Ordinance No. 123167

Council Bill No. 116697

AN ORDINANCE relating to Seattle Public Utilities drainage services; amending Chapter 21.33 of the Seattle Municipal Code to update the definition of "highly infiltrative pervious surface" to include additional pervious surface types.

CF No. _____

Date Introduced: 10.19.09	
Date 1st Referred:	To: (committee) Budget
Date Re - Referred:	To: (committee)
Date Re - Referred:	To: (committee)
Date of Final Passage: 11-23-09	Full Council Vote: 9-0
Date Presented to Mayor: 11-23-09	Date Approved: 12.1.0
Date Returned to City Clerk: 12.3.09	Date Published: T.O. ___ F.T. ✓
Date Vetoed by Mayor:	Date Veto Published:
Date Passed Over Veto:	Veto Sustained:

The City of Seattle - Legislative Department

Council Bill/Ordinance sponsored by: C ~~Licata~~

Councilmember

Committee Action:

11-10-09 Pass As Amended JG, SC, RC, JD, BH, NL, RM, TR

11-23-09 Passed 9-0

This file is complete and ready for presentation to Full Council. Committee: _____ (initial/date)

LAW DEPARTMENT

Law Dept. Review	OMP Review	City Clerk Review	Electronic Copy Loaded	Indexed

Leanne Davis Galati/LDG
SPU Drainage Low Impact Rate ORD – Budget Leg
10/22/2009
Version # 8

ORDINANCE 123167

AN ORDINANCE relating to Seattle Public Utilities drainage services; amending Chapter 21.33 of the Seattle Municipal Code to update the definition of "highly infiltrative pervious surface" to include additional pervious surface types.

WHEREAS, City drainage fees are based on the estimated amount of stormwater runoff from a property that enters the City's drainage system, as determined by the amount and type of impervious and pervious surface on a property; and

WHEREAS, pursuant to Section 21.33.030.C.2 of the Seattle Municipal Code, properties in the undeveloped, light and moderate rate categories are assigned to a low-impact rate category if they contain sufficient quantities of highly infiltrative pervious surface cover to meet defined performance requirements; and

WHEREAS, recent engineering studies by Seattle Public Utilities have demonstrated that certain athletic field designs meet the defined performance requirements for the low-impact rate category, but are not included in the current definition for "highly infiltrative pervious surface;" NOW, THEREFORE,

BE IT ORDAINED BY THE CITY OF SEATTLE AS FOLLOWS:

Section 1. Effective January 1, 2010, Section 21.33.010 of the Seattle Municipal Code is amended as follows:

SMC 21.33.010 Definitions

For purposes of this chapter, the words or phrases below shall have the following meanings:

* * *

J. "Highly infiltrative pervious surface" means vegetated surface of specific types such as forests or non-forested land that is in the natural progression back to a forested state, or athletic fields that have been designed to substantially meet the same Seattle Public Utilities-defined performance characteristics for infiltrating stormwater.

* * *

Section 2. This ordinance shall take effect and be in force thirty (30) days from and after its approval by the Mayor, but if not approved and returned by the Mayor within ten (10) days after presentation, it shall take effect as provided by Municipal Code Section 1.04.020.

Passed by the City Council the 23rd day of November, 2009, and signed by me in open session in authentication of its passage this 23rd day of November, 2009.

President _____ of the City Council

Approved by me this 1st day of December, 2009.

Gregory J. Nickels, Mayor

Filed by me this 3rd day of December, 2009.

Acting City Clerk

(Seal)

Form revised May 5, 2009

2010-2011 BUDGET LEGISLATION FISCAL NOTE

Note: This fiscal note template may be used for most pieces of budget legislation. Certain legislation submitted with the budget (e.g., the Supplemental Ordinance) requires that the standard fiscal note template be used with some modification. Please work with your Budget Analyst so that your fiscal note provides the information that is required during the budget process. The standard template can be found on the Legislation Home Page on the inweb at ***http://inweb/legislationtracking/***

Department:	Contact Person/Phone:	DOF Analyst/Phone:
Seattle Public Utilities	Leanne Davis Galati/684-0455	John McCoy/ 615-0768

Legislation Title: AN ORDINANCE relating to Seattle Public Utilities drainage services; amending Chapter 21.33 of the Seattle Municipal Code to update the definition of "highly infiltrative pervious surface" to include additional pervious surface types.

- Summary of the Legislation:

The proposed ordinance revises the definition for "highly infiltrative pervious surface," which is used in the assignment of properties to drainage rate categories.

- Background: *(Include brief description of the purpose and context of legislation and include record of previous legislation and funding history, if applicable):*

Ordinance 122868 changed the City's drainage rate design in 2008 in order to improve ratepayer equity. One of the changes was the introduction of low impact rate categories that assign lower rates to properties containing sufficient quantities of "highly infiltrative pervious surface." The SMC currently defines "highly infiltrative pervious surface" as vegetated surfaces that are forested or in a natural progression to a forested state. These surfaces infiltrate significantly more runoff, and thus contribute less stormwater and cost to the City's drainage system, than other pervious surface types.

Recent engineering studies by SPU of multi-layer athletic fields concluded that fields meeting certain design requirements infiltrate stormwater at a rate similar to forested lands. These fields are composed of a pervious top layer of sand, synthetic turf, or natural grass, with an underlying base layer (or layers) of native material or fill that holds and slowly releases runoff into native soils. A small amount of runoff goes into underdrains connected to the City's drainage system. The proposed legislation broadens the definition of "highly infiltrative pervious surface" to include any pervious surface cover type, such as the athletic fields described above, that exhibit performance characteristics similar to the vegetated surfaces included in the current definition.

The proposed revision will reduce the 2010 drainage bill for several athletic fields in the city, including fields owned by the Seattle Public Schools and the Department of Parks and Recreation.

- *Please check one of the following*:

____ This legislation does not have any financial implications. (*Stop here and delete the remainder of this document prior to saving and printing.)*

_X__ This legislation has financial implications. *Please complete all relevant sections that follow.*

Summary of Changes to Revenue Generated Specifically From This Legislation: *For budget legislation that changes revenue (e.g., fees, taxes, etc.), please provide detail on each revenue-producing item that is being changed, when it was last changed, and how the item's new overall cost compares with similar costs charged elsewhere in the region.*

	Revenue Source	2010 Proposed	2011 Proposed
Total Fees and Charges Resulting From Passage of This Ordinance	Drainage Utility Services	-$175,600	-$175,600

(If new revenue is for a partial year, provide estimate for full year in the notes section below; also include the effect on the average customer, user or payer.)

Notes: Preliminary analysis suggests that about 32 parcels will be reclassified into a lower tier for 2010, resulting in $175,600 in reduced utility revenue. Rates for 2011 are assumed to be held constant. The loss of rate revenue for these parcels, all other things being equal, will necessitate a very small increase in future rates (significantly less than 1 percent).

Anticipated Total Revenue from Entire Program, Including Changes Resulting From This Legislation:

Fund Name and Number	Revenue Source	Total 2010 Revenue	Total 2010 and 2011 Anticipated Revenue from Entire Program
Drainage and Wastewater Fund 44010	Drainage Utility Services	$57,937,625	$115,875,250
TOTAL		$57,937,625	$115,875,250

- What is the financial cost of not implementing this legislation? *(Estimate the costs to the City of not implementing the legislation, including estimated costs to maintain or expand an existing facility or the cost avoidance due to replacement of an existing facility, potential conflicts with regulatory requirements, or other potential costs if the legislation is not implemented)*

There are no costs associated with not implementing the legislation.

- Does this legislation affect any departments besides the originating department? • *If so, please list the affected department(s), the nature of the impact (financial, operational, etc)., and indicate which staff members in the other department(s) are aware of this Bill.*

Yes, Parks' drainage bill is expected to decline by $74,000 in 2010 and 2011. This reduction has been assumed in Parks' 2010 Proposed Budget.

- What are the possible alternatives to the legislation that could achieve the same or similar objectives? *(Include any potential alternatives to the proposed legislation, such as reducing fee-supported activities, identifying outside funding sources for fee-supported activities, etc.)*

The City could offer stormwater facility credits (SFC) for pervious surfaces with a high infiltration capacity that do not meet the current definition for "highly infiltrative pervious surface." The current SFC program, however, only provides for credits that manage runoff from impervious areas, consistent with the City's Stormwater and Drainage Code requirements. Therefore, legislation would be required to modify the SFC program requirements in this case as well. This alternative is not recommended as it would disconnect program requirements from established industry performance guidelines.

- Is the legislation subject to public hearing requirements? *(If yes, what public hearings have been held to date, and/or what plans are in place to hold a public hearing(s) in the future?)*

No.

- Other Issues (*including long-term implications of the legislation*):

None.

Please list attachments to the fiscal note below:

Exhibit A – **Athletic Field Flow Factor Analysis**

To: Leanne Galati, Seattle Public Utilities

From: Art Griffith, R. W. Beck, Inc.

Subject: **Athletic Field Flow Factor Analysis**

Date: September 22, 2009

Background

In 2005, Dr. Richard Horner prepared recommendations on technical issues related to the analysis of the Seattle Public Utilities (SPU) drainage rate design. These recommendations included the development of *flow factors* for 2-year, 24-hour and 25-year, 24-hour storm events for three land use and cover types: impervious, landscaping >0.5 acre and other pervious. Flow factors indicate the proportion of precipitation that becomes runoff expected for each land cover type and storm event. Later that same year, Dr. Horner collaborated with consultants from R. W. Beck, Inc. (R. W. Beck) in an expanded assessment of flow factors, which included additional storm events and land cover types. A fundamental input to SPU's drainage rate structure implemented in 2008 is a subset of these flow factors, with four land use types:

- Impervious – All Types
- Pervious – Managed Grass
- Pervious – Woods and Unmanaged Grass
- Pervious – Forest, Good Condition

In implementing the new drainage rate system, SPU has since recognized a need to develop flow factors for three types of athletic fields, which were not included in the original analysis: new-generation synthetic turf (commonly called Field Turf, a brand name), sand/silt all-weather fields, and sand-based turf fields. Throughout this memo, these three field types are referred to as follows:

- New-generation synthetic turf: synthetic turf
- Sand/silt all-weather fields: all-weather fields
- Sand-based turf fields: sand-based turf

This memorandum documents the analysis of these field types to determine their approximate flow factors.

Typical Field Design and Flow Pathways

SPU consulted with Seattle Parks Department staff to obtain available typical design drawings and standards for synthetic turf and sand fields. A typical section for synthetic turf was obtained from Parks staff and is provided in Figure 1. Section drawings for other field types generally

were not available and the analysis was based on information included in applicable specifications. All three types of fields typically consist of a surface material overlying a base course. The depths of these layers vary between field surface types.

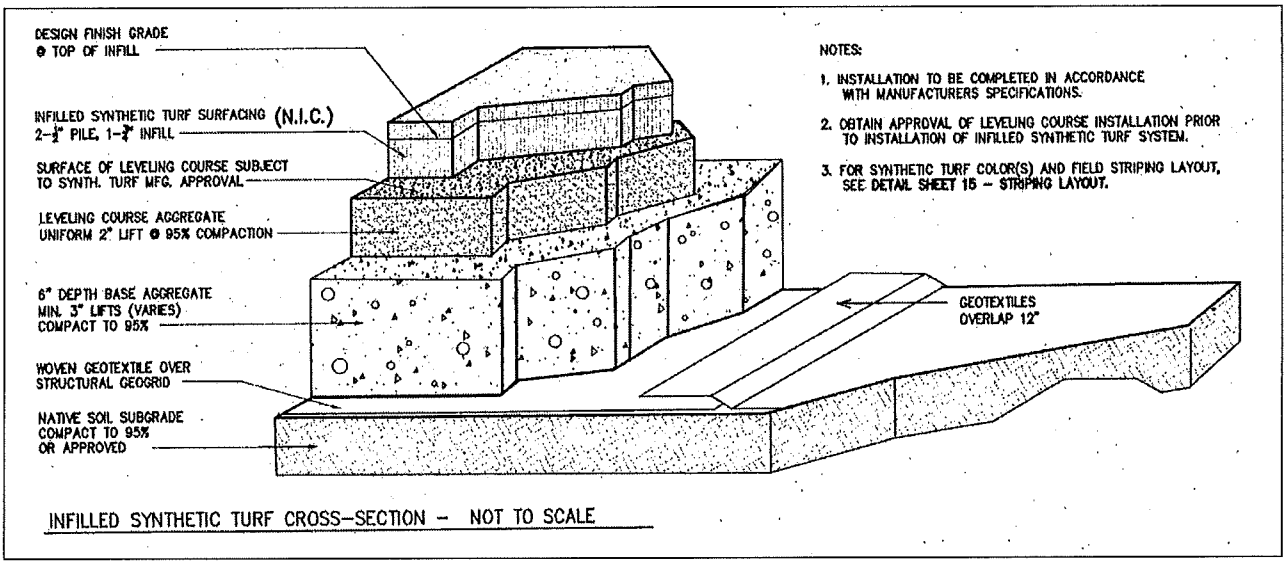


Figure 1. Typical synthetic turf and base cross-section. From Seattle Parks plan drawings for Miller Playfield, February 2009.

The relevant specifications for each field type are summarized of Table 1, based on specifications obtained from http://www.ci.seattle.wa.us/parks/projects/standards/specs.asp. Also shown in Table 1 are the estimated ranges of D10[1] values consistent with each specification. Relevant spec sections are included as Attachment 1.

