Loose, moist, fine to medium grained, with trace gravel, cobbles, and pieces of brick.	
				0/0	6	2					
				0/0	8 10 10	4				Becomes medium dense, with trace organics.	
				0/0	6	6		SP			
				0/0	6	8				Becomes loose, with red oxidation mottling.	
						10					
				0/0	3 3 4	12				BROWN SILTY SAND (SM) Very loose, moist, fine grained, with red oxidation mottling.	
						14					
						16		SM			
				0/0	4 4 6	18				Becomes dark gray, saturated, medium grained.	
						20				Boring terminated at 19 ft bgs. Groundwater encountered at 17 ft bgs during drilling.	
						22					
						24					

Latitude/Longitude: /
 Surface Elevation: _____
 Logged By: KLW

Drill Rig: Mobile B-61
 Equipment/Hammer: D&M/140#/30"
 Date Completed: 4-19-04

King County
 North Wind Weir Site
 Tukwila, Washington



Boring Log MW-A4

Other Tests	Sample No.	Moisture Content (%)	Dry Density (pcf)	PI/D (ppm)	Penetration Resistance (blows / 6 in.)	Depth (feet)	Sample	USCS	Symbol	DESCRIPTION	Elev. (feet)	Well or Piezometer Completion
				0/0	3005	2				BROWN SAND (SP) Medium dense, moist, fine grained, with trace silt and numerous silty sand layers (<1" thick).	[Diagram showing well completion with casing and piezometer]	
						4	SP					
				0/0	345	6				Becomes loose, with some silt and trace organics.		
				0/0	333	8				BROWN SANDY SILT (ML) Medium stiff, moist, with trace to some organics.		
						9	ML					
				0/0	102	12				BROWN SILTY SAND (SM) Very loose, wet, with trace organics and red oxidation mottling, fine grained.		
						14	SM					
				0/0	326	18				Becomes saturated.		
						20				Becomes dark gray, loose, saturated.		
						20				Boring terminated at 20 ft bgs. Groundwater encountered at 15 ft bgs during drilling.		

LOG OF BORING WITH WELL 42526 N WIND WEIR.GPJ CDM BLLV.GDT 6/1/04 REV.

Location: _____
 Surface Elevation: _____
 Logged By: KLW

Drill Rig: Mobile B-61
 Equipment/Hammer: SPT/140#/30"
 Date Completed: 4-19-04

King County
 North Wind Weir Site
 Tukwila, Washington



NEIS BORING LOG 42526 N WIND WEIR.GPJ CDM_BLLV.GDT 6/1/04 REV.

Other Tests	Sample No.	Moisture Content (%)	Dry Density (pcf)	PI (ppm) (reading/background)	Penetration Resistance (blows / 6 in.)	Depth (feet)	Sample	USCS	Symbol	Boring Log A-5 DESCRIPTION	Elev. (feet)
						0				BROWN SILT (ML) Medium stiff, moist, with trace sand and organics.	
			0/0		3 3 4	2		ML			
			0/0		2 3 3	4				BROWN SILTY SAND (SM) Very loose, moist, fine grained.	
			0/0		2 4 5	6				Becomes loose, with some organics.	
			0/0			8					
			0/0			10		SM			
			0/0		1 0 1	12				Becomes very loose, wet, gray-brown.	
			0/0			14					
			0/0			16				GRAY TO DARK GRAY SAND (SP) Medium dense, saturated, with some silt and organics.	
			0/0		2 6 12	18		SP			
						20				Boring terminated at 19 ft bgs. Groundwater encountered at 15 ft bgs during drilling.	
						22					
						24					

Latitude/Longitude: /
 Surface Elevation: _____
 Logged By: KLW
 Drill Rig: Mobile B-61
 Equipment/Hammer: SPT/140#/30"
 Date Completed: 4-19-04

King County
 North Wind Weir Site
 Tukwila, Washington

Boring Log A-5
 Project No: 19897.52426.Task 1
 Figure: B8
 1 of 1



Boring Log A-6

DESCRIPTION

Elev. (feet)

Other Tests	Sample No.	Moisture Content (%)	Dry Density (pcf)	PI (ppm) (reading/background)	Penetration Resistance (blows / 6 in.)	Depth (feet)	Sample	USCS	Symbol	DESCRIPTION
					10 6 5	2		SM		BROWN SILTY SAND (SM) Medium dense, moist, with organics and large concrete debris.
					6 7 9	4				GRAY-BROWN SAND (SP) Medium dense, moist, fine grained, with trace silt and organics.
					6 8 4	6				Becomes fine to medium grained.
					4 4 4	8		SP		Becomes loose, wet, with red oxidation mottling.
					3 3 6	12				GREEN TO BROWN SILTY SAND (SM) Dense, wet, with red mottling and trace organics.
						14		SM		Becomes dark gray, saturated, fine to medium grained, with large woody debris and other organics.
						16				Boring terminated at 19 ft bgs. Groundwater encountered at 17 ft bgs during drilling.
						18				
						20				
						22				
						24				

NEIS_BORING_LOG_42526_N_WIND_WEIR.GPJ CDM BLLV.GDT 6/1/04 REV.

Latitude/Longitude: / _____
 Surface Elevation: _____
 Logged By: KLW

Drill Rig: Mobile B-61
 Equipment/Hammer: D&M/140#/30"
 Date Completed: 4-19-04

King County
 North Wind Weir Site
 Tukwila, Washington



Boring Log A-7

DESCRIPTION

Elev. (feet)

Other Tests	Sample No.	Moisture Content (%)	Dry Density (pcf)	PI/D (ppm) [reading/background]	Penetration Resistance (blows / 6 in.)	Depth (feet)	Sample	USCS	Symbol	DESCRIPTION
						0				GRAY SAND (SP) Medium dense, moist, fine to medium grained, with some silt and trace organics.
				24/0	6 10 10	2		SP		
				0/0	3 6 6	4		SM		GRAY SILTY SAND (SM) Loose, wet, medium grained.
				0/0	2 3 2	6				GRAY SILT (ML) Stiff, wet, with some sand and gravel. Becomes brown, medium stiff, with trace sand, organics present (mostly roots).
				0/0	3 3 6	8		ML		Becomes gray, with some sand, no organics.
				0/0	2 5 7	12				Becomes stiff, saturated.
					5 9 13	14				
					0 16 21	18		SP		DARK GRAY SAND (SP) Medium dense, saturated, medium grained, with some silt. With trace silt.
						20				
						22				Boring terminated at 22 ft bgs. Groundwater encountered at 15 ft bgs.
						24				

NEIS_BORING_LOG_42526 N WIND WEIR.GPJ CDM B.L.V.GDT 6/1/04 REV.

