CASCADE SURVEYING
& ENGINEERING, INC.

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(360) 435-5551 • fax: (360) 435-4012

SURVEYORS
ENGINEERS
PLANNERS

Memorandum

To: Kelli Hale, P.E.
City of Arlington

From: Jacob Dahl, P.E.
Cascade Surveying & Engineering, Inc

Date: March 31, 2009

Subject: Arlington First Baptist Church Drainage Plan

Accompanied with this memo is the drainage plan for the Arlington First Baptist Church building additions. The Church plans to build a 90-ft x 75-ft multi-purpose facility and a 40-ft x 50-ft office building at the south end of their property located at 426 N French Ave. The most southerly existing building will be removed and replaced with the proposed office building. Aside from the existing building to be removed, the remainder of the area of development is maintained lawn.

Onsite soils were investigated at two different times. First, during the permitting process for the existing storm system, in July 2001 one test pit was dug at the north end of the property. The exploration revealed 40-inches of loamy sand over gravelly medium sand to a depth of 9.5-ft. Water was encountered at 9.5-ft (elv=128.00').

Later, in September 2007 Geotest Services dug 4 test pits along the slope at the south end of the property. Their investigation was for the purpose of constructing a retaining wall along Fourth Street. Generally, the test pits revealed silty sand over areas of glacial till or glacial outwash. Test pits were dug to depths ranging from 8-9-ft below the surface and no groundwater was encountered.

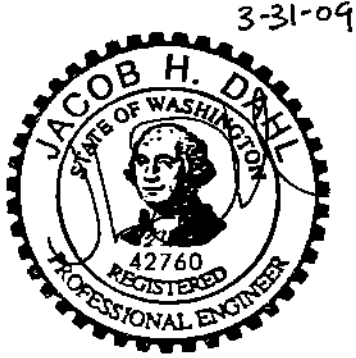
Stormwater runoff generated by the majority of the site is treated and or infiltrated onsite underneath the existing parking lot. This infiltration trench system is a two part system with a water quality treatment trench sized for the 6-month 24-hr runoff generated by the existing improvements. This trench is imbedded in the native gravelly sand; however, it is lined with loamy sand to provide treatment. Larger storm events overflow into a parallel trench imbedded in the native gravelly sand that is capable of fully infiltrating the 100-yr 24-hr storm. This system is at capacity; therefore, will not be utilized for the new improvements.

The drainage plan is to construct a separate rooftop infiltration trench sized to fully infiltrate the 100-yr 24-hr runoff generated by both new buildings. The trench needs to be imbedded within the native gravelly medium sand. If poor soils are encountered during construction, the engineer must be notified in order to make adjustments to the design. Adjustments may include adjusting the infiltration design rate to match the encountered soil's infiltration properties, adjusting the trench depth or dimensions in

order to imbed the trench within the proper soil layer, or relocating the trench to a location the is better suited for infiltration.

The infiltration rate for gravelly medium sand is 20-in/hr. Refer to Table III-3.1 of the 1992 DOE Stormwater Management Manual. For design purposes, an infiltration rate of 10-in/hr was used to simulate the long term infiltration rate. The trench will be 31-ft long by 8-ft wide by 3.5-ft deep. The trench void space available for water storage is calculated to be 32% based on 30% void space for the drain rock backfill and 100% for the perforated pipe. At each end of the trench will be a Type 1L catch basin containing a standard oil/water separator to prevent floatable debris from entering the trench. Each catch basin shall be installed per City of Arlington Standard Detail SD-120. The trench is to be installed a minimum of 10-ft away from the proposed buildings. Please refer to the attached calculations and plans & specifications for greater detail.

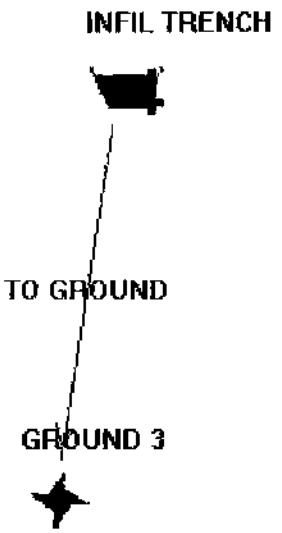
3-31-09



Attachments:

- StormSHED 2G stormwater model calculations
- Table III-3.1 Soil Properties Classified by Soil Texture
- Site plan/Drainage plan
- Original Drainage Report prepared by Cascade Surveying dated Oct. 2, 2001
- City of Arlington Geotechnical Study prepared by Geotest Services dated Oct. 9, 2007

StormSHED 2G Stormwater Model Data



Layout Report: DEVELOPED

Event	Precip (in)
6 month	1.1700
2 year	1.8000
10 year	2.7500
100 year	3.7500

Reach Records

Record Id: TO GROUND

Section Shape:	Circular		
Uniform Flow Method:	Manning's	Coefficient:	0.0120
Routing Method:	Travel Time Translation	Contributing Hyd	
DnNode	GROUND 3	UpNode	INFIL TRENCH
Material	Conc-Spun	Size	48" Diam
Ent Losses	Square Edge w/Headwall		
Length	0.0010 ft	Slope	100.00%
Up Invert	132.5000 ft	Dn Invert	132.4990 ft

Conduit Constraints				
Min Vel	Max Vel	Min Slope	Max Slope	Min Cover
2.00 ft/s	15.00 ft/s	0.50%	2.00%	3.00 ft

Drop across MH	0.0000 ft	Ex/Infil Rate	0.0000 in/hr
Up Invert	132.4990 ft	Dn Invert	132.5000 ft
Match inverts.			

Node Records

Record Id: GROUND 3

Descrip:		Increment	0.10 ft
Start El.	132.5000 ft	Max El.	140.0000 ft
Dummy Type Node			

Record Id: INFIL TRENCH

Descrip:		Increment	0.10 ft
Start El.	132.5000 ft	Max El.	136.0000 ft
Storage Node	STORAGE	Discharge Node	DISCHARGE

Record Id: STORAGE

Descrip:		Increment	0.10 ft
Start El.	132.5000 ft	Max El.	136.0000 ft
Length	31.0000 ft	Width	8.0000 ft
Catch	32.0000	Consider Bottom Only	

Record Id: DISCHARGE

Descrip:		Increment	0.10 ft
Start El.	132.5000 ft	Max El.	136.0000 ft
Infiltration rate	10.0000 in/hr	WP Multiplier	1.00

Contributing Drainage Areas

NEW BUILDINGS Event Summary

Event	Peak Q (cfs)	Peak T (hrs)	Hyd Vol (acft)	Area (ac)	Method	Raintype
6 month	0.0512	7.83	0.0160	0.2009	SBUH	TYPE1A
2 year	0.0840	7.83	0.0264	0.2009	SBUH	TYPE1A
10 year	0.1328	7.83	0.0422	0.2009	SBUH	TYPE1A
100 year	0.1835	7.83	0.0589	0.2009	SBUH	TYPE1A

Record Id: NEW BUILDINGS

Design Method	SBUH	**Rainfall type**	TYPE1A
Hyd Intv	10.00 min	**Peaking Factor**	484.00
		Abstraction Coeff	0.20
Pervious Area	0.00 ac	**DCIA**	0.20 ac
Pervious CN	0.00	**DC CN**	98.00
Pervious TC	0.00 min	**DC TC**	1.03 min

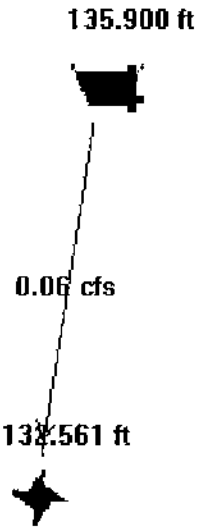
Directly Connected CN Calc

Description	SubArea	Sub cn
MULTI PURPOSE FACILITY AND OFFICE	0.20 ac	98.00
DC Composited CN (AMC 2)		98.00

Directly Connected TC Calc

Type	Description	Length	Slope	Coeff	Misc	TT
Sheet	ROOFTOP	45.00 ft	100.00%	0.0110	1.80 in	0.18 min
Channel (interm)	GUTTER	37.00 ft	0.50%	0.0120		0.21 min
Channel (interm)	PVC PIPE	165.00 ft	1.00%	0.0120		0.65 min
Directly Connected TC						1.03min

StormSHED 2G Stormwater Model 100-yr Calculation



ROUTEHYD [] THRU [DEVELOPED] USING TYPE1A AND [100 year] NOTZERO RELATIVE SCS/SBUH

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Size	nVel (ft/s)	fVel (ft/s)	CBasin / Hyd
LPOOLCOMPUTE [INFIL TRENCH] SUMMARY using Puls									
Event	Match Q (cfs)	Peak Q (cfs)	Peak Stg (ft)	Vol (cf)	Vol (acft)	Time to Empty			
100 year	0.1835	0.0574	135.9000	269.82	0.0062	24.33			
TO GROUND	0.2009	0.0574	1560.32	0.00	0.0210	48" Diam	7.0872	124.1667	NEW BUILDINGS

From Node	To Node	Rch Loss (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	HW Loss Elev (ft)	Max El (ft)
							132.5615
INFIL TRENCH	GROUND 3	130.5923	--na--	--na--	--na--	135.9000	136.0000

Table III-3.1 Soil Properties Classified by Soil Texture

Texture Class	Infiltration Rate Hydrologic (inches/hr.)	Cation Exchange Capacity (milliequivalents/ 100 grams)	Effective Water Capacity (inches per inch)	Hydrologic Soil Group
Coarse Sands or Cobbles	20.00	<5.0	---	A
Sand	8.27	<5.0	0.35	A
Loamy Sand	2.41	5.0	0.31	A
Sandy Loam	1.02	>5.0	0.25	B
Loam	0.52	>5.0	0.19	B
Silt Loam	0.27	>5.0	0.17	C
Sandy Clay Loam	0.17	>5.0	0.14	C
Clay Loam	0.09	>5.0	0.14	D
Silty Clay Loam	0.06	>5.0	0.11	D
Sandy Clay	0.05	>5.0	0.09	D
Silty Clay	0.04	>5.0	0.09	D
Clay	0.02	>5.0	0.08	D

Source (except for cation exchange capacity): Rawls, Brakensiek, and Saxton, 1982 (16)

Cation exchange capacity values are estimated from Buckman and Brady, 1969, (23)

SEC. 02, TWP. 31 N., RGE. 05 E., W.M.
ARLINGTON FIRST BAPTIST CHURCH EXPANSION
SITE/LANDSCAPE/DRAINAGE PLAN
TPN: 00529900500600
00529900500800

LEGAL DESCRIPTION:
MC MAHONS 1ST ADDITION TO ARLINGTON BLOCK 005 D-00
LOTS 1-2-3-4-5-6-7-8-9-10 EX ST OF WA - 01144 00)

CONTACT PERSON(S):

JACOB DAHL, P.E.
CASCADE SURVEYING & ENGINEERING, INC
P.O. BOX 326
ARLINGTON, WA 98223
PHONE: (360)435-5551

APPLICANT:
ARLINGTON FIRST BAPTIST CHURCH
426 N FRENCH AVE
ARLINGTON, WA 98223

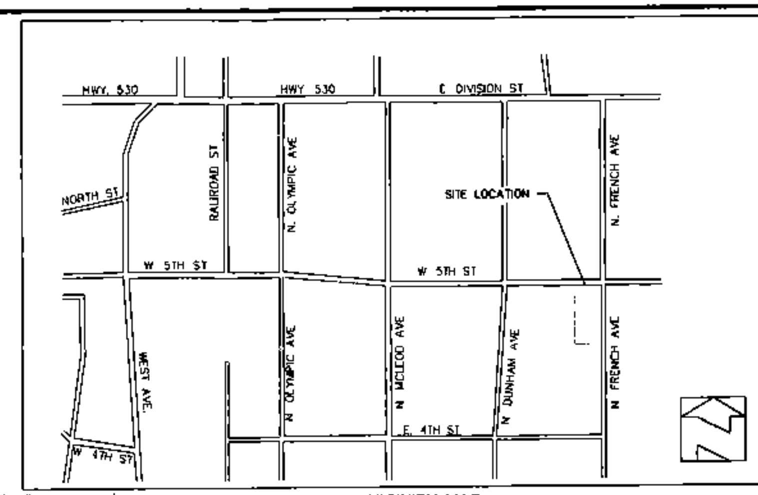
GRAPHIC SCALE
1 INCH = 20 FT

DATUM: NGVD 1929
(TO CONVERT TO NAVD 1988 ADD 3.74')

