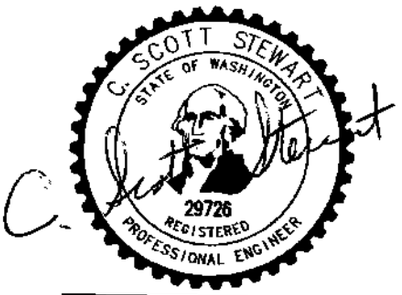
PEAK ENGINEERING, INC.

CONSTRUCTION DRAINAGE REPORT FOR ARLINGTON SQUARE City of Arlington



EXPIRES 07/16/2009

DATE: 7/8/08

Prepared By: Brian R Lindsay
Peak Engineering, Inc.

October 22, 2007
Added additional downstream analysis and
Supplemental Construction Drainage Analysis: April 28, 2008 (brl)
Revised per city review: July 9, 2008
Peak Job #05627

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DRAINAGE INFORMATION SUMMARY FORM

Project Total Area: 8.8 acres

Project Development Area: 7.07 acres

Number of Lots (if applies): 7 buildings

Summary Table

Drainage Basin Information		Individual Basin Information			
		DEV A	BYPASS A	DEV B	
On-Site Sub-basin Area (ac)		6.28	0.35	1.06	
Type of Storage Proposed		DETENTION VAULT	N/A	N/A	
Approx. Storage Volume (ft^3)		55,879	N/A	N/A	
Soil Type(s)		NORMA	NORMA	NORMA	
Pre-developed Runoff Rates			N/A		
Q (cfs)	2 yr.	0.25		0.16	
	10 yr.	0.75		0.32	
	100 yr.	1.54		0.55	
Redevelopment Area					
Post-development Runoff Rates					
Q (cfs)	2yr.	2.24/0.017	0.11	0.15	
	10 yr.	3.55/0.54	0.18	0.32	
	100 yr.	5.16/1.27	0.27	0.56	
Offsite Upstream Area (ac)					
Number of acres					
Offsite Downstream Flow					
Q (cfs)					

SECTION I

INTRODUCTION AND EXISTING CONDITIONS:

This project will construct a commercial complex of retail, office, and residential on an approximately 8.79-ac site. The site is located in the northeast corner of the intersection of SR 531 (172nd St NE) and 67th Ave NE within the city of Arlington. The western portion of the site slopes to the northwest with slopes at 2 to 5%. There is a bank along the eastern portion of the site that slopes to the west at 10 to 20%. As indicated in the Snohomish County Soil Survey Map, soils on site are Norma loam, hydrologic soils group "C/D". See Appendix for soils map. Norma loam is typically very deep and poorly drained. Runoff is very slow, and the hazard of water erosion is slight. The geotechnical engineer has identified the soils on site as silty fine sand. See the separate geotechnical engineering study as prepared by Liu & Associates, Inc., date June 27, 2005.

There are no buildings on the site currently, though there has been development on the site in the past. As such, no demolition will be required on site prior to development. Edgecomb Creek enters the site from the southeast and exits in the southwestern portion of the site. Currently, the site is pastured with some trees in the southern and eastern portions of the site along the stream.

DEVELOPED CONDITIONS:

The site will be accessed from two access driveways along 67th Ave NE and one from SR 531. Half street frontage improvements will be constructed which will widen the existing pavement. There are existing culverts for the stream as it crosses SR 531 which will be extended to allow for the widened pavement.

Storm drainage from the entire site and a portion of the frontage on SR 531 will be conveyed to a detention vault located in the northwest portion of the site. Permanent water quality for the stormwater runoff will be also provided by a Media Filtration System™ unit as manufactured by CONTECH Stormwater Solutions, Inc. The detention vault facility has been designed to match flows at the existing conditions for the 2-yr, 10-yr, and 100-yr 24-hr storms. The allowable release rates will be 50% of the pre-developed 2-yr and 100% of the pre-developed 10 and 100 yr events minus the developed flows from the areas that bypass the vault. The existing conditions were assumed to be second growth forest (CN=81). The allowable release rates were calculated based on the 1992 DOE manual. Per table III-1.1, a volume correction factor of 1.45 was added to determine the minimum detention volume required.

Detained runoff from the vault will be conveyed to the constructed wetland across on the west side of 67th Ave NE.

Storm drainage along the frontage areas that are too low to be conveyed to the detention vault facility will continue to utilize the existing drainage course along 67th Ave NE. Storm drainage in 67th Ave NE flows to the constructed wetland along the west side 67th Ave NE.

Existing category 3 wetlands and a stream have been identified on site. The stream will not be disturbed by the proposed project. Because portions of the onsite wetlands are being filled, new wetland will be created in the northeast portion of the site. Non-pollution generating roof surface from the backside of building B will be directed to the wetland X to maintain flows to the wetland. To be conservative, the entirety of building B was included in the developed basin

detention calculations. (i.e. even though this building will drain to the wetland it is included in the detention vault calculations as if it flowed to the vault.)

Runoff rates and volume calculations were performed, using SBUH and SCS Curve Number methodologies in "StormSHED" by Engenious Systems (See Section II).

Storm Event	Existing	Bypass Developed	Developed Unmitigated	Developed Controlled
2 year	0.25 cfs	0.11 cfs	2.24 cfs	0.017 cfs
10 year	0.75 cfs	0.18 cfs	3.55 cfs	0.54cfs
100 year	1.54 cfs	0.27 cfs	5.16 cfs	1.27 cfs

Table 1: Summary of peak flows from the 24-hour storm events Basin "A"

WATER QUALITY:

Water quality for the proposed project will be handled by a Media Filtration System™ treatment vault unit as manufactured by CONTECH Stormwater Solutions Inc. The MFS™ unit will be located downstream of the detention vault and will handle the water quality flow from the vault. The MFS™ unit is comprised of an inlet bay and treatment area. The treatment area contains filter cartridges that shall contain Perlite as the filtration substrate/adsorption surface. A 22 cartridge unit is being specified for this site. See sizing calculations in Section II of this report.

OPERATION AND MAINTENANCE:

The roof downspouts, detention vault and storm drainage conveyance system shall be inspected annually to ensure that sediment is not occurring and shall be cleaned as necessary. The systems shall be inspected after large storm events to ensure debris has not caused a blockage and is not hindering the system's performance. Additionally, undesirable vegetation that has the potential to interfere with performance of or damage to the vault detention facility, shall be removed. The MFS™ system shall be inspected and cleaned as required per the manufacturer's guidelines. For additional information, see the Operation and Maintenance Manual in this report.

EROSION CONTROL RISK ASSESSMENT AND SWPPP

The project was evaluated to determine the erosion risk category and generate a Storm Water Pollution Prevention Plan (SWPPP). The soil on the proposed project site is classified as Norma loam, which has a slight erosion hazard. The western portion of the site slopes northwest with slopes at 2 to 5% and the bank along the eastern portion of the site slopes to the west at 10 to 20%. Finally, the project site is located within a ¼ mile of a critical area. Overall, the project is classified as high risk for erosion.

A Storm Water Pollution Prevention Plan (SWPPP) has been prepared for this project, which will comply with City and State of Washington D.O.E. standards for erosion control. See the construction plan set and the SWPPP report.

Erosion control BMP's will include leaving existing vegetation as much as practical around the site. Temporary cover and/or surface roughening of exposed areas (mulching, plastic, etc.) will be provided. Measures to limit the level of sediment leaving the site will include silt fences, a rock construction entrance, interceptor ditches, and inlet protection of catch basins. Additional BMP's may be required as need arises during construction.

CONVEYANCE SYSTEM:

The design Q100yr post-developed peak flow rate is 5.16 cfs. Storm water runoff from the development is conveyed to the detention vault via 12" HDPE storm pipe. The full flow capacities were determined for 12" HDPE at 0.60% and 18" HDPE at 0.60% slope, which were 2.99 cfs and 8.81 cfs, respectively. Based on this analysis, a 12" pipe was found to be allowable for all storm drainage pipes on site with the exception of the pipe from CB-4 to the detention vault, which shall be an 18" pipe. For additional information, see the pipe capacity calculations in Section II of this report.

UPSTREAM/DOWNSTREAM CONDITIONS:

Stormwater runoff from portions of the eastern upstream area is intercepted by a storm system along the adjacent property and a berm that directs runoff away from the property's east boundary. The berm starts at approximately 200 ft north of the southeast property corner of the site. The berm directs runoff to an existing ditch along the north boundary of the site. The ditch directs runoff to the northwest property corner where another ditch diverts runoff west to wetland "X". In the developed condition runoff along the rock wall and building "G" will be collected by footing drains and directed to CO-G. The pre-developed 100yr peak rate for Wetland "X" was balanced in the developed condition. (For calculations see Section II-18 & 19) Wetland "X" is channeled along the north property line and drains off site at the northwest corner to an existing 24" CP. There is an existing stream (Edgecomb Creek) along the south property line, which will remain.

In the existing condition, storm water runoff from this site sheet flows to the northwest corner of the site and is collected by the existing channel in wetland "X" mentioned above and flows to the existing 24" CP flowing north along the east side of 67th Ave NE. This system conveys runoff north approximately 175' and crosses under Highland View Drive where runoff is directed west and crosses under 67th Ave NE to a large constructed wetland pond located between the railroad tracks to the west and 67th Ave NE to the east. In the developed condition, the vault maintains the same outfall into the constructed wetland pond.

Runoff from the wetland is conveyed to the west under the railroad tracks and to a conveyance system flowing west through the lumber yard. The Lumberman's yard and Dan Mitzel site discharge to an 18" concrete conveyance system that outfalls into a grass and brush lined ditch along the west side of the lumber yard access road (63rd). In the worst case the 18" concrete pipe and catch basin system has a potential 3.35 ft headwater depth with a capacity of over 14 cfs. For additional information see Section II-17 to II-19 of the drainage report and the Downstream Conveyance Map attached to the Appendix of this report. The 18" concrete pipe conveys runoff for approximately 990' to the ditch flowing south along 63rd. At approximately 480 ft downstream of the 18" concrete pipe outfall a concrete weir control structure discharges 125 ft upstream of the SR 531 (172nd St. NE) crossing. The culvert crossing SR 531 (172nd St. NE) is a 3' concrete culvert. This culvert flows into an existing ditch on the south side of SR 531, continues west approximately 80 feet, turns and flows south approximately 600 feet, and discharges into Edgecomb Creek. Edgecomb Creek meanders south for approximately 4 miles before discharging into Middle Fork Quilceda Creek. The following table is a comparison of the existing on and offsite basin that drains to the west crossing 67th Ave NE and the wetland along the railroad right-of-way for the peak storm events of the 2yr, 10yr and 100yr flows and volume of runoff:

SECTION II
ARLINGTON SQUARE

05627

CONSTRUCTION DRAINAGE ANALYSIS

DETENTION VAULT SYSTEM DESIGN:

ALLOWABLE 2 yr = ½ EXISTING 2 yr – BYPASS 2yr = 0.25 / 2 - 0.11 = **0.015 CFS**

ALLOWABLE 10 yr = EXISTING 10 yr – BYPASS 10yr = 0.75 – 0.18 = **0.57 CFS**

ALLOWABLE 100 yr = EXISTING 100 yr – BYPASS 100yr = 1.54 – 0.27 = **1.27 CFS**

Event Summary:

BasinID	Peak Q (cfs)	Peak T (hrs)	Peak Vol (ac-ft)	Area ac	Method /Loss	Raintype	Event
EXISTING A	0.25	9.17	0.2677	6.67	SBUH/SCS	TYPE1A	2 yr
EXISTING A	0.75	8.67	0.6044	6.67	SBUH/SCS	TYPE1A	10 yr
EXISTING A	1.54	8.50	1.0863	6.67	SBUH/SCS	TYPE1A	100 yr
BYPASS A	0.11	8.00	0.0379	0.35	SBUH/SCS	TYPE1A	2 yr
BYPASS A	0.18	8.00	0.0623	0.35	SBUH/SCS	TYPE1A	10 yr
BYPASS A	0.27	8.00	0.0930	0.35	SBUH/SCS	TYPE1A	100 yr
DEVELOPED A	2.24	8.00	0.7603	6.28	SBUH/SCS	TYPE1A	2 yr
DEVELOPED A	3.55	8.00	1.2143	6.28	SBUH/SCS	TYPE1A	10 yr
DEVELOPED A	5.16	8.00	1.7779	6.28	SBUH/SCS	TYPE1A	100 yr
DEVELOPED A	1.30	8.00	0.4414	6.28	SBUH/SCS	TYPE1A	6 MONTH

RLPCOMPUTE [P-VAULT RLP] SUMMARY (w/ NO VCF)

2 yr Match Q: 0.0152 cfs Peak Out Q: 0.0173 cfs - Peak Stg: 135.25 ft - Active Vol: 0.7620 acft
10 yr Match Q: 0.5725 cfs Peak Out Q: 0.5388 cfs - Peak Stg: 135.79 ft - Active Vol: 0.8633 acft
100 yr Match Q: 1.2716 cfs Peak Out Q: 1.2749 cfs - Peak Stg: 135.91 ft - Active Vol: 0.8847 acft

MIN VAULT VOLUME: 0.8847 ac-ft x 1.45 VCF = 1.2828 ac ft = **55,879 cf**

RLPCOMPUTE [F-VAULT RLP] SUMMARY (w/ 1.45 VCF)

2 yr Match Q: 0.0152 cfs Peak Out Q: 0.0144 cfs - Peak Stg: 134.01 ft - Active Vol: 0.7658 acft
10 yr Match Q: 0.5725 cfs Peak Out Q: 0.1044 cfs - Peak Stg: 135.69 ft - Active Vol: 1.2253 acft
100 yr Match Q: 1.2716 cfs Peak Out Q: 0.7710 cfs - Peak Stg: 135.83 ft - Active Vol: 1.2631 acft

6 MONTH Match Q: 0.0152 cfs Peak Out Q: 0.0109 cfs - Peak Stg: 132.82 ft - Active Vol: 0.4420 acft

Running I:\PROJECTS\627 ARLINGTON SQUARE\DOCS\Storm\P-VAULT RLP Report.pgm on Wednesday, July 09, 2008

Summary Report of all RLPool Data

Project Precips

[2 yr]	1.80 in
[10 yr]	2.70 in
[100 yr]	3.80 in
[6 MONTH]	1.15 in

Drainage Area: EXISTING A

Hyd Method: SBUH Hyd
Peak Factor: 484.00
Storm Dur: 24.00 hrs

Loss Method: SCS CN Number
SCS Abs: 0.20
Intv: 10.00 min

	Area	CN
Pervious	6.6700 ac	81.00
Impervious	0.0000 ac	98.00
Total	6.6700 ac	

TC
0.95 hrs
0.00 hrs

Supporting Data:

Pervious CN Data:

2ND AND 3RD GROWTH FOREST — 81.00 — 6.6700 ac

Pervious TC Data:

Flow type:	Description:	Length:	Slope:	Coeff:	Travel Time
Sheet	TC	300.00 ft	5.10%	0.4000	47.42 min
Shallow	TC	410.00 ft	2.00%	5.0000	9.66 min

Drainage Area: BYPASS A

Hyd Method: SBUH Hyd
Peak Factor: 484.00
Storm Dur: 24.00 hrs

Loss Method: SCS CN Number
SCS Abs: 0.20
Intv: 10.00 min

	Area	CN
Pervious	0.1100 ac	86.00
Impervious	0.2400 ac	98.00
Total	0.3500 ac	

TC
0.17 hrs
0.08 hrs

Supporting Data:

Pervious CN Data:

BYPASS NEW LANDSCAPE — 86.00 — 0.1100 ac

Impervious CN Data:

BYPASS NEW PAVEMENT — 98.00 — 0.2400 ac

Pervious TC Data:

Flow type:	Description:	Length:	Slope:	Coeff:	Travel Time
Fixed	TC	0.00 ft	0.00%	10.0000	10.00 min

Impervious TC Data:

Flow type:	Description:	Length:	Slope:	Coeff:	Travel Time
Fixed	TC	0.00 ft	0.00%	5.0000	5.00 min

Drainage Area: DEVELOPED 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	CN	TC	
Pervious	0.8950 ac	86.00	0.17 hrs	
Impervious	5.3900 ac	98.00	0.08 hrs	
Total	6.2850 ac			

Supporting Data:

Pervious CN Data:

LANDSCAPE	86.00	0.6600 ac
BUILDING F AND G GREEN ROOF	86.00	0.2350 ac

Impervious CN Data:

ONSITE ROAD/PARKING & BUILDINGS	98.00	5.3900 ac

Pervious TC Data:

Flow type:	Description:	Length:	Slope:	Coeff:	Travel Time
Fixed	TC	0.00 ft	0.00%	10.0000	10.00 min

Impervious TC Data:

Flow type:	Description:	Length:	Slope:	Coeff:	Travel Time
Fixed	TC	0.00 ft	0.00%	5.0000	5.00 min

HYDLIST SUMMARY

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

LSTEND

HydID	Peak Q (cfs)	Peak T (hrs)	Peak Vol (ac-ft)	Cont Area (ac)
2YR MATCH	0.02	9.17	0.0161	0.0000
10YR MATCH	0.57	8.67	0.4593	0.0000
100YR MATCH	1.27	8.50	0.8959	0.0000
P-2YR OUT	0.02	24.33	0.0308	6.4700
P-10YR OUT	0.54	15.50	0.4202	6.4700
P-100YR OUT	1.28	10.00	1.0004	6.4700
2 yr-ORIFICE-OutHyd	0.02	24.33	0.0308	6.4700
10 yr-ORIFICE-OutHyd	0.02	15.50	0.0363	0.5587
100 yr-ORIFICE-OutHyd	0.02	10.00	0.0383	0.2477
2 yr-RISER-OutHyd	0.00	0.00	0.0000	0.0000
10 yr-RISER-OutHyd	0.52	15.50	0.3839	5.9113
100 yr-RISER-OutHyd	1.26	10.00	0.9621	6.2223

Node ID: P-VAULT

Desc:	VAULT W/O VCF			
Start El:	131.2000 ft		Max El:	140.0000 ft
Contrib Basin:			Contrib Hyd:	
	Length	Width	Void Ratio	
	91.0000 ft	90.0000 ft	100.00	

Control Structure ID: COMBO - Combination Control Structure

Descrip:	COMBO STRUCTURE	
Start El	Max El	Increment
131.2000 ft	140.0000 ft	0.10
ID List:	ORIFICE	RISER
Split:	Split OutHyd into component hydrographs.	