Latitude/Longitude: / _____
 Surface Elevation: _____
 Logged By: KLW


Drill Rig: Mobile B-61
 Equipment/Hammer: D&M/140#/30"
 Date Completed: 4-20-04

King County
 North Wind Weir Site
 Tukwila, Washington



Boring Log A-7 Figure: B10
 Project No: 19897.52426.Task 1 1 of 1

NEIS_BORING_LOG_42526_N_WIND_WEIR.GPJ_CDM_BLLV.GDT_6/1/04_REV.

Other Tests	Sample No.	Moisture Content (%)	Dry Density (pcf)	PIU (psf) (reading/background)	Penetration Resistance (blows / 6 in.)	Depth (feet)	Sample	USCS	Symbol	Boring Log A-8	Elev. (feet)
										DESCRIPTION	
					50+16"	2		SM		BROWN SILTY SAND (SM) Dense, moist, with coarse gravel.	
						4				Encountered refusal at 3.5 ft bgs. No groundwater encountered during drilling.	
						6					
						8					
						10					
						12					
						14					
						16					
						18					
						20					
						22					
						24					

Latitude/Longitude: /
 Surface Elevation: _____
 Logged By: KLW
 Drill Rig: Mobile B-61
 Equipment/Hammer: D&M/140#/30"
 Date Completed: 4-20-04

King County
 North Wind Weir Site
 Tukwila, Washington



Boring Log A-8
 Project No: 19897.52426.Task 1
 Figure: B11
 1 of 1

Boring Log A-8b

DESCRIPTION

Other Tests	Sample No.	Moisture Content (%)	Dry Density (pcf)	PIB (ppm) [reading/background]	Penetration Resistance (blows / 6 in.)	Depth (feet)	Sample	USCS	Symbol	Elev. (feet)
				0/0	50+/6"	0 - 6		SM		
						6 - 24				

BROWN SILTY SAND (SM)
Dense, moist, with coarse gravel.

Encountered refusal at 6 ft bgs.
No groundwater encountered during drilling.

NEIS BORING_LOG_42526 N WIND WEIR.GPJ_CDM_BLLV.GDT 6/1/04 REV.

Latitude/Longitude: /
 Surface Elevation: _____
 Logged By: KLW
 Drill Rig: Mobile B-61
 Equipment/Hammer: D&M/140#/30"
 Date Completed: 4-20-04

King County
North Wind Weir Site
Tukwila, Washington



Boring Log A-8b Figure: B12
Project No: 19897.52426.Task 1 1 of 1

Boring Log A-8c

Elev. (feet)

DESCRIPTION

Other Tests	Sample No.	Moisture Content (%)	Dry Density (pcf)	PIU (psf) (reading/background)	Penetration Resistance (blows / 6 in.)	Depth (feet)	Sample	USCS	Symbol
				0/0	50/6"	2			
				0/0	6 10 10	4			
				0/0	7 8 10	6			
				0/0	7 8 10	8			
				0/0	7 7 10	12		SP	
				0/0	7 8 10	18			
				0/0	8 8 10	20			
				0/0	-	22			

BROWN SAND (SP)
Dense, moist, fine grained, with some gravel, brick debris and organics.

Becomes medium dense, no gravel, with red oxidation mottling.

Becomes loose with less mottling and trace organics.

Becomes wet.

Becomes saturated.

Becomes gray, with trace organics.

Boring terminated at 22 ft bgs.
Groundwater encountered at 15 ft bgs during drilling.

NEIS BORING LOG 42526 N WIND WEIR.GPJ CDM BLLV.GDT 6/1/04 REV.

Latitude/Longitude: /
Surface Elevation:
Logged By: KLV

Drill Rig: Mobile B-61
Equipment/Hammer: D&M/140#/30"
Date Completed: 4-20-04

King County
North Wind Weir Site
Tukwila, Washington



Boring Log A-8c Figure: B13
Project No: 19897.52426.Task 1 1 of 1

LOG OF BORING WITH WELL 42526 N WIND WEIR.GPJ CDM_BLLV.GDT 6/1/04 REV.

Other Tests	Sample No.	Moisture Content (%)	Dry Density (pcf)	PI/D (ppm)	Penetration Resistance (blows / 6 in.)	Depth (feet)	Sample	USCS	Symbol	DESCRIPTION	Elev. (feet)	Well or Piezometer Completion
						2				BROWN SILTY SAND (SM) Medium dense, moist, with some organics and fine gravel.		
				0/0	5 7 18	4						
				0/0	6 8 9	6				Becomes loose, no organics.		
				0/0	2 4 7	8		SM		Becomes fine grained, with red oxidation mottling and trace organics (roots).		
				0/0	2 4 4	12				Less mottling, organics consist of straw.		
						14				Becomes saturated.		
				0/0	3 5 8	18				BROWN/GRAY SAND (SP) Medium dense, saturated, with some silt.		
				0/0	5 9 14	20		SP				
				0/0	5 11 19	22				Boring terminated at 22 ft bgs. Groundwater encountered at 14 ft bgs during drilling.		
						24						

Location: _____

Surface Elevation: _____

Logged By: KLW

Drill Rig: Mobile B-61

Equipment/Hammer: D&M/140#/30"

Date Completed: 4-20-04

King County
North Wind Weir Site
Tukwila, Washington

Boring Log MWA-9
Project No: 19897.52426.Task 1

Figure: B14
1 of 1



Boring Log A-10

DESCRIPTION

Elev. (feet)

Other Tests	Sample No.	Moisture Content (%)	Dry Density (pcf)	PIV (ppm) [reading/background]	Penetration Resistance (blows / 6 in.)	Depth (feet)	Sample	USCS	Symbol	DESCRIPTION
				0/0	7 12 15	2		SP		BROWN-GRAY SAND (SP) Medium dense, moist, fine grained, with some silt and coarse gravel.
				0/0	34 50/3"	4				Cobbles present.
						6				Encountered refusal at 5.7 ft bgs No groundwater encountered during drilling.
						8				
						10				
						12				
						14				
						16				
						18				
						20				
						22				
						24				

NEIS BORING LOG 42526 N WIND WEIR.GPJ CDM_BLLV.GDT 6/1/04 REV.

