

Western Geotechnical Consultants, Inc.

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March 12, 2013

Mr. Dean Jensen
511 Becky
Arlington, WA 98223

RECEIVED

APR 19 2013

COA Engineering Dept.

**Re: Report – Geotechnical Investigation
Jensen Property
Lot 3 Jensen Farm Div. #3
Tax No. 9904155006
210th Street Northeast
Snohomish County, WA**

Western Geotechnical Consultants, Inc. is pleased to present the results of our geotechnical site investigation for determining the feasibility of using stormwater infiltration/dispersion for the proposed development of the above referenced property. Specifically, the plan is to construct 2 infiltration trenches along the north side of the property in accordance with Low Impact Development (LID) techniques. The property is a near rectangular shaped parcel that is approximately 0.70 acres in size, and the site is located on the east side of 210th Place NE in Snohomish County, Washington.

The purpose of our investigation was to evaluate the site with respect to developing stormwater control using infiltration trenches in accordance with Low Impact Development (LID) methods. Due to the coarse gradation of the site soils, a pretreatment facility will be required. The specific scope of our investigation for the site included the following services:

- Review available published geologic, geotechnical and topographic information for the area.
- Excavate a total of 2 test pits to explore soil and groundwater conditions where infiltration facilities will be sited (1 test pit at each infiltration trench location).
- Classify soils in accordance with the Unified Soils Classification System (USCS).
- Perform field and laboratory testing as deemed necessary in support of our conclusions and recommendations. Laboratory testing included grain size testing performed in accordance with the USDA Textural Triangle methodology to determine soil infiltration rates.
- Return to the site to read groundwater levels in the piezometers.
- Prepare this engineering report including a summary of work performed and our conclusions and recommendations regarding soil and groundwater information for use in evaluating the infiltration rate and storage capacity of the soils.

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Site Conditions

Surface Conditions

The site is 0.70 acres in size and is a near rectangular shaped parcel. The property is a relatively flat parcel that is presently is grass and weed covered.

Subsurface Conditions

On February 25, 2013, a total of two test pits were excavated on the property using a track mounted mini-excavator. The approximate location of the test pits is shown on the Site Plan, Figure 1.

A geotechnical engineer from our office maintained continuous logs of the subsurface soil and ground water conditions encountered in the test pits, and the soils were classified using the Unified Soils Classification System (USCS). Edited, tabulated test pit logs are included in this report along with a USCS Chart explaining soil descriptions.

The subsurface conditions encountered were relatively uniform in both of the test pits. The subsurface profile consisted of 1.3 feet to 2.4 feet of sandy organic SILT to silty SAND with numerous roots and occasional gravel (OL/SM by USCS). This soil unit is underlain by brown sandy GRAVEL (GW to GP by USCS) that extended to a depth of 5-1/2 to 6 feet below grade. This soil unit is underlain by gap graded sandy GRAVEL (GP by USCS).

The USDA Soil Conservation Service (SCS) "Soil Survey of Snohomish County Area, Washington" has classified the site soils as Norma loam. This soil unit is very deep, poorly drained soil in depressional areas on outwash plains and till plans, and it formed in alluvium. Permeability of Norma soil is moderately rapid, runoff is very slow and the hazard of water erosion is slight. The thick topsoil layer is consistent with the SCS soil description.

Groundwater

Wet soil was encountered in Test Pit 1 at 5.5 feet during the subsurface investigation but groundwater was not encountered in Test Pit 2. Piezometers were installed in both of the test pits on February 25, 2013 when the test pits were excavated. On March 11, 2013 we returned to the site to measure water levels. The test pits were both dry to the depth of the test pits.

Laboratory Testing

As part of our evaluation of the infiltration characteristics of the soils for the site we performed soil gradation tests using the USDA Textural Triangle Methodology to define the soil infiltration characteristics for use in stormwater infiltration design.

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We performed a total of 2 tests from soil samples collected at depths ranging from 3.5 feet to 3.8 feet below grade in Test Pits 1 and 2. All the tests revealed that the soil samples are classified as sandy GRAVEL. The results of the grain size tests are attached to this report in the form of Grain Size Distribution Curves. We have also plotted the test results on the USDA Textural Triangle, which is attached to this report. The tests confirmed that the material is classified as a sand by the USDA textural triangle methodology.

