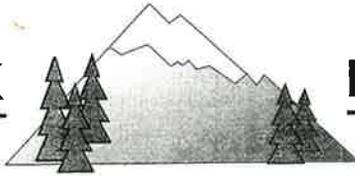


PEAK



ENGINEERING, INC.

**PRELIMINARY
DRAINAGE REPORT
FOR
GLEN HAWK ESTATES
PLAT
City of Arlington**

RECEIVED
FEB 01 2007
Utilities Div.



EXPIRES 07/16/2007

DATE: 1/30/07

**Prepared By: Brian R Lindsay
Peak Engineering, Inc.**

**January 15, 2007
Peak Job # 646**

RECEIVED
JAN 30 2007
C-07-018-PP
COA PERMIT CENTER

TABLE OF CONTENTS

SECTION I

INTRODUCTION AND EXISTING CONDITIONS	1
DEVELOPED CONDITIONS	1
WATER QUALITY	1
OPERATIONS AND MAINTENANCE	2
UPSTREAM/DOWNSTREAM CONDITIONS	2

SECTION II

CALCULATIONS	II-1 to II-5
--------------	--------------

SECTION III

OPERATIONS & MAINTENANCE MANUAL (TO BE PROVIDED AT TIME OF CONSTRUCTION)	
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SECTION IV

STORM WATER POLLUTION PREVENTION PLAN (TO BE PROVIDED AT TIME OF CONSTRUCTION)	
RISK ASSESSMENT DECISION MATRIX	SWPPP-2

APPENDIX

SOIL MAP	
EXISTING BASIN MAP	
DEVELOPED BASIN MAP	
FIGURE III-1.1	
SNOHOMISH COUNTY DRAINAGE INVENTORY MAP	
GEOTECHNICAL ENGINEERING REPORT as provided by Associated Earth Sciences Inc. Dated January 29, 2007	

SECTION I

INTRODUCTION AND EXISTING CONDITIONS:

This project is the proposed 24 lot plat for single-family detached structures on an approximately 7.21 acre site. The site is located on the north side of 172nd St NE with a site address of 7127-172nd St NE within the city of Arlington. The topography of the development area slopes at approximately 10 to 20 % to the southwest. Two existing residences will remain on proposed lots 9 and 13. All other remaining structures will be removed prior to construction. Vegetation on site consists of lawn and landscaping with some 2nd & 3rd growth trees. As indicated in the Snohomish County Soil Survey Map, the soils on site are Tokul gravelly loam and Tokul-Winston (hydrologic soils group "C"). See Appendix for soil map. For additional information see the geotechnical engineering report as provided by Associated Earth Sciences Inc dated January 29th 2007 attached to the Appendix of this report.

DEVELOPED CONDITIONS:

The project proposes to construct 24 lots to serve 22 new single-family residences. All lots will be accessed directly from the internal public and private road system. Lots 21 through 24 will convey impervious surface runoff to the existing detention vault facility on Tract 995 constructed with an earlier project. All remaining storm water runoff from the project will be collected and conveyed to the proposed detention wet pond facility located on Tract 996 except for a portion of 71st Ave NE and SR 531 that bypass the detention facility. The wet pond detention facility will attenuate stormwater runoff to the allowable pre-developed conditions.

For the pre-developed conditions, the 2yr, 10yr and 100yr 24hr storm events were modeled assuming the existing conditions were forested to determine the pre-developed peak runoff rates. The proposed impervious and pervious lawn and landscape areas were calculated and used for the developed condition calculations. To match the pre-developed conditions, flow restrictors have been designed to release the detained runoff under developed conditions at 50% of the two year and 100% of the 10-yr and 100-yr storm events at the pre-developed peak rates. The allowable release rates were reduced to account for a frontage impervious bypass area of 0.22 ac. A volume was calculated and factor of safety of 1.36 times (Per Figure III-1.1) the calculated detention capacity was used to determine the minimum required detention volume.

Runoff rates and volume calculations were performed using SBUH and SCS Curve Number methodologies, in "StormSHED" by Engenious Systems. The detained volumes and associated stages for the 2yr, 10yr, and 100yr 24hr storm events, as well as the flow restrictor specifications, are in Section II of this report.

WATER QUALITY:

Water quality for the proposed site will be provided in the wet pond area of the detention facilities and meets City and DOE criteria. Water quality treatment will be provided in the wet pond area sized to retain the 6-month water quality storm event within the dead storage volume of the open pond and a surface area-pool depth relationship at 2 ft deep over the 30% minimum area required. This area will be seeded with water tolerable plantings to provide additional water quality treatment. The required volume of the 6-month storm event is approximately 14,810 cf and the pond design provides a minimum of 15,000 cf of dead Storage.

OPERATION AND MAINTENANCE:

The catch basins and detention pond shall be inspected annually to ensure that sediment is not filling up the catchments and dead storage volumes, and cleaned as necessary. Additionally, undesirable vegetation that has the potential to interfere with performance of or damage to the vault shall be removed. Key components of the storm water management system (i.e. orifice openings and CB inlets) shall be inspected after large storm events to ensure debris has not caused a blockage and is hindering system performance. The Operation and Maintenance Manual will be provided with the Construction plan submittal.

UPSTREAM/DOWNSTREAM CONDITIONS:

Stormwater runoff from upstream areas east of the site is intercepted by a storm system on the adjacent plat of Edgecomb. Runoff from this eastern area is conveyed to an existing detention facility that discharges to the existing 18" pipe/ditch conveyance system flowing west along the north side of 172nd ST NE (SR 531). Stormwater runoff from upstream areas north of the site is collected by a 12" offsite conveyance system flowing west along the north property boundary.

Runoff from the site sheet flows west along the west property boundary to existing wetlands on the adjacent downstream property. An onsite driveway ditch and 12" pipe starting at approximately 500 ft north of the southwest boundary of the site collects runoff and discharges to the existing 18" concrete pipe flowing west near the southwest property corner of the site. Discharge from the 18" pipe system discharges to the roadside ditch flowing west along 172nd ST NE (SR 531). Drainage continues along the north side of 172nd ST NE to the creek crossing from the south side of 172nd ST NE. The creek is tributary to the Quilceda Creek downstream of 67th Ave NE. This drainage system is a significant drainage course for the City of Arlington and Marysville. No adverse impacts to the upstream / downstream drainage course are anticipated with the development of the Glen Hawk Estates plat.

SECTION II GLEN HAWK ESTATES

646

PRELIMINARY DRAINAGE REPORT:

BASIN "A"

Allowable 2yr = ½ 2yr EXISTING – 2yr BYPASS = 0.26 / 2 – 0.09 = **0.04 cfs**
(Note: Use ½ "diameter orifice minimum per standard.)

DIVERTHYD 15.65 [PRE A] AS [2 yr] [MATCH 2YR] PERCENT
Peak Flow: 0.0400 cfs Peak Time: 8.67 hrs Hyd Vol: 1625.29 cf - 0.0373 acft

Allowable 10yr = 10yr EXISTING – 10yr BYPASS = 0.83 – 0.14 = **0.69 cfs**

DIVERTHYD 83.47 [PRE A] AS [10 yr] [MATCH 10YR] PERCENT
Peak Flow: 0.6900 cfs Peak Time: 8.17 hrs Hyd Vol: 20237.44 cf - 0.4646 acft

Allowable 100yr = 100yr EXISTING – 100yr BYPASS = 1.61 – 0.19 = **1.42 cfs**

DIVERTHYD 88.00 [PRE A] AS [100 yr] [MATCH 100YR] PERCENT
Peak Flow: 1.4200 cfs Peak Time: 8.17 hrs Hyd Vol: 36296.09 cf - 0.8332 acft

POND DESIGN:

Event Summary:

BasinID	Peak Q (cfs)	Peak T (hrs)	Peak Vol (ac-ft)	Area ac	Method /Loss	Raintype	Event

PRE A	0.26	8.67	0.2384	5.94	SBUH/SCS	TYPE1A	2 yr
PRE A	0.83	8.17	0.5566	5.94	SBUH/SCS	TYPE1A	10 yr
PRE A	1.61	8.17	0.9469	5.94	SBUH/SCS	TYPE1A	100 yr
BYPASS A	0.09	8.00	0.0289	0.22	SBUH/SCS	TYPE1A	2 yr
BYPASS A	0.14	8.00	0.0462	0.22	SBUH/SCS	TYPE1A	10 yr
BYPASS A	0.19	8.00	0.0645	0.22	SBUH/SCS	TYPE1A	100 yr
DEV A	1.71	8.00	0.6047	5.72	SBUH/SCS	TYPE1A	2 yr
DEV A	2.91	8.00	1.0218	5.72	SBUH/SCS	TYPE1A	10 yr
DEV A	4.22	8.00	1.4757	5.72	SBUH/SCS	TYPE1A	100 yr
DEV A	0.94	8.00	0.3400	5.72	SBUH/SCS	TYPE1A	6-month

RLPCOMPUTE [P-POND RSF RLP] SUMMARY (POND W/0 VCF)
 2 yr Match Q: 0.0400 cfs Peak Out Q: 0.0399 cfs - Peak Stg: 212.64 ft - Active Vol: 0.5515 acft
 10 yr Match Q: 0.6900 cfs Peak Out Q: 0.5274 cfs - Peak Stg: 212.95 ft - Active Vol: 0.5771 acft
 100 yr Match Q: 1.4200 cfs Peak Out Q: 1.4115 cfs - Peak Stg: 213.21 ft - Active Vol: 0.5986 acft

MIN. DETENTION VOLUME REQ'D = 0.5986 acft (1.36 vcf) = 0.8141acft = 35,462 cf

RLPCOMPUTE [F-POND RSF RLP] SUMMARY (POND W/1.36 VCF)
 2 yr Match Q: 0.0200 cfs Peak Out Q: 0.0346 cfs - Peak Stg: 210.94 ft - Active Vol: 0.5583 acft
 10 yr Match Q: 0.6900 cfs Peak Out Q: 0.3861 cfs - Peak Stg: 212.90 ft - Active Vol: 0.7791 acft
 100 yr Match Q: 1.4200 cfs Peak Out Q: 0.8050 cfs - Peak Stg: 213.04 ft - Active Vol: 0.7951 acft

