Appendix B

Pre-Design Record

DRAFT PRE-DESIGN RECORD
DRAINAGE ANALYSIS & DESIGN CRITERIA SUMMARY

Project Name: Poplar Way Extension – Phase 2

Perteet Job No: 20100156

Date: September 23, 2013

Project Manager: Carl Einfeld, P.E.

Surface Water Engineer: Brian Caferro, P.E.

Client: City of Lynnwood Public Works

City or County: Snohomish County

Project Description:
Major elements of the Poplar Way Extension Bridge project will include a new multi-lane bridge structure with 6 lanes, pedestrian and bicycle facilities; intersection modifications and grade adjustments to accommodate tie-in to existing streets on either side of the freeway; and widening and restriping of portions of Poplar Way, 196th Street SW, Alderwood Mall Boulevard, 33rd Avenue W and Alderwood Mall Parkway.

A. Summary of Recommendations

Provided below is a summary of the major drainage design standards which will be followed on the Poplar Way Extension Bridge Project.

- Since a large portion of the project is within WSDOT right-of-way the project will follow the 2011 WSDOT Highway Runoff Manual (HRM) for runoff flow control and water quality treatment and the 2010 WSDOT Hydraulics Manual (HM) for conveyance and hydraulic report format. The HRM and the Washington State Department of Ecology's 2005 "Stormwater Management Manual for Western Washington" are deemed equivalent by Ecology.
- Conveyance systems are to be designed for 'undetained flows', in the event that a detention facility fails to function properly.
- Detention and Water Quality Hydrologic Analysis: WWHM™ version 4 will be used for flow control analysis (Existing pond retrofit with Thirsty Duck flow regulators) and to size Filterra units.
- Conveyance Model: StormShed3G™ model, using the SBUH method and a 25 year storm event, will be used to size the conveyance systems.
- 'Enhanced Treatment': This criterion is a function of ADTs, derived to the design year of the project, year 2040. This defines whether or not the water quality treatment facilities are to be designed to 'basic' or 'enhanced' treatment levels. ***(Note: the project will require enhanced treatment since the current and future ADT levels are greater than 7,500)***
- Oil Control Treatment at Intersections: This criterion is a function of ADT's at the intersections. The 2040 forecast ADT's for the two intersections associated with this project are as follows:

Poplar Way/Alderwood Mall Blvd
West leg = 27,800 South leg = 31,500
East leg = 13,400 North leg = 23,800

Poplar Way/196th Street SW
West leg = 42,500 South leg = 40,400
East leg = 32,300 North leg = 31,500

The ADT numbers above exceed the thresholds for oil treatment, therefore both intersections will need to incorporate measures for oil treatment.

- If Infiltration is feasible: Use minimum clearances between the bottom of the infiltration facility and the high groundwater table, listed in the HRM, or a mounding analysis can be done by the geotechnical engineer to demonstrate the infiltration facility will function if minimum clearances cannot be achieved.
- Stormwater BMP's: The list of options in the HRM and HRM Category 1 BMPs are acceptable, with the following exceptions: Sand filters are strongly discouraged given their high maintenance needs. Stormwater BMPs approved by Ecology through the TAPE protocol testing and review process, such as Filterra™ and StormFilters, are also acceptable stormwater BMPs.

Standards

Minimum Requirement for Runoff Control and Water quality Treatment, Threshold Analysis and BMP Design Criteria-
The 2011 WSDOT Highway Runoff Manual (HRM).

Conveyance and Hydraulic Report Format-
The 2010 WSDOT Hydraulics Manual (HM)

B. Documentation Summary of Drainage Design Standards

Design Element	Standard Requirement	Source
Threshold Analysis/ Minimum Requirements:	This project shall follow the threshold analysis and minimum requirement determination procedures as outlined in Section 3-2 and 3-3 of the HRM. The threshold determination will be based on requirements set forth in Chapter 3 of the HRM. The following will be applied: Flow Control area = minimum requirement from HRM + 3% (design contingency) Water Quality Treatment area= minimum requirement from HRM and + 3% (design contingency) Since the project is in an early stage of design, a 3% design contingency will be added to the area calculation to account for minor changes that may occur during the on-going road design process.	HRM pgs. 3-1 to 3-30
Hydrologic/Hydraulic Model:		
Flow Control:	MGSFlood for continuous simulation modeling (Version 4) or WWHM4 will be used.	HRM pg. 3-25
Water Quality:	MGS Flood (Version 4) or WWHM4 (for Filterra sizing)	HRM pg. 3-17
Conveyance:	Storm Drains: StormShed3G for pipe sizing and backwater analysis - SBUH Method to be used (minimum Time of Concentration = 5 minutes) *(Manning's roughness coefficient per HM Appendix 4-41)* Culverts: For hydrologic analysis use published flow records, flood reports, USGS Regression or Rational Method. WSDOT has also allowed the use of MGSFlood in the past. For hydraulic analysis and culvert sizing use HY-8 or HEC-RAS. WSDOT has also allowed the use of CulvertMaster in the past. Ditches, channels, roadway gutters, etc. (open channel flow): StormShed3G model using SBUH method. A simple software program such as Flowmaster has	HM pgs. 1-9, 6-11, 6-12 HM pg. 1-9 HM pg. 1-9

Design Element	Standard Requirement	Source
	also been allowed by WSDOT in the past. *(Manning's roughness coefficient per HM Appendix 4-41)*	
Gutter Flow:	Modified WSDOT Spreadsheet	HM pg. 1-9
	Runoff coefficients to be used for the Rational Method shall be taken from Figure 2-5.2 of the 2010 WSDOT Hydraulics Manual (HM). These coefficients are for the 10-year return frequency.	
Infiltration:	MGS Flood (Version 4) – 1 hour time steps	HRM pg. 4-53
Design Storm Events:		
Flow Control:	Provide storage volume required to match the duration of pre-developed peak flows from 50% of the 2-yr storm up to the 50-yr storm flow, using a flow restrictor (such as an orifice or weir) and 1 hour time steps. Check the 100-yr peak flow for property damage. The pre-developed condition to be matched shall be a forested land cover unless the project meets the exceptions as listed under HRM.	HRM pg. 3-25 (Table 3-6)
Water Quality:	Volume based (on-line) (1 hour time steps): Size the wetpool to store the 91st percentile, 24-hour runoff volume. Other volume based infiltration and filtration facilities – Size the facility to treat 91% of the estimated runoff file for the post-developed condition.	HRM pg. 3-17 (Table 3-3)
	Flow-based upstream of flow control facility (15 minute time steps): Size treatment facility so the 91% of the annual average runoff will receive treatment at or below the design loading criteria, under post developed conditions for each TDA. If the flow rate is split upstream of the treatment facility, use the off-line flow rates. (15-minute time steps)	HRM pg. 3-17 (Table 3-3)
	Flow-based downstream of flow control facility (1 hour time steps): Size treatment facility using the full 2-year release rate from the detention facility, under post developed conditions for each TDA.	HRM pg. 3-17 (Table 3-3)
Conveyance:	Storm drain pipes & ditches: 25-year recurrence interval for storm drain laterals and trunks and the 10-year recurrence interval for laterals without trunks.	HM pg. 6-9
	Culverts: • Circular Pipe, Box Culverts and Pipe Arches: 25-year flow event WSEL should not exceed the allowable headwater. Additionally, the WSEL for the 25-year event should	HM pg. 3-8

Design Element	Standard Requirement	Source
	not exceed the elevation of the base course of the roadway. It is recommended that the culverts be sized such that there is no roadway overtopping during the 100-year flow event. • Concrete or Metal Bottomless Culverts: 1 foot of debris clearance should be provided between the water surface and the top of the arch during the 25-year flow event. Additionally the WSEL for the 25-year event should not exceed the elevation of the base course of the roadway. The depth of flow during the 100-year flow event should not exceed the height of the arch. • Temporary Culverts: 2-year storm event unless a different storm event can be justified per the guidelines outlined on pg. 3-12 of the HM.	HM pg. 3-9 HM pg. 3-12
	<u>Ditches, channels, roadway gutters, etc. (open channel flow):</u> 10-year recurrence interval	HM pg. 4-11
Gutter Flow:	10-year recurrence interval for continuous grade analysis 50-year recurrence interval for sag analysis	HM pg. 5-5
Infiltration:	<u>Water Quality Treatment (1 hour time steps):</u> Size the facility to treat 91% of the estimated runoff file for the post-developed condition. <u>Flow Control (1hour time steps):</u> Size facility to infiltrate sufficient volumes so that the overflow matches the duration standard, and check the 100-year peak flow to estimate the potential for downstream property damage, or infiltrate the entire runoff file.	HRM pg. 3-17 (Table 3-3) HRM pg. 3-25 (Table 3-6)
Precipitation Data Source:	<u>Rational Method: Rainfall intensity values from Figure 2-5.4A (Everett):</u> 10 yr: m = 6.31, n = 0.575 25 yr: m = 7.83, n = 0.582 100 yr m = 10.07, n = 0.586 <u>SBUH Method (Type 1A storm):</u> Precipitation isopoluvial maps: Appendix 4A 2 yr: 1.50” 10 yr: 2.20” 25 yr: 3.00” 100 yr: 3.50” <u>Continuous Simulation:</u>	HM pg. 2-14 HM pg. 2-18 HRM pg. 4-14

Design Element	Standard Requirement	Source
	Extended Time Series Region Map: Puget East 40 in MAP	
Pre-Developed Conditions: (Forested, etc.)	Forested conditions. (per HRM Glossary of Terms: pre-developed conditions defined, aka "historic land cover")	HRM pg. 3-25
Conveyance Design Criteria:	<u>Storm Drains:</u> Pipe runs between junctions should not exceed 300 feet for pipes smaller than 48-inches in diameter and 500 feet for pipes 48-inches or larger in diameter.	HM pg. 6-3
	Minimum design velocity is 3 feet per second under full flow conditions. Maximum design velocity is 10 feet per second under full flow conditions.	HM pg. 6-3
	Branch or trunk line pipe crowns of differing diameter should be at the same elevation when entering and exiting junctions.	HM pg. 6-4
	Minimum pipe diameter is 12 inches.	HM pg. 6-4
	Storm drains should be designed to include all Schedule A pipe options, unless specific site constraints limit options.	HM pg. 6-4
	Pipe diameters shall not decrease in downstream runs.	HM pg. 6-4
	Pipes systems shall be designed such that the HGL does not exceed any rim elevations within the system.	HM pg. 6-14
	<u>Ditches/Open Channels:</u> Ditches shall have 0.5 feet of freeboard and a max 2:1 side slope.	HM pg. 4-11
	Vegetated ditch lining is acceptable for ditch grades up to 6% and with a maximum velocity of 5 feet per second. For higher velocities and channel slopes, more protective channel linings are required.	HM pg. 4-11
	<u>Culverts:</u> The minimum diameter of culvert pipes under a main roadway shall be 18 inches and the minimum diameter of culvert pipes under a roadway approach shall be 12 inches.	HM pg. 3-6

Design Element	Standard Requirement	Source
	Circular Pipe, Box Culverts and Pipe Arches: 25-year flow event WSEL should not exceed the allowable headwater. Additionally, the WSEL for the 25-year event should not exceed the elevation of the base course of the roadway. It is recommended that the culverts be sized such that there is no roadway overtopping during the 100-year flow event.	HM pg. 3-8
	Culvert spans over 20 feet are considered bridges and any hydraulic design for bridges is the responsibility of HQ Hydraulics.	HM pg. 3-8
	Concrete or Metal Bottomless Culverts: 1 foot of debris clearance should be provided between the water surface and the top of the arch during the 25-year flow event. Additionally the WSEL for the 25-year event should not exceed the elevation of the base course of the roadway. The depth of flow during the 100-year flow event should not exceed the height of the arch.	HM pg. 3-9
	Allowable Headwater for circular culverts, box culverts and pipe arches shall be as follows: • HW/D < 1.25 for the 25-year event • Headwater shall not overtop the roadway during 100-year event	HM pg. 3-14
	Allowable Headwater for bottomless culverts shall be as follows: • 1 foot of debris clearance shall be provided between the 25-year flow event water surface elevation and the culvert crown. • Headwater depth shall not exceed the culvert crown during the 100-year flow event.	HM pg. 3-15
Flow Control/Water Quality Facility Design Criteria:	<u>Detention Pond:</u> 1 foot minimum freeboard between design surface water elevation and top of pond.	HRM pg. 5-179
	Primary overflow (typically the control structure riser pipe) shall be designed to bypass the 100 year post developed peak flow in the event the control structure becomes plugged.	HRM pg. 5-181
	Minimum orifice diameter is 0.50 inches.	HRM pg. 5-181
	Minimum vertical rectangular orifice length is 0.25 inches.	HRM pg. 5-182
	Consider the use of a flow screen on orifices less than 1 inch in diameter.	HRM pg. 5-181
	Ponds must provide an emergency overflow capable of conveying the 100 year peak flow.	HRM pg. 5-185

Design Element	Standard Requirement	Source
	For impoundments of 10 acre-feet or greater, the emergency overflow spillway must meet the state's dam safety requirements.	HRM pg. 5-185
	Pond bottoms must be a minimum of 0.5 feet below the outlet invert elevation to provide sediment storage.	HRM pg. 5-186
	Interior side slopes should not be steeper than 3H:1V unless fence is provided.	HRM pg. 5-186
	Exterior side slopes must not be steeper than 2H:1V unless analyzed or stability by a geotechnical engineer.	HRM pg. 5-186
	Pond walls may be vertical subject to the requirements outlined in HRM pgs. 5-186 to 5-187.	HRM pg. 5-186
	There shall be a minimum 6 foot top width for pond berms up to 6 feet high.	HRM pg. 5-187
	Pond berms greater than 4 feet high must be constructed by excavating a key trench equal to 50% of the berm embankment cross-sectional height and width unless specified otherwise by a geotechnical engineer.	HRM pg. 5-187
	Ponds must be a minimum of 5 feet from any property line or vegetative buffer and 100 feet from any septic tank or drain field.	HRM pg. 5-189
	If grade allows a gravity drain shall be installed.	HRM pg. 5-27
	<u>Constructed Wetland:</u> Consists of two cells: pre-settling cell and wetland cell.	HRM pg. 5-101
	Pre-settling cell must contain approximately 33% of the wet pool volume and be between 4 feet and 8 feet deep, excluding 1 foot of sediment storage.	HRM pg. 5-101
	Wetland cell must not exceed a water depth of about 1.5 feet (plus or minus 3 inches).	HRM pg. 5-102
	Setbacks same as detention ponds.	HRM pg. 5-189
	For combined detention pond and constructed wetlands, the detention (live) storage shall be limited to the pre-settling cell.	HRM pg. 5-114
	<u>Detention Vault/Tank:</u>	

Design Element	Standard Requirement	Source
	See 2005 Ecology Manual for detention vault and tank guidelines. <u>StormTank (Plastic Detention Chamber):</u> Design criteria per manufacturer's recommendations. <u>Infiltration facilities:</u> Infiltration facilities shall meet the site suitability criteria outlined in the HRM on pgs. 4-34 to 4-37	HRM pgs. 4-34 to 4-37

Appendix C

Alternative Comparison

Alternative #1 Concrete Detention Vault / Filterra Units	
Planning Level Cost $811,700	
Advantages	**Disadvantages**
• Concrete vaults are long lasting. • Facility concentrated within a smaller footprint than an open pond. • Facility located within project area limits. • Less storm drain pipe than Altenative #2	• Concrete vaults are very expensive. • Construction is very labor intensive. • When maintenance is required the procedure is more costly due to confined space rules, visibility and ventilation issues. • Vault located within PUD property. Easement or other agreement needed between PUD and City of Lynnwood. • Cover above vault lid varies from 1 foot to 15 feet. This adds to cost of vault. • Vault would need to be two celled. Hardest to maintain.

Alternative #2 Concrete Detention Vault / Filterra Units	
Planning Level Cost $839,600	
Advantages	**Disadvantages**
• Concrete vaults are long lasting. • Facility concentrated within a smaller footprint than an open pond. • Facility located within project area limits. • Proposed location provides easier access and a shallower system than Alternative #1. • One cell. Easier to maintain than vault in Alternative #1.	• Concrete vaults are very expensive. • Construction is very labor intensive. • When maintenance is required the procedure is more costly due to confined space rules, visibility and ventilation issues. • Vault located within PUD property. Easement or other agreement needed between PUD and City of Lynnwood. • Proposed location of vault is outside of current project limits and would therefore require additional survey. • More conveyance is required for this alternative. • Additional Survey is needed.

Alternative #3 Existing Pond Retrofit / Filterra Units	
Planning Level Cost $319,900	
Advantages	**Disadvantages**
• No new facility needed. • Utilizes an existing regional facility • No maintenance required besides the maintenance which the existing pond currently receives. • Cheapest Alternative.	• Would be the first installation of this product within the City of Lynnwood. City is fairly unfamiliar with the product.

Alternative Comparison			
Item	**Alternative #1 Cost**	**Alternative #2 Cost**	**Alternative #3 Cost**
Detention Vault	$380,000	$350,000	N/A
Filterra Units	$121,000	$121,000	$121,000
Conveyance	$117,410	$143,417	$74,100
Shoring/Excavation	$57,930	$81,690	$21,400
Additional Survey	N/A	$3,500	N/A
Thirsty Duck Retrofit	N/A	N/A	$50,100
Contingencies	$135,270	$139,920	$53,300
Total	**$811,700**	**$839,600**	**$319,900**

Appendix D

Project Summaries

PROJECT SUMMARY SHEET

Project Title: Drainage ditch retrofit to a create a bioretention swale in the Golde Creek basin

Problem Description: Sedimentation in Golde Creek due to runoff from urban development in the watershed. Potential source of fecal coliform bacteria in Swamp Creek downstream (which has a TMDL for fecal coliform bacteria).

Project Description: Conversion of a drainage ditch along the south side of Alderwood Mall Parkway between 28th Ave and Poplar Way to a bioretention swale.

Design Assumptions:

- Vegetation will be selected by the City and local residents and will include a variety of small trees, shrubs, and groundcover. Plants should be selected to be drought tolerant and not require watering after establishment (2-3 years).
- Maximum ponding depth will be 12 inches.
- Planting soil depth should be approximately 1 foot.
- Mulch layer will be 3 inches.
- Underdrain of 6-8 inches slotted PVC pipe.

Project Benefits: Enhanced storage, infiltration, and pollutant removal (e.g., heavy metals, phosphorus, oil, and suspended sediments).

Maintenance Requirements[a]:

- Watering: First 2-3 years until plants are established, watering during prolonged dry periods
- Erosion Control: Inspect periodically and replace soil, plant material, and/or mulch layer in areas where erosion has occurred
- Plant Material: Occasional pruning and removing dead plant material. Periodic weeding is necessary until plants are established.
- Nutrients and Pesticides: Nutrient and pesticide inputs should not be required since the soil mix and plants are selected for plant establishment and growth.
- Mulch: Add mulch as needed to maintain a 2-3 inch depth at least once every 2 years.
- Soil: The soil mix is designed to maintain long-term pollutant processing capability and should not need to be replaced for at least 20 years.

Estimated Project Cost: $120,000

[a] Source: Low Impact Development Technical Guidance Manual for Puget Sound (PSAT 2005).

Figure 1. Potential location for a bioretention swale in the Golde Creek basin.

Figure 2. Current condition of drainage ditch along the south side of Alderwood Mall Parkway between 28th Ave and Poplar Way.

Table 1. Planning level design, permitting, and construction cost estimate for drainage ditch retrofit in the Golde Creek basin.

Item	Quantity	Unit	Unit Cost	Amount	Assumptions/Notes
REMOVE EXISTING ASPHALT	89	SY	$36	$3,200	Assume existing walkway has approximate dimensions 200-feet long by 4-feet wide. Unit cost is from Jan. 2007 Seattle Public Utilities (SPU) Unit Cost Report, 5% added for inflation.
POROUS CONCRETE	800	SF	$10	$8,000	Assume dimensions 200-feet long by 4-feet wide by 6-inch thickness. Telephone conversation with Glacier NW sales person and Robin Kirschbaum on 10-2-2007. Cost includes materials, placement, and environmental surcharge. Unit cost is high end, 5% added for inflation.
TOP COURSE	4.9	CY	$63	$311	2-inch depth. Unit cost is from Jan. 2007 SPU Unit Cost Report. 5% added for inflation.
AGGREGATE BASE	30	CY	$57	$1,689	12-inch depth. Unit cost is from Jan. 2007 SPU Unit Cost Report, 5% added for inflation.
GEOTEXTILE FOR SEPARATION	89	SY	$5.25	$467	Unit cost is from Jan. 2007 SPU Unit Cost Report, 5% added for inflation.
EXCAVATION	119	CY	$37	$4,385	Assume small bobcat access, 1.5-foot depth of bioretention soil mix and 0.5-foot swale depth, 2-foot bottom width, 3:1 side slopes.
INITIAL ROTOTILLING	52	CY	$0.75	$39	6-inch depth. Unit cost from SPU Raincatchers Project
COMPOST	12	CY	$50	$602	3-inch depth. Includes material, installation, and rototilling. Unit cost is from Jan. 2007 SPU Unit Cost Report, 5% added for inflation.
BIORETENTION SOIL	72	CY	$55	$3,972	1.5-foot depth. Includes material, installation, and rototilling. Unit cost is from Jan. 2007 SPU Unit Cost Report, $5/CY price difference from compost quoted by Cedar Grove, 5% added for inflation.
INFLOW SPREADER AND CHECK DAMS	1	LS	$3,000	$3,000	Use quarry spalls, treated timber, or other inexpensive materials. Based on professional judgment.
NATIVE PLANTINGS	1,950	SF	$5.00	$9,750	Tracy Tackett (SPU), personal communication
			Earthwork and Material Subtotal:	$35,415	
OTHER ITEMS					
SUPPLEMENTAL SITE SURVEY DATA				$3,000	
MOBILIZATION			10%	$3,541	
TEMPORARY EROSION AND SEDIMENT CONTROL			10%	$3,541	
TRAFFIC CONTROL			10%	$3,541	
CONTINGENCY			100%	$35,415	
SALES TAX			9%	$3,187	
			Subtotal Construction Cost:	$87,600	
DESIGN			20%	$17,520	Assume a few design plan sheets and no special provisions
PERMITTING				$10,000	Assumes only City permits needed
CONSTRUCTION MANAGEMENT			8%	$7,008	
			Total Estimated Project Cost:	**$120,000**	

PROJECT SUMMARY SHEET

Project Title: Street edge or parking lot runoff treatment retrofits in the Golde Creek drainage basin

Problem Description: Sedimentation in Golde Creek due to increased runoff from urban development in the watershed. Potential source of fecal coliform bacteria to Swamp Creek downstream (which has a TMDL for fecal coliform bacteria).

Project Description: Installation of a street edge or parking lot treatment system such as a Bacterra™ bioretention system.

Design Assumptions:

- Design infiltration rate of 65 inches per hour.
- Sizing infiltration rate from the Washington State Department of Ecology of 33 inches per hour.
- One 6 foot X 8 foot unit would treat 0.5 acre of impervious area (flat slope = 0-5%).
- Unit will be filled with Bacterra™ media to remove fecal coliform bacteria.

Project Benefits: Pollutant removal (e.g., heavy metals, oil, total suspended solids, fecal coliform bacteria).

Maintenance Requirements: The following maintenance activities should occur twice per year (once in the spring and once in the fall):

- Remove foreign debris, silt, mulch, and trash.
- Prune and replace plant, if necessary.
- Replace mulch.

Estimated Project Cost[a]: $94,000

Notes.
[a] Assumes treatment for 1 acre. Total project cost depends on the amount of drainage area treated and the total number of units installed.

Figure 1. Example of a Filterra ® bioretention system (Americast, Inc. 2007).

Table 1. Planning level design, permitting, and construction cost estimate for street edge or parking lot runoff treatment retrofits in the Golde Creek Basin.

	One 6' x 8' Bacterra™ Unit Treating 0.5 Acre	Two 6' x 8' Bacterra™ Units Treating 1.0 Acre
Capital Cost[a]	$13,700	$26,800
Vault Installation Cost (est.)	$15,000	$25,000
Patch Adjacent Pavement	$3,000	$6,000
Subtotal	$31,700	$57,800
Mobilization (10%)	$3,170	$5,780
Traffic Control (10%)	$3,170	$5,780
Temporary Erosion and Sediment Control (5%)	$1,585	$2,890
Design	$10,000	$12,000
Permitting	$5,000	$5,000
Construction Management (8%)	$2,536	$4,624
Total Cost	$55,000	$94,000

[a] Source;Americast, Inc. (Evans 2008). Cost includes delivery, Bacterra unit, plant, mulch, start-up, and 1-year maintenance fee.