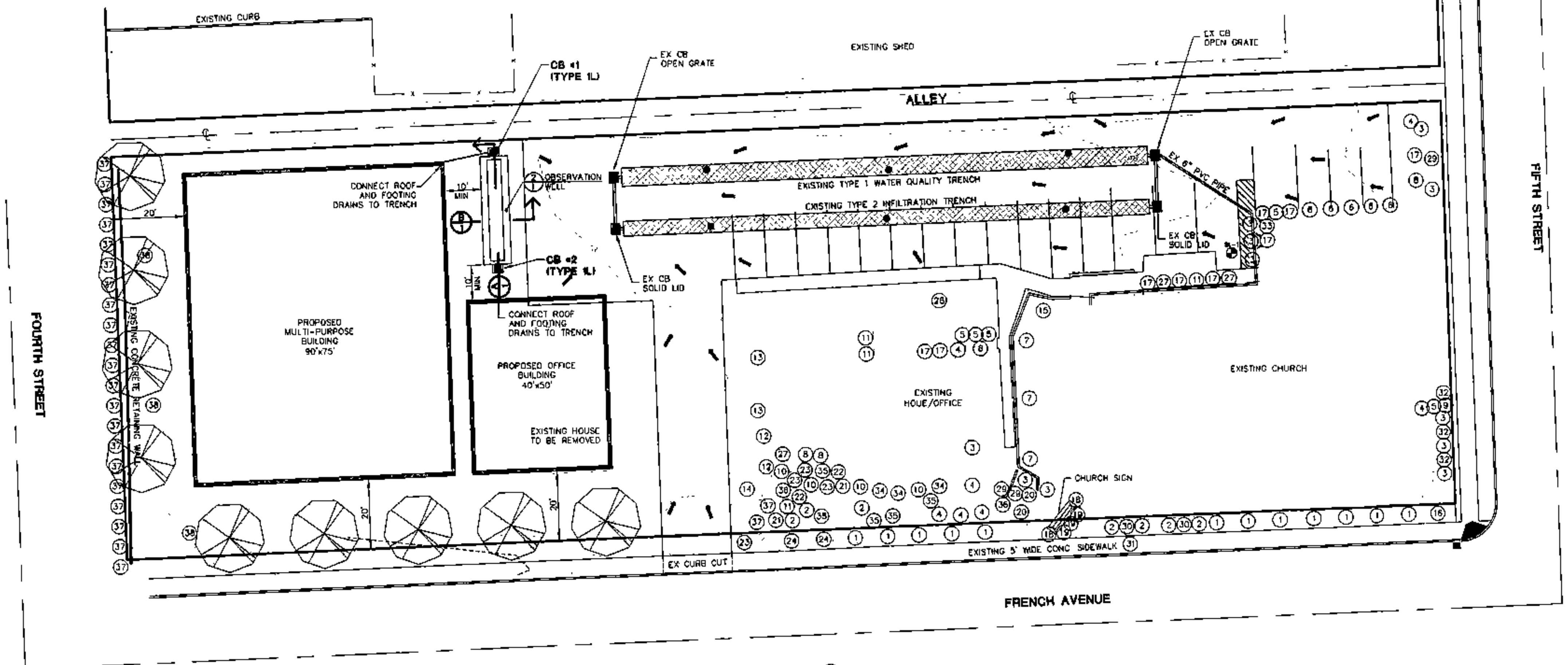
LEGEND:
- PROPERTY LINE
- EXISTING CONTOUR
- EXISTING FENCE
- EXISTING CENTERLINE
- EXISTING ASPHALT
- PROPOSED BUILDING

PROPOSED LANDSCAPE SCHEDULE:

SYMBOL (NTS)	BOTANICAL NAME / COMMON NAME	QTY	SIZE	COMMENTS
	PRUNUS CERASIFERA 'THUNDERCLOUD' FLOWERING PLUM	9	6'	POT OR B&B

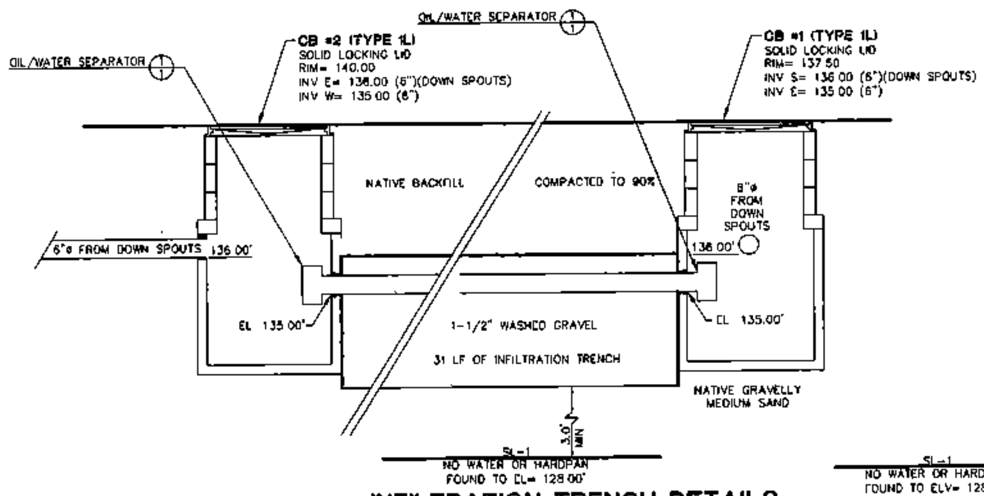


VICINITY MAP
1"=2000'

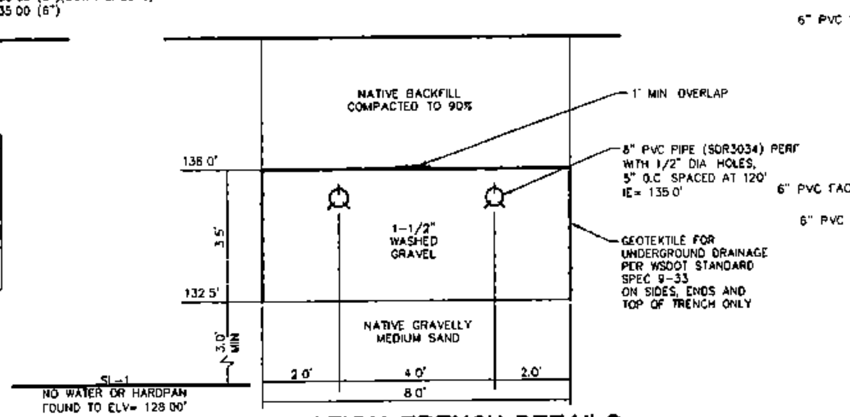


EXISTING LANDSCAPE SCHEDULE:

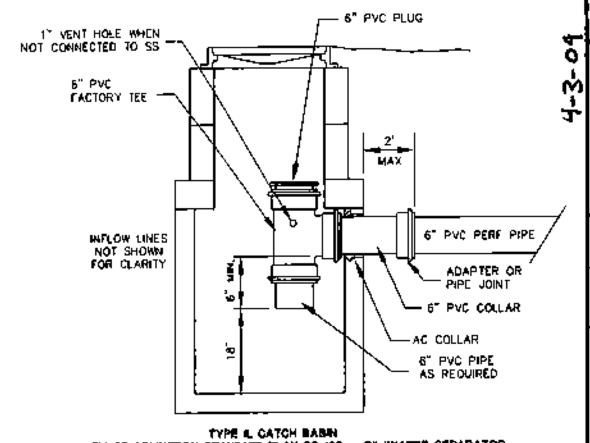
1. *THUJA ARBOVITAE*
2. *NADINA DOMESTICA*
3. *RHODODENDRON*
4. VARIETY OF LILLY
5. FEVERFEW
6. *LUPINUS*
7. *ACER PALMATUM DISSECTUM*
8. FOX GLOVE
9. ROSE CAMPION
10. *HELLEBORUS*
11. *JUNIPER*
12. HOLLY
13. *HAZENUT BUSHES (MATURE)*
14. *ACER - MAPLE*
15. FLOWERING DOGWOOD
16. FLOWERING CHERRY
17. DAFFODILS
18. PRIMROSES
19. CREEPING HEATHER
20. AZALEA
21. *ACSPIRAEA*
22. *VIBURNUM DAVIDII*
23. VARIETY OF LAUREL
24. *BERGENIA*
25. DAISIES
26. *DAHLIA*
27. ORNAMENTAL CEDAR BUSH
28. FILBERT STUMP WITH NEW SHOOTS
29. *MAHONIA AQUIFOLIUM* - OREGON GRAPE
30. LILAC
31. SNOW DROP FLOWERS
32. *CHRYSANTHEMUM*
33. LOVELACE
34. IRIS
35. SPURGE
36. FERN
37. *PIERIS JAPONICA*
38. LARGE MAPLE TO BE REMOVED



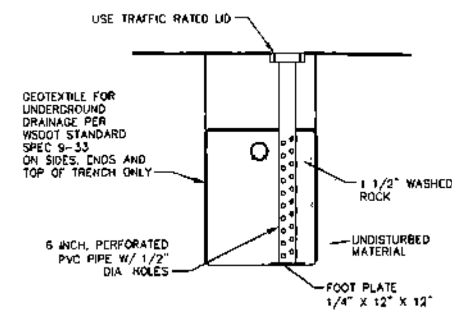
(A) INFILTRATION TRENCH DETAILS
LOOKING SOUTH
NO SCALE



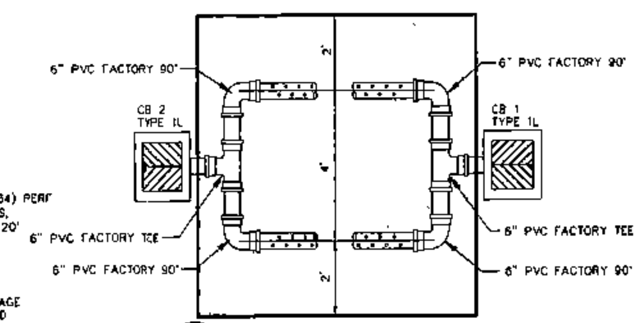
(B) INFILTRATION TRENCH DETAILS
NO SCALE



TYPE 1L CATCH BASIN WITH CITY OF ARLINGTON STANDARD PLAN SD-120 - OIL/WATER SEPARATOR
(1) OIL/WATER SEPARATOR DETAIL
NO SCALE



(2) OBSERVATION WELL
NO SCALE



(3) MANIFOLD DETAIL
NO SCALE

CALL TWO BUSINESS DAYS BEFORE YOU DIG
1-800-424-5555

U:\18575\DWG\CONSTRUCTION\18575 SD.DWG (SITE PLAN)

4-3-09

DESIGNED JD	DATE 4/09	
DRAWN ME	DATE 4/09	
CHECKED JD	DATE 4/09	
FIELD BOOK		

REVISION | DATE | BY

CASCADE SURVEYING & ENGINEERING, INC.
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(360) 435-5551

JACOB H. DAHL — STATE OF WASHINGTON — REGISTERED PROFESSIONAL ENGINEER

ARLINGTON FIRST BAPTIST CHURCH EXPANSION
SITE/LANDSCAPE/DRAINAGE PLAN
ARLINGTON FILE #

1 of 1

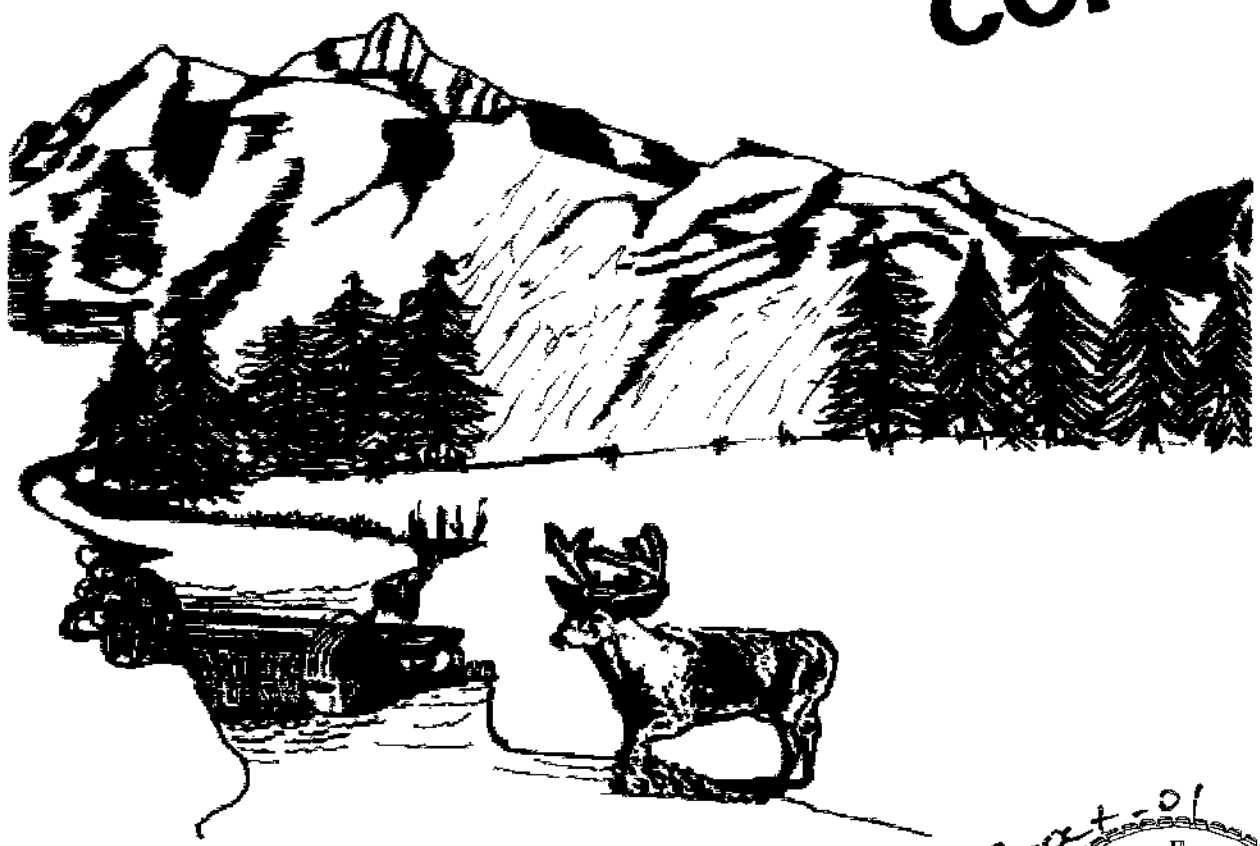
#18575

Drainage Report For:

Arlington First Baptist Church – File Number:

Revised October 2, 2001

COPY



7-oct-01

KELLEY E. FRICO
STATE OF WASHINGTON
35715
REGISTERED
PROFESSIONAL ENGINEER

EXPIRES: 01/01/02

Prepared by:

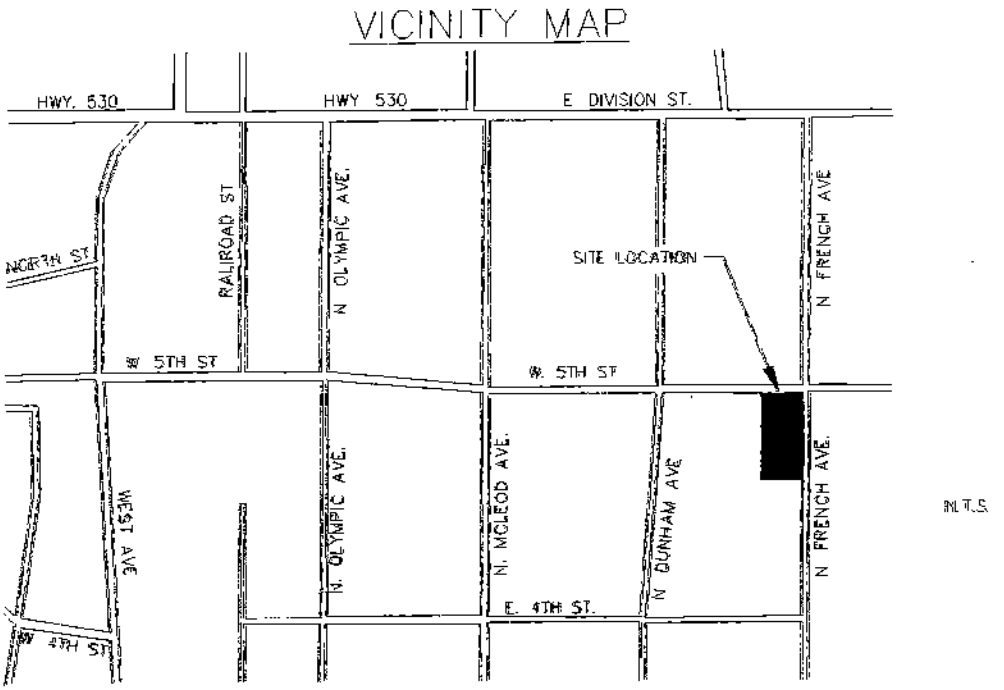
Cascade Surveying & Eng., Inc

JOB #12120

TABLE OF CONTENTS

PROPERTY DESCRIPTION

The proposed site is located in the southeast corner of Section 02-31-05 on the west side of North French Avenue. The site is clear of vegetation and covers approximately 0.30 acres. Onsite soils investigations indicated red-tan loamy sands up to a depth of 40", underlain by gravelly medium sands between depth of 40-60". Between depths of 60-114", gray gravelly medium sand was found (See attached Soil Logs). At 114" of depth, water was found.



SOIL LOGS

July 6, 2001

SOIL LOG 1.

0-40"	(137.50' – 134.17')	Red-Tan Loamy Sand
40-60"	(134.17' – 132.50')	Gravelly Medium Sand
60-114+"	(132.50' – 128.00')	Gray Gravelly Medium Sand
@ 114"	(128.00')	Water Was Found

PROPOSED DEVELOPMENT

The proposal is to create a 2,050 square foot Auditorium. Further development includes an infiltration drainage system and asphalt pavement over the parking surface. (See construction plans for further detail.)

UPSTREAM AND DOWNSTREAM ANALYSIS

Since the property and the adjacent lots are all land locked by curb, sidewalk, and city streets, offsite flow onto the property does not exist. The site is divided into two primary drainage basins (see basin map). The majority of the site, including all improvements, lies on the basin to the north. Stormwater falling on this basin currently leaves the site by infiltrating into the ground. The developed flow from this basin will continue to exit the site via infiltration into the ground. The second basin lies on the south portion of the site. Runoff from this basin drains into a low spot in the center of the basin and infiltrates into the native soils.

RISK ASSESSMENT

Slope: In the area of construction, site slopes moderate; risk is low.

Critical Areas: None

Soils: Surface soils consist of loamy sand.

Ground Movement Potential: Site appears stable.

Source of Water Erosion: Rainfall.

Measures Proposed to Prevent/Minimize Erosion:

During Construction: Temporary construction BMP's.

After Construction: Seeding of exposed soils.

Nearest Downstream body of water other than road ditches: Stillaguamish River, 1/4 mile north.

Nearest fish bearing water: Stillaguamish River.

Conclusion: Potential for significant erosion/siltation impact on or off site is **LOW**
Because of the following reason:

1. Site soils have high infiltration rates, little surface flow is generated.

STREAMBANK EROSION CONTROL

Streambank erosion control will be accomplished through the use of an infiltration trench and a water quality infiltration trench. (See the site plans). All developed flow from the property will be infiltrated.

SOURCE CONTROL OF POLLUTION

The source control BMP recommended for this site would be good housekeeping. As the lot is developed, other specific bmp's may be required for that lot in accordance with the guidelines set forth in D.O.E. Stormwater Manual.

WATER QUALITY BEST MANAGEMENT PLAN

The water quality best management plan proposed for the site will be a water quality infiltration trench. All flow from the driving surface will be directed to the oil/water separators and then to the water quality trench.

CALCULATIONS

Modeling Methodology:

The stormwater-modeling program used for the site was StormSHED Rel. 6.1.5.7. The site was broken down into 4 drainage areas, the eastern portion of the church roof, the parking lot, the southern portion of the property, and the area surrounding the house/office (see basin map).

The eastern portion of the church roof currently drains to a storm drain on N. French Av. The house/office is located in a low spot on the property surrounded by grass covered ground, and currently infiltrates water runoff. The southern portion of the property is currently undeveloped and surrounded by steep slopes on the southern and eastern side. A slight crest exists between the house and the toe of the southern slope. This isolates the southern half from draining into the proposed drainage system. The proposed paved parking lot, the proposed Auditorium, the western portion of the church roof, and the undeveloped area north of the crest will drain to the proposed drainage system (see basin map). The infiltration system was sized to handle runoff from the entire 100-year storm event. Runoff from all driving surfaces will be directed into water quality trenches. These trenches will be lined with 18" of loamy sand. The infiltration rate used in these trenches was 1.205 in/hr, which is half the D.O.E. rate. Rooftops and overflow from the water quality trenches during storm events greater than the 6-month will be directed into a standard infiltration trench. The infiltration rate used in these trench designs was 10 in/hr, which is half the D.O.E. rate for coarse sands. Staged discharge rates were used in the calculations utilizing Darcy's equation.

Because the sides of the water quality trench will be lined, a rectangular trench would be nearly impossible to construct properly. Therefore, a triangle shaped trench will be proposed. The trench will have a 5.25' wide bottom, a depth of 2', and side slopes of 1:1. The water quality trench will have a total length of 150'. The standard trench will be rectangular shaped with dimensions of 150' long, 4.25' wide, and 2' deep.

WATER QUALITY TRENCH BASE RATE:

D.O.E. Rate for loamy sand = 2.41 in/hr (1/2 = 1.205 in/hr)
Bottom Area = 787.5 sq. ft.

$$\frac{787.5\ ft^2}{1} \times \frac{1.205\ in}{hr.} \times \frac{1\ hr.}{60\ min.} \times \frac{1\ min.}{60\ sec.} \times \frac{1\ ft.}{12\ in.} = 0.022\ c.f.s.$$

Darcy's Law: Revised release rate = (Base Rate • (H + L)) ÷ L

DEPTH OF 0.50':
(0.022 c.f.s. • (0.5' + 3.00')) ÷ 3 = 0.026 c.f.s.

DEPTH OF 1.00':
(0.022 c.f.s. • (1.00' + 3.00')) ÷ 3 = 0.029 c.f.s.

DEPTH OF 1.50':
(0.022 c.f.s. • (1.50' + 3.00')) ÷ 3 = 0.033 c.f.s.

DEPTH OF 2.00':
(0.022 c.f.s. • (2.00' + 3.00')) ÷ 3 = 0.037 c.f.s.

A net void of 35% was calculated for the trench assuming a 30% void for the washed gravel and 100% for the 8" pipe. The available storage in the trench will be 341 cubic feet. Based on the StormSHED model the 6-month required storage will be 318 cubic feet.

STANDARD TRENCH BASE RATE:

D.O.E. Rate for coarse sand = 20 in/hr (1/2 = 10 in/hr)
Bottom Area = 637.5 sq. ft.

$$\frac{637.5\ ft^2}{1} \times \frac{10\ in}{hr.} \times \frac{1\ hr.}{60\ min.} \times \frac{1\ min.}{60\ sec.} \times \frac{1\ ft.}{12\ in.} = 0.15\ c.f.s.$$

Darcy's Law: Revised release rate = (Base Rate • (H + L)) ÷ L

DEPTH OF 0.50':
(0.15 c.f.s. • (0.50' + 3.00')) ÷ 3 = 0.175 c.f.s.

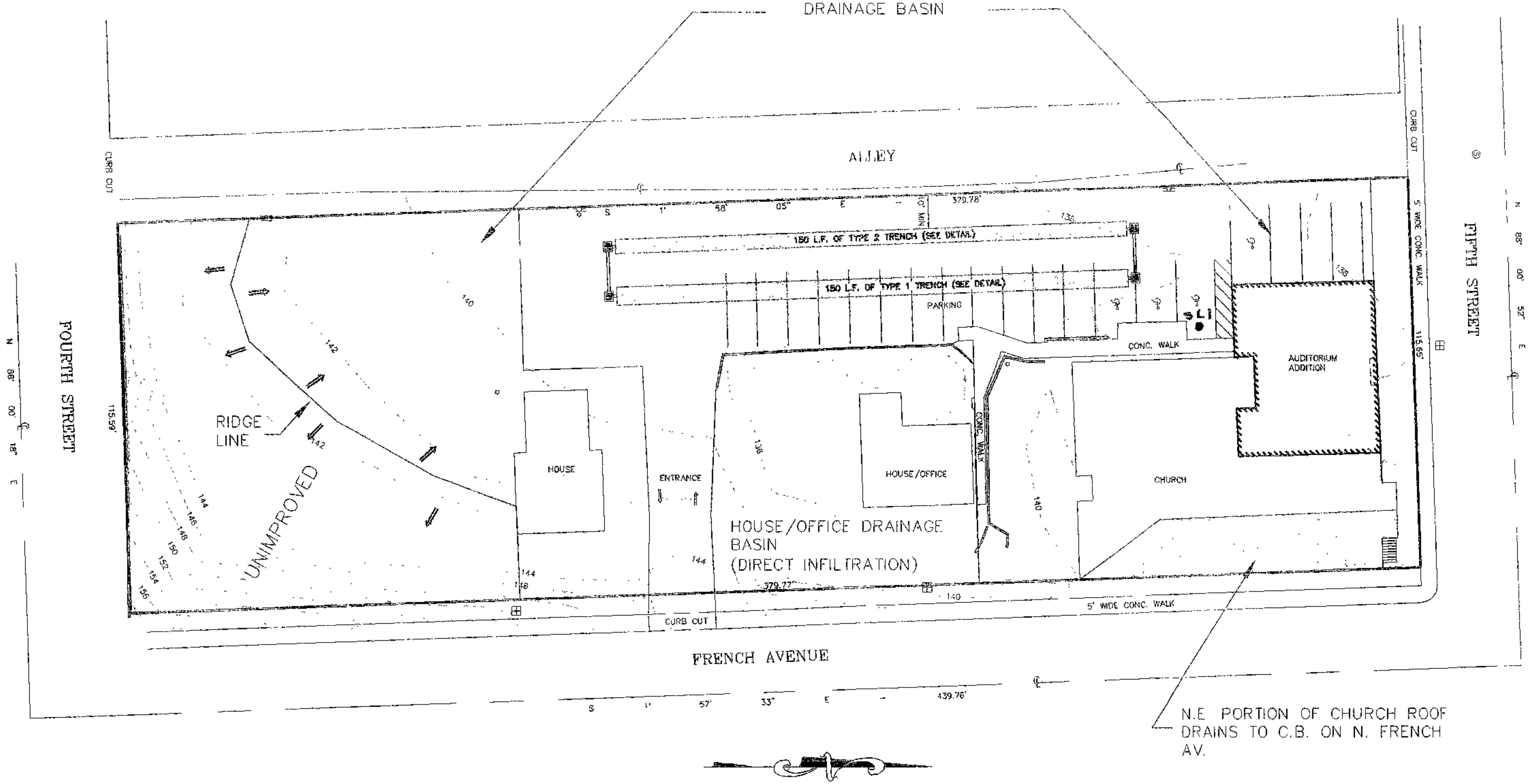
DEPTH OF 1.00':
(0.15 c.f.s. • (1.00' + 3.00')) ÷ 3 = 0.200 c.f.s.

DEPTH OF 1.50':
(0.15 c.f.s. • (1.50' + 3.00')) ÷ 3 = 0.225 c.f.s.

DEPTH OF 2.00':
(0.15 c.f.s. • (2.00' + 3.00')) ÷ 3 = 0.250 c.f.s.

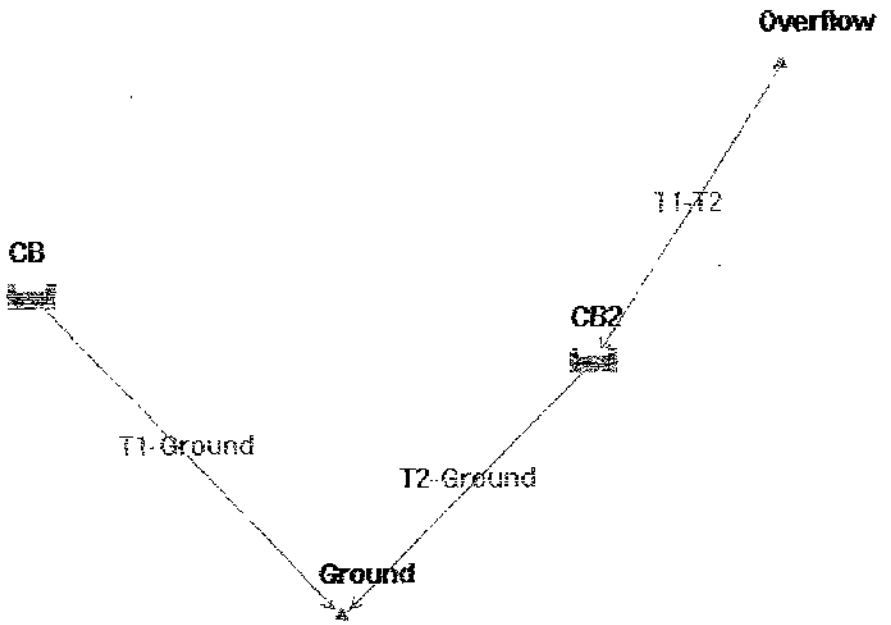
A net void of 35% was calculated for the trench assuming a 30% void for the washed gravel and 100% for the 8" pipe. The available storage in the standard trench will be 433 cubic feet. The combined total storage for the standard and both water quality trenches will be 774 cubic feet. Based on the StormSHED model the 100-year combined required storage will be 749 cubic feet.