6-month Match Q: 0.0400 cfs Peak Out Q: 0.0260 cfs - Peak Stg: 208.70 ft - Active Vol: 0.3050 acft
 Running I:\PROJECTS\646 RSF Development\Docs\Storm\P-POND RSF RLP Report.pgm on Monday,
 December 18, 2006

Summary Report of all RLPool Data

Project Precips

[2 yr]	1.80 in
[10 yr]	2.75 in
[100 yr]	3.75 in
[6-month]	1.16 in

Drainage Area: PRE A

Hyd Method:	SBUH Hyd	Loss Method:	SCS CN Number
Peak Factor:	484.00	SCS Abs:	0.20
Storm Dur:	24.00 hrs	Intv:	10.00 min
	Area	TC	
		CN	
Pervious	5.9400 ac	81.00	0.62 hrs
Impervious	0.0000 ac	98.00	0.00 hrs
Total	5.9400 ac		

Supporting Data:

Pervious CN Data:

TOKUL SOILS ONSITE FORESTED	81.00	5.7200 ac
NEW IMPERVIOUS BYPASS	81.00	0.2200 ac

Pervious TC Data:

Flow type:	Description:	Length:	Slope:	Coeff:	Travel Time
Sheet	TC	325.00 ft	11.00%	0.4000	37.17 min

Drainage Area: BYPASS A

Hyd Method:	SBUH Hyd	Loss Method:	SCS CN Number
Peak Factor:	484.00	SCS Abs:	0.20
Storm Dur:	24.00 hrs	Intv:	10.00 min
	Area	TC	
		CN	
Pervious	0.0000 ac	86.00	0.00 hrs
Impervious	0.2200 ac	98.00	0.10 hrs
Total	0.2200 ac		

Supporting Data:

Impervious CN Data:

NEW ASPHALT BYPASS	98.00	0.2200 ac
--------------------	-------	-----------

Impervious TC Data:

Flow type:	Description:	Length:	Slope:	Coeff:	Travel Time
Fixed	TC	0.00 ft	0.00%	6.0000	6.00 min

Drainage Area: DEV A

Hyd Method:	SBUH Hyd	Loss Method:	SCS CN Number
Peak Factor:	484.00	SCS Abs:	0.20
Storm Dur:	24.00 hrs	Intv:	10.00 min
	Area	TC	
		CN	
Pervious	2.0100 ac	86.00	0.17 hrs
Impervious	3.7100 ac	98.00	0.10 hrs
Total	5.7200 ac		

Supporting Data:

Pervious CN Data:

lawns and landscaping	86.00	2.0100 ac
-----------------------	-------	-----------

Impervious CN Data:

R/W IMPERVIOUS	98.00	1.4100 ac
19 SFR @ 4500 SF EA	98.00	1.9600 ac
POND ACCES & D/L	98.00	0.1200 ac
2 EX RESIDENCES	98.00	0.2200 ac

Pervious TC Data:

Flow type:	Description:	Length:	Slope:	Coeff:	Travel Time
Fixed	min. Tc for model	0.00 ft	0.00%	10.0000	10.00 min

Impervious TC Data:

Flow type:	Description:	Length:	Slope:	Coeff:	Travel Time
Fixed	min. Tc for model	0.00 ft	0.00%	6.0000	6.00 min

HYDLIST SUMMARY

[MATCH 2YR] [MATCH 10YR] [MATCH 100YR] [RSF-P-2YR OUT] [RSF-P-10YR OUT] [RSF-P-100YR OUT]
 [2 yr-RSF ORIFICE-OutHyd] [10 yr-RSF ORIFICE-OutHyd] [100 yr-RSF ORIFICE-OutHyd] [2 yr-RSF NOTCH-OutHyd] [10 yr-RSF NOTCH-OutHyd] [100 yr-RSF NOTCH-OutHyd]

LSTEND

HydID	Peak Q (cfs)	Peak T (hrs)	Peak Vol (ac-ft)	Cont Area (ac)

MATCH 2YR	0.04	8.67	0.0373	0.0000
MATCH 10YR	0.69	8.17	0.4646	0.0000
MATCH 100YR	1.42	8.17	0.8332	0.0000
RSF-P-2YR OUT	0.04	24.33	0.0728	5.7200
RSF-P-10YR OUT	0.53	12.67	0.4803	5.7200
RSF-P-100YR OUT	1.41	9.17	0.9343	5.7200
2 yr-RSF ORIFICE-OutHyd	0.03	24.33	0.0634	5.7200
10 yr-RSF ORIFICE-OutHyd	0.04	18.33	0.0789	1.6226
100 yr-RSF ORIFICE-OutHyd	0.04	12.00	0.0845	0.6602
2 yr-RSF NOTCH-OutHyd	0.00	0.00	0.0000	0.0000
10 yr-RSF NOTCH-OutHyd	0.35	18.33	0.1991	4.0974
100 yr-RSF NOTCH-OutHyd	0.76	12.00	0.6473	5.0598

Node ID: P-POND RSF

Desc:	POND W/O VCF		
Start El:	206.0000 ft	Max El:	214.0000 ft
Contrib Basin:		Contrib Hyd:	
Stage	Area	Volume	Volume
206.00	3423.00	0.00 cf	0.0000 acft
214.00	3813.00	28944.00 cf	0.6645 acft

Control Structure ID: RSF COMBO - Combination Control Structure

Descrip:	COMBINATION STRUCTURE	
Start El	Max El	Increment
205.8000 ft	214.0000 ft	0.10
ID List:	RSF ORIFICE RSF NOTCH	
Split:	Split OutHyd into component hydrographs.	

Control Structure ID: RSF ORIFICE - Multiple Orifice Structure

Descrip:	ORIFICE	
Start El	Max El	Increment
205.8000 ft	214.0000 ft	0.10
Orif Coeff:	0.62	Bottom El: 203.80 ft
		Lowest Diam: 0.7500 in

Control Structure ID: RSF NOTCH - Rectangular weir

Descrip:	NOTCH WEIR	
Start El	Max El	Increment
212.7000 ft	214.0000 ft	0.10
Length:	1.2500 ft	

Summary Report of all RLPool Data

HYDLIST SUMMARY

[MATCH 2YR] [MATCH 10YR] [MATCH 100YR] [MATCH 2YR] [RSF-F-2YR OUT] [RSF-F-10YR
 OUT] [RSF-F 100YR OUT] [RSF-F 6 MONTH OUT] [2 yr-RSF ORIFICE-OutHyd] [10 yr-RSF ORIFICE-
 OutHyd] [100 yr-RSF ORIFICE-OutHyd] [6-month-RSF ORIFICE-OutHyd]
 [2 yr-RSF NOTCH-OutHyd] [10 yr-RSF NOTCH-OutHyd] [100 yr-RSF NOTCH-OutHyd] [6-month-RSF
 NOTCH-OutHyd]

LSTEND

HydID	Peak Q (cfs)	Peak T (hrs)	Peak Vol (ac-ft)	Cont Area (ac)

MATCH 2YR	0.04	8.67	0.0373	0.0000
MATCH 10YR	0.69	8.17	0.4646	0.0000
MATCH 100YR	1.42	8.17	0.8332	0.0000
MATCH 2YR	0.04	8.67	0.0373	0.0000
RSF-F-2YR OUT	0.03	24.33	0.0634	5.7200
RSF-F-10YR OUT	0.39	18.33	0.2780	5.7200
RSF-F 100YR OUT	0.81	12.00	0.7318	5.7200
RSF-F 6 MONTH OUT	0.03	24.33	0.0474	5.7200
2 yr-RSF ORIFICE-OutHyd	0.03	24.33	0.0634	5.7200
10 yr-RSF ORIFICE-OutHyd	0.04	18.33	0.0789	1.6226
100 yr-RSF ORIFICE-OutHyd	0.04	12.00	0.0845	0.6602
6-month-RSF ORIFICE-OutHyd	0.03	24.33	0.0474	5.7200
2 yr-RSF NOTCH-OutHyd	0.00	0.00	0.0000	0.0000
10 yr-RSF NOTCH-OutHyd	0.35	18.33	0.1991	4.0974
100 yr-RSF NOTCH-OutHyd	0.76	12.00	0.6473	5.0598
6-month-RSF NOTCH-OutHyd	0.00	0.00	0.0000	0.0000

Node ID: F-POND RSF

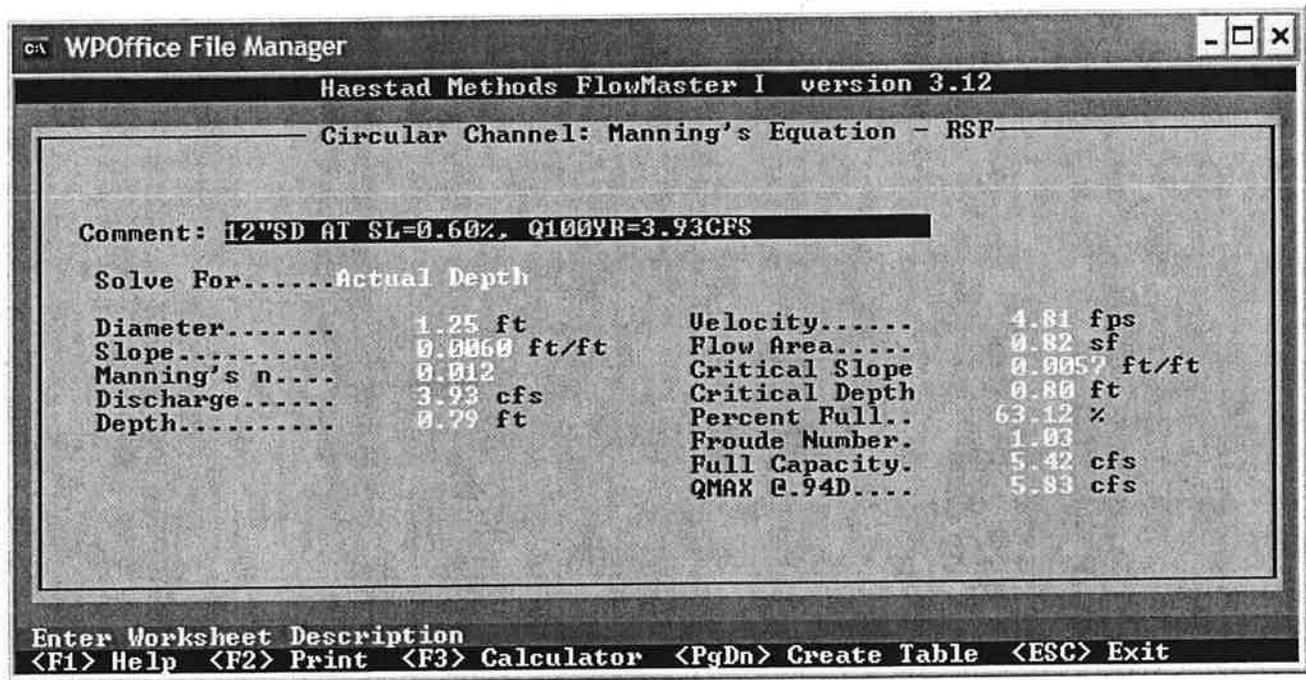
Desc:	POND W/1.36 VCF		
Start El:	206.0000 ft	Max El:	214.0000 ft
Contrib Basin:		Contrib Hyd:	
Stage	Area	Volume	Volume
206.00	4656.00	0.00 cf	0.0000 acft
214.00	5186.00	39368.00 cf	0.9038 acft