Control Structure ID: ORIFICE - Multiple Orifice Structure

Descrip:	Multiple Orifice				
Start El	Max El	Increment			
131.2000 ft	140.0000 ft	0.10			
Orif Coeff:	0.62		Bottom El:	129.20 ft	
			Lowest Diam:	0.5625 in	

Control Structure ID: RISER - Overflow riser

Descrip:	RISER				
Start El	Max El	Increment			
135.6500 ft	140.0000 ft	0.10			
Riser Dia:	12.00 in	Orif Coeff:	3.78	Weir Coeff:	9.74

Summary Report of all RLPool Data

HYDLIST SUMMARY

[2YR MATCH] [10YR MATCH] [100YR MATCH] [2YR MATCH] [F-2YR OUT] [F-10YR OUT] [F-100YR OUT] [F-6 MONTHOUT] [2 yr-ORIFICE-OutHyd] [10 yr-ORIFICE-OutHyd] [100 yr-ORIFICE-OutHyd] [6 MONTH-ORIFICE-OutHyd]
[2 yr-RISER-OutHyd] [10 yr-RISER-OutHyd] [100 yr-RISER-OutHyd] [6 MONTH-RISER-OutHyd]

LSTEND

HydID	Peak Q (cfs)	Peak T (hrs)	Peak Vol (ac-ft)	Cont Area (ac)
2YR MATCH	0.02	9.17	0.0161	0.0000
10YR MATCH	0.57	8.67	0.4593	0.0000
100YR MATCH	1.27	8.50	0.8959	0.0000
2YR MATCH	0.02	9.17	0.0161	0.0000
F-2YR OUT	0.01	24.33	0.0257	6.4700
F-10YR OUT	0.10	24.17	0.0425	6.4700
F-100YR OUT	0.77	15.50	0.6211	6.4700
F-6 MONTHOUT	0.01	24.33	0.0192	6.4700
2 yr-ORIFICE-OutHyd	0.01	24.33	0.0257	6.4700
10 yr-ORIFICE-OutHyd	0.02	24.17	0.0331	5.0464
100 yr-ORIFICE-OutHyd	0.02	15.50	0.0367	0.3827
6 MONTH-ORIFICE-OutHyd	0.01	24.33	0.0192	6.4700
2 yr-RISER-OutHyd	0.00	0.00	0.0000	0.0000
10 yr-RISER-OutHyd	0.09	24.17	0.0093	1.4236
100 yr-RISER-OutHyd	0.75	15.50	0.5844	6.0873
6 MONTH-RISER-OutHyd	0.00	0.00	0.0000	0.0000

Node ID: F-VAULT

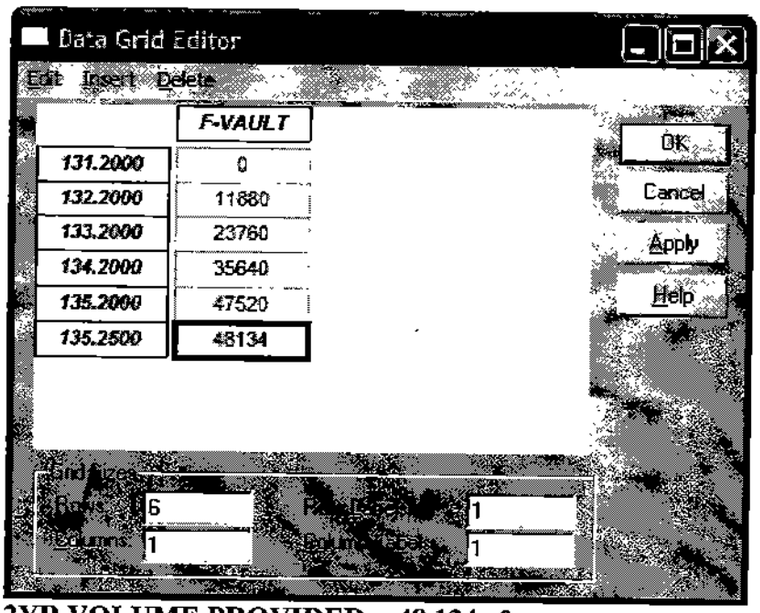
Desc:	VAULT W/1.45 VCF			
Start El:	131.2000 ft		Max El:	140.0000 ft
Contrib Basin:			Contrib Hyd:	
	Length	Width	Void Ratio	
	132.0000 ft	90.0000 ft	100.00	

DISCHLIST

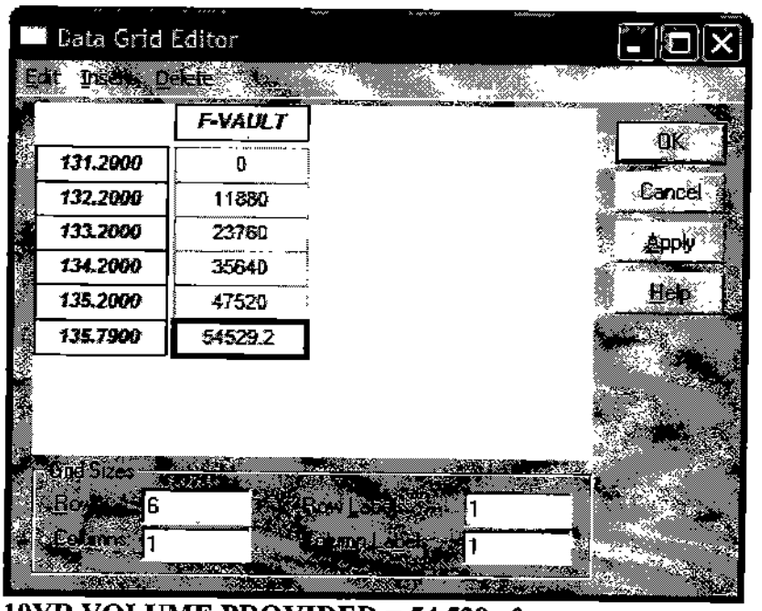
[COMBO] [ORIFICE] [RISER]

LSTEND

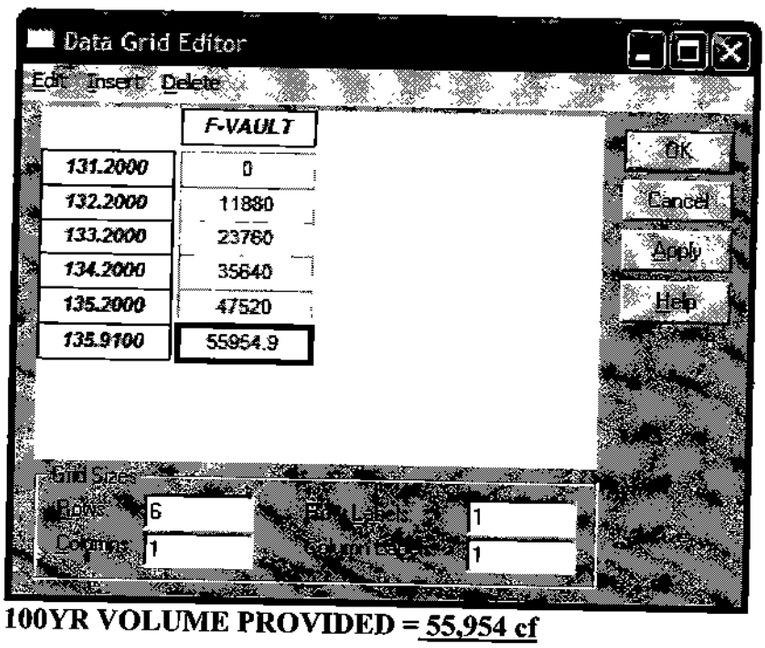
DETENTION VOLUME PROVIDED:



2YR VOLUME PROVIDED = 48,134 cf



10YR VOLUME PROVIDED = 54,529 cf



100YR VOLUME PROVIDED = 55,954 cf

SOUTH BASIN ANALYSIS:

Event Summary:

BasinID	Peak Q (cfs)	Peak T (hrs)	Peak Vol (ac-ft)	Area ac	Method /Loss	Raintype	Event
EXISTING B	0.16	8.00	0.0674	1.02	SBUH/SCS	TYPE1A	2 yr
EXISTING B	0.32	8.00	0.1258	1.02	SBUH/SCS	TYPE1A	10 yr
EXISTING B	0.55	8.00	0.2051	1.02	SBUH/SCS	TYPE1A	100 yr
ADJUSTED B	0.15	8.00	0.0655	1.06	SBUH/SCS	TYPE1A	2 yr
ADJUSTED B	0.32	8.00	0.1260	1.06	SBUH/SCS	TYPE1A	10 yr
ADJUSTED B	0.56	8.00	0.2084	1.06	SBUH/SCS	TYPE1A	100 yr

Drainage Area: EXISTING B

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	CN	TC	
Pervious	0.7300 ac	81.00	0.17 hrs	
Impervious	0.2900 ac	98.00	0.08 hrs	
Total	1.0200 ac			

Supporting Data:

Pervious CN Data:

2ND AND 3RD GROWTH FOREST	81.00	0.7300 ac

Impervious CN Data:

EXISTING ASPHALT IN SR531	98.00	0.2900 ac

Pervious TC Data:

Flow type:	Description:	Length:	Slope:	Coeff:	Travel Time
Fixed	TC	0.00 ft	0.00%	10.0000	10.00 min

Impervious TC Data:

Flow type:	Description:	Length:	Slope:	Coeff:	Travel Time
Fixed	TC	0.00 ft	0.00%	5.0000	5.00 min

Drainage Area: ADJUSTED B

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	CN	TC	
Pervious	0.8500 ac	82.35	0.17 hrs	
Impervious	0.2100 ac	98.00	0.08 hrs	
Total	1.0600 ac			

Supporting Data:

Pervious CN Data:

2ND AND 3RD GROWTH FOREST	81.00	0.6200 ac
LAWN AND LANDSCAPE	86.00	0.2300 ac

Impervious CN Data:

ADJUSTED ASPHALT AREA	98.00	0.1000 ac
EX ASPHALT	98.00	0.1100 ac

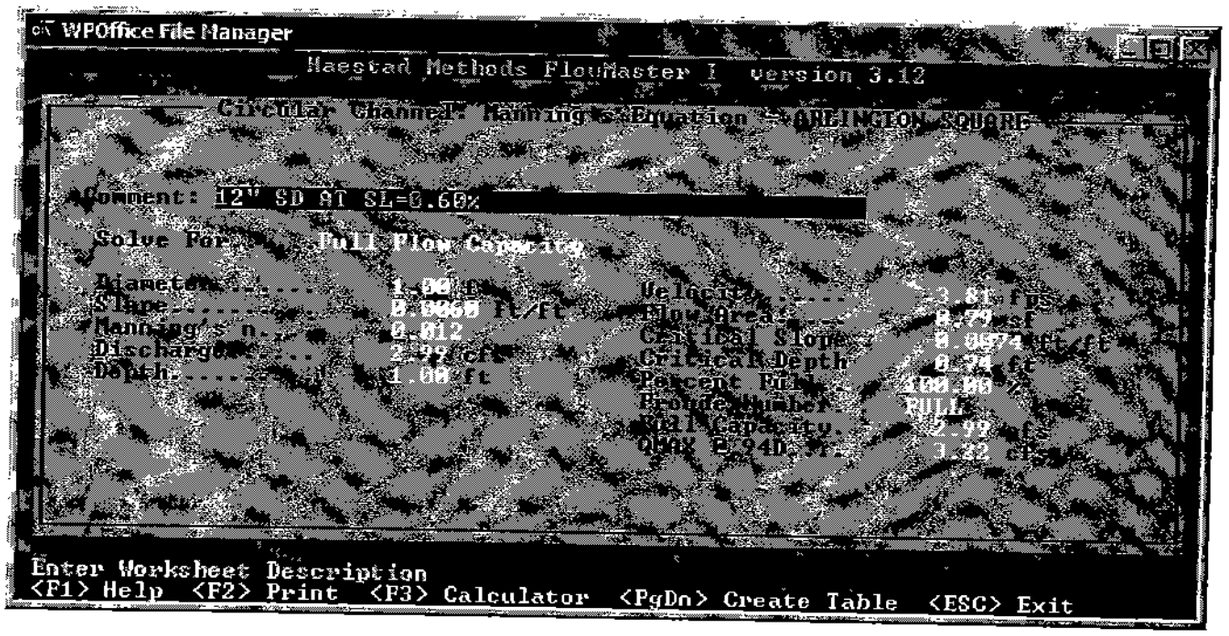
Pervious TC Data:

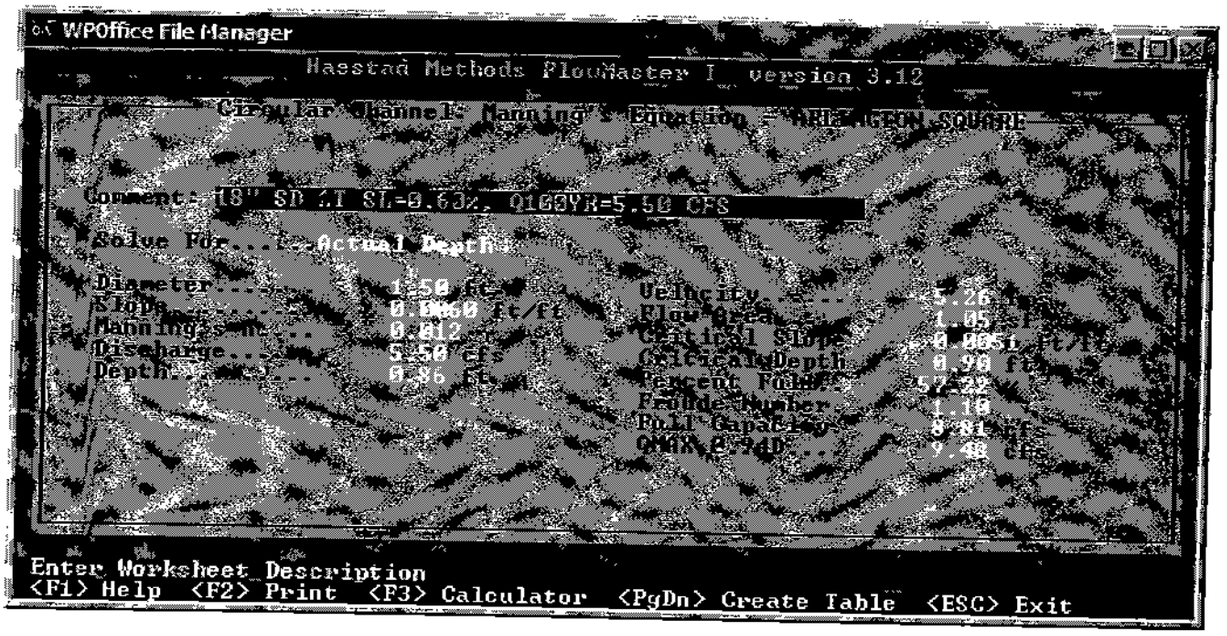
Flow type:	Description:	Length:	Slope:	Coeff:	Travel Time
Fixed	TC	0.00 ft	0.00%	10.0000	10.00 min

Impervious TC Data:

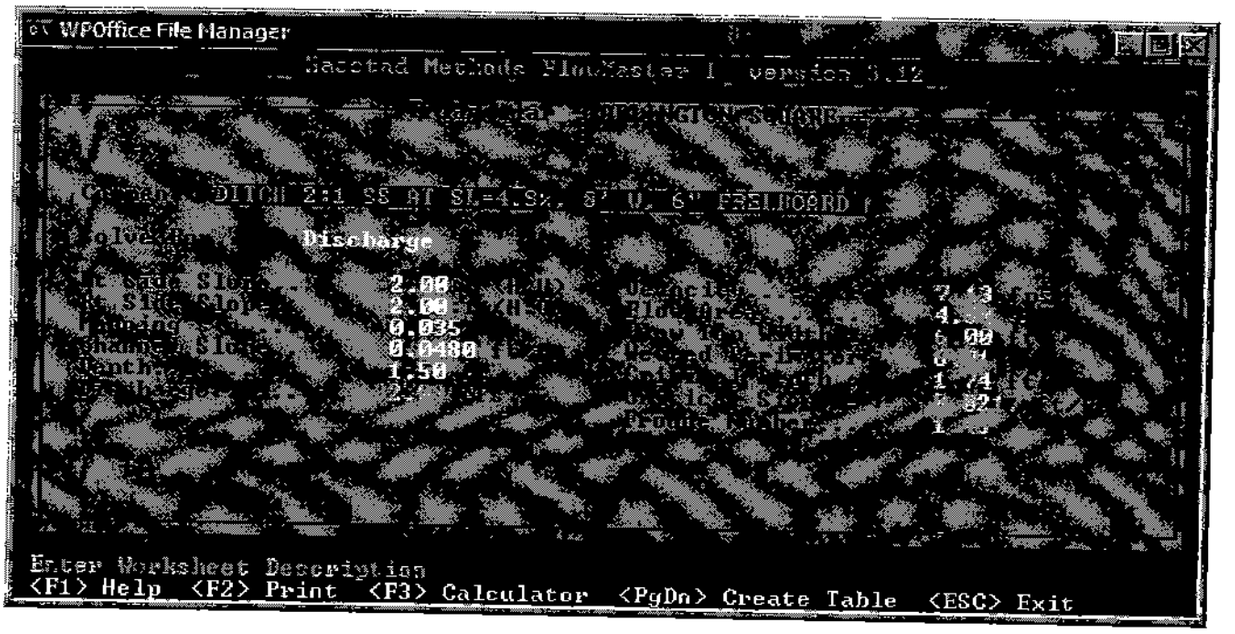
Flow type:	Description:	Length:	Slope:	Coeff:	Travel Time
Fixed	TC	0.00 ft	0.00%	5.0000	5.00 min