BASIN MAP


DRAINAGE BASIN
ALLEY
CURB CUT
S 1° 58' 05" E 379.78'
10' MIN
150 L.F. OF TYPE 2 TRENCH (SEE DETAIL)
150 L.F. OF TYPE 1 TRENCH (SEE DETAIL)
PARKING
CONC. WALK
AUDITORIUM ADDITION
FIFTH STREET
N 88° 00' 52" E
115.65'
5' WIDE CONC. WALK
FOURTH STREET
N 88° 00' 18" E
115.59'
RIDGE LINE
UNIMPROVED
HOUSE
ENTRANCE
HOUSE/OFFICE
HOUSE/OFFICE DRAINAGE BASIN (DIRECT INFILTRATION)
CHURCH
379.77'
CURB CUT
FRENCH AVENUE
S 1° 57' 33" E 439.76'
N.E PORTION OF CHURCH ROOF DRAINS TO C.B. ON N. FRENCH AV.

Drainage Models

Arlington First Baptist Church Drainage Model.



Project Precips:

[6 mo]	1.17 in
[100 yr]	3.75 in

Reach Records:

Reach ID: T1-Ground

Section Properties:

Shape:	Circular		Routing Method:	Travel Time Translation
Size	Material	Mannings n	Hyd params By	
12" Diam	Smooth CDEP	0.0050	Mannings Formula	
Length	Slope	Entrance Loss		
1.0000 ft	100.00 %	Groove End Projecting		
Diam				
1.0000 ft				
Up Node	Dn Node	Up Invert	Dn Invert	
CB	Ground	133.5000 ft	132.5000 ft	

Conduit Constraints:

Min Vel	Max Vel	Min Cov	Min Slope	Max Slope	Min drop
2.0000 ft	15.0000 ft	3.0000 ft	0.5000 ft	2.0000 ft	0.0000 ft
In/Exfil	Hold Up	Hold Dn	Match Inv	Allow Smaller	
0.0000 in/hr	NO	NO	YES	NO	

Conduit Summary:

Trib Area	Flow	Capacity	Velocity	Normal Depth
0.2441 ac	0.0296 cf	94.7778 cf	13.9635 ft/s	0.0137 ft
Ent Loss	Exit Loss	Frict Loss	Start TW	
0.605526 ft	3.027632 ft	0.000000 ft	132.6826 ft	

Reach ID: T1-T2

Section Properties:

Shape:	Circular		Routing Method:	Travel Time Translation	
Size	Material	Mannings n	Hyd params By		
8" Diam	Smooth CDEP	0.0120	Mannings Formula		
Length	Slope	Entrance Loss			
1.0000 ft	0.50 %	Groove End Projecting			
Diam					
0.6667 ft					
Up Node	Dn Node	Up Invert	Dn Invert		
Overflow	CB2	135.4000 ft	135.4450 ft		

Conduit Constraints:

Min Vel	Max Vel	Min Cov	Min Slope	Max Slope	Min drop
2.0000 ft	15.0000 ft	3.0000 ft	0.5000 ft	2.0000 ft	0.0000 ft
In/Exfil	Hold Up	Hold Dn	Match Inv	Allow Smaller	
0.0000 in/hr	NO	NO	YES	NO	

Conduit Summary:

Trib Area	Flow	Capacity	Velocity	Normal Depth
0.3659 ac	0.4208 cf	0.9282 cf	2.5942 ft/s	0.3149 ft
Ent Loss	Exit Loss	Frict Loss	Start TW	
0.020900 ft	0.104502 ft	0.001028 ft	135.7599 ft	

Reach ID: T2-Ground

Section Properties:

Shape:	Circular		Routing Method:	Travel Time Translation	
Size	Material	Mannings n	Hyd params By		
12" Diam	Smooth CDEP	0.0050	Mannings Formula		
Length	Slope	Entrance Loss			
1.0000 ft	100.00 %	Groove End Projecting			
Diam					
1.0000 ft					
Up Node	Dn Node	Up Invert	Dn Invert		
CB2	Ground	133.5000 ft	132.5000 ft		

Conduit Constraints:

Min Vel	Max Vel	Min Cov	Min Slope	Max Slope	Min drop
2.0000 ft	15.0000 ft	3.0000 ft	0.5000 ft	2.0000 ft	0.0000 ft
In/Exfil	Hold Up	Hold Dn	Match Inv	Allow Smaller	
0.0000 in/hr	NO	NO	YES	NO	

Conduit Summary:

Trib Area	Flow	Capacity	Velocity	Normal Depth
0.3659 ac	0.1993 cf	94.7778 cf	23.8963 ft/s	0.0342 ft
Ent Loss	Exit Loss	Frict Loss	Start TW	
1.773401 ft	8.867006 ft	0.000004 ft	132.6826 ft	

Node Records:

Node ID: CB

Desc:	Primary trench entrance			
Start El:	133.5000 ft		Max El:	135.5000 ft
Contrib Basin:	Dev		Contrib Hyd:	
Hgl Elev:	135.4286 ft			
Storage Id:	Trench1	Discharge Id:	H20quality	

Node ID: Trench1

Desc:	Water quality trench			
Start El:	133.5000 ft		Max El:	135.5000 ft
Contrib Basin:			Contrib Hyd:	
Stage	Area	Volume	Volume	
133.50	275.63	0.00 cf	0.0000 acft	
135.50	65.63	341.26 cf	0.0078 acft	

Control Structure ID: H20quality - Combination Control Structure

Descrip:	Trench lined w/loamy sand	
Start El	Max El	Increment
133.5000 ft	137.0000 ft	0.10
ID List:	Loamy Sand	Over
Split:	Split OutHyd into component hydrographs.	

Control Structure ID: Loamy Sand - Stage Discharge rating curve

Descrip:	Trench lined w/loamy sand	
Start El	Max El	Increment
133.5000 ft	137.0000 ft	0.10
Stage		Discharge
133.5000 ft		0.0000 cfs
133.5100 ft		0.0220 cfs
137.0000 ft		0.0360 cfs

Control Structure ID: Over - Multiple Orifice Structure

Descrip:	Overflow pipes 2-8" pipes			
Start El	Max El	Increment		
135.4000 ft	137.0000 ft	0.10		
Orif Coeff:	0.62		Bottom El:	0.00 ft
			Lowest Diam:	8.0000 in
out to 2nd:	0.0000 ft		Diam:	8.0000 in

Node ID: CB2

Desc:	Overflow structure			
Start El:	133.5000 ft		Max El:	135.5000 ft
Contrib Basin:			Contrib Hyd:	
Hgl Elev:	135.4341 ft			
Storage Id:	Trench2	Discharge Id:	Gr-Sand	

Node ID: Trench2

Desc:	Standard trench			
Start El:	133.5000 ft		Max El:	135.5000 ft
Contrib Basin:			Contrib Hyd:	
	Length	Width	Void Ratio	
	150.0000 ft	4.2500 ft	34.00	

Control Structure ID: Gr-Sand - Stage Discharge rating curve

Descrip:	Gravelly Sand	
Start El	Max El	Increment
133.5000 ft	137.0000 ft	0.10
Stage		Discharge
133.5000 ft		0.0000 cfs
133.5100 ft		0.1480 cfs
137.0000 ft		0.2410 cfs

Node ID: Ground

Desc:	Ground		
Start El:	132.5000 ft	Max El:	135.0000 ft
Contrib Basin:		Contrib Hyd:	
Hgl Elev:	132.6826 ft		

Node ID: Overflow

Desc:	Overflow node/point which trench 1 overflows		
Start El:	135.4000 ft	Max El:	137.0000 ft
Contrib Basin:		Contrib Hyd:	
Hgl Elev:	135.8865 ft		

Contributing Drainage Areas:

Drainage Area: Dev

Hyd Method:	SCS Unit Hyd		Loss Method:	SCS CN Number
Peak Factor:	484.00		SCS Abs:	0.20
Storm Dur:	24.00 hrs		Intv:	10.00 min
	Area	CN	TC	
Pervious	0.1700 ac	68.00	0.19 hrs	
Impervious	0.5000 ac	98.00	0.04 hrs	
Total	0.6700 ac			

Supporting Data:

Pervious CN Data:

grass area south of paved area	68.00	0.1100 ac

Impervious CN Data:

rooftops and paved surfaces	98.00	0.5000 ac

Pervious TC Data:

Flow type:	Description:	Length:	Slope:	Coeff:	Travel Time
Sheet	along grass area	85.00 ft	3.75%	0.1500	8.92 min
Sheet	paved surface	75.00 ft	0.50%	0.0110	2.23 min

Impervious TC Data:

Flow type:	Description:	Length:	Slope:	Coeff:	Travel Time
Sheet	along paved surface	75.00 ft	0.50%	0.0110	2.23 min

Layout Hydrographs:

Hydrograph ID: Ground - 6 mo

Area:	0.5000 ac	Hyd Int:	10.00 min	Base Flow:	
Pending tt translation:	0.00 min				
Peak Flow:	0.0294 cfs	Peak Time:	9.83 hrs	Hyd Vol:	0.0393 acft

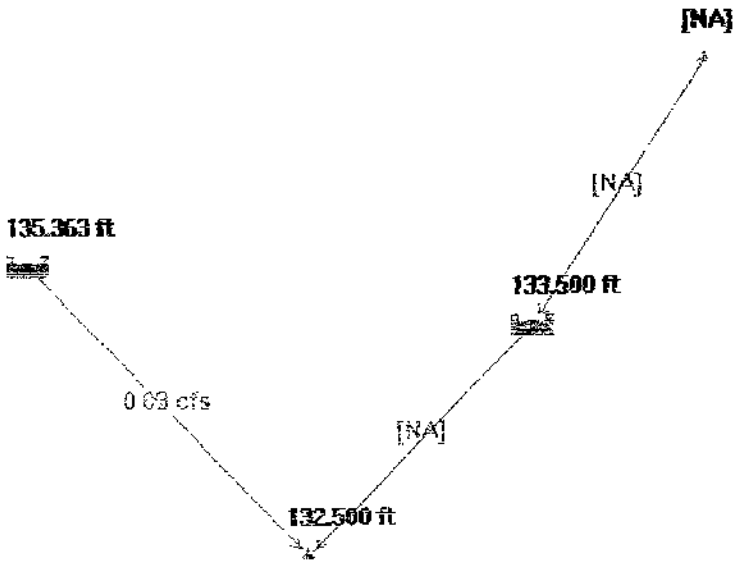
Time	Flow	Time	Flow	Time	Flow
hr	cfs	hr	cfs	hr	cfs
2.83	0.0086	10.17	0.0294	17.17	0.0251
3.00	0.0054	10.33	0.0294	17.33	0.0249
3.17	0.0086	10.50	0.0293	17.50	0.0248
3.33	0.0075	10.67	0.0293	17.67	0.0247
3.50	0.0086	10.83	0.0292	17.83	0.0246
3.67	0.0097	11.00	0.0291	18.00	0.0244
3.83	0.0097	11.17	0.0291	18.17	0.0243
4.00	0.0107	11.33	0.0290	18.33	0.0242
4.17	0.0118	11.50	0.0289	18.50	0.0240
4.33	0.0129	11.67	0.0288	18.67	0.0239
4.50	0.0129	11.83	0.0287	18.83	0.0238
4.67	0.0150	12.00	0.0287	19.00	0.0237
4.83	0.0150	12.17	0.0286	19.17	0.0235
5.00	0.0161	12.33	0.0284	19.33	0.0234
5.17	0.0172	12.50	0.0284	19.50	0.0233
5.33	0.0193	12.67	0.0282	19.67	0.0231
5.50	0.0172	12.83	0.0281	19.83	0.0230
5.67	0.0215	13.00	0.0280	20.00	0.0229
5.83	0.0215	13.17	0.0279	20.17	0.0227
6.00	0.0215	13.33	0.0278	20.33	0.0226
6.17	0.0220	13.50	0.0277	20.50	0.0225
6.33	0.0221	13.67	0.0276	20.67	0.0224
6.50	0.0221	13.83	0.0275	20.83	0.0222
6.67	0.0222	14.00	0.0274	21.00	0.0221
6.83	0.0224	14.17	0.0272	21.17	0.0215
7.00	0.0225	14.33	0.0271	21.33	0.0097
7.17	0.0227	14.50	0.0270	21.50	0.0161
7.33	0.0230	14.67	0.0269	21.67	0.0129
7.50	0.0232	14.83	0.0268	21.83	0.0129
7.67	0.0240	15.00	0.0266	22.00	0.0150
7.83	0.0254	15.17	0.0265	22.17	0.0118
8.00	0.0267	15.33	0.0264	22.33	0.0129
8.17	0.0276	15.50	0.0263	22.50	0.0129
8.33	0.0280	15.67	0.0262	22.67	0.0118
8.50	0.0284	15.83	0.0260	22.83	0.0129
8.67	0.0288	16.00	0.0259	23.00	0.0129
8.83	0.0290	16.17	0.0258	23.17	0.0118
9.00	0.0292	16.33	0.0257	23.33	0.0129
9.17	0.0293	16.50	0.0255	23.50	0.0129
9.33	0.0293	16.67	0.0254	23.67	0.0129
9.50	0.0294	16.83	0.0253	23.83	0.0118
9.67	0.0294	17.00	0.0252	24.00	0.0129
9.83	0.0294	17.17	0.0251	24.17	0.0021
10.00	0.0294	17.33	0.0249	24.33	0.0000