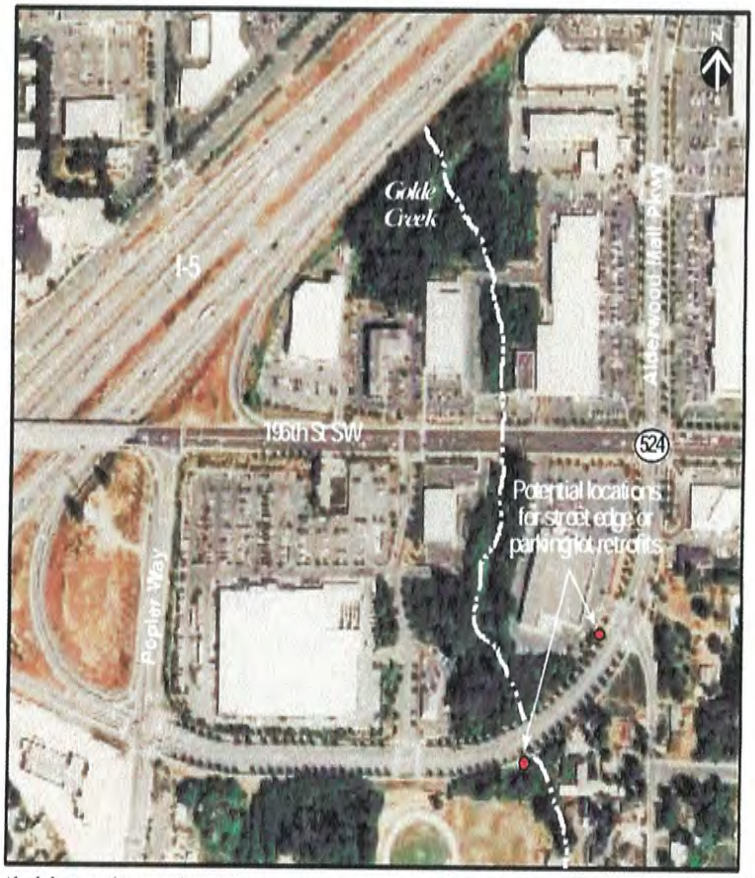


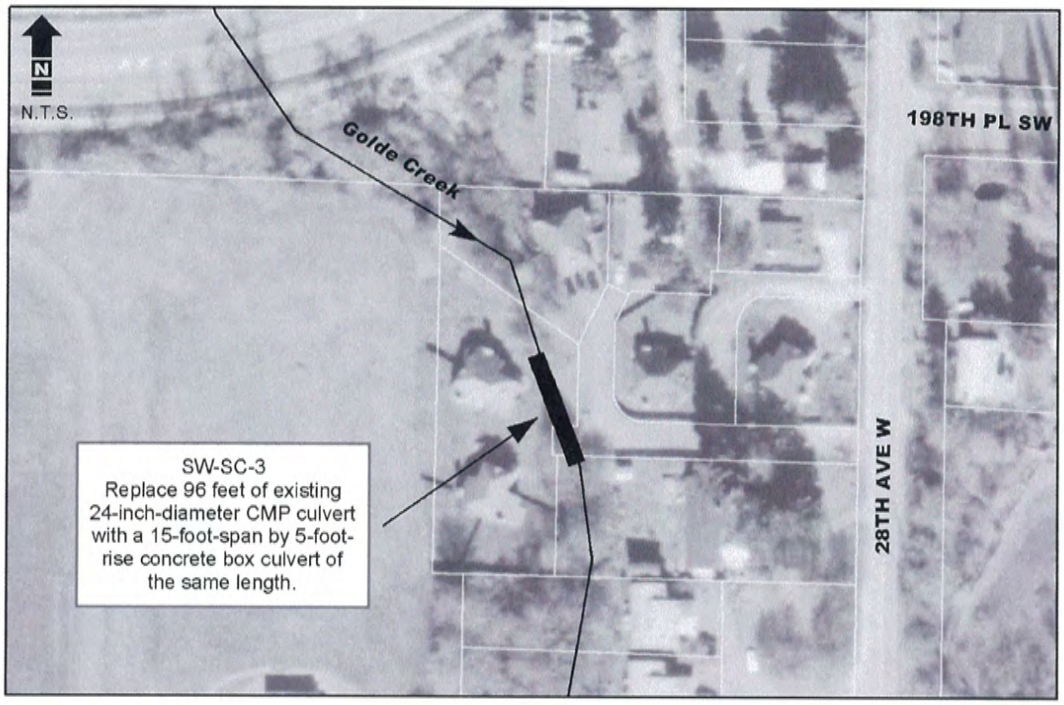
Figure 2. Potential locations for street edge or parking lot retrofits in the Golde Creek basin.

Figures 3 and 4. Potential location for a street edge retrofit along Alderwood Mall Parkway (left) and an example of commercial development in the Golde Creek basin (above).

PROJECT SUMMARY SHEET

Project Title:	**Golde Creek Culvert Replacement at Private Driveway Upstream of 28th Avenue W**
Problem Description:	Culvert has insufficient capacity and causes driveway flooding at the 2-year frequency for existing and future land use conditions. (Problem SW-SC-F-Ex-22).
Project Description:	Replace 96 feet of existing 24-inch-diameter CMP culvert with 15-foot-span by 5-foot-rise concrete box culvert of the same length. Install substrate of natural materials including cobbles and medium boulders with several large anchored boulders to enhance substrate stability, to reduce velocities, and to improve habitat conditions.
Design Assumptions:	Conveyance of the 25-year event for future land use conditions. WDFW criteria for fish passage. Preliminary culvert sizing based on the No Slope Design Option. To accommodate the limited height between the stream grade and top of road, a wide box culvert was selected rather than a CMPA culvert. Culvert is located on private property and an easement will be required. No cost for the easement acquisition is included because it is assumed that the project would benefit the property owner.
Project Benefits:	Prevent flooding of private driveway up to the 25-year event and improve fish passage conditions and access to upstream habitat for trout and juvenile salmon.
Estimated Project Cost:	$540,000
Associated Projects:	SW-SC-1, 2, 4 and 7 through 11 are culvert replacement projects either downstream or upstream of this project on Golde Creek. SW-SC-6 is a channel enhancement and storage project upstream of this project. SW-SC-12 is a detention pond project upstream of this project.

Project Sketch



Project Cost Estimate

Golde Creek Culvert Replacement at Private Driveway Upstream of 28th Avenue W

PLANNING LEVEL CONSTRUCTION COST OPINION

PROJECT:	SW-SC-3 Golde Creek Culvert Replacement at Private Driveway Upstream of 28th Avenue W	CHECKED BY:	Mike Giseburt
BY:	CLC	DATE:	8/9/2002

ITEM NO.	BID ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	REMOVE PAVEMENT	307	SY	$ 20.00	$ 6,140
2	REMOVE PIPE	96	LF	$ 15.00	$ 1,440
3	REINF. CONC. BOX CULVERT 15 -FOOT SPAN x 5 -FOOT RISE	96	LF	$ 1,540.00	$ 147,840
4	STRUCTURAL CONCRETE	20	CY	$ 500.00	$ 10,000
5	CRUSHED SURFACE BASE COURSE	207	TN	$ 23.00	$ 4,767
6	PAVEMENT, ASPHALT CONCRETE CL B {QTY, <500}	69	TN	$ 80.00	$ 5,526
7	ROUND RIVER ROCK	108	TN	$ 40.00	$ 4,320
8	BOULDERS	12	TN	$ 50.00	$ 603
9	ROADSIDE PLANTING/LANDSCAPING	100	SY	$ 25.00	$ 2,500
10	TEMPORARY BYPASS	1	LS	$ 6,000.00	$ 6,000
11	UTILITY RELOCATIONS	1	LS	$ 2,000.00	$ 2,000
				Subtotal	$ 191,137
	DEWATERING	10%			$ 19,114
	EROSION & SEDIMENTATION CONTROL	15%	(See Note 3)		$ 28,670
	TRAFFIC CONTROL	5%	(See Note 4)		$ 9,557
	CONTINGENCY	30%			$ 57,341
				Subtotal	$ 305,818
	MOBILIZATION (GENERAL REQUIREMENT)	10%			$ 30,582
				Construction Subtotal (Rounded)	$ 336,000
	STATE SALES TAX	8.9%			$ 29,904
	ENGINEERING/LEGAL/ADMIN	25%	($90,000 minimum)		$ 90,000
	CONSTRUCTION MANAGEMENT	20%			$ 67,200
	PERMITTING	5%			$ 16,800
				Project Subtotal (Rounded)	$ 540,000
	LAND ACQUISITION	0	AC	$ -	$ -
	CONTINGENCY	0%			$ -
2002 Dollars				**Total Estimated Project Cost (Rounded)**	**$ 540,000**

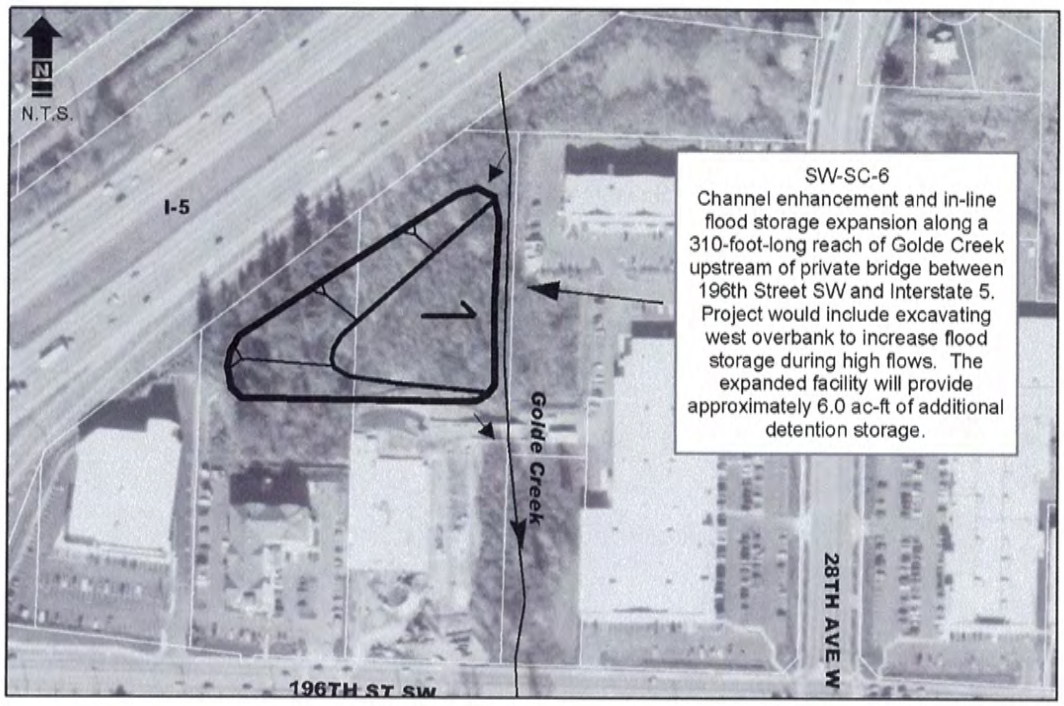
Notes:

1. The above cost opinion is in 2002 dollars and does not include future escalation, financing, or O&M costs.
2. The order-of-magnitude cost opinion has been prepared for guidance in project evaluation from the information available at the time of preparation and for the assumptions stated. The final costs of the project will depend on actual labor and material costs, actual site conditions, productivity, competitive market conditions, final project scope and schedule, and other variable factors. As a result, the final project costs will vary from those presented above. Because of these factors, funding needs for individual projects must be scrutinized prior to establishing the final project budgets.
3. Increase percentage markup if work is in or immediately adjacent to flowing or standing water, steep slope, and/or other erosion-prone conditions.
4. Increase percentage markup if work is in or immediately adjacent to secondary, arterial, or other high-volume road or temporarily closes a roadway.
5. Land Acquisition unit costs include Administrative Costs and Condemnation.

PROJECT SUMMARY SHEET

Project Title:	**Golde Creek Channel Enhancement and Storage Project between 196th Street SW and I-5**
Problem Description:	Basin-wide flooding results from increased future flows due to future land use changes that causes roadway, driveway and property flooding along the creek. (This project is not associated with a specific problem ID.)
Project Description:	Channel enhancement and in-line flood storage expansion along a 310-foot-long reach of Golde Creek upstream of private bridge between 196th Street SW and Interstate 5. Project would include excavating west overbank to increase flood storage during high flows. The expanded facility will provide approximately 6.0 ac-ft of additional detention storage. Overbank area would be planted/landscaped for riparian/wetland enhancement.
Design Assumptions:	Design optimized to increase storage within reach of Golde Creek between 196th Street SW and I-5. Low flow channel (approximately 1-year event) in Golde Creek will remain intact (i.e. excavation of overbank area would be at or above the 1-yr water surface elevation). Minimum .5 percent side slopes will be maintained to ensure drainage to the low flow channel to prevent fish stranding. This project assumes the property could be acquired by the county. However, WSDOT may also be considering this site for a stormwater facility. It is noted that instead of sloping the overbank area to the creek an alternative approach could be to have a defined channel that drains the overbank area directed to the creek at the downstream end of the project. A potential benefit of this approach could be more storage provided. Assume land acquisition of 4 acres will be required.
Project Benefits:	Detain flows to mitigate for increased flows caused by future development and proposed conveyance improvements. Detention will reduce downstream flooding and erosion problems.
Estimated Project Cost:	$3,197,000
Associated Projects:	SW-SC-1 through 4 and 7 through 11 are culvert replacement projects either downstream of this project on Golde Creek.

Project Sketch



Project Cost Estimate

Golde Creek Channel Enhancement and Storage Project between 196th Street SW and I-5

PLANNING LEVEL CONSTRUCTION COST OPINION

PROJECT:	SW-SC-6 Golde Creek Channel Enhancement and Storage Project Between 196th Street SW and I-5	CHECKED BY:	Mike Giseburt
BY:	CLC	DATE:	8/20/2002

ITEM NO.	BID ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	CLEARING AND GRUBBING	4	AC	$5,000.00	$ 20,000
2	CHANNEL EXCAVATION	15700	CY	$16.00	$ 251,200
3	EROSION CONTROL, HYDRO-SEEDING (QTY >= 5000)	1000	SF	$0.15	$ 150
4	FENCE, TEMPORARY SILT CONTAINMENT	250	LF	$7.80	$ 1,950
5	TREE	50	EA	$135.00	$ 6,750
6	SHRUB	200	EA	$15.00	$ 3,000
7	WET POND SEEDING	60000	SF	$1.50	$ 90,000
8	ACCESS ROAD (15' WIDE, 6" GRAVEL DEPTH)	200	LF	$17.00	$ 3,400
				Subtotal	$ 376,450
	DEWATERING	10%			$ 37,645
	EROSION & SEDIMENTATION CONTROL	15%	(See Note 3)		$ 56,468
	TRAFFIC CONTROL	3%	(See Note 4)		$ 11,294
	CONTINGENCY	30%			$ 112,935
				Subtotal	$ 594,791
	MOBILIZATION (GENERAL REQUIREMENT)	10%			$ 59,479
				Construction Subtotal (Rounded)	$ 654,000
	STATE SALES TAX	8.9%			$ 58,206
	ENGINEERING/LEGAL/ADMIN	25%			$ 163,500
	CONSTRUCTION MANAGEMENT	1	LS	$100,000.00	$ 100,000
	PERMITTING	5%			$ 32,700
				Project Subtotal (Rounded)	$ 1,008,000
	LAND ACQUISITION	4	AC	$ 420,950.25	$ 1,683,801
	CONTINGENCY	30%			$ 505,140
2002 Dollars				**Total Estimated Project Cost (Rounded)**	**$ 3,197,000**

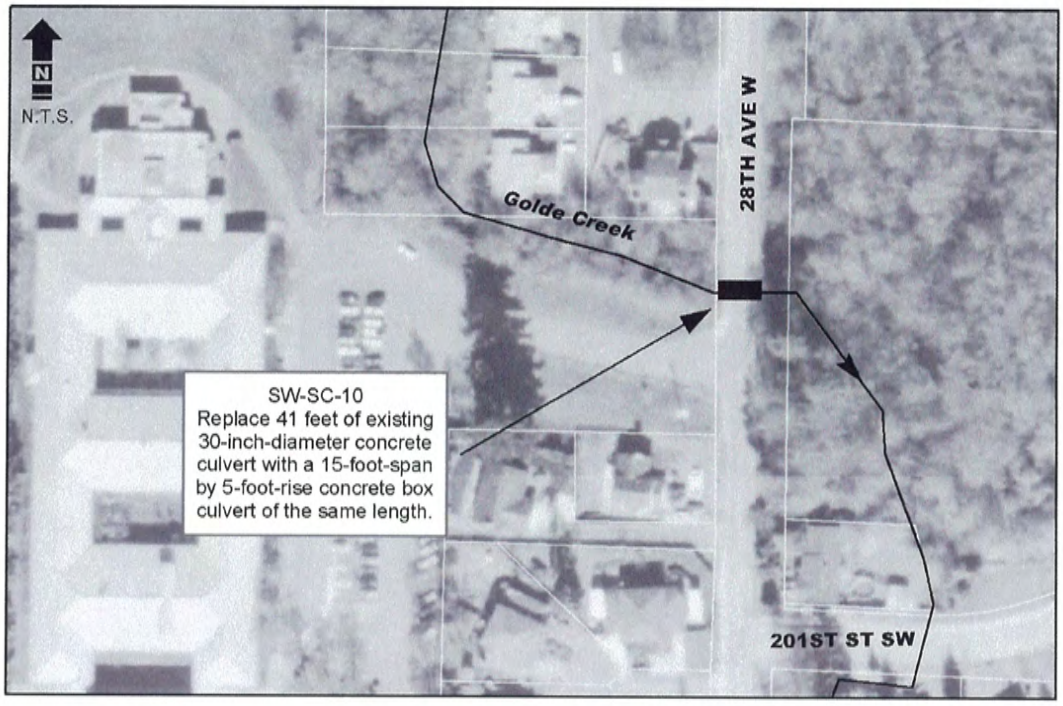
Notes:

1. The above cost opinion is in 2002 dollars and does not include future escalation, financing, or O&M costs.
2. The order-of-magnitude cost opinion has been prepared for guidance in project evaluation from the information available at the time of preparation and for the assumptions stated. The final costs of the project will depend on actual labor and material costs, actual site conditions, productivity, competitive market conditions, final project scope and schedule, and other variable factors. As a result, the final project costs will vary from those presented above. Because of these factors, funding needs for individual projects must be scrutinized prior to establishing the final project budgets.
3. Increase percentage markup if work is in or immediately adjacent to flowing or standing water, steep slope, and/or other erosion-prone conditions.
4. Increase percentage markup if work is in or immediately adjacent to secondary, arterial, or other high-volume road or temporarily closes a roadway.
5. Land Acquisition unit costs include Administrative Costs and Condemnation.

PROJECT SUMMARY SHEET

Project Title:	**Golde Creek Culvert Replacement at 28th Avenue W**
Problem Description:	Culvert has insufficient capacity and causes flooding of 28th Avenue W at the 2-year frequency under existing and future land use conditions. Culvert has also been identified as a total fish passage barrier due to slope based on the Level A analysis. (Problems SW-SC-F-Ex-21 and SW-SC-H-Ex-2).
Project Description:	Replace 41 feet of existing 30-inch-diameter concrete culvert with 15-foot-span by 5-foot-rise concrete box culvert of the same length. Install substrate of natural materials including cobbles and medium boulders with several large anchored boulders to enhance substrate stability, to reduce velocities, and to improve habitat conditions.
Design Assumptions:	Conveyance of the 25-year event for future land use conditions. WDFW criteria for fish passage. Preliminary sizing based on the No Slope Design Option. To accommodate cover requirements for traffic loading and width requirements for fish passage, this design proposes a concrete box culvert rather than a CMPA culvert.
Project Benefits:	Prevent flooding of 28th Avenue W up to the 25-year event and improve fish passage conditions and access to upstream habitat for trout and juvenile salmon.
Estimated Project Cost:	$356,000
Associated Projects:	SW-SC-1 through 4, 7 through 9 and 11 are culvert replacement projects either downstream or upstream of this project on Golde Creek. SW-SC-6 is a channel enhancement and storage project upstream of this project. SW-SC-12 is a detention pond project upstream of this project.

Project Sketch



Project Cost Estimate

Golde Creek Culvert Replacement at 28th Avenue W

PLANNING LEVEL CONSTRUCTION COST OPINION

PROJECT:	SW-SC-10 Golde Creek Culvert Replacement at 28th Avenue W	CHECKED BY:	Mike Giseburt
BY:	CLC	DATE:	8/9/2002

ITEM NO.	BID ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	REMOVE PAVEMENT	115	SY	$ 20.00	$ 2,293
2	REMOVE PIPE	41	LF	$ 15.00	$ 615
3	REINF. CONC. BOX CULVERT 15 -FOOT SPAN x 5 -FOOT RISE	41	LF	$ 1,540.00	$ 63,140
4	STRUCTURAL CONCRETE	20	CY	$ 500.00	$ 10,000
5	CRUSHED SURFACE BASE COURSE	77	TN	$ 23.00	$ 1,780
6	PAVEMENT, ASPHALT CONCRETE CL B (QTY, <500)	26	TN	$ 80.00	$ 2,064
7	ROUND RIVER ROCK	46	TN	$ 40.00	$ 1,845
8	BOULDERS	5	TN	$ 50.00	$ 258
9	ROADSIDE PLANTING/LANDSCAPING	100	SY	$ 25.00	$ 2,500
10	UTILITY RELOCATIONS	1	LS	$ 15,000.00	$ 15,000
11	TEMPORARY BYPASS	1	LS	$ 10,000.00	$ 10,000
				Subtotal	$ 109,495
	DEWATERING	10%			$ 10,950
	EROSION & SEDIMENTATION CONTROL	15%	(See Note 3)		$ 16,424
	TRAFFIC CONTROL	15%	(See Note 4)		$ 16,424
	CONTINGENCY	30%			$ 32,849
				Subtotal	$ 186,142
	MOBILIZATION (GENERAL REQUIREMENT)	10%			$ 18,614
				Construction Subtotal (Rounded)	$ 205,000
	STATE SALES TAX	8.9%			$ 18,245
	ENGINEERING/LEGAL/ADMIN	35%			$ 71,750
	CONSTRUCTION MANAGEMENT	20%			$ 41,000
	PERMITTING	10%			$ 20,500
				Project Subtotal (Rounded)	$ 356,000
	LAND ACQUISITION	0	AC	$ -	$ -
	CONTINGENCY	0%			$ -
2002 Dollars				**Total Estimated Project Cost (Rounded)**	$ 356,000

Notes:
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5. Land Acquisition unit costs include Administrative Costs and Condemnation.

PROJECT SUMMARY SHEET

Project Title: **Scriber Creek Subbasin: Riparian Revegetation at Two Locations**

Problem Description: Riparian habitat lacks adequate native woody vegetation at two locations in the Scriber Creek Subbasin (problem SW-SC-H-Ex-11 and 12).

Project Description: Underplant native woody vegetation, remove invasive vegetation from existing riparian area. For specific locations, see riparian units identified in the table below.

Design Assumptions: 1) A 200-ft wide riparian corridor centered on the existing stream. 2) Enhancement of riparian area will satisfy an increase of Snohomish County DNR criteria of one riparian category. 3) No land acquisition will be needed. The County will acquire an easement or agreements with landowners to facilitate riparian plantings.

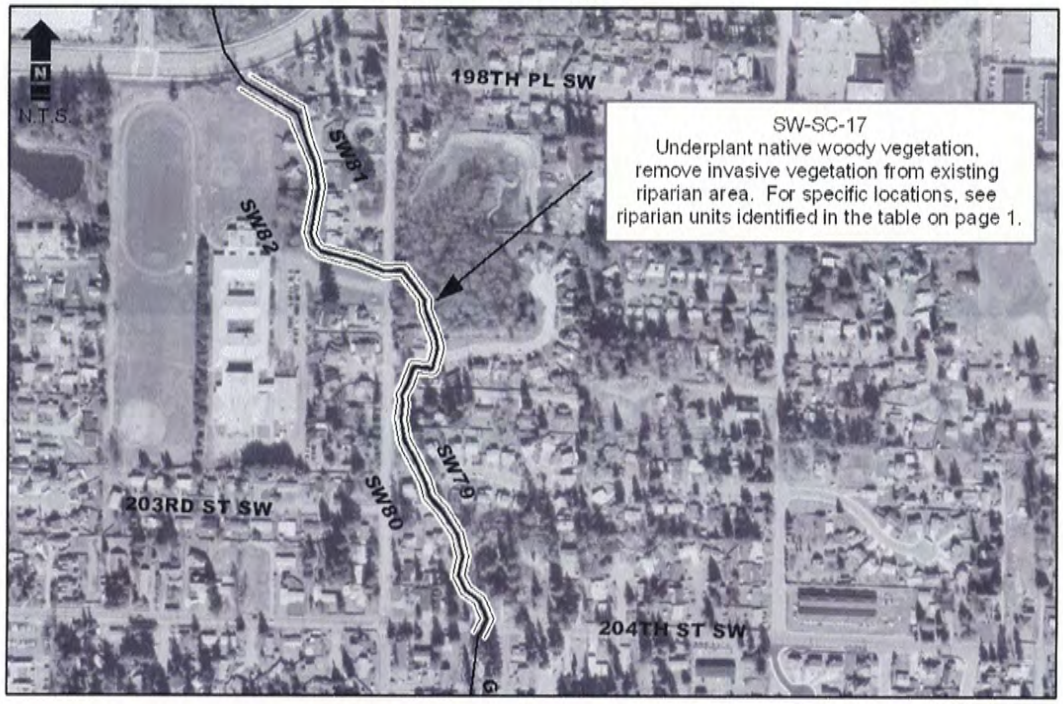
Project Benefits: Planting native woody vegetation provides for future instream LWD, decreased stream temperatures, support of food webs, stabilized streambanks, filtering of sediment and pollutants, support of wildlife and added hydraulic roughness to floodplains.

