Storm Drainage Report
for
Oosterwyk Chiropractic Clinic

Puget Sound Exchange Facilitator Corp.
4218 Rucker Ave
Everett, WA 98203

SITE LOCATION:
113 Division St.
Arlington, WA 98223

Brian G. Harron, P.E.
Patrick Harron & Associates, LLC
14900 Interurban Ave. S. Suite 279
Seattle, WA 98168

PHA Project#: 07905
Date: March 2008
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TABLE OF CONTENTS

ITEM **PAGE**

LIST OF FIGURES

ITEM **PAGE**

1. INTRODUCTION

This storm drainage report is provided as support documentation necessary for the proposed construction of a medical office building site for the Puget Sound Exchange Facilitator Corporation.

This project proposes to construct a 2,516 sf building and a drive-thru espresso stand along with exterior parking and required infrastructure (stormwater facilities, utilities, etc.) on a 0.37 acre site.

Stormwater runoff from the site will be collected, treated, and infiltrated onsite in a water quality and infiltration trench system.

Frontage improvements consisting of landscaping, sidewalk, and drainage systems are proposed along Division Street and West Avenue where required. Infiltration system is proposed for the drainage system within Division Street. West Avenue drainage system will connect into the existing City system.

The site is located at 113 Division St City of Arlington. Section 2, Township 31N, Range 5E, Willamette Meridian. See Figure 1 - Vicinity Map.

Figure 1 - Vicinity Map

2. DRAINAGE INFORMATION SUMMARY FORM

Project: **Oosterwyk Medical Office Bldg. – 113 Division St.**

Engineer: **Patrick Harron and Associates, LLC**
2722 Colby Avenue., Suite 419
Everett, WA 98201
Attention: Kelley Wrigg, P.E.

Total site area: **0.37 acres**
Developable area: **0.37acres**

Applicant: **PUGET SOUND EXCHANGE FACILITATOR CORP**
4218 Rucker Ave
Everett, WA 98203

New Buildings: **1**

Drainage Basin Information	Basin 1	Basin 2
Onsite Developed Area	0.37 ac	–
Offsite Alley	0.03 ac	–
Offsite Division Street Frontage	–	0.15 ac
Total Basin Area	0.40 ac	0.15 ac
Developed Runoff Rates	Basin 1	Basin 2
2-year	0.15 cfs	0.07 cfs
10-year	0.19 cfs	0.09 cfs
100-year	0.27 cfs	0.13 cfs

Refer to *Figure 2 – Site and Drainage Basins Exhibit* to aid in the following description.

Description of drainage plan:
This project consists of an onsite and offsite basin. The onsite basin, which includes proposed improvement area in the alley to the north of the site, (Basin 1) will be treated and infiltrated onsite. Frontage improvements on Division Street along with the half street tributary area are included in Basin 2. Stormwater runoff from this basin will be infiltrated in a trench system within the planter strip of the right-of-way. Basin analysis were not performed for the frontage improvements to West Avenue since flow control is not proposed for this small area (approximately 950 sf). Instead drainage system is proposed to connect directly into the City's existing drainage system.

Proposed design standards and criteria:
The design for this project will meet or exceed the requirements of the City of Arlington and the 1992 Department of Ecology (DOE) Stormwater Management Manual for the Puget Sound Basin.

Description of Drainage Basins:
The developed basin map is attached (Figure 2). For Calculation purposes the site is has one basin. The basin is for the portion of the property going to the Infiltration trench. The office building rooftop drainage will be tightlined directly to the infiltration trench. The paved areas and interior sidewalk will drain to the water quality trench. Overflow from that trench will go to the infiltration trench.

3. EXISTING SITE CHARACTERISTICS and ASSUMPTIONS

The site is located at 113 Division St, NW of the intersection of Division St. and West Ave in the City of Arlington. The site is located in Section 2, Township 31N, Range 5E, Willamette Meridian. See Figure 1 - Vicinity Map. The entire property contains land adding to a total of 0.37 acres (16,421 sf).

Land use around the site is primarily commercial although residential properties are located across the alley to the north. This site had an existing residence, gravel parking area (large), and separate garage. All the structures were removed recently under a demolition permit.

The existing site is trapezoidal in shape, and contains about 16,421 sf of land. The grades on the site are relatively flat. The vegetation found on the existing property mainly consists of grass in the eastern third of the property and with sparse trees and shrubs throughout the site. Most if not all of the existing trees were removed as part of the demolition permit.

The soil hydrologic types for this site have been identified as Type 17 in the Snohomish County Soil Survey Map, see photo below (old aerial photo). This soil is labeled as, Everett Gravelly Sandy Loam, 0-8% slopes. It is a type A Soil.

17-Everett gravelly sandy loam, 0 to 8 percent slopes. *This very deep, somewhat excessively drained soil is on terraces and outwash plains. It formed in glacial outwash. Areas are long and narrow and are oriented in a northwest to southeast direction. They are 10 to 40 acres in size. The native vegetation is mainly conifers. Elevation is near sea level to 500 feet. The average annual precipitation is about 40 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 170 to 190 days.*
Typically, the surface layer, where mixed to a depth of about 6 inches, is dark brown gravelly sandy loam. The subsoil is dark brown very gravelly sandy loam about 12 inches thick. The upper part of the substratum is brown very gravelly loamy sand about 5 inches thick. The lower part to a depth of 60 inches or more is dark brown extremely gravelly sand. In some areas the substratum is weakly cemented. Included in this unit are small areas of Alderwood soils on till plains, Indianola soils on terraces and outwash plains, and Ragnar soils on outwash plains. Included areas make up about 15 percent of the total acreage. Permeability of this Everett soil is rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. This unit is used mainly as woodland and for urban development. It is also used for pasture. Douglas-fir is the main woodland species on this unit. index is 141. On the basis of a 50-year site curve, the mean site index is 111. The mean annual increment at culmination (CMAI) for Douglas-fir at age 65 is 146 cubic feet per acre. Among the trees of limited extent are western hemlock, western redcedar, and red alder. The common forest understory plants are salal, brackenfern, red huckleberry, common rose, and Oregon-grape. This unit is well suited to year-round logging. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available on this unit. Seedling mortality is the main limitation for the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. High soil temperature and low soil moisture content during the growing season cause a high mortality of seedlings. When openings are made in the canopy, invading brushy plants, if not controlled, can delay the establishment of seedlings. If this unit is used for pasture, the main limitations are low available water capacity and low soil fertility. Proper grazing practices, weed control, and fertilizer are needed for maximum quality of forage. Supplemental irrigation is also needed. Periodic mowing and spreading of droppings help to maintain uniform growth and discourage selective grazing. This unit is suited to urban development; however, if the density of housing is moderate to high, community sewage systems are needed in places to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems. This map unit is in capability subclass VIs
(From the SCS Soils Manual for Snohomish County)

No Soil Logs have been excavated onsite yet, however the soil logs on the neighboring lot (to the West) confirm the SCS soil typing, as well as soils excavated at Cascade Surveying and Engineering (1 block to the East). The applicant proposes to confirm soil types at the time of construction.