Hydrograph ID: Ground - 100 yr

Area:	0.6700 ac	Hyd Int:	10.00 min	Base Flow:	
Pending tt translation:	0.00 min				
Peak Flow:	0.2302 cfs	Peak Time:	8.17 hrs	Hyd Vol:	0.1606 acft

Time	Flow	Time	Flow	Time	Flow
hr	cfs	hr	cfs	hr	cfs
1.00	0.0172	10.00	0.1840	18.83	0.0296
1.17	0.0150	10.17	0.1784	19.00	0.1001
1.33	0.0220	10.33	0.0585	19.17	0.0367
1.50	0.0221	10.50	0.1344	19.33	0.0549
1.67	0.0222	10.67	0.0657	19.50	0.0386
1.83	0.0224	10.83	0.1163	19.67	0.0694
2.00	0.0225	11.00	0.0748	19.83	0.0422
2.17	0.0228	11.17	0.1127	20.00	0.0657
2.33	0.0231	11.33	0.0621	20.17	0.0458
2.50	0.0234	11.50	0.1091	20.33	0.0621
2.67	0.0237	11.67	0.0766	20.50	0.0494
2.83	0.0240	11.83	0.0910	20.67	0.0439
3.00	0.0243	12.00	0.0802	20.83	0.0802
3.17	0.0247	12.17	0.0910	21.00	0.0296
3.33	0.0250	12.33	0.0657	21.17	0.0784
3.50	0.0254	12.50	0.1055	21.33	0.0332
3.67	0.0258	12.67	0.0513	21.50	0.0748
3.83	0.0262	12.83	0.0983	21.67	0.0368
4.00	0.0266	13.00	0.0639	21.83	0.0712
4.17	0.0271	13.17	0.0874	22.00	0.0404
4.33	0.0276	13.33	0.0675	22.17	0.0513
4.50	0.0281	13.50	0.0910	22.33	0.0422
4.67	0.0287	13.67	0.0549	22.50	0.0657
4.83	0.0293	13.83	0.0983	22.67	0.0458
5.00	0.0784	14.00	0.0603	22.83	0.0459
5.17	0.0657	14.17	0.0820	23.00	0.0477
5.33	0.0983	14.33	0.0621	23.17	0.0531
5.50	0.0693	14.50	0.0856	23.33	0.0494
5.67	0.0965	14.67	0.0657	23.50	0.0440
5.83	0.0712	14.83	0.0603	23.67	0.0477
6.00	0.1127	15.00	0.0820	23.83	0.0621
6.17	0.0892	15.17	0.0621	24.00	0.0476
6.33	0.1127	15.33	0.0802	24.17	0.0295
6.50	0.0965	15.50	0.0639	24.33	0.0291
6.67	0.1308	15.67	0.0621	24.50	0.0287
6.83	0.1272	15.83	0.0802	24.67	0.0283
7.00	0.1254	16.00	0.0314	24.83	0.0279
7.17	0.1561	16.17	0.1164	25.00	0.0275
7.33	0.1543	16.33	0.0384	25.17	0.0271
7.50	0.1615	16.50	0.0694	25.33	0.0267
7.67	0.1862	16.67	0.0730	25.50	0.0263
7.83	0.2042	16.83	0.0549	25.67	0.0260
8.00	0.2216	17.00	0.0693	25.83	0.0256
8.17	0.2302	17.17	0.0567	26.00	0.0253
8.33	0.2298	17.33	0.0693	26.17	0.0249
8.50	0.2294	17.50	0.0567	26.33	0.0245
8.67	0.2269	17.67	0.0675	26.50	0.0242
8.83	0.2224	17.83	0.0585	26.67	0.0239
9.00	0.2163	18.00	0.0675	26.83	0.0235
9.17	0.2131	18.17	0.0585	27.00	0.0232
9.33	0.2069	18.33	0.0531	27.17	0.0229
9.50	0.2011	18.50	0.0585	27.33	0.0226
9.67	0.1952	18.67	0.0657	27.50	0.0222
9.83	0.1894	18.83	0.0296	27.67	0.0140

6-Month Event:

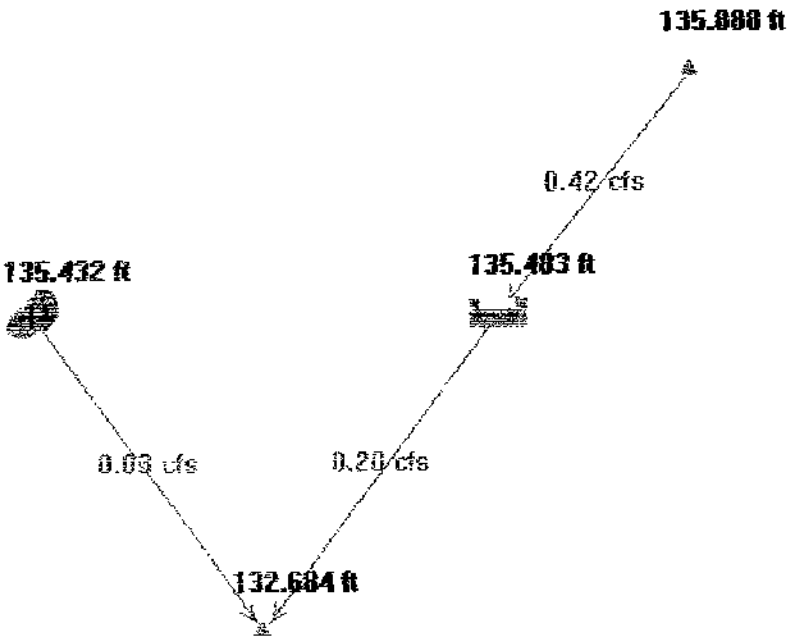


ROUTEHYD [] THRU [Infil] USING TYPE1A AND [6 mo] NOTZERO RELATIVE

Reach	Area	Flow	Full Q	% Full	nDepth	Size	nVel	fVel	CBasin / Hyd
----	ac	cfs	cfs	ratio	ft	—	ft/s	ft/s	----------
Routing spit hyd [6 mo-Over-OutHyd] through T1-T2									
T1-T2	0.0000	0.0000	0.9282	0.00	0.0000	8" Diam	2.5967	2.6590	
Routing thru RLPool Node CB2; 6 mo event									
6 mo	MatchQ=PeakQ= 0.0000 cfs Peak Out Q: 0.0000 cfs - Peak Stg: 133.50 ft - Active Vol: 0.00 cf								
T2-Ground	0.0000	0.0000	94.7778	0.00	0.0000	12" Diam	24.0586	120.6748	
Routing thru RLPool Node CB; 6 mo event									
6 mo	Match Q: 0.0000 cfs Peak Out Q: 0.0294 cfs - Peak Stg: 135.36 ft - Active Vol: 317.84 cf								
Routing spit hyd [6 mo-Loamy Sand-OutHyd] through T1-Ground									
T1-Ground	0.5000	0.0294	94.7778	0.00	0.0137	12" Diam	13.8664	120.6748	Dev

From Node	To Node	Rch Loss ft	App Head ft	Bend Loss ft	Junct Loss ft	HW Elev ft	Max El/ Rim El ft
	Ground					132.5000	
CB2	Ground	0.0000	–na–	–na–	–na–	133.5000	135.5000
Overflow	CB2	0.0000	–na–	–na–	–na–	0.0000	137.0000
CB	Ground	133.0947	–na–	–na–	–na–	135.3628	135.5000

100-Year Event:



ROUTEHYD [] THRU [Infil] USING TYPE1A AND [100 yr] NOTZERO RELATIVE

Reach	Area	Flow	Full Q	% Full	nDepth	Size	nVel	fVel	CBasin / Hyd
---	ac	cfs	cfs	ratio	ft	---	ft/s	ft/s	----------
Routing spit hyd [100 yr-Over-OutHyd] through T1-T2									
T1-T2	0.4096	0.4226	0.9282	0.46	0.3156	8" Diam	2.5967	2.6590	
Routing thru RLPool Node CB2; 100 yr event									
100 yr	Match Q: 0.0000 cfs Peak Out Q: 0.2006 cfs - Peak Stg: 135.48 ft - Active Vol: 429.82 cf								
T2-Ground	0.4096	0.2006	94.7778	0.00	0.0342	12" Diam	24.0586	120.6748	
Routing thru RLPool Node CB; 100 yr event									
100 yr	Match Q: 0.0000 cfs Peak Out Q: 0.4522 cfs - Peak Stg: 135.43 ft - Active Vol: 329.63 cf								
Routing spit hyd [100 yr-Loamy Sand-OutHyd] through T1-Ground									
T1-Ground	0.2604	0.0296	94.7778	0.00	0.0137	12" Diam	13.9637	120.6748	Dev

From Node	To Node	Rch Loss ft	App Head ft	Bend Loss ft	Junct Loss ft	HW Elev ft	Max El/ Rim El ft
	Ground					132.6836	
CB2	Ground	133.2478	–na–	–na–	–na–	135.4830	135.5000
Overflow	CB2	135.8875	–na–	–na–	–na–	135.8875	137.0000
CB	Ground	133.0952	–na–	–na–	–na–	135.4318	135.5000

Maintenance Requirements

MAINTENANCE COMPONENT	DEFECT	CONDITIONS WHEN MAINTENANCE IS NEEDED	RESULTS EXPECTED WHEN MAINTENANCE IS PERFORMED
INFILTRATOIN TRENCH	SEDIMENT	A PERCOLATION TEST PIT OR TEST OF FACILITY INDICATES FACILITY IS ONLY WORKING AT 90% OF ITS DESIGNED CAPABILITIES. IF TWO INCHES OR MORE SEDIMENT IS PRESENT, REMOVE.	SEDIMENT IS REMOVED AND/OR FACILITY IS CLEANED SO THAT INFILTRATION SYSTEM WORKS ACCORDING TO DESIGN.
CATCH BASIN	COVER NOT IN PLACE	COVER IS MISSING OR ONLY PARTIALLY IN PLACE. ANY OPEN MANHOLE REQUIRED MAINTENANCE.	MANHOLE IS CLOSED.
	TRASH & DEBRIS (INCLUDES SEDIMENT)	TRASH OR DEBRIS OF MORE THAN 1/2 CUBIC FOOT WHICH IS LOCATED IMMEDIATELY IN FRONT OF THE CATCH BASIN OPENING OR IS BLOCKING CAPACITY OF BASIN BY MORE THAN 10%.	NO TRASH OR DEBRIS LOCATED IMMEDIATELY IN FRONT OF CATCH BASIN OPENING.
		TRASH OR DEBRIS (IN THE BASIN) THAT EXCEEDS 1/3 THE DEPTH FROM THE BOTTOM OF BASIN TO INVERT T OF THE LOWEST PIPE INTO OR OUT OF THE BASIN.	NO TRASH OR DEBRIS IN THE CATCH BASIN
		TRASH OR DEBRIS IN ANY INLET OR OUTLET PIPE BLOCKING MORE THAN 1/3 OF ITS HEIGHT.	INLET AND OUTLET PIPES FREE OF TRASH OR DEBRIS.
		DEAD ANIMALS OR VEGETATION THAT COULD GENERATE ODORS THAT WOULD CAUSE COMPLAINTS OR DANGEROUS GASES (E.G., METHANE).	NO DEAD ANIMALS OR VEGETATION PRESENT WITHIN THE CATCH BASIN.
		DEPOSITS OF GARBAGE EXCEEDING 1 CUBIC FOOT IN VOLUME.	NO CONDITION PRESENT WHICH WOULD ATTRACT OR SUPPORT THE BREEDING OF INSECTS OR RODENTS.
	STRUCTURAL DAMAGE TO FRAME AND/OR TOP SLAB	CORNER OF FRAME EXTENDS MORE THAN 3/4 INCH PAST CURB FACE INTO THE STREET (IF APPLICABLE).	FRAME IS EVEN WITH CURB.
		TOP SLAB HAS HOLES LARGER THAN 2 SQUARE INCHES OR CRACKS WIDER THAN 1/4 INCH (INTENT IS TO MAKE SURE ALL MATERIAL IS RUNNING INTO THE BASIN).	TOP SLAB IS FREE OF HOLES AND CRACKS.
		FRAME NOT SITTING FLUSH ON TOP SLAB, I. E., SEPARATION OF MORE THAN 3/4 INCH OF THE FRAME FROM THE TOP SLAB.	FRAME IS SITTING FLUSH ON TOP SLAB.
	CRACKS IN BASIN WALLS/BOTTOM	CRACKS WIDER THAN 1/2 INCH AND LONGER THAN 3 FEET, ANY EVIDENCE OF SOIL PARTICLES ENTERING CATCH BASIN THROUGH CRACKS, OR MAINTENANCE PERSON JUDGES THAT STRUCTURE IS UNSOUND.	BASIN REPLACED OR REPAIRED TO DESIGN STANDARDS.
		CRACKS WIDER THAN 1/2 INCH AND LONGER THAN 1 FOOT AT THE JOINT OF ANY INLET/OUTLET PIPE OR ANY EVIDENCE OF SOIL PARTICLES ENTERING CATCH BASIN THROUGH CRACKS.	NO CRACKS MORE THAN 1/4 INCH WIDE AT THE JOINT OF INLET/OUTLET PIPE.