Conclusions and Recommendations

General

Based on our geotechnical investigation, we conclude that infiltration of stormwater using infiltration trenches is feasible on the property. The upper 2-1/2 to 3 feet should be removed down to the native sandy gravel where infiltration is proposed. The following section provides a description of our analyses and recommendations for stormwater infiltration based on our geotechnical investigation and subsequent laboratory testing.

Infiltration Rate

We determined the infiltration rate for representative soils encountered in our test pits at the site in accordance with "Method 2, ASTM Gradation Testing at Full Scale Infiltration Facilities" of Section 3.3.5, "Design Infiltration Rate Determination – Guidelines and Criteria" per the August 2005, Stormwater Management Manual for Western Washington. Representative samples were taken from beneath the topsoil/surface layer in both of the test pits.

Grain size analyses of these samples were performed to determine grain size distribution in accordance with the USDA textural triangle methodology detailed in the Stormwater Manual. The Soil Gradation Curves are attached to this report. The native sandy gravel soils have a $D_{10} > 0.4\text{mm}$. We have also attached the USDA textural triangle illustrating where the soils plot on the graph. The soils plot as a sand, and Table 3.8 of the stormwater manual recommends long-term (design) infiltration rate of 9 inches an hour for the native sandy gravel soils with a $D_{10} > 0.4\text{mm}$ that is present at a depth of about 2-1/2 to 3 feet below the existing ground surface. The design engineer plans to use a correction factor of 4, which results in an infiltration rate of 2.25 in. /hr. used in sizing the infiltration trenches.

Groundwater Mounding Analysis

Due to the location of the groundwater table (greater than 5.5 feet) and the highly permeable nature of the site soils ($D_{10} \sim 0.5\text{mm}$.) groundwater mounding analyses was not performed. Groundwater mounding analyses can be performed upon request.

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Closure

The scope of our services included the excavation of 2 test pits to obtain subsurface information for determining stormwater infiltration rates. If during construction subsurface conditions encountered are different than those indicated in this report, we should be advised immediately so we can review and revise our recommendations, if necessary.

We appreciate the opportunity to be of assistance to you on this project. If you have any questions regarding the contents of this report, or if we can be of further assistance, please contact our office.

Sincerely,

Western Geotechnical Consultants, Inc.



Theodore Hammer, P.E.
Geotechnical Engineer



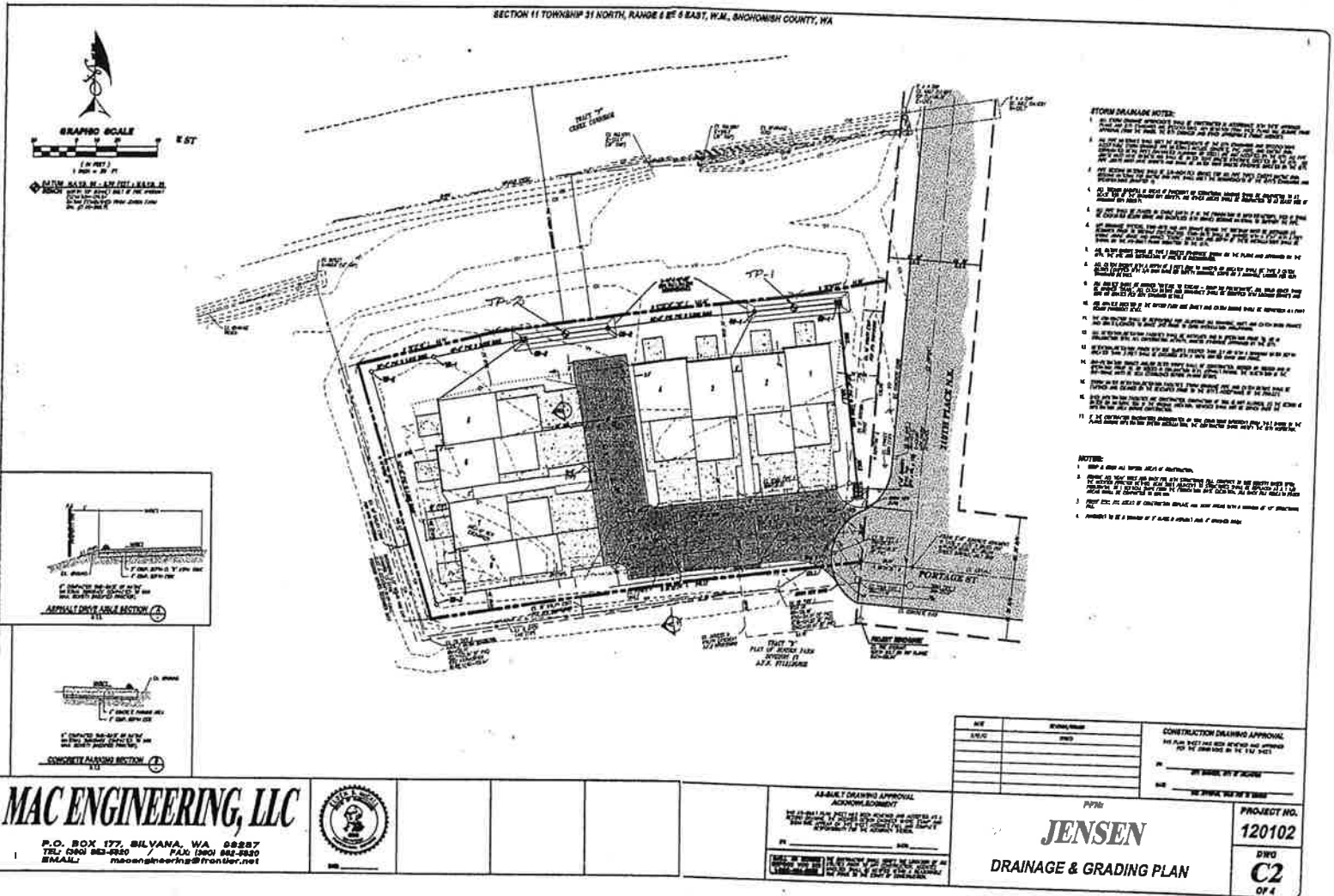
Inclusions: Figure 1, Site Plan
USCS Classification Chart
Tabulated Test Pit Logs