4. NARRATIVE OF DEVELOPED SITE CHARACTERISTICS

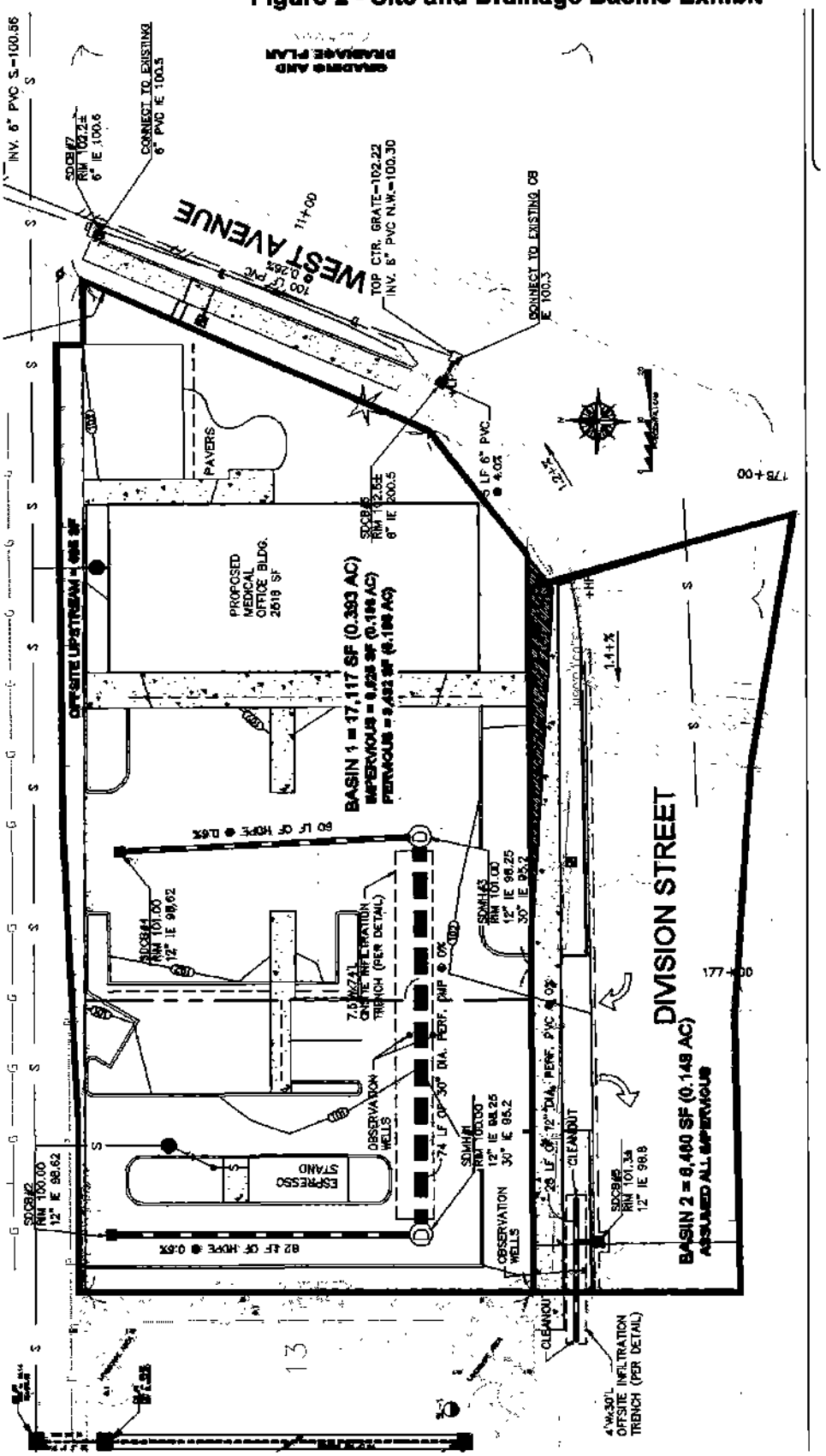
Refer to *Figure 2 – Site and Drainage Basins Exhibit* to aid in the following discussion.

This project proposes to construct a 2,516 sf building and a drive-thru espresso stand along with exterior parking and required infrastructure (stormwater facilities, utilities, etc.). Access will be improved from the street and the alley at the existing site access points.

Stormwater runoff from the site (Basin 1) will be collected, treated, and infiltrated onsite in a water quality and infiltration trench system.

Stormwater runoff from the frontage along Division Street (Basin 2) will be collected in a catch basin and infiltrated into native soils within the planter strip of the right-of-way. Stormwater runoff from the frontage on West Avenue will be collected in catch basins and connected into the City's existing drainage system near the intersection of Division Street and West Avenue. Currently, stormwater ponds at the northwest this corner of this intersection due to lack of drainage at the low point (existing catch basin is located approximately 7 ft off the flowline of the curb). The proposed drainage system along this frontage will rectify this existing problem.

Figure 2 - Site and Drainage Basins Exhibit



5. DESCRIPTION OF PROPOSED EROSION CONTROL BMP's

Clearing, grading, and temporary erosion and sediment control plans will be prepared as part of the civil construction drawings. However, since a construction site is dynamic it will be necessary to reassess the erosion control BMP's during construction and install additional measures when necessary.

Proposed temporary measures possible for this project will include the following BMP's:

- Installation of stabilized rock construction entrance(s).
- Filter fences
- Straw mulch, hydroseed or other mulching and planting method to stabilized unworked areas.
- Inlet protection of new and existing catch basins.