Latitude/Longitude: /
 Surface Elevation: _____
 Logged By: KLW

Drill Rig: Mobile B-61
 Equipment/Hammer: D&M/140#/30"
 Date Completed: 4-20-04

King County
 North Wind Weir Site
 Tukwila, Washington



Boring Log A-10 Figure: B15
 Project No: 19897.52426.Task 1 1 of 1

Boring Log A-10b

Elev. (feet)

DESCRIPTION

Other Tests	Sample No.	Moisture Content (%)	Dry Density (pcf)	PIB (ppm) (reading/background)	Penetration Resistance (blows / 6 in.)	Depth (feet)	Sample	USCS	Symbol	DESCRIPTION
					20 50/5"	2				BROWN SILTY SAND (SM) Very dense, moist, fine to medium grained, with fine to coarse gravel and brick debris.
					13 33 24	4		SM		Becomes dense, medium grained.
					9 13 17	6				Becomes medium dense, fine grained, with red oxidation mottling.
						8				
						10				
					9 13 15	12				BROWN-GRAY SAND (SP) Medium dense, wet, medium grained, with some silt.
						14		SP		
					7 9 11	16				Becomes saturated, gray, fine to medium grained.
						18				Boring terminated at 16.5 ft bgs. Groundwater encountered at 15 ft bgs during drilling.
						20				
						22				
						24				

NEIS BORING LOG 42526 N WIND WEIR.GPJ CDM B.L.V.GDT 6/1/04 REV.

Latitude/Longitude: / _____
 Surface Elevation: _____
 Logged By: KLW

Drill Rig: Mobile B-61
 Equipment/Hammer: D&M/140#/30"
 Date Completed: 4-21-04

King County
 North Wind Weir Site
 Tukwila, Washington

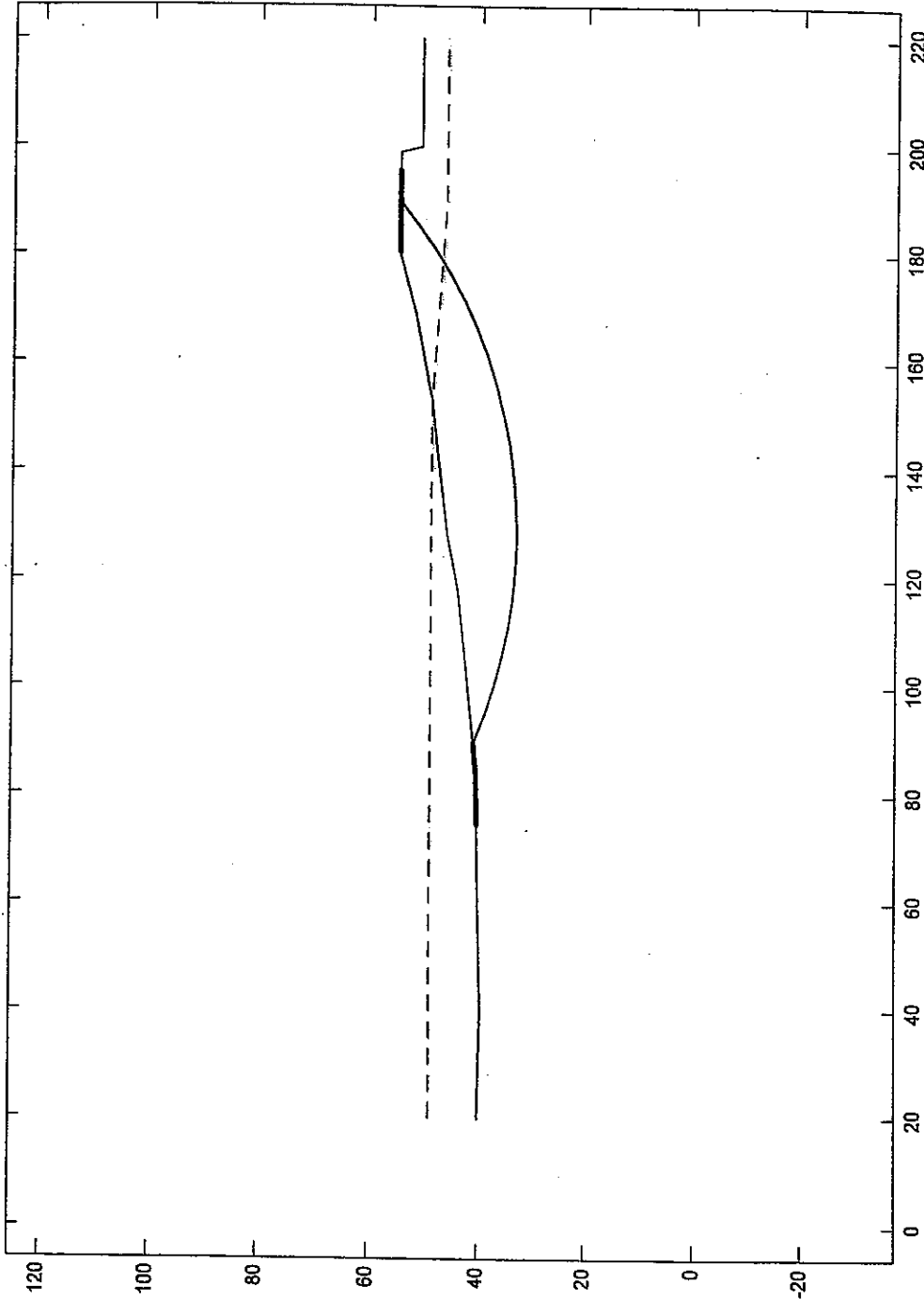


Boring Log A-10b Figure: B16
 Project No: 19897.52426.Task 1 1 of 1

Appendix B

Slope Stability Models and Results

Static Mean High High Water Condition
Static Mean High High w/ 5 Feet Drawdown
Pseudostatic Mean High High