CONVEYANCE ANALYSIS:



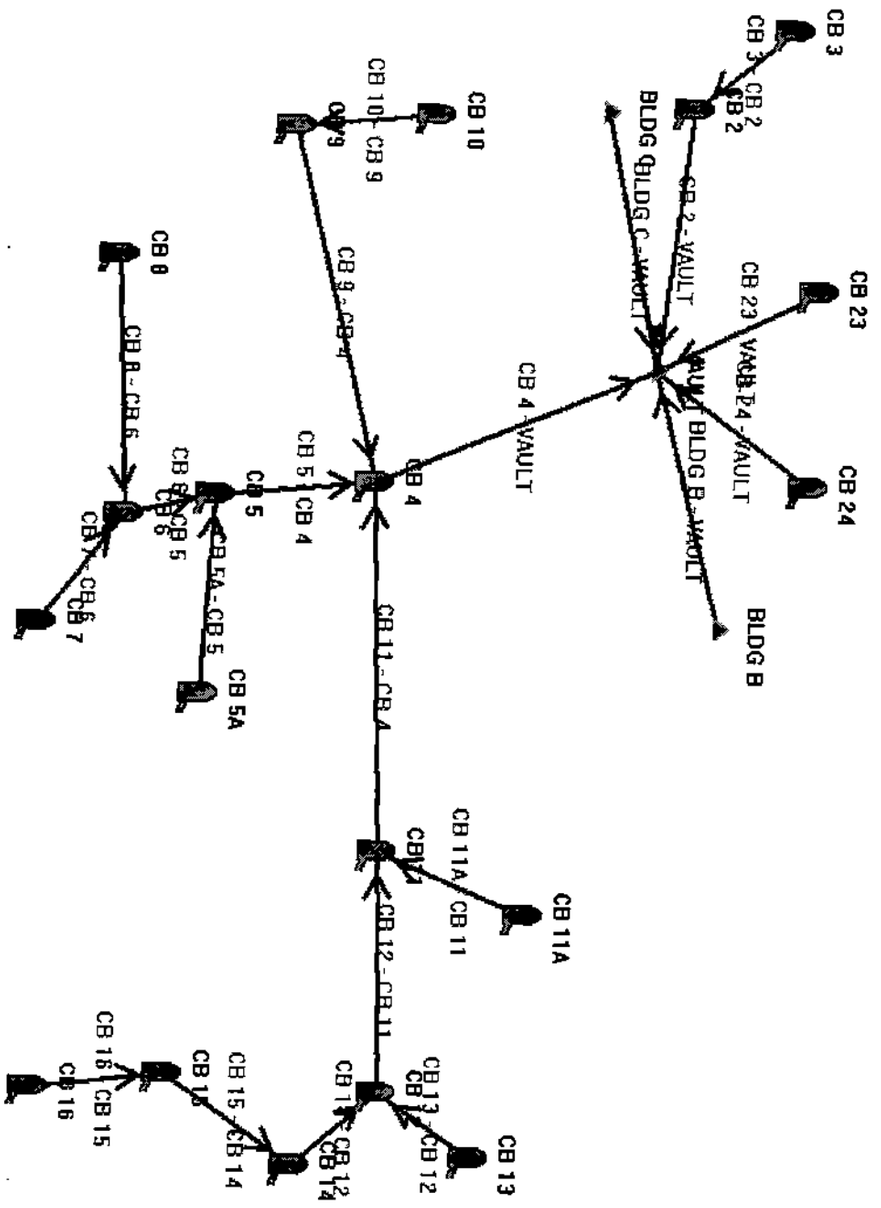


ROADSIDE DITCH, 172nd ST NE:



BACKWATER ANALYSIS

LAYOUT



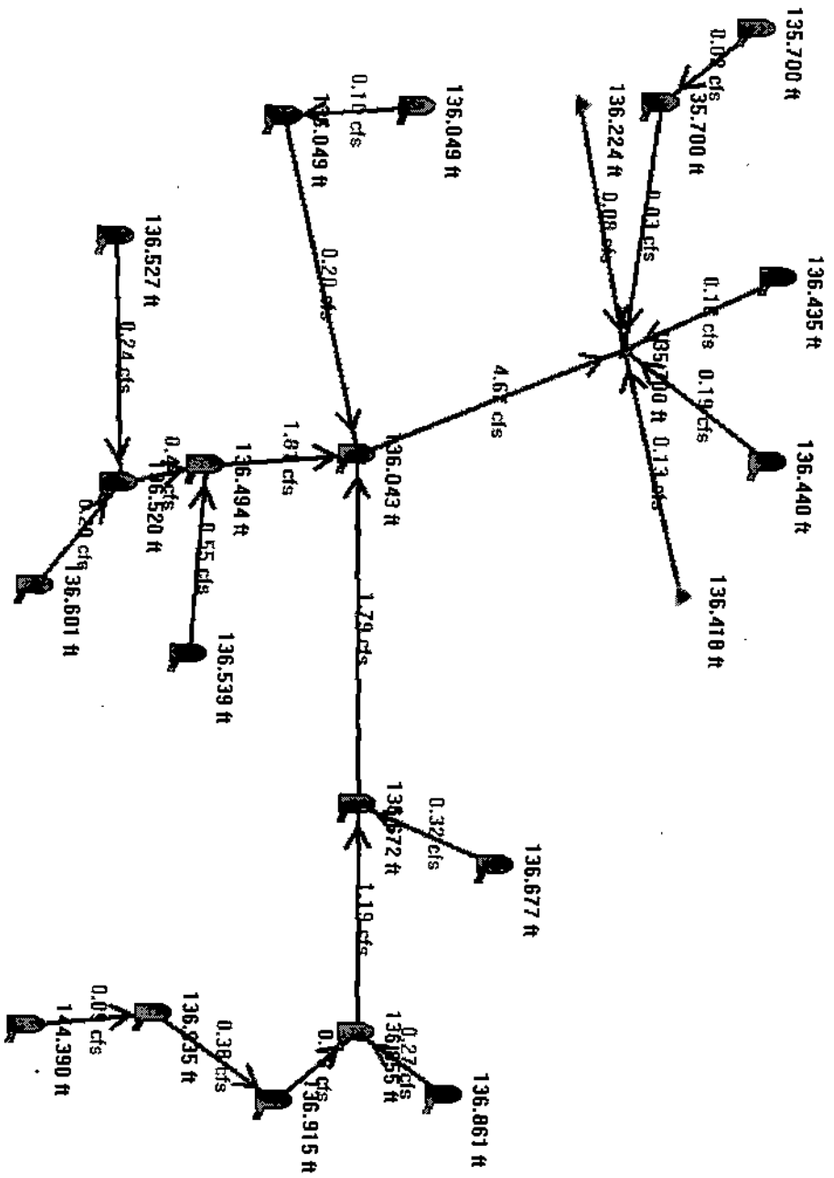
100 YR STORM EVENT

BLDG B - VAULT: 8" Diam 0.13 cfs @ 2.0000%
CB 24 - VAULT: 12" Diam 0.19 cfs @ 100.0000%
CB 23 - VAULT: 12" Diam 0.18 cfs @ 100.0000%
CB 11A - CB 11: 12" Diam 0.32 cfs @ 5.0000%
CB 13 - CB 12: 12" Diam 0.27 cfs @ 2.0000%
CB 16 - CB 15: 12" Diam 0.09 cfs @ 10.9000%
CB 15 - CB 14: 12" Diam 0.38 cfs @ 0.6000%
CB 14 - CB 12: 12" Diam 0.78 cfs @ 0.6000%
CB 12 - CB 11: 12" Diam 1.19 cfs @ 0.6000%
CB 11 - CB 4: 12" Diam 1.79 cfs @ 0.5000%
CB 5A - CB 5: 12" Diam 0.55 cfs @ 0.6000%
CB 8 - CB 6: 12" Diam 0.24 cfs @ 0.6000%
CB 7 - CB 6: 12" Diam 0.20 cfs @ 4.0000%
CB 6 - CB 5: 12" Diam 0.44 cfs @ 0.6000%
CB 5 - CB 4: 12" Diam 1.81 cfs @ 0.6000%
CB 10 - CB 9: 12" Diam 0.10 cfs @ 0.6000%
CB 9 - CB 4: 12" Diam 0.20 cfs @ 1.0000%
CB 4 - VAULT: 18" Diam 4.67 cfs @ 0.6000%
BLDG C - VAULT: 8" Diam 0.08 cfs @ 2.0000%
CB 3 - CB 2: 12" Diam 0.02 cfs @ 0.6000%
CB 2 - VAULT: 12" Diam 0.03 cfs @ 0.6000%

ROUTEHYD [] THRU [DEV] 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	----------
BLDG B - VAULT	0.1500	0.1301	1.8564	0.07	0.1195	8" Diam	3.0648	5.3180	BLDG B
CB 24 - VAULT	0.2230	0.1875	38.7009	0.00	0.0503	12" Diam	12.6598	49.2756	CB 24
CB 23 - VAULT	0.2140	0.1813	38.7009	0.00	0.0493	12" Diam	12.6059	49.2756	CB 23
CB 11A - CB 11	0.3720	0.3167	8.6538	0.04	0.1308	12" Diam	5.2320	11.0183	CB 11A
CB 13 - CB 12	0.3630	0.2680	5.4731	0.05	0.1505	12" Diam	3.6092	6.9686	CB 13
CB 16 - CB 15	0.1100	0.0888	12.7772	0.01	0.0596	12" Diam	4.6653	16.2684	CB 16
CB 15 - CB 14	0.4930	0.3804	2.9978	0.13	0.2405	12" Diam	2.6160	3.8169	CB 15
CB 14 - CB 12	1.0120	0.7810	2.9978	0.26	0.3483	12" Diam	3.2093	3.8169	CB 14
CB 12 - CB 11	1.5390	1.1912	2.9978	0.40	0.4382	12" Diam	3.5979	3.8169	CB 12
CB 11 - CB 4	2.2460	1.7926	2.7366	0.66	0.5902	12" Diam	3.7158	3.4843	CB 11
CB 5A - CB 5	0.6940	0.5498	2.9978	0.18	0.2900	12" Diam	2.9076	3.8169	CB 5A
CB 8 - CB 6	0.2730	0.2365	2.9978	0.08	0.1899	12" Diam	2.2769	3.8169	CB 8
CB 7 - CB 6	0.2360	0.2047	7.7402	0.03	0.1119	12" Diam	4.2450	9.8551	CB 7
CB 6 - CB 5	0.5090	0.4412	2.9978	0.15	0.2592	12" Diam	2.7305	3.8169	
CB 5 - CB 4	2.1740	1.8074	2.9978	0.60	0.5600	12" Diam	3.9941	3.8169	CB 5
CB 10 - CB 9	0.1210	0.1033	2.9978	0.03	0.1271	12" Diam	1.7798	3.8169	CB 10
CB 9 - CB 4	0.2390	0.2040	3.8701	0.05	0.1560	12" Diam	2.6088	4.9276	CB 9
CB 4 - VAULT	5.6660	4.6672	8.8384	0.53	0.7747	18" Diam	5.0697	5.0015	CB 4
BLDG C - VAULT	0.0890	0.0772	1.8564	0.04	0.0928	8" Diam	2.6218	5.3180	BLDG C
CB 3 - CB 2	0.0190	0.0165	2.9978	0.01	0.0532	12" Diam	1.0232	3.8169	CB 3
CB 2 - VAULT	0.0360	0.0330	2.9978	0.01	0.0737	12" Diam	1.2631	3.8169	CB 2

From Node	To Node	Rch Loss ft	App Head ft	Bend Loss ft	Junct Loss ft	HW Elev ft	Max El/ Rim El ft
	VAULT					135.7000	
BLDG B	VAULT	136.4178	--na--	--na--	--na--	136.4178	139.3000
CB 24	VAULT	136.4395				136.4395	138.7000
CB 23	VAULT	136.4354				136.4354	138.7000
CB 4	VAULT	136.0431				136.0431	137.3100
CB 11	CB 4	136.7007	0.0357	0.0002	0.0070	136.6722	136.8900
CB 11A	CB 11	136.6769				136.6769	137.5400
CB 12	CB 11	136.8593	0.0154	0.0072	0.0038	136.8549	138.5500
CB 13	CB 12	136.8608				136.8608	137.6800
CB 14	CB 12	136.9154	0.0036	0.0036		136.9153	137.5800
CB 15	CB 14	136.9354	0.0002	0.0001		136.9352	137.5800
CB 16	CB 15	144.3896				144.3896	149.2100
CB 5	CB 4	136.4892	0.0076	0.0084	0.0036	136.4936	137.1200
CB 5A	CB 5	136.5387				136.5387	137.5200
CB 6	CB 5	136.5187	0.0014	0.0023	0.0007	136.5203	141.2200
CB 8	CB 6	136.5273				136.5273	137.7200
CB 7	CB 6	136.6007				136.6007	140.3800
CB 9	CB 4	136.0485	0.0003	0.0004		136.0487	136.2000
CB 10	CB 9	136.0494				136.0494	136.2000
BLDG C	VAULT	136.2239	--na--	--na--	--na--	136.2239	139.9500
CB 2	VAULT	135.7001	0.0000	0.0000		135.7001	136.2000
CB 3	CB 2	135.7001				135.7001	136.2000



100 yr Backwater Elevation within Drainage Structures

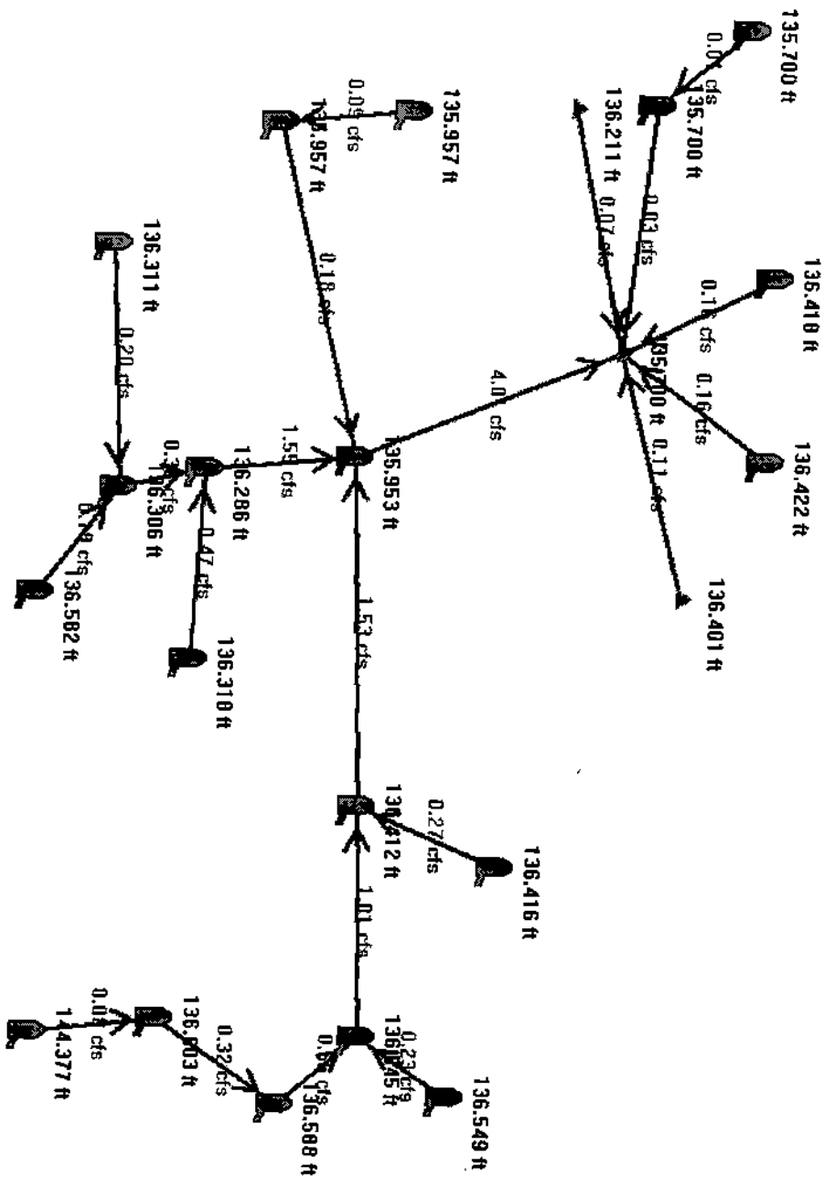
25 YR STORM EVENT

BLDG B - VAULT: 8" Diam 0.11 cfs @ 2.0000%
CB 24 - VAULT: 12" Diam 0.16 cfs @ 100.0000%
CB 23 - VAULT: 12" Diam 0.16 cfs @ 100.0000%
CB 11A - CB 11: 12" Diam 0.27 cfs @ 5.0000%
CB 13 - CB 12: 12" Diam 0.23 cfs @ 2.0000%
CB 16 - CB 15: 12" Diam 0.08 cfs @ 10.9000%
CB 15 - CB 14: 12" Diam 0.32 cfs @ 0.6000%
CB 14 - CB 12: 12" Diam 0.66 cfs @ 0.6000%
CB 12 - CB 11: 12" Diam 1.01 cfs @ 0.6000%
CB 11 - CB 4: 12" Diam 1.53 cfs @ 0.5000%
CB 5A - CB 5: 12" Diam 0.47 cfs @ 0.6000%
CB 8 - CB 6: 12" Diam 0.20 cfs @ 0.6000%
CB 7 - CB 6: 12" Diam 0.18 cfs @ 4.0000%
CB 6 - CB 5: 12" Diam 0.38 cfs @ 0.6000%
CB 5 - CB 4: 12" Diam 1.55 cfs @ 0.6000%
CB 10 - CB 9: 12" Diam 0.09 cfs @ 0.6000%
CB 9 - CB 4: 12" Diam 0.18 cfs @ 1.0000%
CB 4 - VAULT: 18" Diam 4.01 cfs @ 0.6000%
BLDG C - VAULT: 8" Diam 0.07 cfs @ 2.0000%
CB 3 - CB 2: 12" Diam 0.01 cfs @ 0.6000%
CB 2 - VAULT: 12" Diam 0.03 cfs @ 0.6000%

