LABORATORY COMPACTION CHARACTERISTICS OF SOIL

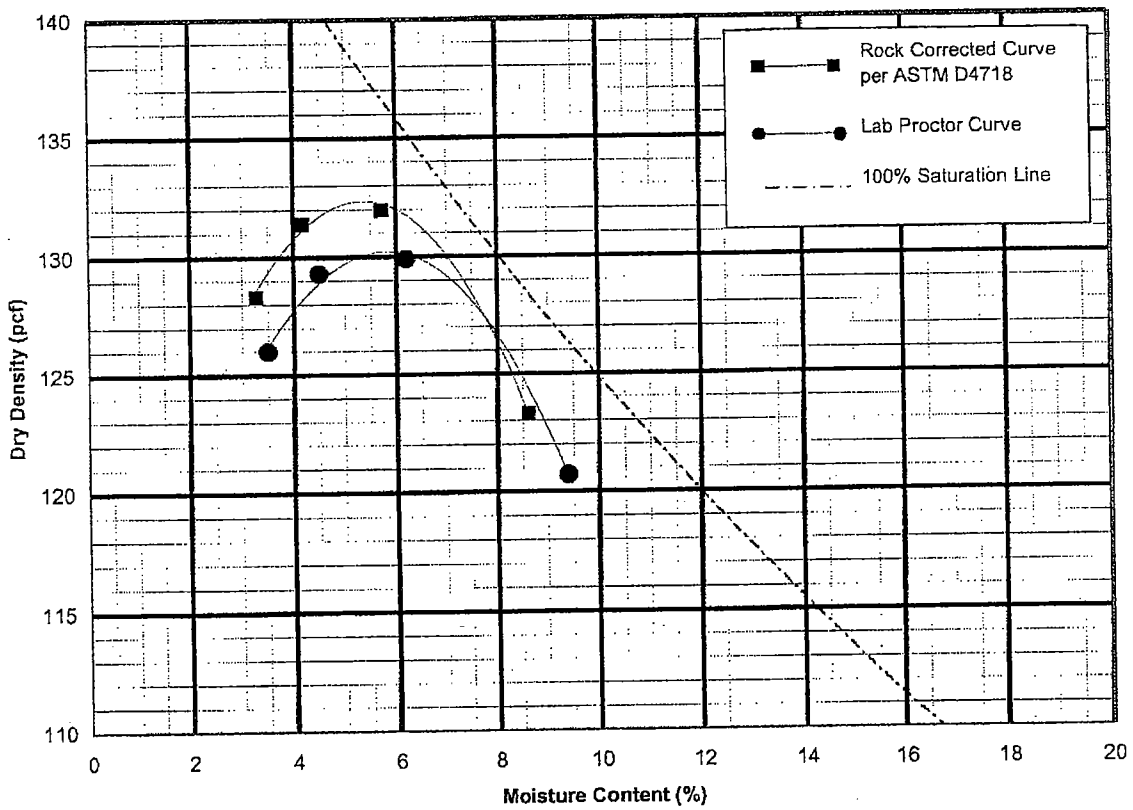
HWA GEOSCIENCES INC.

CLIENT: *Glacier North West*
PROJECT:
SAMPLE ID: *PBS-3*
PROJECT NO: *2005097-23* Sampled By: *Client* Tested By: *EJB*
Date Sampled: *1/17/2006* Date Received: *1/17/2006* Date Tested: *1/18/2006*

MATERIAL TYPE OR DESCRIPTION:
Permeable Base Stone
MATERIAL SOURCE, SAMPLE LOCATION AND DEPTH:
Delivered by client

Designation: [X] ASTM D 698 [ ] ASTM D 1557 Natural Moisture Content: *3.5* %
Method: [ ] A [ ] B [X] C Oversize: *9.3* % retained on: *3/4* in.
Preparation: [ ] Dry [X] Moist Rammer: [X] Auto [ ] Manual Assumed S.G.: *2.5*