Analysis: 1
Multiple Stability Analysis
Method: Bishop Simplified
Surface: Circular

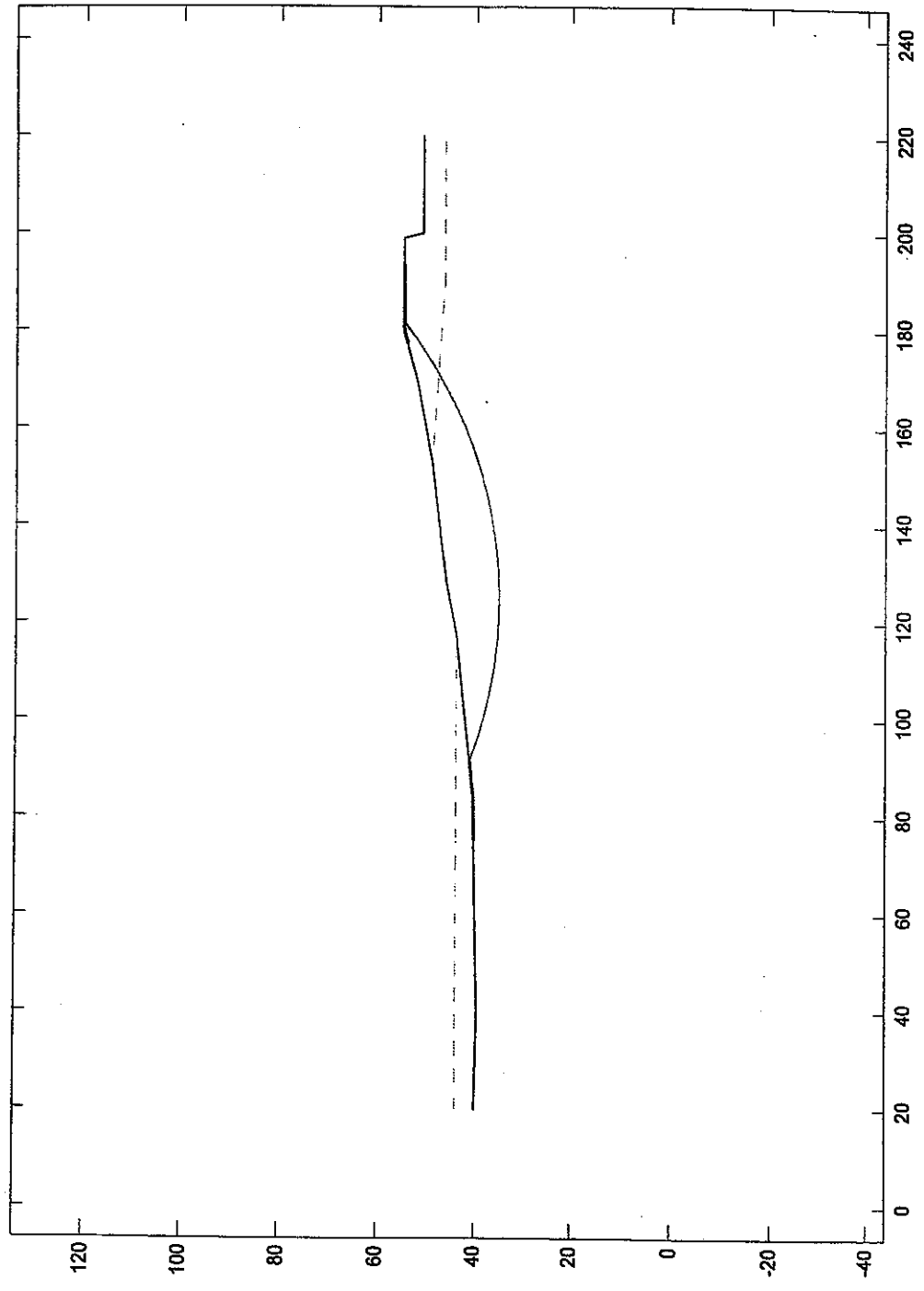
Results
Critical (minimum)
Factor of Safety: 3.42

Project: North Wind Weir Section D
Static High Groundwater Condition

File: C:\Documents and Settings\acorwin\Desktop\GalenaData\North Wind 2.gmf

Plate 1

King County Materials Laboratories



Analysis: 1
Multiple Stability Analysis
Method: Bishop Simplified
Surface: Circular