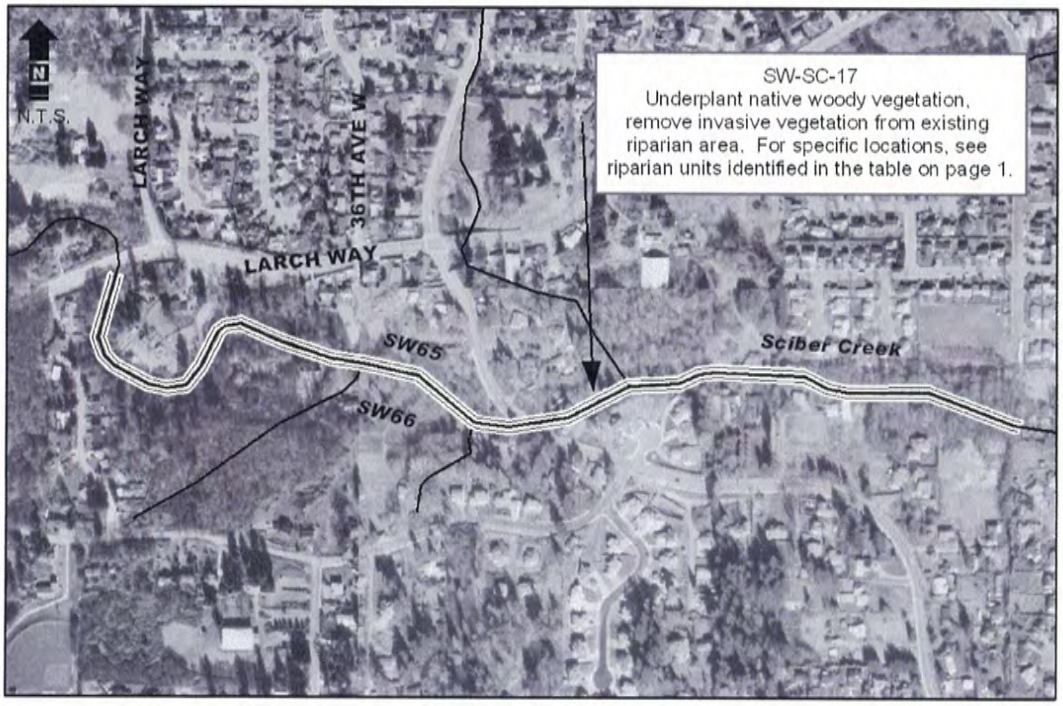
Estimated Project Cost: $ 72,000

Associated Projects: None

Riparian Unit	Stream and Reach Number	Location	Recommended Improvements	Length of Bank (ft)	Planting Area Total (ac)
SW65 and 66	Scriber Creek	700 feet of stream upstream from 204th Street SW	Underplant native woody vegetation	1,100	5.05
SW79, 80, 81, and 82	Golde Creek (2874.3)	The 2,100 feet of stream upstream from 204th Street SW	Underplant native woody vegetation	2,100	9.64
			TOTALS	**3,200**	**14.69**

Project Sketch





Project Cost Estimate

Scriber Creek Subbasin: Riparian Revegetation at Two Locations

PLANNING LEVEL CONSTRUCTION COST OPINION

PROJECT:	Swamp Creek DNR - Project SW-SC-17, Scriber Creek Subbasin: Riparian Revegetation at Two Locations	CHECKED BY:	Bill Kleindl
BY:	Pete Lawson	DATE:	7/1/2002

ITEM NO.	BID ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	RIPARIAN SUPPLEMENT UNDERPLANTINGS/REVEGETATION	15	AC	$ 3,000.00	$ 44,070
				Subtotal	$ 44,070
	CONTINGENCY	15%			$ 6,611
				Subtotal	$ 50,681
	MOBILIZATION (GENERAL REQUIREMENT)	10%			$ 5,068
				Construction Subtotal (Rounded)	$ 56,000
	STATE SALES TAX	8.9%			$ 4,984
	ENGINEERING/LEGAL/ADMIN	10%			$ 5,600
	CONSTRUCTION MANAGEMENT	10%			$ 5,600
				Project Subtotal (Rounded)	$ 72,000
	LAND ACQUISITION, R- 7,200				$ -
	ADMINISTRATIVE COSTS, CONSTRUCTION EASMENT				$ -
	CONDEMNATION				$ -
	CONTINGENCY				$ -
2002 Dollars				**Total Estimated Project Cost (Rounded)**	**$ 72,000**

Notes:

1. The above cost opinion is in 2002 dollars and does not include future escalation, financing, or O&M costs.
2. The order-of-magnitude cost opinion has been prepared for guidance in project evaluation from the information available at the time of preparation and for the assumptions stated. The final costs of the project will depend on actual labor and material costs, actual site conditions, productivity, competitive market conditions, final project scope and schedule, and other variable factors. As a result, the final project costs will vary from those presented above. Because of these factors, funding needs for individual projects must be scrutinized prior to establishing the final project budgets.
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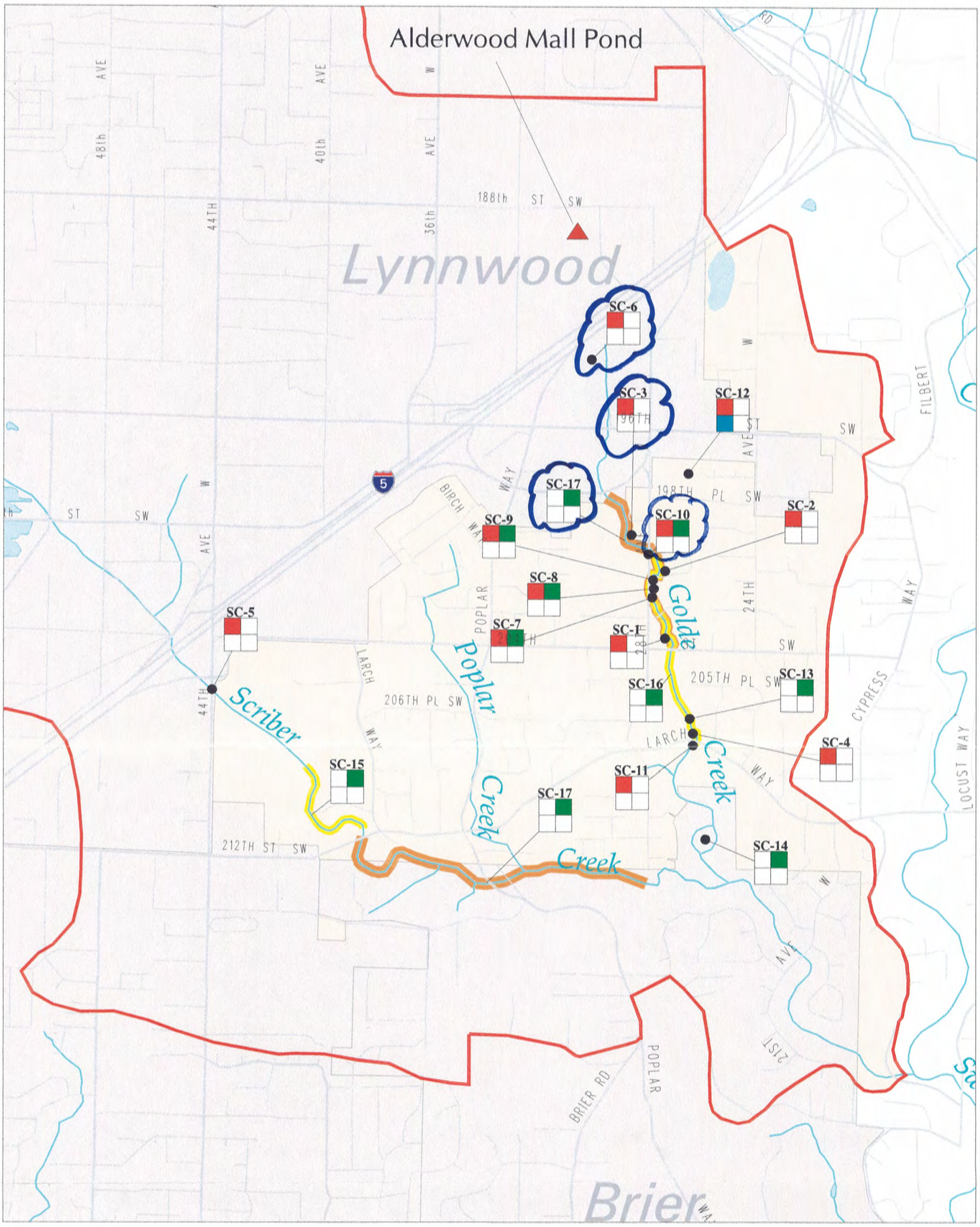

Legend

- Recommended Project
- Recomended Riparian Habitat Project
- Recomended Riparian/Instream Habitat Project
- Recomended Instream Habitat Project

CIP Project Type

- Flooding Problem Addressed
- Habitat Problem Addressed
- Erosion Problem Addressed
- Water Quality Problem Addressed

- Subbasin Boundary
- Major Road
- Secondary Road
- Stream
- Water Body
- Incorporated Area
- DNR Study Area
- Existing Detention Facility

Habitat Reach Projects are general locations. For detailed information on these projects refer to Table 9-6.

.2 0 0.2
Scale in Miles

Snohomish County
PUBLIC WORKS
SURFACE WATER MANAGEMENT

Appendix F

Scriber Creek

Recommended CIP Projects

Swamp Creek Drainage Needs Report

swc-10.aml

Appendix E

Filterra GULD

WASHINGTON STATE DEPARTMENT OF ECOLOGY

February 2013

GENERAL USE LEVEL DESIGNATION FOR BASIC (TSS), ENHANCED, & OIL TREATMENT
&
CONDITIONAL USE LEVEL DESIGNATION FOR PHOSPHORUS TREATMENT

For

Americast Filterra®

Ecology's Decision:

Based on Americast's submissions, including the Final Technical Evaluation Report, dated December 2009 and additional information provided to Ecology dated October 9, 2009, Ecology hereby issues the following use level designations:

1. **A General Use Level Designation for Basic, Enhanced, and Oil Treatment.**
   - **Sized for Basic and Oil Treatment using a filter hydraulic conductivity of 35.46 inches/hour (assuming a hydraulic gradient of 1.41 inch/inch as listed in the TER).**
   - **Sized for Enhanced Treatment using a filter hydraulic conductivity of 24.82 inches/hour (assuming a hydraulic gradient of 1.41 inch/inch as listed in the TER).**
   - **The Filterra® unit is not appropriate for oil spill-control purposes.**
2. **A Conditional Use Level Designation for Phosphorus Treatment.**
   - **Sized for Phosphorus Treatment using a filter hydraulic conductivity of 35.46 inches/hour (assuming a hydraulic gradient of 1.41 inch/inch as listed in the TER).**
3. **Ecology approves the Filterra® units for treatment at the hydraulic loading rates listed above, to achieve the maximum water quality design flow rate. Calculate the water quality design flow rates using the following procedures:**
   - **Western Washington: For treatment installed upstream of detention or retention, the water quality design flow rate is the peak 15-minute flow rate as calculated using the sand filter module in the latest version of the Western Washington Hydrology Model or other Ecology-approved continuous runoff model. The model must indicate the unit is capable of processing 91 percent of the influent runoff file.**
   - **Eastern Washington: For treatment installed upstream of detention or retention, the water quality design flow rate is the peak 15-minute flow rate as calculated using one of the three methods described in Chapter 2.2.5 of the Stormwater Management Manual for Eastern Washington (SWMMEW) or local manual.**
   - **Entire State: For treatment installed downstream of detention, the water quality design flow rate is the full 2-year release rate of the detention facility.**

4. **The Conditional Use Level Designation for Phosphorus treatment expires on December 1, 2014 unless extended by Ecology, and is subject to the conditions specified below.**

5. **The General Use Level Designation has no expiration date but Ecology may revoke or amend the designation, and is subject to the conditions specified below.**

Ecology's Conditions of Use:

Filterra® units shall comply with these conditions shall comply with the following conditions:

1. **Design, assemble, install, operate, and maintain the Filterra units in accordance with applicable Americast Filterra manuals, document, and the Ecology Decision.**

2. **Each site plan must undergo Filterra® review before Ecology can approve the unit for site installation. This will ensure that site grading and slope are appropriate for use of a Filterra® unit.**

3. **Filterra® media shall conform to the specifications submitted to and approved by Ecology.**

4. **Maintenance includes removing trash, degraded mulch, and accumulated debris from the filter surface and replacing the mulch layer. Use inspections to determine the site-specific maintenance schedules and requirements. Follow maintenance procedures given in the most recent version of the Filterra® Operation and Maintenance Manual.**

5. **Filterra® commits to submitting a QAPP by January 31, 2013 for Ecology review and approval of a new test site that meets the TAPE requirements for attaining a GULD for phosphorus treatment. Filterra® must submit a QAPP and monitor a minimum of one site where the unit will provide phosphorus treatment.**

6. **Filterra® shall submit a TER for Ecology review for phosphorus treatment by December 1, 2013.**

7. **Filterra® units come in standard sizes. The minimum size filter surface-area is determined by using the sand filter module in the latest version of WWHM or other Ecology approved continuous runoff model. Model inputs include**
    a. **Filter media depth: 1.8 feet**
    b. **Effective Ponding Depth: 0.75 feet (This is equivalent to the 6-inch clear zone between the top of the mulch and the bottom of the slab plus 3-inches of mulch.)**
    c. **Side slopes: Vertical**
    d. **Riser height: 0.70 feet**
    e. **Filter Hydraulic Conductivity: Must be back-calculated assuming a target infiltration rate of 35 inches per hour (enhanced treatment) or 50 inches per hour (Basic, oil, or phosphorus treatment). Hydraulic conductivity in the WWHM includes the effective ponding depth as well as the filter media depth.**

8. **Filterra® may request Ecology to grant deadline or expiration date extensions, upon showing cause for such extensions. Ecology does not view lack of funds to complete the monitoring as sufficient cause for time extensions.**

9. **Discharges from the Filterra® units shall not cause or contribute to water quality standards violations in receiving waters.**

Approved Alternate Configurations

Filterra Internal Bypass - Pipe System

1. **The Filterra Internal Bypass – Pipe (FTIB-P)** allows for piped-in flow from area drains, grated inlets, trench drains and/or roof drains. Design capture flows and peak flows enter the structure through an internal slotted pipe. Fliterra inverted the slotted pipe to allow design flows to drop through to a series of splash plates that then disperse the design flows over the top surface of the Filterra planter area. Higher flows continue to bypass the slotted pipe and convey out the structure. .
2. **Use the information from the following Table to determine the size of the FTIB-P unit.**

FTIB-P Unit Basic, Oil/Grease, and Phosphorus Treatment Sizing

Maximum Design Flow (cfs)		FTIB-P Unit Size
Basic, Oil/Grease, and Phosphorus Treatment	Enhanced Treatment	
0.0185	0.0130	FTIB-P 4x4
0.0278	0.0194	FTIB-P 6x4
0.0370	0.0259	FTIB-P 8X4
0.0417	0.0292	FTIB-P 6X6
0.0556	0.0389	FTIB-P 8X6
0.0694	0.0486	FTIB-P 10X6
0.0833	0.0583	FTIB-P 12X6

Filterra Bioretention Shallow System

1. **The Filterra Bioretention Shallow System provides additional flexibility for design engineers and designers in situations where there is limited depth and various elevation constraints to applying a standard Filterra model configuration. Engineers can design this system up to six inches shallower than any of the previous Filterra unit configurations noted above.**
2. **Ecology requires that the Filterra Bioretention Shallow System provide a contact time equivalent to that of the standard system. This means that with a smaller depth of media, the surface area must increase.**
3. **To select a Filterra Bioretention Shallow System unit, the designer must first identify the size of the standard unit using the guidance described above.**
4. **Once the size of the standard Filterra unit is established, use information from the following table to select the appropriate size Filterra Bioretention Shallow System unit.**

Shallow Unit Basic, Enhanced, and Oil Treatment Sizing

Standard Depth	Equivalent Shallow Depth
4x4	4x6 or 6x4
4x6 or 6x4	6x6
4x8 or 8x4	6x8 or 8x6
6x6	6x10 or 10x6
6x8 or 8x6	6x12 or 12x6
6x10 or 10x6	7x13 or 13x7

Notes:

1. **Shallow Depth Boxes are less than the standard depth of 3.5 feet but no less than 3.0 feet deep (TC to INV).**

Filterra

Applicant: Filterra Bioretention Systems, division of Americast, Inc.

Applicant's Address: 11352 Virginia Precast Road
Ashland, VA, 23005

Application Documents:

- State of Washington Department of Ecology Application for Conditional Use Designation, Americast (September 2006)
- Quality Assurance Project Plan Filterra® Bioretention Filtration System Performance Monitoring, Americast (April 2008)
- Quality Assurance Project Plan Addendum Filterra® Bioretention Filtration System Performance Monitoring, Americast (June 2008)
- Draft Technical Evaluation Report Filterra® Bioretention Filtration System Performance Monitoring, Americast (August 2009)
- Final Technical Evaluation Report Filterra® Bioretention Filtration System Performance Monitoring, Americast (December 2009)
- Technical Evaluation Report Appendices Filterra® Bioretention Filtration System Performance Monitoring, Americast, August 2009 Draft)
- Memorandum to Department of Ecology Dated October 9, 2009 from Americast, Inc. and Herrera Environmental Consultants
- Quality Assurance Project Plan Filterra Bioretention System Phosphorus treatment and Supplemental Basic and Enhanced Treatment Performance Monitoring, Americast (November 2011)
- Filterra letter August 24, 2012 regarding sizing for the Filterra Shallow System.

Applicant's Use Level Request:

General Level Use Designation for Basic, Enhanced, and Oil Treatment and General Use Level for Phosphorus Treatment.

Applicant's Performance Claims:

Field-testing and laboratory testing show that the Filterra® unit is promising as a stormwater treatment best management practice and can meet Ecology's performance goals for basic, enhanced and oil treatment and has the potential to meet Ecology's goal for phosphorus treatment.

Findings of Fact:

1. Filterra® completed field-testing at two sites at the Port of Tacoma. Continuous flow and rainfall data collected during the 2008-2009 monitoring period indicated that 89 storm events occurred. The monitoring obtained water quality data from 27 storm events. Not all the sampled storms produced information that met TAPE criteria for storm and/or water quality data.
2. During the testing at the Port of Tacoma, 98.96 to 99.89 percent of the annual influent runoff volume passed through the POT1 and POT2 test systems respectively. Stormwater runoff bypassed the POT1 test system during nine storm events and bypassed the POT2 test system during one storm event. Bypass volumes ranged from 0.13% to 15.3% of the influent storm volume. Both test systems achieved the 91 percent water quality treatment-goal over the 1-year monitoring period.
3. Consultants observed infiltration rates as high as 133 in/hr during the various storms. Filterra did not provide any paired data that identified percent removal of TSS, metals, oil, or phosphorus at an instantaneous observed flow rate.
4. The maximum storm average hydraulic loading rate associated with water quality data is <40 in/hr, with the majority of flow rates < 25 in/hr. The average instantaneous hydraulic loading rate ranged from 8.6 to 53 inches per hour.
5. The field data showed a removal rate greater than 80% for TSS with an influent concentration greater than 20 mg/l at an average instantaneous hydraulic loading rate up to 53 in/hr (average influent concentration of 28.8 mg/l, average effluent concentration of 4.3 mg/l).
6. The field data showed a removal rate generally greater than 54% for dissolved zinc at an average instantaneous hydraulic loading rate up to 60 in/hr and an average influent concentration of 0.266 mg/l (average effluent concentration of 0.115 mg/l).
7. The field data showed a removal rate generally greater than 40% for dissolved copper at an average instantaneous hydraulic loading rate up to 35 in/hr and an average influent concentration of 0.0070 mg/l (average effluent concentration of 0.0036 mg/l).
8. The field data showed an average removal rate of 93% for total petroleum hydrocarbon (TPH) at an average instantaneous hydraulic loading rate up to 53 in/hr and an average

influent concentration of 52 mg/l (average effluent concentration of 2.3 mg/l). The data also shows achievement of less than 15 mg/l TPH for grab samples. Filterra provided limited visible sheen data due to access limitations at the outlet monitoring location.

9. The field data showed low percentage removals of total Phosphorus at all storm flows at an average influent concentration of 0.189 mg/l (average effluent concentration of 0.171 mg/l). We may relate the relatively poor treatment performance of the Filterra® system at this location to influent characteristics for total phosphorus that are unique to the Port of Tacoma site. It appears that the Filterra® system will not meet the 50 percent removal performance goal when you expect the majority of phosphorus in the runoff to be in the dissolved form.
10. Filterra performed laboratory testing on a scaled down version of the Filterra® unit. The lab data showed an average removal from 83-91% for TSS with influents ranging from 21 to 320 mg/L, 82-84% for total copper with influents ranging from 0.94 to 2.3 mg/L, and 50-61% for orthophosphate with influents ranging from 2.46 to 14.37 mg/L.
11. Filterra® conducted permeability tests on the soil media.
12. Lab scale testing using Sil-Co-Sil 106 showed percent removals ranging from 70.1% to 95.5% with a median percent removal of 90.7%, for influent concentrations ranging from 8.3 to 260 mg/L. Filterra® ran these laboratory tests at an infiltration rate of 50 in/hr.
13. Supplemental lab testing conducted in September 2009 using Sil-Co-Sil 106 showed an average percent removal of 90.6%. These laboratory tests were run at infiltration rates ranging from 25 to 150 in/hr for influent concentrations ranging from 41.6 to 252.5 mg/l. Regression analysis results indicate that the Filterra® system's TSS removal performance is independent of influent concentration in the concentration rage evaluated at hydraulic loading rates of up to 150 in/hr.

Contact Information:

Applicant:

Chris French
Filterra Bioretention Systems, division of Americast, Inc.
11352 Virginia Precast Road
Ashland, VA 23005
(800) 752-1427 (voice) (804) 798-8400 (fax)
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Applicant's Website: http://www.filterra.com

Ecology web link: http://www.ecy.wa.gov/programs/wq/stormwater/newtech/index.html

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Date	Revision
December 2009	GULD for Basic, Enhanced, and Oil granted, CULD for Phosphorus
September 2011	Extended CULD for Phosphorus Treatment
September 2012	Revised design storm discussion, added Shallow System.
January 2013	Revised format to match Ecology standards, changed Filterra contact information
February 2013	Added FTIB-P system

Appendix F

Inspection and Maintenance Documentation

Appendix G

Alderwood Mall Expansion Drainage Report Excerpts

ENTRANCO

Drainage Report

ALDERWOOD MALL EXPANSION
Lynnwood, Washington

FINAL

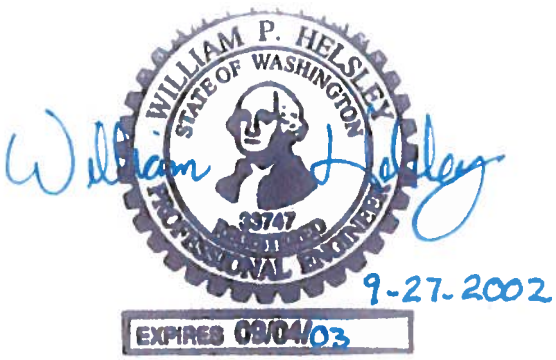
Prepared for

General Growth Properties, Inc

Prepared by

ENTRANCO, Inc.
10900 NE 8th Street, Suite 300
Bellevue, Washington 98004
(425) 454-5600

September 27, 2002



CONTENTS

FIGURES

TABLES

DRAINAGE REPORT
ALDERWOOD MALL EXPANSION

INTRODUCTION

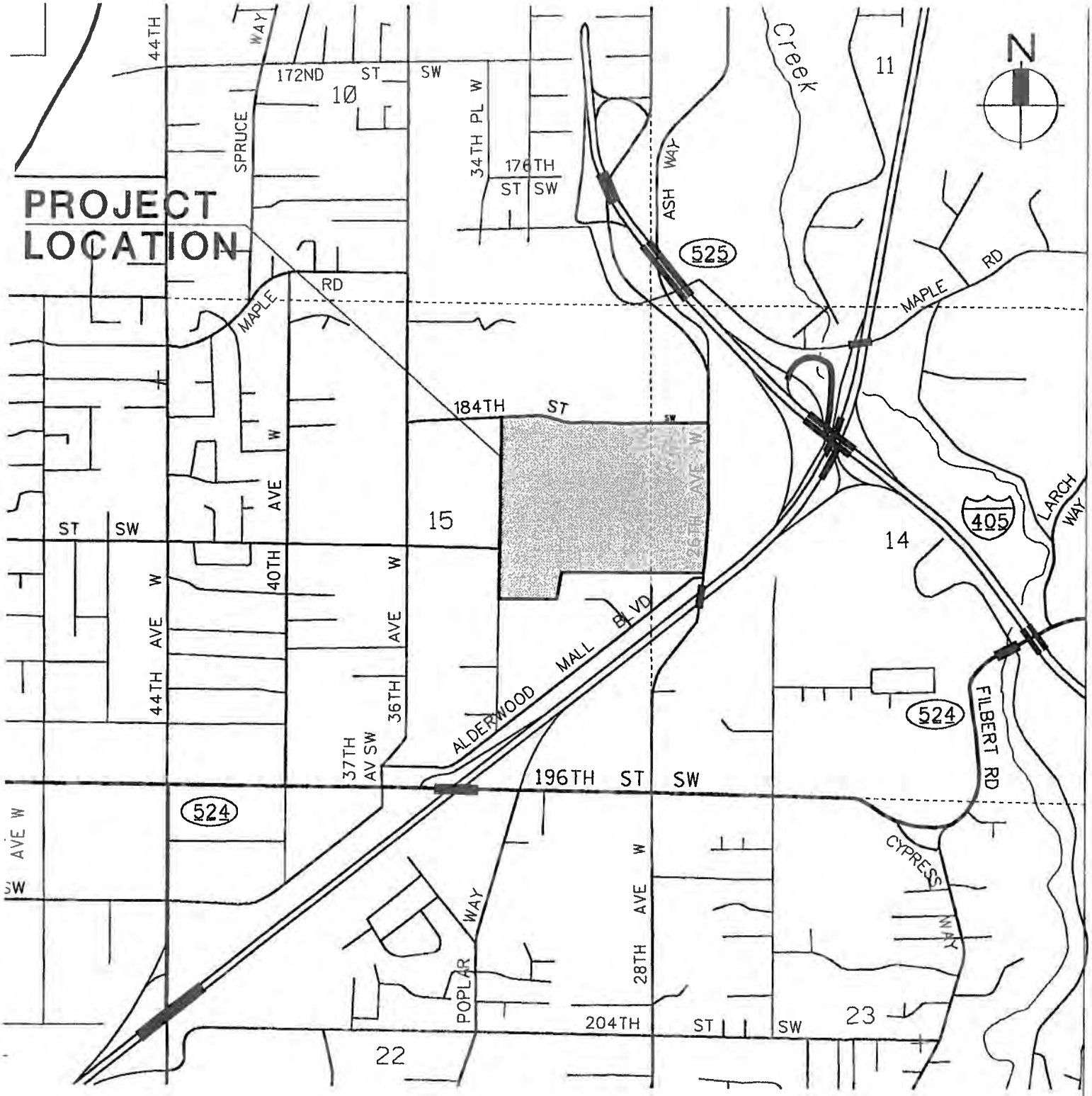
General Growth properties is proposing to expand the Alderwood Mall. The mall expansion project is located within the City of Lynnwood in the northwest quarter of Section 14/northeast quarter of Section 15, Township 27 North, Range 4 East, Willamette Meridian, in Snohomish County, Washington. The site comprises 83.9 acres. **Figure 1** is a vicinity map for the project. The existing and proposed site plans are shown in **figures 2** and **3**. The site is bounded by 184 Street SW to the north, 26th Avenue W to the east, Alderwood Mall Boulevard to the south, and 33rd Avenue W to the west. The proposed modifications to the existing retail site includes demolishing 192,000 sf; adding 245,000 sf to the existing mall complex; and constructing 196,000 sf of exterior pedestrian shopping area, a new 80,000 sf cinema, three parking garages. The project is also expected to provide a net increase in landscaped area. The topography is fairly flat, with the grade sloping slightly from the north to the south.

This report addresses the storm drainage issues associated with proposed expansion project using criteria developed with the City of Lynnwood Department of Public Works, including the Washington State Department of Ecology (Ecology) Stormwater Management Manual for the Puget Sound Basin, 1992. The Ecology manual outlines the hydraulic modeling and treatment techniques. Applicable portions of the Ecology Design Manual and other documents are provided.