Permanent measures to reduce or eliminate erosion or water quality degradation will include the following BMP's:

- Paving all traffic areas
- Drainage collection system
- Permanent landscaping in pervious areas.
- Limiting cut and fill slopes to 2:1 maximum and 3:1 maximum where exposed to standing water.
- Water quality facilities that will include a water quality infiltration trench.
- Routine maintenance and inspection of the grounds and response to developing problems.

The listed erosion control BMP's will be engineered for anticipated conditions in compliance with the City of Arlington guidelines. With proper installation, maintenance and inspection the proposed BMP's should result in minimal impact to the surrounding environment. The City retains the authority by code to require additional measures should the existing measures prove insufficient.

6. Upstream and Downstream Analysis

There is no upstream for this project. The commercial site to the west infiltrates its stormwater, the alley drainage is mostly accounted for, and the roads to the south and east have a storm system which routes stormwater away from the site.

Existing Sub-Basins and Downstream paths

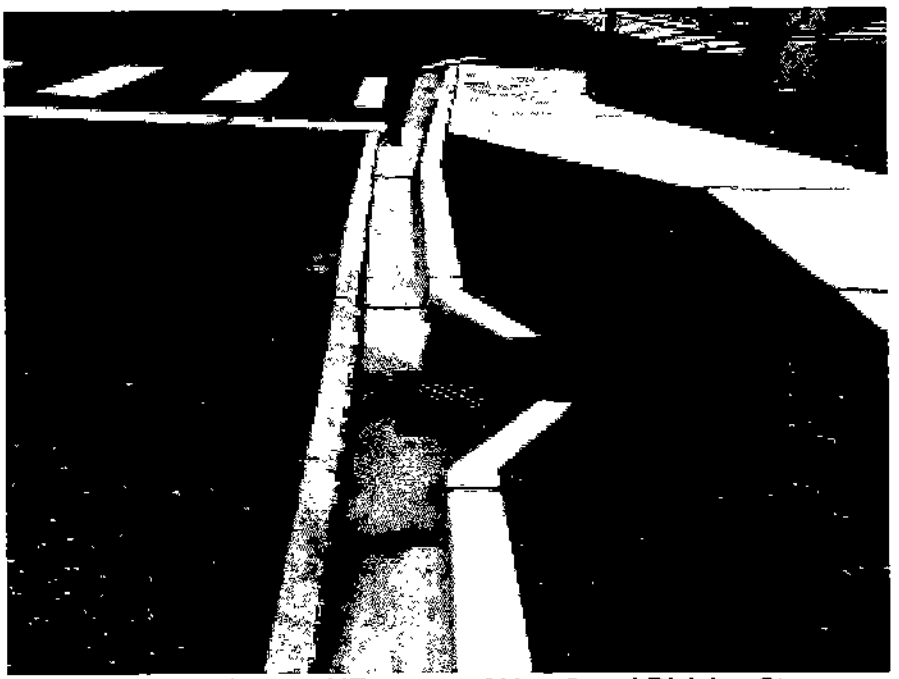
Stormwater on property currently infiltrate into the native site soils. The proposal is to continue to infiltrate all site stormwater into the native soils.

Stormwater runoff from the two frontages flow in different directions. Flows on Division head west, while flows on West Ave, go south. (See photo's on next few pages.)

Looking West near SW property corner on Division St.

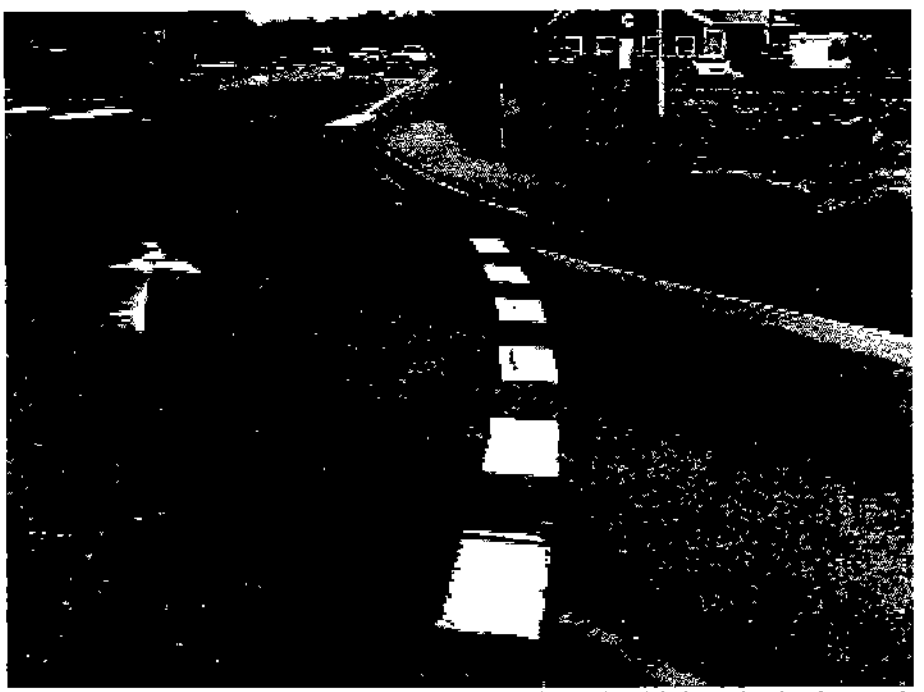
Looking East Near SW property corner on Division St.

Flow from the Division St. Frontage flows westerly along the frontage to a Catchbasin near the northeast corner of the Hwy 9 and Division St. Intersection.