DISCHLIST

[RSF COMBO] [RSF ORIFICE] [RSF NOTCH]

LSTEND

Conveyance Analysis:



DEAD STORAGE VOLUME PROVIDED:

CELL A

ELV.	AREA	VOL.
200.00	400.0	0.0000
206.00	4656.0	<u>15,168.0</u>
		Total = <u>15,168 cf</u> Dead storage volume provided

SECTION III
OPERATIONS & MAINTENANCE MANUAL
(TO BE PROVIDED AT TIME OF CONSTRUCTION)

SECTION IV
SWPPP
(TO BE PROVIDED AT TIME OF CONSTRUCTION)

SECTION IV

GLEN HAWK ESTATES

SWPPP RISK ASSESSMENT DECISION MATRIX

	LOW	MED.	<u>HIGH</u>	VERY HIGH
Winter Grading Proposed:	NO	NO	<u>MAYBE REQUIRES LEVEL III</u>	NOT ALLOWED
Area Disturbed:	LESS THAN 1 acre	<u>1 to 5 acres</u>	5 to 20 acres	MORE THAN 20 ACRES
Slope:	Average less than 8% in development area	Average more than 8% but all areas are less than 15%.	<u>Average more than 8% but less than 15% no slope greater than 33%</u>	Average more than 15%
Soil erosion hazard per Appendix A POL-3044:	LOW SCS Soil type A (Permeable soil)	LOW A or Type B	<u>MEDIUM type C</u>	HIGH Type D
Critical Areas down slope of or downstream of discharge point:	Greater than ¼ mile	Greater than ¼ mile	<u>Less than ¼ mile</u>	Less than ¼ mile flows directly to ESA stream
Level SWPPP Required:	Level I	Level II	<u>Level III</u>	Level III

Note: **Bold** and underlined indicates category this project falls in.

APPENDIX

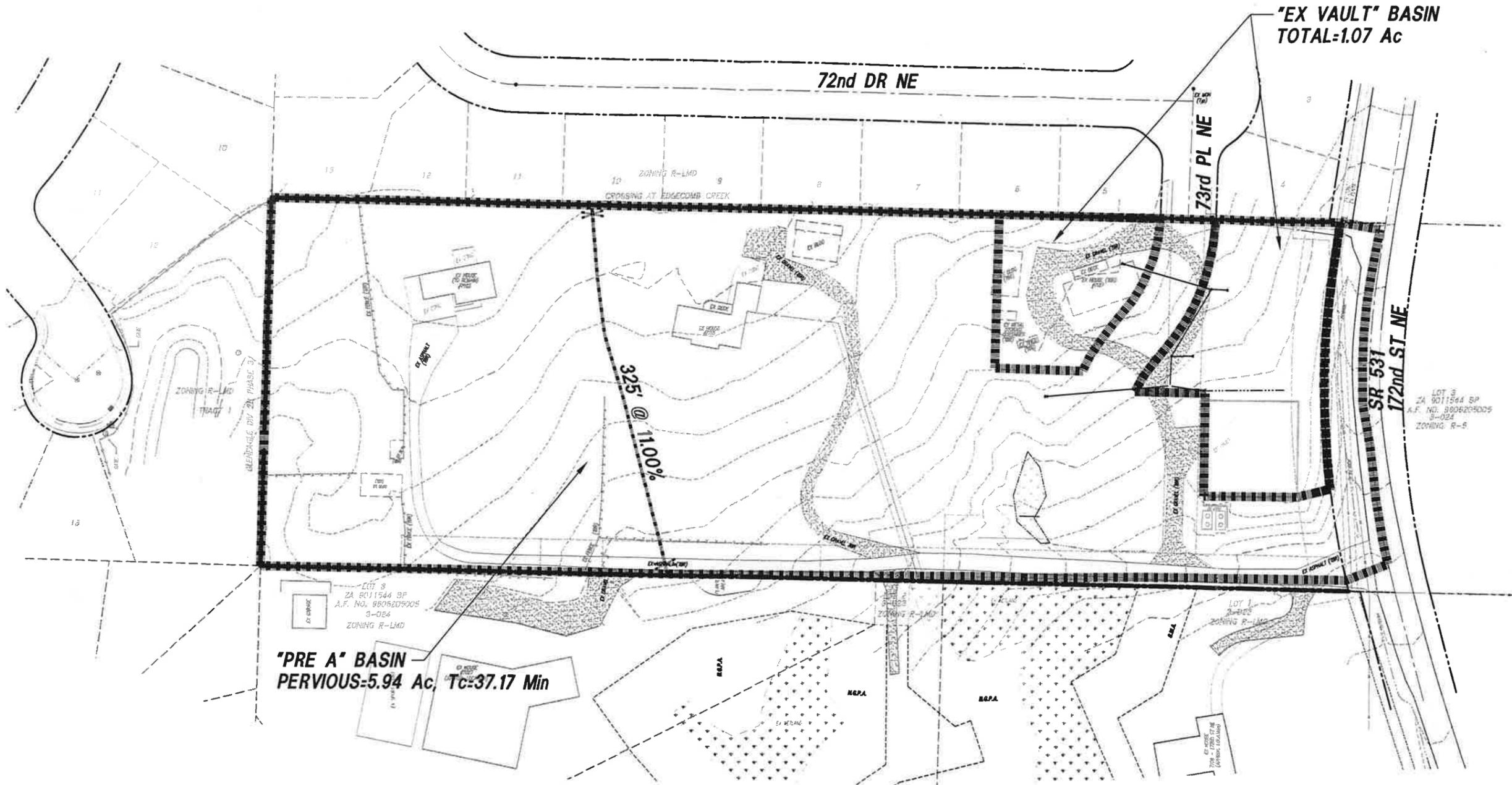
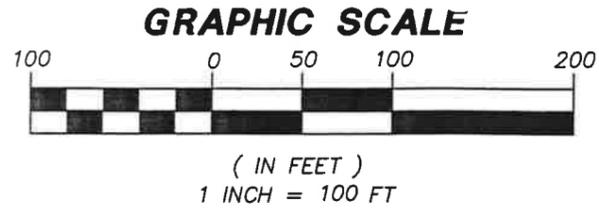
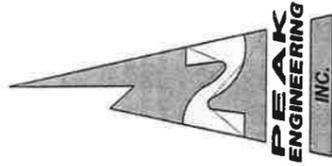
SOIL SURVEY OF SNOHOMISH COUNTY AREA, WASHINGTON



Map Unit Legend Summary

Snohomish County Area, Washington

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
72	Tokul gravelly loam, 0 to 8 percent slopes	4.0	57.0
74	Tokul gravelly loam, 15 to 25 percent slopes	2.7	38.8
77	Tokul-Winston gravelly loams, 25 to 65 percent slopes	0.3	4.1



"PRE A" BASIN
PERVIOUS=5.94 Ac, Tc=37.17 Min

"EX VAULT" BASIN
TOTAL=1.07 Ac

VEGETATION:

NATIVE UNDERBRUSH, LANDSCAPE, 2nd & 3rd GROWTH FOREST

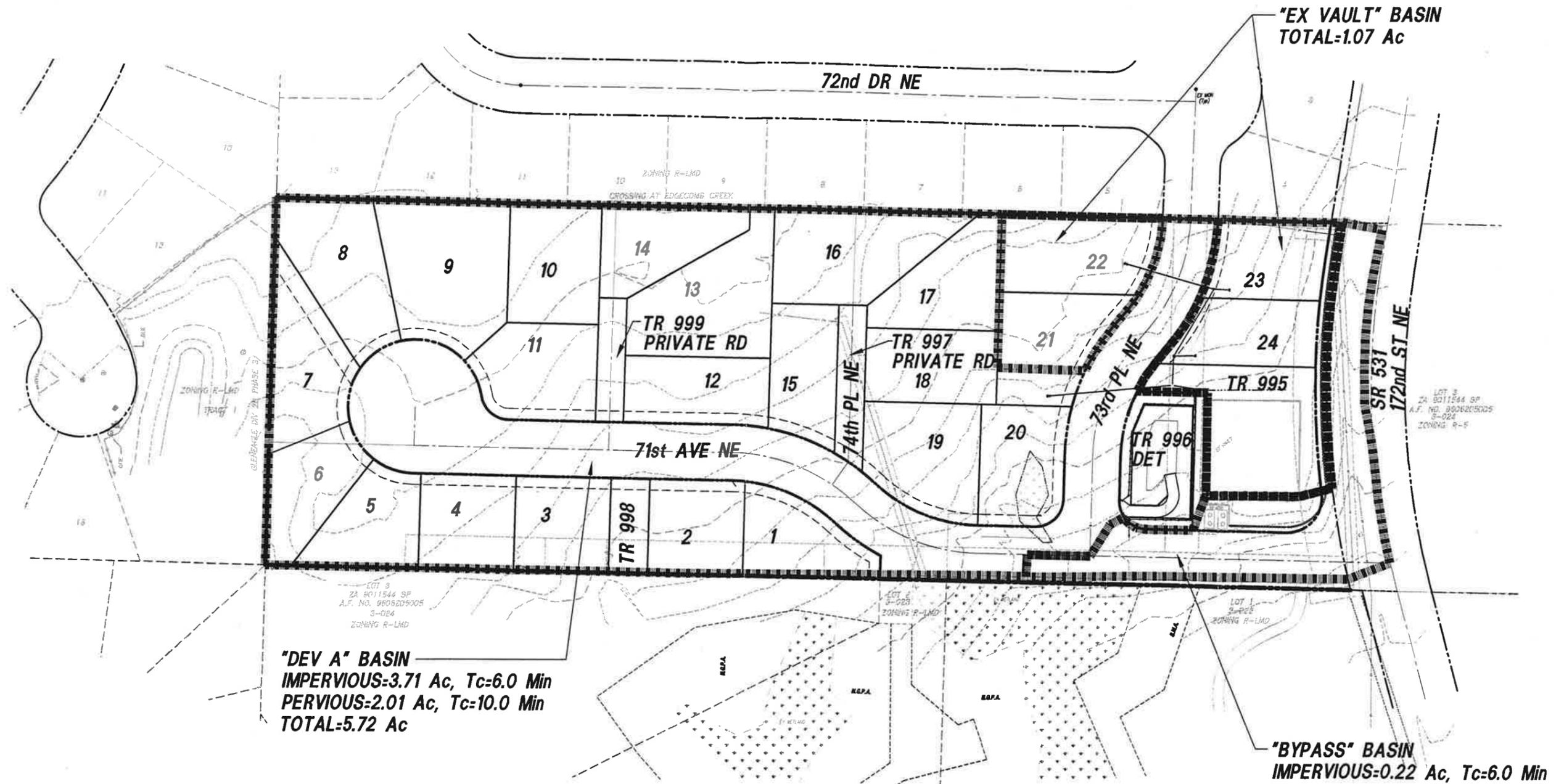
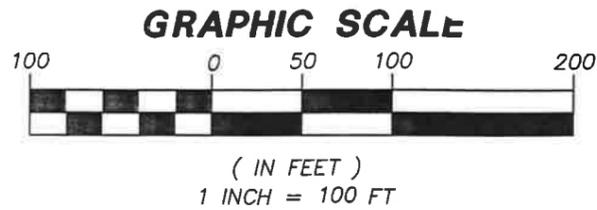
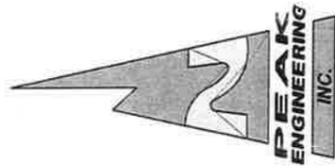
SOILS:

TOKUL GRAVELLY LOAM & TOKUL WINSTON

GLEN HAWK ESTATES

EXISTING CONDITIONS
BASIN MAP EXHIBIT

PEAK JOB NO. 05646



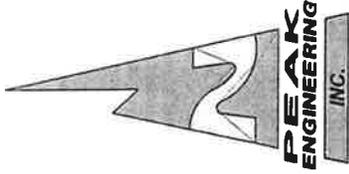
"DEV A" BASIN
 IMPERVIOUS=3.71 Ac, Tc=6.0 Min
 PERVIOUS=2.01 Ac, Tc=10.0 Min
 TOTAL=5.72 Ac

"BYPASS" BASIN
 IMPERVIOUS=0.22 Ac, Tc=6.0 Min

VEGETATION:
 NATIVE UNDERBRUSH, LANDSCAPE, 2nd & 3rd GROWTH FOREST

SOILS:
 TOKUL GRAVELLY LOAM & TOKUL WINSTON

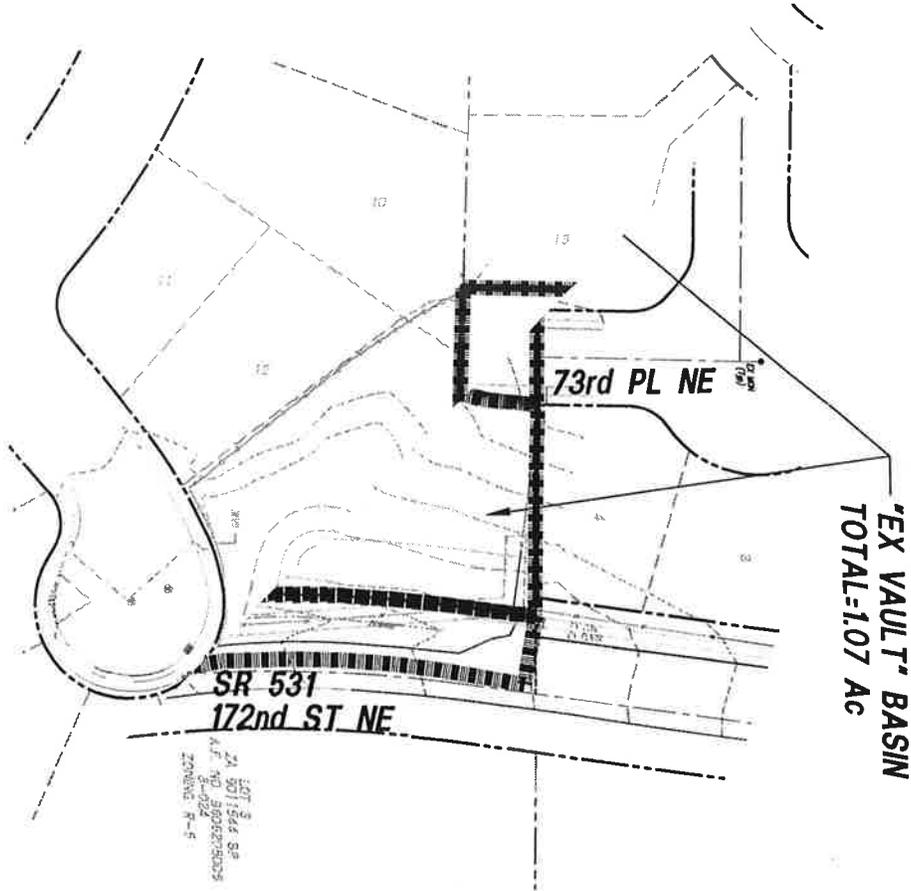
GLEN HAWK ESTATES
 DEVELOPED CONDITIONS
 BASIN MAP EXHIBIT
 PEAK JOB NO. 05646