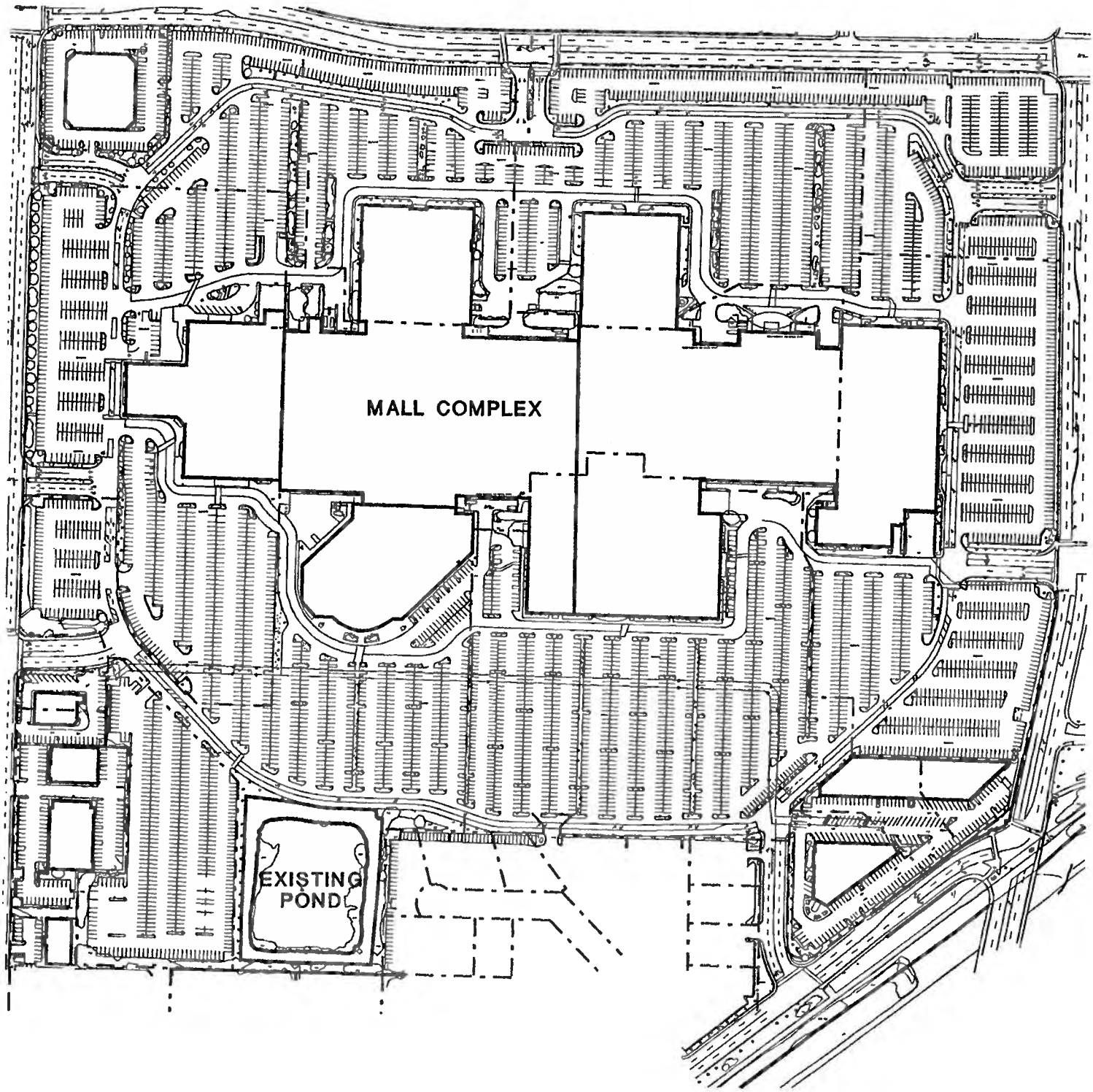
EXISTING CONDITIONS

Soils

The soil on the project site is classified in the *Soil Survey of Snohomish County Area, Washington* (**USDA Soil Conservation Service, 1973**) as Urban land (see **figure 4**). Urban land is considered to be compacted imported or native soils with runoff characteristics similar to glacial till. Till soils have a high runoff potential and are typically classified as hydraulic soil group "D".



	ALDERWOOD MALL EXPANSION	SCALE: N.T.S. DATE:	VICINITY MAP FIGURE 1

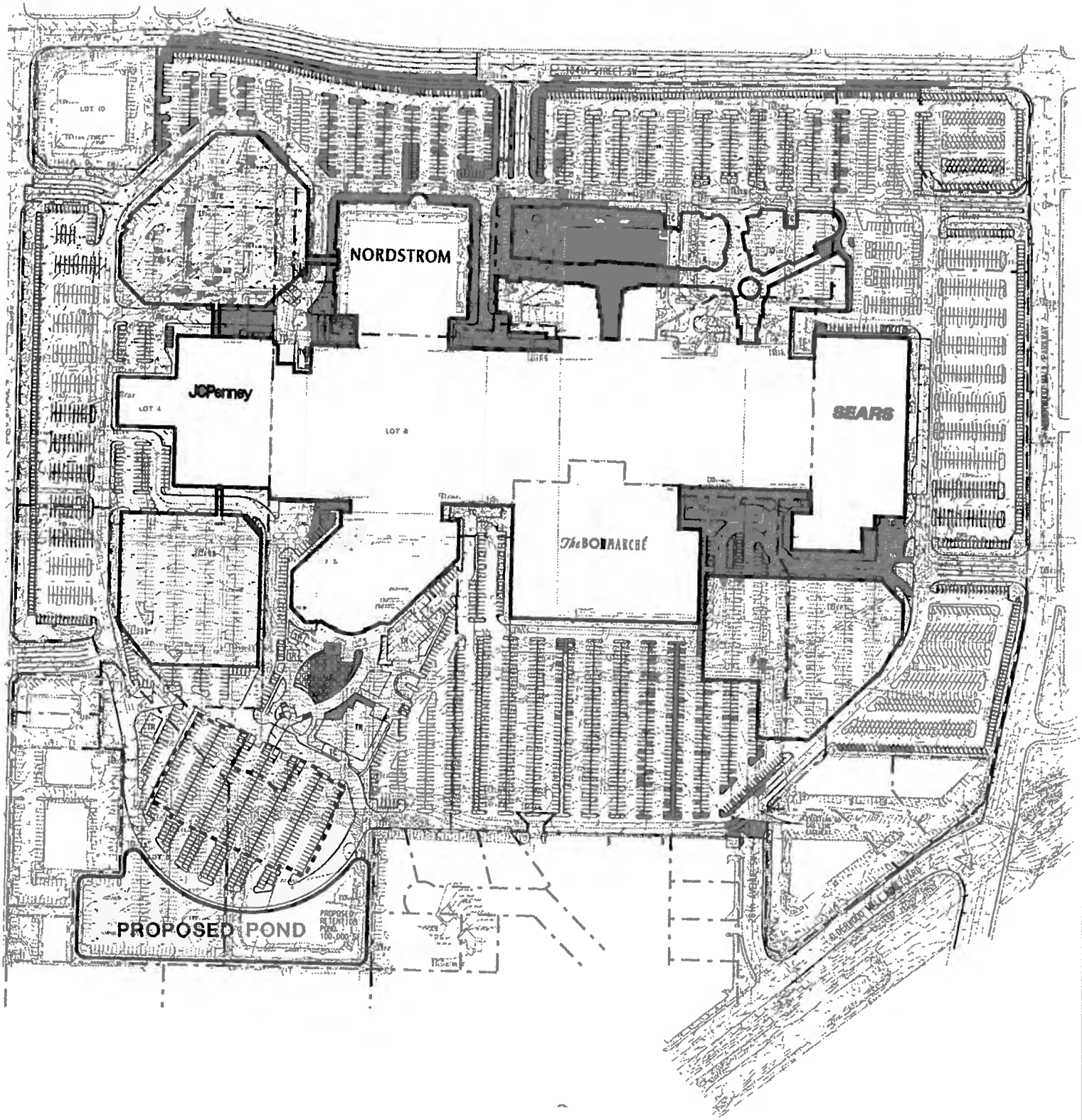


ALDERWOOD MALL EXPANSION

SCALE: 1"=300'

DATE: 6/14/02

EXISTING SITE FIGURE 2



ALDERWOOD MALL EXPANSION

SCALE: _____

DATE: _____

PROPOSED SITE FIGURE 3

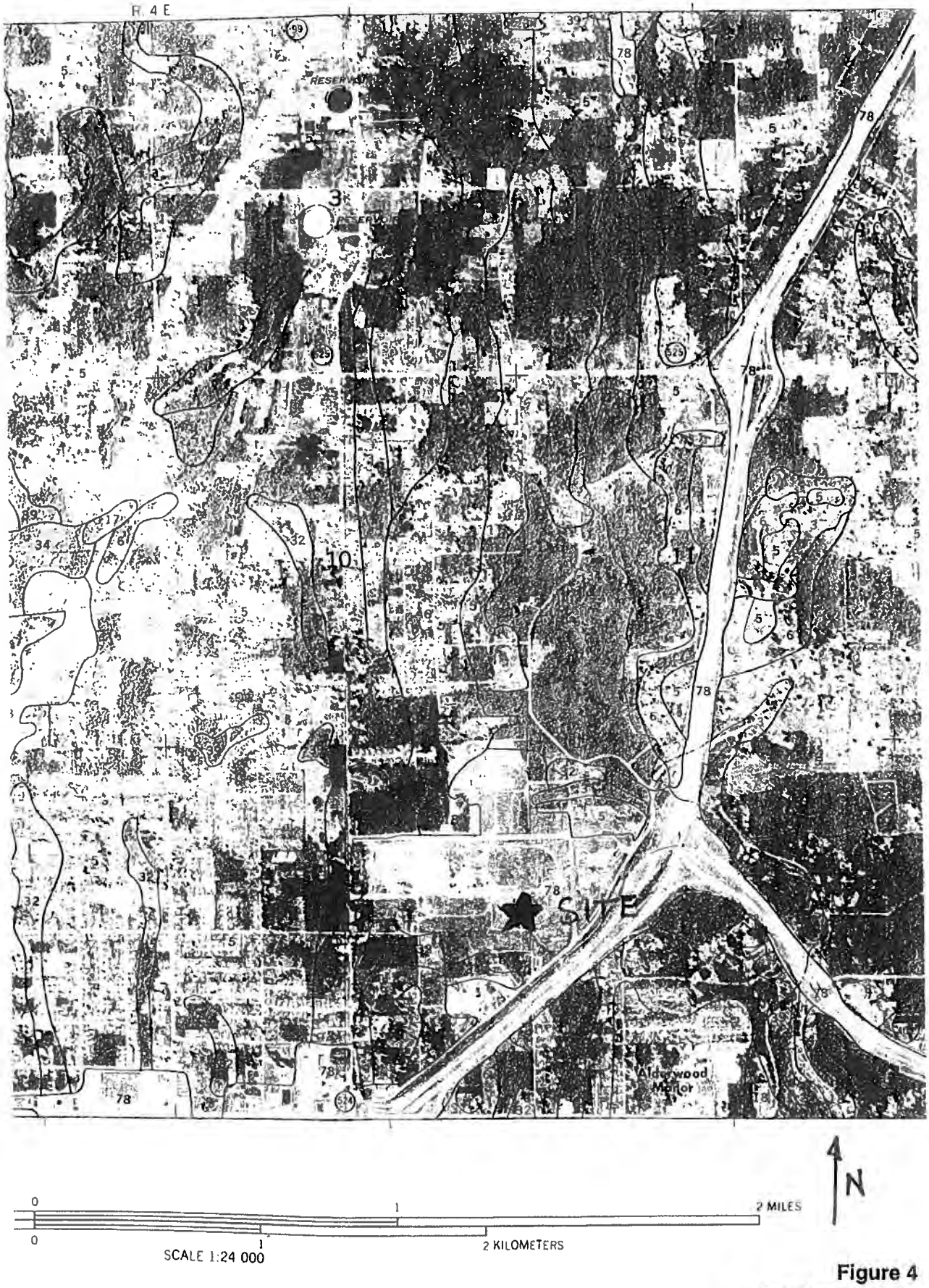


Figure 4
Soil Survey Map

See next page for list of soil units.

SOIL LEGEND

SYMBOL	NAME
1	Alderwood gravelly sandy loam, 2 to 8 percent slopes
2	Alderwood gravelly sandy loam, 8 to 15 percent slopes
3	Alderwood gravelly sandy loam, 15 to 25 percent slopes
4	Alderwood-Everett gravelly sandy loams, 25 to 70 percent slopes
5	Alderwood-Urban land complex, 2 to 8 percent slopes
6	Alderwood-Urban land complex, 8 to 15 percent slopes
7	Bellingham silty clay loam
8	Bellingham Variant mucky silty clay loam
9	Cathcart loam, 3 to 15 percent slopes
10	Cathcart loam, 15 to 25 percent slopes
11	Cathcart loam, 25 to 50 percent slopes
12	Cryohemists, nearly level
13	Custer fine sandy loam
14	Elwell silt loam, 3 to 30 percent slopes
15	Elwell-Olomount complex, 15 to 30 percent slopes
16	Elwell-Olomount-Rock outcrop complex, 30 to 60 percent slopes
17	Everett gravelly sandy loam, 0 to 8 percent slopes
18	Everett gravelly sandy loam, 8 to 15 percent slopes
19	Everett gravelly sandy loam, 15 to 25 percent slopes
20	Fluvaquents, tidal
21	Getchell silt loam, 3 to 30 percent slopes
22	Getchell-Oso complex, 15 to 30 percent slopes
23	Getchell-Oso-Rock outcrop complex, 30 to 65 percent slopes
24	Greenwater loamy sand
25	Hartnit-Potchub-Rock outcrop complex, 65 to 90 percent slopes
26	Indianola loamy sand, 15 to 25 percent slopes
27	Kitsap silt loam 0 to 8 percent slopes
28	Kitsap silt loam, 8 to 25 percent slopes
29	Kitsap silt loam, 25 to 50 percent slopes
30	Lynnwood loamy sand, 0 to 3 percent slopes
31	Lynnwood-Nargar complex, 65 to 90 percent slopes
32	McKenna gravelly silt loam, 0 to 8 percent slopes
33	Menzel silt loam, 0 to 3 percent slopes
34	Mukilteo muck
35	Nargar fine sandy loam, 0 to 15 percent slopes
36	Nargar fine sandy loam, 15 to 30 percent slopes
37	Nargar-Lynnwood complex, 30 to 65 percent slopes
38	Nargar Variant sandy loam, 3 to 30 percent slopes
39	Norma loam
40	Norma Variant loam
41	Ogarty-Tokul-Rock outcrop complex, 65 to 90 percent slopes
42	Olomount gravelly loam, 3 to 15 percent slopes
43	Olomount-Elwell-Rock outcrop complex, 65 to 90 percent slopes
44	Orcas peat
45	Oso gravelly loam, 3 to 15 percent slopes
46	Oso-Getchell-Rock outcrop complex, 65 to 90 percent slopes
47	Pastik silt loam, 0 to 8 percent slopes
48	Pastik silt loam, 8 to 25 percent slopes
49	Pastik silt loam, 25 to 50 percent slopes
50	Pilchuck loamy sand
51	Pits
52	Potchub silt loam, 3 to 30 percent slopes
53	Potchub-Hartnit complex, 15 to 30 percent slopes
54	Potchub-Hartnit-Rock outcrop complex, 30 to 65 percent slopes
55	Puget silty clay loam
56	Puyallup fine sandy loam
57	Ragnar fine sandy loam, 0 to 8 percent slopes
58	Ragnar fine sandy loam, 8 to 15 percent slopes
59	Riverwash
60	Rober silt loam, 0 to 15 percent slopes
61	Rober silt loam, 15 to 30 percent slopes
62	Rober silt loam, 30 to 65 percent slopes
63	Skykomish gravelly loam, 0 to 30 percent slopes
64	Snohomish silt loam
65	Sulsavar gravelly loam, 0 to 8 percent slopes
66	Sultan silt loam
67	Sultan Variant silt loam
68	Sumas silt loam
69	Terric Medisaprists, nearly level
70	Tokul silt loam, 2 to 8 percent slopes
71	Tokul silt loam, 8 to 15 percent slopes
72	Tokul gravelly loam, 0 to 8 percent slopes
73	Tokul gravelly loam, 8 to 15 percent slopes
74	Tokul gravelly loam, 15 to 25 percent slopes
75	Tokul-Ogarty-Rock outcrop complex, 0 to 25 percent slopes
76	Tokul-Ogarty-Rock outcrop complex, 25 to 65 percent slopes
77	Tokul-Winston gravelly loams, 25 to 65 percent slopes
78	Urban land
79	Verlot mucky silt loam, 3 to 25 percent slopes
80	Winston gravelly loam, 0 to 3 percent slopes
81	Winston gravelly loam, 3 to 30 percent slopes
82	Xerorthents, nearly level

Index to Soil Map Units (see figure 4)

Existing Stormwater System

Existing Detention

Alderwood Mall was constructed in 1978 in compliance with requirements in place at that time. A detention pond was created to mitigate impacts for the 175-acre basin that includes the 83.9-acre mall. In 1995, KPFF performed a study on the operational capacity of that original pond for a previous mall expansion entitled, *Stormwater Management Analysis for Alderwood Mall Expansion*, (KPFF, 01/27/95). This operational analysis stated that the original pond was sized to release the 10- and 25-year, 6-hour storm at predeveloped rates. The report mentioned a proposed increase in impervious area of 4.7 acres, but proposed no additional volume to be added to the existing pond. According to the report, this acreage was considered to be "grandfathered" in the original construction of the pond. Calculations were performed to ensure that the existing pond with the new impervious area met the City standards at the time. The following excerpt is KPFF's summary of the analysis performed:

> "To determine if under current requirements for detention the new parking areas would require more detention volume than provided for the previous design, KPFF ran hydrographs of the 10-year and 25-year, 6-hour storms predeveloped and developed, and the 10-year and 25-year, 24-hour storm predeveloped and developed. We determined from these hydrographs that the storage volume for the 6-hour storm was actually greater than would be required for the 24-hour storm (see Appendix D). Since the new parking lots were included in the original detention design, no additional detention would be required." (KPFF, 01/27/95)

The standards the City appeared to be using at the time of the KPPF report in 1995 are different than those outlined in the 1992 edition of the Ecology Manual, the current regulations for the City. According to the report, the grandfathered pond volume of 3.6 acre-feet was adequate.

Some assumptions in the KPFF report are used in the current storm system analysis for consistency.

Existing Water Quality

The existing pond water quality system was enhanced according to the KPFF report, using the Ecology Manual as a guideline. No specific sizing criteria were mentioned, though the addition of a "forebay" was proposed to facilitate settling of particles. Oil/water separators and catch basin filters were considered too costly, and the small area of increased impervious area was not considered to create a noticeable decrease in water quality. In addition, this "forebay" was assumed to provide additional detention volume for the pond.

Existing Conveyance

On-site stormwater generally sheet flows to the mall's catch basin and pipe conveyance system. Off-site stormwater flows through a conveyance system that ties into the system that services the mall. This network drains to the existing detention pond in the southwest corner of the site.

Downstream Analysis

The on-site and off-site stormwater is routed through the existing detention system which outlets to a virtually flat, 54-inch conveyance line. This conveyance system continues south and drains to Swamp Creek.

DEVELOPED CONDITIONS

Drainage Plan

The proposed development includes the construction of new structures and additions to an existing structure. The proposed site area will include more pervious area than the existing, as impervious parking areas will be replaced by parking structures, freeing up more area for landscaping.

The proposed on-site drainage is similar to the existing system. The construction of the parking structures, retail space, cinema, and mall additions will require that portions of the existing stormwater system be rerouted. This system will transport both the on-site and off-site flows to a new water quality and detention system in the location of the existing pond. The portions of the site disturbed by construction and not covered by surface parking or the proposed buildings will be landscaped or hydroseeded to protect against erosion.

Runoff Calculations

Design flow rates were calculated with Waterworks design software using SBUH type 1a rainfall distribution. Precipitation volumes for design storms are listed in **table 1**. The hydrologic soil group used was "D" and the pervious and impervious areas are based on assumed final conditions. The time of concentration for the predeveloped on-site area was calculated using the grading shown as existing in the original construction documents for the mall (**Edward J. DeBartollo and Associates, 9-2-77**). The proposed on-site time of concentration was calculated based on assumed final design for the on-site conveyance system. The off-site time of concentration and pervious and impervious areas were taken from Stormwater Management Analysis for Alderwood Mall Expansion, (**KPFF, 01/27/95**). Please see **Appendix A** for calculations.

Table 1 Precipitation Volumes for Design Storms.	
Storm Event	**Precipitation** (in/day)
Water Quality Storm (64% of 2-yr)	0.96
2-year	1.50
10-year	2.20
100-year	3.30

Detention

Bill Franz with the City of Lynnwood Public Works Department agreed that the proposed detention system should control flows for the 83.9-acre mall site to current City standards and should provide adequate storage as to not overtop during the 100-year event for the 175-acre basin. Current City detention standards are taken from the Ecology Manual, 1992. The proposed detention pond system will be designed to release the proposed on-site 2-year flow rate at one-half of the predeveloped 2-year flow rate, the proposed on-site 10-year flow rate at the predeveloped 10-year flow rate, and the proposed on-site 100-year flow rate at the predeveloped 100-year flow rate, per the requirements outlined in the Ecology Manual, 1992. Flows in excess of design flows for the on-site storms, the flow generated in the remaining area of the 175 acres off-site, will be routed through the system with the peak 100-year elevation for the entire basin not exceeding the top elevation of the pond, plus one-foot of freeboard.

The proposed pond and outlet structure were designed using Waterworks hydraulic modeling software. For comparison, the existing pond was also modeled to show the improved detention performance. The current operation of the existing detention system differs from the KPFF report. The pond has a 30-inch weir outlet structure set 1.88 feet below the rim elevation of the structure. The elevation of this weir sets the permanent pool water surface elevation and leaves 1.88 feet of live storage in the pond before overflow. In the overflow condition, when the rim of the control structure is overtopped, the walls of the concrete box become the outlet structure. This condition was modeled as a riser pipe with a 10-foot diameter for simplification. **Table 2** shows the design flows and compares the outflows from the existing and proposed system. Please see **Appendix B** for the, preliminary pond configuration and staging, the routing table, and the inflow and outflow hydrographs.

Table 2
Detention Flow Rates

Storm Event	Peak Flow Rate (cfs)		Peak System Release Rate (cfs)	
	Developed	Predeveloped	Existing Detention	Proposed Detention
2-year on-site	19.78	5.97	10.62	2.98
10-year on-site	30.62	13.09	17.33	8.03
100-year on-site	47.58	25.72	38.55	25.60
100-year full basin	81.74	N/A	76.86	46.71

Water Quality

The proposed water quality pond is sized to contain the volume of the 6-month, 24-hour storm per the Ecology Manual, 1992. The 6-month, 24-hour storm is equivalent to 64 percent of the 2-year, 24-hour storm. See **Appendix B** for the stormwater quality volumes and the preliminary pond configuration.

Conveyance

The onsite conveyance system will be designed and modeled prior to completion of mall improvements. It will provide conveyance capacity such that the 25-year storm hydraulic gradeline will be one-half foot below the rim elevation of the catch basins.

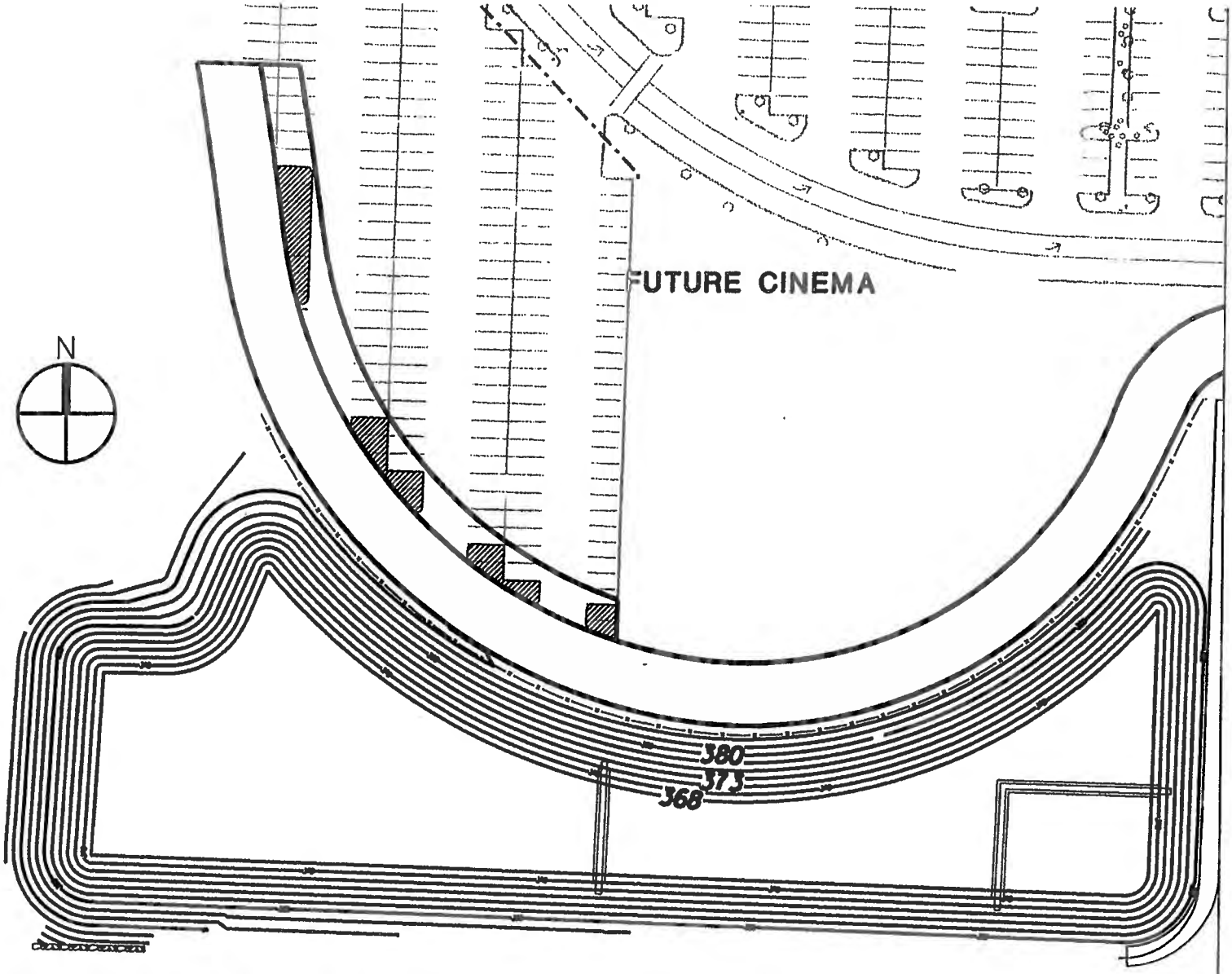
Downstream Analysis

The proposed detention system will outlet to the existing 54-inch conveyance system, which discharges to Swamp Creek. The downstream conveyance system will operate better, and the impact to Swamp Creek will be less, in the proposed condition than in the existing, because the proposed peak release rates are less for every design storm, and significantly less for the 100-year, 175-acre basin condition (see **table 2**).

Conclusion

The proposed pond is shown in **figure 5.** The pond was designed to provide a water quality treatment volume of **247,383 cubic feet** for the 83.9-acre mall site and a

minimum live storage volume of **461,982 cubic feet** plus one foot of freeboard over the peak water surface elevation for the 175-acre basin.