Test Data					
Dry Density (pcf)	*129.3*	*129.9*	*120.7*	*126.0*	
Moisture Content (%)	*4.5*	*6.2*	*9.4*	*3.5*	



Data Summary*	
Percent Oversize	*9.3%*
Max. Dry Density (pcf)*	*132.3*
Optimum Moisture (%)*	*5.3*

Test Values At Other Oversize Percentages						
0.0%	5.0%	10.0%	15.0%	20.0%	25.0%	30.0%
130.3	*131.4*	*132.5*	*133.6*	*134.8*	*135.9*	*137.1*
5.7	*5.5*	*5.2*	*5.0*	*4.8*	*4.5*	*4.3*

* values corrected for oversize material per ASTM D4718, using assumed Specific Gravity shown and oversize moisture content of 1%

Reviewed By: *JRS* FIGURE *1*

Remold Calculation Form

Project Name: Glacier NW Project #: 2005-097-23

Sample Designation: Permeable Base Stone Source: DuPont Pit

Product Number: 8834 Sample #: PBS-3

Tested By: JRS Date: 01/26/06

Soil Description: Gray poorly graded coarse gravel with sand (GP)

Maximum Dry Density (pcf):	132.3	Optimum Moisture Content (%):	5.3
Target Relative Density (%):	95	Target Moisture Content (%):	5.3
Target Dry Density (pcf):	125.7	Target Wet Density (pcf):	132.3
Target Sample Height (in):	8.00	Target Sample Height (cm):	20.32
Target Sample Diameter (in):	8.00	Target Sample Diameter (cm):	20.32
Target Sample Volume (in^3):	402.12	Target Sample Volume (ft^3):	0.2327
Target Wet Soil Wt (lbs):	30.80	Target Wet Soil Wt (g):	13970.2
Lift Thickness (in):	2.67	Lift Thickness (cm):	6.77
Number of Lifts:	3		
Weight per Lift (lbs):	10.27	Weight per Lift (g):	4656.7

Remolded Sample Data

Sample Height (in):	8.00	Sample Height (cm):	20.32
Sample Diameter (in):	8.00	Sample Diameter (cm):	20.32
Sample Volume (in^3):	402.12	Sample Volume (ft^3):	0.2327
Sample Wt (g):	13880.2		
Wet Density (pcf)	131.5	Moisture Content (%)	5.2
Dry Density (pcf):	125.0	Relative Density (%)	94.5

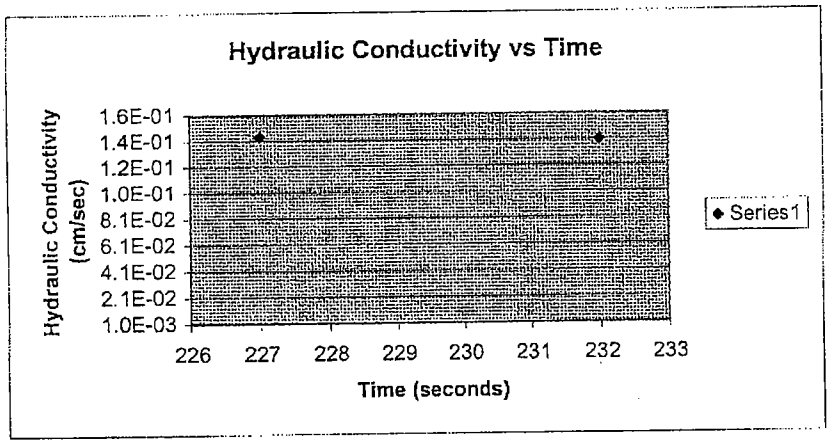
HWA GEOSciences Inc. MATERIALS TESTING LABORATORY
Falling Head Permeability Test
Performed in general accordance with the Army Corps of Engineers EM 1110-2-1906
Laboratory Soils Testing Manual, Appendix VII.