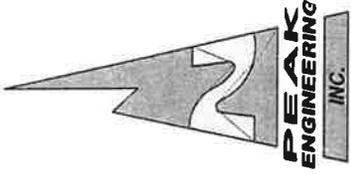


GRAPHIC SCALE

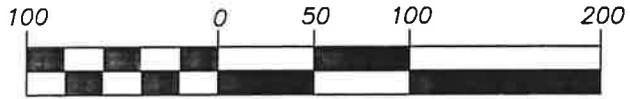


(IN FEET)
1 INCH = 100 FT





GRAPHIC SCALE



(IN FEET)
1 INCH = 100 FT

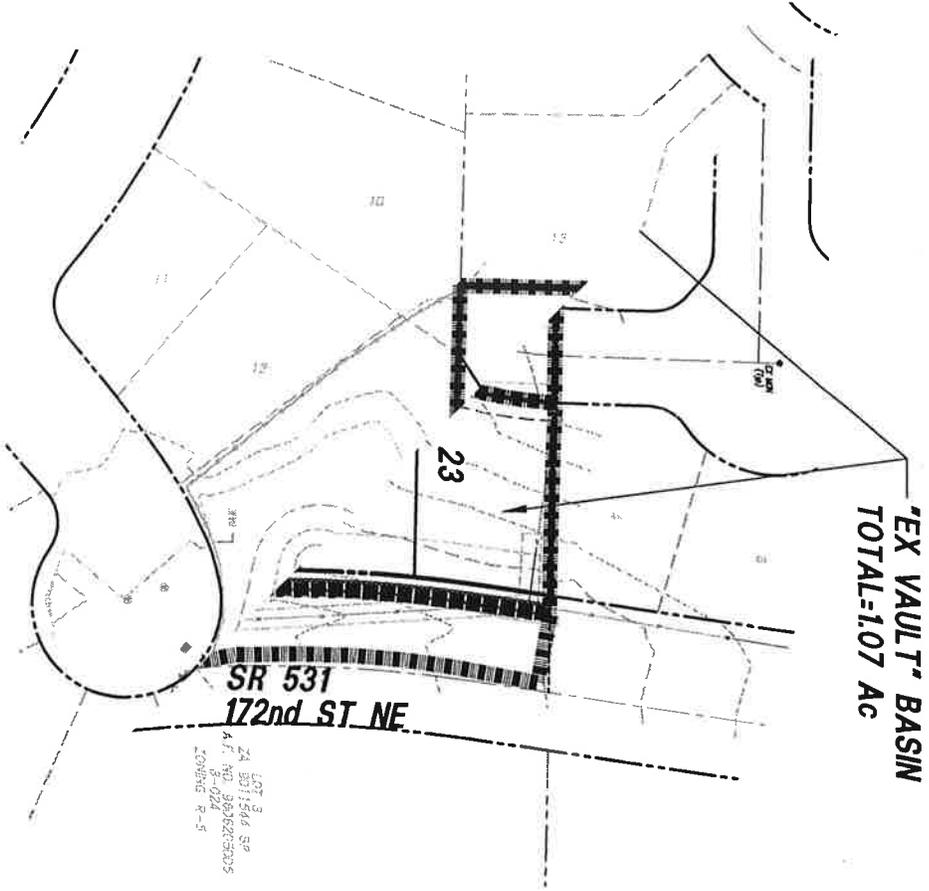
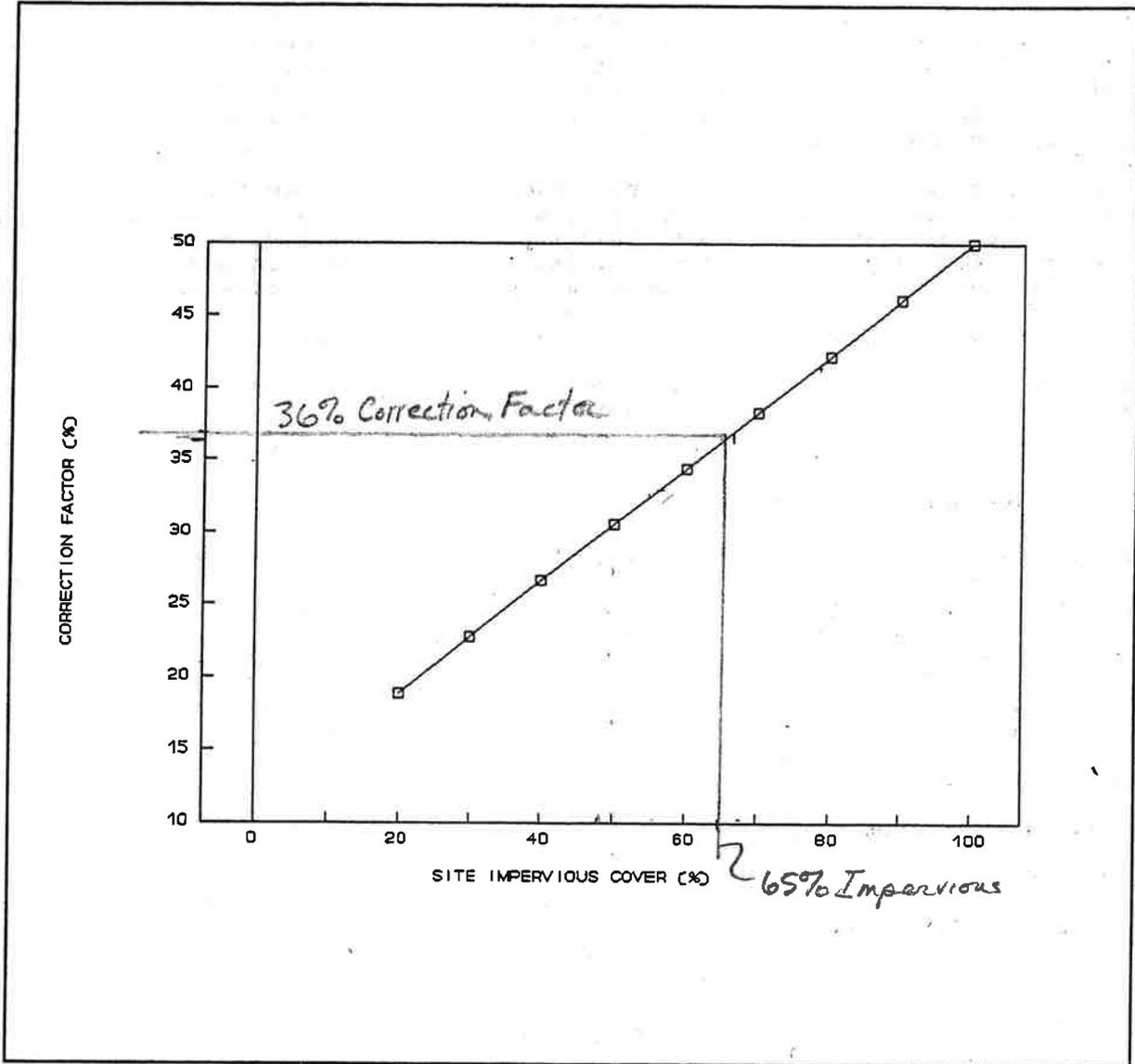


FIGURE III-1.1
 Volume Correction Factor to be Applied to
 Streambank Erosion Control BMPs
 Based on Site Impervious Cover



Impervious = 3.71 Ac site impervious cover = $\frac{5.72}{3.71} = 0.65$ or 65%
 Pervious = 2.01 Ac
 Total Basin Area = 5.72 Ac

Associated Earth Sciences, Inc.



Celebrating 25 Years of Service

January 29, 2007
Project No. KE060858A

RFS Development, LLC
11706 Marine View Drive
Marysville, Washington 98271

Attention: Mr. Joe Firchau

Subject: Assessment of Road Construction Impacts to Wetland Recharge
RFS Arlington
7103, 7115, and 7127 172nd Street NE
Arlington, Washington

Dear Mr. Firchau:

This letter presents the results of the subsurface exploration and wetland recharge assessment recently completed for the subject site. Our work has been completed for the exclusive use of RFS Development, LLC and their agents in general accordance with our contract agreement dated December 18, 2006.

INTRODUCTION

The project site consists of approximately 7.2 acres located on the north side of 172nd Street NE, approximately ¼ mile east of 67th Avenue NE in Arlington, Washington (Figure 1). Three existing residences are located on the site. The addresses of these residences are 7102, 7115, and 7127 172nd Street NE. A buried storm water detention vault for an upslope development is located in the southwestern portion of the site. Access to the existing homes is provided by a private road that enters the property off of 172nd Street NE. The areas between the existing structures, roads, and driveways consist predominantly of sod and other landscaping. A forested area is located in the southern portion of the site. A small wetland has been identified in a low-lying area within the forested area. Additional, more extensive wetlands are located on the adjacent property to the west. It is our understanding previous work at the site has determined that the on-site wetland and the off-site wetlands to the west are

not connected hydrologically. The topography of the site generally slopes down toward the southwest at gradients ranging from approximately 10 to 25 percent. The locations of the existing structures, topographic contours, wetlands, and other major site features are depicted on Figure 2.

It is our understanding the current plans call for subdividing the property into 24 residential lots. Access to the lots will be provided by two new public roads (71st Avenue NE and 73rd Place NE), and two private roads. One of the new public roads, 71st Avenue NE, will pass between the existing on-site wetland and the off-site wetlands to the west. This portion of 71st Avenue NE will be located along the same alignment as the existing road into the property. The proposed development plans include filling the on-site wetland.

It is our understanding that the City is concerned that construction of the new road will impact ground water recharge to the off-site wetlands to the west. The purpose of this study is to evaluate the impact of the road construction on ground water recharge to the off-site wetlands.

SUBSURFACE CONDITIONS

In order to evaluate subsurface conditions for the project, nine exploration pits were excavated on the site approximately where shown on the Site and Exploration Plan, Figure 2. The various types of sediments, as well as the depths where characteristics of the sediments changed, are indicated on the attached exploration logs. The depths indicated on the logs where conditions changed may represent gradational variations between sediment types. Our explorations were approximately located in the field relative to known site features shown on the previously referenced topographic site plan (Figure 2). Because of the nature of exploratory work below ground, extrapolation of subsurface conditions between field explorations is necessary. It should be noted that differing subsurface conditions may sometimes be present due to the random nature of deposition and the alteration of topography by past grading and/or filling.

The exploration pits were excavated with a tractor-mounted backhoe. The pits permitted direct, visual observation of subsurface conditions. Materials encountered in the exploration pits were studied and classified in the field by an engineering geologist from our firm. All exploration pits were backfilled immediately after examination and logging. Selected samples were then transported to our laboratory for further visual classification and testing, as necessary.

Stratigraphy

Subsurface conditions at the project site were inferred from the field explorations accomplished for this study, visual reconnaissance of the site, and review of applicable geologic literature. As shown on the field logs, the exploration pits generally encountered granular glacial

sediments. Areas of fill and fine-grained natural sediments were also encountered. Descriptions of the individual geologic units underlying the site are provided below, organized from the youngest to the oldest sediment types.

Fill

Fill soils (those not naturally placed) were encountered in exploration pits EP-1 and EP-7. The existing fill generally consisted of loose to medium dense, silty sand with gravel and minor quantities of organic debris. Fill thicknesses of approximately 7.5 feet and 3 feet were observed in exploration pits EP-1 and EP-7, respectively.

Sod/Topsoil

A surficial organic sod/topsoil layer was encountered at each of the exploration pit locations, with the exception of exploration pit EP-7. Where encountered, the thickness of the sod/topsoil layer ranged from approximately 3 to 6 inches.

Vashon Lodgement Till

Sediments encountered below the fill, or directly below the surficial sod/topsoil layer where no fill was present, generally consisted of unsorted, silty sand with gravel. We interpret these sediments to be representative of Vashon lodgement till. The Vashon lodgement till consists of sediments that were deposited directly from basal, debris-laden glacial ice during the Vashon Stade of the Fraser Glaciation approximately 12,500 to 15,000 years ago. The high relative density characteristic of lodgement till is due to its consolidation by the massive weight of the glacial ice from which it was deposited. In those exploration pits where no fill was encountered (EP-2 through EP-6, EP-8, and EP-9), the upper portion of the till was observed to be loose to medium dense and reddish brown to tan to depths of approximately 2 to 4 feet. Below this depth, these sediments were observed to be dense to very dense and tan to gray in color. The reduced density and coloration of the upper portion of the till is interpreted to be due to weathering. At the location of exploration pit EP-7, a 4-foot-thick weathered till horizon was encountered below the surficial fill. No weathered till horizon was encountered below the surficial fill layer in exploration pit EP-1. At the locations of all of the exploration pits except EP-8, the lodgement till extended beyond the maximum depths explored of approximately 6 to 9.5 feet. At the location of exploration pit EP-8, the lodgement till extended to a depth of approximately 6 feet.

Vashon to Pre-Vashon Undifferentiated Sediments

Sediments encountered below the till at the location of exploration pit EP-8 generally consisted of hard, blue-gray silt with interbeds of micaceous, silty fine sand. It was not determined whether these sediments are representative of a Vashon-aged unit that pre-dates the lodgement till, or an older, pre-Vashon unit. At the location of exploration pit EP-8, these sediments

extended beyond the maximum depth explored of approximately 8 feet. The Vashon to pre-Vashon undifferentiated sediments were not encountered in any of the other exploration pits excavated at the site. It should be noted that exploration pit EP-8 was excavated in the area of the proposed detention pond, near the lowest-lying portion of the proposed development area.