Attachments: Two Grain Size Distribution Curves
USDA Textural Triangle

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Figure 1

**Site Plan/Test Hole Locations - Lot 3 Jensen Farm
 210th Street Northeast - Snohomish County, WA**



MAC ENGINEERING, LLC
 P.O. BOX 177, SILVANA, WA 98287
 TEL: (360) 863-9820 / FAX: (360) 863-9820
 EMAIL: macengineering@ronter.net



DATE	DESCRIPTION

AS-BUILT DRAINAGE APPROVAL
 ACKNOWLEDGEMENT
 I HEREBY ACKNOWLEDGE THAT I HAVE REVIEWED THE AS-BUILT DRAINAGE PLAN AND THAT IT ACCURATELY REPRESENTS THE FIELD CONDITIONS AND THAT I AM PROVIDING THIS APPROVAL TO THE CITY OF SNOHOMISH.

DATE: _____
 BY: _____

DATE	DESCRIPTION

CONSTRUCTION DRAINAGE APPROVAL
 I HEREBY ACKNOWLEDGE THAT I HAVE REVIEWED THE CONSTRUCTION DRAINAGE PLAN AND THAT IT ACCURATELY REPRESENTS THE FIELD CONDITIONS AND THAT I AM PROVIDING THIS APPROVAL TO THE CITY OF SNOHOMISH.

DATE: _____
 BY: _____

PROJECT NO.
120102

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 OF 4

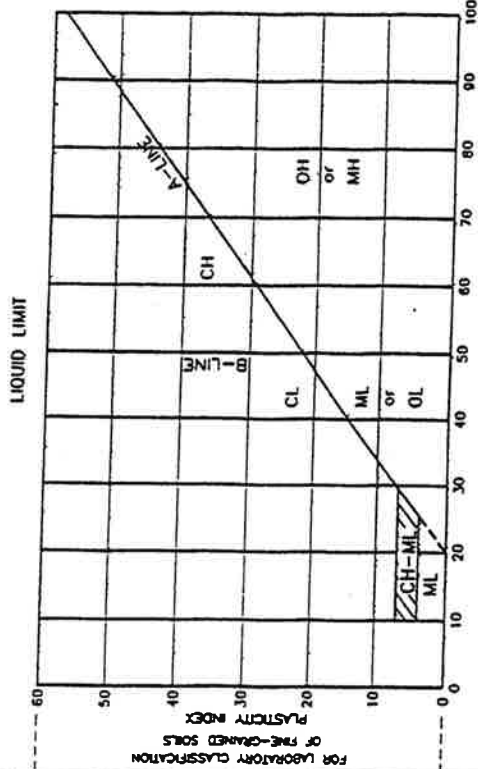
Unified Soil Classification System & Key to Test Pit Descriptions