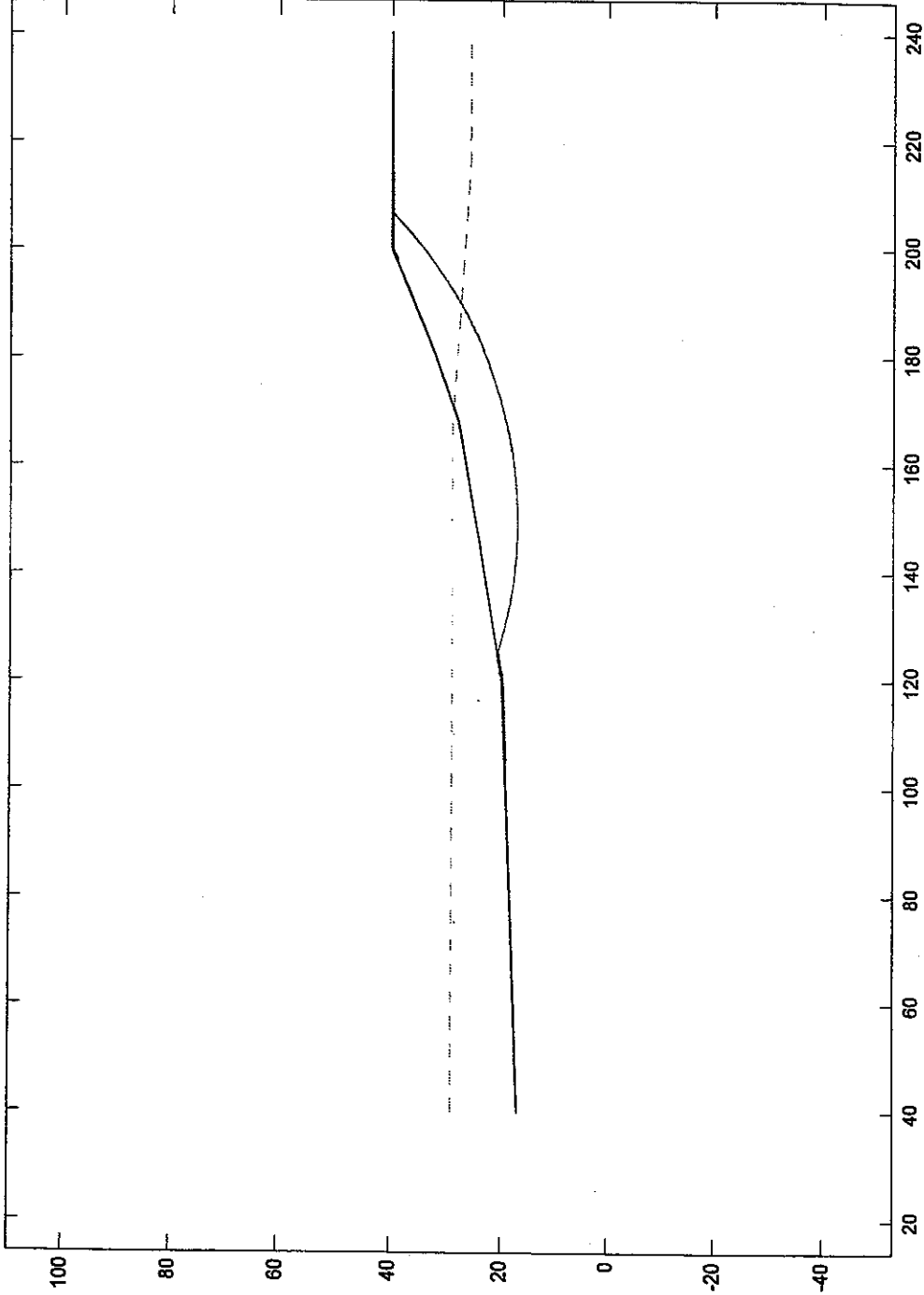
Results
Critical (minimum)
Factor of Safety: 2.38

Project: North Wind Weir Section D
Static Drawdown Conditions

File: C:\Documents and Settings\acorwin\Desktop\GalenaData\North Wind Weir Section D DD.gmf

Plate 2

King County Materials Laboratories

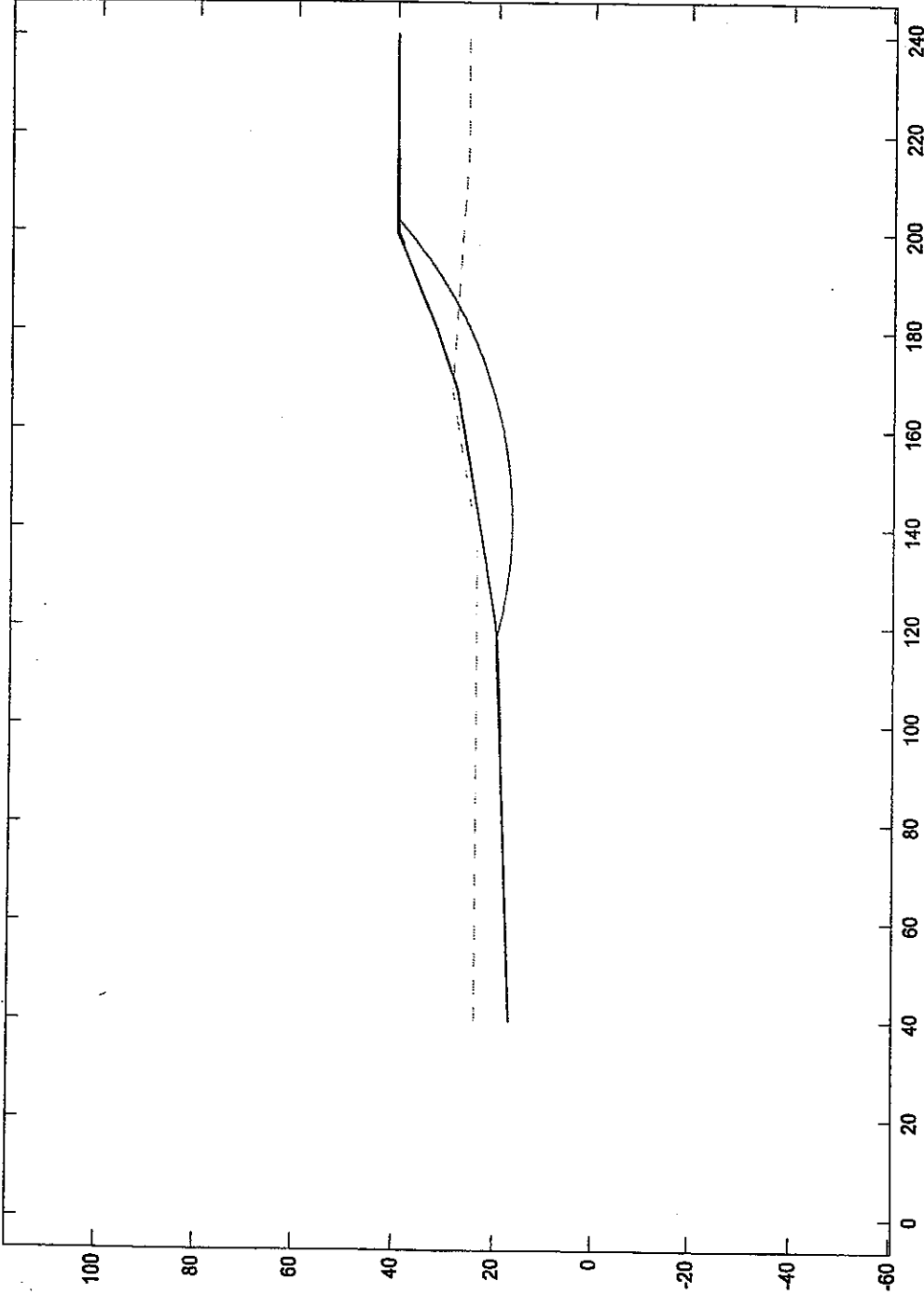


Analysis: 1
Multiple Stability Analysis
Method: Bishop Simplified
Surface: Circular