POND VOLUMES

BOTTOM OF WATER QUALITY= 368.0
TOP OF WATER QUALITY=373.0, VOLUME 247,383 CF

BOTTOM OF DETENTION =373.0
TOP OF 100-YR DETENTION FOR MALL SITE =377.6, VOLUME =292,751 CF
TOP OF 46% VOLUME ADJUSTMENT =379.5, VOLUME =432,122 CF
TOP OF FULL BASIN 100-YR =379.9, VOLUME =461,982 CF
TOP OF FREEBOARD=382.0

	ALDERWOOD MALL EXPANSION	SCALE: 1"=80' DATE: 6/14/02	**POND VOLUMES**

.\Figures\dr-rep pondvolume.dgn 09/27/2002 04:09:17 PM

Peak Onsite Flow Calculations

BASIN SUMMARY

BASIN ID: E10 NAME: PREDEVELOPED 10 YEAR
SBUH METHODOLOGY
TOTAL AREA.....: 83.86 Acres BASEFLOWS: 0.00 cfs
RAINFALL TYPE....: TYPE1A PERV IMP
PRECIPITATION....: 2.20 inches AREA..: 83.86 Acres 0.00 Acres
TIME INTERVAL....: 10.00 min CN....: 89.00 0.00
TC....: 48.58 min 0.00 min
ABSTRACTION COEFF: 0.20
TcReach - Sheet L: 300.00 ns:0.1500 p2yr: 1.50 s:0.0200
TcReach - Shallow L:2100.00 ks:11.00 s:0.0200
PEAK RATE: 13.09 cfs VOL: 8.36 Ac-ft TIME: 490 min

BASIN ID: E100 NAME: PREDEVELOPED 100 YEAR
SBUH METHODOLOGY
TOTAL AREA.....: 83.86 Acres BASEFLOWS: 0.00 cfs
RAINFALL TYPE....: TYPE1A PERV IMP
PRECIPITATION....: 3.30 inches AREA..: 83.86 Acres 0.00 Acres
TIME INTERVAL....: 10.00 min CN....: 89.00 0.00
TC....: 48.58 min 0.00 min
ABSTRACTION COEFF: 0.20
TcReach - Sheet L: 300.00 ns:0.1500 p2yr: 1.50 s:0.0200
TcReach - Shallow L:2100.00 ks:11.00 s:0.0200
PEAK RATE: 25.72 cfs VOL: 15.19 Ac-ft TIME: 490 min

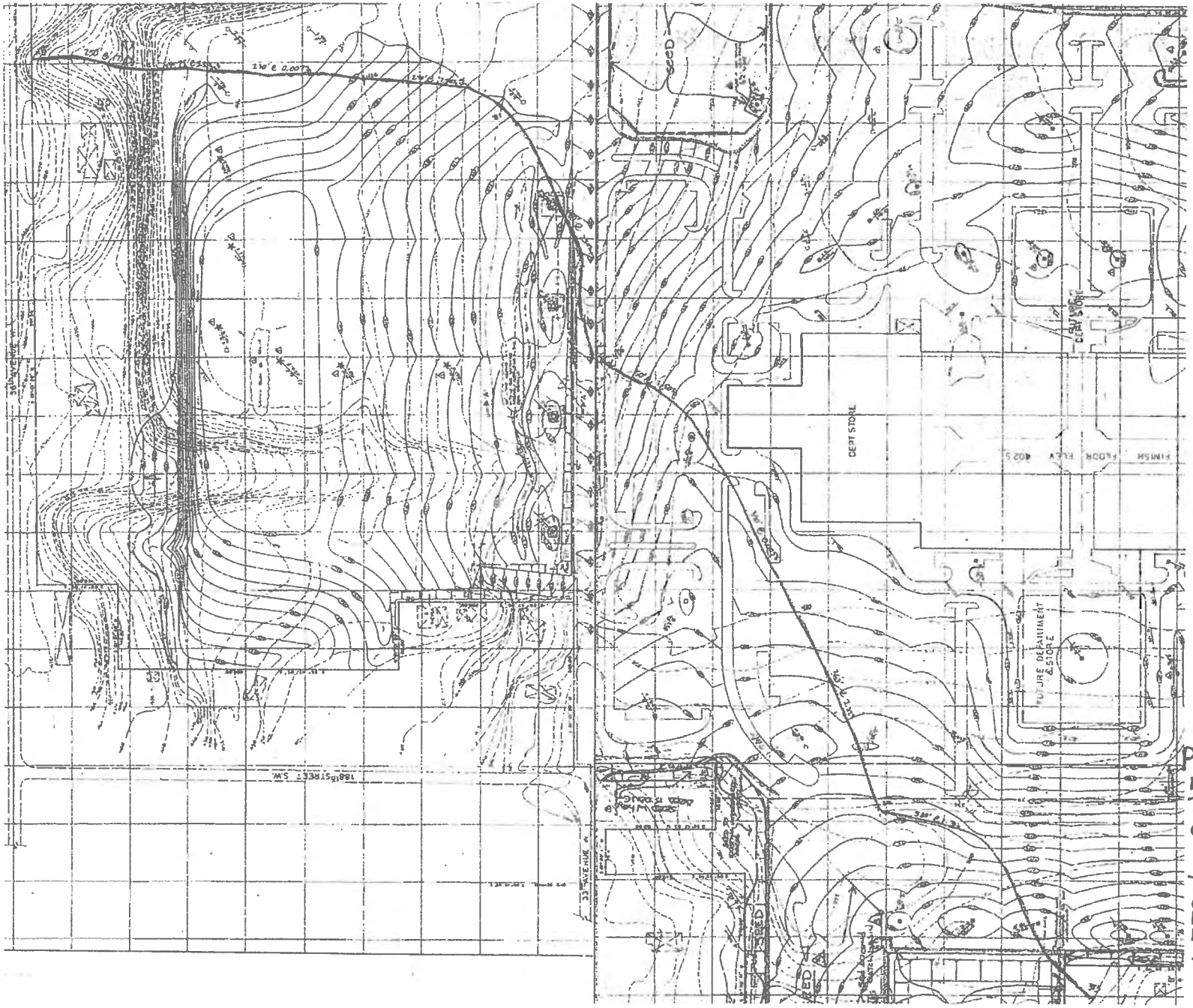
BASIN ID: E2 NAME: PREDEVELOPED 2 YEAR
SBUH METHODOLOGY
TOTAL AREA.....: 83.86 Acres BASEFLOWS: 0.00 cfs
RAINFALL TYPE....: TYPE1A PERV IMP
PRECIPITATION....: 1.50 inches AREA..: 83.86 Acres 0.00 Acres
TIME INTERVAL....: 10.00 min CN....: 89.00 0.00
TC....: 48.58 min 0.00 min
ABSTRACTION COEFF: 0.20
TcReach - Sheet L: 250.00 ns:0.1500 p2yr: 1.50 s:0.1750
TcReach - Sheet L: 50.00 ns:0.1500 p2yr: 1.50 s:0.0070
TcReach - Shallow L: 240.00 ks:11.00 s:0.0750
TcReach - Shallow L: 640.00 ks:11.00 s:0.0250
TcReach - Shallow L:1280.00 ks:11.00 s:0.0110
PEAK RATE: 5.97 cfs VOL: 4.41 Ac-ft TIME: 490 min

BASIN SUMMARY

BASIN ID: D10 NAME: DEVELOPED 10 YEAR
SBUH METHODOLOGY
TOTAL AREA.....: 83.86 Acres BASEFLOWS: 0.00 cfs
RAINFALL TYPE....: TYPE1A PERV IMP
PRECIPITATION....: 2.20 inches AREA..: 7.28 Acres 76.58 Acres
TIME INTERVAL....: 10.00 min CN....: 90.00 98.00
TC....: 20.73 min 20.73 min
ABSTRACTION COEFF: 0.20
TcReach - Sheet L: 100.00 ns:0.1500 p2yr: 1.50 s:0.0200
TcReach - Shallow L: 100.00 ks:27.00 s:0.0200
TcReach - Channel L:3000.00 kc:42.00 s:0.0100
impTcReach - Sheet L: 100.00 ns:0.1500 p2yr: 1.50 s:0.0200
impTcReach - Shallow L: 100.00 ks:27.00 s:0.0200
impTcReach - Channel L:3000.00 kc:42.00 s:0.0100
PEAK RATE: 30.62 cfs VOL: 13.36 Ac-ft TIME: 480 min

BASIN ID: D100 NAME: DEVELOPED 100 YEAR
SBUH METHODOLOGY
TOTAL AREA.....: 83.86 Acres BASEFLOWS: 0.00 cfs
RAINFALL TYPE....: TYPE1A PERV IMP
PRECIPITATION....: 3.30 inches AREA..: 7.28 Acres 76.58 Acres
TIME INTERVAL....: 10.00 min CN....: 90.00 98.00
TC....: 20.73 min 20.73 min
ABSTRACTION COEFF: 0.20
TcReach - Sheet L: 100.00 ns:0.1500 p2yr: 1.50 s:0.0200
TcReach - Shallow L: 100.00 ks:27.00 s:0.0200
TcReach - Channel L:3000.00 kc:42.00 s:0.0100
impTcReach - Sheet L: 100.00 ns:0.1500 p2yr: 1.50 s:0.0200
impTcReach - Shallow L: 100.00 ks:27.00 s:0.0200
impTcReach - Channel L:3000.00 kc:42.00 s:0.0100
PEAK RATE: 47.58 cfs VOL: 20.95 Ac-ft TIME: 480 min

BASIN ID: D2 NAME: DEVELOPED 2 YEAR
SBUH METHODOLOGY
TOTAL AREA.....: 83.86 Acres BASEFLOWS: 0.00 cfs
RAINFALL TYPE....: TYPE1A PERV IMP
PRECIPITATION....: 1.50 inches AREA..: 7.28 Acres 76.58 Acres
TIME INTERVAL....: 10.00 min CN....: 90.00 98.00
TC....: 20.73 min 20.73 min
ABSTRACTION COEFF: 0.20
TcReach - Sheet L: 100.00 ns:0.1500 p2yr: 1.50 s:0.0200
TcReach - Shallow L: 100.00 ks:27.00 s:0.0200
TcReach - Channel L:3000.00 kc:42.00 s:0.0050
impTcReach - Sheet L: 100.00 ns:0.1500 p2yr: 1.50 s:0.0200
impTcReach - Shallow L: 100.00 ks:27.00 s:0.0200
impTcReach - Channel L:3000.00 kc:42.00 s:0.0100
PEAK RATE: 19.78 cfs VOL: 8.58 Ac-ft TIME: 480 min



---PRE-DEVELOP CONTOU

PREDEVELOPI
MALL AREA
TIME OF
CONCENTRAT
N.T.S.

TAKEN FROM
GRADING PLAN
BY EDWARD J.
DEBARTOLO &
ASSOCIATES
9-2-77

PREDEVELOPED TIME OF CONCENTRATION FOR MALL SITE

OVERLAND SHEET FLOW SECTION 300' MAX

$$T_t = \frac{0.42\,(n_s L)^{0.8}}{(P_2)^{0.527}(S_o)^{0.4}}$$ 1992 WSDOE MANUAL

n_s = sheet flow mannings coefficient

L = flow length (ft.)

P_2 = 2yr, 24hr rainfall (in) = 1.50"

S_o = slope

n_s for short prairie grass, 0.15

1ST SECTION

$L = 250'$

$S_o = 0.175$

$T_t = 12.37 \text{ min}$

2ND SECTION

$L = 50'$

$S_o = 5.33\%$

$T_t = 5.50 \text{ min}$

SHALLOW CONCENTRATED FLOW

$$T_t = \frac{L}{60V} \qquad V = k\sqrt{S_o}$$

k_s = shallow concentrated flow coefficient

3RD SECTION

$L = 25'$

$k_s = 11$ for pastures and lawns

$S = 0.0533$

$V = 11\sqrt{0.0533} = 2.54 \text{ fps}$

$T_t = \frac{25}{60 \times 2.54} = \underline{0.16 \text{ min}}$

4TH SECTION

$L = 270'$

$k_s = 11$

$S = 0.007$

$V = 11\sqrt{0.007} = 0.92 \text{ fps}$

$T_t = \frac{270}{60 \times 0.92} = \underline{4.89 \text{ min}}$

5TH SECTION

$L = 240'$

$k_s = 11$

$S = 0.075$

$V = 11\sqrt{0.075} = 3.01 \text{ fps}$

$T_t = \frac{240'}{60 \times 3.01} = \underline{1.33 \text{ min}}$

6TH SECTION

$L = 480'$

$k_s = 11$

$S = 0.025$

$V = 11\sqrt{0.025} = 1.74 fps$

$T_t = \frac{480}{60 \times 1.74} = 4.60 min$

7TH SECTION

$L = 160'$

$k_s = 11$

$S = 0.025$

$V = 11\sqrt{0.025} = 1.74 fps$

$T_t = \frac{160}{60 \times 1.74} = 1.53 min$

8TH SECTION

$L = 390'$

$k_s = 11$

$S = 0.005$

$V = 11\sqrt{0.005} = 0.78 fps$

$T_t = \frac{390}{60 \times 0.78} = 8.36 min$

9TH SECTION

$L = 360'$

$k_s = 11$

$S = 0.022$

$V = 11\sqrt{0.022} = 1.63 fps$

$T_t = \frac{360}{60 \times 1.63} = 3.68 min$

10TH SECTION

$L = 530'$

$k_s = 11$

$S = 0.017$

$V = 11\sqrt{0.017} = 1.43 fps$

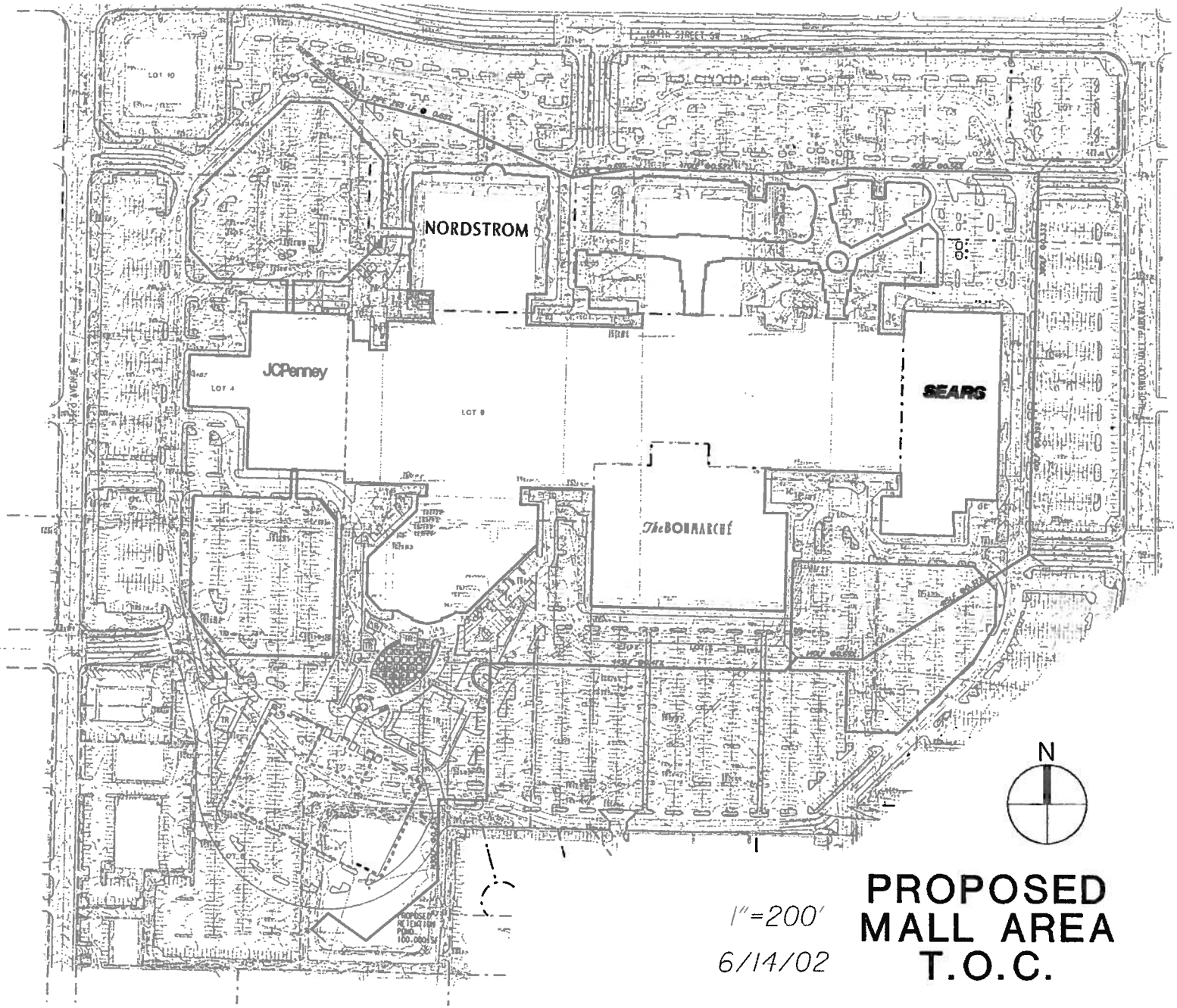
$T_t = \frac{530}{60 \times 1.43} = \underline{6.16 min}$

TIME OF CONCENTRATION

$T_c = T_{t1} + T_{t2} + T_{t3} + \ldots + T_{t10}$

$T_c = 12.37 + 5.50 + 0.16 + 4.89 + 1.33 + 4.60 + 1.53 + 8.36 + 3.68 + 6.16$

$= \underline{48.58 min}$



1"=200'

6/14/02

PROPOSED MALL AREA T.O.C.

ENTRANCO

SHEET NO. ___ OF ___

JOB NO. -00151-60

PROJECT ALDERWOOD MALL EXPANSION

CALCULATIONS FOR TIME OF CONCENTRATION

MADE BY JJT DATE 5/30/02 CHECKED BY _____ DATE _____

PROPOSED TIME OF CONCENTRATION FOR MALL SITE

OVERLAND FLOW

1ST SECTION

$$T_t = \frac{0.42\,(n_s L)^{0.8}}{(P_2)^{0.527}(S_o)^{0.4}}$$

$n_2 = 0.011$

$L = 150'$

$P_2 = 1.5$ in

$S_o = 0.017$

$T_t = \underline{2.58 \text{ min}}$

PIPE FLOW

2ND SECTION

$$T_t = \frac{L}{60V} \qquad V = k\sqrt{S_o}$$

$k = 0.807/n$ $\quad n = 0.013$ for concrete, pvc

$L = 265'$

$S_o = 0.0068$

$k = 62.1$

$V = 62.1\sqrt{.0068} = 5.12$ fps

$T_t = \frac{265}{5.12 \times 60} = \underline{0.86 \text{ min}}$

3RD SECTION

$L = 132'$
$S_o = 0.0069$
$k = 62.1$
$V = 62.1\sqrt{0.0069} = 5.16 \text{ fps}$
$T_t = \frac{132}{60 \times 5.16} = \underline{0.43 \text{ min}}$

4TH SECTION

$L = 470'$
$S_o = 0.0052$
$k = 62.1$
$V = 62.1\sqrt{0.0052} = 4.48 \text{ fps}$
$T_t = \frac{470}{60 \times 4.48} = \underline{1.75 \text{ min}}$

5TH SECTION

$L = 405'$
$S_o = 0.0056$
$k = 62.1$
$V = 62.1\sqrt{0.0056} = 4.65 \text{ fps}$
$T_t = \frac{405}{60 \times 4.65} = \underline{1.45 \text{ min}}$

6TH SECTION

$L = 390'$
$S_o = 0.0033$
$k = 62.1$
$V = 62.1\sqrt{0.0033} = 3.57 \text{ fps}$
$T_t = \frac{390}{60 \times 3.57} = \underline{1.82 \text{ min}}$

7TH SECTION

$L = 410'$

$S_o = 0.0039$

$k = 62.1$

$V = 62.1\sqrt{0.0039} = 3.88 \text{ fps}$

$T_t = \frac{410}{60 \times 3.88} = 1.76 \text{ min}$

8TH SECTION

$L = 415'$

$S_o = 0.0037$

$k = 62.1$

$V = 62.1\sqrt{0.0037} = 3.78 \text{ fps}$

$T_t = \frac{415}{60 \times 3.78} = 1.83 \text{ min}$

9TH SECTION

$L = 140'$

$S_o = 0.0069$

$k = 62.1$

$V = 62.1\sqrt{0.0069} = 5.16 \text{ fps}$

$T_t = \frac{140}{60 \times 5.16} = 0.45 \text{ min}$

10TH SECTION

$L = 443'$

$S_o = 0.0047$

$k = 62.1$

$V = 62.1\sqrt{0.0047} = 4.26$ fps

$T_t = \frac{443}{60 \times 4.26} = \underline{1.73 \text{ min}}$

11TH SECTION

$L = 1130'$

$S_o = 0.0025$

$k = 62.1$

$V = 62.1\sqrt{0.0025} = 3.11$ fps

$T_t = \frac{1130}{60 \times 3.11} = 6.07$ min

Tc TOTAL

$T_c = T_{t_1} + T_{t_2} + \ldots T_{t_{11}}$

$= \underline{20.73 \text{ min}}$

Peak Full Basin Flow Calculations

ALDERWOOD MALL EXPANSION

==========

BASIN SUMMARY

BASIN ID: D100BIG NAME: DEVELOPED 100 YEAR WHOLE BASIN
SBUH METHODOLOGY

TOTAL AREA.....:	175.00 Acres	BASEFLOWS:	0.00 cfs	
RAINFALL TYPE....:	TYPE1A		PERV	IMP
PRECIPITATION....:	3.30 inches	AREA..:	22.00 Acres	153.00 Acres
TIME INTERVAL....:	10.00 min	CN....:	90.00	98.00
		TC....:	40.00 min	40.00 min

ABSTRACTION COEFF: 0.20
TcReach - Sheet L: 100.00 ns:0.1500 p2yr: 1.50 s:0.0200
TcReach - Shallow L: 100.00 ks:27.00 s:0.0200
TcReach - Channel L:3000.00 kc:42.00 s:0.0100
impTcReach - Sheet L: 100.00 ns:0.1500 p2yr: 1.50 s:0.0200
impTcReach - Shallow L: 100.00 ks:27.00 s:0.0200
impTcReach - Channel L:3000.00 kc:42.00 s:0.0100
PEAK RATE: 80.35 cfs VOL: 43.25 Ac-ft TIME: 490 min

Excerpts from Stormwater Management Analysis for Alderwood Mall Expansion, KPFF January 27,1995

kpff Consulting Engineers
1201 Third Avenue, Suite 900
Seattle, Washington 98101
(206) 622-5822 Fax (206) 622-8130

project	ALDERWOOD MALL	by	PMA	sheet no.
location	LYNWOOD, WA	date	12/29/94	
client				job no.
	DRAINAGE BASIN			

- TOTAL AREA OF DRAINAGE BASIN:
  APPROXIMATELY 175 acres

- BREAKDOWN OF AREA

	APPROX. AREA (ac)	ASSUMED % OF IMPERV
RESIDENTIAL		
MED. DENSITY (4 DU/AC)	15	*42%
MULTIPLE FANILY	20	80%
COMMERCIAL		
URBAN COMMERCIAL	120	90%
INDUSTRIAL		
BUSINESS/ TECH PARK	20	90%
TOTAL	175 acres	

ASSUME
HYDROLOGIC SOIL GROUP C "ALDERWOOD"
USE D TO BE CONSERVATIVE

* FROM KING COUNTY

kpff Consulting Engineers
1201 Third Avenue, Suite 900
Seattle, Washington 98101
(206) 622-5822 Fax (206) 622-8130

project ALDERWOOD MALL		by PMA
location LYNNWOOD WA		date 12/29/94
client		
DRAINAGE BASIN		

CN=98 CN=92

EXISTING

	AREA		INP. AREA	PERV AREA
RESIDENTIAL				
MED DENSITY (4 DU/AC)	15	(42%)	6.3	8.7
MULTI-FAMILY	20	(80%)	16	4
COMMERCIAL				
URBAN COMMERCIA	120	(90%)	108	12
INDUSTRIAL				
BUSSINESS/TECH PARK	20	(90%)	18	2
TOTAL	175		148.3 ac	26.7 ac

DEVELOPED

ADD APPROXIMATELY 4.7 acres of Parking 100% IMPERV
REPLACING 4.7 acres of 100% PERV

SO, TOTAL IMPERVIOUS AREA = 148.3 + 4.7
= 153 acres

PERVIOUS AREA = 26.7 - 4.7
= 22 acres

1 THE ORIGINAL CALCULATIONS ASSUMED THAT ALL 175 acres WAS TO BE IMPERVIOUS.

kpff Consulting Engineers
1201 Third Avenue, Suite 900
Seattle, Washington 98101
(206) 622-5822 Fax (206) 622-8130

project	ALDERWOOD MALL	by	PMA	sheet no
location	LYNNWOOD, WA	date	12/29/94	
client				job no.
TIME OF CONCENTRATION				

TIME OF CONCENTRATION (T_c)

FIRST 300'.

$$T_1 = \frac{0.42\,(n_s L)^{0.8}}{P_2^{0.5}\,(S_o)^{0.4}}$$

$L = 300$

$n_s = 0.15$ (lawns & short grasses)

$P_2 = 1.4$

$S_o = \frac{525 - 517.5}{300} = 0.025$ ft/ft

$T_1 = 32.6$ MIN

NEXT 400' OVERLAND, $L = 400$, $K_s = 11$, $S_o = \frac{517.5 - 48}{400} = 0.075$

$T_2 = \frac{L}{60V}$ $\quad V = K_s\sqrt{S_o} = 11\sqrt{0.075}$ (lawns)