Geologic cross sections through the site, based on the conditions encountered in the exploration pits, are shown on Figures 3, 4, and 5. The locations of Cross Sections A-A', B-B', and C-C' are shown on Figure 2.

Review of the regional geologic map titled *Distribution and Description of the Geologic Units in the Arlington West Quadrangle, Washington*, by James Minard (1980), indicates that the area of the subject site is underlain by Vashon lodgement till with exposures of Vashon advance outwash and Vashon to pre-Vashon undifferentiated sediments present in portions of the surrounding vicinity. Our interpretation of the sediments encountered in our explorations is in general agreement with the regional geologic map.

Hydrology

Slow ground water seepage was encountered at the base of the fill at the location of exploration pit EP-1. The seepage was limited to a thin zone less than 6 inches thick and appeared to be perched atop the underlying, unweathered lodgement till. Ground water seepage was not encountered in any of the other exploration pits excavated at the site.

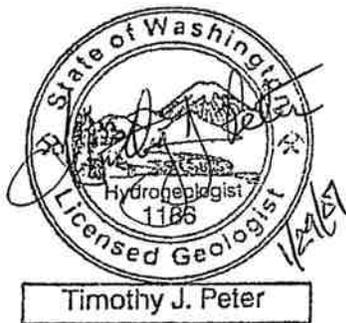
CONCLUSIONS

In some areas underlain by lodgement till, it is common for seepage to accumulate at the base of the weathered till horizon. This seepage, known as interflow, occurs when surface water percolates down through the surficial weathered till sediments and becomes perched atop the underlying, lower-permeability unweathered till sediments. Depending upon factors such as soil density, grain size distribution, topography, and weather, interflow may be present in areas underlain by lodgement till throughout the entire year, seasonally, or not at all. No interflow was observed in any of the exploration pits excavated at the site. Given that our exploration was conducted in January 2007 during an unusually wet fall and winter, it is our opinion that interflow from on-site sources is not a major source of recharge to the off-site wetlands to the west. Due to their high relative densities and high fines content, the permeabilities of the lodgement till and Vashon to pre-Vashon undifferentiated sediments encountered in our explorations below the interflow zone are very low. In addition, neither of these units were saturated at the time of our exploration. Based on the subsurface conditions observed in our explorations, it is our opinion that recharge to the off-site wetlands from on-site interflow or other shallow ground water systems at the site is minimal. Accordingly, it is our opinion that construction of the new road, as proposed, will not disrupt interflow or ground water recharge to the off-site wetlands. Therefore, provisions to provide transmission

of interflow or other shallow ground water below the roadway are not warranted to maintain recharge to the off-site wetlands.

We appreciate this opportunity to have been of service to you with your project. Should you have any questions, or require additional information, please do not hesitate to call.

Sincerely,
ASSOCIATED EARTH SCIENCES, INC.
Kirkland, Washington



Timothy J. Peter, P.E.G., P.Hg.
Senior Project Hydrogeologist

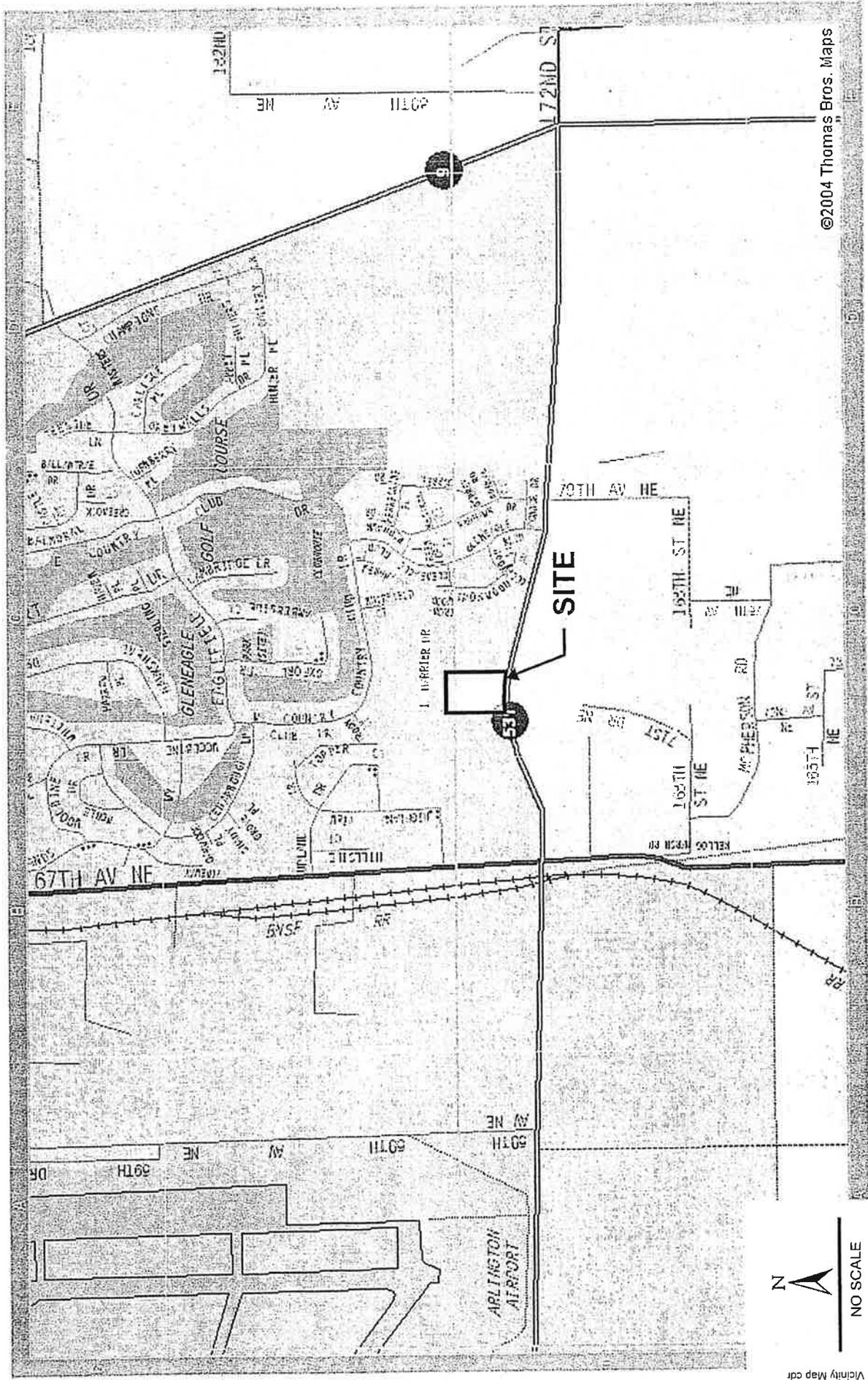


Jon N. Sondergaard, P.G., P.E.G.
Principal Engineering Geologist

Attachments: Figure 1. Vicinity Map
Figure 2. Site and Exploration Plan
Figure 3. Geologic Cross Section A-A'
Figure 4. Geologic Cross Section B-B'
Figure 5. Geologic Cross Section C-C'
Exploration Logs

cc: Peak Engineering
601 Delta Avenue
Marysville, Washington 98270
Attn: Ms. Debbie Rothfus

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-
-
-
-

**VICINITY MAP
RFS DEVELOPMENT
ARLINGTON, WASHINGTON**

FIGURE 1
DATE 1/07
PROJ. NO. KE060858A

Snohomish County

Drainage Inventory
Map date: August 27, 2006

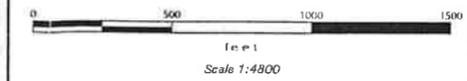
Section 23
T 31 N, R 5 E

Legend

Drainage Network	Drainage Features
— Open Channel System	● Pipe In
- - - Surface Flow	● Pipe Out
— Pipe Diameter 12 & under	● Pipe Invert (Flow direction unclear)
— Pipe Diameter 15 to 21	● Other Drainage Feature
— Pipe Diameter 24 to 30	
— Pipe Diameter 36 & greater	Catch Basins
— Arched Pipe	□ CB Yard Drain
Base Map Features	□ CB Type 1 Inlet
— Section	□ CB Type 1
— Quarter Section	□ CB Type 2
— Parcel Boundary	□ CB Type 2 Flow/Pool
— City Boundary	□ Other CBs
— Urban Growth Boundary	Access Points
— 20 Ft Contours	⊕ Vault Access
■ Water	⊕ Detention Pipe Access