Results
Critical (minimum)
Factor of Safety: 1.98

Project: North Wind Weir, Section F
Static High Groundwater Conditions

File: C:\Documents and Settings\acorwin\Desktop\GalenaData\North Wind F Hww.gmf



Analysis: 1
Multiple Stability Analysis
Method: Bishop Simplified
Surface: Circular

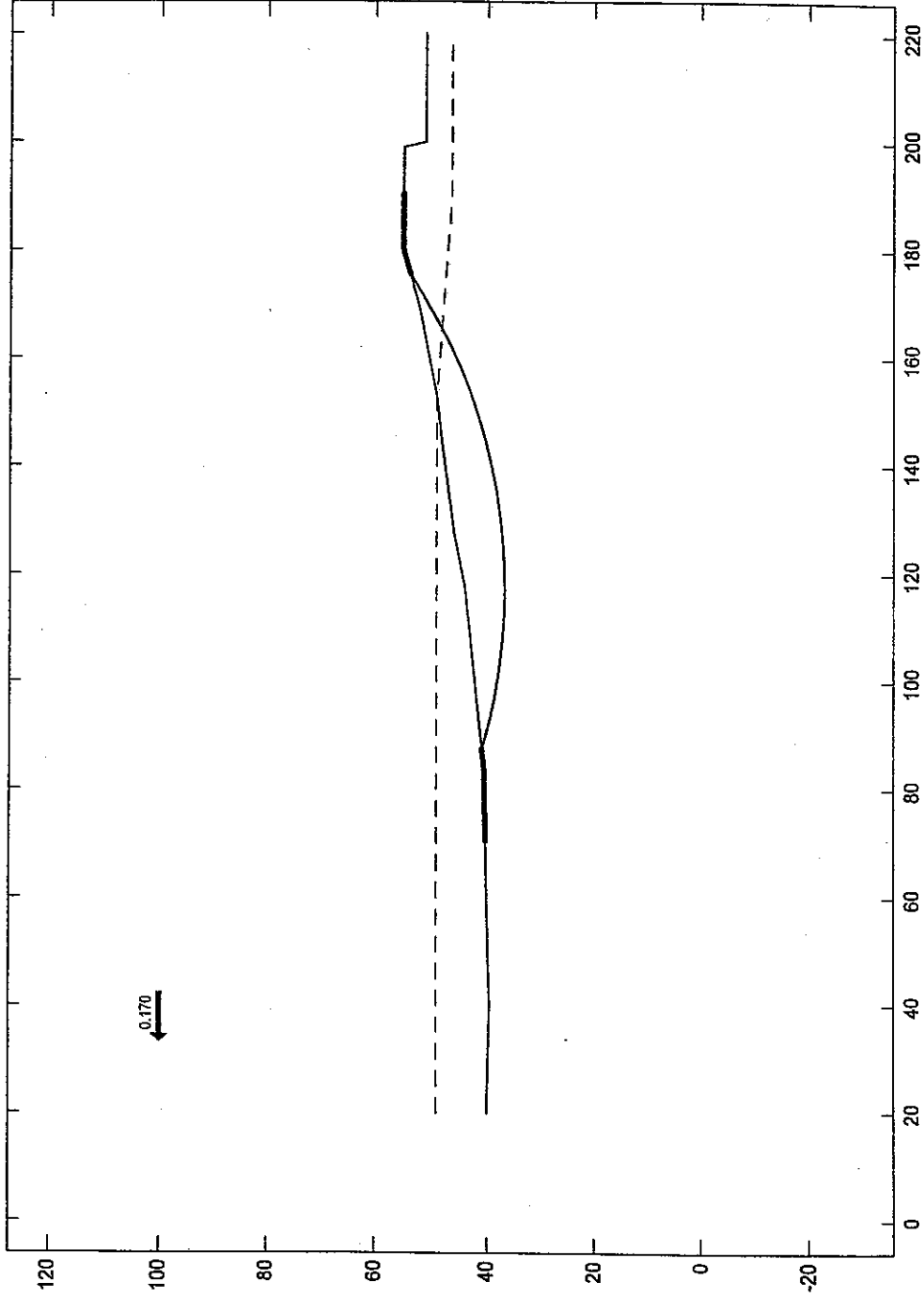
Results
Critical (minimum)
Factor of Safety: 1.61

Project: North Wind Weir, Section F
Static Drawdown Condition

File: C:\Documents and Settings\acorwin\Desktop\GalenaData\North Wind Weir Section F DD.gmf