$V = 3.$

$= \frac{400}{60\,(3)} = 2.2$ MIN

PIPE FLOW $L = 2700'$

$T_3 = \frac{L}{60V}$

$= \frac{2700}{60\,(8.6)} = 5.2$ min

$S_o = \frac{487.5 - 374.4}{2700}$

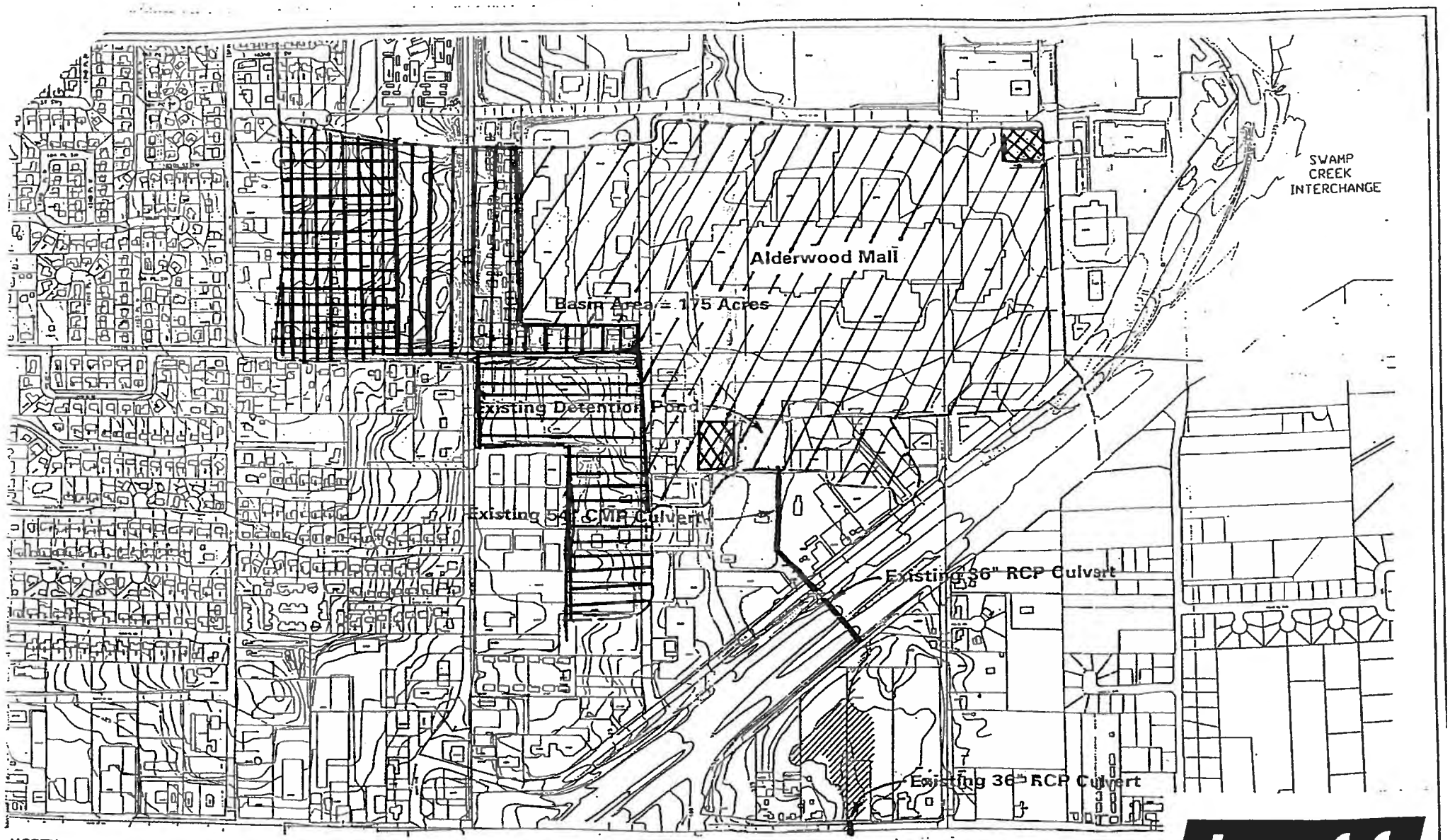
$S = 0.042$

$V = K_s\sqrt{S_o}$

$K_s = 42$ ASSUM CONC. PIPE

$V = 8.6$ FPS

* $T_c = 32.6 + 2.2 + 5.2 = 40$ min



NORTH

Scale 1'=500'

URBAN COMMERCIAL

MULTIPLE FAMILY

BUSINESS/TECH PARK

MED DENSITY 4-20/AC

ADDITIONAL IMPERVIOUS AREA
AREA = 4.7 ac

DRAINAGE BASIN MAP

kpff

APPENDIX A

Applicable Portions of the 1992 Ecology Manual

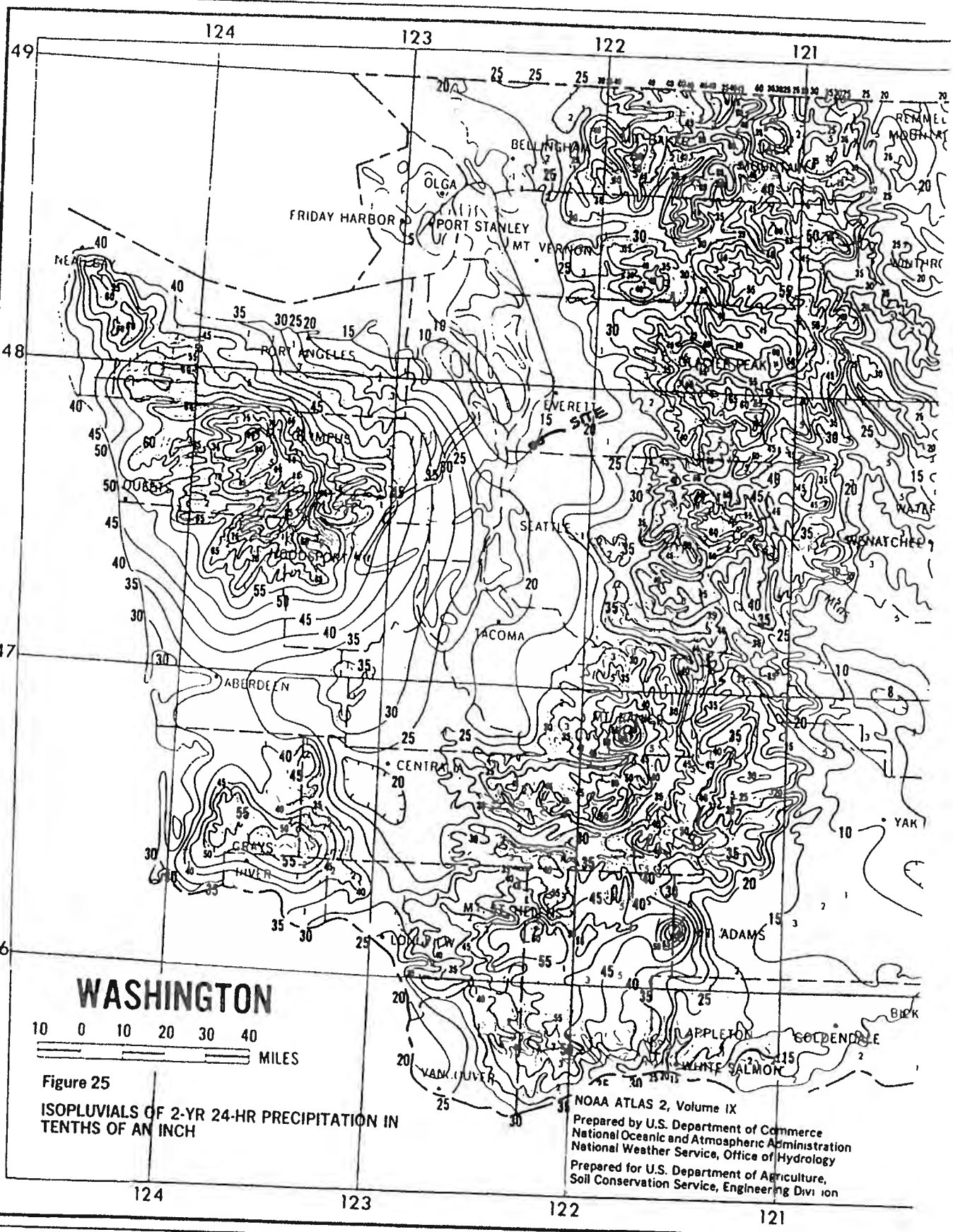


Figure 25

ISOPLUVIALS OF 2-YR 24-HR PRECIPITATION IN TENTHS OF AN INCH

NOAA ATLAS 2, Volume IX

Prepared by U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service, Office of Hydrology

Prepared for U.S. Department of Agriculture,
Soil Conservation Service, Engineering Division

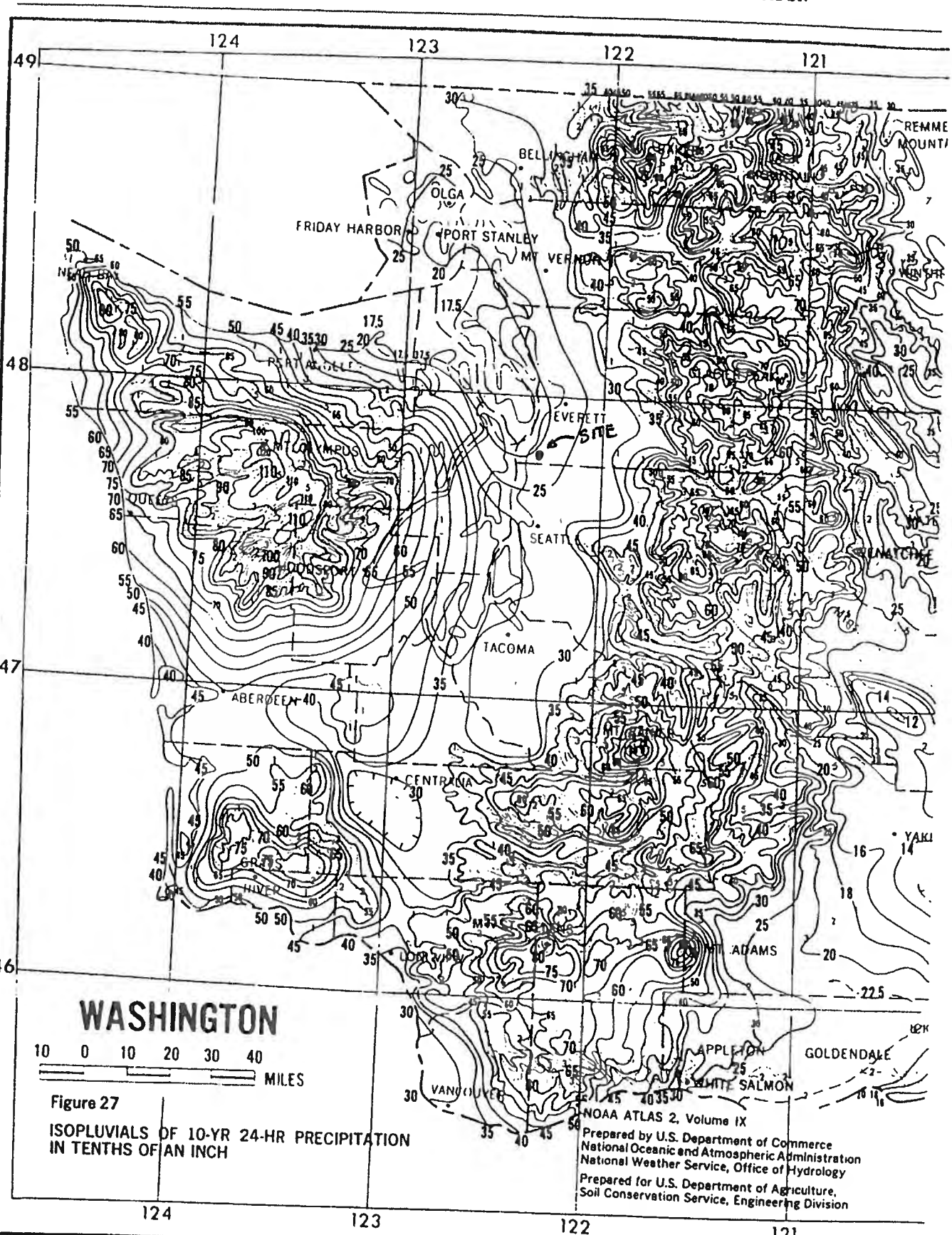


Figure 27

ISOPLUVIALS OF 10-YR 24-HR PRECIPITATION IN TENTHS OF AN INCH

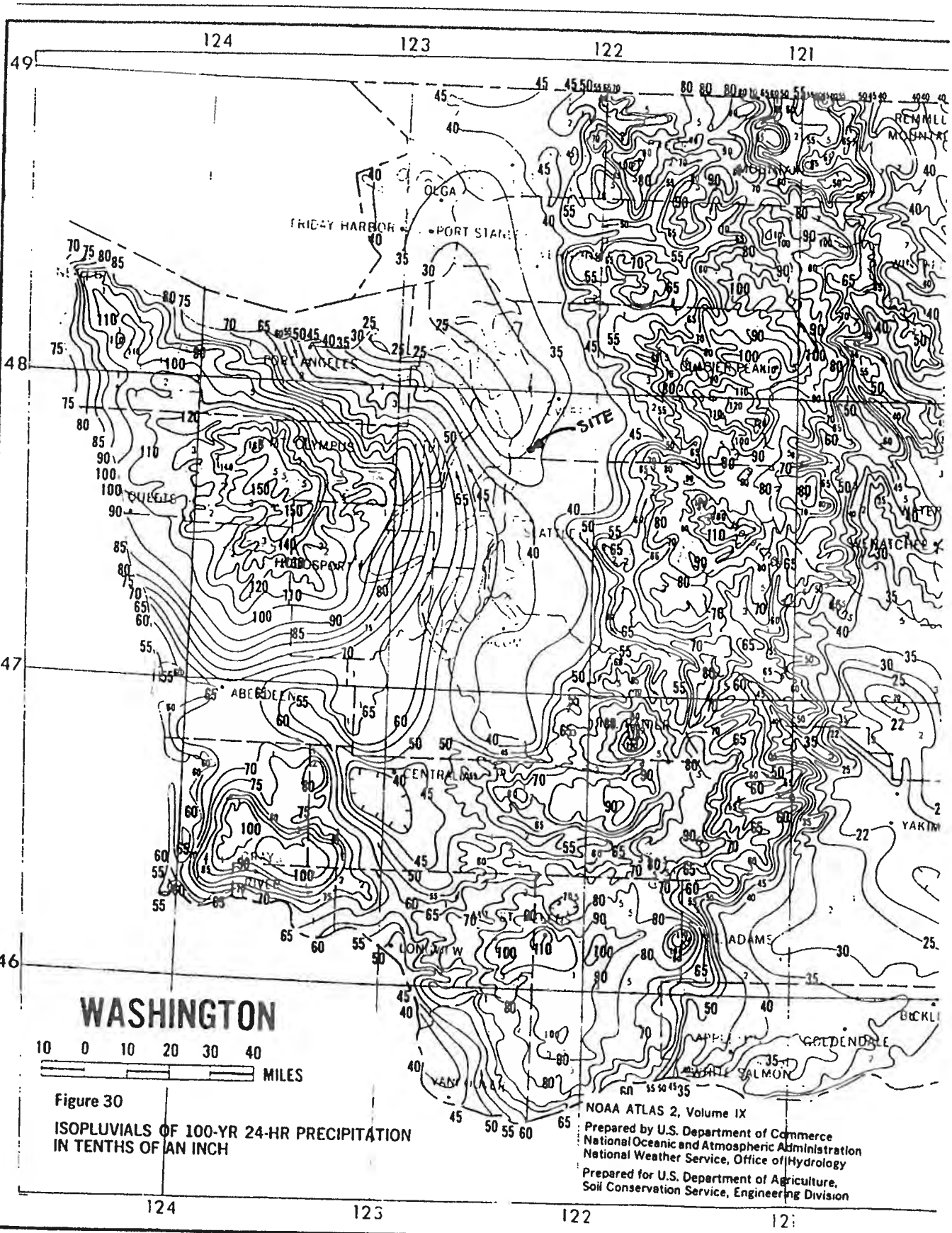


Figure 30

ISOPLUVIALS OF 100-YR 24-HR PRECIPITATION IN TENTHS OF AN INCH

NOAA ATLAS 2, Volume IX

Prepared by U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service, Office of Hydrology

Prepared for U.S. Department of Agriculture,
Soil Conservation Service, Engineering Division

Soil Type	Hydrologic Soil Group	Soil Type	Hydrologic Soil Group
Newberg	B	Spanaway	A/B
Nisqually	B	Springdale	B
Nooksack	C	Sultavar	B
Norma	C/D	Sultan	C
Ogarty	C	Sultan variant	B
Olete	ND	Sumas	C
Olomount	C	Swantown	ND
Olympic	B	Tacoma	D
Orcas	D	Tanwax	ND
Oridia	D	Tealwhit	ND
Orting	ND	Tenino	C
Oso	C	Tisch	D
Ovall	C	Tokul	ND
Pastik	C	Townsend	C
Pheeney	C	Triton	ND
Phelan	ND	Tukwila	D
Pilchuck	C	Tukey	ND
Potchub	C	Urban	variable
Poulsbo	C	Vailton	B
Prather	C	Verlot	C
Puget	D	Wapato	ND
Puyallup	B	Warden	B
Queets	ND	Whidbey	ND
Quilcene	ND	Wilkeson	B
Ragnar	B	Winston	A
Rainier	C	Woodinville	B
Raught	B	Yelm	C
Reed	ND	Zynbar	B

Hydrologic Soil Group Classifications

A. (Low runoff potential). Soils having high infiltration rates, even when thoroughly wetted, and consisting chiefly of deep, well-to-excessively drained sands or gravels. These soils have a high rate of water transmission.

B. (Moderately low runoff potential). Soils having moderate infiltration rates when thoroughly wetted, and consisting chiefly of moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission.

C. (Moderately high runoff potential). Soils having slow infiltration rates when thoroughly wetted, and consisting chiefly of soils with a layer that impedes downward movement of water, or soils with moderately fine to fine textures. These soils have a slow rate of water transmission.

D. (High runoff potential). Soils having very slow infiltration rates when thoroughly wetted and consisting chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a hardpan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very slow rate of water transmission.

ND Data not currently available for this soil type.

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

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.

Detention

ALDERWOOD MALL EXPANSION

LEVEL POOL TABLE SUMMARY

<--------DESCRIPTION--------->	MATCH (cfs)	INFLOW (cfs)	-STO- --id-	-DIS- --id-	<-PEAK-> <STAGE>	id	OUTFLOW (cfs)	STORAGE VOL (cf)
2yr to 1/2 2yr	2.99	19.78	9-26-02	combo1	376.09	11	2.98	4.3426 ac-ft
10yr to 10yr	13.09	30.62	9-26-02	combo1	376.98	12	8.03	5.7462 ac-ft
100 yr to 100 yr	25.72	47.58	9-26-02	combo1	377.58	13	25.60	6.6950 ac-ft
100yr whole basin	0.00	80.35	9-26-02	combo1	379.85	14	46.71	10.5180 ac-ft

STAGE DISCHARGE TABLE

COMBINATION DISCHARGE ID No. combo1
Description: orifice and riser
Structure: ORFICE Structure:
Structure: riser Structure:
Structure:

STAGE (ft)	<--DISCHARGE---> ---cfs-- -------	STAGE (ft)	<--DISCHARGE---> ---cfs-- -------	STAGE (ft)	<--DISCHARGE---> ---cfs-- -------	STAGE (ft)	<--DISCHARGE---> ---cfs-- -------
373.00	0.0000	376.30	3.0766	379.60	44.950	382.90	64.423
373.10	0.5356	376.40	3.1229	379.70	45.665	383.00	64.920
373.20	0.7574	376.50	3.1685	379.80	46.369	383.10	65.414
373.30	0.9276	376.60	3.2134	379.90	47.062	383.20	65.904
373.40	1.0711	376.70	3.5300	380.00	47.745	383.30	66.391
373.50	1.1976	376.80	4.7159	380.10	48.418	383.40	66.874
373.60	1.3119	376.90	6.3881	380.20	49.081	383.50	67.353
373.70	1.4170	377.00	8.4287	380.30	49.735	383.60	67.829
373.80	1.5148	377.10	10.779	380.40	50.381	383.70	68.302
373.90	1.6067	377.20	13.402	380.50	51.018	383.80	68.771
374.00	1.6936	377.30	16.271	380.60	51.648	383.90	69.237
374.10	1.7763	377.40	19.367	380.70	52.269	384.00	69.700
374.20	1.8553	377.50	22.673	380.80	52.883	384.10	70.160
374.30	1.9310	377.60	26.177	380.90	53.490	384.20	70.617
374.40	2.0039	377.70	27.893	381.00	54.090	384.30	71.071
374.50	2.0743	377.80	29.059	381.10	54.683	384.40	71.522
374.60	2.1423	377.90	30.177	381.20	55.270	384.50	71.971
374.70	2.2082	378.00	31.251	381.30	55.851	384.60	72.416
374.80	2.2722	378.10	32.288	381.40	56.425	384.70	72.859
374.90	2.3345	378.20	33.290	381.50	56.994	384.80	73.299
375.00	2.3951	378.30	34.262	381.60	57.557	384.90	73.736
375.10	2.4543	378.40	35.205	381.70	58.114	385.00	74.171
375.20	2.5120	378.50	36.122	381.80	58.666	385.10	74.603
375.30	2.5685	378.60	37.016	381.90	59.213	385.20	75.033
375.40	2.6237	378.70	37.887	382.00	59.755	385.30	75.460
375.50	2.6778	378.80	38.738	382.10	60.291	385.40	75.885
375.60	2.7309	378.90	39.570	382.20	60.823	385.50	76.307
375.70	2.7829	379.00	40.384	382.30	61.351	385.60	76.727
375.80	2.8340	379.10	41.181	382.40	61.873	385.70	77.145
375.90	2.8841	379.20	41.963	382.50	62.392	385.80	77.560
376.00	2.9334	379.30	42.730	382.60	62.906	385.90	77.974
376.10	2.9819	379.40	43.483	382.70	63.415	386.00	78.385
376.20	3.0296	379.50	44.223	382.80	63.921		

ALDERWOOD MALL EXPANSION

STAGE STORAGE TABLE

CUSTOM STORAGE ID No. 9-26-02
Description: 9-26-02 pond

STAGE (ft)	STORAGE ---cf---	STORAGE --Ac-Ft-	STAGE (ft)	STORAGE ---cf---	STORAGE --Ac-Ft-	STAGE (ft)	STORAGE ---cf---	STORAGE --Ac-Ft-	STAGE (ft)	STORAGE ---cf---	STORAGE --Ac-Ft-
373.00	0.0000	0.0000	375.10	126982	2.9151	377.20	265356	6.0917	379.30	417192	9.5774
373.10	5831	0.1339	375.20	133225	3.0584	377.30	272205	6.2490	379.40	424657	9.7488
373.20	11662	0.2677	375.30	139468	3.2017	377.40	279054	6.4062	379.50	432122	9.9202
373.30	17493	0.4016	375.40	145711	3.3451	377.50	285902	6.5634	379.60	439587	10.092
373.40	23324	0.5354	375.50	151954	3.4884	377.60	292751	6.7206	379.70	447052	10.263
373.50	29155	0.6693	375.60	158197	3.6317	377.70	299600	6.8779	379.80	454517	10.434
373.60	34986	0.8032	375.70	164440	3.7750	377.80	306449	7.0351	379.90	461982	10.606
373.70	40817	0.9370	375.80	170683	3.9183	377.90	313298	7.1923	380.00	469448	10.777
373.80	46648	1.0709	375.90	176926	4.0617	378.00	320147	7.3496	380.10	477380	10.959
373.90	52479	1.2048	376.00	183169	4.2050	378.10	327612	7.5209	380.20	485313	11.141
374.00	58311	1.3386	376.10	190017	4.3622	378.20	335077	7.6923	380.30	493246	11.323
374.10	64553	1.4819	376.20	196866	4.5194	378.30	342542	7.8637	380.40	501178	11.505
374.20	70796	1.6253	376.30	203715	4.6767	378.40	350007	8.0351	380.50	509111	11.688
374.30	77039	1.7686	376.40	210564	4.8339	378.50	357472	8.2064	380.60	517044	11.870
374.40	83282	1.9119	376.50	217413	4.9911	378.60	364937	8.3778	380.70	524977	12.052
374.50	89525	2.0552	376.60	224262	5.1483	378.70	372402	8.5492	380.80	532909	12.234
374.60	95768	2.1985	376.70	231111	5.3056	378.80	379867	8.7206	380.90	540842	12.416
374.70	102011	2.3418	376.80	237960	5.4628	378.90	387332	8.8919	381.00	548775	12.598
374.80	108254	2.4852	376.90	244809	5.6200	379.00	394797	9.0633			
374.90	114497	2.6285	377.00	251658	5.7773	379.10	402262	9.2347			
375.00	120740	2.7718	377.10	258507	5.9345	379.20	409727	9.4060			

PEAK 100-YR WSE 175-ACRE BASIN

Hydrograph List

1. Predeveloped 2-year runoff for mall site
2. Predeveloped 10-year runoff mall site
3. Predeveloped 100-year runoff mall site
4. Proposed 2-year runoff mall site
5. Proposed 10-year runoff mall site
6. Proposed 100-year runoff mall site
7. Proposed 100-year runoff 175-acre basin
11. 2-year outflow from detention system for mall site
12. 10-year outflow from detention system for mall site
13. 100-year outflow from detention system for mall site

ALDERWOOD MALL EXPANSION

DETAIL HYDROGRAPH SUMMARY

HYDROGRAPH No. 1

Peak runoff: 5.9668 cfs Total Vol: 4.41 ac-ft

TIME (min)	DESIGN RUNOFF (cfs)	TIME (min)	DESIGN RUNOFF (cfs)	TIME (min)	DESIGN RUNOFF (cfs)	TIME (min)	DESIGN RUNOFF (cfs)	TIME (min)	DESIGN RUNOFF (cfs)
10		410	0.8551	810	2.9095	1210	2.2877	1610	0.0644
20		420	0.9639	820	2.8251	1220	2.2885	1620	0.0524
30		430	1.2611	830	2.7581	1230	2.2901	1630	0.0426
40		440	1.7472	840	2.7055	1240	2.2973	1640	0.0347
50		450	2.2287	850	2.7017	1250	2.2989	1650	0.0282
60		460	3.0738	860	2.7426	1260	2.3010	1660	0.0229
70		470	4.2813	870	2.7783	1270	2.3088	1670	0.0187
80		480	5.4700	880	2.8049	1280	2.3107	1680	0.0152
90		490	5.9668	890	2.8335	1290	2.3130	1690	0.0123
100		500	5.8183	900	2.8591	1300	2.3210	1700	0.0100
110		510	5.7283	910	2.8774	1310	2.3231	1710	0.0082
120		520	5.6251	920	2.8993	1320	2.3255	1720	0.0066
130		530	5.5105	930	2.9192	1330	2.2861	1730	0.0054
140		540	5.4390	940	2.9328	1340	2.2126	1740	0.0044
150		550	5.2454	950	2.9508	1350	2.1533	1750	0.0036
160		560	4.9464	960	2.9676	1360	2.1002	1760	0.0029
170		570	4.7127	970	2.8564	1370	2.0629	1770	0.0024
180		580	4.5356	980	2.6501	1380	2.0330	1780	0.0019
190		590	4.3967	990	2.4830	1390	2.0038	1790	0.0016
200		600	4.2925	1000	2.3429	1400	1.9859	1800	0.0013
210		610	4.1843	1010	2.2345	1410	1.9719	1810	0.0010
220		620	4.0720	1020	2.1469	1420	1.9556	1820	0.0008
230		630	3.9874	1030	2.1554	1430	1.9481	1830	0.0007
240		640	3.9213	1040	2.2474	1440	1.9425	1840	0.0006
250		650	3.8782	1050	2.3236	1450	1.7564	1850	0.0005
260		660	3.8496	1060	2.3870	1460	1.4286	1860	0.0004
270		670	3.7607	1070	2.4400	1470	1.1620	1870	0.0003
280		680	3.6214	1080	2.4845	1480	0.9451	1880	0.0002
290		690	3.5121	1090	2.4819	1490	0.7687	1890	0.0002
300		700	3.4313	1100	2.4357	1500	0.6253	1900	0.0002
310	0.0023	710	3.3651	1110	2.3990	1510	0.5086	1910	0.0001
320	0.0215	720	3.3149	1120	2.5271	1520	0.4136	1920	0.0001
330	0.0683	730	3.2822	1130	2.4752	1530	0.3364	1930	
340	0.1384	740	3.2548	1140	2.2821	1540	0.2736	1940	
350	0.2264	750	3.2361	1150	2.2829	1550	0.2226	1950	
360	0.3279	760	3.2288	1160	2.2794	1560	0.1810	1960	
370	0.4313	770	3.2219	1170	2.2774	1570	0.1472	1970	
380	0.5333	780	3.2197	1180	2.2818	1580	0.1198	1980	
390	0.6380	790	3.1484	1190	2.2811	1590	0.0974	1990	
400	0.7452	800	3.0157	1200	2.2814	1600	0.0792	2000	