Table 1. Particle size distribution and estimated D10 for three athletic field types

	Base Material		Surface Material
Synthetic Turf	Sieve	Percent Passing	Cryogenic Crumb Rubber and Sand
	1-1/4" square	100	
Section 02205	1" square	90-100	D10: Not available
(& Sections 02201	¾" square	80-100	
and 02222 by	½" square	50-80	
reference from	3/8" square	40-60	
Section 02205)	#4	20-40	
	#8	15-30	
	#30	5-20	
	#100*	2-10	
	#200*	2-6	
	D10 range: 100 sieve to 30 sieve (0.15 mm to 0.6 mm; 0.006" to 0.023")		

[1] D10 is the particle diameter for which 10 percent of the material is found to be smaller

	Base Material		Surface Material	
All-Weather Fields **Section 02221 (& Section 02200 by reference from Section 02221; last used for new construction circa 1999)**	Sieve #4 #8 #16 #30 #60 #140 200* #270* D10 range: 100 sieve to 40 sieve (0. 15 mm to 0.4 mm; 0.006" to 0.016")	Percent Passing 100% 95-100% 85-100% 50-75% 0-30% 0-5% 0-2% 0%	Sieve 1/4 inch #10 #40 #60 #80 #100 #140 #200* #270* D10 range: 270 sieve to 200 sieve (0. 053 mm to 0.075 mm; 0.002" to 0.003")	Percent Passing 100% 95-100% 65-75% 45-55% 30-40% 25-35% 17-22% 10-14% 6-9%
Sand-Based Turf **Section 02201**	Sieve ¼" #4 #10 #20 #30 #60 #100 #200 D10 range: 60 sieve to 40 sieve (0. 25 mm to 0.4 mm; 0.01" to 0.016")	Percent Passing 100 90-100 80-90 60-80 40-60 <10 <5 <2	Combination of base material plus organic matter (compost). Sample report (for 95-5-5 material) provided by Parks indicates D10 = 0.003" (no range available)	

As shown in Figure 2, precipitation on the fields is assumed to be conveyed via three primary pathways:

- Surface runoff
- Infiltration into subgrade material
- Lateral flow to underdrains

As shown in the standard detail (Figure 1), the base course is placed over a compacted subgrade (native material or fill), separated by a highly permeable geotextile. The field typically slopes at about one to two percent toward the lateral subsurface drains (perforated pipes), which are placed in gravel-filled trenches every 15 feet. The trenches are cut into the native subgrade material below the base course. The trenches are 12-20 inches wide. The perforated subsurface drain pipes are placed 2-4 inches over the bottom of the trenches. This would create a small reservoir below the drains, allowing runoff to be stored and eventually infiltrated. This would reduce the amount of flow from the underdrains. However, for purposes of this analysis, the effect of the reservoir is not considered.

Runoff factors are calculated using a 24-hour storm. Over a 24-hour period, evapotranspiration will be negligible compared to other drainage pathways, and is not included in the calculations.

Surface runoff and flow to the subsurface drains are assumed to constitute the flows reaching the storm drain system, and thus are the flows included in the flow factor.

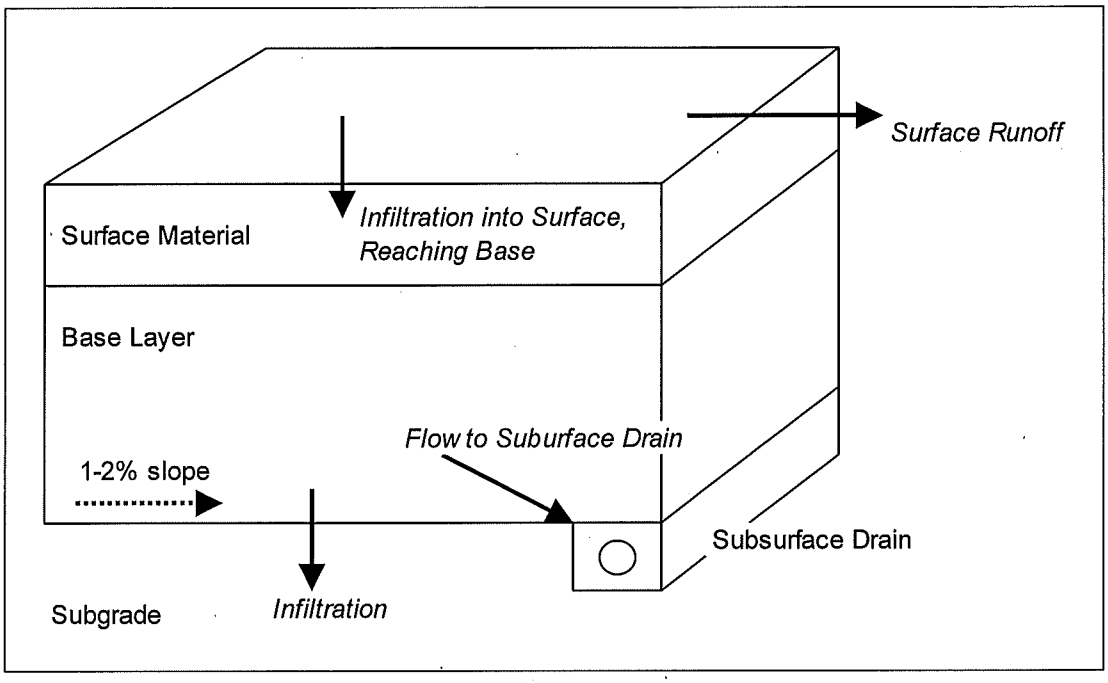


Figure 2. Flow pathways for athletic fields.

Key Design Parameters – Permeability and Vertical and Lateral Flow Rate

Surface and Base Material

Using methodology in the Department of Ecology's *Stormwater Management Manual for Western Washington*, the infiltration rate (or hydraulic conductivity) in a soil layer is estimated as a function of the native soil type or the 10th percentile particle size (D10; see Table 1 and Figure 3). The assumed surface and base material permeability is reported in Table 2 on the following page.

For the all-weather fields, the infiltration rate of the surface material is taken from the middle of the recommended range because the sand/silt material tends to remain uncompacted under normal use. In contrast, for the sand-based turf, the infiltration rate is assumed in the lower end to the middle of the range indicated in Figure 3, because the addition of organic material tends to result in some compaction due to foot traffic. The infiltration rate of the synthetic turf surface material (cryogenic rubber) is reported separately, as 70 inches per hour (HWA 2006; Attachment 2).

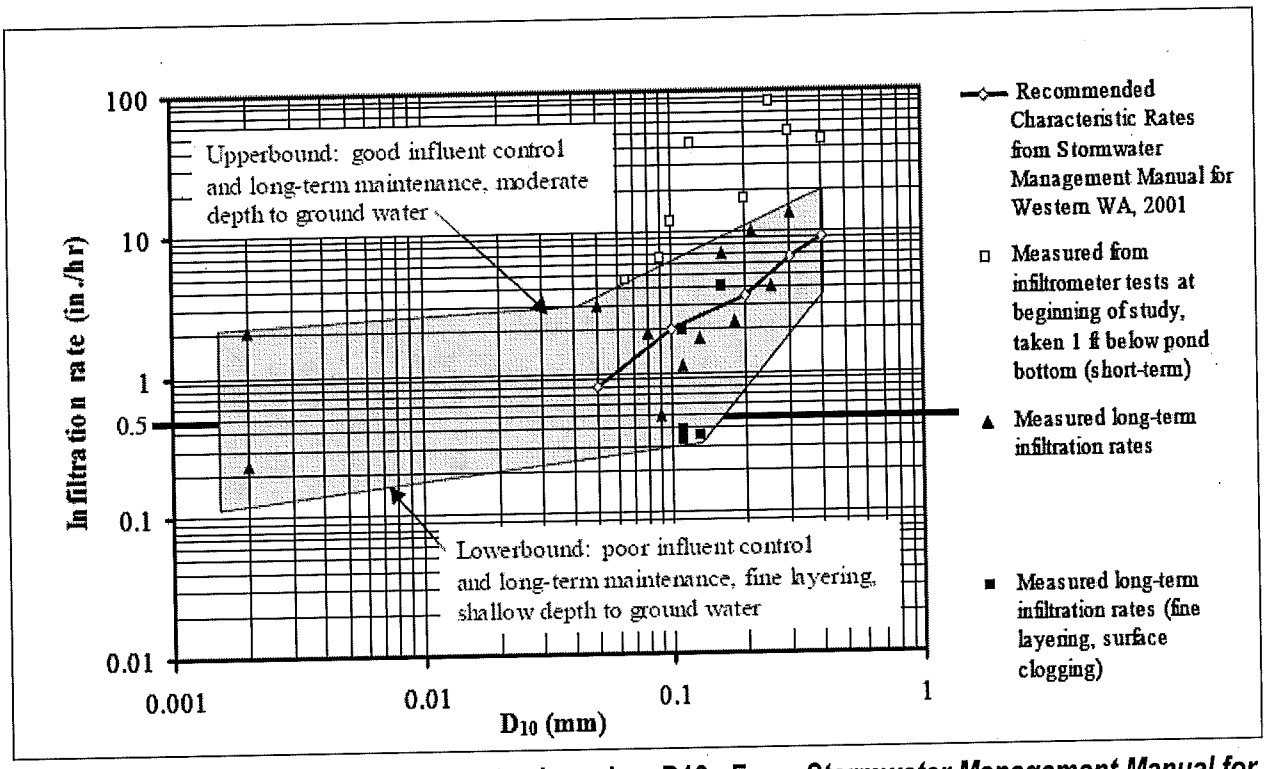


Figure 3. Recommended infiltration rates based on D10. From *Stormwater Management Manual for Western Washington.*

The hydraulic conductivity of the base material is assumed in the middle of the range for all three field types, as it is protected by the overlying surface material, does not contain organic material, and does not receive direct traffic. The base material vertical permeability is not limiting in the model; that is, the model does not evaluate vertical infiltration through the base material because (1) only one to three time steps (depending on the design storm) have precipitation greater than the base material permeability, and (2) the base material permeability is more than twice the subgrade material permeability. The base layer is assumed to pass water directly through to the subgrade or convey it laterally to the subsurface drains.

Table 2. Estimated infiltration rates

	Base Material	Surface Material
Synthetic Turf	D10 range: 100 sieve to 30 sieve (0.15 mm to 0.6 mm; 0.006" to 0.023") K range: 3 – 10 inches per hour	D10: Not available K: 70 inches/hour (HWA memo, Attachment xx)
All-Weather Fields	D10 range: 100 sieve to 40 sieve (0. 15 mm to 0.4 mm; 0.006" to 0.016") K range: 3 – 8 inches per hour	D10 range: 270 sieve to 200 sieve (0. 053 mm to 0.075 mm; 0.002" to 0.003") K range: 0.8 to 1.5 inches per hour
Sand-Based Turf	D10 range: 60 sieve to 40 sieve (0. 25 mm to 0.4 mm; 0.01" to 0.016") K range: 5 to 8 inches per hour	D10 = 0.003" (no range available) K range: 0.25 – 1 inches per hour

Native Subgrade

The native subgrade soil is assumed to have a long-term infiltration rate of 0.01 inch per hour. This is based on typical infiltration rates for uncompacted hydrologic soil group C (using the middle of a range of 0.05 – 0.15 inches per hour (Refer to Attachment 3), and consideration of the effects of compaction. Attachment 1 (Section 02201, 3.08.B.2) describes subgrade compaction requirements. Compaction also substantially reduces infiltration rates and a wide range of impacts is reported (Refer to Attachment 3). For the purposes of this analysis, it is assumed that compaction reduces the long-term infiltration rate by a factor of 10.

Modeling

A spreadsheet model was developed to estimate the proportion of precipitation that runs off the field surface, enters the subsurface drains, and infiltrates. This modeling method uses several simplifying assumptions.

In ten-minute time steps over a 24-hour unit storm, the model performs the following calculations:

- Report *precipitation* increment
- Determine *infiltration into the surface* as the lesser of *infiltration rate over the 10-minute period* or *precipitation*
- Tally *surface runoff* as *precipitation - infiltration*
- Determine *infiltration into subgrade* as lesser of *infiltration rate over the 10-minute period* or (*accumulated water in the base material from the previous time step + infiltration into the surface*)
- Determine *new saturated depth* as (*accumulated water in the base material from the previous time step + infiltration into the surface - infiltration into subgrade*) ÷ *void space in base material*
- Determine *lateral gradient* as *new saturated depth* ÷ (*space between laterals* ÷ 2); this assumes the saturated depth in the center of each "cell" represents the average depth
- Calculate the *lateral flow to the subsurface drains* (converted to inches averaged over the cell) as *lateral permeability * lateral gradient * saturated depth * void space in base material * time ÷ space between laterals.* Lateral flow rate is calculated using Darcy's

Law, where flow velocity is the product of the hydraulic conductivity and the head gradient.

- If *lateral flow to the subsurface drains* does not drain the volume represented in the *new saturated depth* calculate *ending saturated depth* as the *remaining volume ÷ void space in base material*

Modeling Assumptions and Validations

Assumptions are shown in bold, with the validation of each assumption in the text that follows.

- **Flow only toward downslope subsurface drain:** For simplification, the model assumes that all flow within each "cell" goes to the downslope subsurface drain (not splitting between the uphill and downhill drains).
- **No surface runoff due to the turf becoming fully saturated:** During this analysis, the saturated depth did not exceed 9 inches at any time step.
- **Subgrade infiltration occurs before lateral flow to subsurface drains:** Within each time step, the model routes flow to infiltration before routing it laterally.
- **All lateral flow reaches subsurface drains in each time step:** Any time that water accumulates in the base layer (when it does not fully infiltrate), the lateral flow rate is calculated for that time step, and all lateral flow is assumed to reach the subsurface drains.

Results

The calculated flow factors for each field type are summarized in Table 3, for the ranges of surface and base infiltration rates shown in Table 2. These flow factors represent the combined percentage of precipitation that becomes surface runoff or reaches the underdrains (the percentage of water that does not infiltrate).

Also provided are flow factors for land cover types currently used in SPU's rate structure.