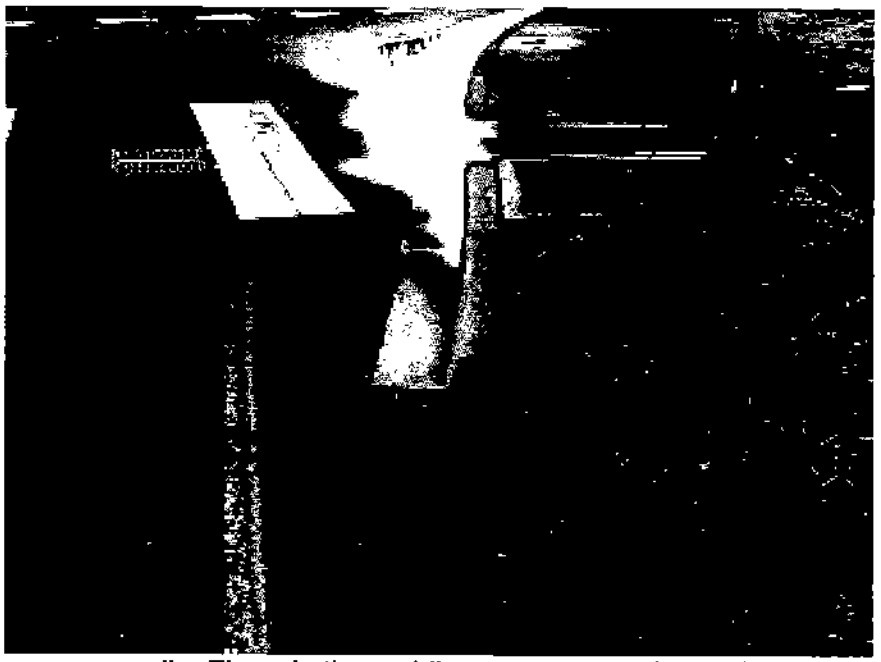


Catchbasin near NE corner of Hwy 9 and Division St.

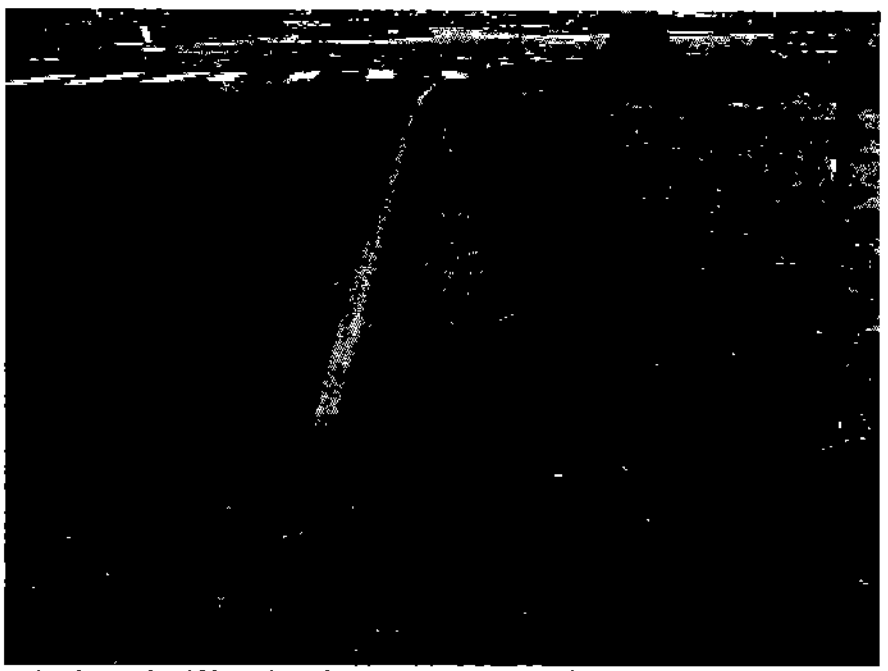
From this catchbasin the flow is routed thru the City storm sewer system to a regional pond.



NW corner of Division St and West Ave intersection, the high point in the curb is near where the white striped line intersects the curb line.



Low point near crosswalk. Flows in the curbline are supposed to go into the existing catch basin, but instead tend to puddle in the flowline along the curb.



Looking South along the West Ave frontage, note that flows are constricted to the edge of pavement by the existing ground/vegetation which is higher than the road edge. The pavement edge falls from south to north along this frontage.

Looking North across the alley entrance and along the West edge of West Ave.

The flow from the road frontage along West Ave is collected in this catch basin. The flow from this catch basin flows to the existing catch basin to the south near the Division Street intersection. This system continues to flow southwest to the main trunkline in the center of Division Street. This system discharges untreated stormwater into the Stillaguamish River. Proposed improvements along West Avenue will discharge to this system. Credit will be taken for areas within Division Street to mitigate flows to this system. See Offsite narrative under the following Section.

7. INFILTRATION DESIGN AND CALCULATIONS

Refer to *Figure 2 – Site and Drainage Basins Exhibit* and *Figure 3 – Infiltration Trench Details* (following page) to aid in the following discussion.

Infiltration Trench Design

The stormwater infiltration trenches were designed as follows:

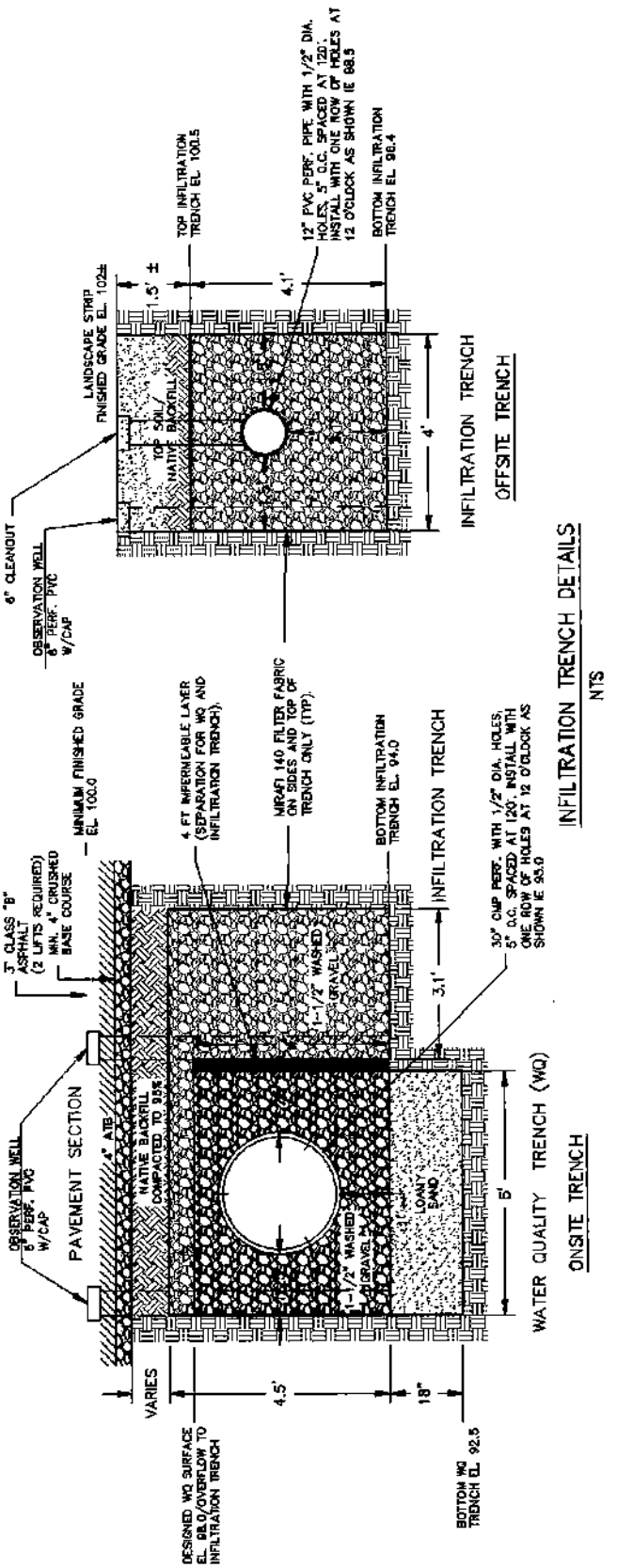
Onsite:
Stormwater from the site is collected and conveyed to a 30" diameter perforated pipe in a gravel filled trench located near the southern entrance of the site. The pipe and trench is designed to retain flows up to the 6-month storm event while infiltrating through a sandy loam layer as designed for water quality treatment. Both the top and sides of the trench is enclosed in an impermeable fabric. Above the design water quality surface elevation (top of designed trench) is an additional gravel layer which provides overflow into another gravel filled trench designed for infiltration up to the 100-year storm event.