	SETTLEMENT/ MISALIGNMENT	BASIN HAS SETTLED MORE THAN 1 INCH OR HAS ROTATED MORE THAN 2 INCHES OUT OF ALIGNMENT.	BASIN REPLACED OR REPAIRED TO DESIGN STANDARDS.
	FIRE HAZARD	PRESENCE OF CHEMICALS SUCH AS NATURAL GAS. OIL, GASOLINE.	NO FLAMMABLE CHEMICALS PRESENT.
	VEGETATION	VEGETATION GROWING ACROSS AND BLOCKING MORE THAN 10% OF THE BASIN OPENING.	NO VEGETATION BLOCKING OPENING TO BASIN.
		VEGETATION GROWING IN INLET/OUTLET PIPE JOINTS THAT IS MORE THAN SIX INCHES TALL AND LESS THAN SIX INCHES APART.	NO VEGETATION OR ROOT GROWTH PRESENT.
	POLLUTION	NONFLAMMABLE CHEMICALS OF MORE THAN 1/2 CUBIC FOOT PER THREE FEET OF BASIN LENGTH.	NO POLLUTION PRESENT OTHER THAN SURFACE FILM.
CATCH BASIN COVER	COVER NOT IN PLACE	COVER IS MISSING OR ONLY PARTIALLY IN PLACE. ANY OPEN CATCH BASIN REQUIRED MAINTENANCE.	CATCH BASIN COVER IS CLOSED.
	LOCKING MECHANISM NOT WORKING	MECHANISM CANNOT BE OPENED BY ONE MAINTENANCE PERSON WITH PROPER TOOLS. BOLTS INTO FRAME HAVE LESS THAN 1/2 INCH OF THREAD.	MECHANISM OPENS WITH PROPER TOOLS.
	COVER DIFFICULT TO REMOVE	ONE MAINTENANCE PERSON CANNOT REMOVE LID AFTER APPLYING 80 LBS. OF LIFT; INTENT IS KEEP COVER FROM SEALING OFF ACCESS TO MAINTENANCE.	COVER CAN BE REMOVED BY ONE MAINTENANCE PERSON.
PIPES	SEDIMENT & DEBRIS	ACCUMULATED SEDIMENT THAT EXCEEDS 20% OF THE DIAMETER OF THE PIPE.	PIPE CLEANED OF ALL SEDIMENT AND DEBRIS.
	VEGETATION	VEGETATION THAT REDUCES FREE MOVEMENT OF WATER THROUGH PIPES.	ALL VEGETATION REMOVED SO WATER FLOWS FREELY THROUGH PIPES.
	DAMAGED	PROTECTIVE COATING IS DAMAGED; RUST IS CAUSING MORE THAN 50% DETERIORATION TO ANY PART OF PIPE.	PIPE REPAIRED OR REPLACED.
		ANY DENT THAT DECREASES THE CROSS SECTION AREA OF PIPE BY MORE THAN 20%.	PIPE REPAIRED OR REPLACED.
	TRASH & DEBRIS	TRASH AND DEBRIS EXCEEDS 1 CUBIC FOOT PER 1,000 SQUARE FEET OF DITCH AND SLOPES.	TRASH AND DEBRIS CLEARED FROM DITCHES.

GEOTEST

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October 9, 2007
Job No. 07-0754

City of Arlington Engineering Department
238 North Olympic Avenue
Arlington, WA 98223

COPY

Attn: Kelli Hale, P.E.

Re: **Limited Geotechnical Engineering Evaluation**
Retaining Wall
East 4th Street and North French Avenue
Arlington, Washington

Dear Ms. Hale,

As requested, GeoTest Services, Inc. is pleased to submit this report summarizing the results of our limited geotechnical engineering evaluation for the referenced project. The purpose of this evaluation was to establish general subsurface conditions beneath the site from which conclusions and recommendations for construction of the proposed retaining wall could be formulated.

PROJECT DESCRIPTION

We understand that the existing concrete retaining wall located along East 4th Street at the North French Avenue intersection has experienced several inches of overturning and is planned to be replaced with a new poured-in-place concrete retaining wall. The proposed wall will be approximately 120 feet in length and may reach up to 18 feet above the elevation of the adjacent property to the north. It is our opinion that poor drainage behind the existing retaining wall likely caused the overturning from excessive hydrostatic pressure buildup. A new church is planned to be located a short distance to the north of the proposed improvements. The site is located in Arlington, Washington as shown on the attached Vicinity Map, Figure 1.

SITE CONDITIONS

This section discusses the general surface and subsurface conditions observed at the project site at the time of our field investigation. Interpretations of the site conditions are based on the results of our review of available information, site reconnaissance, subsurface explorations, and our experience in the project vicinity.

General Geologic Conditions

Geologic information for the project site was obtained from the *Surficial Geologic Map of Port Townsend 30- by 60-Minute Quadrangle, Puget Sound Region, Washington* (Pessl, et. al 1989), published by the U.S. Geological Survey. According to Pessl, near-surface soils in the vicinity of the project site consist of glacial till and recessional-continental deposits (glacial outwash). Glacial till deposits are described by Pessl as a poorly sorted

mixture of rock fragments deposited directly by the Vashon-age ice sheet. Finer components consist of silt, sand and clay in variable proportions, constituting a coherent to friable, moderately to highly compact matrix in which the coarse components (pebbles, cobbles and boulders) are firmly embedded. Recessional-continental deposits (glacial outwash) are described as medium to well sorted, pebble-cobble gravel and coarse to medium sand with local lenses of fine sand and silt. Site soils encountered within our test pits were consisted with the mapped geology.

Surface Conditions

The site of the proposed retaining wall is located along the north side of East 4th Street at the North French Avenue intersection in Arlington, Washington. The existing retaining wall is approximately 120 feet in length and extends westward from North French Avenue to a gravel alleyway. A sidewalk is located immediately behind the existing retaining wall and a gravel area approximately 6 feet in width is located behind the sidewalk and between East 4th Street. The topography in front of the existing retaining wall ranges from approximately 2H:1V (horizontal: vertical) at the east end and decreases to approximately 5H:1V at the west end. The height of the existing retaining wall ranges from approximately 18 feet above the elevation of the flat area to the north of the wall and decreases to approximately 6 feet in height at the east side. Site vegetation generally includes grasses and weeds with a couple of large deciduous trees located a few feet in front of the existing retaining wall. Surface water was not observed at the site during our investigation in September of 2007.

Subsurface Soil Conditions

Subsurface conditions within the areas of interest at the site were explored by excavating and sampling four test pits with a rubber tired backhoe on September 27, 2007. The test pits (TP-1 through TP-4) were advanced to depths that ranged from approximately 8 to 9 feet below ground surface (BGS). One test pit was advanced behind the existing retaining wall and three test pits were advanced in front of the wall. The approximate location of the test pits are shown on the Site and Exploration Plan, Figure 2.

The subsurface profile generally consisted of fill overlaying native glacial till or glacial outwash deposits. At the surface of all four explorations, loose to medium dense, generally brown, generally dry, gravelly, silty, fine to coarse sand to sandy gravel (fill) with occasional cobbles and wood debris was encountered to depths that ranged from approximately 2 to 6½ feet BGS. Underlying the fill at exploration TP-4, approximately 4 inches of medium stiff, dark brown, moist, organic, sandy silt (relic topsoil) was encountered. Below the fill at exploration TP-3, medium dense, gray-brown, dry, very sandy, fine to coarse gravel (glacial outwash) was encountered to the full extent of exploration. Below the relic topsoil at exploration TP-4 and underlying the fill at explorations TP-1 and TP-2, medium dense, red-brown, dry to damp, slightly gravelly to gravelly, silty to very silty sand (weathered glacial till) was encountered to the full extent of exploration in TP-1 and to depths ranging between approximately 5 to 7½ feet BGS in explorations TP-2 and TP-4. Underlying the weathered glacial till at explorations TP-2 and TP-3, dense, gray-brown, damp, slightly gravelly, very silty, fine to coarse sand (glacial till) was encountered to the full extent of exploration. More detailed descriptions of the subsurface conditions can be found with the test pit logs attached with this report.

Groundwater

At the time of our subsurface investigation in September of 2007, groundwater seepage or evidence of a seasonal high water table, typically indicated by a distinct mottled horizon, was not observed within any of our explorations. The groundwater conditions reported on the test pit logs are for the specific locations and dates indicated, and therefore may not necessarily be indicative of other locations and/or times. Groundwater levels are not static and it is anticipated that groundwater conditions will vary depending on local subsurface conditions, season, precipitation, changes in land use both on and off site, and other factors.

CONCLUSIONS AND RECOMMENDATIONS

Based upon evaluation of the data collected during this investigation, it is our opinion that subsurface conditions at the site are suitable for the proposed construction, provided the recommendations contained herein are incorporated into the project design.

Foundation Support and Settlement

Foundation support for the proposed concrete retaining wall may be provided by the native, medium dense to dense, sandy gravel (glacial outwash) or slightly gravelly, silty sand (glacial till) encountered below the site or on properly compacted structural fill placed directly over undisturbed native soil.

Based on the subsurface conditions encountered below the site, up to approximately 8 feet of uncontrolled fill and loose, upper weathered portions of the native soil may have to be removed to reach suitable bearing conditions. We recommend that a representative from GeoTest Services verify that suitable soil has been reached prior to placing structural fill or foundation formwork. In addition, all structural fill placed below the proposed retaining wall should be compacted to a minimum of 95 percent of the maximum dry density based on test method ASTM D 1557. Structural fill should be placed in lifts not exceeding approximately 8 to 10 inches in thickness and thoroughly compacted with a steel drum vibrating roller, hoe pack, or equivalent equipment. We recommend that compaction be tested after each lift of the fill pad.

In order to prevent excessive hydrostatic pressure from building up behind the new retaining wall, we recommend that properly functioning footing drain(s) be incorporated into the wall design. GeoTest would be pleased to assist with footing drain design upon request. In addition, we recommend that stormwater runoff from East 4th Street be intercepted and redirected away from the wall with a curb and gutter or other appropriate means and not allowed to infiltrate behind the new retaining wall.

The proposed retaining wall footing should be founded a minimum of 18 inches below the lowest adjacent final grade for freeze/thaw protection.

Allowable Bearing Capacity

Assuming the above foundation support criteria are satisfied, the retaining wall footing founded directly on the native, glacial outwash/glacial till or on compacted structural fill placed directly over undisturbed native soils may be proportioned using a maximum net

allowable soil bearing pressure of 2,500 pounds per square ft (psf). The term "net allowable bearing pressure" refers to the pressure that can be imposed on the soil at foundation level resulting from the dead loads, exclusive of the weight of the footing or any backfill placed above the footing. The net allowable bearing pressure may be increased by one-third for transient wind or seismic loads.

Foundation Settlement

Settlement of shallow foundations depends on foundation size and bearing pressure, as well as the strength and compressibility characteristics of the underlying soil. Assuming construction is accomplished as previously recommended and for the maximum allowable soil bearing pressure recommended above, we estimate the total settlement of retaining wall foundations should be less than about 1 inch and differential settlement between two adjacent load-bearing components supported on competent soil should be less than about one half the total settlement. The soil response to applied stresses caused by retaining wall loads is expected to be predominantly elastic in nature, with most of the settlement occurring during construction as loads are applied.

Resistance to Lateral Loads

Passive earth pressures developed against the sides of foundations, in conjunction with friction developed between the base of the footings and the supporting subgrade, will resist lateral loads transmitted from the structure to its foundation. For design purposes, the passive resistance of well-compacted fill placed against the sides of foundations may be considered equivalent to a fluid with a density of 250 pounds per cubic ft. The recommended value includes a safety factor of about 1.5 and is based on the assumption that the ground surface adjacent to the structure is level in the direction of movement for a distance equal to or greater than twice the embedment depth. The recommended value also assumes drained conditions that will prevent the buildup of hydrostatic pressure in the compacted fill. In design computations, the upper 12 inches of passive resistance should be neglected if the soil is not covered by pavement. If future plans call for the removal of the soil providing resistance, the passive resistance should not be considered.

An allowable coefficient of base friction of 0.25, applied to vertical dead loads only, may be used between the underlying native soil and the base of the footing. If a minimum of 12 inches of properly compacted import structural fill is placed below the footing, then the allowable coefficient of base friction may be increased to 0.30, as applied to vertical dead loads only. However, if passive and frictional resistance are considered together, one half the recommended passive soil resistance value should be used since larger strains are required to mobilize the passive soil resistance as compared to frictional resistance. A safety factor of about 1.5 is included in the base friction design value. We do not recommend increasing the coefficient of friction to resist seismic or wind loads.

The lateral earth pressures that develop against retaining walls will depend on the method of backfill placement, degree of compaction, slope of backfill, type of backfill material, provisions for drainage, magnitude and location of any adjacent surcharge loads, and the degree to which the wall can yield laterally during or after placement of backfill. If the wall is allowed to rotate or yield so the top of the wall moves an amount equal to or greater than about 0.001 to 0.002 times its height (a yielding wall), the soil pressure exerted will be the active soil pressure. When a subsurface wall is restrained

against lateral movement or tilting (a nonyielding wall), the soil pressure exerted is the at-rest soil pressure. Wall restraint may develop if a rigid structural network is constructed prior to backfilling or the wall is inherently stiff.

We recommend that yielding walls with level backfill under drained conditions be designed for an equivalent fluid density of 35 pounds per cubic ft (pcf) for structural backfill (pit run) in active soil conditions. Nonyielding walls with level backfill under drained conditions should be designed for an equivalent fluid density of 55 pcf for at-rest conditions for structural backfill (pit run). We do not recommend reusing the native slightly gravelly, very silty sand (glacial till) or any existing uncontrolled fill as structural backfill behind the wall. Native sandy gravel (glacial outwash) may be used as structural fill behind the wall if approved by a licensed geotechnical engineer. Design of subsurface walls should include appropriate lateral pressures caused by surcharge loads located within a horizontal distance equal to or less than the height of the wall. For uniform surcharge pressures, a uniformly distributed lateral pressure equal to 35 percent and 50 percent of the vertical surcharge pressure should be added to the lateral soil pressures for yielding and nonyielding walls, respectively.