Table 3. Flow factors for athletic fields

Surface Type	Average Storm	6-month Storm	2-year Storm	25-year Storm
Athletic Fields				
Synthetic Turf	0% to 2%	4% to 14%	6% to 17%	16% to 35%
All-Weather Fields	0% to 2%	4% to 12%	6% to 16%	17% to 33%
Sand-Based Turf	~1%	4% to 18%	6% to 21%	17% to 37%
Existing Surface Types				
Impervious- All Types	61.3%	84.8%	89.0%	92.5%
Pervious – All Other	2.2%	31.4%	43.3%	56.4%
Pervious – Woods and Unmanaged Grass	2.1%	11.4%	21.4%	34.9%
Pervious – Good Forest	2.0%	4.8%	12.7%	24.9%

There is considerable variation in the flow factors because there is considerable variation allowed in the specifications for each athletic field type. Generally, all three field types have flow factors that span the range of "Good Forest" and "Woods and Unmanaged Grass"

condition, and for purposes of determining drainage rates, treatment as Woods and Unmanaged Grass is appropriate for the range of specifications evaluated.

The performance of the fields can be explained by the behavior of the surface and base materials. The surface materials allow the majority of the precipitation to infiltrate. The interface between the base course and the subgrade is much larger than the interface between the base course and the drain trench, so more water travels vertically to the subgrade than laterally to the subsurface drains. This is consistent with observations by Seattle Parks Staff[2] of minimal flow from the subsurface drains into the storm drain system.

However, flow factors in the upper end of the D10 range (meaning largest particle size and highest hydraulic conductivity) produce more runoff to the subsurface drains compared with flow factors in the lower end of the D10 range. This is because the lateral flow rates increase, and more water is able to reach the subsurface drains as opposed to infiltrating into the compacted subgrade.

The recommended flow factor classifications provided in this memo apply only to fields with similar design characteristics. In particular, the fields should have the following design features:

- Surface material: D100 no greater than 0.25 inch and D10 no less than 0.002 inch. If specifications indicate presence of organic material, the surface material must be no more than 15 percent organic.
- Base material: non-organic material with D10 between 0.004 inch and 0.023 inch, minimum depth at least six inches.
- Combined depth of surface and base materials exceeding nine inches.
- Subsurface drains spaced at least 15 feet, and subsurface drain pipes located at least two inches above bottom of subsurface drain trenches.
- Maximum slope two percent toward subsurface drains.
- Permeable liner.

Fields with different designs should be evaluated separately to ensure that they will generate similar flow volumes. The spreadsheet model developed for this application can be used to evaluate different fields.

[2] Mark Orth, Seattle Parks Department Engineer.

ATTACHMENT 1: RELEVANT SPEC SECTIONS

PART 1- GENERAL

1.01 Description:

Provide all labor, materials, and equipment necessary to perform the complete installation of the Synthetic Turf Base.

1.02 Related Sections:

Coordinate related work specified in other parts of the Project Manual, including but not limited to following:

Section 02201 - Earthwork for Athletic Fields
Section 02222 - Synthetic Athletic Field Turf Systems

1.03 References:

City of Seattle Standard Specifications for Road, Bridge and Municipal Construction (most recent edition)

1.04 Quality Assurance:

A. The Contractor is responsible for verifying the quality of the work and shall perform compaction and density tests on request of the Engineer to check compliance with these specifications. A copy of the test reports shall be furnished to the Engineer.

B. The Engineer's Testing Agency may perform compaction and density tests to check compliance with these specifications.

C. The Engineer may require that an independent testing laboratory test imported materials at any time. If the material is found to be non-compliant with the Contract, the Contractor shall bear the cost of testing, removal of all non-compliant materials from the Project Site, and replacement of the materials with

materials meeting the requirements of the Contract. If the materials tested are found to be compliant with the requirements of the Contract, the Owner will reimburse the Contractor for costs incurred by testing plus mark-ups as allowed for elsewhere in the Contract.

D. It is the responsibility of the Contractor to verify the accuracy of all survey information provided by the Owner prior to commencing excavations or filling operations. Commencement of these operations constitutes acceptance of the survey information as appropriate to meet the intent of the Contract.

E. Submittals: The Engineer shall approve in principle all products used in the execution of this section prior to their importation to the Project Site. Submit a particle gradation analysis in graph and table form for each product specified. Approval of the Engineer of an analysis does not constitute approval of the actual product, which may be subject to additional testing at any time per paragraph 1.04.C above.

PART 2- PRODUCTS

2.01 Prior to the importation of any materials, the Contractor shall provide the Engineer with a certified test lab reports indicating properties of each product. The Engineer shall be the final determining factor in establishing compliance with requirements. No material shall be brought onto the job site until the initial analysis has been approved in writing. During the course of importation of materials, the Contractor shall be responsible for continually checking the materials to insure that they continue to meet the Specifications.

2.02 Base Geo-textiles:

Refer to Section 02201 - Earthwork for Athletic Fields

2.03 Field Base Aggregates:

A. General:

1. Provide Aggregates with the specified properties.
2. Provide independent laboratory test results (supplier lab results will not be accepted) identifying performance to the properties specified in the units identified here.

B. Base Course Aggregate:

The Base Coarse Aggregate (Permeable Base Stone) shall be fully fractured, highly permeable gradation of aggregates for installation on prepared sub-grade to defined slopes and grades. Provide materials meeting the following property specifications:

1. Material shall contain less than 1/10 of 1% organic material by weight as measured by burn test.
2. All surfaces of individual particles shall be fractured. No worn or naturally occurring faces shall be present.
3. Permeability of a minimum 24" depth, compacted to 95% Proctor, shall be a minimum of 100 inches per hour.
4. Material shall meet or exceed the following sieve analysis:

Sieve Size	Percent Passing
1-1/4" square sieve	100
1" square sieve	90 to 100
¾" square sieve	80 to 100
½" square sieve	50 to 80
3/8" square sieve	40 to 60
No. 4 sieve	20 to 40
No. 8 sieve	15 to 30
No. 30 sieve	5 to 20
No. 100 (wet)	2 to 10
No. 200 (wet)	2 to 6

Modified Type 2 Aggregate, screened to meet the properties described, or Permeable Base Stone from Glacier Northwest, or approved equal.

C. Leveling Course Aggregate:

The Leveling Coarse Aggregate (Permeable Top Stone) shall be fully fractured, highly permeable gradation of aggregates for installation on prepared Base Aggregate to defined slopes and grades. Provide materials meeting the following property specifications:

1. Material shall contain less than 1/10 of 1% organic material by weight as measured by burn test.
2. All surfaces of individual particles shall be fractured. No worn or naturally occurring faces shall be present.

3. Permeability of a minimum 12" depth, compacted to 95% Proctor, shall be a minimum of 50 inches per hour.

Sieve Size	Percent Passing
½" square sieve	100
3/8" square sieve	90 to 100
No. 4 sieve	55 to 75
No. 8 sieve	30 to 50
No. 30 sieve	5 to 25
No. 100 (wet)	2 to 10
No. 200 (wet)	2 to 6

Modified Type 1 Aggregate, screened to meet the properties described, or Permeable Top Stone from Glacier Northwest, or approved equal.

PART 3- EXECUTION

3.01 Protection of Work In Progress:

It is the responsibility of the Contractor to protect all work in progress from damage due to extremes of cold, moisture, or drying, or mechanical damage from equipment traffic or foot traffic. Alert the Engineer to the presence or likelihood of conditions that may adversely affect the quality of the work, the physical structure of soils, or transport of site soils off-site.

A. Do not work frozen soils.

B. Protect soils from excessive moisture. During periods of prolonged precipitation, take aggressive steps to avoid over-saturation, erosion, or homogenization of soils by covering with protective plastic sheeting, collection and controlled dewatering, detention for sediment removal, and allowing excessively wetted soils to remain fallow until approved by the Engineer as appropriate for continued work.

C. Apply supplemental moisture to overly dry soils.

D. Do not operate heavy equipment near excavations where trench wall or cut-slope failure may result.

3.02 Inspection:

A. Prior to commencing the work of this Section, confirm that Section 02200, 3.09, Geo-textiles have been approved by the Engineer as satisfactorily installed.

B. Protect the approved work as installation of Field Base is commenced and completed.

3.03 Base Course Aggregate:

A. Do not operate machinery directly on approved Geotextile installation.

B. Place approved Base Course Aggregate in a manner that will minimize disturbance to the Geotextile installation. Use only approved transport methods for placement of materials. Thoroughly cover Geotextile with sufficient Base Course Aggregate to evenly distribute compressive forces of placement operation.

C. Spread lift of Base Course Aggregate to the depth specified in the Contract Drawings. Place and mechanically compact in lifts not exceeding 9" at any one time. Perform compaction with a static roller of sufficient weight to insure proper compaction.

D. Perform testing indicating initial lift of Base Course Aggregate is at 95% of maximum density.

E. Provide complete compaction to the lines, grades, and slopes indicated on the Contract Drawings. Vertical tolerance for the Base Course Aggregate installation shall be ½" over 10' as measured from a string line.

3.04 Leveling Course Aggregate:

A. Place approved Leveling Course Aggregate in a manner that will minimize disturbance to the approved Base Course Aggregate installation. Use only approved transport methods for placement of materials.

B. Spread a single lift of Leveling Course Aggregate to the depth specified in the Contract Drawings, allowing for compaction. Perform compaction with a static roller of sufficient weight to insure proper compaction.

C. Provide complete compaction to the lines, grades, and slopes indicated on the Contract Drawings. Vertical tolerance for the Leveling Course Aggregate

installation shall be ¼" over 10' from any given point in any direction, as measured with a string line.

D. Coordinate approval of Leveling Course Aggregate installation with the requirements of Section 02222 Synthetic Turf System.

3.05 Disposal of Excess and Waste Materials

Remove from Owner's property all waste materials, including unacceptable materials, trimmings, roll cores, trash and debris, and dispose of it off site in a legal manner. Provide dump receipts from an approved dumpsite.

END OF SECTION 02206

PART 1 - GENERAL

1.01 Description: Provide all labor, materials, and equipment to perform the following work of the Contract, including incidentals related to that work and coordination and support of other work specified elsewhere in the Contract Documents:

A. Safety Monitoring & Response.
B. Protection of Existing Features and Work in Progress.
C. Survey for horizontal and vertical control of all work of the Contract.
D. Grading and compaction as required achieving lines and grades on Drawings.
E. Installation of Sub-grade Geotextile.
F. Excavation and backfill of excavations for Storm Drainage System to lines and grades on Drawings.
G. Excavation and backfill of excavations for Irrigation system as shown on Drawings.
H. Grading & Compaction of sub-grade and base aggregates for Concrete and Asphalt Concrete Paving.
I. Import and Placement of Base Sand.
J. Import and placement of Playfield Soils for Hydroseeded Lawn Areas.
K. Placement and compaction of Structural Soils for Reinforced Turf.
L. Removing materials from the site which are in excess of that required.
M. Coordinate Earthwork operations with other work of the project.

1.02 Related Sections: Coordinate related work specified in other parts of the Project Manual, including but not limited to following:

Section 02050 - Site Demolition
Section 02051 - Tree and Plant Protection
Section 02060 - Mineral Aggregates
Section 02100 - Site Preparation
Section 02120 - Site Utility Removal
Section 02205 - Athletic Field Natural Turf Base
Section 02206 - Athletic Field Synthetic Turf Base
Section 02221 - Athletic Field Sand Silt Surfacing
Section 02222 - Athletic Field Synthetic Turf Surfacing
Section 02510 - Asphalt Paving for Site Work
Section 02515 - Concrete Masonry Unit Paving
Section 02520 - Concrete Paving for Site Work
Section 02525 - Pre-cast Reinforced Concrete Turf Paving
Section 02526 - Plastic Reinforced Turf Paving
Section 02720 - Storm Sewers and Sub-surface Drainage Systems
Section 02730 - Sanitary Sewers
Section 02810 - Irrigation Systems

Section 02990 - Site Restoration

1.03 References:

Seattle Standard Plans and Specifications for Road, Bridge and Municipal Construction (most recent edition).
City of Seattle Title 22.802: Stormwater, Grading and drainage Control Code (most recent edition).
R.C.W. – Chapter 39.04.180 Public Works/Trench Excavations – Safety Systems Required.
R. C. W. – Chapter 49.17 WISHA.
WAC 296-155 – Safety Standards for Construction Work.
WAC 296-155-660.

1.04 Quality Assurance:

A. The Contractor is responsible for verifying the quality of the work and shall perform compaction and density tests on request of the Engineer to check compliance with these specifications. A copy of the test reports shall be furnished to the Engineer.

B. The Engineer's Testing Agency may perform compaction and density tests to verify compliance with these specifications.

C. The Engineer may require that an independent testing laboratory test imported materials at any time. If the material is found to be non-compliant with the Contract, the Contractor shall bear the cost of testing, removal of all non-compliant materials from the Project Site, and replacement of the materials with materials meeting the requirements of the Contract. If the materials tested are found to be compliant with the requirements of the Contract, the Owner will reimburse the Contractor for costs incurred by testing plus mark-ups as allowed for elsewhere in the Contract.

D. It is the responsibility of the Contractor to verify the accuracy of all survey information provided by the Owner prior to commencing excavations or filling operations. Commencement of these operations constitutes acceptance of the survey information as appropriate to meet the intent of the Contract.

E. Submittals:

1. Safety Products - Submit for the Engineer's approval, the manufacturer's product data for each worker safety product specified.

2. Bulk Materials - The Engineer shall approve in principle all products used in the execution of this section prior to their importation to the Project Site. Submit a particle gradation analysis in graph and table form for each product specified. Approval of the Engineer of an analysis does not constitute approval of the actual product, which may be subject to additional testing at any time per paragraph 1.04.C above.