Offsite:

As discussed in Section 4, runoff from Division Street will be collected in catch basins and conveyed to the existing City storm drainage system alleviating the existing ponding problem at the intersection. Stormwater runoff from the portion of Division Street fronting the site will be collected in a catch basin and conveyed to an infiltration trench located within the planter strip of the right-of-way near the southwest corner of the site. This infiltration trench is also designed to accommodate the 100-year storm event. Alternatively, this catch basin could be routed into the system within Western Avenue but grades do not allow for adequate drainage or cover (existing CB invert el. 100.3, new CB rim 101.3).

Note that this infiltration trench is designed with enough capacity for approximately 0.15 acres of estimated tributary area from Division Street which is greater than the improvements proposed for both Division Street and West Avenue. Credit will be taken for mitigation of stormwater requirements for the improvements within West Avenue not collected in the infiltration trench system.

Figure 3 – Infiltration Trench Details



Soils and Infiltration Rates

The site is flat with type A soils. The majority of the site will be covered with pavement and buildings although about 29% of the site will be landscaped. Landscaped areas are assumed to have a curve number of 68 in the calculations. Rooftops, sidewalks and pavement have all been assigned a curve number of 98.

Onsite soils assumed to be similar to those of the adjacent All Seasons Spa and Stove property to the west. Long term infiltration rate used for the proposed infiltration trench was **10 in/hr**. The water quality trench which is to be backfilled with sandy loam was designed with an infiltration rate of **0.5 in/hr**. Design infiltration rates used were based on long-term design values presented in the table below taken from the DOE Stormwater Design Manual. Design infiltration rates are appropriate based on those used for the All Seasons Spa and Stove site (pertinent excerpts in Appendix A).

Table 3.7 -- Recommended Infiltration Rates based on USDA Soil Textural Classification.

	*Short-Term Infiltration Rate (in./hr)	Correction Factor, CF	Estimated Long-Term (Design) Infiltration Rate (in./hr)
Clean sandy gravels and gravelly sands (i.e., 90% of the total soil sample is retained in the #10 sieve)	20	2	10
Sand	8	4	2
Loamy Sand	2	4	0.5
Sandy Loam	1	4	0.25
Loam	0.5	4	0.13

*From WEF/ASCE, 1998.

Infiltration Trench Calculations

BASIN 1 - ONSITE

Basin 1 Event Summary:

BasinID	Peak Q (cfs)	Peak T (hrs)	Peak Vol (ac-ft)	Area ac	Method /Loss	Raintype	Event
Basin 1	0.10	7.83	0.0317	0.40	SBUH/SCS	TYPE1A	6 mo.
Basin 1	0.15	7.83	0.0488	0.40	SBUH/SCS	TYPE1A	2 yr
Basin 1	0.19	7.83	0.0629	0.40	SBUH/SCS	TYPE1A	10 yr
Basin 1	0.24	7.83	0.0803	0.40	SBUH/SCS	TYPE1A	25 yr
Basin 1	0.27	7.83	0.0922	0.40	SBUH/SCS	TYPE1A	100 yr

Drainage Area: Basin 1

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	0.1000 ac	68.00	0.11 hrs	
Impervious	0.3000 ac	98.00	0.02 hrs	
Total	0.4000 ac			

Supporting Data:
Pervious CN Data:

landscaping		68.00	0.1000 ac			
Impervious CN Data:						
pavement, c&g (including alley)		98.00	0.2100 ac			
sidewalk (onsite)		98.00	0.0300 ac			
building		98.00	0.0600 ac			
Pervious TC Data:						
Flow type:	Description:		Length:	Slope:	Coeff:	Travel Time
Fixed	Assumed		0.00 ft	0.00%	6.3000	6.30 min
Impervious TC Data:						
Flow type:	Description:		Length:	Slope:	Coeff:	Travel Time
Sheet	sheet flow to cb		110.00 ft	2.50%	0.0110	1.48 min

WQ TRENCH: 6-MONTH STORM EVENT

Control Structure ID: trench-discharge - Infiltration control structure

Descrip:	Infiltration			
Start El	Max El	Increment		
100.0000 ft	105.0000 ft	0.10		
Infil:	**0.50 in/hr**		Multiplier:	1.00

Node ID: Trench Storage

Desc:	Infiltration trench			
Start El:	100.0000 ft		Max El:	104.0000 ft
Contrib Basin:			Contrib Hyd:	
	Length	Width	Void Ratio*	
	74.0000 ft	**5.0000 ft**	**47.00**	

Node ID: Trench

Desc:	infiltration trench		
Start El:	100.0000 ft	Max El:	105.0000 ft
Contrib Basin:		Contrib Hyd:	
Hgl Elev:	99.3251 ft		
Storage Id:	Trench Storage Discharge Id:	trench-discharge	

RLPCOMPUTE [Trench] SUMMARY

6 mo. MatchQ=PeakQ= 0.1005 cfs Peak Out Q: 0.0112 cfs - **Peak Stg: 103.79 ft - Active Vol: 659.49 cf**

*Note that the void ratio was calculated to account for the 30" diameter pipe (see table below).