ROUTEHYD [] THRU [DEV] USING TYPE1A AND [25 yr] NOTZERO RELATIVE

Reach	Area	Flow	Full Q	% Full	nDepth	Size	nVel	fVel	CBasin / Hyd
----	ac	cfs	cfs	ratio	ft	----	ft/s	ft/s	----------
BLDG B - VAULT	0.1500	0.1125	1.8564	0.06	0.1113	8" Diam	2.9329	5.3180	BLDG B
CB 24 - VAULT	0.2230	0.1614	38.7009	0.00	0.0469	12" Diam	12.0984	49.2756	CB 24
CB 23 - VAULT	0.2140	0.1563	38.7009	0.00	0.0461	12" Diam	11.9910	49.2756	CB 23
CB 11A - CB 11	0.3720	0.2731	8.6538	0.03	0.1218	12" Diam	5.0042	11.0183	CB 11A
CB 13 - CB 12	0.3630	0.2263	5.4731	0.04	0.1387	12" Diam	3.4328	6.9686	CB 13
CB 16 - CB 15	0.1100	0.0760	12.7772	0.01	0.0552	12" Diam	4.4735	16.2684	CB 16
CB 15 - CB 14	0.4930	0.3234	2.9978	0.11	0.2218	12" Diam	2.4954	3.8169	CB 15
CB 14 - CB 12	1.0120	0.6641	2.9978	0.22	0.3198	12" Diam	3.0673	3.8169	CB 14
CB 12 - CB 11	1.5390	1.0133	2.9978	0.34	0.4007	12" Diam	3.4464	3.8169	CB 12
CB 11 - CB 4	2.2460	1.5318	2.7366	0.56	0.5349	12" Diam	3.5822	3.4843	CB 11
CB 5A - CB 5	0.6940	0.4693	2.9978	0.16	0.2675	12" Diam	2.7791	3.8169	CB 5A
CB 8 - CB 6	0.2730	0.2044	2.9978	0.07	0.1769	12" Diam	2.1801	3.8169	CB 8
CB 7 - CB 6	0.2360	0.1770	7.7402	0.02	0.1044	12" Diam	4.0659	9.8551	CB 7
CB 6 - CB 5	0.5090	0.3813	2.9978	0.13	0.2408	12" Diam	2.6179	3.8169	
CB 5 - CB 4	2.1740	1.5535	2.9978	0.52	0.5107	12" Diam	3.8511	3.8169	CB 5
CB 10 - CB 9	0.1210	0.0891	2.9978	0.03	0.1184	12" Diam	1.7021	3.8169	CB 10
CB 9 - CB 4	0.2390	0.1760	3.8701	0.05	0.1453	12" Diam	2.4956	4.9276	CB 9
CB 4 - VAULT	5.6660	4.0063	8.8384	0.45	0.7084	18" Diam	4.8788	5.0015	CB 4
BLDG C - VAULT	0.0890	0.0667	1.8564	0.04	0.0864	8" Diam	2.5127	5.3180	BLDG C
CB 3 - CB 2	0.0190	0.0142	2.9978	0.00	0.0498	12" Diam	0.9760	3.8169	CB 3
CB 2 - VAULT	0.0380	0.0285	2.9978	0.01	0.0688	12" Diam	1.2082	3.8169	CB 2

From Node	To Node	Rch Loss ft	App Head ft	Bend Loss ft	Junct Loss ft	HW Elev ft	Max El/ Rim El ft
	VAULT					135.7000	
BLDG B	VAULT	136.4011	–na–	–na–	–na–	136.4011	139.3000
CB 24	VAULT	136.4216	——	——	——	136.4216	138.7000
CB 23	VAULT	136.4180	——	——	——	136.4180	138.7000
CB 4	VAULT	135.9528	——	——	——	135.9528	137.3100
CB 11	CB 4	136.4330	0.0258	0.0001	0.0052	136.4124	136.8900
CB 11A	CB 11	136.4159	——	——	——	136.4159	137.5400
CB 12	CB 11	136.5478	0.0111	0.0052	0.0027	136.5446	138.5500
CB 13	CB 12	136.5489	——	——	——	136.5489	137.6800
CB 14	CB 12	136.5884	0.0026	0.0026	——	136.5883	137.5800
CB 15	CB 14	136.6028	0.0001	0.0001	——	136.6027	137.5800
CB 16	CB 15	144.3771	——	——	——	144.3771	149.2100
CB 5	CB 4	136.2823	0.0055	0.0061	0.0027	136.2856	137.1200
CB 5A	CB 5	136.3185	——	——	——	136.3185	137.5200
CB 6	CB 5	136.3043	0.0011	0.0017	0.0005	136.3055	141.2200
CB 8	CB 6	136.3108	——	——	——	136.3108	137.7200
CB 7	CB 6	136.5825	——	——	——	136.5825	140.3800
CB 9	CB 4	135.9568	0.0002	0.0003	——	135.9569	136.2000
CB 10	CB 9	135.9575	——	——	——	135.9575	136.2000
BLDG C	VAULT	136.2114	–na–	–na–	–na–	136.2114	139.9500
CB 2	VAULT	135.7001	0.0000	0.0000	——	135.7001	136.2000
CB 3	CB 2	135.7001	——	——	——	135.7001	136.2000



25 yr Backwater Elevation within Drainage Structures

DOWNSTREAM CONVEYANCE ANALYSIS:

PRE SITE Event Summary:

BasinID	Peak Q	Peak T	Peak Vol	Area	Method	Raintype	Event
----	(cfs)	(hrs)	(ac-ft)	ac	/Loss		
PRE SITE	2.79	14.50	3.9336	98.00	SBUH/SCS	TYPE1A	2 yr
PRE SITE	7.06	10.17	8.8801	98.00	SBUH/SCS	TYPE1A	10 yr
PRE SITE	14.07	9.50	15.9615	98.00	SBUH/SCS	TYPE1A	100 yr

Drainage Area: PRE SITE

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	CN	TC	
Pervious	98.0000 ac	81.00	2.66 hrs	
Impervious	0.0000 ac	98.00	0.00 hrs	
Total	98.0000 ac			

Supporting Data:

Pervious CN Data:

2ND AND 3RD GROWTH FOREST 81.00 98.0000 ac

Pervious TC Data:

Flow type:	Description:	Length:	Slope:	Coeff:	Travel Time
Sheet	TC	300.00 ft	0.50%	0.4000	120.05 min
Shallow	TC	750.00 ft	6.00%	3.0000	17.01 min
Shallow	TC	1000.00 ft	8.00%	5.0000	11.79 min
Channel	TC	600.00 ft	3.40%	5.0000	10.85 min

OFFSITE Event Summary:

BasinID	Peak Q	Peak T	Peak Vol	Area	Method	Raintype	Event
-------	(cfs)	(hrs)	(ac-ft)	ac	/Loss		
OFFSITE	2.59	14.50	3.6527	91.00	SBUH/SCS	TYPE1A	2 yr
OFFSITE	6.56	10.17	8.2458	91.00	SBUH/SCS	TYPE1A	10 yr
OFFSITE	13.06	9.50	14.8214	91.00	SBUH/SCS	TYPE1A	100 yr

Drainage Area: OFFSITE

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	CN	TC	
Pervious	91.0000 ac	81.00	2.66 hrs	
Impervious	0.0000 ac	98.00	0.00 hrs	
Total	91.0000 ac			

Supporting Data:

Pervious CN Data:

2ND AND 3RD GROWTH FOREST 81.00 91.0000 ac

Pervious TC Data:

Flow type:	Description:	Length:	Slope:	Coeff:	Travel Time
Sheet	TC	300.00 ft	0.50%	0.4000	120.05 min
Shallow	TC	750.00 ft	6.00%	3.0000	17.01 min
Shallow	TC	1000.00 ft	8.00%	5.0000	11.79 min
Channel	TC	600.00 ft	3.40%	5.0000	10.85 min

ON & OFF SITE HYDROGRAPH ANALYSIS:

ADDHYD [OFFSITE] AS [2 yr] [F-2YR OUT] AS [2 yr] TO [OFFSITE + F-2YR OUT]
Peak Flow: 2.6086 cfs Peak Time: 14.50 hrs Hyd Vol: 160489.64 cf - 3.6843 acft

ADDHYD [OFFSITE] AS [10 yr] [F-10YR OUT] AS [10 yr] TO [OFFSITE + F-10YR OUT]
Peak Flow: 6.5716 cfs Peak Time: 10.17 hrs Hyd Vol: 363999.32 cf - 8.3563 acft

ADDHYD [OFFSITE] AS [100 yr] [F-100YR OUT] AS [100 yr] TO [OFFSITE + F-100YR OUT]
Peak Flow: 13.0800 cfs Peak Time: 9.50 hrs Hyd Vol: 675695.54 cf - 15.5118 acft

PEAK FLOW AND VOLUME COMPARISON OF ON & OFFSITE BASIN "A"

STORM EVENT	PRE SITE DEVELOPMENT	POST SITE DEVELOPMENT
2 YR	2.79 cfs / 3.93 ac ft	2.61 cfs / 3.68 ac ft
10 YR	7.06 cfs / 8.88 ac ft	6.57 cfs / 8.34 ac ft
100 YR	14.07 cfs / 15.96 ac ft	13.08 cfs / 15.51 ac ft

WETLAND "X" DRAINAGE ANALYSIS:

Event Summary:

BasinID	Peak Q (cfs)	Peak T (hrs)	Peak Vol (ac-ft)	Area ac	Method /Loss	Raintype	Event
PRE WETLAND X	0.13	8.67	0.1164	2.90	SBUH/SCS	TYPE1A	2 yr
PRE WETLAND X	0.39	8.17	0.2628	2.90	SBUH/SCS	TYPE1A	10 yr
PRE WETLAND X	0.81	8.17	0.4723	2.90	SBUH/SCS	TYPE1A	100 yr
POST WETLAND X	0.25	8.00	0.1250	1.91	SBUH/SCS	TYPE1A	2 yr
POST WETLAND X	0.49	8.00	0.2341	1.91	SBUH/SCS	TYPE1A	10 yr
POST WETLAND X	0.81	8.00	0.3822	1.91	SBUH/SCS	TYPE1A	100 yr

Drainage Area: PRE WETLAND X

Hyd Method: SBUH Hyd
Peak Factor: 484.00
Storm Dur: 24.00 hrs

Loss Method: SCS CN Number
SCS Abs: 0.20
Intv: 10.00 min

	Area	CN	TC
Pervious	2.9000 ac	81.00	0.61 hrs
Impervious	0.0000 ac	98.00	0.00 hrs
Total	2.9000 ac		

Supporting Data:
Pervious CN Data:
2ND AND 3RD GROWTH FOREST 81.00 2.9000 ac
Pervious TC Data:

Flow type:	Description:	Length:	Slope:	Coeff:	Travel Time
Sheet	TC	300.00 ft	5.10%	0.2400	31.51 min
Shallow	TC	410.00 ft	2.00%	9.0000	5.37 min

Drainage Area: POST WETLAND X

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	CN	TC	
Pervious	1.3800 ac	81.00	0.61 hrs	
Impervious	0.5300 ac	98.00	0.08 hrs	
Total	1.9100 ac			

Supporting Data:

Pervious CN Data:

2ND AND 3RD GROWTH FOREST	81.00	1.3800 ac

Impervious CN Data:

BUILDING B	98.00	0.5300 ac

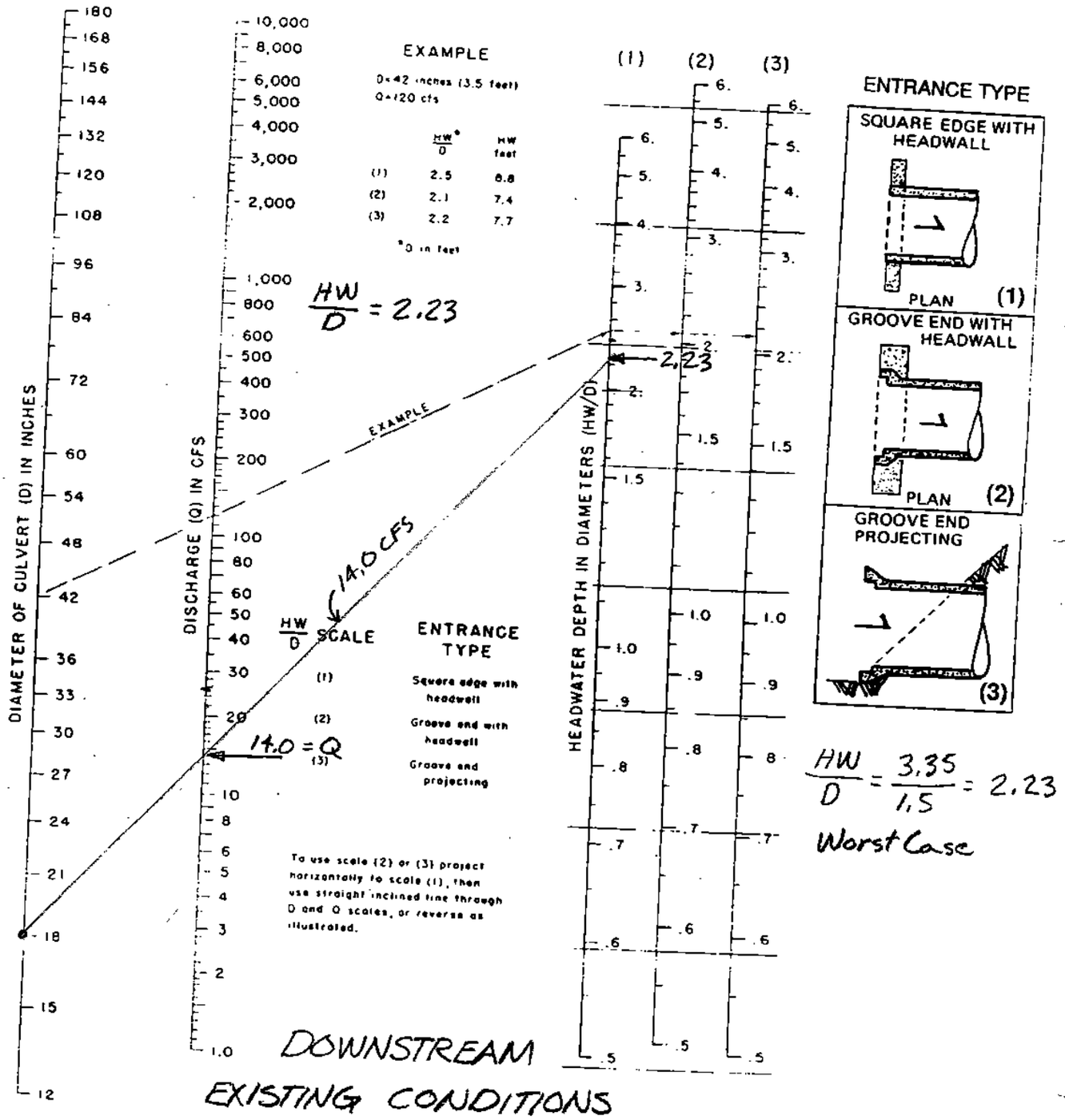
Pervious TC Data:

Flow type:	Description:	Length:	Slope:	Coeff:	Travel Time
Sheet	TC	300.00 ft	5.10%	0.2400	31.51 min
Shallow	TC	410.00 ft	2.00%	9.0000	5.37 min

Impervious TC Data:

Flow type:	Description:	Length:	Slope:	Coeff:	Travel Time
Fixed	TC	0.00 ft	0.00%	5.0000	5.00 min

Figure III-2.14 - Headwater Depth for Smooth Interior Pipe Culverts With Inlet Control



Size and Cost Estimate

Prepared by Kathryn Thomason on October 24, 2007

Arlington Square – Stormwater Treatment System

Arlington, WA

Information provided:

- Total contributing area = 6.68 acre
- Impervious area = 5.785 acre
- Detention release rate, Q_{treat} = 0.036 cfs
- Presiding agency = City of Arlington, WA

Assumptions:

- Media = Perlite cartridges
- Per cartridge flow rate = 4.9 gpm
- Drop required from inlet to outlet = 1.4' minimum

Size and cost estimates:

The MFS is a flow-based system, and therefore, is sized by calculating the peak water quality flow rate associated with the design storm. However, when the MFS is placed downstream of detention the flow rate generated at the water quality storm is not always representative of the total volume of water that will go through the system or type of pollutant-loading the system may experience in one year.

For this site, CONTECH Stormwater Solutions Inc. recommends using an 8'x16' precast MFS with 22 cartridges (see attached detail). The estimated cost of this system is $48,000, complete and delivered to the job site. This estimate assumes that the vault is 6 feet deep. The final system cost will depend on the actual depth of the unit and whether extras like doors rather than castings are specified. The contractor is responsible for setting the MFS and all external plumbing.

The 8'x16' precast MFS have an internal bypass capacity of 5.0 cfs. If the peak discharge off the site is expected to exceed this rate, we recommend placing a high-flow bypass upstream of the MFS system. CONTECH Stormwater Solutions could provide our high-flow bypass, the StormGate, which provides a combination weir-orifice control structure to limit the flow to the MFS. The estimated cost of this structure is $4,500. The final cost would depend on the actual depth and size of the unit.

12021-B NE Airport Way, Portland OR 97220
Toll-free: 800.548.4667 Fax: 800.561.1271

CONTECH STORMWATER SOLUTIONS INC.