1.05 Existing Conditions: Documentation regarding existing conditions, in addition to the current survey supplied in the Contract Drawings, includes the following;

A. Project Site Record Drawings - Complete archival documentation of previous improvements made by the Owner at the project site may be reviewed during regular business hours at the offices of the Park Engineer, located at 800 Maynard Ave., Seattle WA. Telephone 206-233-7920 to arrange review of these documents. Copy services are available for a fee unless other arrangements are made.

B. Geotechnical and Soils Reports - The Owner shall provide updated geotechnical and/or soils reports in anticipation of this project if they are available. Those reports will be attached in their entirety, for informational purposes only, following this Section.

C. Other Available Information - Other information regarding utilities belonging to jurisdictions other than the Owner may be obtained through the Seattle Public Utilities (SPU) and/or King County - Metro.

1.06 Manufacturer's Qualifications: The Contractor shall cause the materials that are to be furnished under this section to be the product of firms that are regularly engaged in the manufacture of the specified materials.

PART 2 - PRODUCTS

2.01 General:

A. Prior to the importation of any materials, the Contractor shall provide the Engineer with a certified test lab report of the sieve analysis of each aggregate product. The Engineer shall be the final determining factor in establishing compliance with sieve requirements. No material shall be brought onto the job site until the initial sieve analysis has been approved in writing.

B. During the course of importation of materials, the Contractor shall be responsible for continually checking the materials to insure that they continue to meet the Specifications.

2.02 Safety, Monitoring, & Response Equipment:

A. General: The Contractor shall provide barricades, safety guards, temporary fencing, signage and/or other methods to secure trenches, open excavations, and other unsafe conditions resulting from this construction. Undertake work in full compliance with all applicable regulatory requirements.

B. Monitoring Equipment:

1. Contractor shall require workers engaged in trenching deeper than 36" below existing finished grade or in the presence of landfill materials to wear monitors or badges capable of detecting methane gas. Monitors shall emit an audible alarm if methane gas in excess of 10% of the lower explosive limit (LEL) is detected. Monitors shall be used in accordance with the manufacturer's directions.
2. Contractor shall have a portable hand-held methane monitor capable of indicating percent of LEL on site at all times during trenching and grading. Contractor's personnel shall be familiar with operation of the monitor and capable of obtaining accurate readings.

C. Personal Protective Gear: Contractor shall have Tyvek® suits and latex gloves, or gloves offering greater protection, on site and available for use by workers during trenching and grading work. In the event that buried refuse is encountered, workers shall use Tyvek suits and latex (or better) gloves for personal protection.

2.03 Geo-textiles & Geo-grid:

A. Base Geo-textile shall be a woven, non-biodegradable, highly permeable polypropylene fabric. Fabric shall possess the following properties;

Property	Test Method	Value/Units
Grab Tensile	ASTM D4632	200 lb.s
Grab Elongation	ASTM D4632	15%
Puncture	ASTM D4833	90 lb.s
Mullen Burst	ASTM D3786	400 psi
Permittitivity	ASTM D4491	.07 cm/sec

Base Geo-textile shall be supplied in minimum 15' wide rolls of sufficient length to provide continuous cover of sub-grades receiving base sand with no more than a single interrupting seam or splice.

GTF 200S Woven Polypropylene Fabric as manufactured by LINQ Industrial Fabrics, Inc., Somerville, SC (800) 543-9966, or approved equal.

B. Structural Geo-grid shall be a biaxial polymeric grid as follows (values given are for weakest axis);

Property	Value/Units
Initial Modulus	15,170 lbs./ft
Tensile Strength @ 2% Strain	280 lbs./ft
Tensile Strength @ 5% Strain	580 lbs./ft
Junction Efficiency	93%
Junction Strength	MD 98 lb TD 111 lb
Flexural Rigidity	250,000 mg-cm

Product supplied minimum roll width of 4 meters x 50 meters length per roll.

2.04 Storm Drainage Backfill:

A. Perforated Drainage:

1. Pipe Bedding & Backfill shall be Type 4 aggregate, 1½" washed drain rock. Perforated pipe bedding shall consist of well-graded mineral aggregate with no fractured surfaces, meeting a particle gradation as follows:

Sieve Size	Percent Passing
1-1/2" square	100
1-1/4" square	90-100
3/4" square	0-20
3/8" square	0-2

2. Middle Lift shall be 3/8" pea gravel. The perforated pipe middle lift shall consist of well graded mineral aggregate with no fractured surfaces, meeting a particle gradation where 100% of the particles fall between 1/4" and 1/2" (largest measured diameter).

3. Top Lift shall be 3/16" pea gravel (4X8 gravel). The perforated pipe top lift shall consist of well graded mineral aggregate with no fractured surfaces, meeting a particle gradation where 100% of the particles fall between 1/8" and 1/4" (#4, #8 screen), (largest measured diameter).

B. Solid Pipe:

1. Bedding - For use as bedding in solid pipe storm drainage trenches shall be Type 22, 5/8" crushed gravel, meeting the following particle gradation:

Sieve Size	Percent Passing
5/8"	100
1/2"	75-100
1/4"	0-25

2. Backfill: Backfill for solid piped drainage shall be of native soils occurring on-site, less any particles over 3" in any measured diameter. Provide proper screening of materials prior to backfill.

2.05 Irrigation Trench Backfill:

A. Sand for pipe bedding and backfill around all irrigation heads shall be building sand that meets the following sieve gradation:

Sieve Size	Percent Passing
No. 6	95-100
No. 8	85-95
No. 50	15-30
No. 200	0-2

Base Sand may be substituted only with the Engineer's approval.

B. Suitable backfill material for use around all pipes and equipment as shown on the drawings shall be native topsoil with no rocks or other debris more than 1/2 inch diameter or common builder's sand. Provide proper screening of materials prior to backfill.

C. Irrigation trench backfill shall comply with Section 02810.

2.06 Pavement Base Aggregate: For use as imported base course for Concrete, Asphaltic Concrete, and Concrete Unit Pavement;

Type 1 Mineral Aggregate (5/8" minus crushed rock, bearing no naturally occurring or worn surfaces) per City of Seattle Standard Specifications (most recent edition) Section 9-03.16,. Gradation of the base course shall be:

Sieve Size	Percent Passing
5/8" square sieve	100
1/4" square sieve	50 – 75
No. 40 sieve	8 – 24
No. 200 sieve	10.0 maximum

2.07 Base Sand: Base Sand shall be composed of no less than 99.7% mineral aggregates by dry weight (as measured by organic burn test) meeting the following particle analysis gradation:

Screen Size	% Passing
¼"	100
#4	90-100
#10	80-90
#20	60-80
#30	40-60
#60	<10
#100	<5
#200	<2

Base Sand compacted to 95% of maximum dry density as measured by the Modified Proctor test (ASTM D1557) shall exhibit an infiltration rate of a minimum of 9 inches per hour.

2.08 Topsoils:

A. General: Two topsoil conditions are specified as follows;

1. Topsoil (Playfield Soil) for Lawns and Grass Areas, consisting of 80% Base Sand as specified in 3.07 above and 20% Composted Organic material as specified below.

2. Topsoil (Planting Soil) for Landscape Plantings, consisting of 67% Sandy/Loam as specified in 3.07 above and 33% Composted Organic material as specified below.

B. Composted Organic material shall consist of composted yard debris or organic waste material composted for a minimum of 6 months. Compost shall consist of 100% recycled content. In addition, the organic material shall have the following physical characteristics:

1. Shall be ground and screened using a sieve no finer than 5/16 inch and no greater than 7/16 inch.
2. Shall have a pH from 5.5 to 7.5.
3. Shall have a maximum electrical conductivity of 3.0 ohms/cm.
4. Shall have a maximum carbon to nitrogen ratio of 40:1.
5. Shall be certified by the Process to Further Reduce Pathogens (PFRP, most recent edition) guideline for hot composting as established by the United States Environmental Protection Agency.

C. Submit soil analysis from a soils testing laboratory for both Playfield Soil and Planting Soil to the Engineer. Indicate source and obtain the Engineer's approval before hauling to site (analysis test with a 2 pound bag sample is required).

D. Suggested Sources for Composted Organic Material:

Inclusion on this list does not constitute pre-approval of any materials. All materials for use on the project are subject to all testing and inspections either specifically listed in this section or implied elsewhere in the Contract.

1. Red-E Topsoils
   18816 - NE 80th Street
   Redmond, WA 98052
   Ph. (425) 868-6500
   www.red-e-topsoil.com
2. Cedar Grove Compost Company
   17825 Cedar Grove Road S.E.
   Maple Valley, WA 98038
   Ph. (425) 432-2395, (425) 432-7043 (fax), 1-877-SOILS-4U (toll free)
   www.cedar-grove.com

3. Sawdust Supply Company, Inc.
   6314 - 7th Ave South
   Seattle, WA 98108
   Ph. (206) 622-4321, (206) 622-3476, (206) 878-8455, 1-888-622-4321 (toll free)
   www.sawdustsupply.com
4. Or, approved equal.

2.09 Common Fill:

Where on-site soils prove to be insufficient in quantity or quality to achieve design sub-grades, import fills may be accepted upon approval of the Engineer. Common Fill shall be pit run sand available from a recognized commercial source meeting the following sieve gradation per Section 9-03.12(5) of the Standard Specifications:

Sieve Size	Percent Passing
3/8" square	100
1/4" square	25-75
#200	0-5

Organic content shall be no greater than 8% dry weight. Variations to this particle gradation may be considered dependant on the application. Submit to the Engineer a written request to import Common Fill including the total volume of import anticipated (or range) and the source including name, address, and phone number of supplier, and geographic source of the material proposed to be imported.

PART 3 - EXECUTION

3.01 Safety Monitoring & Response: In addition to all current State and Local Safety Requirements;

A. Contractor shall require workers engaged in trenching deeper than 36" below existing finished grade or in the presence of landfill materials to wear monitors capable of detecting methane gas. Monitors shall emit an audible alarm if methane gas in excess of 10% of the lower explosive limit (LEL) is detected. Monitors shall be used in accordance with the manufacturer's directions.

B. Contractor shall have a portable hand-held methane monitor capable of indicating percent of LEL on site at all times during trenching and grading. Contractor's personnel shall be familiar with operation of the monitor and capable of obtaining accurate readings. Contractor shall periodically inspect trenches using the

monitor. Inspections shall be done at least at the start of work each day and at mid-day. In the event that a monitor(s) worn by a worker(s) detect methane, the portable detector shall be used to confirm the presence of methane and determine the actual percentage of the LEL.

C. In the event that methane gas in excess of 10% of LEL is found to be present, the Contractor shall stop work in the affected area and allow the methane to dissipate. As the contractor's option, fans may be used to speed dissipation of the methane. Work shall not resume in the affected area until the methane gas level has decreased below 10% of LEL.

D. When working in the presence of landfill materials (exposed refuse), workers shall wear Tyvek suits and latex gloves or other approved protection.

E. Maintain conformance to Contractor's Health and Safety Plan.

3.02 Protection of Existing Facilities:

A. Utilities: The Contractor shall protect from damage private and public utilities. Verify the locations of underground utilities minimum 48 hours prior to excavation.

B. Pavement: The Contractor shall protect from damage all pavement or paved areas including curbs and walks intended to remain. Contractor shall be responsible for replacement if damage occurs to pavement or curbs.

C. Access Streets and Roadways: Provide wheel cleaning stations to clean wheels and undercarriage of trucks before leaving site, as necessary to prevent dirt from being carried onto public streets. If streets are fouled, they must be cleaned immediately in conformance with City of Seattle and all governing requirements and regulations.

D. Repair and or replacement of damaged facilities to the Engineer's satisfaction will be accomplished at the Contractor's expense.

3.03 Protection of Work In Progress: It is the responsibility of the Contractor to protect all work in progress from damage due to extremes of cold, moisture, or drying, or mechanical damage from equipment traffic or foot traffic. Alert the Engineer to the presence or likelihood of conditions that may adversely affect the quality of the work, the physical structure of soils, or transport of site soils off-site.

A. Do not work frozen soils.

B. Protect soils from excessive moisture. During periods of prolonged precipitation, take aggressive steps to avoid over-saturation, erosion, or homogenization of soils by covering with protective plastic sheeting, collection and controlled dewatering, detention for sediment removal, and allowing excessively wetted soils to remain fallow until approved by the Engineer as appropriate for continued work.

C. Apply supplemental moisture to overly dry soils.

D. Do not operate heavy equipment near excavations where trench wall or cut-slope failure may result.

3.04 Survey Control:

A. General:

1. Contractor Responsibilities: It is the responsibility of the Contractor to construct the improvements to the lines and grades as defined in the Contract Drawings. Further, it is the responsibility of the Contractor to anticipate and alert the Engineer immediately to any conflicts of dimension, either vertical or horizontal, that may result in accumulated error.
2. Qualifications: Secure the services of a State Licensed Land Surveyor to establish the primary lines and grades required for the layout of the work. Coordinate the work of the project surveyor with establishment of baselines, hubs, and/or temporary benchmarks to be provided by the Owner.

B. Horizontal Control: The Owner shall provide initial horizontal control by establishment of baselines defined by points as described on the layout drawings. A minimum of three initial points will be provided. The Contractor shall request establishment of initial horizontal control through the Engineer a minimum of 72 hours prior to need. Once established, it is the responsibility of the Contractor to protect the baseline hubs for the duration of need.

C. Vertical Control: The Owner shall provide initial vertical control by establishment of temporary and permanent benchmarks within or adjacent to the Project Limit. A minimum of two vertical control points will be provided. The Contractor shall request establishment of initial vertical control through the Engineer a minimum of 72 hours prior to need. Once established, it is the responsibility of the Contractor to protect the temporary and permanent benchmarks. Report damage or disturbance of permanent survey points directly to the Engineer, and the Office of the Seattle Parks Department Survey Crew Chief, 206-684-4954.