Pipe			Trench			Total			
Diameter		Unit Area	Width	Depth	Unit Area*	Void Area/LF	Length	Void Volume	Void Ratio
(in)	(ft)	(sf)	(ft)	(ft)	(sf)	(sf)	(ft)	(cf)	(%)
30	2.5	4.91	5	4	15.09	9.43	74	698	47%

*Calculated at 30% void ratio

Required Volume = 660 cf < Provided Volume 698 cf (6% safety factor) → OK

INFILTRATION TRENCH (SDMH#1-SDMH#3): 100-YEAR STORM EVENT

Control Structure ID: trench-discharge - Infiltration control structure

Descrip:	Infiltration			
Start El	Max El	Increment		
100.0000 ft	105.0000 ft	0.10		
Infil:	**10.00 in/hr**		Multiplier:	1.00

Node ID: Trench Storage

Desc:	Infiltration trench		
Start El:	100.0000 ft	Max El:	106.0000 ft
Contrib Basin:		Contrib Hyd:	
	Length	Width	Void Ratio
	74.0000 ft	**2.5000 ft**	**30.00**

Node ID: Trench

Desc:	infiltration trench		
Start El:	100.0000 ft	Max El:	105.0000 ft
Contrib Basin:		Contrib Hyd:	
Hgl Elev:	99.3251 ft		
Storage Id:	Trench Storage	Discharge Id:	trench-discharge

RLPCOMPUTE [Trench] SUMMARY

6 mo. MatchQ=PeakQ= 0.1005 cfs Peak Out Q: 0.0774 cfs - Peak Stg: 100.97 ft - Active Vol: 54.06 cf
2 yr MatchQ=PeakQ= 0.1496 cfs Peak Out Q: 0.1048 cfs - Peak Stg: 101.75 ft - Active Vol: 97.23 cf
10 yr MatchQ=PeakQ= 0.1883 cfs Peak Out Q: 0.1322 cfs - Peak Stg: 102.52 ft - Active Vol: 139.92 cf
100 yr MatchQ=PeakQ= 0.2739 cfs Peak Out Q: 0.1922 cfs - **Peak Stg: 104.22 ft - Active Vol: 234.44 cf**

Trench			Total			
Width	Depth	Unit Area*	Void Area/LF	Length	Void Volume	Void Ratio
(ft)	(ft)	(sf)	(sf)	(ft)	(cf)	(%)
3.1	4.5	13.95	4.19	74	310	30%

*Calculated at 30% void ratio

Required Volume = 235 cf < Provided Volume 310 cf (32% safety factor) → OK

BASIN 2 - OFFSITE

Basin 2 Event Summary:

BasinID	Peak Q	Peak T	Peak Vol	Area	Method	Raintype	Event
------	(cfs)	(hrs)	(ac-ft)	ac	/Loss		
Basin 2	0.05	7.83	0.0156	0.15	SBUH/SCS	TYPE1A	6 mo.
Basin 2	0.07	7.83	0.0234	0.15	SBUH/SCS	TYPE1A	2 yr
Basin 2	0.09	7.83	0.0296	0.15	SBUH/SCS	TYPE1A	10 yr
Basin 2	0.12	7.83	0.0371	0.15	SBUH/SCS	TYPE1A	25 yr
Basin 2	0.13	7.83	0.0421	0.15	SBUH/SCS	TYPE1A	100 yr

Drainage Area: Basin 2

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	0.0000 ac	68.00	0.00 hrs	
Impervious	0.1500 ac	98.00	0.04 hrs	
Total	0.1500 ac			

Supporting Data:

Impervious CN Data:

offsite area	98.00	0.1500 ac

Impervious TC Data:

Flow type:	Description:	Length:	Slope:	Coeff:	Travel Time
Sheet	sheet flow to cb	145.00 ft	1.40%	0.0110	2.32 min

INFILTRATION TRENCH (SDCB#5): 100-YEAR STORM EVENT

Control Structure ID: trench-discharge - Infiltration control structure

Descrip:	Infiltration			
Start El	Max El	Increment		
100.0000 ft	105.0000 ft	0.10		
Infil:	**10.00 in/hr**		Multiplier:	1.00

Node ID: Trench Storage

Desc:	Infiltration trench			
Start El:	100.0000 ft		Max El:	106.0000 ft
Contrib Basin:			Contrib Hyd:	
	Length	Width	Void Ratio	
	30.0000 ft	**4.0000 ft**	**30.00**	

Node ID: Trench

Desc:	infiltration trench		
Start El:	100.0000 ft	Max El:	105.0000 ft
Contrib Basin:		Contrib Hyd:	
Hgl Elev:	99.3251 ft		
Storage Id:	Trench Storage Discharge Id:	trench-discharge	

RLPCOMPUTE [Trench] SUMMARY

6 mo. MatchQ=PeakQ= 0.0500 cfs Peak Out Q: 0.0364 cfs - Peak Stg: 100.55 ft - Active Vol: 19.79 cf
2 yr MatchQ=PeakQ= 0.0744 cfs Peak Out Q: 0.0507 cfs - Peak Stg: 101.45 ft - Active Vol: 52.21 cf
10 yr MatchQ=PeakQ= 0.0936 cfs Peak Out Q: 0.0598 cfs - Peak Stg: 102.03 ft - Active Vol: 73.11 cf
100 yr MatchQ=PeakQ= 0.1317 cfs Peak Out Q: 0.0821 cfs - **Peak Stg: 103.46 ft - Active Vol: 124.44 cf**

*Note that the void ratio used was 30% (less than actual calculated accounting for void volume of pipe).