ALDERWOOD MALL EXPANSION

DETAIL HYDROGRAPH SUMMARY

HYDROGRAPH No. 2

Peak runoff: 13.0933 cfs Total Vol: 8.36 ac-ft

TIME (min)	DESIGN RUNOFF (cfs)	TIME (min)	DESIGN RUNOFF (cfs)	TIME (min)	DESIGN RUNOFF (cfs)	TIME (min)	DESIGN RUNOFF (cfs)	TIME (min)	DESIGN RUNOFF (cfs)
10		410	2.9382	810	5.1588	1210	3.8552	1610	0.1069
20		420	3.1199	820	4.9993	1220	3.8535	1620	0.0870
30		430	3.7723	830	4.8715	1230	3.8530	1630	0.0707
40		440	4.8602	840	4.7696	1240	3.8621	1640	0.0575
50		450	5.8677	850	4.7536	1250	3.8618	1650	0.0468
60		460	7.6150	860	4.8159	1260	3.8624	1660	0.0381
70		470	10.0518	870	4.8691	1270	3.8724	1670	0.0310
80		480	12.3097	880	4.9069	1280	3.8727	1680	0.0252
90		490	13.0933	890	4.9483	1290	3.8738	1690	0.0205
100		500	12.5685	900	4.9844	1300	3.8843	1700	0.0167
110		510	12.1807	910	5.0081	1310	3.8849	1710	0.0135
120		520	11.7874	920	5.0380	1320	3.8862	1720	0.0110
130		530	11.3913	930	5.0646	1330	3.8179	1730	0.0090
140		540	11.0959	940	5.0804	1340	3.6929	1740	0.0073
150		550	10.5863	950	5.1039	1350	3.5917	1750	0.0059
160		560	9.8948	960	5.1253	1360	3.5012	1760	0.0048
170		570	9.3438	970	4.9276	1370	3.4368	1770	0.0039
180		580	8.9139	980	4.5677	1380	3.3850	1780	0.0032
190		590	8.5679	990	4.2757	1390	3.3345	1790	0.0026
200		600	8.2970	1000	4.0305	1400	3.3027	1800	0.0021
210		610	8.0279	1010	3.8402	1410	3.2774	1810	0.0017
220		620	7.7593	1020	3.6861	1420	3.2485	1820	0.0014
230	0.0006	630	7.5489	1030	3.6962	1430	3.2343	1830	0.0011
240	0.0112	640	7.3783	1040	3.8487	1440	3.2232	1840	0.0009
250	0.0457	650	7.2547	1050	3.9743	1450	2.9136	1850	0.0008
260	0.1048	660	7.1616	1060	4.0780	1460	2.3698	1860	0.0006
270	0.1831	670	6.9636	1070	4.1638	1470	1.9275	1870	0.0005
280	0.2766	680	6.6786	1080	4.2351	1480	1.5678	1880	0.0004
290	0.3796	690	6.4513	1090	4.2265	1490	1.2752	1890	0.0003
300	0.4906	700	6.2786	1100	4.1441	1500	1.0372	1900	0.0003
310	0.6681	710	6.1348	1110	4.0781	1510	0.8436	1910	0.0002
320	0.9126	720	6.0220	1120	4.2904	1520	0.6862	1920	0.0002
330	1.1656	730	5.9423	1130	4.1991	1530	0.5581	1930	0.0001
340	1.4228	740	5.8738	1140	3.8692	1540	0.4539	1940	0.0001
350	1.6812	750	5.8222	1150	3.8670	1550	0.3692	1950	
360	1.9384	760	5.7920	1160	3.8575	1560	0.3003	1960	
370	2.1661	770	5.7635	1170	3.8508	1570	0.2443	1970	
380	2.3647	780	5.7442	1180	3.8548	1580	0.1987	1980	
390	2.5575	790	5.6042	1190	3.8505	1590	0.1616	1990	
400	2.7477	800	5.3574	1200	3.8478	1600	0.1314	2000	

DETAIL HYDROGRAPH SUMMARY

HYDROGRAPH No. 3
Peak runoff: 25.7197 cfs Total Vol: 15.19 ac-ft

TIME (min)	DESIGN RUNOFF (cfs)	TIME (min)	DESIGN RUNOFF (cfs)	TIME (min)	DESIGN RUNOFF (cfs)	TIME (min)	DESIGN RUNOFF (cfs)	TIME (min)	DESIGN RUNOFF (cfs)
10		410	7.1692	810	8.7696	1210	6.3211	1610	0.1734
20		420	7.4358	820	8.4866	1220	6.3147	1620	0.1410
30		430	8.6981	830	8.2584	1230	6.3104	1630	0.1147
40		440	10.8423	840	8.0748	1240	6.3218	1640	0.0933
50		450	12.7453	850	8.0363	1250	6.3178	1650	0.0759
60		460	16.0312	860	8.1299	1260	6.3154	1660	0.0617
70		470	20.5455	870	8.2086	1270	6.3284	1670	0.0502
80		480	24.5504	880	8.2615	1280	6.3255	1680	0.0408
90		490	25.7197	890	8.3207	1290	6.3241	1690	0.0332
100		500	24.4517	900	8.3713	1300	6.3378	1700	0.0270
110		510	23.4650	910	8.4012	1310	6.3356	1710	0.0220
120		520	22.4973	920	8.4417	1320	6.3346	1720	0.0179
130		530	21.5510	930	8.4769	1330	6.2205	1730	0.0145
140		540	20.8112	940	8.4941	1340	6.0143	1740	0.0118
150		550	19.7136	950	8.5241	1350	5.8471	1750	0.0096
160		560	18.3166	960	8.5508	1360	5.6973	1760	0.0078
170	0.0076	570	17.1928	970	8.2144	1370	5.5902	1770	0.0064
180	0.0476	580	16.3035	980	7.6096	1380	5.5035	1780	0.0052
190	0.1322	590	15.5792	990	7.1183	1390	5.4192	1790	0.0042
200	0.2534	600	15.0014	1000	6.7056	1400	5.3654	1800	0.0034
210	0.4008	610	14.4397	1010	6.3845	1410	5.3221	1810	0.0028
220	0.5659	620	13.8897	1020	6.1240	1420	5.2731	1820	0.0023
230	0.7474	630	13.4510	1030	6.1355	1430	5.2479	1830	0.0018
240	0.9379	640	13.0896	1040	6.3826	1440	5.2279	1840	0.0015
250	1.1631	650	12.8168	1050	6.5851	1450	4.7249	1850	0.0012
260	1.4195	660	12.6027	1060	6.7512	1460	3.8430	1860	0.0010
270	1.6773	670	12.2132	1070	6.8878	1470	3.1258	1870	0.0008
280	1.9380	680	11.6792	1080	7.0003	1480	2.5424	1880	0.0007
290	2.1904	690	11.2497	1090	6.9812	1490	2.0679	1890	0.0005
300	2.4387	700	10.9181	1100	6.8408	1500	1.6820	1900	0.0004
310	2.8721	710	10.6396	1110	6.7275	1510	1.3680	1910	0.0004
320	3.4725	720	10.4176	1120	7.0717	1520	1.1127	1920	0.0003
330	4.0430	730	10.2546	1130	6.9172	1530	0.9050	1930	0.0002
340	4.5841	740	10.1129	1140	6.3712	1540	0.7361	1940	0.0002
350	5.0967	750	10.0018	1150	6.3634	1550	0.5987	1950	0.0002
360	5.5820	760	9.9289	1160	6.3438	1560	0.4870	1960	0.0001
370	5.9787	770	9.8602	1170	6.3288	1570	0.3961	1970	0.0001
380	6.2953	780	9.8082	1180	6.3316	1580	0.3222	1980	
390	6.5934	790	9.5537	1190	6.3207	1590	0.2620	1990	
400	6.8821	800	9.1202	1200	6.3127	1600	0.2131	2000	

ALDERWOOD MALL EXPANSION

DETAIL HYDROGRAPH SUMMARY

HYDROGRAPH No. 4

Peak runoff: 19.7786 cfs Total Vol: 8.58 ac-ft

TIME (min)	DESIGN RUNOFF (cfs)	TIME (min)	DESIGN RUNOFF (cfs)	TIME (min)	DESIGN RUNOFF (cfs)	TIME (min)	DESIGN RUNOFF (cfs)	TIME (min)	DESIGN RUNOFF (cfs)
10		410	5.5802	810	3.9654	1210	3.0502	1610	0.0008
20		420	5.6168	820	3.8266	1220	3.0466	1620	0.0005
30		430	6.9877	830	3.7425	1230	3.0448	1630	0.0003
40		440	9.2150	840	3.6918	1240	3.0582	1640	0.0002
50		450	10.6490	850	3.7740	1250	3.0524	1650	0.0001
60		460	13.5233	860	3.9515	1260	3.0492	1660	
70		470	17.3196	870	4.0609	1270	3.0618	1670	
80	0.0076	480	19.7786	880	4.1147	1280	3.0555	1680	
90	0.0616	490	18.7177	890	4.1626	1290	3.0520	1690	
100	0.1785	500	15.4511	900	4.1927	1300	3.0643	1700	
110	0.3300	510	13.4715	910	4.1979	1310	3.0579	1710	
120	0.4949	520	12.0478	920	4.2161	1320	3.0543	1720	
130	0.6952	530	10.9749	930	4.2280	1330	2.9380	1730	
140	0.9254	540	10.3305	940	4.2220	1340	2.7530	1740	
150	1.1384	550	9.3747	950	4.2333	1350	2.6400	1750	
160	1.3290	560	8.2254	960	4.2410	1360	2.5568	1760	
170	1.5105	570	7.5275	970	3.8789	1370	2.5204	1770	
180	1.6751	580	7.1191	980	3.3187	1380	2.4984	1780	
190	1.8182	590	6.8601	990	2.9764	1390	2.4707	1790	
200	1.9576	600	6.7060	1000	2.7533	1400	2.4683	1800	
210	2.0836	610	6.5057	1010	2.6313	1410	2.4670	1810	
220	2.1907	620	6.2768	1020	2.5569	1420	2.4521	1820	
230	2.2989	630	6.1400	1030	2.7383	1430	2.4574	1830	
240	2.3969	640	6.0457	1040	3.0904	1440	2.4608	1840	
250	2.5587	650	6.0049	1050	3.3061	1450	1.9765	1850	
260	2.7604	660	5.9828	1060	3.4385	1460	1.2084	1860	
270	2.9165	670	5.7363	1070	3.5200	1470	0.7387	1870	
280	3.0513	680	5.3520	1080	3.5703	1480	0.4516	1880	
290	3.1523	690	5.1188	1090	3.4881	1490	0.2761	1890	
300	3.2418	700	4.9918	1100	3.3105	1500	0.1688	1900	
310	3.6736	710	4.9019	1110	3.2022	1510	0.1032	1910	
320	4.3175	720	4.8486	1120	3.5768	1520	0.0631	1920	
330	4.7612	730	4.8315	1130	3.3657	1530	0.0386	1930	
340	5.0780	740	4.8086	1140	2.8108	1540	0.0236	1940	
350	5.3131	750	4.7962	1150	2.9123	1550	0.0144	1950	
360	5.4949	760	4.8040	1160	2.9605	1560	0.0088	1960	
370	5.5484	770	4.7962	1170	2.9902	1570	0.0054	1970	
380	5.5184	780	4.7929	1180	3.0230	1580	0.0033	1980	
390	5.5135	790	4.5681	1190	3.0291	1590	0.0020	1990	
400	5.5340	800	4.1936	1200	3.0331	1600	0.0012	2000	

DETAIL HYDROGRAPH SUMMARY

HYDROGRAPH No. 5
Peak runoff: 30.6216 cfs Total Vol: 13.36 ac-ft

TIME (min)	DESIGN RUNOFF (cfs)	TIME (min)	DESIGN RUNOFF (cfs)	TIME (min)	DESIGN RUNOFF (cfs)	TIME (min)	DESIGN RUNOFF (cfs)	TIME (min)	DESIGN RUNOFF (cfs)
10		410	8.9532	810	5.9553	1210	4.5508	1610	0.0011
20		420	8.9771	820	5.7455	1220	4.5450	1620	0.0007
30		430	11.1066	830	5.6179	1230	4.5418	1630	0.0004
40		440	14.5712	840	5.5405	1240	4.5613	1640	0.0003
50		450	16.7612	850	5.6624	1250	4.5522	1650	0.0002
60	0.0044	460	21.1599	860	5.9274	1260	4.5470	1660	
70	0.0857	470	26.9488	870	6.0902	1270	4.5653	1670	
80	0.2970	480	30.6216	880	6.1695	1280	4.5554	1680	
90	0.5892	490	28.8842	890	6.2399	1290	4.5497	1690	
100	0.9089	500	23.7875	900	6.2837	1300	4.5677	1700	
110	1.2272	510	20.6882	910	6.2902	1310	4.5576	1710	
120	1.5295	520	18.4590	920	6.3160	1320	4.5518	1720	
130	1.8865	530	16.7799	930	6.3326	1330	4.3782	1730	
140	2.2895	540	15.7642	940	6.3223	1340	4.1021	1740	
150	2.6347	550	14.2845	950	6.3379	1350	3.9334	1750	
160	2.9222	560	12.5180	960	6.3481	1360	3.8092	1760	
170	3.1866	570	11.4425	970	5.8052	1370	3.7547	1770	
180	3.4165	580	10.8100	980	4.9661	1380	3.7215	1780	
190	3.6052	590	10.4067	990	4.4533	1390	3.6800	1790	
200	3.7886	600	10.1640	1000	4.1189	1400	3.6761	1800	
210	3.9498	610	9.8530	1010	3.9358	1410	3.6739	1810	
220	4.0805	620	9.4997	1020	3.8241	1420	3.6514	1820	
230	4.2193	630	9.2866	1030	4.0948	1430	3.6591	1830	
240	4.3453	640	9.1384	1040	4.6205	1440	3.6639	1840	
250	4.5867	650	9.0714	1050	4.9424	1450	2.9428	1850	
260	4.8995	660	9.0331	1060	5.1397	1460	1.7991	1860	
270	5.1321	670	8.6568	1070	5.2607	1470	1.0998	1870	
280	5.3283	680	8.0734	1080	5.3352	1480	0.6724	1880	
290	5.4664	690	7.7182	1090	5.2115	1490	0.4111	1890	
300	5.5829	700	7.5236	1100	4.9456	1500	0.2513	1900	
310	6.2724	710	7.3852	1110	4.7833	1510	0.1536	1910	
320	7.3085	720	7.3021	1120	5.3419	1520	0.0939	1920	
330	7.9961	730	7.2736	1130	5.0261	1530	0.0574	1930	
340	8.4652	740	7.2367	1140	4.1971	1540	0.0351	1940	
350	8.7959	750	7.2155	1150	4.3481	1550	0.0215	1950	
360	9.0381	760	7.2249	1160	4.4194	1560	0.0131	1960	
370	9.0733	770	7.2109	1170	4.4634	1570	0.0080	1970	
380	8.9766	780	7.2037	1180	4.5117	1580	0.0049	1980	
390	8.9246	790	6.8639	1190	4.5203	1590	0.0030	1990	
400	8.9168	800	6.2996	1200	4.5259	1600	0.0018	2000	

ALDERWOOD MALL EXPANSION

DETAIL HYDROGRAPH SUMMARY

HYDROGRAPH No. 6

Peak runoff: 47.5799 cfs Total Vol: 20.95 ac-ft

TIME (min)	DESIGN RUNOFF (cfs)	TIME (min)	DESIGN RUNOFF (cfs)	TIME (min)	DESIGN RUNOFF (cfs)	TIME (min)	DESIGN RUNOFF (cfs)	TIME (min)	DESIGN RUNOFF (cfs)
10		410	14.2554	810	9.0649	1210	6.8971	1610	0.0017
20		420	14.2552	820	8.7441	1220	6.8879	1620	0.0010
30		430	17.5700	830	8.5486	1230	6.8825	1630	0.0006
40	0.0041	440	22.9689	840	8.4296	1240	6.9116	1640	0.0004
50	0.0867	450	26.3377	850	8.6137	1250	6.8975	1650	0.0002
60	0.2980	460	33.1162	860	9.0154	1260	6.8890	1660	0.0001
70	0.7345	470	42.0157	870	9.2616	1270	6.9162	1670	
80	1.3621	480	47.5799	880	9.3808	1280	6.9009	1680	
90	1.9976	490	44.7804	890	9.4865	1290	6.8917	1690	
100	2.5943	500	36.8201	900	9.5517	1300	6.9185	1700	
110	3.1333	510	31.9685	910	9.5602	1310	6.9029	1710	
120	3.6099	520	28.4790	920	9.5981	1320	6.8936	1720	
130	4.1818	530	25.8515	930	9.6219	1330	6.6303	1730	
140	4.8305	540	24.2548	940	9.6050	1340	6.2118	1740	
150	5.3497	550	21.9560	950	9.6274	1350	5.9561	1750	
160	5.7542	560	19.2250	960	9.6417	1360	5.7677	1760	
170	6.1221	570	17.5594	970	8.8161	1370	5.6848	1770	
180	6.4356	580	16.5767	980	7.5411	1380	5.6343	1780	
190	6.6824	590	15.9477	990	6.7619	1390	5.5713	1790	
200	6.9267	600	15.5667	1000	6.2535	1400	5.5651	1800	
210	7.1379	610	15.0825	1010	5.9751	1410	5.5615	1810	
220	7.2977	620	14.5349	1020	5.8050	1420	5.5271	1820	
230	7.4709	630	14.2027	1030	6.2153	1430	5.5385	1830	
240	7.6220	640	13.9702	1040	7.0125	1440	5.5455	1840	
250	7.9706	650	13.8624	1050	7.5004	1450	4.4540	1850	
260	8.4405	660	13.7988	1060	7.7990	1460	2.7229	1860	
270	8.7719	670	13.2198	1070	7.9819	1470	1.6647	1870	
280	9.0417	680	12.3253	1080	8.0942	1480	1.0177	1880	
290	9.2154	690	11.7797	1090	7.9059	1490	0.6222	1890	
300	9.3549	700	11.4795	1100	7.5018	1500	0.3804	1900	
310	10.4382	710	11.2653	1110	7.2550	1510	0.2325	1910	
320	12.0838	720	11.1357	1120	8.1014	1520	0.1422	1920	
330	13.1449	730	11.0896	1130	7.6220	1530	0.0869	1930	
340	13.8427	740	11.0307	1140	6.3644	1540	0.0531	1940	
350	14.3133	750	10.9959	1150	6.5928	1550	0.0325	1950	
360	14.6407	760	11.0077	1160	6.7005	1560	0.0199	1960	
370	14.6385	770	10.9841	1170	6.7666	1570	0.0121	1970	
380	14.4292	780	10.9707	1180	6.8394	1580	0.0074	1980	
390	14.2967	790	10.4515	1190	6.8520	1590	0.0045	1990	
400	14.2390	800	9.5906	1200	6.8599	1600	0.0028	2000	

ALDERWOOD MALL EXPANSION

DETAIL HYDROGRAPH SUMMARY

HYDROGRAPH No. 7

Peak runoff: 80.3515 cfs Total Vol: 43.25 ac-ft

TIME (min)	DESIGN RUNOFF (cfs)	TIME (min)	DESIGN RUNOFF (cfs)	TIME (min)	DESIGN RUNOFF (cfs)	TIME (min)	DESIGN RUNOFF (cfs)	TIME (min)	DESIGN RUNOFF (cfs)
10		410	28.7101	810	20.3585	1210	14.3746	1610	0.1856
20		420	28.8416	820	19.6389	1220	14.3580	1620	0.1444
30		430	32.8486	830	19.0800	1230	14.3454	1630	0.1123
40	0.0047	440	39.9424	840	18.6462	1240	14.3742	1640	0.0873
50	0.0999	450	45.5538	850	18.6141	1250	14.3587	1650	0.0679
60	0.3575	460	55.5007	860	18.9329	1260	14.3469	1660	0.0528
70	0.9090	470	68.8715	870	19.1818	1270	14.3764	1670	0.0411
80	1.7501	480	79.4449	880	19.3384	1280	14.3613	1680	0.0320
90	2.6919	490	80.3515	890	19.4994	1290	14.3499	1690	0.0249
100	3.6623	500	73.6722	900	19.6255	1300	14.3796	1700	0.0193
110	4.6160	510	68.4987	910	19.6865	1310	14.3647	1710	0.0150
120	5.5258	520	63.8581	920	19.7730	1320	14.3534	1720	0.0117
130	6.5539	530	59.6663	930	19.8413	1330	14.0383	1730	0.0091
140	7.6952	540	56.4199	940	19.8572	1340	13.4868	1740	0.0071
150	8.7229	550	52.3293	950	19.9086	1350	13.0580	1750	0.0055
160	9.6234	560	47.5782	960	19.9495	1360	12.6864	1760	0.0043
170	10.4666	570	43.8886	970	18.9896	1370	12.4359	1770	0.0033
180	11.2297	580	41.0619	980	17.3274	1380	12.2412	1780	0.0026
190	11.8920	590	38.8310	990	16.0348	1390	12.0516	1790	0.0020
200	12.5197	600	37.1009	1000	14.9916	1400	11.9427	1800	0.0016
210	13.0838	610	35.4581	1010	14.2187	1410	11.8582	1810	0.0012
220	13.5624	620	33.8827	1020	13.6178	1420	11.7543	1820	0.0009
230	14.0261	630	32.6612	1030	13.7619	1430	11.7119	1830	0.0007
240	14.4430	640	31.6769	1040	14.5238	1440	11.6792	1840	0.0006
250	15.0681	650	30.9527	1050	15.1170	1450	10.3497	1850	0.0004
260	15.8561	660	30.3929	1060	15.5790	1460	8.0497	1860	0.0003
270	16.5247	670	29.3170	1070	15.9389	1470	6.2609	1870	0.0003
280	17.1268	680	27.8389	1080	16.2193	1480	4.8696	1880	0.0002
290	17.6094	690	26.6914	1090	16.1322	1490	3.7875	1890	0.0002
300	18.0273	700	25.8387	1100	15.7207	1500	2.9458	1900	0.0001
310	19.5197	710	25.1395	1110	15.4011	1510	2.2912	1910	
320	21.8325	720	24.5975	1120	16.3386	1520	1.7820	1920	
330	23.7028	730	24.2158	1130	15.8824	1530	1.3860	1930	
340	25.2215	740	23.8827	1140	14.3805	1540	1.0780	1940	
350	26.4606	750	23.6254	1150	14.3984	1550	0.8385	1950	
360	27.4767	760	23.4649	1160	14.3744	1560	0.6521	1960	
370	28.0352	770	23.3038	1170	14.3562	1570	0.5072	1970	
380	28.2306	780	23.1801	1180	14.3806	1580	0.3945	1980	
390	28.3814	790	22.4770	1190	14.3616	1590	0.3068	1990	
400	28.5301	800	21.2849	1200	14.3472	1600	0.2386	2000	

ALDERWOOD MALL EXPANSION

DETAIL HYDROGRAPH SUMMARY

HYDROGRAPH No. 11

Peak runoff: 2.9759 cfs Total Vol: 8.30 ac-ft

TIME (min)	DESIGN RUNOFF (cfs)	TIME (min)	DESIGN RUNOFF (cfs)	TIME (min)	DESIGN RUNOFF (cfs)	TIME (min)	DESIGN RUNOFF (cfs)	TIME (min)	DESIGN RUNOFF (cfs)
10		410	1.3970	810	2.8656	1210	2.9718	1610	2.7674
20		420	1.4400	820	2.8715	1220	2.9721	1620	2.7536
30		430	1.4817	830	2.8764	1230	2.9724	1630	2.7398
40		440	1.5291	840	2.8808	1240	2.9727	1640	2.7261
50		450	1.5909	850	2.8848	1250	2.9730	1650	2.7122
60		460	1.6660	860	2.8888	1260	2.9734	1660	2.6984
70		470	1.7515	870	2.8934	1270	2.9737	1670	2.6847
80		480	1.8560	880	2.8986	1280	2.9741	1680	2.6709
90	0.0002	490	1.9754	890	2.9043	1290	2.9744	1690	2.6571
100	0.0020	500	2.0921	900	2.9101	1300	2.9747	1700	2.6433
110	0.0084	510	2.1884	910	2.9161	1310	2.9751	1710	2.6296
120	0.0216	520	2.2642	920	2.9221	1320	2.9755	1720	2.6158
130	0.0425	530	2.3271	930	2.9282	1330	2.9758	1730	2.6019
140	0.0722	540	2.3806	940	2.9342	1340	2.9759	1740	2.5882
150	0.1117	550	2.4279	950	2.9397	1350	2.9753	1750	2.5745
160	0.1611	560	2.4696	960	2.9452	1360	2.9742	1760	2.5607
170	0.2186	570	2.5046	970	2.9506	1370	2.9726	1770	2.5468
180	0.2830	580	2.5339	980	2.9553	1380	2.9707	1780	2.5330
190	0.3533	590	2.5598	990	2.9581	1390	2.9688	1790	2.5193
200	0.4280	600	2.5834	1000	2.9589	1400	2.9667	1800	2.5055
210	0.5063	610	2.6057	1010	2.9585	1410	2.9646	1810	2.4917
220	0.5574	620	2.6268	1020	2.9574	1420	2.9625	1820	2.4779
230	0.5931	630	2.6463	1030	2.9558	1430	2.9604	1830	2.4642
240	0.6304	640	2.6648	1040	2.9545	1440	2.9582	1840	2.4504
250	0.6691	650	2.6825	1050	2.9543	1450	2.9561	1850	2.4365
260	0.7099	660	2.6995	1060	2.9554	1460	2.9530	1860	2.4227
270	0.7539	670	2.7162	1070	2.9571	1470	2.9472	1870	2.4090
280	0.7909	680	2.7322	1080	2.9593	1480	2.9389	1880	2.3953
290	0.8290	690	2.7462	1090	2.9618	1490	2.9284	1890	2.3814
300	0.8685	700	2.7586	1100	2.9642	1500	2.9163	1900	2.3676
310	0.9089	710	2.7701	1110	2.9661	1510	2.9035	1910	2.3538
320	0.9492	720	2.7809	1120	2.9673	1520	2.8905	1920	2.3401
330	0.9938	730	2.7912	1130	2.9691	1530	2.8771	1930	2.3263
340	1.0458	740	2.8012	1140	2.9712	1540	2.8635	1940	2.3124
350	1.0989	750	2.8111	1150	2.9717	1550	2.8498	1950	2.2987
360	1.1518	760	2.8209	1160	2.9713	1560	2.8362	1960	2.2849
370	1.2059	770	2.8306	1170	2.9711	1570	2.8224	1970	2.2713
380	1.2564	780	2.8401	1180	2.9711	1580	2.8087	1980	2.2573
390	1.3064	790	2.8495	1190	2.9713	1590	2.7949	1990	2.2435
400	1.3521	800	2.8583	1200	2.9715	1600	2.7812	2000	2.2297