Project:	Glacier NW	Sample No.:	PBS-3
Client:	Same	Sample Source:	DuPont Pit
HWA Project No.:	2005-097-23	Product No.:	8834
Date Sampled:	N/A	Sample Description:	Gray poorly graded gravel with sand (GP)
Sampled By:	Client		
Date Tested:	01/26/06		
Tested By:	JRS		

	Trial Number			
	1	2	3	4
(A) Length of sample (cm):	20.32	20.32		
(B) Initial height of water above datum (cm):	12.7	12.7		
(C) Final height of water above datum (cm):	2.54	2.54		
(D) Total test time (sec):	227	232		
Permeability, k* (cm/sec)	1.4E-01	1.4E-01		
Permeability, k* (in/hr)	204.1	199.7		

* k={ 2.3 (A) Log10 [(B) / (C)] } / (D)

Average Hydraulic Conductivity (cm/sec):	1.4E-01
Average Hydraulic Conductivity (in/hr):	201.9



Porosity Calc's

Project Name:	Glacier NW	Project #:	2005-097-23
Tested By:	JRS	Date:	02/10/06
Product Designation:	Permeable Base Stone		
Product Number:	#8834		
Sample #:	PBS-3		

Porosity (n) = 1 - Dry Density / (Specific Gravity * Unit wt of H2o)

n = 0.258

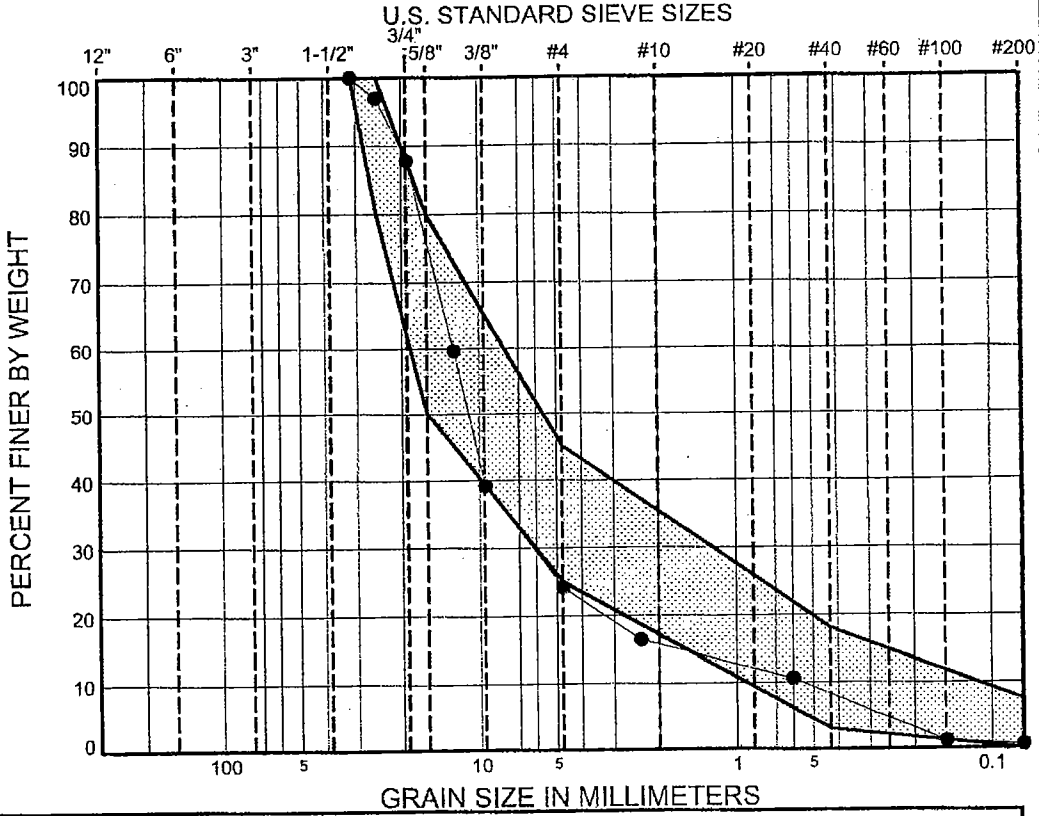
Where:

Dry Density = 125.0 pcf

Specific Gravity is 2.70 (estimated)

Unit Wt of Water = 62.4 pcf

COBBLES	GRAVEL		SAND		
	Coarse	Fine	Coarse	Medium	Fine



SAMPLE ID	DATE SAMPLED	SAMPLED FROM
PBS-3	1/17/2006	Dupont Pit, #8834

WSDOT 9-03.9(3) CSBC		
Sieve Size	Percent Passing	Specification Limits
8 Inch		
7 Inch		
6 Inch		
5 Inch		
4 Inch		
3 Inch		
2 1/2 Inch		
2 Inch		
1 1/2 Inch		
1 1/4 Inch	100.0%	100%
1 Inch	97.0%	80-100%
3/4 Inch	87.7%	
5/8 Inch		50-80%
1/2 Inch	59.6%	
3/8 Inch	39.1%	
1/4 Inch		
No. 4	24.2%	25-45%
No. 8	16.4%	
No. 10		
No. 16		
No. 20		
No. 30	10.6%	
No. 40		3-18%
No. 50		
No. 60		
No. 80		
No. 100	1.2%	
No. 200	0.6%	0.0-7.5%

MATERIAL CLASSIFICATION / DESCRIPTION	Moisture %	Sand Equiv't	L.A. Abras'n	Degra-dation	Dust Ratio	MgSO4 Sound	Plastic Index	Fracture %
Permeable Base Stone	2.5							

HWA GeoSciences Inc.

Glacier Northwest

SIEVE ANALYSIS
OF AGGREGATE
METHOD ASTM C136

PROJECT NO.: 2005097 FIGURE: 1

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19730 - 64th Avenue W., Suite 200
Lynnwood, WA 98036-5957

Phone: (425) 774-0106
Fax: (425) 774-2714

Date Received	January 17, 2006
Date Reported	February 10, 2006
Sample Number	PBS-3
Source	Glacier Northwest, DuPont Pit
Product Description	Permeable Base Stone
Product Number	#8834

Gravel Distribution Analysis (ASTM C 136)

Sieve Size		Sample	Specification
		Percent Passing	
1 1/4"	31.5 mm	100	100
1 inch	25.0 mm	97	90-100
3/4 inch	19.0 mm	87.7	80-100
1/2 inch	12.5 mm	59.6	50-80
3/8 inch	9.5 mm	39.1	40-60
No. 4	4.75 mm	24.2	20-40
No. 8	2.36 mm	16.4	15-30
No. 30	0.60 mm	10.6	5-20
No. 100 (wet)	0.15 mm	1.2	2-10
No. 200 (wet)	0.075 mm	0.6	2-6

Infiltration Rate Inches/Hour	Compaction % Proctor	Total Porosity	Percent Fracture
Corp Of Engineers **EM 1110-2-1906** Appendix VII	ASTM **D 698** Standard Proctor	Calculated	WAQTC **TM 1** (Supercedes WSDOT 106)
202	**94.5**	**0.258**	**96**

Reviewed by: _____

Sand Point Magnuson Park
Synthetic Turf Fields
Lateral Drainage Rate Estimate

Alternate Design with Four Equally Spaced Drainage Laterals - 8" Aggregate Depth

All drainage from the synthetic turf field areas will be collected by 4 lateral drain lines in the
vertical percolation through the synthetic turf and the permeable aggregate layers
lateral percolation through the permeable aggregate across the field width to the perimeter drain
vertical percolation through the pea gravel backfill
pipe flow through the drainage collector to the onsite storm system or daylight locations