Pipe			Trench			Total			
Diameter		Unit Area	Width	Depth	Unit Area*	Void Area/LF	Length	Void Volume	Void Ratio
(in)	(ft)	(sf)	(ft)	(ft)	(sf)	(sf)	(ft)	(cf)	(%)
12	1	0.79	4	4.1	15.62	5.47	30	164	33%

*Calculated at 30% void ratio

Required Volume = 125 cf < Provided Volume 160 cf (31% safety factor) ➔ OK

8. CONVEYANCE CALCULATIONS

Using Manning's equation to determine pipe capacity for a 6" diameter pipe (minimum designed) at 0.5% slope (minimum allowable):

Manning Pipe Calculator

Given Input Data:

Shape	Circular
Solving for	Flowrate
Diameter	6.0000 in
Depth	6.0000 in
Slope	0.0050 ft/ft
Manning's n	0.0120

Computed Results:

Flowrate	**0.4298 cfs**
Area	0.1963 ft2
Wetted Area	0.1963 ft2
Wetted Perimeter	18.8496 in
Perimeter	18.8496 in
Velocity	2.1891 fps
Hydraulic Radius	1.5000 in
Percent Full	100.0000 %
Full flow Flowrate	0.4298 cfs
Full flow velocity	2.1891 fps

Critical Information

Critical depth	4.7575 in
Critical slope	0.0084 ft/ft
Critical velocity	3.5483 fps
Critical area	0.1714 ft2
Critical perimeter	12.9398 in
Critical hydraulic radius	1.9075 in
Critical top width	6.0000 in
Specific energy	0.6154 ft
Minimum energy	0.5947 ft
Froude number	0.7191
Flow condition	Subcritical

Pipe Capacity = ***0.43 cfs*** > Q_{100} = ***0.27 cfs*** ➔ ***OK***

9. Maintenance and Operations Manual

The owner will be responsible for maintaining the stormwater facilities within this site. Included in this manual are checklists for each feature specific to this project. Copies should be made of the checklists as necessary during routine inspections and required maintenance. Specific problems can be recorded along with the appropriate action taken. Along with normal maintenance the Association will enter into a long term maintenance agreement with STORMWATER Management.

The checklists are a guide for inspections and maintenance. The frequency of the inspections/maintenance is identified in the left hand column with the following abbreviations:

A = Annual (March or April preferred)
M = Monthly
S = After Major Storms (Use 1-inch in 24 hours as a guideline)

Routine inspections and maintenance will improve the long-term performance of the stormwater facilities. If at any time you are unsure if a problem exists or how to address a specific problem contact a Professional Engineer.

Maintenance Checklist for Conveyance Systems (Pipes, Ditches, and Swales)

Frequency	Drainage Systems Feature		Problem	Conditions to Check for	Conditions that should exist
M,S	Pipes		Sediment and debris	Accumulated sediment that exceeds 20% of the diameter of the pipe.	Pipe cleaned of all sediment and debris.
M			Vegetation	Vegetation that reduces free movement of water through pipes.	All vegetation removed so water flows freely through pipes.
A			Damaged (rusted, bent, or crushed)	Protective coating is damaged; rust is causing more than 50% deterioration to any part of pipe.	Pipe repaired or replaced.
M				Any dent that significantly impedes flow (I.e., decreases the cross section area of pipe by more than 20%0.	Pipe repaired or replaced.
M				Pipe has major cracks or tears allowing groundwater leakage.	Pipe repaired or replaced.
M,S	Open ditches		Trash and debris	Dumping of yard wastes such as grass clippings and branches into basin. Unsightly accumulation of non-degradable materials such as glass, plastic, metal, foam, and coated paper.	Remove trash and debris and dispose as prescribed by the County.
M			Sediment buildup	Accumulated sediment that exceeds 20% of the design depth.	Ditch cleaned of all sediment and debris so that it matches design.
A			Vegetation	Vegetation I.e., weedy shrubs or saplings that reduces tree movements of water through ditches.	Water flows freely through ditches. Grassy vegetation be left alone.
M			Erosion damage to slopes	See Ponds Checklist.	See Ponds Checklist.
A			Rock lining out of place or	Maintenance person can see native	Replace rocks to design standard.

			missing (if applicable)	soil beneath the rock lining.	
Varies	Catch basins			See Catch Basins Checklist.	See Catch Basins Checklist.
M,S	Swales		Trash & debris	See above for Ditches.	See above for Ditches.
M,S			Sediment buildup	See above for Ditches.	Vegetation may need to be replanted after cleaning.
M			Vegetation not growing or overgrown	Grass cover is sparse and seedy or areas are overgrown with woody vegetation.	Aerate soils and reseed and mulch bare areas. Maintain grass height at a minimum of 6 inches for best stormwater treatment. Remove woody growth, recontour, and reseed as necessary.
M,S			Erosion damage to slopes	See Ponds Checklist.	See Ponds Checklist.
M,S			Conversion by homeowner to incompatible use	Swale has been filed in or blocked by shed, woodpile, shrubbery, etc.	If possible, speak with homeowner and request that swale area be restored. Contact the County to report problem if not rectified voluntarily.
A			Swale does not drain	Water stands in swale or flow velocity is very slow. Stagnation occurs.	A survey may be needed to check grades. Grades need to be in 1-5% range if possible. If grade is less than 1% underdrains may need to be installed.

Maintenance Checklist for Grounds (Landscaping)					
Frequency	Drainage Systems Feature		Problem	Conditions to Check for	Conditions that should exist
M	General		Weeds (nonpoisonous)	Weeds growing in more than 20% of the landscaped area (trees and shrubs only)	Weeds present in less than 5% of the landscaped area.
M			Insect hazard	Any presence of poison ivy or other poisonous vegetation or insect nests.	No poisonous vegetation or insect nests present in landscaped area.
M,S			Trash or litter	See Ponds Checklist.	See Ponds Checklist.
M,S			Erosion of Ground Surface	Noticeable ruts are seen in landscaped areas.	Causes of erosion are identified and steps taken to slow down/spread out the water. Eroded areas are filled, contoured, and seeded.
A	Trees and shrubs		Damage	Limbs or parts of trees or shrubs that are split or broken which affect more than 25% of the total foliage of the tree or shrub.	Trim trees/shrubs to restore shape. Replace trees.shrubs with severe damage.
M				Trees or shrubs that have been blown down or knocked over.	Replant tree, inspecting for injury to stem or roots. Replace if severely damaged.
A				Trees or shrubs which are no adequately supported or are leaning over. Causing exposure of the roots.	Place stakes and rubber-coated tubes around young trees/shrubs for support.