GRADATION CHART

MATERIAL SIZE	PARTICLE SIZE			
	LOWER LIMIT MILLIMETERS	UPPER LIMIT MILLIMETERS	UPPER LIMIT MILLIMETERS	UPPER LIMIT MILLIMETERS
SAND	0.75	2.00	4.75	F40
	0.42	2.00	4.75	F10
	0.075	2.00	4.75	F4
GRAVEL	4.75	75	191	3/4"
	191	3/4"	762	3"
COBBLES	76.2	3"	304.8	12"
	304.8	12"	914.4	36"

• U.S. STANDARD • CLEAR SQUARE OPENINGS
 5-12% FINES (SILT & CLAY) DUAL CLASS

PLASTICITY CHART



Key to Test Pit Logs Using the
 Unified Soil Classification System

DATE: 01/11/05 SCALE: 1" = 10'

UNIFIED SOIL CLASSIFICATION CHART (USCS)

MAJOR DIVISIONS	GRAPH SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS	CLEAN GRAVELS (LITTLE OR NO FINES) < 5%	GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
		GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES	
	GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES	
SAND AND SANDY SOILS	CLEAN SANDS (LITTLE OR NO FINES) < 5%	SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
	SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)	SP	POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
FINE GRAINED SOILS	SILTS AND CLAYS	SM	SILTY SANDS, SAND-SILT MIXTURES
		SC	CLAYEY SANDS, SAND-CLAY MIXTURES
HIGHLY ORGANIC SOILS	LIQUID LIMIT LESS THAN 50	ML	INORGANIC SILTS AND VERY FINE SANDS, POORLY-GRADED OR CLAYEY FINE SANDS, NO CLAYEY SILTS WITH SLIGHT PLASTICITY
		CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
		OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	LIQUID LIMIT GREATER THAN 50	MH	INORGANIC SILTS, INORGANIC OR DATUMACIOUS FINE SAND OR SILTY SOILS
		CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
		OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
PT	PEAT, MUCK, SWAMP SOILS WITH HIGH ORGANIC CONTENTS		

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A:TEST PITS

		Log of Test Pits				File: 13 20 1
Test Pit No.	Depth Interval (feet)	USCS Class.	Soil Description	Sample No./ Depth (feet)	Water Content (%)	Lab Testing
TP- 1	0-1.3	OL/SM	Dark brown sandy organic SILT to silty SAND with some rounded gravel, numerous roots and organic matter (topsoil)			
	1.3-5.5	GP	Brown medium to coarse sandy GRAVEL (moist, relatively compact) (gravel is rounded 2" minus) (wet soil at 5.5 feet)	1-1/3.5'	6.8%	*GS/OC
	5.5-6.5	GP/GW	Gap graded sandy GRAVEL (moist grading wet, relatively compact)	1-2/6.5	10.5%	

Notes:

Test pit terminated on 2/25/13 at 6.5 feet
 Wet soil encountered at 5.5 feet.
 Piezometer installed.
 Test pit backfilled upon completion.
 Piezometer read on 3/11/13 and test pit was dry.

*GS/OC = Grain Size analysis per ASTM D-423 test method/Organic Content per Walkley Black method

Test Pit No.	Depth Interval (feet)	USCS Class.	Log of Test Pits			File: 13 20 1
			Soil Description	Sample No./ Depth (feet)	Water Content (%)	Lab Testing
TP- 2	0-2.4	OL/SM	Dark brown sandy organic SILT to silty SAND with some rounded gravel, numerous roots and organic matter (topsoil)			
	2.4-6.0	GW	Brown medium to coarse sandy GRAVEL (moist, relatively compact) (gravel is rounded 2" minus)	2-1/3.8'	3.9%	*GS/OC
	6.0-6.8	GP/GW	Gap graded sandy GRAVEL (moist grading wet, relatively compact) (no groundwater encountered)	2-2/6.3'	3.7%	

Notes:

Test pit terminated on 2/25/13 at 6.8 feet
 No groundwater encountered.
 Piezometer installed.
 Test pit backfilled upon completion.
 Piezometer read on 3/11/13 and test pit was dry.