Determining Number of Cartridges for Systems Downstream of Detention

CONTECH Stormwater Solutions Inc. Engineer:	KET	Blue Cells = Input
Date	10/24/2007	Black Cells = Calculation

Site Information

Project Name	Arlington Square
Project State	Washington
Project Location	Arlington
Drainage Area, Ad	6.68 ac
Impervious Area, Ai	5.79 ac
Pervious Area, Ap	0.90
% Impervious	87%
Runoff Coefficient, Rc	0.83

Upstream Detention System

Peak release rate from detention, $Q_{release\ peak}$	1.59 cfs
Treatment release rate from detention, $Q_{release\ treat}$	0.04 cfs
Detention pretreatment credit (from removal efficiency calcs)	60%

Mass loading calculations

Mean Annual Rainfall, P	38 in
Agency required % removal	80%
Percent Runoff Capture	90%
Mean Annual Runoff, V_t	687,831 ft^3
Event Mean Concentration of Pollutant, EMC	60 mg/l
Annual Mass Load, M_{total}	2574.83 lbs

Filter System

Filtration brand	MFS
Cartridge height	12 in
Specific Flow Rate	1.0 gpm/ft^2

Number of cartridges - mass loading

Mass removed by pretreatment system, M_{pre}	1544.90 lbs
Mass load to filters after pretreatment, M_{pass1}	1029.93 lbs
Estimate the required filter efficiency, E_{filter}	0.50
Mass to be captured by filters, M_{filter}	514.97 lbs
Allowable Cartridge Flow rate, Q_{cart}	4.91
Mass load per cartridge, M_{cart} (lbs)	24.00 lbs
Number of Cartridges required, N_{mass}	22
Treatment Capacity	0.24 cfs

Determine Critical Sizing Value

Number of Cartridges using $Q_{release\ treat}$, N_{flow}	4

Method to Use: **MASS-LOADING**

SUMMARY

Treatment Flow Rate, cfs	0.24
Cartridge Flow Rate, gpm	4.9
Number of Cartridges	22

SECTION III
OPERATIONS & MAINTENANCE MANUAL

OPERATION & MAINTENANCE MANUAL

Table of Contents

CATCH BASINS/MANHOLES

Maintenance Component	Defect	Conditions When Maintenance is Needed	Desired Conditions
General	Trash & debris (includes sediment)	Trash or debris of more than ½ ft^3 which is located immediately in front of the catch basin opening or is blocking capacity of the 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 of its height.	Inlet and outlet pipes free of trash or debris.
		Dead animals or vegetation that could generate odors that could cause complaints or dangerous gases (i.e. methane).	No dead animals or vegetation present within the catch basin.
		Deposits of garbage exceeding 1 ft^3 in volume.	No condition present which would attract or support the breeding of insects or rodents.
		Trash, debris, or sediment in the basin that exceeds 60% of the sump depth, or trash, debris, or sediment that is within 6" of the invert of the lowest pipe	No trash, debris or sediment within the catch basin
	Structure Damage to Frame and/or top slab	Corner of frame extends more than ¾" past curb face into the street (if applicable).	Frame is even with curb.
		Top slab has holes larger that 2 in^2 or cracks wider than ¼" (intent is to make sure all material is running into basin).	Top slab is free of holes & cracks.
		Frame not sitting flush on top slab; i.e. separation of more than ¾" of the frame from the top slab.	Frame is sitting flush on top slab.
	Cracks in Basin Walls/Bottom	Maintenance person judges that structure is unsound.	Basin replaced or repaired to design standards.
		Cracks wider than ½" and longer than 1 ft at the joint of any inlet/outlet pipe or any evidence of soil particles entering catch basin through cracks.	No cracks more than ¼" wide at the joint of inlet/outlet pipe.
	Settlement/Misalignment	Basin has settled more than 1" or has rotated more than 2" out of alignment.	Basin replaced or repaired to design standards.
	Fire Hazard	Presence of chemicals such as natural gas, oil, and/or gasoline.	No flammable chemicals present.
	Vegetation	Vegetation growing across & 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 6" tall and less than 6" apart.	No vegetation or root growth present.
	Pollution	Non-flammable chemicals of more than ½ ft^3 per 3 ft of basin length.	No pollution present other than surface film.

CATCH BASINS/MANHOLES

Maintenance Component	Defect	Conditions When Maintenance is Needed	Desired Conditions
Catch Basin Cover	Cover Not in Place	Cover is missing or only partially in place. Any open catch basin requires maintenance.	Catch basin cover is closed.
	Locking Mechanism Not Working	Mechanism cannot be opened by 1 maintenance person with proper tools. Bolts into frame have less than ½" of thread.	Mechanism opens with proper tools.
	Cover Difficult to Remove	1 Maint. person cannot remove lid after applying 80 lbs of lift; intent is to keep cover from sealing off access to maintenance personnel.	Mechanism opens with proper tools.
Ladder	Ladder rungs Unsafe	Ladder is unsafe due to missing rungs, misalignment, rust, cracks, or sharp edges.	Ladder meets design standards & allows maint. personnel safe access.
Metal Grates (if applicable)	Grate Opening Unsafe	Grate with opening wider than 7/8"	Grate meets design standards.
	Trash & Debris	Trash & debris that is blocking more than 20% of grate surface.	Grate is free of trash & debris.
	Damaged or Missing	Grate missing or broken member(s) of the grate.	Grate is in place & meets design standards.

CONVEYANCE SYSTEMS (PIPES, DITCHES & SWALES)

Maintenance Component	Defect	Conditions When Maintenance is Needed	Desired Conditions
Pipes	Sediment & Debris	Accumulated sediment that exceeds 20% of the pipe.	Pipe cleaned of all sediment & debris.
	Vegetation	Vegetation that reduces free movement of water through pipes.	All vegetation removed so water flows freely through pipe.
	Damaged	Protective coating is damaged; rust is causing more than 50% deterioration to any part of the pipe.	Pipe repaired or replaced.
		Any dent that decreases the cross sectional area of the pipe by more than 20%.	Pipe repaired or replaced.
Open Ditches	Trash & Debris	Trash & debris exceeds 1 ft^3 per 1,000 ft of ditch and slopes.	Trash and debris cleared from ditches.
	Sediment	Accumulated sediment that exceeds 20% of the design depth.	Ditch cleaned/flushed of all sediment and debris so that it matches design.
	Vegetation	Vegetation that reduces free movement of water through ditches.	Water flow freely through ditches.
	Erosion Damage to Slopes	Erosion of the ditch's side slopes and/or scouring of the ditch bottom that exceeds 6", or where continued erosion is prevalent.	Slopes should be stabilized by using proper erosion control measures, and repair methods.
	Rock Lining out of Place or Missing (if Applicable)	Maintenance person can see native soil beneath the rock lining.	Replace rocks to design standards.
Swales	Trash & Debris	See above for ditches	See above for ditches.
	Sediment buildup	See above for ditches	Vegetation may need to be replanted after cleaning.
Catch Basins		See "Catch Basins" standard.	See "Catch Basins" standard.
Debris Barriers (e.g. Trash Rack)	Sediment & Debris	Accumulated sediment/debris that exceeds 20% the inlet opening.	Debris barrier is free of sediment & debris.
	Vegetation	Vegetation obstructs more than 20% of the inlet opening.	Debris barrier is free of obstructing vegetation.

CLOSED DETENTION SYSTEMS (PIPES/TANKS/VAULTS)

Maintenance Component	Defect	Conditions When Maintenance is Needed	Desired Conditions
Storage Area	Plugged Air Vents	One-half of the end area of a vent is blocked at any point with debris and sediment. Plugged vent can cause storage area to collapse.	Vents free of debris and sediment.
	Debris & Sediment	Accumulated sediment depth exceeds 10% of available storage depth in over half of the vault or 15% in any part of it.	All sediment & debris removed from storage area.
	Joints between tank/pipe section	Any crack allowing material to leak into facility.	All joints between tank/pipe sections are sealed.
	Tank/pipe bent out of shape.	Any part of tank/pipe is noticeably bent out of shape.	Tank/pipe repaired or replaced to design. Contact a professional engineer for evaluation.
	Vault structure includes cracks in wall, bottom, damage to frame and/or top slab	Maintenance/inspection personnel determine that the wall is not structurally sound.	Vault replaced or repaired to design specifications and is structurally sound.
Manhole		See "Catch Basin/Manhole" standards	See "Catch Basin/Manhole" standards

CONTROL STRUCTURE/FLOW RESTRICTOR

Maintenance Component	Defect	Conditions When Maintenance is Needed	Desired Conditions
General	Trash & Debris (Includes Sediment)	Material exceeds 25% of sump depth or 1 foot below orifice plate.	All trash, debris, & sediment is removed. Control structure orifice is not blocked.
	Structural Damage	Structure is not securely attached to manhole wall & outlet pipe structure should support at least 1,000 lbs of up or down force.	Structure firmly attached to wall & outlet pipe.
		Structure is not in upright position (allow up to 10% from plumb)	Structure in correct position.
		Connections to outlet pipe are not water tight and show signs of rust.	Connections to outlet pipe are not are water tight; structure repaired or replaced and functions as designed.
		Any holes-other than by design-in structure.	Structure has no holes other than by design.
Cleanout Gate	Damaged or Missing	Cleanout gate is not water tight or is missing	Gate is water tight and functions as designed.
		Gate can not be moved up and down by one maintenance person.	Gate moves up and down easily & is water tight.
		Chain leading to gate is missing or damaged.	Gate is repaired or replaced to meet design standards.
		Gate is rusted over 50% of its surface area.	Gate is repaired or replaced to meet design standards.
Orifice Plate	Damaged or Missing	Control device is not working properly due to missing, out of place, or bent orifice plate.	Plate is in place and works as designed.
	Obstructions	Any trash, debris, sediment, or vegetation blocking the plate.	Plate is free of all obstructions and works as designed.
Overflow Pipe	Obstructions	Any trash or debris blocking (or having the potential of blocking) the overflow pipe.	Pipe is free of all obstructions and works as designed.
Manhole		See "Closed Detention Systems" standards.	See "Closed Detention Systems"
Catch Basin		See "Catch Basins/Manhole" standards.	See "Catch Basins" standards.

ENERGY DISSIPATERS

Maintenance Component	Defect	Conditions When Maintenance is Needed	Desired Conditions
Rock Pad	Missing or moved rock	Only one layer of rock exists above native soil in area 5 ft^2 or larger, or any exposure of native soil.	Replace rocks to design standard.
Rock-filled trench for pond discharge	Missing or moved rock	Trench is not full of rock.	Add large rock (± 30 lbs each) so that rock is visible above edge of trench.
Dispersion trench	Pipe Plugged with sediment	Accumulated sediment that exceeds 20% of the design depth.	Pipe cleaned/flushed.
	Perforations plugged	Over ½ of perforations in pipe are plugged with debris and sediment.	Clean or replace perforated pipe.
	Not discharging water properly	Visual evidence of water discharging at concentrated points along trench (normal condition is a "sheet flow" of water along trench). Intent is to prevent erosion damage.	Pipe must be replaced or trench must be redesigned/rebuilt to standards.
	Water flows out top of "distributor" catch basin	Maintenance person observes water flowing out during any storm less than the design storm or it is causing or appears likely to cause damage.	Facility must be rebuilt or redesigned to standards. Pipe is probably plugged or damaged and needs replacement.
	Receiving area over-saturated	Water in receiving area is causing or has potential of causing a landslide.	Stabilize slope with grass or other vegetation, or rock if condition is severe. Contact a professional engineer for evaluation.

FENCING, SHRUBBERY, AND OTHER LANDSCAPING

Maintenance Component	Defect	Conditions When Maintenance is Needed	Desired Conditions
General	Missing or broken/dead shrubbery	Any defect in the fence or screen that permits easy entry to a facility.	Fence is mended or shrubs replaced to form a solid barrier to entry.
	Erosion	Erosion has resulted in an opening under a fence that allows entry by people or pets.	Replace soil under fence so that no opening exceeds 4" in height.
	Unruly vegetation	Shrubbery is growing out of control or is infested with weeds.	Shrubbery is trimmed and weeded to provide appealing aesthetics. Do not use chemicals to control weeds.
Wire Fences	Damaged parts	Posts out of plumb more than 6".	Posts plumb to within 1-1/2" of plumb.
		Top rails bent more than 6".	Top rail free of bends greater than 1".
		Any part of fence (including posts, top rails, and fabric) more than 1 ft out of design alignment.	Fence is aligned and meets design standards.
		Missing or loose tension wire.	Tension wire in place and holding fabric.
		Missing or lose barbed wire that is sagging more than 2-1/2" between posts.	Barbed wire in place with less than ¾" sag between posts.
		Extension arm missing, broken, or bent out of shape more than 1-1/2".	Extension arm in place with no bends larger than ¾".
	Deteriorated paint or protective coating	Part or parts that have a rusting or scaling condition that has affected structural adequacy.	Structurally adequate posts or parts with a uniform protective coating.
	Openings in fabric	Openings in fabric are such that an 8" diameter ball could fit through.	No openings in fabric.

Project Description

Project Name: _____

Project Location: _____

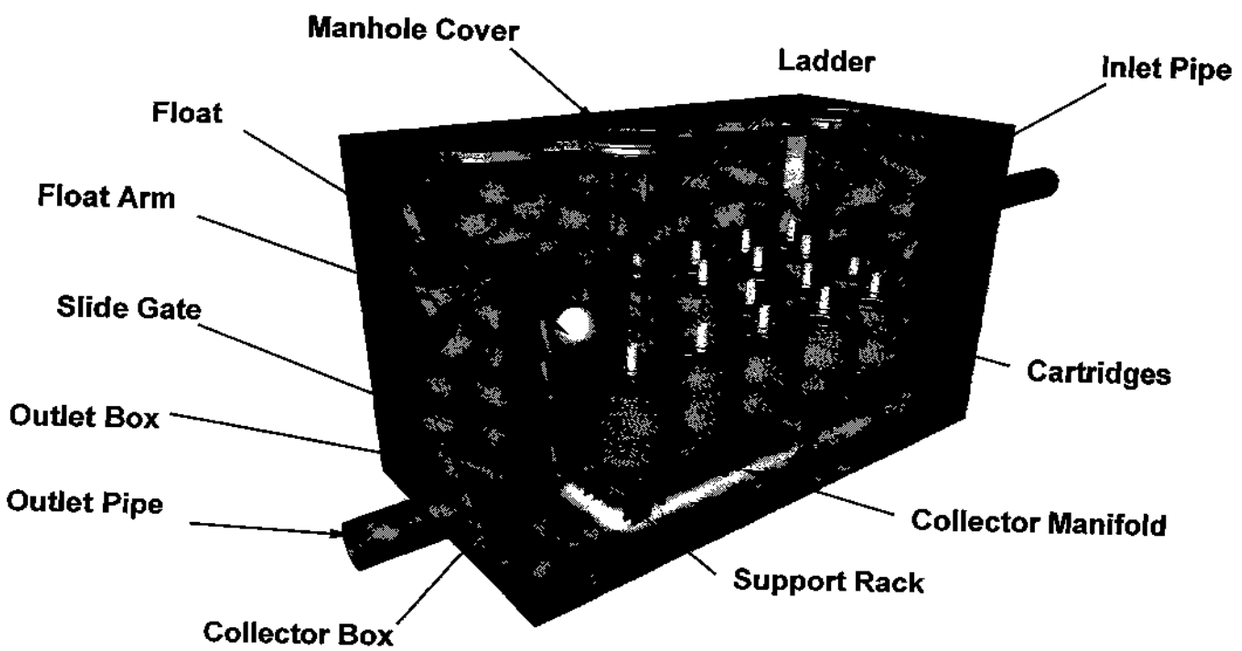
Install Date: _____

MFS Model No. _____

Water Quality Flow Rate (cfs): _____

Number of Cartridges: _____

Height of Cartridges (inch): _____



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OPERATION AND MAINTENANCE

CDS Technologies, Inc. is pleased to provide the enclosed information regarding the importance of on going Maintenance for the CDS Media Filtration System (MFS). This packet provides guidance in determining the frequency for maintenance on the CDS MFS, service and inspection contract options provided by CDS Technologies, Inc. and step by step instructions for service by the owner.

Storm water treatment media cartridge system are designed to remove solids from runoff by capturing and storing solids, particulate associate contaminants (metals, nutrients), oil and grease on the media surfaces and within the void spaces between the media particles. Captured solid particles gradually reduce the ability of the storm water to flow through the media, eventually maintenance should be performed to replace the consumed media and install new media for continued operation.

It is important to replace the media when solids have filled the voids reducing the flow to zero or to a minimal flow. Replacing cartridges is critical in the effort to continue to treat the storm water runoff flow for which the CDS MFS was designed and to continue to keep pollution from entering our Waterways.

General Maintenance Guidelines

The **Media Filtration System** with the dedicated volume for the capture and retention of larger sized solids beneath the media filled cartridges will extend the period before replacement of cartridges is required thus reducing maintenance costs. In addition, the design of the large forebay and cartridges mounted on a support rack above the forebay, allows the cartridges to be maintained numerous times prior to the need to clean out the forebay.

Removal of sediments from the bottom of the vault is not always required when the cartridges are replaced. However, the solids in the vault should be removed when they reach a depth of about 12-inches. A vacuum truck provides the easiest means of removing these settled solids from the vault floor. If the materials extracted from the vault were hazardous, it is recommended to analyze a grab sample to confirm if special handling for disposal is required.

The maintenance requirements and frequency for the media cartridges in direct filtration systems is highly site specific depending on the characteristics of the runoff including: sediment particle size distribution, pollutants associated with those particulates, particularly oil and grease and the amount of organics, trash and debris. Field monitoring has shown that particle sizes can range from 10-microns to 500-microns with suspended solid concentrations varying from less than 20 mg/l to over 1000mg/l.

CDS recommends that each CDS MFS is inspected after the first 6-months of operation. This initial inspection will provide valuable information regarding the size and amount of solids in the runoff from a particular site and the subsequent maintenance frequency required.

Heavier, larger particles will settle in the forebay of the vault, while the lighter and smaller particles are to be removed from the runoff flow as the water filters through the media in the cartridges. As stated earlier, the depth of sediment in the vault is an easy measurement to determine vactor truck cleaning of the sump below the cartridges.