3.05 Earthwork:

A. General: Removal of materials beyond indicated sub-grade elevations or dimensions without specific direction of the Engineer is not authorized. Unauthorized excavation, as well as remedial work directed by the Engineer, shall be at the Contractor's expense.

B. Stability of excavations:

1. Sides of excavations to be vertical as shown on the Drawings. Maintain sides of excavations in a clean and safe condition until completion of back filling.
2. Shoring and bracing are required at excavations deeper than 4 feet below adjacent existing grade. All shoring and bracing shall conform to the requirements of the City of Seattle Standard Specifications (most recent edition) and requirements of the Washington Industrial Safety and Health Act.

C. Dewatering: Prevent surface and subsurface water from flowing into excavations and from flooding project site. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey rain water and water removed from excavations to collecting or run-off areas. If required, line ditches and sumps with coarse-grained material that acts as a filter. Do not use trench excavations as temporary drainage ditches. All dewatering shall conform to the requirements of the City of Seattle Standard Specifications (most recent edition) and Title 22.80 of the City of Seattle Stormwater, Grading, and Drainage Control Code (most recent edition).

D. Material Storage: Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade and shape the stockpiles for proper drainage.

E. Locate and retain soil materials away from edge of excavations and drip lines of trees to remain.

F. Dispose of excess soil material and waste materials as herein specified.

3.06 Grading:

A. General: Uniformly grade areas within limits of grading under this section, including adjacent transition areas. Smooth finished surface within specified areas. Smooth finished surface within specified tolerances, compact with uniform

levels or slopes between points where elevations are shown, or between such points and existing grades. Finish surfaces shall be free from irregular surface changes.

B. Landscape, Lawn, and landscape repair areas finish grade to be minus 1/2 inch from adjacent paving surfaces with smooth transition to adjacent grades.

3.07 Excavation:

A. Layout: All work shall be surveyed and staked by the Contractor as required to complete earthwork. Maintain all benchmarks, control monuments and stakes, whether newly established or previously existing. Protect from damage and dislocation. If necessary to disturb existing benchmarks, re-establish in a safe place. Notify Engineer a minimum of 3 days prior to excavation of work areas. Engineer shall inspect staking and layout of work.

B. Excavation for Field Surfacing: Cut surface under Field to comply with cross section, profile, elevations and grades as indicated. Depth of base material, if any, shall be taken into consideration.

C. Excavation for Trenches: Provide neat trenches to the depth, slope (where appropriate) and width as indicated in the Contract Drawings. Allow for import of surfacing materials and bedding. Provide clean, smooth trench walls and trench floors.

3.08 Compaction:

A. General: Control soil compaction during construction providing minimum percentage of density specified for area classification. Do not allow equipment traffic to overly compact areas beyond specified percentages. Remediate over-compaction as directed by the Engineer including ripping, regrading and re-compaction or over-excavation and in-kind replacement per plan.

B. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages for maximum density for soils which exhibit a well-defined moisture density relationship (cohesive soils) determined in accordance with ASTM D698; and not less than the following percentages of relative density; determined in accordance with ASTM 4253, for soils which will not exhibit a well defined moisture density relationship (cohesionless soils).

1. Backfill:
   a. Solid Piped Drainage Bedding under pipe- 95%
   b. Solid Piped Drainage Bedding over pipe - 75%

c. Solid Piped Drainage Backfill - 95%
d. Perforated Piped Drainage Bedding and Top Lift, water settle, 75%.
e. Irrigation Pipe Bedding below pipe - 95%
f. Irrigation Pipe Bedding over pipe - hand tamp to 75%
g. Irrigation Pipe Backfill - 85%
h. Over Excavation Backfill of Existing Sub-grade to remain - 95%

2. Sub-grades:
   a. Sub-grade soils in lawn areas (outside Playfield) - 75%
   b. Sub-grade soils on Playfield – 90%
   c. Base Sand on Playfield – 95%
   d. Sub-grade soils in landscape planting areas – 70%
   e. Import aggregate base material in paving areas - 95%.
3. Surface Fills:
   a. Playfield Soils - 85%
   b. Planting Soils - 70%
   c. Structural Soils - 90%
   d. Fills on slopes exceeding 3:1, to prevent erosion - 90%

C. Moisture Control:

1. Where sub-grade or lift of soil material must be moisture conditioned before compaction, uniformly apply water to surface of sub-grade, or layer of soil material, to prevent free water appearing on surface during or subsequent to compaction operations.
2. Before compaction, moisten or aerate each layer as necessary to provide optimum content. Compact each layer to required percentages of maximum dry density or relative dry density for each area classification.
3. Do not perform compaction operations on excessively wetted soils.

3.09 Sub-grade Geo-textiles:

A. Inspection: Prior to commencing installation of Sub-grade Geo-textiles, secure the approval of the Engineer that sub-grades and trenches have been cut and/or filled and compacted to the requirements of the Contract.

B. General:

1. This specification refers to the structural geo-grid and woven geo-textile materials collectively as "the geo-textiles".
2. Install structural geo-grid on the approved sub-grade as indicated, and the woven geo-textile immediately on the approved structural geo-grid.

3. Install all geo-textiles without wrinkles, folds, or excessive tension. Anchor ends and long runs with inert weights such as tires, sand bags, or precast concrete blocks. Do not anchor fabric with soil unless explicitly approved by the Engineer.
4. Place geo-textiles five feet beyond the horizontal layout indicated to allow placement of specified covering materials to the design layout limit. Cut and remove excess following placement of those materials.

C. Definitions:

1. Course: completed installation of fabric across the east-west width of the finished surface.
2. Longitudinal Seam(s): Seams created which run in the longest parallel axis of the finished field surface, within a single installed course of fabric.
3. Transverse Seam(s): Seams running across the east-west width of the finished field surface, between courses.

D. Install Geotextile as follows;

1. Install individual courses of fabric across the width of the field sub-grade and adjacent areas identified as receiving geo-textile.
2. Begin at area of the lowest Synthetic Turf Base Aggregate sub-grade elevation.
3. Lay fabric smooth over the full contour of the cross-section, including trenches, without wrinkles, folds, or excessive tension.
4. Install fabric with no more than one longitudinal seam per course. Overlap fabric a minimum of 36" at each longitudinal seam. Create longitudinal seams within the middle half of the field only. Offset longitudinal seams in adjacent courses of fabric a minimum of 50'. Install the fabric of the upslope side of each longitudinal seam above that of the down slope side.
5. There shall be no longitudinal seams within 20' of any trench or abrupt change in grade.
6. Overlap adjacent courses of fabric 18" (transverse seam). Run the upslope course 18" over the down slope course.
7. Install two initial courses of fabric for the Engineer's inspection and approval prior to continuing fabric installation.

3.10 Trench Backfill

A. General: Place fill materials in specified lifts to required sub-grade elevations, for each area classification as described in this Section.

B. Backfill excavations as promptly as work permits, but not until completion of the following:

1. Inspection, testing, approval, and recording locations of underground utilities.
2. Removal of shoring and bracing, and back filling of voids with satisfactory materials.
3. Removal of trash and debris.

C. Placement and Compaction: Place backfill and fill materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand operated tampers. All compaction shall be by mechanical methods. Water settling may be used for Perforated Piped Drainage aggregates only. Do not place backfill for fill material on surfaces that are overly wet or dry, frozen, or graded inconsistently.

D. Perforated Piped Drainage Trench Backfill:

1. Provide a single, consistent 4" lift of Perforated Piped Drainage Bedding.
2. Coordinate installation of piping per the requirements of Section 02710 Storm Drainage.
1. Upon Engineers approval of installation of Perforated Piped Drainage, backfill with Perforated Piped Drainage bedding to within 12" of the design sub-grade.
4. Place a uniform 6" settled lift of Perforated Piped Drainage Middle Lift Aggregate.
5. Complete installation with 6" settled lift of Perforated Piped Drainage Top Lift Aggregate to design sub-grade.
6. Where design depths of pipe do not accommodate the installation of the three specified products as described, delete the installation of middle lift aggregate following identification of the limit of the area to be modified and the approval of the Engineer.

E. Solid Piped Drainage Backfill:

1. Provide a single, consistent 4" compacted lift of Solid Piped Drainage Bedding.
2. Coordinate the installation of Solid Piped Drainage per the requirements of Section 02720 Storm Drainage.
3. Upon approval of the Engineer of installation of Solid Piped Drainage, install and additional single lift of Solid Piped Drainage Bedding in a

thickness allowing a minimum 4" (compacted) coverage over crown of Solid Pipe.

4. Complete installation with specified native soils or Common Fill as approved by the Engineer, compacted to design sub-grade.

F. Irrigation Trench Backfill:

1. Provide a single, consistent 4" compacted lift of Irrigation Pipe Bedding Sand.
2. Coordinate installation of Irrigation Piping per Section 02810 Irrigation Systems.
3. Upon Engineers approval of installation of Irrigation Piping, install an additional lift of Irrigation Pipe Bedding to 4" above pipe crown.
4. Complete backfill with specified native soils or Common Fill as approved by the Engineer, compacted to design sub-grade.

3.11 Pavement Base Backfill:

A. Provide a minimum 6" compacted lift of specified Pavement Base Aggregate true to the elevations either described or implied in the Contract Drawings or as required to match adjacent existing pavements or landscapes, and a minimum of 4" beyond the horizontal layout lines of pavement or as indicated on the Contract Drawings.

B. Pavement Bases shall be graded such that upon approval of compaction, the surface of the Base is at the correct elevation to receive pavement to design finished grade.

3.12 Backfill of Over-excavations: Backfill over-excavations with approved excess native soils or approved Common Fill true to the design elevations per the Contract Drawings unless otherwise directed. Install and compact to specified rates in lifts not exceeding 8" of loose material.

3.13 Base Sand: Upon approval of the installation of Sub-grade Geo-textiles, import, place, grade and compact Base Sand to the requirements of sections 3.04, 3.05, and 3.07 above.

3.14 Playfield Soil Installations:

A. General: Upon approval of the installed Base Sand or sub-grade preparation as appropriate, install Playfield Soil per the requirements of paragraphs 3.04, 3.05, and 3.07 above.

B. Install Playfield Soil in a single, uniform 6" lift to the lines and elevations indicated on the Contract Drawings. Do not "feather" edges into existing surfaces.

3.15 Planting Soil:

A. General: Upon approval of the prepared sub-grade, install Planting Soil per the requirements of paragraphs 3.04, 3.05, and 3.07 above.

B. Install Planting Soil in a single, uniform 6" lift to the lines and elevations indicated on the Contract Drawings. Do not "feather" edges into existing surfaces.

3.16 Disposal of Excess and Waste Materials

Remove from Owner's property all waste materials, including unacceptable excavated material, trash and debris, and dispose of it off site in a legal and timely manner. Provide dump receipts from an approved dumpsite if directed.

END OF SECTION 02201

PART 1 - GENERAL

1.01 Description:

Provide all necessary labor, materials, equipment, and incidentals required to install a Short Pile Synthetic Turf system over precast rubber tiles, on an aggregate base described elsewhere, for use in batting cages and bullpen areas outside of the field of play.

1.02 Related Sections:

Section 02201 - Earthwork for Athletic Fields
Section 02205 - Synthetic Athletic Field Turf Base

1.03 References: U.S. Consumer Product Safety Commission Publication (CPSC) #325, "Handbook for Public Playground Safety".

1.04 Quality Assurance: All materials proposed for the work of this Section shall be new and undamaged, in the manufacturer's original unopened packaging. Materials shall be manufactured for the specified use.

1.05 Delivery, Storage and Handling: Provide for delivery of all materials required to complete the work of this section. Store all materials in such a manner as to prevent ground contact or exposure to sun, wind, or rain. Pay particular attention to maintaining infill materials as dry and flowable. Handle all materials in accordance with the manufacturer's recommendations or requirements for maintenance of the requirements of the Warranty.

PART 2 - PRODUCTS

2.01 General: Supply all products necessary to provide for the installation of the Short Pile Synthetic Turf System on an aggregate base as indicated in the Contract Drawings, including materials which may not be mentioned here but are required either by the manufacturer or installer to complete the installation.

2.02 Synthetic Turf Carpet: Short Pile Synthetic Turf Carpet shall be AstroTurf® System 6 as manufactured by South West Recreational Industries, Inc., Leander, TX (800) 233-5714, or approved equal. Provide adhesives as recommended by the manufacturer.

2.03 Precast Rubber Tiles: Commercially available pre-cast rubber tile safety surfacing manufactured for fall protection to the most current CPSC standards for deceleration and Head Injury Criteria from a Critical Height of six feet. System provided shall have an

integrated connection device such as interlocking shapes precast into the individual units or dowels. Glue will not be accepted as a standard connector detail. Color shall be black. Example product Dinoflex 2-1/4" system, Dinoflex Manufacturing Ltd., Salmon Arm, BC (604) 832-7780, or approved equal.

2.04 Edging: All edges of the Short Pile Synthetic Turf System shall be contained within 4"x 4"x12' (dimensional or nominal) recycled plastic timbers as approved. Recycled plastic materials shall be thoroughly blended and homogenized within the full cross section of any extrusion. Recycled plastic edging shall be secured with grade 60 - #4 (4/8) deformed reinforcing steel.

PART 3 - EXECUTION

3.01 Base Inspection: Inspect the aggregate base prepared to Specifications provided elsewhere as acceptable and appropriate to receive the work.

3.02 Maintenance: Coordinate with other trades to insure that all work in progress and completed work is protected and maintain all completed work in a like-new condition. Correct all damage to a condition acceptable to Engineer at no additional cost to the Owner.

3.03 Edging:

A. Prior to commencing installation of edging, perform a utility locate of installed and existing utilities including irrigation, drainage, and electrical. Verify that the installation of the edging will not result in damage to subsurface utilities.