*GS/OC = Grain Size analysis per ASTM D-423 test method/Organic Content per Walkley Black method

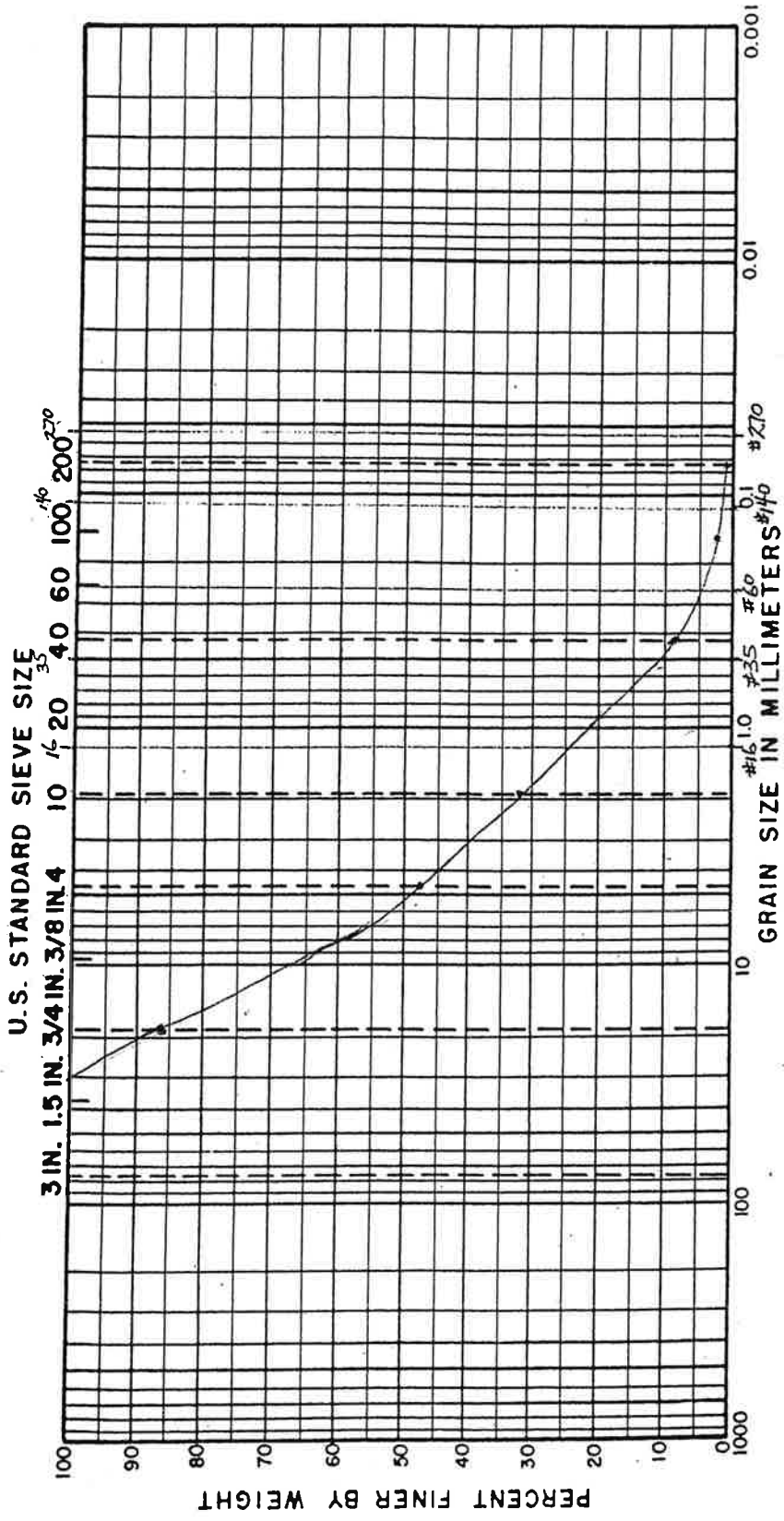
Attachments

Two Grain Size
Distribution Curves

USDA Textural Triangle

BY _____ DATE _____
 BY _____ DATE _____
 PLATE _____ OF _____

CHECKED BY _____ DATE _____



USDA Test No.	DEPTH	CLASSIFICATION	SAND				SILT OR CLAY								
			NAT. WC	LL	PL	PI	NAT. WC	LL	PL	PI					
triangle	3.5'	GP medium to coarse sandy GRAVEL	6.8%												
															$D_{10} = 0.48 \text{ mm}$ (category) = 9 in/hr