Township 31, Range 5

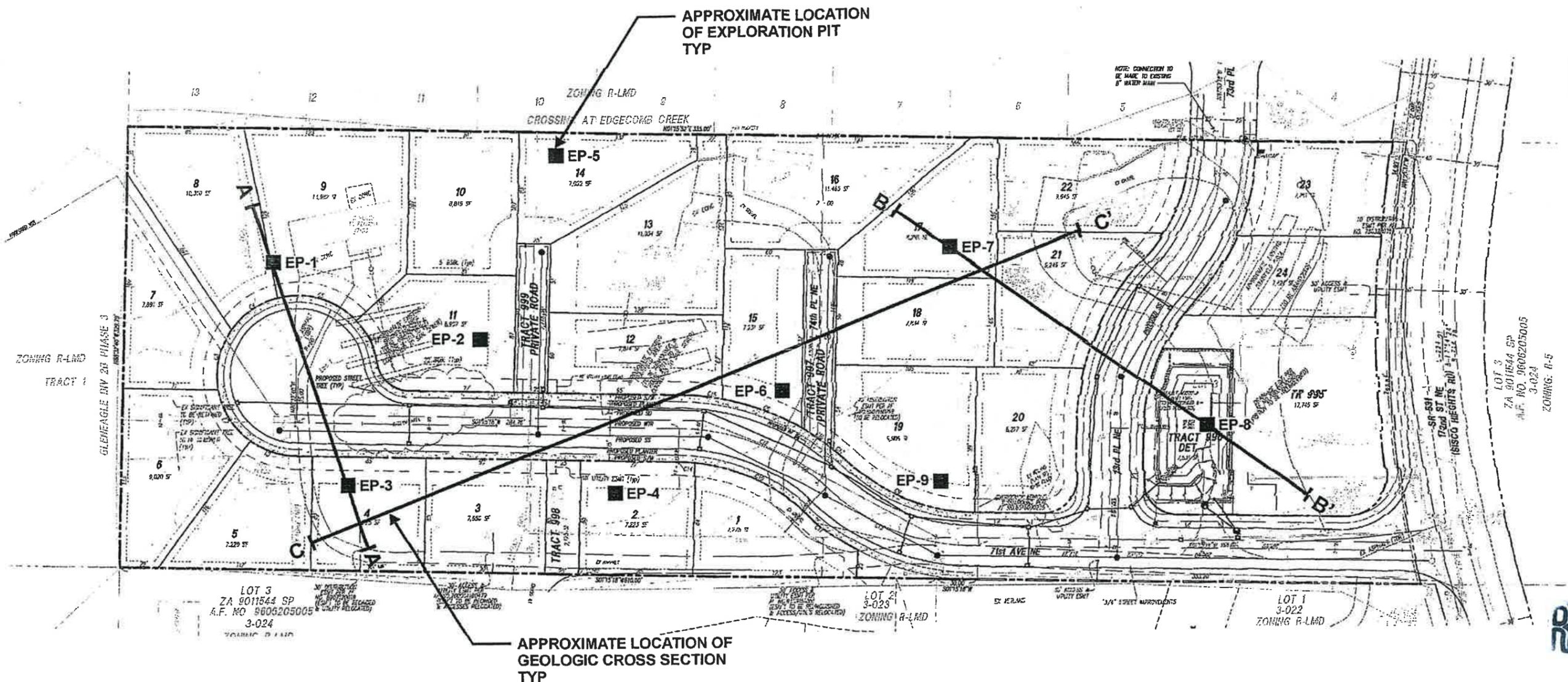


Snohomish County has no warranty for the information presented on this map for any particular purpose. The information is provided as a general guide only. The user assumes all responsibility for any use of this map. The drainage inventory is a public record and is available for inspection and copying at the Snohomish County Public Works Department, 10000 1st Avenue NE, Everett, WA 98203. The information is provided as a public record and is available for inspection and copying at the Snohomish County Public Works Department, 10000 1st Avenue NE, Everett, WA 98203.



Snohomish County
PUBLIC WORKS
Surface Water Management
Drainage Infrastructure Program
(425) 388-3464
Map produced by PW-SWM/31S
August 27, 2006





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060858 RSF Arlington 060858 Site and Expl.cdr

Reference: Peak Engineering Inc.

Associated Earth Sciences, Inc.

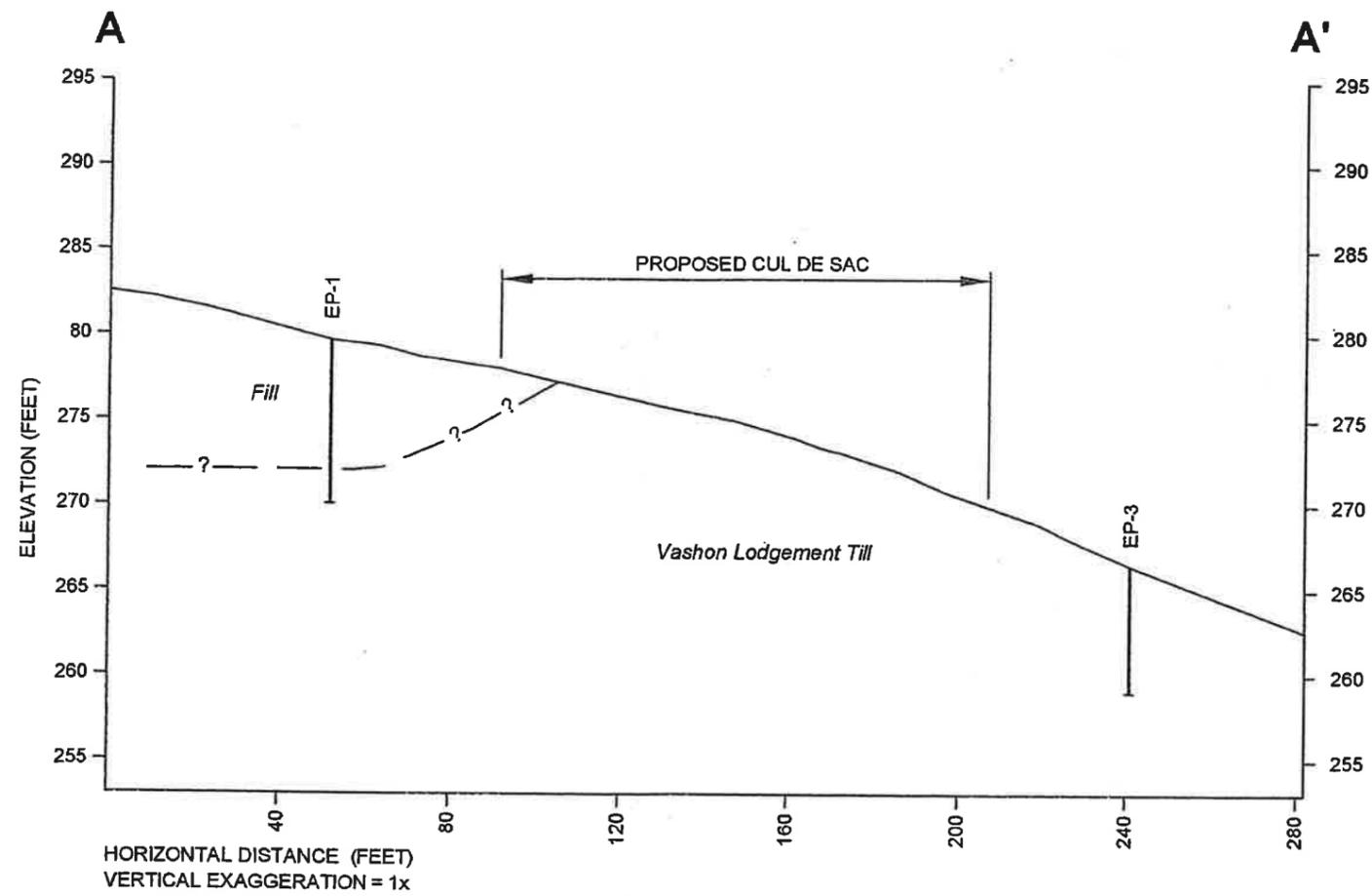


SITE AND EXPLORATION PLAN
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FIGURE 2

DATE 1/07

PROJ. NO. KE060858A



060858 RSF Arlington 1 060858 Geo Sects.dwg LAYOUT: Sect A-A

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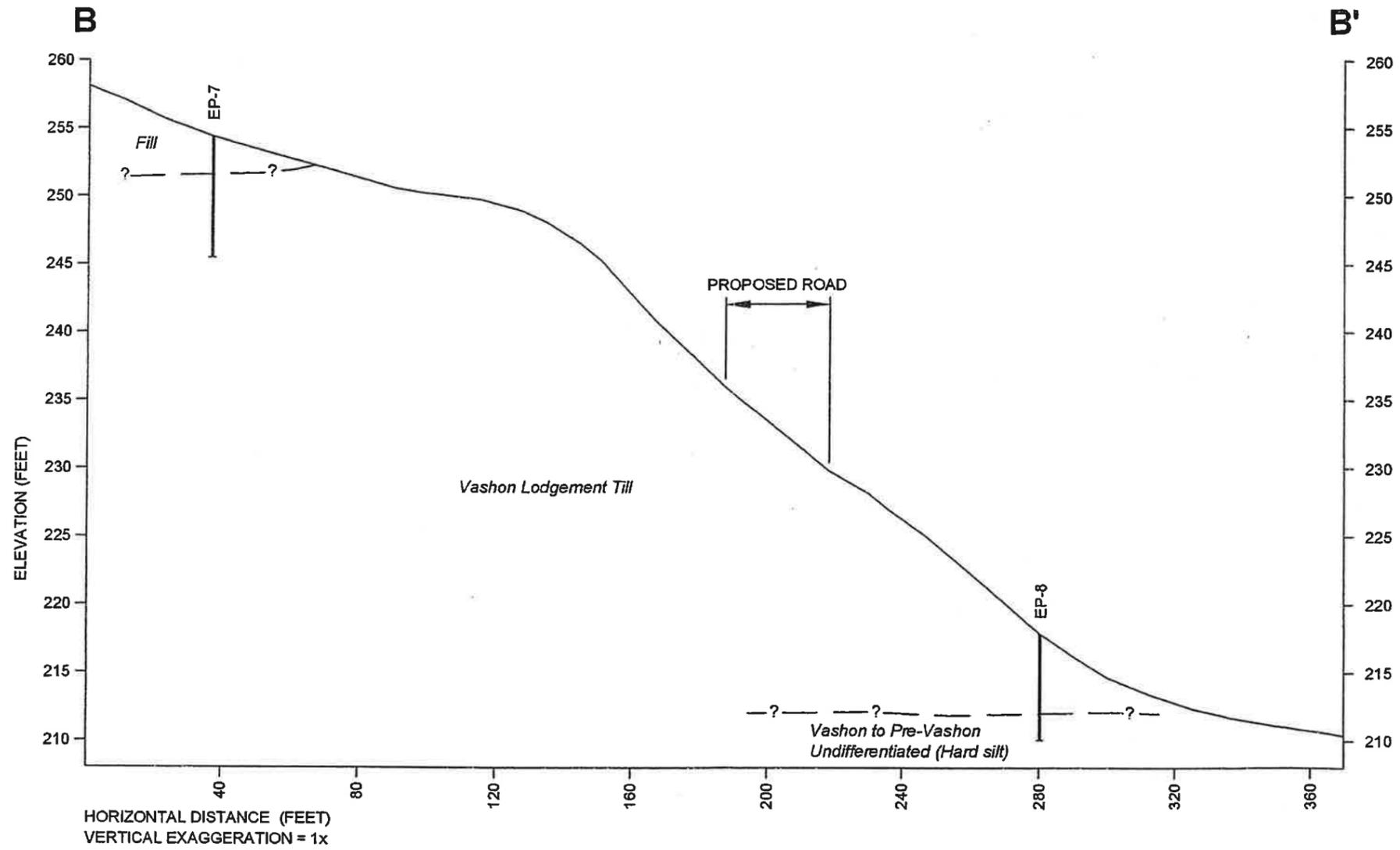