Plate 4

King County Materials Laboratories

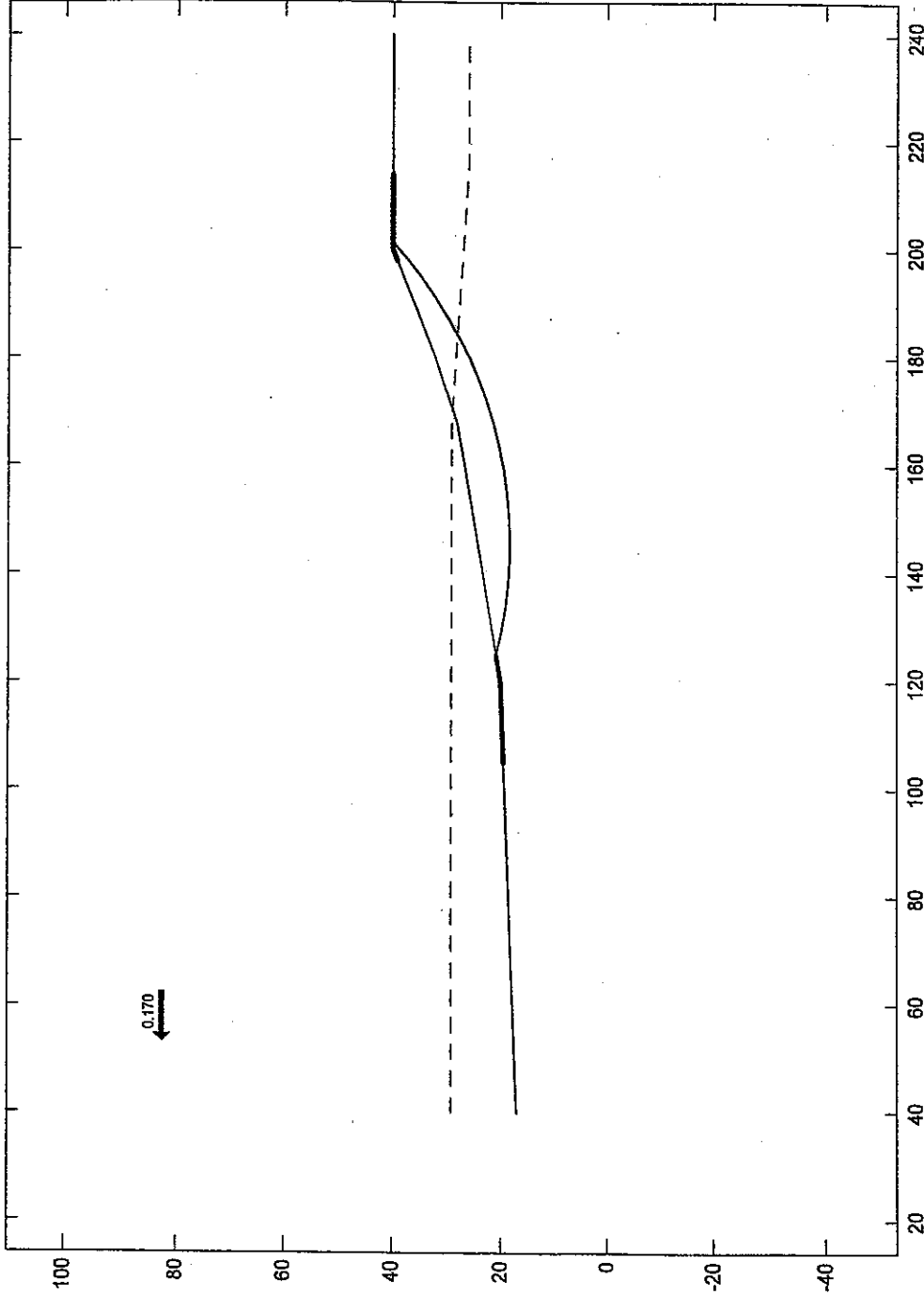


Analysis: 1
Multiple Stability Analysis
Method: Bishop Simplified
Surface: Circular

Results
Critical (minimum)
Factor of Safety: 1.17

Project: North Wind Weir Section D
Seismic High Groundwater Condition

File: C:\Documents and Settings\acorwin\Desktop\GalenaData\North Wind 2.gmf



Analysis: 1
Multiple Stability Analysis
Method: Bishop Simplified
Surface: Circular

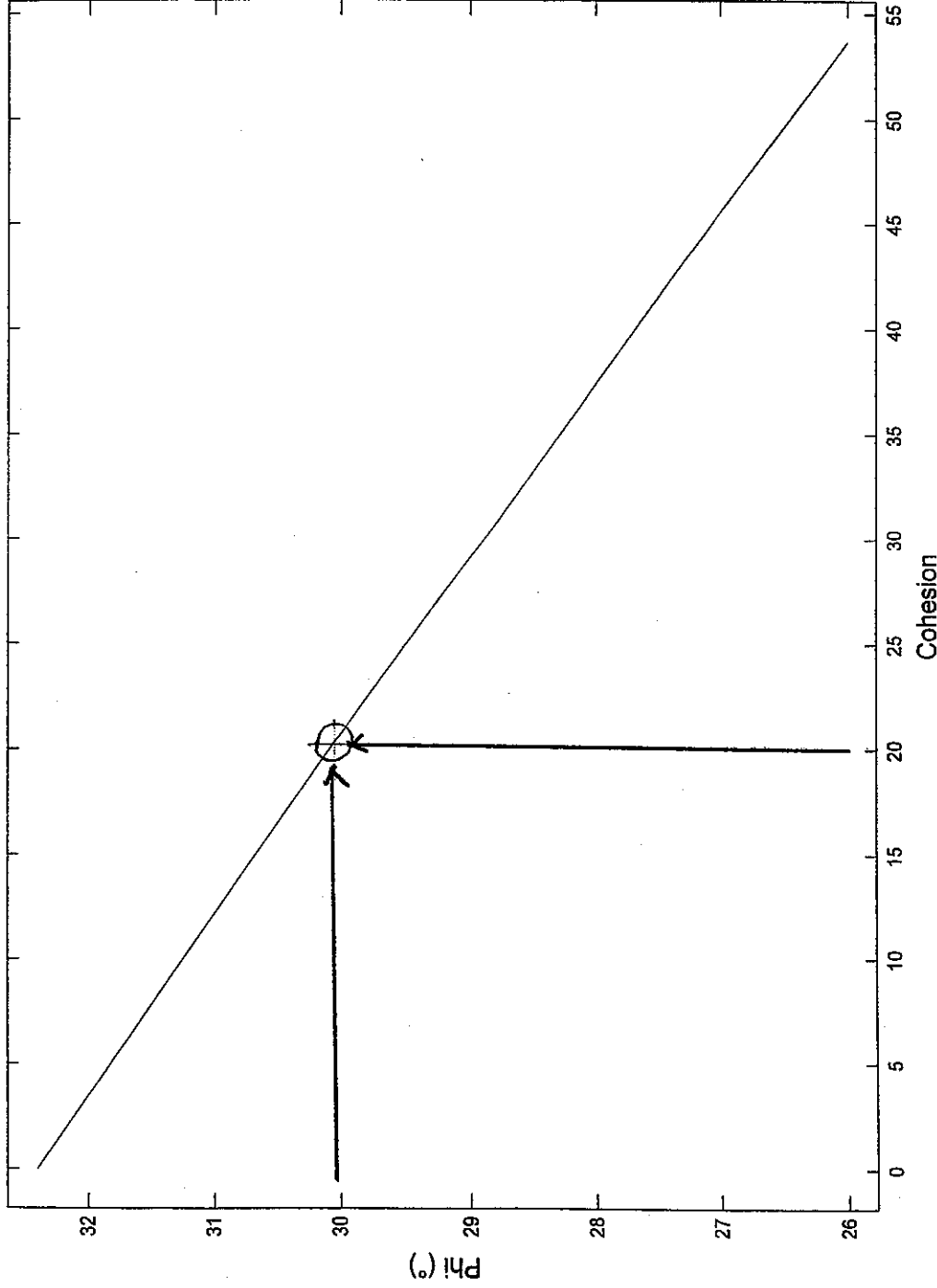
Results
Critical (minimum)
Factor of Safety: 0.98