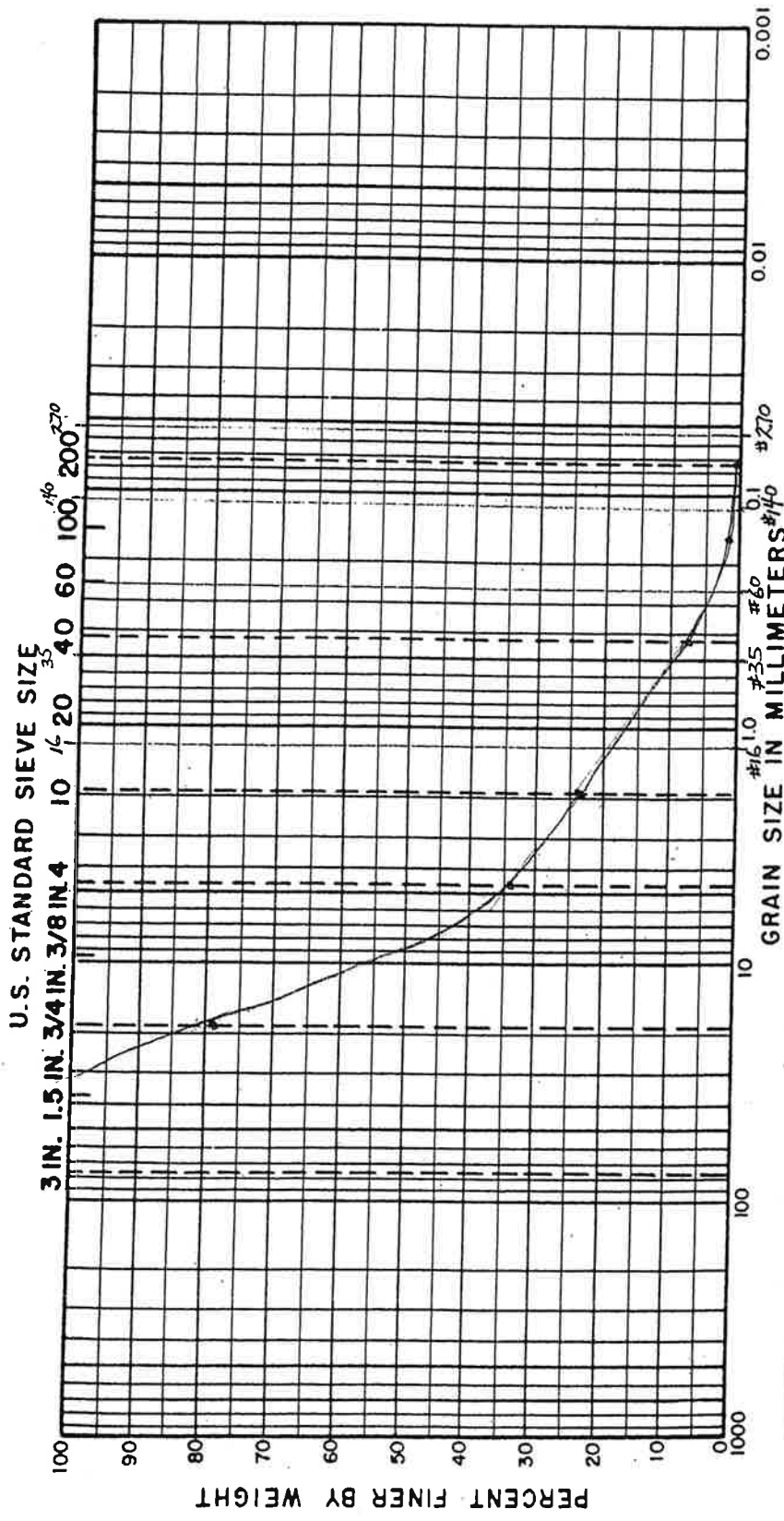
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GRADATION CURVE