B. Install recycled plastic timber edging in such a manner as to allow the finished Synthetic Turf System to conform to the finish grade lines and elevations as indicated in the Contract Drawings, generally 1/4" below finished grade of adjacent surfaces. Drill each length of timber a minimum of 4 places per timber, beginning 6" from each end and spaced equally a maximum of 4'-0 on center. The pre-drilled holes shall be sized to insure that a tight friction bond exists with the anchoring steel, at 3/8" to 1\2" diameter.

3.04 Synthetic Turf System Installation:

A. Install approved pre-cast rubber tiles to the manufacturer's specification, within the recycled plastic containment installed as 3.03 above.

B. Install Short Pile Synthetic Turf with the manufacturers specified or approved adhesives. Meet the following specific requirements;

1. Use extreme care maneuvering rolled carpet into place. Protect finished base aggregates and tile installation from disturbance. Replace and recompact disturbances to original lines, grades, and densities.
2. Note climatic conditions during placement of individual segments of carpet materials. Make allowances for heat and cold as necessary to provide uniform elongation and tension.
3. No seams shall be constructed within the middle 10' of the installation, as measured across the shortest distance.
4. All seams shall be fully secured by approved means to the strength of the carpet backing.
5. Lay carpet uniformly smooth throughout, with no wrinkles, folds, or overly tight areas.

3.04 Synthetic Turf Acceptance: Protect and maintain the installation until the Physical Completion of the complete work of the Contract. Keep the surface of the field free of construction debris, leaves, and other litter. Repair or replace any damage caused by vandalism, other trades, traffic, or weather.

END OF SECTION 02222

PART 1 - GENERAL

1.01 Description: Work includes but is not limited to the following:

A. Excavation and removal of existing surfacing materials.

B. Protection of existing subdrainage structures and granular material and irrigation equipment.

C. Removing materials from the site.

D. Placement of base sand and all-weather top course surfacing material to lines and grades as shown on the drawings.

1.02 Related Sections: Coordinate related work specified in other parts of the Project Manual, including but not limited to following:

Section 02050 - Site Preparation
Section 02200 - Earthwork for Site Work
Section 02900 - Site Restoration

1.03 Quality Assurance

A. The Contractor is responsible to check quality of work and shall perform compaction and density tests on request of the Engineer to check compliance with these specifications. A copy of the test reports shall be furnished to the Engineer.

B. The Engineer's Testing Agency may perform compaction and density tests to check compliance with these specifications.

1.04 Existing Utilities:

A. Protect from damage any pipes encountered; notify Engineer of their existence and record on Record Drawings. Verify the locations of underground utilities, minimum 48 hours prior to excavation.

B. Should unsurveyed piping or other utilities be encountered, consult the Engineer immediately for directions.

C. Drainage aggregate material in existing subdrainage trenches is to remain uncontaminated with soil, silt or other materials.

PART 2 - PRODUCTS

2.01 Base Sand: Base sand shall be fresh water washed sand graded as follows:

Sieve	Percent Passing
#4	100%
#8	95-100%
#16	85-100%
#30	50-75%
#60	0-30%
140	0-5%
200*	0-2%
#270*	0%

* Indicates wet sieve test

2.02 All Weather Surfacing Top Course: All weather surfacing top course shall be graded and strictly tested as follows:

Sieve	Percent Passing
1/4 inch	100%
#10	95-100%
#40	65-75%
#60	45-55%
#80	30-40%
#100	25-35%
#140	17-22%
#200*	10-14%
#270*	6-9%

* Indicates wet sieve test

2.03 Allowable Variance: An accumulated variance on specified sieve analysis of up to 5 percentage points is acceptable provided no single screen varies by more than 1.5 percentage points above or below the range specified above.

2.04 Sampling of Materials:

A. Prior to the importation of any base materials and surfacing materials, the Contractor shall provide the Engineer with a certified test lab report of the sieve

analysis of the product. The Engineer shall be the final determining factor in establishing compliance with sieve requirements. No material shall be brought onto the job site until the initial sieve analysis has been approved in writing. The testing laboratory shall be an independent testing laboratory. The Contractor shall submit certified lab test reports required as early as possible to avoid potential delays in the Contract due to sample rejection.

B. During the course of importation of materials, the Contractor shall be responsible for continually checking the materials to insure that they continue to meet the Specifications. Failure to do so may require the Contractor to remove non-qualifying material from the site at his own cost. The Engineer will have the option to take random samples for testing at their own laboratory. In the event that non-qualifying material is being imported, the Contractor shall cease all importation until the Engineer is assured that the Contractor is meeting the Specifications. In the event that the Engineer's sieve analysis and the Contractor's sieve analysis are at variance, and either analysis reveals the material to be non-complying, the Contractor shall be responsible for obtaining the service of a third party professional testing laboratory, which, in turn shall analyze samples selected by the Engineer. Such analysis shall be turned over to the Engineer for resolution. Payment for these tests shall be by the Contractor.

PART 3 - EXECUTION

3.01 General:

A. Removal of materials beyond indicated sub-grade elevations or dimensions without specific direction of Engineer is not authorized. Unauthorized excavation, as well as remedial work directed by Engineer shall be at the Contractor's expense.

B. Dewatering: Prevent surface and subsurface water from flowing into excavations and from flooding project site. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey rain water and water removed from excavations to collection or run-off areas.

C. Material Storage: Stockpile excavated materials where directed, until removal from project site. Place, grade and shape the stockpiles for proper drainage. Locate and retain soil materials away from edge of excavations and drip lines of trees to remain.

D. Dispose of excess soil material and waste materials as herein specified.

3.02 Excavation of Existing Surfacing:

A. All existing surfacing within the limits established for the all-weather surfacing shall be removed (refer to details).

B. Drainage aggregate material in existing subdrainage trenches is to remain uncontaminated with soil, silt or other materials. In the event of contamination of drainage granular material excavate drainage trenches to a depth of 3 inches and replace with same material to the satisfaction of the Engineer.

3.03 Layout: Layout of all work shall be surveyed and staked as required. Maintain all benchmarks, control monuments and stakes, whether newly established or previously existing. Protect from damage and dislocation. If necessary to disturb existing benchmarks, re-establish in a safe place. Notify Engineer a minimum of 3 days prior to excavation of work areas. Engineer shall inspect staking and layout of work.

3.04 Sand Base:

A. Sand base shall be placed on the entire area delineated as all-weather field, which shall include the soccer fields and baseball infield areas. It shall be placed at 4 inches minimum depth over the entire all-weather area. The finish grade elevations shall govern depth.

B. Once sub-grade has been established after the drainage work and irrigation work is completed, base sand course shall be placed at the side or the ends of the underdrained all-weather field area and then spread with tracked equipment. Do so only when sub-grade is dry and firm. Hard-tired equipment, which leaves the sub-grade in a rutted condition, shall not be used. Wet the base sand course completely and roll to the sub-grade required by the Drawings with a 2,000 pound roller. Finish depth shall be 4 inches after being rolled. Keep field most before placement of all-weather top course. Finish elevation of base sand course shall have a tolerance of +/- 0.05 feet. Control shall be equal to "laser" control. All prescribed base sand depths shall be compacted depths.

3.05 All Weather Surfacing Top Course:

A. Spread sufficient top course material on the base sand course to insure a full 4 inches of top course after compaction to 80 percent density. Top course material shall not be placed when the material is wet or whenever it is raining. It shall be very lightly dampened to give it "body" and rolled with a 2,000-pound roller. Take random probes in the presence of the Engineer to insure a full 4-inch rolled

depth. Grade tolerance shall be +/- 0.05 feet, "laser" controlled. Install top course only when the material is dry or slightly damp but never when wet or saturated.

B. Finish grade after rolling at edges shall be flush with edge of existing concrete swale.

C. Irrigate the fields lightly after installation and thereafter as required avoiding dust (until project is completed).

END OF SECTION 02221

PART 1 - GENERAL

1.01 Description: This Section includes all Site Preparation as indicated on the Contract Documents. Work includes but is not limited to the following:

A. Pre-mobilization DVD of Existing Site Conditions
B. Locate and Documentation of underground utilities and controls
C. Protect from harm any trees or other objects not designated for removal.
D. Temporary security fencing.
E. Temporary Erosion and Sedimentation Control (TESC) facilities.
F. Temporary construction access pads.
G. Staging & Stockpile Areas
H. Temporary Facilities
I. Installation, Continuous Maintenance, and final Removal of each element included in this Section.

1.02 Related Sections: In addition to the Sections listed below, all work of the Contract shall be performed in compliance with the requirements of this Section.

Section 02050 - Site Demolition
Section 02051 - Tree and Plant Protection
Section 02115 - Tree and Plant Removal
Section 02120 - Site Utility Removal
Section 02200 - Earthwork for Site work
Section 02720 - Storm Sewer Systems & Sub-surface Drainage
Section 02990 - Site Restoration

1.03 References:

A. City of Seattle Standard Specifications for Road, Bridge, and Municipal Construction (most recent edition).

B. SMC Title 22.800, Stormwater, Grading, & Drainage Control Code, Volume 2 "Construction Stormwater Control Technical Requirements Manual" (most recent edition).

1.04 Submittals:

A. Submit for the Engineers Project file 1 copy of DVD of existing conditions of fences, surfaces, equipment, and adjacent improvements that might be misconstrued as damage related to the removal operation. The Engineer, prior to any mobilization onto the project site (See Section 01010) must receive this submittal.

B. Submit for review and approval a complete site access, staging, and stockpiling plan using a copy of the basic site layout. Identify all areas to be used for access, staging, and stockpiling throughout various phases of the construction sequence. Provide a legend or key as appropriate where phasing affects location.

C. Submit the following product information for approval prior to delivery or installation;

1. Shop drawing of portable temporary fencing panels and connection hardware for approval.
2. Signage- shop drawing or sample.
3. Source of supply for straw bales- includes supplier name and address, location of origination.
4. Filter Fabric for Inlet Protection and Siltation Control Fencing- provide 12"x12" sample and technical data.
5. Geo-textile for Temporary Access Pad - provide 12"x12" sample and technical data.
6. Particle Gradation / Sieve Analysis for Temporary Access Pad base and surfacing.

PART 2 - PRODUCTS

2.01 Temporary PVC Fencing:

A. 4' wide rolls Orange PVC Web Fencing for low security and approved tree protection applications.

B. 6' lengths of #5 deformed steel reinforcing bar.

C. Safety caps for #5 steel reinforcing bar.

2.02 Temporary Chain Link Fencing: Prefabricated portable galvanized chain link fence panels including fabric, posts, top and bottom rails, and driven posts with rolled fabric & wire ties for areas of uneven terrain.

A. Prefabricated portable fence panels shall be a minimum of 6 feet high by maximum 10 feet wide. Post bases shall be minimum 16 inches by 8 inches by 8 inches high concrete pier with sleeve for post, or as approved. Prefabricated portable temporary fence panels shall be constructed to industry standards for fixed chain link fencing.

1. Posts - minimum 1-1/2" OD Schedule 40 galvanized steel pipe.

2. Fabric - minimum 11 gauge galvanized two-inch diamond mesh steel wire interwoven. Knuckled or twisted selvage is acceptable.

B. Bracing: Provide additional panels or outriggers as necessary to provide a rigid, stable run of fence.

C. Driven Post Fencing:

1. Posts - Schedule 40 galvanized steel pipe.
2. Fabric - minimum 11 gauge galvanized two-inch diamond mesh steel wire interwoven. Knuckled or twisted selvage is acceptable.
3. Wire Ties – minimum 9-gauge aluminum wire.

D. Gates shall be 20 feet wide (two prefabricated panels) with double padlocks to allow Contractor and Owner forces entry. Hinged sides of each operating panel shall include double bracketing. Owner will provide 1 lock keyed for City personnel for each entry. Contractor shall provide a lock keyed for Contractor and Subcontractor for each entry.

E. Signage: Provide warning signage every 50' of running fence line. Signage shall be a minimum of 18" square, brightly colored with contrasting lettering as follows:

WARNING
CONSTRUCTION
KEEP OUT

Or, as approved by the Engineer.

F. Barbed wire will not be allowed.

2.03 Temporary Erosion and Sedimentation Control:

A. Straw bales/mulch: wheat straw or similar straw, which is free of weed seeds. Do not use hay cut from Reed Canary Grass.

B. Filter fabric: shall be polyvinyl chloride (PVC) woven cloth, reinforced chlorosulfinated polyethylene cloth.

Type of filter fabric used for siltation control fencing and methods for securing it using stable, durable staking methods and shall be as approved by the Engineer.

C. Catch Basin sediment control sock: shall be a pre-manufactured Catch Basin Insert, or approved equal, as approved by the Engineer.

D. Plastic covering: shall be 6 mil clear plastic sheeting.

E. Sand bags: shall be ½ to 1 cubic foot capacity constructed of UV stabilized synthetic woven materials of sufficient strength to support the weight of the bag capacity in mineral aggregate.

E. Erosion Control Log: shall be made of new crop agricultural straw, coconut husk fiber, woodchip mulch, or approved equal with a consistent size (approx. 9"-12" in diameter) and density of fibers evenly distributed throughout the log. Erosion control logs shall be 100% free of noxious weed seed and wrapped in seamless, photodegradable, polyethylene netting. Use PermeaTex/Permealok Straw Log 9 as manufactured by Northwest Linings & Geo-textile Products, Inc., 1-800-729-6954; Curlex Sediment Log as manufactured by American Excelsior Company, 1-800-777-7645; or approved equal.

2.04 Temporary Construction Access:

A. Woven polypropylene Geo-textile, LINQ Industrial Fabrics GTF 200S, or approved equal.

B. 2"x 4" Fractured Aggregate ("Rip-Rap") base.

C. 1¼'' Minus Crushed Fractured Aggregate, City of Seattle Standard Specifications (most recent edition) Section 9-03.9(3) - Crushed Surfacing.