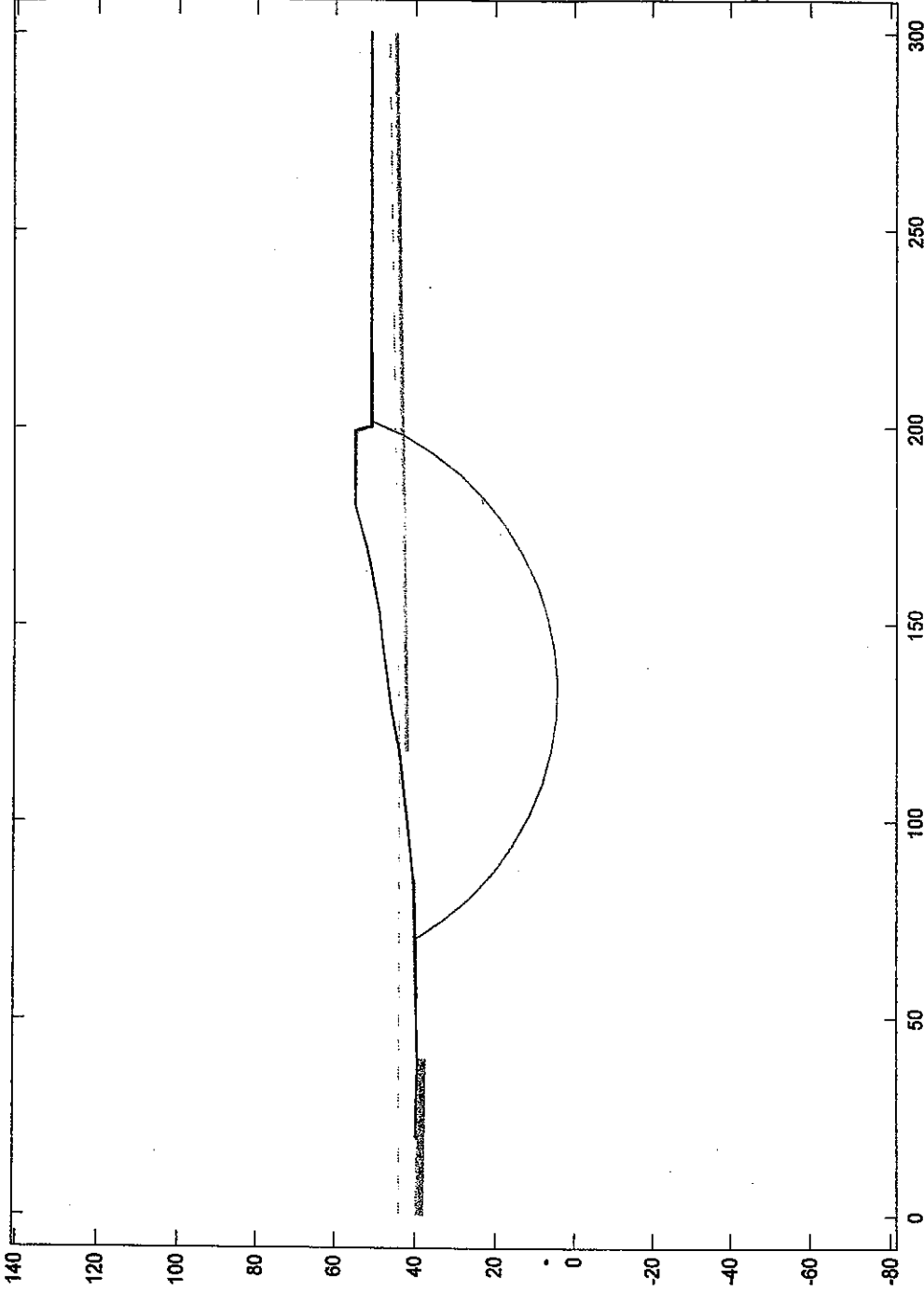
Project: North Wind Weir, Section F
Seismic High Groundwater Conditions
File: C:\Documents and Settings\aconwin\Desktop\GalenaData\North Wind F Hww.gmf

Plate 6
King County Materials Laboratories

Analysis: 1
Single BackAnalysis
Method: Bishop Simplified
Surface: Circular

Criteria
Material: 1
Minimum Phi: 26.0
Factor of Safety: 1.10





Analysis: 1
Multiple Stability Analysis
Method: Bishop Simplified
Surface: Circular

Results
Critical (minimum)
Factor of Safety: 1.35

Project: North Wind Weir Section D
Liquefied Soil Condition

File: C:\Documents and Settings\acorwin\Desktop\GalenaData\North Wind Section D Liquefied.gmf