Temporary and Permanent Slopes

Actual construction slope configurations and maintenance of safe working conditions, including temporary excavation stability, should be the responsibility of the contractor, who is able to monitor the construction activities and has direct control over the means and methods of construction. All applicable local, state, and federal safety codes should be followed. All open cuts should be monitored during and after excavation for any evidence of instability. If instability is detected, the contractor should flatten the side slopes or install temporary shoring.

Temporary excavations in excess of 4 ft should be shored or sloped in accordance with Safety Standards for Construction Work Part N, WAC 296-155-657. Temporary unsupported excavations in the generally medium dense, gravelly, silty sand (fill) and sandy gravel (glacial outwash) encountered at the project site are classified as a Type C soil according to WAC 296-155-657 and may be sloped as steep as 1.5H:1V. Temporary unsupported excavations in the generally dense, slightly gravelly, very silty sand (glacial till) encountered at the project site are classified as a Type B soil according to WAC 296-155-657 and may be sloped as steep as 1H:1V. All soils encountered are classified as Type C soil in the presence of groundwater seepage. Flatter slopes or temporary shoring may be required in areas where groundwater flow is present and unstable conditions develop.

We recommend that permanent cut or fill slopes be designed for inclinations of 2H:1V or flatter. All permanent cut slopes should be vegetated or otherwise protected to limit the potential for erosion as soon as practical after construction. Permanent slopes requiring immediate protection from the effects of erosion should be covered with either mulch or erosion control netting/blankets. Areas requiring permanent stabilization should be seeded with an approved grass seed mixture, or hydroseeded with an approved seed-mulch-fertilizer mixture.

Occasionally subsurface conditions may result in the concentration of seepage within particular soil zones. The need for additional drainage within specific seepage zones can best be determined during or following construction.

Geotechnical Consultation and Construction Monitoring

We recommend that geotechnical construction monitoring services be provided. These services should include observation by geotechnical personnel during fill placement/compaction activities and subgrade preparation operations to verify that design subgrade conditions are obtained beneath the proposed retaining wall. We also recommend that periodic field density testing be performed to verify that the appropriate degree of compaction is obtained. The purpose of these services would be to observe compliance with the design concepts, specifications, and recommendations of this report, and in the event subsurface conditions differ from those anticipated before the start of construction, provide revised recommendations appropriate to the conditions revealed during construction. GeoTest Services would be pleased to provide these services for you.

USE OF THIS REPORT

GeoTest Services has prepared this report for the exclusive use of City of Arlington Engineering Department and their design consultants for specific application to the design of the proposed retaining wall to be located at East 4th Street and North French Avenue in Arlington, Washington. Use of this report by others or for another project is at the user's sole risk. Within the limitations of scope, schedule, and budget, our services have been conducted in accordance with generally accepted practices of the geotechnical engineering profession; no other warranty, either express or implied, is made as to the professional advice included in this report.

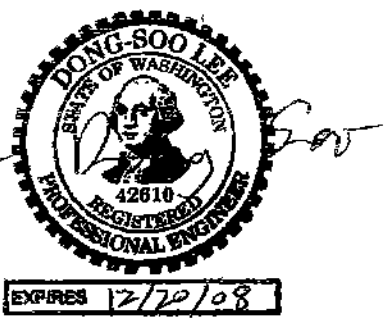
Our site explorations indicate subsurface conditions at the dates and locations indicated. It is not warranted that they are representative of subsurface conditions at other locations and times. The analyses, conclusions, and recommendations contained in this report are based on site conditions to the limited depth of our explorations at the time of our exploration program, a brief geological reconnaissance of the area, and review of published geological information for the site. We assume that the exploration is representative of the subsurface conditions throughout the site during the preparation of our recommendations. If variations in subsurface conditions are encountered during construction, we should be notified for review of the recommendations of this report, and revision of such if necessary. If there is a substantial lapse of time between submission of this report and the start of construction, or if conditions change due to construction operations at or adjacent to the project site, we recommend that we review this report to determine the applicability of the conclusions and recommendations contained herein.

The earthwork contractor is responsible to perform all work in conformance with all applicable WISHA/OSHA regulations. GeoTest Services, Inc. should not be assumed to be responsible for job site safety on this project, and this responsibility is specifically disclaimed.

We appreciate the opportunity to be of service to you on this project. If any questions should arise regarding this report, please contact the undersigned.

Respectfully Submitted,
GeoTest Services, Inc.

David Jelium
Staff Geologist



10/9/07

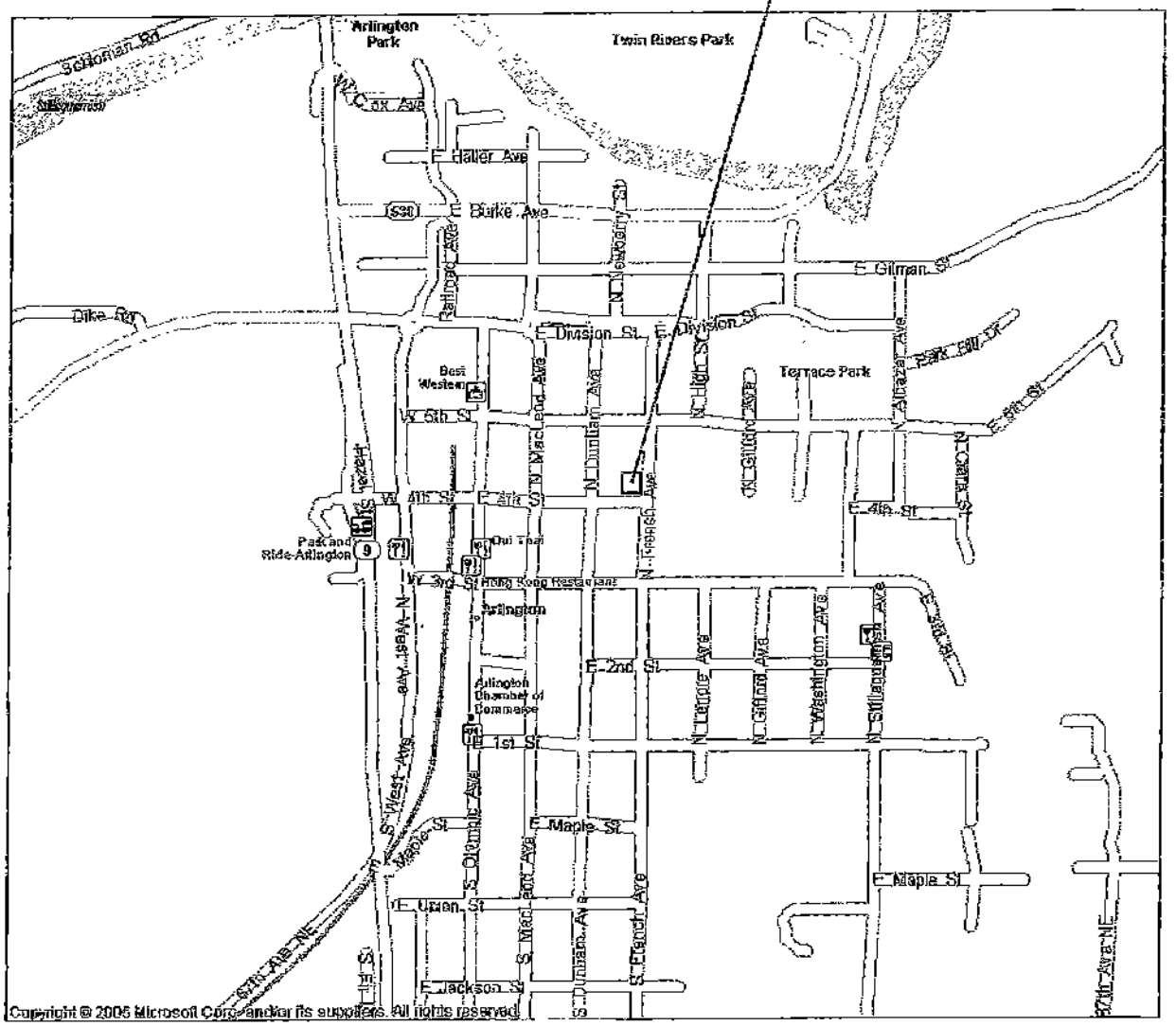
Dong-Soo Lee, P.E.
Geotechnical Engineer

Attachments:	Figure 1	Vicinity Map
	Figure 2	Site and Exploration Plan
	Figure 3	Soil Classification System and Key
	Figures 4 & 5	Logs of Test Pits
	Figure 6	Grain Size Test Data

REFERENCES

Pessl Jr., F, Dethier, D.P., Booth, D.B., Minard, J.P. 1989. *Surficial Geologic Map of Port Townsend 30- by 60-Minute Quadrangle, Puget Sound Region, Washington.* United States Geological Survey. Map I-1198-F.

PROJECT LOCATION



NORTH

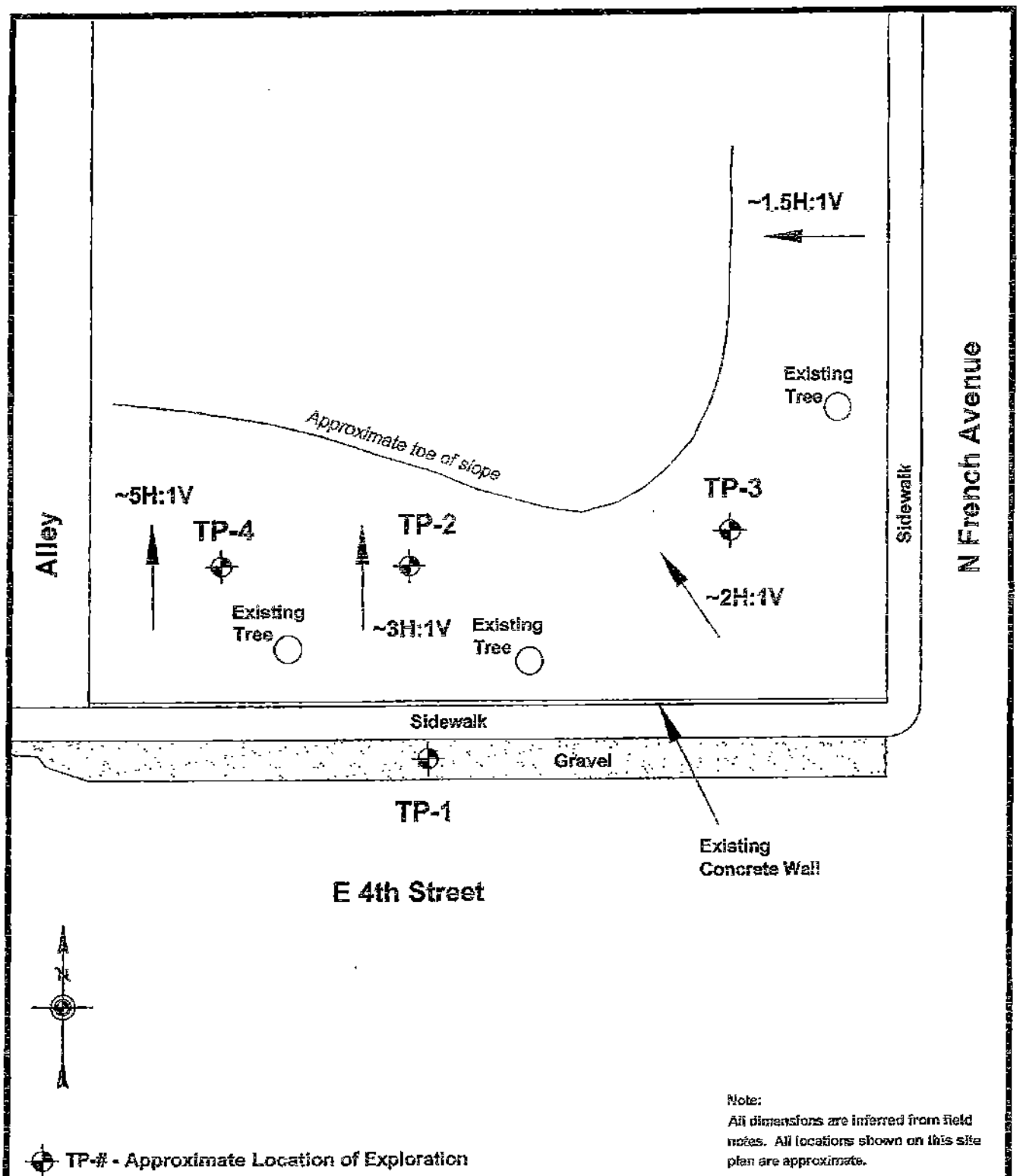
Reference Map Provided By
Microsoft Streets and Trips 2006

GEOTEST SERVICES, INC.
741 Marine Drive
Bellingham, WA 98225
phone: (360) 733-7318
fax: (360) 733-7418

Date: 10-8-07	By: DJ	Scale: NONE	Project 07-0754

SITE VICINITY MAP
NEW RETAINING WALL
N FRENCH AVE AND E 4TH STREET
ARLINGTON, WASHINGTON

Figure 1



TP-# - Approximate Location of Exploration

Note:
All dimensions are inferred from field notes. All locations shown on this site plan are approximate.