2.05 Temporary Facilities:

A. Temporary Enclosed Work Space: provide a temporary enclosed workspace ("Job Shack" or Trailer) suitable for storage of Project Documentation and use as meeting space, minimum interior space 6' x 20'. Furnish the interior with a working surface sufficient to accommodate the Contract Documents, minimum 3' x 4'. Provide a minimum of 4 chairs and a table of sufficient size to conduct weekly Project Meetings.

B. Temporary Sanitation Facilities: engage the services of a licensed, commercial provider of portable temporary sanitary facilities. Provide sufficient capacity and maintenance for no less than 125% of the anticipated peak workforce.

PART 3 - EXECUTION

3.01 Authorization to Commence:

A. The Engineer will issue a formal Notice to Proceed authorizing commencement of the work. No work shall begin until the date specified on this notice.

B. Obtain required permits and permission from local governing authorities and Engineer prior to commencing work.

3.02 Documentation of Utilities and Controls: Maintain a separate drawing to be stored on-site for identifying key utilities and controls. Identify and apply color-coded markings identifying shut-offs for domestic water, irrigation water, power, and gas. Identify sanitary sewerage, storm water discharge, gas, fiber optics, and telephone (all as appropriate) lines, which are to be maintained in service during the work. Color-code emergency contact information for each utility directly on the drawing. Additionally;

A. Coordinate location of Domestic Service and Irrigation Point of Connection systems with the Engineer.

B. Maintain domestic water supply to sanitary facilities in the Park throughout the course of construction, except temporarily while isolating Irrigation Systems.

C. Protect and maintain sanitary sewerage lines throughout the Park.

3.03 Temporary Security Fence: Secure the project site from trespass or unintentional entrance by unauthorized personnel.

A. All disturbed ground stockpiles, staging and on-site transport routes shall be fully enclosed by a perimeter security fence. Areas either under construction or completed but not specifically accepted by the Engineer as Substantially Complete shall be completed enclosed. Areas included in the Contract but not yet under construction may be left open to public access at the discretion of the Engineer.

B. Temporary chain link fence panels shall be connected mechanically by means of pre-fabricated, bolted bracket manufactured specifically for the purpose. Fencing shall not be wired together. Where long straight runs result in an unstable condition, sufficient out-rigging shall be incorporated to maintain fencing upright. Use only pre-manufactured outriggers or additional fence panels. Out-riggers shall be placed on the interior side of the fence unless approved by the Engineer. Alternatively, and where appropriate, a "zig-zag" arrangement of panels for stability may be used.

D. Uneven Terrain: Where uneven terrain will not allow the use of pre-manufactured portable fence panels, or where otherwise directed by the Engineer, drive posts directly into the earth plumb and 8' on center along the approved alignment. It is the Contractors responsibility to perform a complete locates for

underground utilities in any area to receive driven posts. Drive posts to sufficient depth to assure stability and durability for the life of the installation, maintain a minimum of 6' above grade. Reset loose posts at the direction of the Engineer. Secure chain link fabric to posts using approved wire ties within 6" of the top and bottom of each post, and a minimum of 18" on center between. Provide posts at each end of each driven post installation at a point that is sufficiently level to clamp prefabricated portable fence panels directly to the driven post installation.

E. Where approved for short-term, low security applications, use 4' high orange PVC web fencing wired to #5 reinforcing bar "posts" set 5' on center or as appropriate. Cap each bar with a safety cap manufactured specifically for #5 reinforcing steel.

3.04 Temporary Erosion and Sedimentation Control (TESC): Shall conform to SMC Title 22.800, Stormwater, Grading, & Drainage Control Code, Volume 2 "Construction Stormwater Control Technical Requirements Manual" (most recent edition), and Section 01566 of the Project Manual.

A. Keep streets and site drains open for drainage at all times. TESC facilities shall be inspected daily during periods of rain, otherwise inspected weekly.

B. The Contractor shall clean out catch basin sumps prior to placement of filter fabric. At no time shall more than one inch of sediment shall be allowed to accumulate on the filter fabric in the catch basin. Sediment buildup on catch basin filter fabric shall be removed or the fabric replaced. The Contractor shall clean out catch basins again after completion of construction. The cleaning operation shall not flush sediment-laden water into the downstream system.

C. Any area stripped of vegetation where no further work is anticipated for a period of 15 days, shall be immediately stabilized with clear plastic covering or straw mulch. During periods when a reasonable expectation of significant rainfall may be present, the contractor shall cover any stripped slopes 4:1 or steeper with plastic sheeting. Straw, when used, shall be applied at a thickness of 2 inches minimum.

D. If sediment is transported on to a road surface, the road shall be cleaned thoroughly at the end of each day. Sediment shall be removed from roads by a method as approved by the Engineer and be transported to a controlled sediment disposal area. Street washing shall be allowed only after sediment has been removed in this manner.

E. The Contractor shall protect stockpile areas from release of sediment. Stockpiles shall be covered at all times while not in use to keep stored material dry.

Materials stockpiled on pavement shall be surrounded by two rows of straw bales with joints staggered.

F. Siltation Control Fencing:

1. Silt Control Fencing shall be installed as directed by the Engineer. A linear measurement equal to the perimeter of the Contract site shall be installed as directed by the Engineer. Additional lengths of silt control fencing shall be installed as deemed necessary by the Engineer throughout the Contract.
2. Silt Control Fencing shall be installed reasonably taught between stakes, with no sagging or bunching of the fabric. Bottom edge of fabric shall be embedded into the sub-grade and back-filled with 5/8" pea gravel in areas where significant future work is anticipated. In areas at the project limit, where no significant restoration or additional work is anticipated by the Engineer, do not trench bottom edge of fabric into ground, rather fold inward toward the source of potential siltation and cover with 5/8" pea gravel.
3. Maintain Silt Control Fencing by removing accumulated materials off-site when accumulations exceed 6" above original grade or grade behind the fencing.
4. Inspect undisturbed ground down-flow of fencing to verify functionality. Where the fencing has failed, correct it. Where accumulated water has focused erosive forces down-flow of fencing, provide additional silt fence or hay-bale baffles to dissipate erosive energy.

G. Settling Ponds: During periods of excessive precipitation or when dewatering significant volumes of inadvertently detained stromwater, or when directed by the Engineer, construct temporary stormwater settling ponds for storage of silt-laden runoff. Provide sufficient pumping capacity to remove the settled water to the stormwater conveyance as directed.

3.05 Temporary Access Pads: The Contractor, for approval, shall submit layout and design of stabilized construction entrances and wash pads by the Engineer. The entrances shall be installed at the beginning of construction and maintained to meet applicable standards for the duration of the project. Additional measures may be required to ensure that all paved areas are kept clean for the duration of the project.

Following approval of layout by the Engineer;

A. Remove sufficient existing earth to accommodate a minimum 12" depth of stabilizing aggregates.

B. Install stabilizing geo-textile with a minimum 12" overlap at each joint. Extend geo-textile 24" beyond excavation limit.

C. Place 2"x4" fractured aggregate base material to settled depth of approx. 9".

D. Cover with 1¼ "minus crushed aggregate surfacing.

3.06 Tree Protection:

A. Foot and vehicular traffic over root systems of existing trees to remain is not permitted.

B. All trees in the construction area shall be protected with PVC Web fence to the drip line of the tree. Stake the location of protection fencing. Notify the Engineer at least 48 hours prior to commencing work for approval of flagging and fencing.

C. Do not park any vehicles or equipment, store materials or stockpile soil, dispose of building materials, chemicals, or other detrimental substances within drip line of trees.

D. If required, trimming or pruning of tree branches shall be executed by a qualified tree surgeon. Do not prune unless approved and directed by the Engineer.

E. Excavate within the drip line of trees only where designated. Where trenching for utility lines within the drip line, hand dig around or tunnel under roots whenever possible. Cut all roots encountered with sharp pruners or saws. Notify Engineer before cutting any roots over 2 inches in diameter.

F. Trees which are to be protected, that become damaged or die shall be replaced with tree of same species and equal size. Damaged or destroyed trees which cannot be replaced, shall be paid for at the rate of $50.00 per square inch of cross sectional area of the trunk, measured 3 feet above existing grade, for trees up to and including 6 inch caliper, and at the rate of $100.00 per square inch of cross sectional area for trees larger than 6 inches in caliper size. This amount shall be credited to the Owner.

3.07 Removal: All materials and debris associated with the work of this Section shall be removed at the appropriate time as follows;

A. Removal and restoration of Temporary Access Pads shall be undertaken as quickly as possible following the conclusion of transport of bulk materials and demobilization of heavy equipment, with the prior approval of the Engineer.

B. Removal of Trailer and Sanitary Facilities shall not be undertaken until the Engineer has established that the work is Substantially Complete according to the requirements of Section 00700, or as directed by the Engineer.

C. Removal of temporary siltation control fencing shall be performed at the direction of the Engineer, but in no case prior to establishment of the Contract as Substantially Complete. The Owner reserves the right to take ownership and control of temporary siltation control facilities following thorough maintenance by the Contractor and immediately prior to acceptance of the Contract as Physically Complete.

D. Removal of Temporary Tree Protection and Security Fencing shall be performed within 2 weeks of establishment of the Contract Work as Substantially Complete. The Owner reserves the right of transfer of any rental agreement or contract for Temporary Fence installations, with the cost of eventual removal to be born by the Contractor upon transfer.

E. Following establishment of the work as Substantially Complete and removal by the Contractor of accumulated sediment from all manholes, catch basins, and inlets, the Contractor shall place new filter fabric as specified between each the frame and grate of each structure.

F. All removal shall include complete site restoration as directed by the Engineer.

END OF SECTION

ATTACHMENT 2: HWA LATERAL FLOW ANALYSIS

LABORATORY COMPACTION CHARACTERISTICS OF SOIL

HWA GEOSCIENCES INC.

CLIENT: *Glacier North West* SAMPLE ID: *PBS-3*

PROJECT:

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

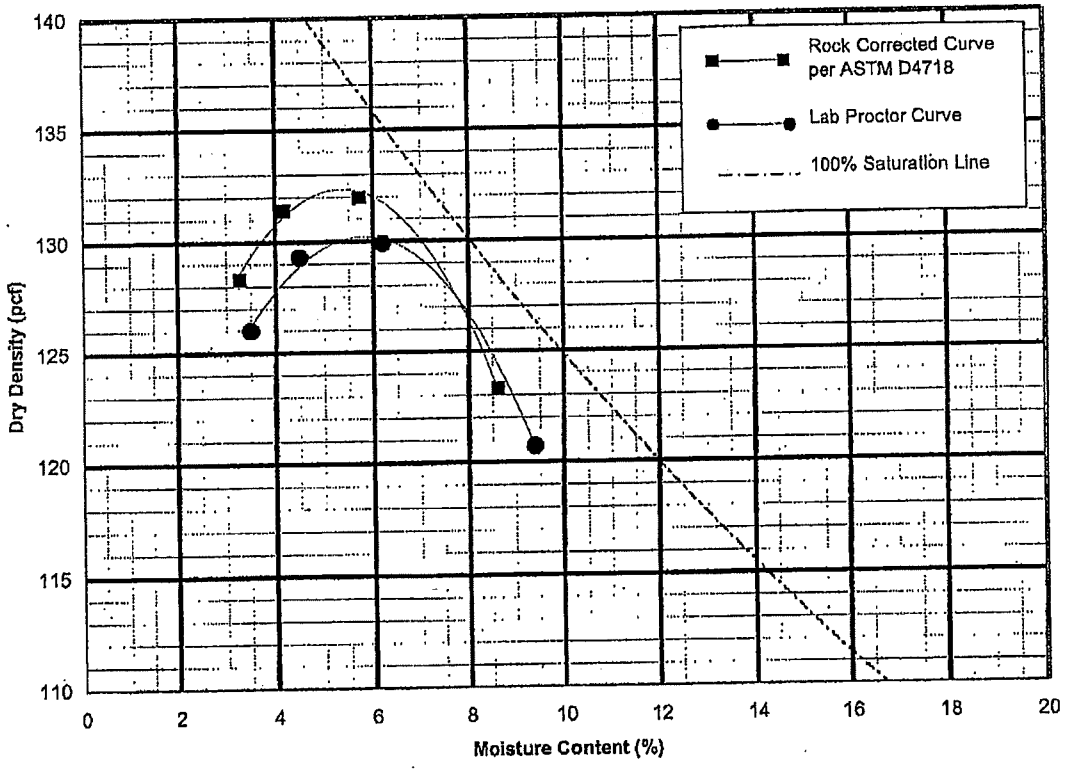
MATERIAL SOURCE, SAMPLE LOCATION AND DEPTH:
Delivered by client

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*

FISC. Exh a, att 2

Remold Calculation Form

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

Sample Designation: Permeable Base Stone Source: DuPont Plt

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

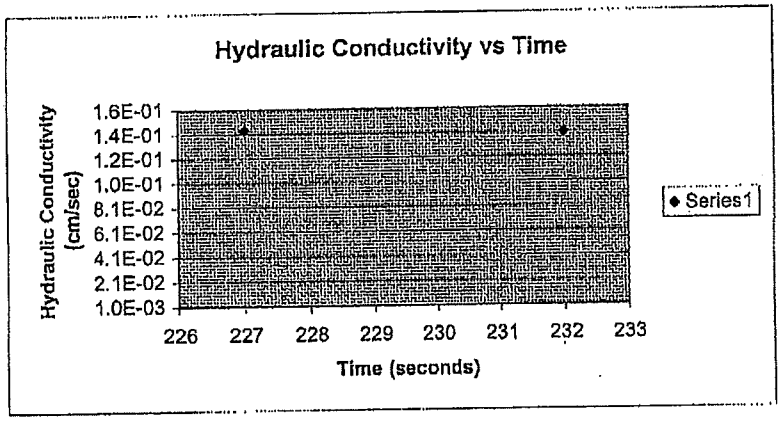
HWA GEOSciences Inc. MATERIALS TESTING LABORATORY
Falling Head Permeability Test
Performed in general accordance with the Army Corps of Engineers EM 1110-2-1906
Laboratory Soils Testing Manual, Appendix VII.