There are two additional indicators in the CDS MFS which help determine the amount of solids that are captured in the cartridges and the maintenance frequency in regards to the replacement of the cartridges for the life of the system. The first indicator is the color of the media. The darker the media, the more sediment has been captured and prevented from entering the water ways. If the media is still light gray or white at the top of cartridge, the cartridges do not require maintenance. To view the media, the top of the cartridge should be removed and the color of the media inspected. This process involves first unthreading the vented pipe and removing it from the top of the cartridge. Then use the handles to carefully remove the top disk, insuring that filtration media does not spill into the vault. If the perlite media appears dark at the top of the cartridge, maintenance is required. The standard 22-inch tall cartridge can hold 45 – 55 pounds of sediment. This inspection should be performed on a dry day 4 to 6 months after installation.

Another indicator of required cartridge media replacement is when the area around the cartridges has standing water and the cartridges are submerged. If water is flowing over the head control weir at the outlet box during light storm events and over one inch of floatables have collected on the screen surface inside of the cartridge vent pipe, the cartridges are full and the water is bypassing the media. This observation should be made on a rainy day 4 to 6 months after installation. Please see the graphic on the cover page of this manual for the location of outlet box and the vented pipe.

This initial inspection will establish the maintenance frequency guidelines for the life of the system.

When the media needs to be replaced, or the vault forebay needs to be cleaned, confined space entry is required, and needs to be carried out in conformance with all safety provisions required for the entry being followed.

Typical Cleaning and Inspection Schedule

Initial inspection to determine the type of sediment loading on the site – **4 - 6 months after the system has gone on line**	**4 - 6 Months after Installation**
Annual or Semi Annual Inspection: Note if floatables have been caught on the screen inside the vent pipe located on top of the cartridge. If a significant amount of debris has accumulated, bypassing has been frequent and maintenance may be necessary. Measure depth of sediment in the storage area below the cartridges. A sediment depth of more than 12" indicates vacuuming is necessary.	**June and Dec Annually if sediment loads are High**
Cartridge Replacement : Should occur every 6 months to once every 2 years depending on sediment loading. Perform dry season maintenance to recharge/ replace media/ cartridges, and remove floatable trash and debris.	**May – Aug Annually at a Minimum**
Cartridge replacement and sediment storage cleaning: Bi-Annual maintenance. Replace Filter Cartridges, and clean sediment storage area below cartridges with Vactor truck.	**May - Aug Every 2 - 3 Years at a Minimum**

Maintenance Options

Full Service Contract with CDS / Partial Service Contract with CDS / Owner Performed Maintenance (for Municipalities)

There are three options for performing the ongoing, required maintenance of the CDS Media Filtration System. A contract can be signed with CDS Technologies, Inc. to perform the inspection and all maintenance services. Additionally, CDS will provide certification to owners and municipalities upon completion of such services.

Alternatively, CDS Technologies can provide new filled cartridges to the project site and remove the old cartridges. This option allows for the labor and vacuum truck services to be commissioned by the owner with recharged cartridges, and on site direction from CDS Technologies, for a fee.

The last option is for public owners to perform the entire maintenance activity themselves. Upon approval from the specifying agency, this option may be investigated by private owners.

The first maintenance option engages the owner of the Media Filtration System and CDS Technologies, Inc. into a contract for full services. If this option is preferred please refer to the Maintenance Contract section of this Operation and Maintenance Manual, Appendix B.

The second option is for recycled cartridges with clean media to be purchased from CDS Technologies, Inc. for installation on site by the owner. In this case, CDS would deliver recycled cartridges filled with the required media to the site along with new O-Ring gaskets. CDS will pick up the used and empty, cartridges at the same time. The owner would be responsible for properly transporting the spent media to a facility where the media is disposed of. It is typical that the vacuum truck hired by the owner will vacuum the water and settleable solids and for an additional charge, vacuum the spent media directly from the cartridges. This will reduce the weight and allow the cartridges to be removed easier. This booklet serves as the guidance document for the maintenance procedures. Confined space entry equipment and training will be required for the laborers performing the maintenance.

Recycled cartridges with fresh media are estimated at $100 per cartridge. Shipping / delivery charges will apply. The procedure guidelines included in this manual provide steps for the owner to follow with regards to removing the spent cartridges and installing the recycled cartridges. For an hourly rate, a CDS staff person can remain on site and answer any questions during the procedure.

The third option is for owners who wish to perform the full maintenance. All labor, equipment and disposal requirements will be the responsibility of the owner. This option is ideal for public systems owned by cities or counties, and is not recommended for private owners unless agreed upon by the governing municipality.

For public systems owned and maintained by a City of County, he XSORB perlite media is available from:

Impact Absorbent Technologies
5255 Traffic Way
PO Box 1131
Atascadero, CA 93423-1131
(805) 466-4709 x17

For a standard height, 22" tall cartridge 5.25 cubic feet of perlite is vibrated and compacted into the cartridge. The vibration and compaction process removes the fine perlite from the mix and insures the media will not settle during use which might create unwanted void spaces. Perlite is a nuisance dust and all MSDS procedures must be followed while working with the perlite. Again, municipalities are typically set up for this, while private owners are not.

Ilustrations of CDS MFS Cartridge & Maintenance

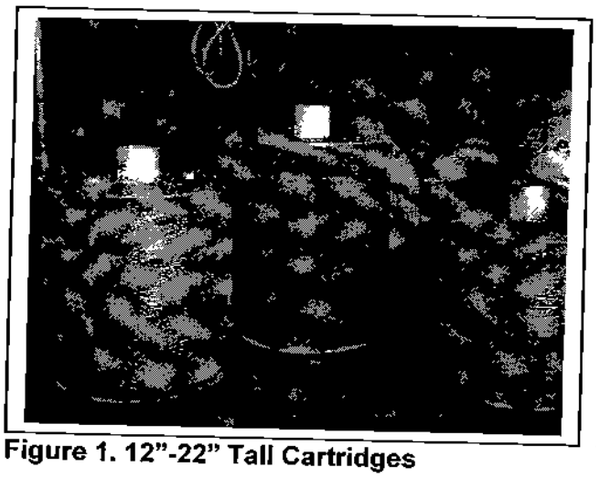


Figure 1. 12"-22" Tall Cartridges

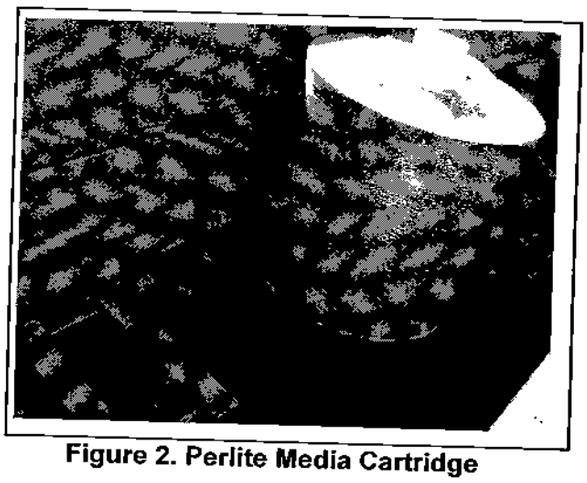


Figure 2. Perlite Media Cartridge

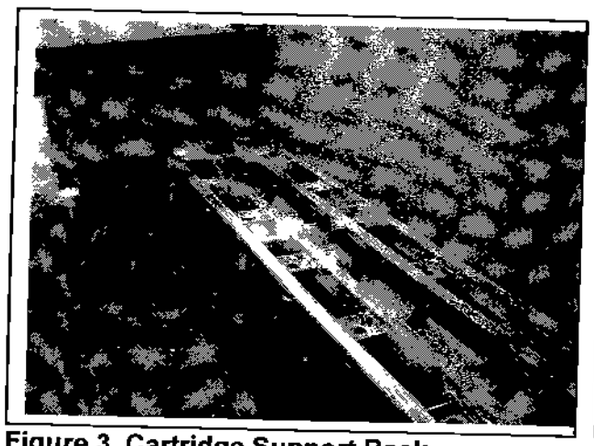


Figure 3. Cartridge Support Rack
(Down - Operation Position)

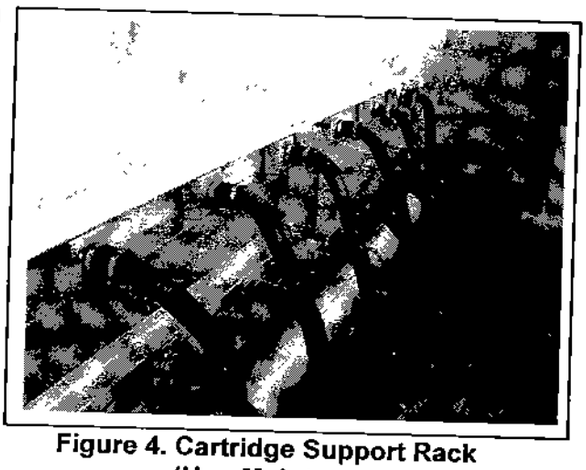


Figure 4. Cartridge Support Rack
(Up - Maintenance Position)

Figure 5. Cartridge Clip (Unlocked Position)
(Maintenance)

Figure 6. Cartridge Clip in locked Position
(Operation)

Maintenance Procedures

Procedure Summary: The maintenance process requires setting up traffic control if necessary, setting up and performing a confined space entry and twisting the cartridges to an unlocked position. The best method for twisting the cartridges is to grab the top of the cartridge on each side and twist about ¼ of a turn. The handles provide the mechanism for lifting the cartridges out of the vault, however, they are not intended to be used for twisting the cartridge into place. The next step is removing the cartridges from the vault, removing the pin between the support rack and the support leg (for multiple cartridge racks only) and rotating the hinged cartridge support racks against the walls to expose all of the forebay area to an unimpeded work area. For multiple cartridge racks, the support leg may be attached to the floor. This will remain in place while the rest of the rack is rotated against the wall.

After the solids are vacuumed out (if necessary), the cartridge support rack is rotated into position, new cartridges are reloaded into the vault, secured on the gasketed nipple and twisted into position. Details of this procedure follow.

Suggested Tools for Maintenance

- Safety Cones
- Wader Boots
- Vault Pentalock Tool/ Manhole casting lifter
- Large Shovel
- Hand Shovel
- Confined Entry Equipment
- Flashlight
- Garbage Bags/Cans – or Dump truck
- Duct Tape
- Pool net for floatables removal

Suggested Equipment for Maintenance

- New media or replacement cartridges
- Small crane with 800 lb. Lifting capacity or cable pulling system for manual lifting of the cartridges. The weight of the cartridges will vary depending on media. Perlite filled cartridges will vary between 100 and 200 lbs when wet and filled with sediment.
- Vacuum truck with water hose (for use during 2 to 3 year cycle when cleaning forbay area underneath cartridges)
- Flat bed truck to transport cartridges

Recommended Maintenance Procedure

The following list outlines step- by- step instructions for maintenance:

1. Set up vehicle and pedestrian traffic control as required. Safety Cones should be placed around the Access Hatches of the Media Filtration System vault.

2. Verify explosive gas is not present before opening hatch. The air monitor from the confined space equipment should be used for this procedure. The access hatches should be opened upon arriving on site.

3. Confined entry equipment must be used to test the air quality of the CDS Media Filter vault and for all persons who enter the structure.

4. The ladder inside of the filter vault should be pulled up and secured. The installed ladder is the safest way to enter the structure.

5. Entrance into the vault can occur by stepping down the ladder or steps to gain access to the floor of the vault (the sediment storage bay). The support rack is also an available place to stand. The sediment storage bay may have up to 21-in of standing water. Wader or hip boots are recommended.

6. Using the pool net to scoop floatables, trash and debris from the surface and dispose them in the trash bag. Removing these items will allow better access to the cartridge filters.

7. It is suggested to start cartridge maintenance from the cartridge filter closest to the center of the vault.

8. Turn the cartridge by grabbing the cartridge near the top and twisting ¼ turn to release them from the locked position on the support rack. The handles are not intended to help twist the cartridge. (Figure 5 & 6)

9. Each of the cartridges should be lifted using the handles on top of the cartridges.

10. Alternatively, if a vacuum truck is on site, the tops of the cartridges may be removed and the media can be vacuumed from the cartridges before they are lifted out of the vault. This will reduce the lifting weight.

11. Each cartridge can be removed by hand or via a small crane.

Multiple Cartridge Support Racks or Single Cartridge Support Racks: The cartridges will be installed in the catch basin, manhole, vault or cast in place structure with either a multiple cartridge support rack as shown in Figure 3 and Figure 4, or on single cartridge support racks as shown in Figures 5 and 6.

12. If multiple Cartridge support racks are installed these support racks should be rotated into position against the wall to provide full access to the floor of the vault. As shown in Figure 4. There is a hitch pin that is used to hold the rack in the down or up position. As shown in Figure 7, the removable hitch pin is the one that extends only through the support rack. **DO NOT REMOVE THE CONNECTION PIN HOLDING THE SUPPORT RACK TO THE WALL.**

    Removal of the hitch pin as indicated in Figure 7 at each hinge location allows the support rack to rotate into the up position, or the Maintenance position. This pin should then be inserted back into the holes on the rack to secure the rack in the up position during maintenance. A cotter pin is installed on the end of the hitch pin to lock the hitch pin in place.

Figure 7. Multiple Cartridge Hinged support rack connected to the wall with hitch pin securing rack in the Up (Maintenance) Position

13. If single cartridge support racks are installed, the single rack can be rotated by removing the hinge pin at the wall. When the rack is raised up (Maintenance position) it will drop down ½-inch and secure itself in the up position.

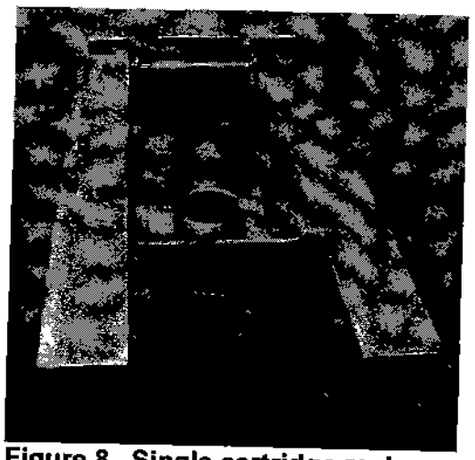


Figure 8. Single cartridge rack (hinge pin is inserted at the wall – remove to rotate rack into Up (Maintenance) position

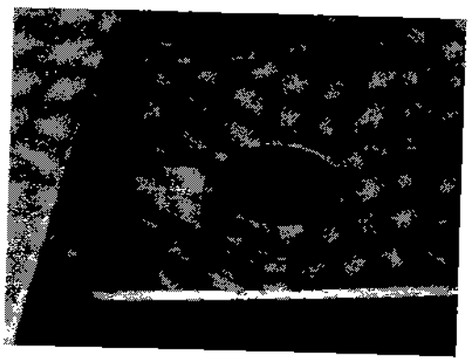


Figure 9. O Ring Gasket

14. If the forbay area is with accumulated sediment exceeding 12-in, these sediments needs to be removed by a vacuum truck. Flushing of the vault floor may be necessary.

15. If new media is to be installed in the cartridges on site, the used media should be emptied into garbage bags/ cans or into a dump truck. Please contact CDS Technologies, Inc at (888) 535-7559 for information on recycling the used cartridges.

16. Once vacuuming is completed, the support racks should be lowered back in to the down position, as shown in Figure 3 for multiple cartridge rack or Figure 8 for single cartridge rack, and the hitch pin inserted into the holes on the support rack.

17. Once the cartridges have been filled with new media or the new cartridges are on site, they can be lowered into the vault. New cartridges are delivered wrapped in shrink wrap. The shrink should be removed when the system is ready to go on line.

18. The slip connection on the bottom of the cartridge should be installed over the aluminum nipple on the support rack. Inspect the O Ring on the nipple of the support rack to insure it is installed in the gasket groove before securing the cartridge into place. The black O Ring gasket is shown in Figure 8. It is suggested to use silicone or pipe slick to lube the O Ring.

19. Be sure to shut and lock the access doors, and clean the job site if necessary.

CDS TECHNOLOGIES
INSPECTION / OBSERVATION LOG

CDS INSTALLATION:

MODEL DESIGNATION_____ DATE_____

SITE LOCATION_____

WAS VAULT FLOOR VACUUMED DURING LAST MAINTENANCE: YES NO

INSPECTIONS:

DATE/INSPECTOR	DEPTH OF SEDIMENTS OF VAULT FLOOR*	HAVE FLOATABLES ACCUMULATED ON THE SCREEN INSIDE THE VENT PIPE	IS OIL & GREASE VISIBLE ON THE WATER SURFACE	IS THERE STANDING WATER ABOVE THE BOTTOM OF THE CARTRIDGES	IS THE MEDIA STILL WHITE, GRAY, BLACK OR DARK BLACK

* If this depth is greater than 12-in, vacuum service should be performed.