GEOTEST SERVICES, INC.
741 Marine Drive
Bellingham, WA 98225
Phone: (360) 733-7318
Fax (360) 733-7418

Date: 10-3-07	By: DJ	Scale: 1" = 20'

SITE AND EXPLORATION PLAN
NEW RETAINING WALL
N FRENCH AVE AND E 4TH ST
ARLINGTON, WASHINGTON

Project
07-0754

Figure
2

Soil Classification System

MAJOR DIVISIONS			GRAPHIC SYMBOL	USCS LETTER SYMBOL	TYPICAL DESCRIPTIONS[1][2]
COARSE-GRAINED SOIL (More than 50% of material is larger than No. 200 sieve size)	GRAVEL AND GRAVELLY SOIL (More than 50% of coarse fraction retained on No. 4 sieve)	CLEAN GRAVEL (Little or no fines)		GW	Well-graded gravel; gravel/sand mixture(s); little or no fines
				GP	Poorly graded gravel; gravel/sand mixture(s); little or no fines
		GRAVEL WITH FINES (Appreciable amount of fines)		GM	Silty gravel; gravel/sand/silt mixture(s)
				GC	Clayey gravel; gravel/sand/clay mixture(s)
	SAND AND SANDY SOIL (More than 50% of coarse fraction passed through No. 4 sieve)	CLEAN SAND (Little or no fines)		SW	Well-graded sand; gravelly sand; little or no fines
				SP	Poorly graded sand; gravelly sand; little or no fines
		SAND WITH FINES (Appreciable amount of fines)		SM	Silty sand; sand/silt mixture(s)
				SC	Clayey sand; sand/clay mixture(s)
FINE-GRAINED SOIL (More than 50% of material is smaller than No. 200 sieve size)	SILT AND CLAY (Liquid limit less than 50)			ML	Inorganic silt and very fine sand; rock flour; silty or clayey fine sand or clayey silt with slight plasticity
				CL	Inorganic clay of low to medium plasticity; gravelly clay; sandy clay; silty clay; lean clay
				OL	Organic silt; organic, silty clay of low plasticity
	SILT AND CLAY (Liquid limit greater than 50)			MH	Inorganic silt; micaceous or diatomaceous fine sand
				CH	Inorganic clay of high plasticity; fat clay
				OH	Organic clay of medium to high plasticity; organic silt
	HIGHLY ORGANIC SOIL			PT	Peat; humus; swamp soil with high organic content

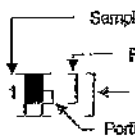
OTHER MATERIALS	GRAPHIC SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTIONS
PAVEMENT		AC or PC	Asphalt concrete pavement or Portland cement pavement
ROCK		RK	Rock (See Rock Classification)
WOOD		WD	Wood, lumber, wood chips
DEBRIS		DB	Construction debris, garbage

Notes:
1. Soil descriptions are based on the general approach presented in the *Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)*, as outlined in ASTM D 2488. Where laboratory index testing has been conducted, soil classifications are based on the *Standard Test Method for Classification of Soils for Engineering Purposes*, as outlined in ASTM D 2487.
2. Soil description terminology is based on visual estimates (in the absence of laboratory test data) of the percentages of each soil type and is defined as follows:

Primary Constituent:	> 50% - "GRAVEL," "SAND," "SILT," "CLAY," etc.
Secondary Constituents:	> 30% and ≤ 50% - "very gravelly," "very sandy," "very silty," etc.
	> 12% and ≤ 30% - "gravelly," "sandy," "silty," etc.
Additional Constituents:	> 5% and ≤ 12% - "slightly gravelly," "slightly sandy," "slightly silty," etc.
	≤ 5% - "trace gravel," "trace sand," "trace silt," etc., or not noted.

Drilling and Sampling Key

SAMPLE NUMBER & INTERVAL



SAMPLER TYPE Code	Description
a	3.25-inch O.D., 2.42-inch I.D. Split Spoon
b	2.00-inch O.D., 1.50-inch I.D. Split Spoon
c	Shelby Tube
d	Grab Sample
e	Other - See text if applicable
1	300-lb Hammer, 30-inch Drop
2	140-lb Hammer, 30-inch Drop
3	Pushed
4	Other - See text if applicable

Groundwater

▽ ATD — Approximate water elevation at time of drilling (ATD) or on date noted. Groundwater levels can fluctuate due to precipitation, seasonal conditions, and other factors.

Field and Lab Test Data

Code	Description
PP = 1.0	Pocket Penetrometer, tsf
TV = 0.5	Torvane, tsf
PID = 100	Photoionization Detector VOC screening, ppm
W = 10	Moisture Content, %
D = 120	Dry Density, pcf
-200 = 60	Material smaller than No. 200 sieve, %
GS	Grain Size - See separate figure for data
AL	Atterberg Limits - See separate figure for data
GT	Other Geotechnical Testing
CA	Chemical Analysis

10/9/07 X:\0-PROJECTS\GEOCITY OF ARLINGTON ENGINEERING DIVISION - 07-0754 - FRENCH AND 4TH RETAINING WALL\GINT.GPJ SOIL CLASS SHEET

GEOTEST

New Retaining Wall
N French Ave & E 4th St
Arlington, Washington

Soil Classification System and Key

Figure 3

TP-1

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Sample Number & Interval	Sampler Type	Test Data	Graphic Symbol	USCS Symbol	Excavation Method: Rubber-tired Backhoe Ground Elevation (ft): Not Determined	
0					GP	Loose to medium dense, brown, dry, clean to slightly silty, sandy, fine to coarse GRAVEL, occasional cobbles (fill); scattered small roots and wood pieces.	Groundwater not encountered.
2	1	d	W = 2				
4	2	d	W = 2 GS				
6					SM	Loose to medium dense, red-brown, dry, gravelly, silty SAND (weathered glacial till).	
8	3	d	W = 8			Test pit terminated due to severe sidewall caving.	
10							
12							

Test Pit Completed 09/27/07
Total Depth of Test Pit = 8.0 ft.

TP-2

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Sample Number & Interval	Sampler Type	Test Data	Graphic Symbol	USCS Symbol	Excavation Method: Rubber-tired Backhoe Ground Elevation (ft): Not Determined	
0					SM	Loose to medium dense, light brown, dry, gravelly, silty, fine to coarse SAND, occasional cobbles (fill); numerous tree roots encountered.	Groundwater not encountered.
2	1	d	W = 6 GS				
4	2	d	W = 5				
6					SM	Medium dense, red-brown, dry to damp, slightly gravelly, silty SAND (weathered glacial till).	
8					SM	Dense, gray-brown, damp, slightly gravelly, very silty, fine to coarse SAND (glacial till).	
	3	d	W = 15 GS				
10							
12							

Test Pit Completed 09/27/07
Total Depth of Test Pit = 9.0 ft.

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

GEOTEST	New Retaining Wall N French Ave & E 4th St Arlington, Washington	Log of Test Pits	Figure 4

TP-3

Depth (ft)	Sample Number & Interval	Sampler Type	Test Data	Graphic Symbol	USCS Symbol	SOIL PROFILE (Excavation Method: Rubber-tired Backhoe; Ground Elevation (ft): Not Determined)	GROUNDWATER
0					SM	Loose, dark brown, dry, gravelly, silty SAND (fill); occasional plastic, wood and glass debris.	Groundwater not encountered.
2					GP	Medium dense, gray-brown, damp, very sandy, fine to coarse GRAVEL (glacial outwash); numerous tree roots to ~4 feet BGS.	
6	1	d	W = 2				
8	2	d	W = 2 GS				

Test Pit Completed 09/27/07
Total Depth of Test Pit = 9.0 ft.

TP-4

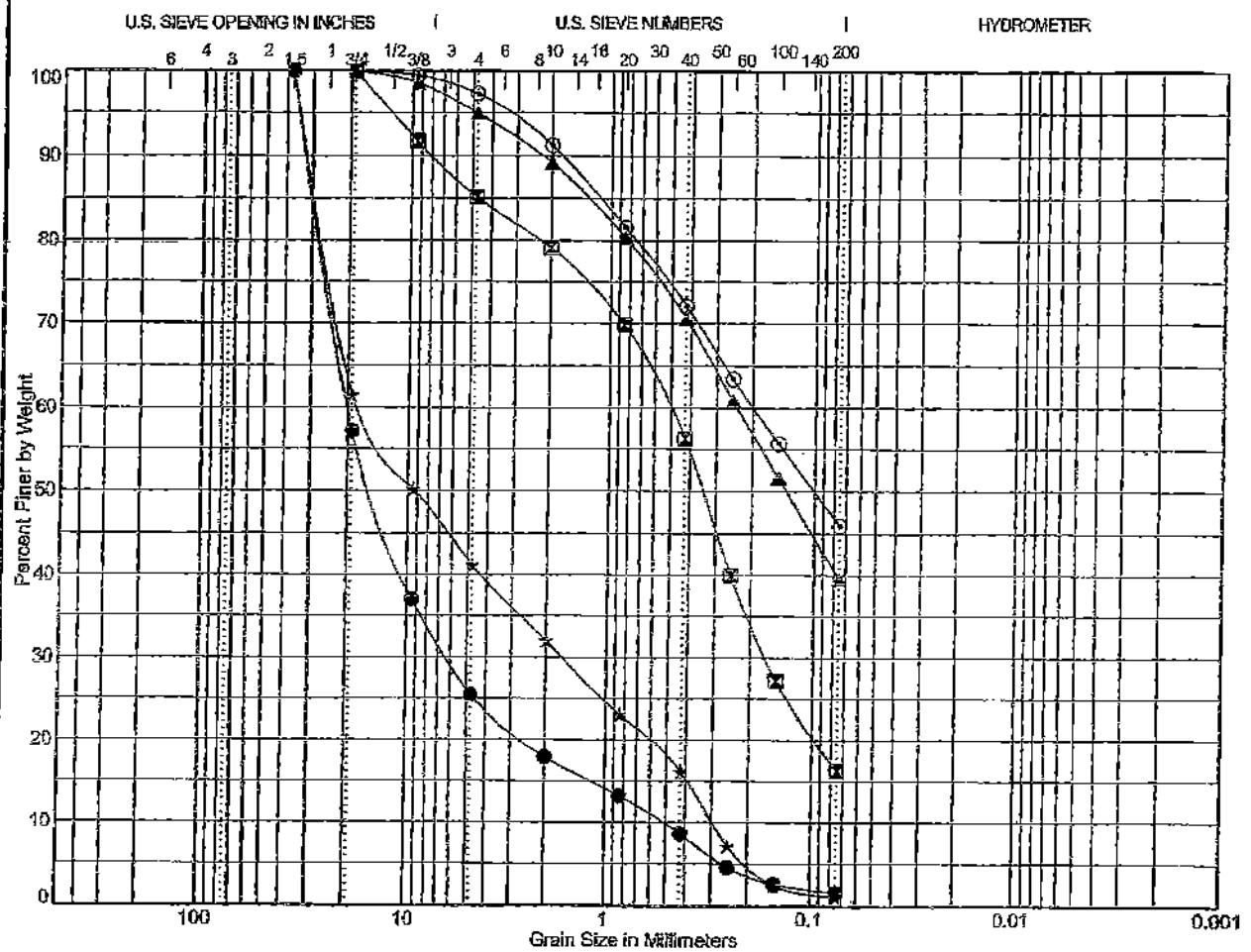
Depth (ft)	Sample Number & Interval	Sampler Type	Test Data	Graphic Symbol	USCS Symbol	SOIL PROFILE (Excavation Method: Rubber-tired Backhoe; Ground Elevation (ft): Not Determined)	GROUNDWATER
0					SM	Loose to medium dense, brown to light brown, dry to damp, slightly gravelly, very silty SAND (fill); occasional concrete pieces up to ~2 feet in diameter.	Groundwater not encountered.
2	1	d	W = 14				
					OL	Medium stiff, dark brown, damp, organic, sandy SILT (relic topsoil); approximately 4 inches in thickness.	
4					SM	Medium dense, red-brown, damp, slightly gravelly, very silty SAND (weathered glacial till).	
					SM	Dense, gray-brown, damp, slightly gravelly, very silty, fine to coarse SAND (glacial till).	
8	2	d	W = 13 GS				

Test Pit Completed 09/27/07
Total Depth of Test Pit = 8.0 ft.

Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

-416885.00 10/8/07 X:\0-PROJECTS GEO\CITY OF ARLINGTON ENGINEERING DIVISION - 07-0754 - FRENCH AND 4TH RETAINING WALL\GINT.GPJ TEST PIT LOG

GEOTEST	New Retaining Wall N French Ave & E 4th St Arlington, Washington	Log of Test Pits	Figure 5



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

Point		Depth	Classification	LL	PL	PI	C_c	C_u
●	TP-1	5.0	Sandy, fine to coarse GRAVEL (GP)				3.74	38.04
⊠	TP-2	2.5	Gravelly, silty, fine to coarse SAND (SM)					
▲	TP-2	8.5	Slighily gravelly, very silty, fine to coarse SAND (SM)					
★	TP-3	8.5	Very sandy, fine to coarse GRAVEL (GP)				0.53	58.61
⊙	TP-4	7.5	Very silty, fine to coarse SAND (SM)					

Point		Depth	D_{100}	D_{60}	D_{50}	D_{30}	D_{10}	%Coarse Gravel	% Fine Gravel	% Coarse Sand	% Medium Sand	% Fine Sand	% Fines
●	TP-1	5.0	37.5	19.874	14.852	6.23	0.522	42.8	31.7	7.5	9.3	7.1	1.6
⊠	TP-2	2.5	19	0.515	0.347	0.168		0.0	14.8	6.1	22.9	40.0	16.3
▲	TP-2	8.5	19	0.238	0.137			0.0	5.0	5.8	18.7	31.0	39.5
★	TP-3	8.5	37.5	17.32	9.355	1.654	0.296	38.5	20.3	9.2	15.8	15.0	1.1
⊙	TP-4	7.5	19	0.199	0.1			0.0	2.7	6.1	19.1	26.1	45.9

$C_c = D_{30}^2/(D_{60} * D_{10})$ $\quad C_u = D_{60}/D_{10}$

To be well graded: $1 < C_c < 3$ and $C_u > 4$ for GW or $C_u > 6$ for SW

GeoTest

New Retaining Wall
N French Ave & E 4th St
Arlington, Washington

Grain Size Test Data

Figure 6