BY _____ DATE _____
 BY _____ DATE _____
 PLATE _____ OF _____

CHECKED BY _____ DATE _____
 BY _____ DATE _____



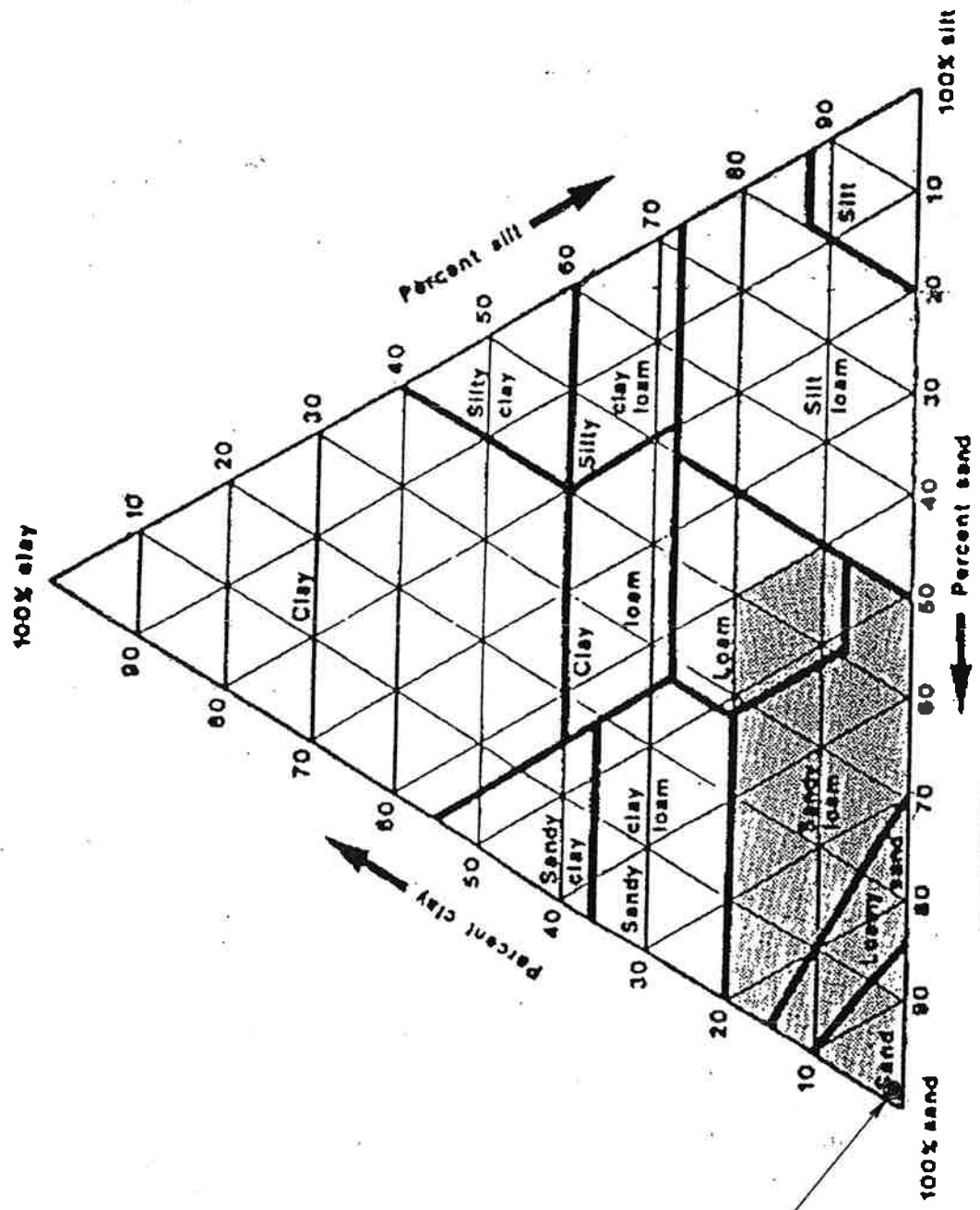
USDA texture	DEPTH	GRAVEL			SAND			PI	PL	Classification
		COARSE	FINE	COARSE	MEDIUM	FINE				
triangular	3.8'	GW	medium to coarse sandy GRAVEL	3.9%						TP-R/S-1 D ₁₀ = 0.5mm / i _{design} = 9 in/hr.

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GRADATION CURVE

Textural Triangle U.S.D.A.



JOB NO.	DATE	SCALE	IN
DESIGNED BY			
DRAWN BY			
CHECKED BY			
Western Geotechnical Consultants		DATE	
4165 Salt Spring Drive		N/A	
Ferndale, WA 98248			
(360) 360-2807			