	Reach Type	Surface Description	Permeability "k" (ft/min)	Length Feet	Gradient	Velocity (ft/min)	T of C (min)
AB	Percolation	Turf	.0970	0.15	1.00	0.097	1.55
BC	Percolation	Aggregate	.7087	0.00	1.00	0.709	.00
	Gradient Buildup - assume earlier storm - no time						
CD	Percolation	Aggregate	.7087	79.00	0.013	**0.009**	8575.21
DE	Percolation	Pea Gravel	9.3388	1.50	1.00	9.339	0.16

Total Tc = **8576.92** Minutes
142.95 Hours
5.96 Days

Synthetic Turf System Permeability
Testing performed on other synthetic turf surfaces indicated a drainage rate of approximately 70 inches/hour
This corresponds to a rate of 0.097 feet per minute

Aggregate Permeability
The permeabilty of the aggregate is estimated with the 10th percentile particle size. Based on sieve testing from the primary supplier, the 10th percentile partical size typically ranges around the #30 sieve.
The permeablitiy rate is calculated as follows:
K=100(DxD) where D = 10th % partical size in cm and K= permeability in cm/sec
D = 0.06 cm
K = 0.36 cm/sec
K = 0.7087 ft/min

Gradient Build Up
For the purposes of this calculation, a 1/2% gradient associated with the subgrade slope and the aggregate is assumed to be saturated to the full depth of 8 inches resulting in a hydrualic grade of 1.3%.

Lateral Percolation
This is calculated with Darcy's Law where the flow velocity is the product of the permeability rate and the gradient.

Sand Point Magnuson Park
Synthetic Turf Fields
Lateral Drainage Rate Estimate

Current Design with Subsurface Drainage System (15' o.c. Drainage Laterals) 10.25" Aggregate Depth

There will be no surface runoff from the sythetic field areas. All drainage from the synthetic turf field areas will be collected by the subsurface drainage system. The drainage path for these areas is comprised of the following:

vertical percolation through the synthetic turf and the permeable aggregate layers
lateral percolation on a gradient through the permeable aggregate to the subsurface drainage trench
vertical percolation through the pea gravel backfill
pipe flow through the subsurface drainage system to the onsite storm system or daylight locations

	Reach Type	Surface Description	Permeability "k" (ft/min)	Length Feet	Gradient	Velocity (ft/min)	T of C (min)
AB	Percolation	Turf	.0970	0.15	1.00	0.097	1.55
BC	Percolation	Aggregate	.7087	0.85	1.00	0.709	1.21
	Gradient Buildup - assume earlier storm - no time						
CD	Percolation	Aggregate	.7087	9.00	0.04	**0.028**	317.50
DE	Percolation	Pea Gravel	9.3388	1.50	1.00	9.339	0.16

Total Tc = **320.41** Minutes
5.34 Hours

Synthetic Turf System Permeability
Testing performed on other synthetic turf surfaces indicated a drainage rate of approximately 70 inches/hour
This corresponds to a rate of 0.097 feet per minute

Aggregate Permeability
The permeabilty of the aggregate is estimated with the 10th percentile particle size. Based on sieve testing from the primary supplier, the 10th percentile partical size typically ranges around the #30 sieve.
The permeablitiy rate is calculated as follows:
$K=100(DxD)$ where D = 10th % partical size in cm and K= permeability in cm/sec
D = 0.06 cm
K = 0.36 cm/sec
K = 0.7087 ft/min

Gradient Build Up
For the purposes of this calculation, a 4 inch gradient is assumed to be already inplace between each of the subsurface drainage trenches. This would be the case with successive storm events.
If a gradient is not in place, the time of concentration would be significanly longer due a flatter gradient.

Lateral Percolation
This is calculated with Darcy's Law where the flow velocity is the product of the permeability rate and the gradient.