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

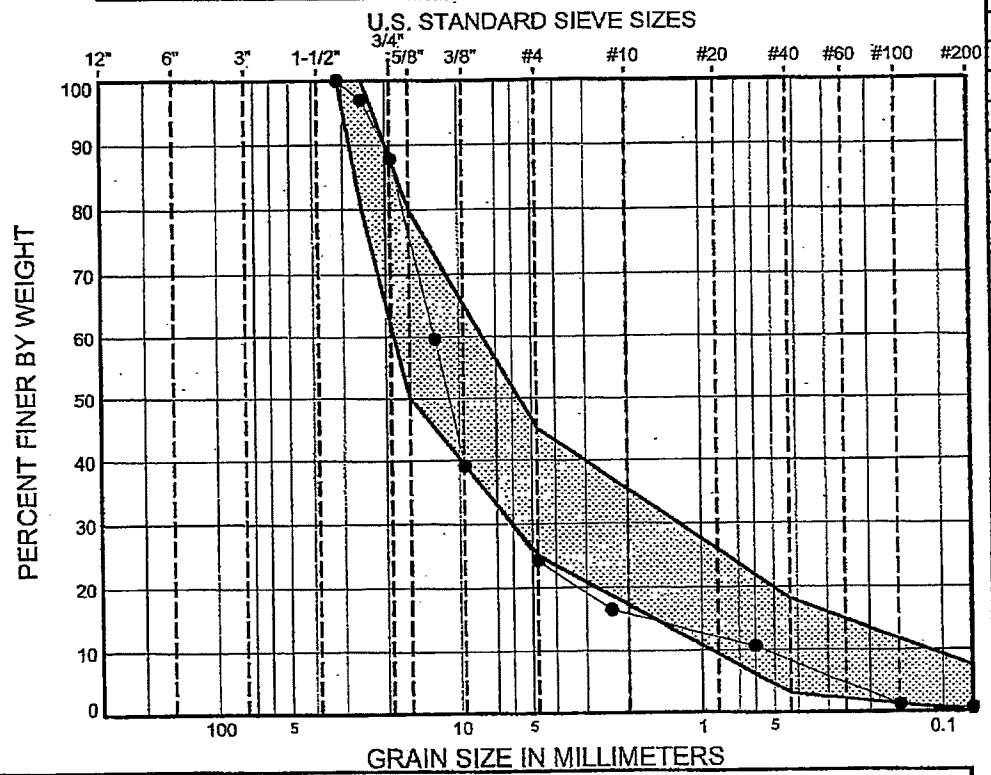
Where:

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

SPECGS 2005097.GPJ 2/10/06

HWA GeoSciences Inc.
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: John M Stahl

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.

ATTACHMENT 3: WSDOT HIGHWAY RUNOFF MANUAL EXCERPTS

Washington State
Department of Transportation

TECHNICAL MANUAL

Highway Runoff Manual

M 31-16.01

June 2008

Environmental and Engineering Programs
Design Office

Table 4B-1. Hydrologic soil series for selected soils in Washington State (continued).

Soil Type	Hydrologic Soil Group	Soil Type	Hydrologic Soil Group
Phelan	D	Sultan	C
Phoebe	B	Sultan variant	B
Pilchuck	C	Sumas	C
Potchub	C	Swantown	D
Tacoma	D	Vailton	B
Tanwax	D	Vassar	B
Tanwax, Drained	C	Verlot	C
Tealwhit	D	Wapato	D
Tekoa	C	Warden	B
Tenino	C	Wethey	C
Tisch	D	Whidbey	C
Tokul	C	Wilkeson	B
Townsend	C	Winston	A
Triton	D	Wolfeson	C
Tukwila	D	Woodinville	B
Tukey	C	Yelm	C
Uhlig	B	Zynbar	B
Urbana	C		

Hydrologic Soil Group Classifications, as defined by the Soil Conservation Service:

A = (Low runoff potential) Soils having low runoff potential and high infiltration rates, even when thoroughly wetted. They consist chiefly of deep, well- to excessively drained sands or gravels, and have a high rate of water transmission (greater than 0.30 in/hr).

B = (Moderately low runoff potential) Soils having moderate infiltration rates when thoroughly wetted and consisting chiefly of moderately deep to deep, moderately well- to well-drained soils, with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission (0.15–0.3 in/hr).

C = (Moderately high runoff potential) Soils having low infiltration rates when thoroughly wetted and consisting chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine textures. These soils have a low rate of water transmission (0.05–0.15 in/hr).

D = (High runoff potential) Soils having high runoff potential. They have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with a high swelling potential; soils with a permanent high water table; soils with a hardpan or clay layer at or near the surface; and shallow soils over nearly impervious material. These soils have a very low rate of water transmission (0–0.05 in/hr).

* = From SCS, TR-55, Second Edition, June 1986, Exhibit A-1. Revisions made from SCS, Soil Interpretation Record, Form #5, September 1988 and various county soil surveys.

This information can also be found online at: websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx

Use the following equation to convert K_{sat} from cm/s to ft/day:

$$K_{sat}\,(\text{ft/day}) = K_{sat}\,(\text{cm/s}) \times 2{,}834.65$$

If the licensed professional conducting the investigation determines that deeper layers will influence the rate of infiltration for the facility, soil layers at greater depths must be considered when assessing the site's saturated hydraulic conductivity characteristics. Massmann (2003) indicates that where the water table is deep, soil or rock strata up to 100 feet below an infiltration facility can influence the rate of infiltration. Note that only the layers near and above the water table or low permeability zone (such as a clay, dense glacial till, or rock layer) need to be considered, as the layers below the groundwater table or low permeability zone do not significantly influence the rate of infiltration. Also, note that this equation for estimating saturated hydraulic conductivity assumes minimal compaction consistent with the use of tracked (low-to-moderate ground pressure) excavation equipment, as described in the Site Design Elements of Section 5-4.2.1.

If the soil layer being characterized has been exposed to heavy compaction, or is heavily overconsolidated due to its geologic history (for example, overridden by continental glaciers), the saturated hydraulic conductivity for the layer could be approximately an order of magnitude less than what would be estimated based on grain size characteristics alone (Pitt, 2003). In such cases, compaction effects must be taken into account when estimating saturated hydraulic conductivity. For clean, uniformly graded sands and gravels, the reduction in K_{sat} due to compaction will be much less than an order of magnitude. For well-graded sands and gravels with moderate-to-high silt content, the reduction in K_{sat} will be close to an order of magnitude. For soils that contain clay, the reduction in K_{sat} could be greater than an order of magnitude.

There are field tests that can estimate specific soil layer K_{sat} values. These tests include the packer permeability test (above or below the water table), the piezocone (below the water table), an air conductivity test (above the water table), and a pilot infiltration test (PIT), as described in Ecology's SMMWW. Note that these field tests generally provide a saturated hydraulic conductivity combined with a hydraulic gradient (see Darcy's Law, Equation 4-18). In some of these field tests, the hydraulic gradient may be close to 1.0. For this condition, Darcy's Law would show that the K_{sat} would be nearly equal to the infiltration rate of that soil layer. It is important to recognize that the gradient in theses field tests may not be the same as the gradient likely to occur in the full-scale infiltration facility in the long term (when groundwater mounding is fully developed). This issue will need to be evaluated on a case-by-case basis when interpreting the results of field tests.

For Infiltration Pond, Infiltration Trench, Infiltration Vault, and the underlying soils for CAVFS, once the saturated hydraulic conductivity for each layer has been identified, determine the effective average saturated hydraulic conductivity below the BMP. Saturated hydraulic conductivity estimates from different layers can be combined using the harmonic mean:

ORDINANCE _____

AN ORDINANCE relating to Seattle Public Utilities drainage services; amending Chapter 21.33 of the Seattle Municipal Code to update the definition of "highly infiltrative pervious surface" to include additional pervious surface types.

WHEREAS, City drainage fees are based on the estimated amount of stormwater runoff from a property that enters the City's drainage system, as determined by the amount and type of impervious and pervious surface on a property; and

WHEREAS, pursuant to Section 21.33.030.C.2 of the Seattle Municipal Code, properties in the undeveloped, light and moderate rate categories are assigned to a low-impact rate category if they contain sufficient quantities of highly infiltrative pervious surface cover to meet defined performance requirements; and

WHEREAS, recent engineering studies by SPU have demonstrated that certain pervious surfaces meet the defined performance requirements for the low impact rate category, but are not included in the current definition for "highly infiltrative pervious surface;" NOW, THEREFORE,

BE IT ORDAINED BY THE CITY OF SEATTLE AS FOLLOWS:

Section 1. Effective January 1, 2010, Section 21.33.010 of the Seattle Municipal Code is amended as follows:

SMC 21.33.010 Definitions

For purposes of this chapter, the words or phrases below shall have the following meanings:

* * *

J. "Highly infiltrative pervious surface" means vegetated surface of specific types such as forests or non-forested land that is in the natural progression back to a forested state, or upon evidence satisfactory to the Utility, other pervious surface types that substantially meet the same Utility-defined performance characteristics for infiltrating stormwater.

* * *

Section 2. This ordinance shall take effect and be in force thirty (30) days from and after its approval by the Mayor, but if not approved and returned by the Mayor within ten (10) days after presentation, it shall take effect as provided by Municipal Code Section 1.04.020.

Passed by the City Council the ____ day of _____, 2009, and signed by me in open session in authentication of its passage this

_____ day of _____, 2009.

_____
President _____of the City Council

Approved by me this ____ day of _____, 2009.

_____
Gregory J. Nickels, Mayor

Filed by me this ____ day of _____, 2009.

_____
City Clerk

(Seal)

City of Seattle

Gregory J. Nickels, Mayor

Office of the Mayor

September 25, 2009

Honorable Richard Conlin
President
Seattle City Council
City Hall, 2nd Floor

Dear Council President Conlin:

I am pleased to transmit the attached proposed Council Bill for consideration with the 2010 Proposed Budget. This legislation revises a drainage rate definition to allow more parcels to qualify for the low-impact rate category. Low-impact parcels contain large amounts of highly pervious cover that infiltrates a significant amount of stormwater runoff, reducing impacts on our drainage system.

Seattle Public Utilities (SPU) implemented several changes to its drainage rate design in 2008 to improve ratepayer equity. In response to customer inquiries, the SPU recently conducted engineering studies on several athletic fields and found that many common ball field designs infiltrate stormwater at a rate similar to forested lands. For billing purposes, the proposed legislation authorizes SPU to treat other pervious surfaces with highly infiltrative characteristics the same way it treats more naturally forested areas. Passage of this legislation will result in a slight drainage bill reduction for several parcels owned by the Department of Parks and Recreation and the Seattle Public Schools. Parks' 2010 Proposed Budget has been reduced accordingly.

Thank you for your consideration of this legislation. Should you have questions, please contact Leanne Galati at 684-0455.

Sincerely,

GREG NICKELS
Mayor of Seattle

600 Fourth Avenue, 7th Floor, P.O. Box 94749, Seattle, WA 98124-4749
Tel: (206) 684-4000, TDD: (206) 615-0476 Fax: (206) 684-5360, Email: mayors.office@seattle.gov

Ord. 123167

STATE OF WASHINGTON – KING COUNTY

--ss.

248052 No.
CITY OF SEATTLE,CLERKS OFFICE

Affidavit of Publication

The undersigned, on oath states that he is an authorized representative of The Daily Journal of Commerce, a daily newspaper, which newspaper is a legal newspaper of general circulation and it is now and has been for more than six months prior to the date of publication hereinafter referred to, published in the English language continuously as a daily newspaper in Seattle, King County, Washington, and it is now and during all of said time was printed in an office maintained at the aforesaid place of publication of this newspaper. The Daily Journal of Commerce was on the 12th day of June, 1941, approved as a legal newspaper by the Superior Court of King County.

The notice in the exact form annexed, was published in regular issues of The Daily Journal of Commerce, which was regularly distributed to its subscribers during the below stated period. The annexed notice, a

CT:123167 ORDINANCE

was published on

12/10/09

The amount of the fee charged for the foregoing publication is the sum of $ 99.05, which amount has been paid in full.

JENNIFER A. PATTEN
NOTARY PUBLIC
STATE OF WASHINGTON
COMMISSION EXPIRES

Subscribed and sworn to before me on

12/10/09

Notary public for the State of Washington,
residing in Seattle

Affidavit of Publication

State of Washington, King County

City of Seattle

ORDINANCE 123167

AN ORDINANCE relating to Seattle Public Utilities drainage services; amending Chapter 21.33 of the Seattle Municipal Code to update the definition of "highly infiltrative pervious surface" to include additional pervious surface types.

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* * *

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* * *

Section 2. This ordinance shall take effect and be in force thirty (30) days from and after its approval by the Mayor, but if not approved and returned by the Mayor within ten (10) days after presentation, it shall take effect as provided by Municipal Code Section 1.04.020.

Passed by the City Council the 23rd day of November, 2009, and signed by me in open session in authentication of its passage this 23rd day of November, 2009.

Richard Conlin

President of the City Council

Approved by me this 1st day of December, 2009.

Gregory J. Nickels, Mayor

Filed by me this 3rd day of December, 2009.

Publication ordered by the City Clerk

Date of publication in the Seattle Daily Journal of Commerce, December 10, 2009.

12/10(248052)