GEOLOGIC CROSS SECTION A - A'
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FIGURE 3

DATE 1/07

PROJECT NO. KE06858A



060858 RSF Arlington \ 060858 Gao Sects.dwg LAYOUT: Sect B-B

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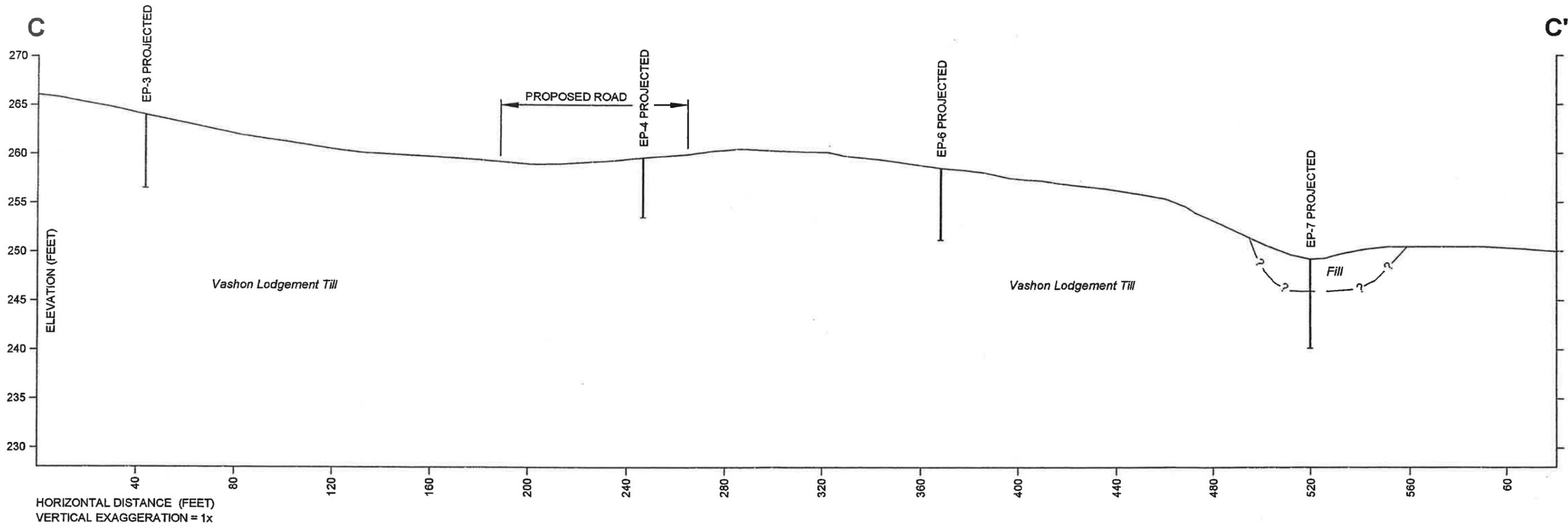
GEOLOGIC CROSS SECTION A - A'

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FIGURE 4

DATE 1/07

PROJECT NO. KE06858A



060658 RSF Arlington 1 D60658 Geo Sects.dwg LAYOUT: Sect C-C

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GEOLOGIC CROSS SECTION A - A'

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FIGURE 5

DATE 1/07

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LOG OF EXPLORATION PIT NO. EP-1

Depth (ft)	<p style="font-size: small;">This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.</p> <p style="text-align: center;">DESCRIPTION</p>	
1	Sod/Topsoil	
2	Fill	
3	Loose to medium dense, very moist, tan to brown, silty SAND with gravel, scattered twigs (SM); wet at 7 1/2 feet.	
4		
5		
6		
7		
8	Vashon Lodgement Till	
9	Very dense, very moist, grayish tan, silty SAND with gravel (SM).	
10		
11	Bottom of exploration pit at depth 9.5 feet Slow seepage accompanied by minor sloughing at 7 1/2 feet.	
12		
13		
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**RFS Development
Arlington, WA**

Associated Earth Sciences, Inc.



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 Approved by: *TJP*

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1/15/07

LOG OF EXPLORATION PIT NO. EP-2

Depth (ft)	<p style="font-size: small;">This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.</p> <p style="margin-top: 10px;">DESCRIPTION</p>
1	<p style="margin: 0;">Sod/Topsoil</p> <hr/> <p style="margin: 0;">Weathered Vashon Lodgement Till</p>
2	<p>Loose, moist, reddish brown, silty SAND with gravel (SM); becomes medium dense and very moist below 2 feet.</p>
3	
4	
5	<p style="margin: 0;">Vashon Lodgement Till</p>
6	<p>Very dense, moist, grayish tan, silty SAND with gravel (SM).</p>
7	
8	
9	
10	
11	<p>Bottom of exploration pit at depth 8.5 feet No seepage. No caving</p>
12	
13	
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LOG OF EXPLORATION PIT NO. EP-3

Depth (ft)	<p>This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.</p> <p style="text-align: center;">DESCRIPTION</p>	
1	Sod/Topsoil	
2	Weathered Vashon Lodgement Till	
3	Loose, moist, reddish brown, silty SAND with gravel (SM); becomes medium dense and very moist below 2 1/2 feet.	
4	Vashon Lodgement Till	
5	Very dense, moist, grayish tan, silty SAND with gravel (SM).	
6		
7		
8	Bottom of exploration pit at depth 7.5 feet No seepage. No caving.	
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1/15/07

LOG OF EXPLORATION PIT NO. EP-4

Depth (ft)	<p style="font-size: small;">This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.</p> <p style="margin: 0;">DESCRIPTION</p>
1	<p style="font-size: x-small; margin: 0;">Sod/Topsoil</p> <p style="font-size: x-small; margin: 0;">Weathered Vashon Lodgement Till</p> <p style="font-size: x-small; margin: 0;">Loose, moist, reddish brown, silty SAND with gravel (SM); becomes medium dense and very moist below 1 1/2 feet.</p>
2	<p style="font-size: x-small; margin: 0;">Vashon Lodgement Till</p> <p style="font-size: x-small; margin: 0;">Very dense, moist, grayish tan, silty SAND with gravel (SM).</p>
3	
4	
5	
6	
7	<p style="font-size: x-small; margin: 0;">Bottom of exploration pit at depth 6 feet No seepage. No caving.</p>
8	
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LOG OF EXPLORATION PIT NO. EP-5

Depth (ft)	<p style="font-size: small;">This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.</p> <p style="margin: 0;">DESCRIPTION</p>
1	<p style="margin: 0;">Sod/Topsoil</p> <p style="margin: 0;">Weathered Vashon Lodgement Till</p> <p style="margin: 0;">Loose, moist, reddish tan, silty SAND with gravel (SM); becomes medium dense and very moist below 18 inches.</p>
2	
3	<p style="margin: 0;">Vashon Lodgement Till</p> <p style="margin: 0;">Very dense, moist, grayish tan, silty SAND with gravel (SM).</p>
4	
5	
6	
7	<p style="margin: 0;">Bottom of exploration pit at depth 6.5 feet</p> <p style="margin: 0;">No seepage. No caving.</p>
8	
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LOG OF EXPLORATION PIT NO. EP-6

Depth (ft)	<p>This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.</p>
	DESCRIPTION
	Sod/Topsoil
1	Weathered Vashon Lodgement Till
2	Loose, moist, reddish brown, silty SAND with gravel (SM); becomes medium dense, very moist and tan below 1 1/2 feet.
3	
	Vashon Lodgement Till
4	Very dense, moist, grayish tan, silty SAND with gravel (SM).
5	
6	
7	
8	Bottom of exploration pit at depth 7 feet No seepage. No caving.
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LOG OF EXPLORATION PIT NO. EP-7

Depth (ft)	DESCRIPTION
1	Fill Loose to medium dense, moist, tan and brown, silty SAND with gravel and scattered small pieces of wood debris.
2	
3	
4	Weathered Vashon Lodgement Till Loose, moist, reddish brown, silty SAND with gravel (SM); becomes medium dense, very moist, reddish tan at approximately 6 feet.
5	
6	
7	Vashon Lodgement Till Dense to very dense, very moist, grayish tan, silty SAND with gravel (SM).
8	
9	
10	Bottom of exploration pit at depth 9 feet No seepage. No caving.
11	
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LOG OF EXPLORATION PIT NO. EP-8

Depth (ft)	<p style="font-size: small;">This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.</p> <p style="margin-top: 10px;">DESCRIPTION</p>
1	Sod/Topsoil
2	Weathered Vashon Lodgement Till
3	Loose, very moist, reddish brown, silty SAND with gravel (SM); become medium dense and mottled gray below 3 feet.
4	Vashon Lodgement Till
5	Dense to very dense, very moist, gray, silty SAND with gravel (SM).
6	Vashon to Pre-Vashon Undifferentiated
7	Hard, very moist, blue-gray, SILT (ML); interbedded with very moist, blue-gray, silty fine SAND (SM); micaceous.
8	
9	Bottom of exploration pit at depth 8 feet No seepage. No caving.
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1/15/07

LOG OF EXPLORATION PIT NO. EP-9

Depth (ft)		
	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.	
	DESCRIPTION	
	Topsoil	
1	Weathered Vashon Lodgement Till	
2	Loose to medium dense, moist, reddish brown, silty SAND with gravel (SM); becomes very moist below 3 feet; abundant roots.	
3		
4	Vashon Lodgement Till	
5	Very dense, moist, tan, silty SAND with gravel (SM).	
6		
7		
8		
9	Bottom of exploration pit at depth 8 feet No seepage. No caving.	
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RFS Development Arlington, WA

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