OTHER OBSERVATIONS: _____

_____

_____

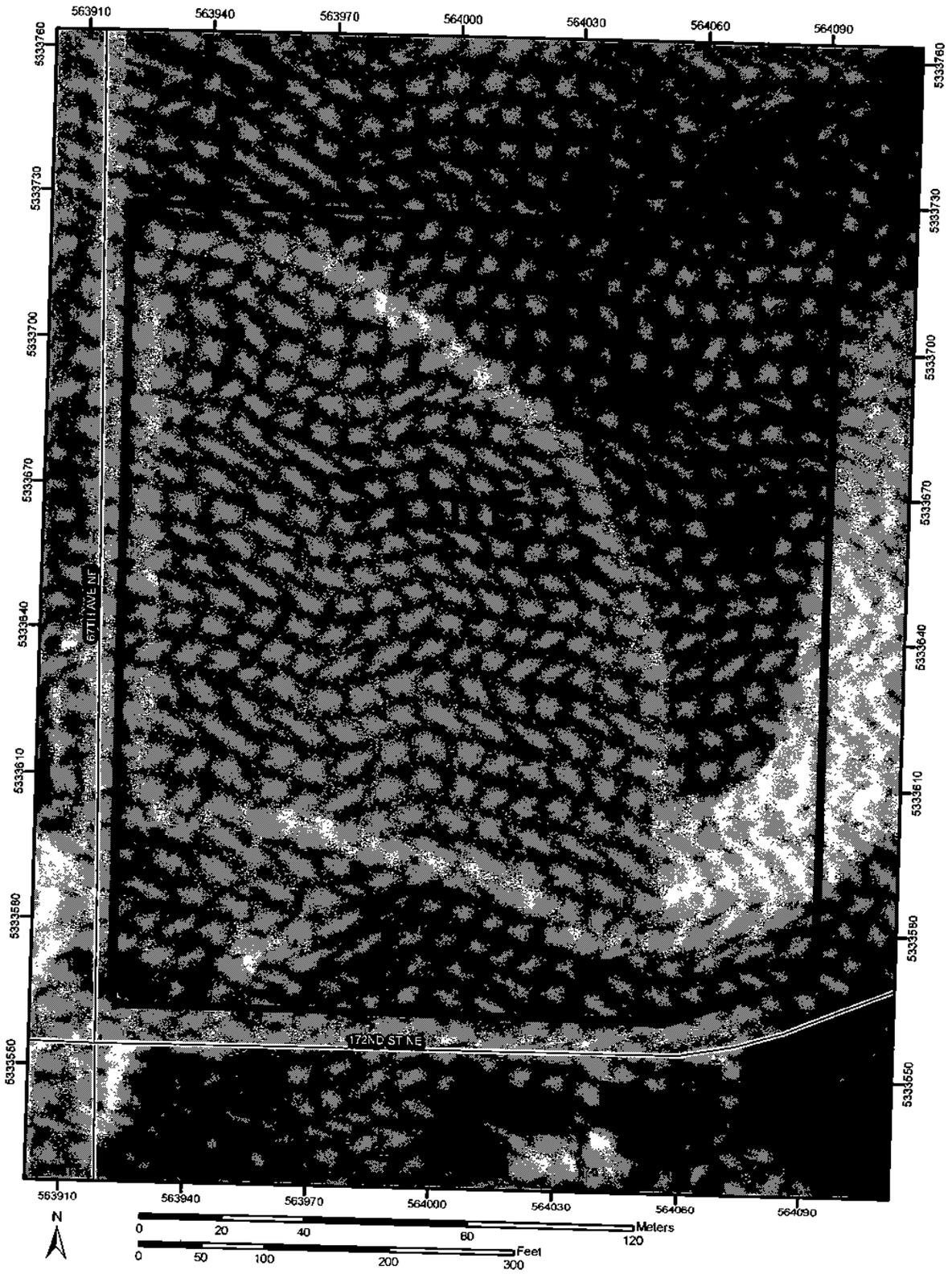
_____

_____

_____

CERTIFICATION:_____**TITLE:**_____
DATE:_____

APPENDIX


563910
563940
563970
564000
564030
564060
564090
5333760
5333730
5333700
5333670
5333640
5333610
5333580
5333550
67TH AVE NE
172ND ST NE
N
0
20
40
60
120
Meters
0
50
100
200
300
Feet

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Units

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other

Special Line Features
- Gully
- Short Steep Slope
- Other

Political Features

Municipalities
- Cities
- Urban Areas

Water Features
- Oceans
- Streams and Canals

Transportation
- Rails

Roads
- Interstate Highways
- US Routes
- State Highways
- Local Roads
- Other Roads

MAP INFORMATION

Original soil survey map sheets were prepared at publication scale. Viewing scale and printing scale, however, may vary from the original. Please rely on the bar scale on each map sheet for proper map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 10N

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

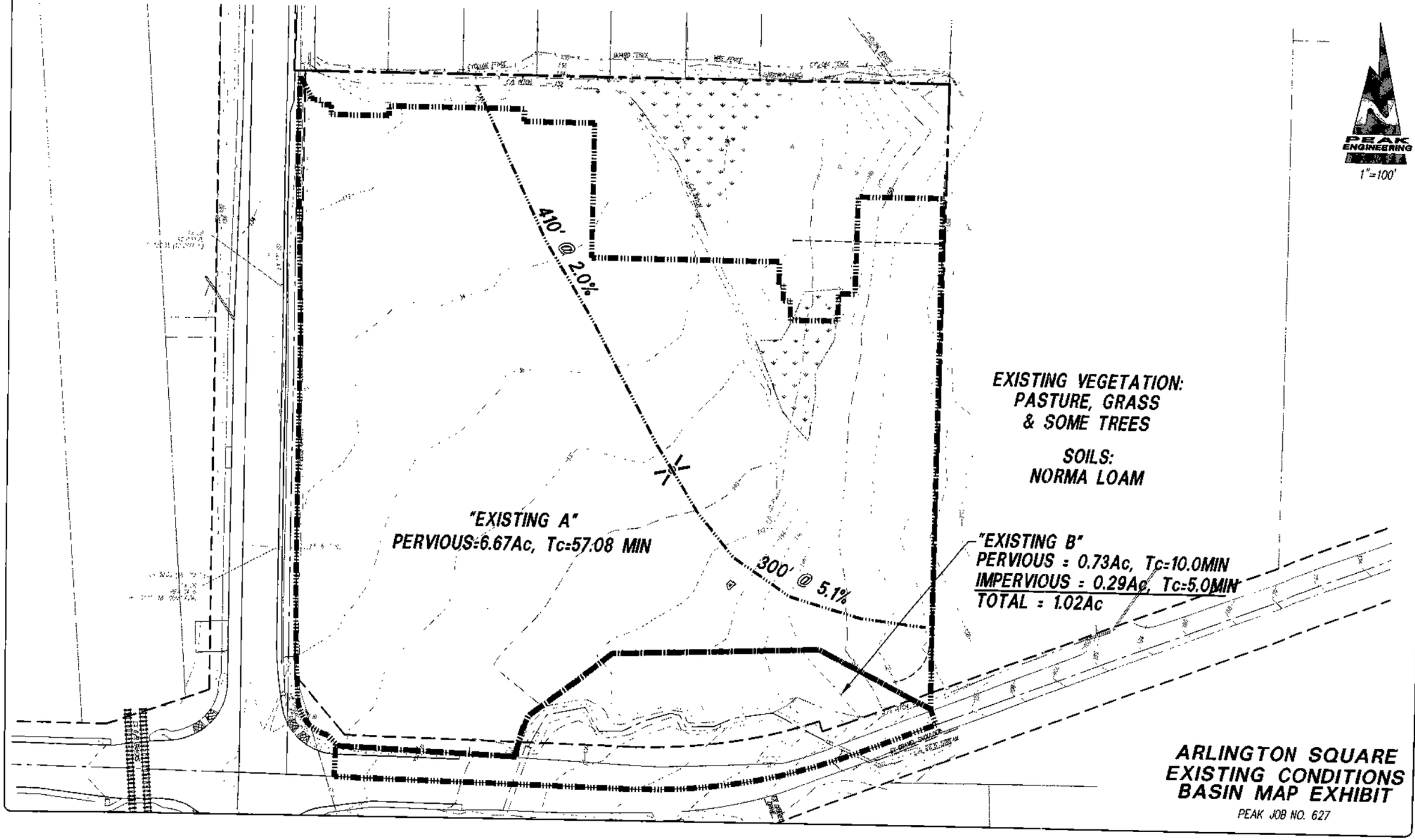
Soil Survey Area: Snohomish County Area, Washington
Survey Area Data: Version 4, Dec 12, 2006

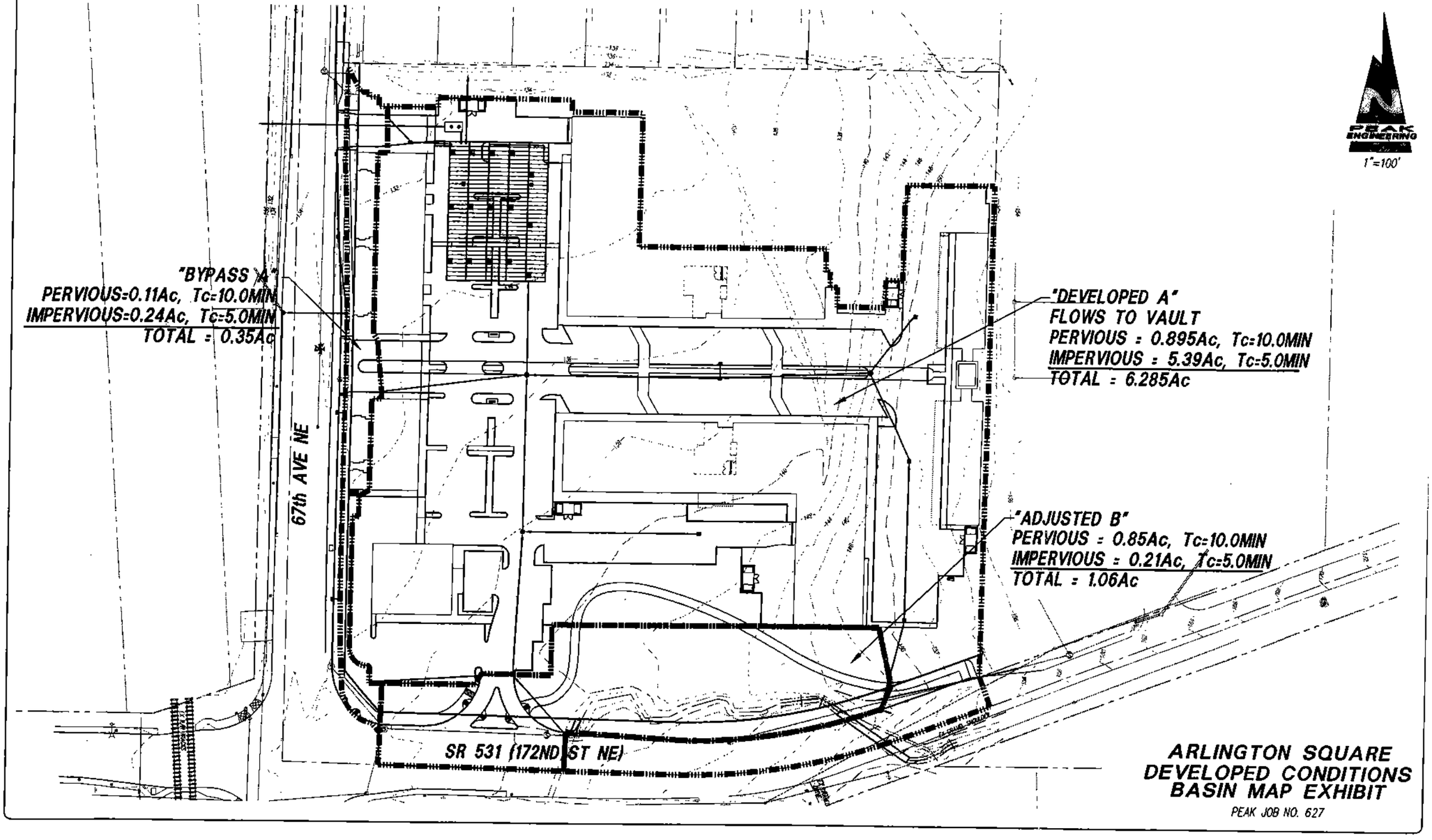
Date(s) aerial images were photographed: 7/10/1990; 7/18/1990

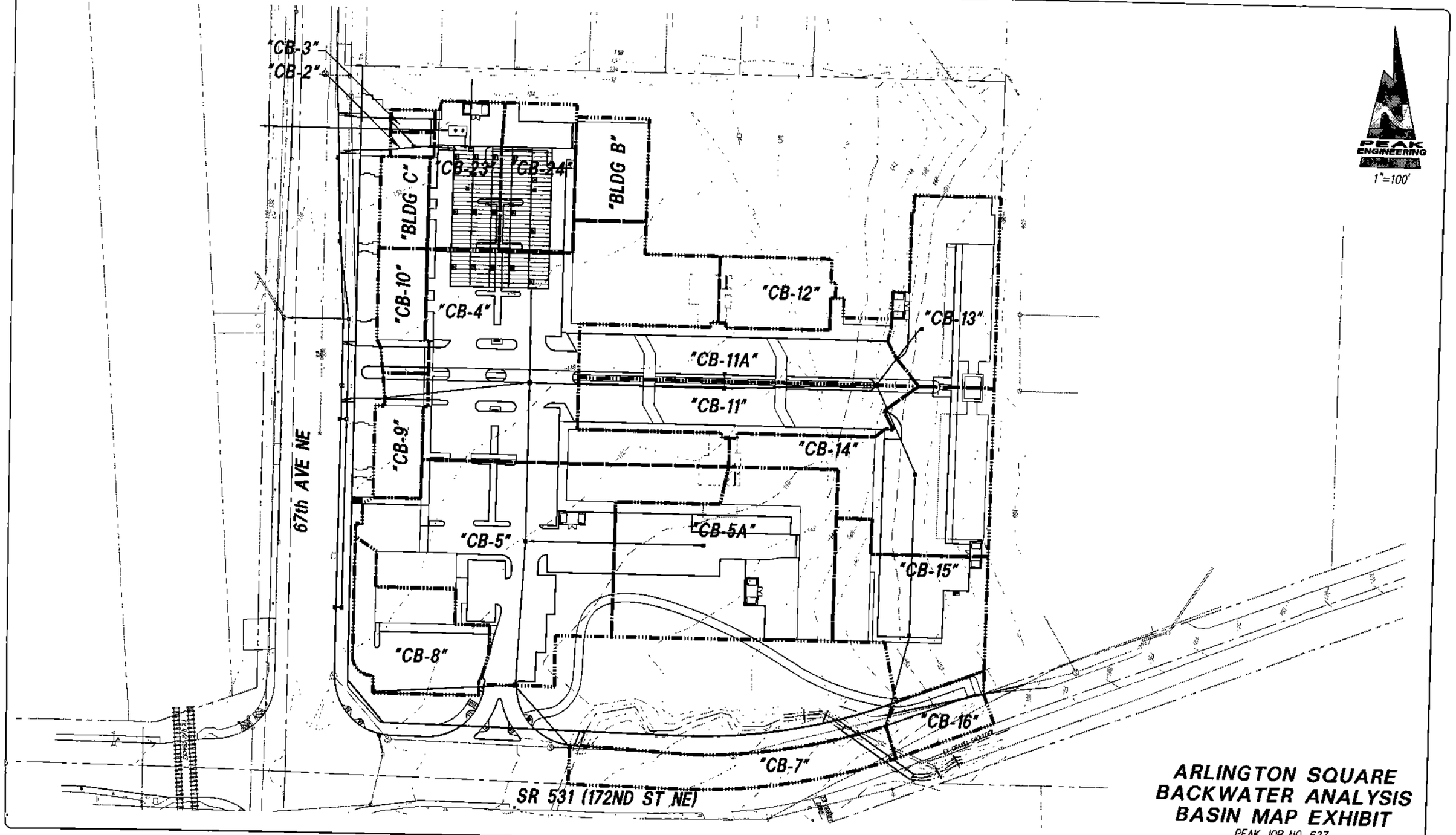
The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Snohomish County Area, Washington (WA661)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
18	Everett gravelly sandy loam, 8 to 15 percent slopes	0.3	3.7%
39	Norma loam	8.0	96.3%
Totals for Area of Interest (AOI)		8.3	100.0%

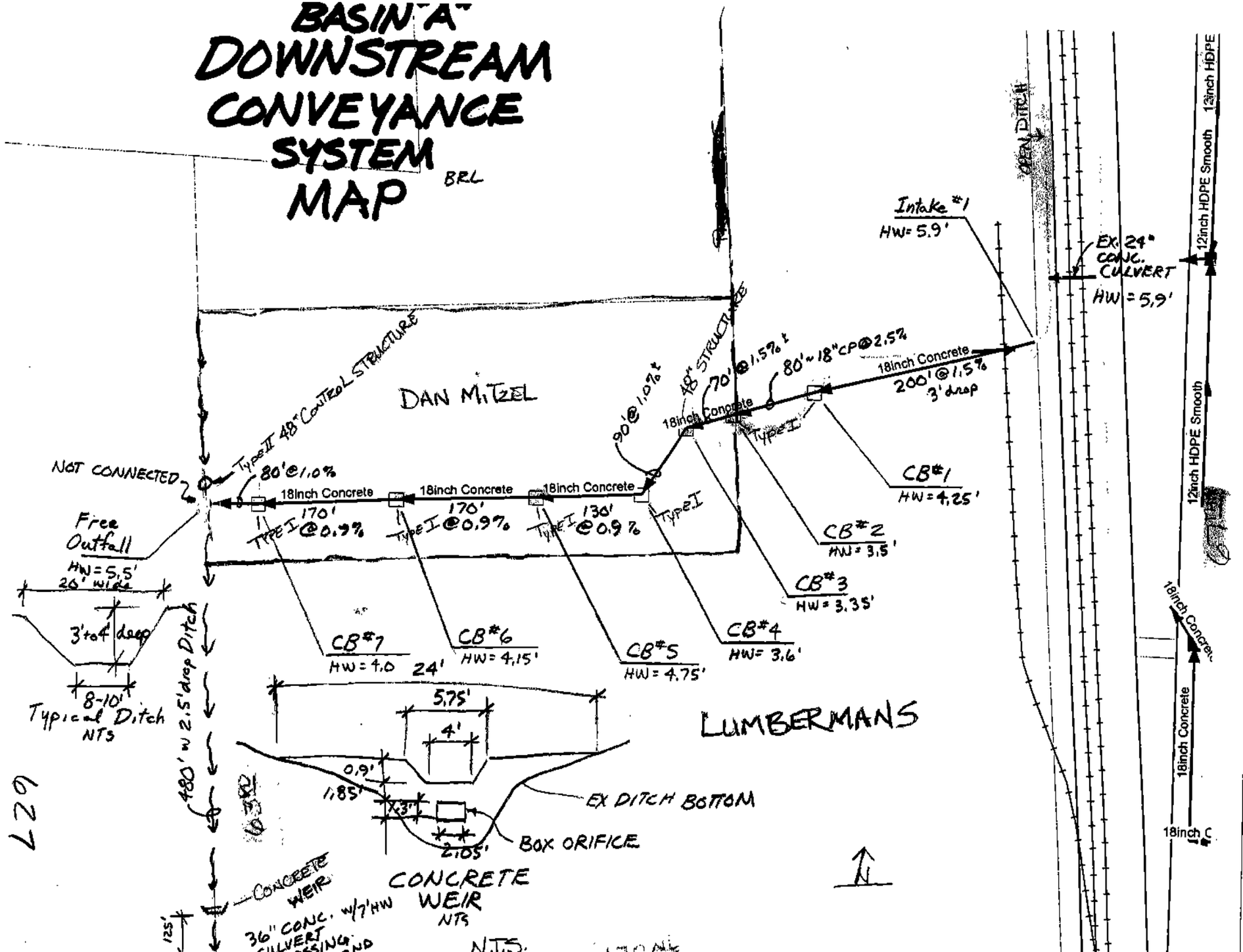

410' @ 2.0%
300' @ 5.1%
"EXISTING A"
PERVIOUS=6.67Ac, Tc=57.08 MIN
EXISTING VEGETATION:
PASTURE, GRASS
& SOME TREES
SOILS:
NORMA LOAM
"EXISTING B"
PERVIOUS = 0.73Ac, Tc=10.0MIN
IMPERVIOUS = 0.29Ac, Tc=5.0MIN
TOTAL = 1.02Ac
PEAK ENGINEERING
1"=100'
ARLINGTON SQUARE
EXISTING CONDITIONS
BASIN MAP EXHIBIT
PEAK JOB NO. 627