Maintenance checklist for Infiltration Systems

Frequency	Drainage Systems Feature		Problem	Conditions to Check for	Conditions that should exist
M,S	General		Trash & debris buildup in pond	See Maintenance Checklist for Ponds.	See Maintenance Checklist for Ponds.
M			Poisonous vegetation	See Maintenance Checklist for Ponds.	See Maintenance Checklist for Ponds.
M,S			Fire hazard or pollution	See Maintenance Checklist for Ponds.	See Maintenance Checklist for Ponds.
M			Vegetation not growing or overgrown	See Maintenance Checklist for Ponds.	See Maintenance Checklist for Ponds.
M			Rodent holes	See Maintenance Checklist for Ponds.	See Maintenance Checklist for Ponds.
M			Insects	See Maintenance Checklist for Ponds.	See Maintenance Checklist for Ponds.
A	Storage area		Sediment buildup in system	A soil texture test indicates facility is not working at its designed capabilities or was incorrectly designed.	Sediment is removed and/or facility is cleaned so that infiltration system works according to design. A sediment trapping area is installed to reduce sediment transport into infiltration area.
A			Storage area drains slowly (more than 48 hours) or overflows	A soil texture test indicates facility is not working at its designed capabilities or was incorrectly designed.	Additional volume is added through excavation to provide needed storage. Soil is aerated and retilled to improve drainage. Contact the County for

					information on its requirements regarding excavation.
M			Sediment trapping area	Any sediment and debris filling area to 10% depth from sump bottom to bottom of outlet pipe or obstructing flow into the connector pipe.	Clean out sump to design depth.
One Time			Sediment trapping area not present	Stormwater enters infiltration area directly without treatment .	Add a trapping area by constructing a sump for settling of solids. Segregate settling area from rest of facility. Contact the County for guidance.
M	Rick filters		Sediment and debris	By visual inspection little or no water flows through filter during heavy rain storms.	Replace gravel in rock filter.

Catch Basins and Inlets

Frequency	Drainage Systems Feature		Problem	Conditions to Check for	Conditions that shall exist
M,S	General		Trash, debris, and sediment in or on basin.	Trash or debris in front of the catch basin opening is blocking capacity by more than 10%.	No trash or debris located immediately in front of catch basin opening. Grate is kept clean and allows water to enter.
M				Sediment or debris (in the basin) that exceeds 1/3 the depth from the bottom of basin to invert of the lowest pipe into or out of the basin.	No sediment or debris in the catch basin. Catch basin is dug out and clean.
M,S				Trash or debris in any inlet or pipe blocking more than 1/3 of its height.	Inlet and outlet pipes free of trash or debris.
M			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.
M				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.
M				Frame is 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.
A			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 unbound.	Basin replaced or repaired to design standards. Contact a professional engineer for evaluation.
A				Cracks wider than 1/2 inch and longer than 1 foot at the joint of any inlet/outlet	No cracks more than 1/4 inch wide at the joint of inlet/outlet pipe. Contact a

				pipe or any evidence of soil particles entering catch basin through cracks.	professional engineer for evaluation.
A			Settlement/ misalignment	Basin has settled more than 1 inch or has rotated more than 2 inches out of alignment.	Basin replaced or repaired to deign standards. Contact a professional engineer for evaluation.
M,S			Fire hazard or other pollution	Presence of chemicals such as natural gas, oil, and gasoline. Obnoxious color, odor, or sludge noted.	No color, odor, or sludge. Basin is dug out and clean.
M,S			Outlet pipe is clogged with vegetation	Vegetation or roots growing inlet/outlet pipe joints that is more than six inches tall and less than six inches apart.	No vegetation or root growth present.

APPENDIX A

ALL SEASON'S SPA AND STOVE
STORM DRAINAGE REPORT EXCERPT

DRAINAGE NOTES AND CALCULATIONS

FOR

All Seasons Spa and Stove- File Number: Z-05-038

Prepared by:

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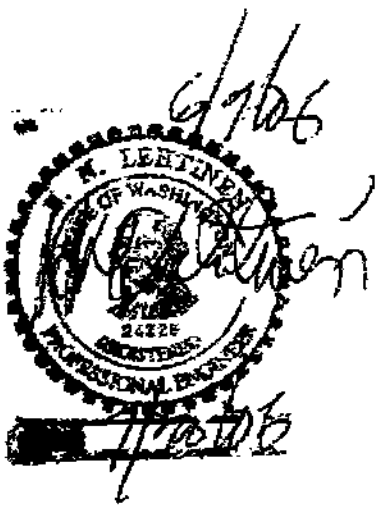

PROPOSED DEVELOPMENT

The proposal is to combine the three lots into one and to build a retail store with landscaping, walkways, hard surfaced display areas and a parking lot. Access will be taken from the gravel alleyway. The alleyway will be asphalt paved along the north property boundary. Impervious areas include the parking lot and associated pavement and the building roof. The parking lot and associated pavement shall be directed to the water quality trench for water quality control. The roof downspouts will be directed to the infiltration trench with underground pipes.

The alley way will be graded to direct stormwater runoff into the landscaped areas. Landscaping areas will be graded to provide a swale within the landscape areas and allowed to infiltrate directly into the soil.

Two separate infiltration trenches will provide water Quality Control and Water Quantity Control for the site. The infiltration trenches have been sized to store and infiltrate runoff generated by the impervious areas.

Two soil test pits were excavated onsite to depths of 10.5 feet and 12 feet. The soil logs demonstrate that the native soil has a high rate of infiltration. We have estimated the long term infiltration rates for the native soil to be 10 inches per hour, half of the 1992 DOE Stormwater Manual's infiltration rate for coarse sand and cobbles. We have used 1.2 inches per hour for the infiltration rate of the water quality trench, one half of the DOE rate for loamy sand.

Water Quality:

All impervious surfaces will be graded to two catch basins, one on either end of the water quality trench. The bottom of the water quality trench will be lined with a minimum of 18-inches of loamy sand for stormwater treatment during the infiltration process. The water quality trench has been sized to store and infiltrate the six-month storm event.

Water Quantity:

Larger storm events will pass from the water quality trench via a flow diverter in the catch basins and flow directly into the infiltration trench. Roof downspouts will be piped directly to the infiltration trench. See Infiltration Trench Plan, Figure 2, Page 10, and Infiltration Detail, Figure 3, Page 11.

SOIL LOGS:

SL-1:

0-2'	Brown loamy gravelly sand
2-4'	Tan loamy gravelly sand
4-12'	Gray gravelly medium sand
	No mottling, hardpan or water was encountered

SL-2:

0-1'	Brown loamy gravelly sand
1-4'	Tan gravelly medium sand
4-10.5'	Gray gravelly coarse sand
	No mottling, hardpan or water was encountered