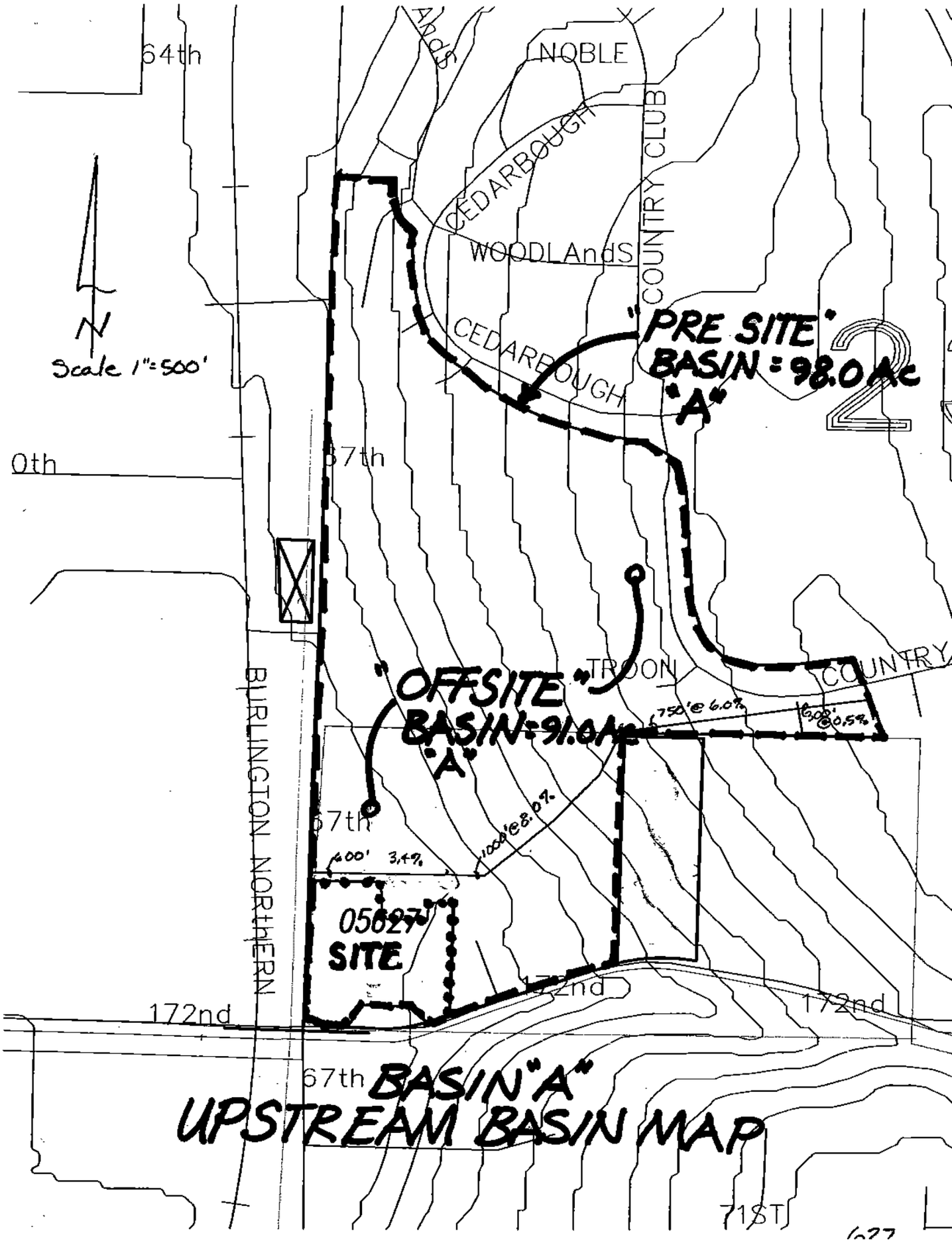

"BYPASS A"
PERVIOUS=0.11Ac, Tc=10.0MIN
IMPERVIOUS=0.24Ac, Tc=5.0MIN
TOTAL = 0.35Ac
67th AVE NE
"DEVELOPED A"
FLOWS TO VAULT
PERVIOUS = 0.895Ac, Tc=10.0MIN
IMPERVIOUS = 5.39Ac, Tc=5.0MIN
TOTAL = 6.285Ac
"ADJUSTED B"
PERVIOUS = 0.85Ac, Tc=10.0MIN
IMPERVIOUS = 0.21Ac, Tc=5.0MIN
TOTAL = 1.06Ac
SR 531 (172ND ST NE)
PEAK ENGINEERING
1"=100'
ARLINGTON SQUARE
DEVELOPED CONDITIONS
BASIN MAP EXHIBIT
PEAK JOB NO. 627


"CB-3"
"CB-2"
"CB-23"
"CB-24"
"BLDG B"
"BLDG C"
"CB-10"
"CB-4"
"CB-12"
"CB-13"
"CB-11A"
"CB-11"
"CB-9"
"CB-14"
"CB-5A"
"CB-5"
"CB-15"
"CB-8"
"CB-16"
"CB-7"
67th AVE NE
SR 531 (172ND ST NE)
PEAK ENGINEERING
1"=100'
ARLINGTON SQUARE
BACKWATER ANALYSIS
BASIN MAP EXHIBIT
PEAK JOB NO. 627

BASIN "A" DOWNSTREAM CONVEYANCE SYSTEM MAP

BRL





BASIN "A"
UPSTREAM BASIN MAP

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

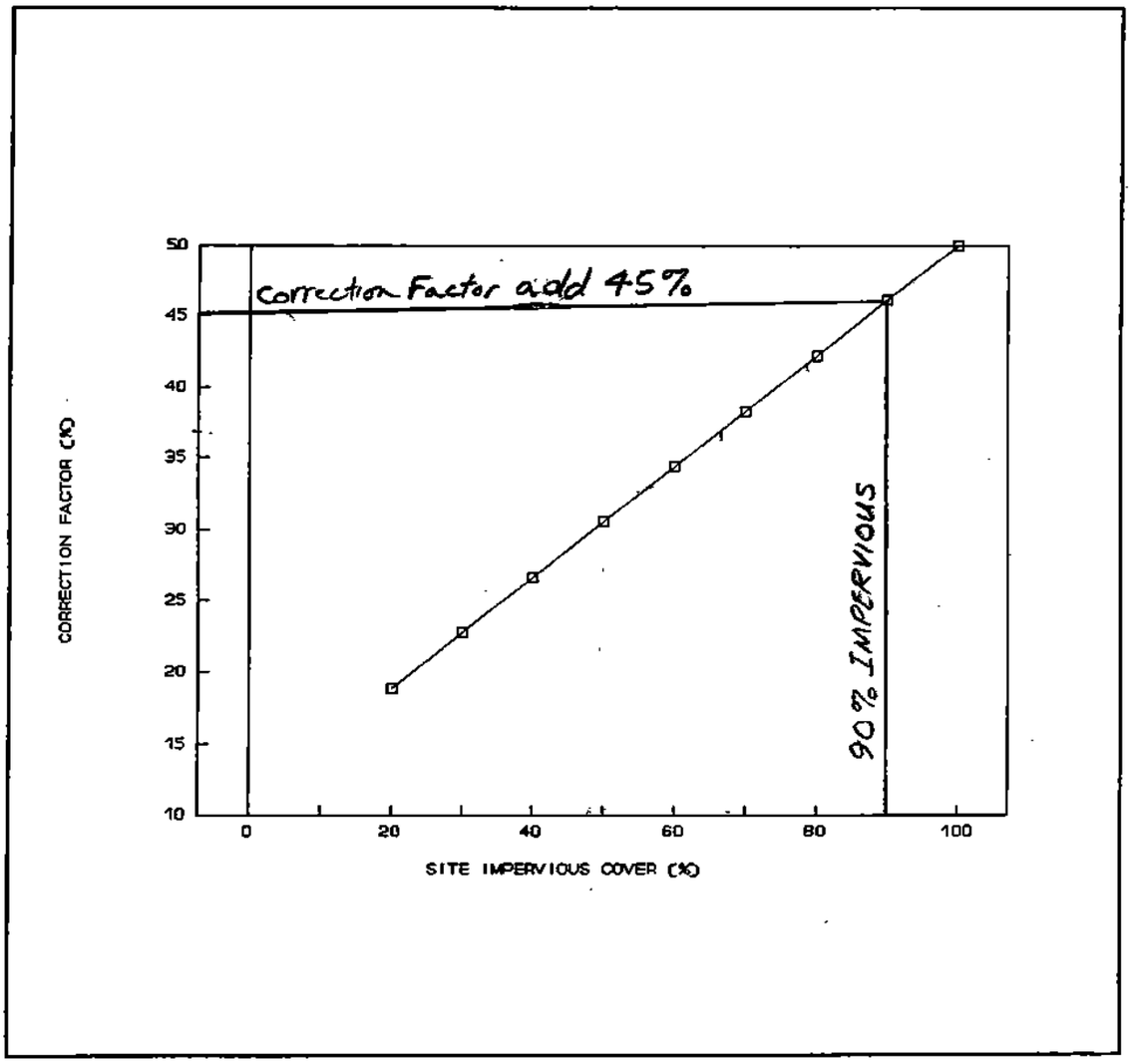


Table III-1.3 SCS Western Washington Runoff Curve Numbers
(Published by SCS in 1982) Runoff curve numbers for selected agricultural, suburban and urban land use for Type 1A rainfall distribution, 24-hour storm duration.

LAND USE DESCRIPTION		CURVE NUMBERS BY HYDROLOGIC SOIL GROUP A	B	C	D
Cultivated land(1):	winter condition	86	91	94	95
Mountain open areas:	low growing brush & grasslands	74	82	89	92
Meadow or pasture:		65	78	85	89
Wood or forest land:	undisturbed	42	64	76	81
Wood or forest land:	young second growth or brush	55	72	81	86
Orchard:	with cover crop	81	88	92	94
Open spaces, lawns, parks, golf courses, cemeteries, landscaping.					
Good condition:	grass cover on ≥75% of the area	68	80	86	90
Fair condition:	grass cover on 50-75% of the area	77	85	90	92
Gravel roads & parking lots:		76	85	89	91
Dirt roads & parking lots:		72	82	87	89
Impervious surfaces, pavement, roofs etc.		98	98	98	98
Open water bodies:	lakes, wetlands, ponds etc.	100	100	100	100
Single family residential(2):					
Dwelling Unit/Gross Acre	%Impervious(3)				
1.0 DU/GA	15				
1.5 DU/GA	20				
2.0 DU/GA	25				
2.5 DU/GA	30				
3.0 DU/GA	34				
3.5 DU/GA	38				
4.0 DU/GA	42				
4.5 DU/GA	46				
5.0 DU/GA	48				
5.5 DU/GA	50				
6.0 DU/GA	52				
6.5 DU/GA	54				
7.0 DU/GA	56				
PUD's, condos, apartments, commercial businesses & industrial areas	%impervious must be computed				
		Separate curve number shall be selected for pervious & impervious portions of the site or basin			

(1) For a more detailed description of agricultural land use curve numbers refer to National Engineering Handbook, Sec. 4, Hydrology, Chapter 9, August 1972.
(2) Assumes roof and driveway runoff is directed into street/storm system.
(3) The remaining pervious areas (lawn) are considered to be in good condition for these curve numbers.

Date: April 1, 2008

To: Menglou Wang, PE
City Engineer
City of Arlington Public Works Department

From: C. Scott Stewart, P.E.
Peak Engineering, Inc.

RE: Arlington Square – PWD20070046

Subject: Supplemental Construction Drainage Analysis

Dear Mr. Wang,

This letter is written to clarify the drainage analysis on the above mentioned project. I trust this letter will address the city and your concerns regarding the basin map delineation, conveyance system and detention vault design that was discussed in your meeting with David Milne on March 19th, 2008.

In the existing condition the drainage basin area is defined by the site sloping from east to west with Edgecomb Creek flowing along the south property boundary of the site and a drainage ditch along the north property boundary. A relatively small onsite site area along the south drains to the Edgecomb Creek (labeled "Stream" pervious = 0.62 acres* in old Construction Drainage Report dated 10/31/07) with the remaining area draining to the north ditch ("Existing" Pervious = 7.07 acres in old Construction Drainage Report dated 10/31/07). A frontage area of 0.35 acres along 67th Ave NE is downstream of the detention vault and is considered bypass. The developed flows have been reduced to allow for this bypass area.

The northern drainage system flows approximately 180 ft north from the northwest property corner of the site along the eastside of 67th Ave NE, then crosses to the west side of 67th Ave NE into a city maintained pond system. The north basin flows have been attenuated within the vault to maintain a pre-developed runoff rate based on forested ground cover and not the existing pasture cover flow rates. The detention vault facility has been designed to match the peak flows for ½ of the 2yr, 10yr and 100yr peak runoff rates from the site. Further, the vault has been designed with an additional volume correction factor of 45% added to the preliminary vault, which further decreases the actual flow released from the vault. The net result is that the runoff flow rates from this development are reduced from the pre-developed (forested) condition. (Note: The existing site is primarily pasture, which actually has an increased runoff rate than if it were forested conditions.) The following table is a comparison of peak flows for the drainage system flowing to the north:

* This area conformed to the stream buffer enhancement plan for Edgecomb Creek. The actual basin area is 0.73 acres.

601 Delta Ave. • Marysville, WA 98270
PHONE (360) 658-6986 • FAX (360) 658-7826 • Website: peak-engineering.net

NORTH BASIN PEAK FLOW COMPARISON

Storm Event	PRE-DEVELOPED Allowable (cfs)	SUBTRACT BYPASS From Allowable (cfs)	POST-DEVELOPED P-Vault (cfs)	RELEASE RATE FROM VAULT F-Vault (cfs)
2yr	½ 2yr = 0.29/2 = **0.145**	0.145-0.11 = **0.035**	**0.02**	**0.02**
10yr	**0.89**	0.89 – 0.18 = **0.71**	**0.57**	**0.36**
100yr	**1.87**	1.87-0.27 = **1.60**	**1.42**	**0.81**

The city is concerned that this project may cause overflowing problems for the city pond along the west side of 67th Ave NE during various storm events. Based on the information provided, this project is not expected to cause overflow problems of the existing pond. The calculations indicate that the storm runoff flow rates from the site at full development will actually be lower than what exists today.

Based on conversations with city staff regarding downstream flow problems (flooding) it is our understanding that these problems were over 10 years ago and related to lack of maintenance (i.e. sawdust plugging the storm system downstream of the pond).

The south basin flows to existing catch basins within the SR 531 right-of way near the southwest property corner of the site that ultimately flows to the Edgecomb Creek. The south basin is 1.02 acres in size. Edgecomb Creek flows through this basin (See Existing Conditions Basin Map). SR 531 frontage currently flows into the creek undetained and untreated. This project will collect runoff from SR 531 and direct it to the onsite detention vault and stormwater vault, providing both treatment and detention for 14,630 sf of roadway. The onsite area along the creek (0.73 acres) will continue to flow to the creek. The area of the new right-in right-out access will flow south and not to the detention and water quality vaults. The new asphalt (bypass) is 4,300 sf which is less than the 5,000 sf threshold above which detention is required and it is 3,340 sf less than the existing amount of road surface which currently flows to the creek undetained and untreated. This project results in 3,340 sf of net additional area being treated and detained above and maintains the flow rates to the south (creek). The following table is a comparison of peak flows for the drainage system flowing to the south:

SOUTH BASIN PEAK FLOW COMPARISON

Storm Event	PRE-DEVELOPED (cfs)	POST-DEVELOPED (cfs)
2yr	0.16	0.14
10yr	0.32	0.31
100yr	0.55	0.55

Regarding the city's concern of the combining of public and private stormwater the owner of Arlington Square will provide a hold harmless agreement that will release the city's responsibility of maintenance for small area and amount of water flowing from the right-of-way to the Arlington Square's drainage facilities.

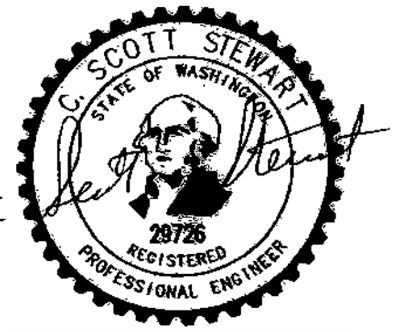
The conveyance system for the site has been designed to convey flows up to and including the 100yr storm event. The attached calculations indicate that there should not be any over toping of the drainage structures within the property site conveyance system.

For additional information see the attached calculations. If you have any questions or comments please call.

Sincerely,

C. Scott Stewart

C. Scott Stewart, P.E.
Peak Engineering Inc.



EXPIRES 07/16/2009

DATE: 4/2/08

SUPPORTING CALCULATIONS AND FIGURES SEE SECTION II OF THE DRAINAGE REPORT