DETAIL HYDROGRAPH SUMMARY

HYDROGRAPH No. 11
Peak runoff: 2.9759 cfs Total Vol: 8.30 ac-ft

TIME (min)	DESIGN RUNOFF (cfs)	TIME (min)	DESIGN RUNOFF (cfs)	TIME (min)	DESIGN RUNOFF (cfs)	TIME (min)	DESIGN RUNOFF (cfs)	TIME (min)	DESIGN RUNOFF (cfs)
2010	2.2161	2210	1.9404	2410	1.6623	2610	1.3668	2810	1.0728
2020	2.2023	2220	1.9266	2420	1.6475	2620	1.3521	2820	1.0573
2030	2.1884	2230	1.9127	2430	1.6329	2630	1.3375	2830	1.0418
2040	2.1746	2240	1.8988	2440	1.6183	2640	1.3232	2840	1.0265
2050	2.1608	2250	1.8850	2450	1.6038	2650	1.3087	2850	1.0115
2060	2.1472	2260	1.8713	2460	1.5887	2660	1.2934	2860	0.9967
2070	2.1333	2270	1.8578	2470	1.5737	2670	1.2782	2870	0.9820
2080	2.1194	2280	1.8438	2480	1.5589	2680	1.2633	2880	0.9677
2090	2.1056	2290	1.8299	2490	1.5442	2690	1.2485	2890	0.9535
2100	2.0919	2300	1.8160	2500	1.5297	2700	1.2339	2900	0.9395
2110	2.0783	2310	1.8023	2510	1.5153	2710	1.2195	2910	0.9254
2120	2.0644	2320	1.7887	2520	1.5002	2720	1.2052	2920	0.9093
2130	2.0505	2330	1.7751	2530	1.4851	2730	1.1905	2930	0.8935
2140	2.0367	2340	1.7611	2540	1.4703	2740	1.1751	2940	0.8780
2150	2.0230	2350	1.7471	2550	1.4555	2750	1.1599	2950	0.8628
2160	2.0093	2360	1.7333	2560	1.4409	2760	1.1449	2960	0.8478
2170	1.9955	2370	1.7196	2570	1.4265	2770	1.1301	2970	0.8331
2180	1.9816	2380	1.7060	2580	1.4119	2780	1.1155	2980	0.8186
2190	1.9677	2390	1.6923	2590	1.3967	2790	1.1011	2990	0.8044
2200	1.9540	2400	1.6773	2600	1.3817	2800	1.0868	3000	0.7904
2210	1.9404	2410	1.6623	2610	1.3668	2810	1.0728		

DETAIL HYDROGRAPH SUMMARY

HYDROGRAPH No. 12
Peak runoff: 8.0254 cfs Total Vol: 12.73 ac-ft

TIME (min)	DESIGN RUNOFF (cfs)	TIME (min)	DESIGN RUNOFF (cfs)	TIME (min)	DESIGN RUNOFF (cfs)	TIME (min)	DESIGN RUNOFF (cfs)	TIME (min)	DESIGN RUNOFF (cfs)
10		410	1.8992	810	7.2263	1210	4.6927	1610	3.1018
20		420	1.9496	820	7.0459	1220	4.6775	1620	3.0893
30		430	1.9985	830	6.8497	1230	4.6647	1630	3.0768
40		440	2.0529	840	6.6581	1240	4.6527	1640	3.0642
50		450	2.1239	850	6.4810	1250	4.6427	1650	3.0516
60		460	2.2099	860	6.3453	1260	4.6342	1660	3.0391
70	0.0001	470	2.3116	870	6.2702	1270	4.6259	1670	3.0265
80	0.0025	480	2.4375	880	6.2345	1280	4.6190	1680	3.0139
90	0.0127	490	2.5818	890	6.2202	1290	4.6132	1690	3.0013
100	0.0357	500	2.7227	900	6.2181	1300	4.6072	1700	2.9888
110	0.0740	510	2.8395	910	6.2241	1310	4.6024	1710	2.9763
120	0.1273	520	2.9319	920	6.2327	1320	4.5985	1720	2.9636
130	0.1944	530	3.0023	930	6.2423	1330	4.5942	1730	2.9511
140	0.2756	540	3.0628	940	6.2535	1340	4.5814	1740	2.9386
150	0.3728	550	3.1164	950	6.2636	1350	4.5477	1750	2.9253
160	0.4848	560	3.1640	960	6.2726	1360	4.4953	1760	2.9114
170	0.5660	570	3.2042	970	6.2822	1370	4.4337	1770	2.8977
180	0.6221	580	3.3896	980	6.2542	1380	4.3693	1780	2.8840
190	0.6826	590	3.7873	990	6.1356	1390	4.3070	1790	2.8701
200	0.7464	600	4.4610	1000	5.9410	1400	4.2471	1800	2.8563
210	0.8002	610	5.1585	1010	5.7151	1410	4.1909	1810	2.8426
220	0.8535	620	5.8205	1020	5.4848	1420	4.1400	1820	2.8288
230	0.9084	630	6.3468	1030	5.2657	1430	4.0928	1830	2.8150
240	0.9589	640	6.8383	1040	5.0874	1440	4.0496	1840	2.8012
250	1.0076	650	7.2279	1050	4.9878	1450	4.0113	1850	2.7875
260	1.0583	660	7.5359	1060	4.9597	1460	3.9413	1860	2.7736
270	1.1075	670	7.7848	1070	4.9708	1470	3.7862	1870	2.7598
280	1.1580	680	7.9587	1080	5.0021	1480	3.5554	1880	2.7460
290	1.2094	690	8.0254	1090	5.0425	1490	3.4640	1890	2.7323
300	1.2583	700	8.0042	1100	5.0740	1500	3.3841	1900	2.7185
310	1.3082	710	7.9413	1110	5.0746	1510	3.3006	1910	2.7047
320	1.3582	720	7.8614	1120	5.0459	1520	3.2158	1920	2.6909
330	1.4166	730	7.7764	1130	5.0482	1530	3.2016	1930	2.6772
340	1.4791	740	7.6962	1140	5.0667	1540	3.1893	1940	2.6633
350	1.5448	750	7.6239	1150	5.0046	1550	3.1770	1950	2.6495
360	1.6112	760	7.5586	1160	4.9047	1560	3.1646	1960	2.6358
370	1.6763	770	7.5031	1170	4.8336	1570	3.1520	1970	2.6221
380	1.7366	780	7.4563	1180	4.7801	1580	3.1395	1980	2.6082
390	1.7935	790	7.4154	1190	4.7401	1590	3.1270	1990	2.5944
400	1.8476	800	7.3528	1200	4.7113	1600	3.1144	2000	2.5806

DETAIL HYDROGRAPH SUMMARY

HYDROGRAPH No. 12
Peak runoff: 8.0254 cfs Total Vol: 12.73 ac-ft

TIME (min)	DESIGN RUNOFF (cfs)	TIME (min)	DESIGN RUNOFF (cfs)	TIME (min)	DESIGN RUNOFF (cfs)	TIME (min)	DESIGN RUNOFF (cfs)	TIME (min)	DESIGN RUNOFF (cfs)
2010	2.5669	2210	2.2911	2410	2.0155	2610	1.7395	2810	1.4475
2020	2.5531	2220	2.2775	2420	2.0018	2620	1.7258	2820	1.4330
2030	2.5392	2230	2.2636	2430	1.9879	2630	1.7121	2830	1.4187
2040	2.5255	2240	2.2497	2440	1.9740	2640	1.6986	2840	1.4035
2050	2.5118	2250	2.2359	2450	1.9602	2650	1.6840	2850	1.3884
2060	2.4979	2260	2.2222	2460	1.9465	2660	1.6691	2860	1.3735
2070	2.4841	2270	2.2086	2470	1.9329	2670	1.6542	2870	1.3587
2080	2.4703	2280	2.1947	2480	1.9190	2680	1.6395	2880	1.3441
2090	2.4567	2290	2.1808	2490	1.9050	2690	1.6249	2890	1.3296
2100	2.4428	2300	2.1670	2500	1.8912	2700	1.6104	2900	1.3153
2110	2.4290	2310	2.1533	2510	1.8775	2710	1.5955	2910	1.3003
2120	2.4152	2320	2.1396	2520	1.8639	2720	1.5804	2920	1.2851
2130	2.4015	2330	2.1257	2530	1.8502	2730	1.5656	2930	1.2700
2140	2.3877	2340	2.1119	2540	1.8362	2740	1.5508	2940	1.2552
2150	2.3738	2350	2.0981	2550	1.8223	2750	1.5362	2950	1.2405
2160	2.3600	2360	2.0844	2560	1.8085	2760	1.5218	2960	1.2260
2170	2.3463	2370	2.0707	2570	1.7948	2770	1.5070	2970	1.2117
2180	2.3326	2380	2.0568	2580	1.7813	2780	1.4919	2980	1.1975
2190	2.3187	2390	2.0429	2590	1.7674	2790	1.4770	2990	1.1820
2200	2.3049	2400	2.0291	2600	1.7534	2800	1.4622	3000	1.1667
2210	2.2911	2410	2.0155	2610	1.7395	2810	1.4475		

DETAIL HYDROGRAPH SUMMARY

HYDROGRAPH No. 13
Peak runoff: 25.6043 cfs Total Vol: 20.26 ac-ft

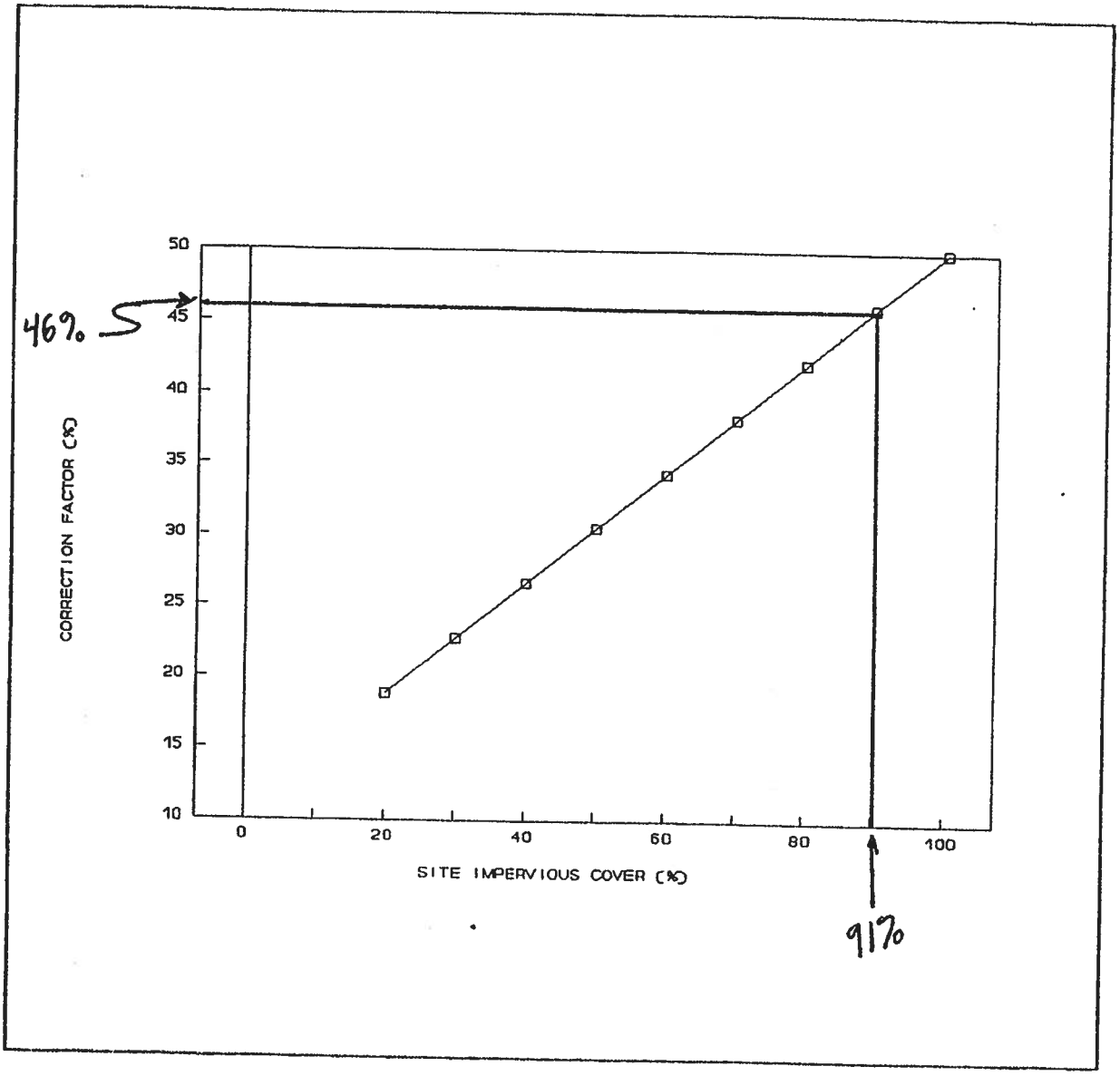
TIME (min)	DESIGN RUNOFF (cfs)	TIME (min)	DESIGN RUNOFF (cfs)	TIME (min)	DESIGN RUNOFF (cfs)	TIME (min)	DESIGN RUNOFF (cfs)	TIME (min)	DESIGN RUNOFF (cfs)
10		410	2.5336	810	11.0048	1210	7.0262	1610	3.1429
20		420	2.5964	820	10.6704	1220	7.0020	1620	3.1304
30		430	2.6574	830	10.3408	1230	6.9840	1630	3.1178
40		440	2.7252	840	10.0245	1240	6.9678	1640	3.1052
50	0.0001	450	2.8123	850	9.7378	1250	6.9562	1650	3.0927
60	0.0025	460	2.9171	860	9.5108	1260	6.9477	1660	3.0802
70	0.0127	470	3.0316	870	9.3808	1270	6.9388	1670	3.0676
80	0.0397	480	3.1712	880	9.3356	1280	6.9329	1680	3.0550
90	0.0938	490	5.7138	890	9.3329	1290	6.9289	1690	3.0424
100	0.1789	500	12.9434	900	9.3517	1300	6.9235	1700	3.0299
110	0.2924	510	19.3236	910	9.3830	1310	6.9205	1710	3.0173
120	0.4303	520	23.1578	920	9.4152	1320	6.9189	1720	3.0047
130	0.5577	530	25.0382	930	9.4458	1330	6.9155	1730	2.9922
140	0.6330	540	25.6043	940	9.4765	1340	6.8903	1740	2.9797
150	0.7204	550	25.4576	950	9.5021	1350	6.8133	1750	2.9670
160	0.8048	560	24.8316	960	9.5234	1360	6.6936	1760	2.9545
170	0.8873	570	23.7030	970	9.5441	1370	6.5571	1770	2.9419
180	0.9676	580	22.3086	980	9.4853	1380	6.4208	1780	2.9290
190	1.0454	590	20.9827	990	9.2414	1390	6.3114	1790	2.9152
200	1.1197	600	19.7884	1000	8.8512	1400	6.2147	1800	2.9014
210	1.1932	610	18.8021	1010	8.4155	1410	6.1264	1810	2.8877
220	1.2619	620	17.9717	1020	8.0379	1420	6.0496	1820	2.8738
230	1.3300	630	17.2163	1030	7.6854	1430	5.9806	1830	2.8600
240	1.3951	640	16.5363	1040	7.4105	1440	5.9195	1840	2.8462
250	1.4582	650	15.9720	1050	7.2798	1450	5.8680	1850	2.8325
260	1.5213	660	15.5130	1060	7.2760	1460	5.7495	1860	2.8187
270	1.5842	670	15.1373	1070	7.3373	1470	5.4545	1870	2.8049
280	1.6479	680	14.7738	1080	7.4281	1480	5.0095	1880	2.7911
290	1.7105	690	14.3270	1090	7.5282	1490	4.5660	1890	2.7774
300	1.7692	700	13.8191	1100	7.6056	1500	4.1960	1900	2.7635
310	1.8263	710	13.3357	1110	7.6217	1510	3.8311	1910	2.7497
320	1.8860	720	12.9311	1120	7.5818	1520	3.5170	1920	2.7360
330	1.9532	730	12.5744	1130	7.5976	1530	3.4259	1930	2.7222
340	2.0268	740	12.2731	1140	7.6409	1540	3.3353	1940	2.7084
350	2.1031	750	12.0231	1150	7.5347	1550	3.2460	1950	2.6946
360	2.1799	760	11.8150	1160	7.3614	1560	3.2055	1960	2.6809
370	2.2562	770	11.6474	1170	7.2441	1570	3.1930	1970	2.6671
380	2.3305	780	11.5131	1180	7.1603	1580	3.1805	1980	2.6532
390	2.4013	790	11.4027	1190	7.1017	1590	3.1681	1990	2.6395
400	2.4688	800	11.2602	1200	7.0597	1600	3.1555	2000	2.6258

DETAIL HYDROGRAPH SUMMARY

HYDROGRAPH No. 13
Peak runoff: 25.6043 cfs Total Vol: 20.26 ac-ft

TIME (min)	DESIGN RUNOFF (cfs)	TIME (min)	DESIGN RUNOFF (cfs)	TIME (min)	DESIGN RUNOFF (cfs)	TIME (min)	DESIGN RUNOFF (cfs)	TIME (min)	DESIGN RUNOFF (cfs)
2010	2.6119	2210	2.3363	2410	2.0605	2610	1.7849	2810	1.4959
2020	2.5981	2220	2.3224	2420	2.0466	2620	1.7712	2820	1.4810
2030	2.5843	2230	2.3086	2430	2.0328	2630	1.7571	2830	1.4661
2040	2.5706	2240	2.2948	2440	2.0191	2640	1.7432	2840	1.4514
2050	2.5568	2250	2.2811	2450	2.0055	2650	1.7294	2850	1.4369
2060	2.5429	2260	2.2674	2460	1.9916	2660	1.7158	2860	1.4225
2070	2.5292	2270	2.2535	2470	1.9777	2670	1.7022	2870	1.4076
2080	2.5155	2280	2.2396	2480	1.9639	2680	1.6881	2880	1.3925
2090	2.5017	2290	2.2259	2490	1.9502	2690	1.6731	2890	1.3775
2100	2.4878	2300	2.2123	2500	1.9366	2700	1.6582	2900	1.3627
2110	2.4740	2310	2.1984	2510	1.9227	2710	1.6434	2910	1.3480
2120	2.4603	2320	2.1845	2520	1.9088	2720	1.6288	2920	1.3335
2130	2.4465	2330	2.1707	2530	1.8949	2730	1.6143	2930	1.3192
2140	2.4327	2340	2.1570	2540	1.8812	2740	1.5995	2940	1.3044
2150	2.4189	2350	2.1434	2550	1.8675	2750	1.5845	2950	1.2891
2160	2.4052	2360	2.1294	2560	1.8539	2760	1.5696	2960	1.2741
2170	2.3914	2370	2.1156	2570	1.8399	2770	1.5548	2970	1.2592
2180	2.3775	2380	2.1018	2580	1.8260	2780	1.5402	2980	1.2444
2190	2.3637	2390	2.0881	2590	1.8122	2790	1.5257	2990	1.2299
2200	2.3500	2400	2.0745	2600	1.7985	2800	1.5111	3000	1.2155
2210	2.3363	2410	2.0605	2610	1.7849	2810	1.4959		

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



TOTAL SITE AREA = 83.9 ACRES

SITE IMPERVIOUS AREA = 76.6

PERCENT IMPERVIOUS = $\frac{76.6}{83.9}$ = 91%

CORRECTION FACTOR = 46%

Detention Requirement (1 of 1)

nutrients are phosphorus and nitrogen. Nutrients can be a concern for both surface water and ground water. Eutrophication of lakes is typically caused by nutrients and ground water contamination by nitrates is also a common problem.

A subcategory of runoff treatment BMPs is those that provide pretreatment in order to protect primary treatment BMPs from siltation. The selection of pretreatment BMPs is described further in the BMP selection process (Section I-4.3) and illustrated in Table I-4.6.

A special category of runoff treatment BMPs includes those designed to remove oil contained in runoff. Oil, being lighter than water, typically floats on top of the water column and different removal techniques may be needed for treatment. Oil will, however, often adhere to suspended solids. Oil concentrations in urban runoff are often too low to justify the use of oil/water separators, but some land uses may require these BMPs, especially when the possibility of spills is present. There are three basic types of oil/water separators. Spill control (SC-type) are designed only to capture spills, while API and CPS-type separators are specifically designed to remove free oil from the water column. Sand filtration BMPs are currently allowed as an interim alternative to API and CPS oil/water separators in this edition of the manual. The ability of sand filtration to remove free oil shows promise but is under further investigation.

I-4.2.3 Streambank Erosion Control BMPs

Streambank erosion control (SBEC) BMPs are designed to prevent or control the excessive erosion that typically occurs in streams located in urbanizing watersheds. This erosion results not only because of the dramatic increase in peak flow rates from runoff but also due to increases in the frequency and duration of high flow conditions. Conventional flood control ponds are only marginally effective at controlling streambank erosion because they control only peak flow rates. The goal of streambank erosion control BMPs is to replicate, to the extent possible, the pre-existing hydrologic regime in streams by attenuating runoff from development sites and slowly releasing it back to the natural system.

The two-year return period storm has been identified as a key event for controlling streambank erosion. The two-year storm is typically the event in which streams are flowing "bankfull," a highly erosive condition. Urbanization increases the frequency and duration of bankfull conditions, thus greatly accelerating the streambank erosion process. Larger storms, such as the 10-year and 100-year events, are also important for streambank erosion control. These storms may periodically alter the morphology of streams and are important for the transport and deposition of sediments necessary for the ecological health of stream systems.

Ecology's streambank erosion control standards attempt to replicate, to the extent practicable, the stream flow conditions that would occur under natural conditions for specified design storms. Accordingly BMPs are to be designed to meet the following on-site detention requirements:

- Limit the peak rate of runoff to 50 percent of the *existing site condition* 2-year, 24-hour design storm, with a correction factor applied;

- Maintain the peak flow rate of runoff for the *existing site condition* 10-year and 100-year, 24-hour storms, with a correction factor applied.

The correction factor is applied to the BMP volume and should range from 20 to 50 percent for sites with impervious cover ranging from 20 to 100 percent. A correction factor is necessary to account for the inadequacies of current hydrologic analysis methods. Improved methods are under development and should be available no later than 1993. See Chapter III-1 for more details.

Water Quality

Water Quality Volume Required=Volume of 6-month, 24-hr storm

6-month, 24 hr precipitation volume=0.64 X 2-year precipitation (in.)

2-yr precip. = 1.5 inches
6-month, 24 hr precip. = 0.64x1.5= 0.96 inches

Volume required=4.98 acre-ft

=216,929 cubic feet

Volume provided=5.51 acre-ft
=240,000 cubic feet

ALDERWOOD MALL EXPANSION

BASIN SUMMARY

BASIN ID: D6mo NAME: DEVELOPED 6 MONTH
SBUH METHODOLOGY

TOTAL AREA.....:	83.86 Acres	BASEFLOWS:	0.00 cfs	
RAINFALL TYPE....:	TYPE1A		PERV	IMP
PRECIPITATION....:	0.96 inches	AREA..:	7.28 Acres	76.58 Acres
TIME INTERVAL....:	10.00 min	CN....:	90.00	98.00
		TC....:	20.73 min	20.73 min

ABSTRACTION COEFF: 0.20
TcReach - Sheet L: 100.00 ns:0.1500 p2yr: 1.50 s:0.0200
TcReach - Shallow L: 100.00 ks:27.00 s:0.0200
TcReach - Channel L:3000.00 kc:42.00 s:0.0050
impTcReach - Sheet L: 100.00 ns:0.1500 p2yr: 1.50 s:0.0200
impTcReach - Shallow L: 100.00 ks:27.00 s:0.0200
impTcReach - Channel L:3000.00 kc:42.00 s:0.0100
PEAK RATE: 11.42 cfs VOL: 4.98 Ac-ft TIME: 480 min

ALDERWOOD MALL EXPANSION

STAGE STORAGE TABLE

CUSTOM STORAGE ID No. WQ
Description: WATER QUALITY

STAGE (ft)	STORAGE ---cf---	STORAGE --Ac-Ft-	STAGE (ft)	STORAGE ---cf---	STORAGE --Ac-Ft-	STAGE (ft)	STORAGE ---cf---	STORAGE --Ac-Ft-	STAGE (ft)	STORAGE ---cf---	STORAGE --Ac-Ft-
368.00	0.0000	0.0000	369.60	71759	1.6474	371.20	150428	3.4533	372.80	236089	5.4198
368.10	4485	0.1030	369.70	76244	1.7503	371.30	155488	3.5695	372.90	241736	5.5495
368.20	8970	0.2059	369.80	80729	1.8533	371.40	160549	3.6857	373.00	247383	5.6791
368.30	13455	0.3089	369.90	85214	1.9563	371.50	165610	3.8019	373.10	253029	5.8088
368.40	17940	0.4118	370.00	89699	2.0592	371.60	170670	3.9181	373.20	258676	5.9384
368.50	22425	0.5148	370.10	94760	2.1754	371.70	175731	4.0342	373.30	264323	6.0680
368.60	26910	0.6178	370.20	99821	2.2916	371.80	180792	4.1504	373.40	269970	6.1977
368.70	31395	0.7207	370.30	104881	2.4077	371.90	185852	4.2666	373.50	275617	6.3273
368.80	35880	0.8237	370.40	109942	2.5239	372.00	190913	4.3828	373.60	281264	6.4569
368.90	40365	0.9266	370.50	115003	2.6401	372.10	196560	4.5124	373.70	286911	6.5866
369.00	44850	1.0296	370.60	120063	2.7563	372.20	202207	4.6420	373.80	292558	6.7162
369.10	49335	1.1326	370.70	125124	2.8725	372.30	207854	4.7717	373.90	298205	6.8458
369.20	53820	1.2355	370.80	130185	2.9886	372.40	213501	4.9013	374.00	303852	6.9755
369.30	58305	1.3385	370.90	135245	3.1048	372.50	219148	5.0309			
369.40	62790	1.4414	371.00	140306	3.2210	372.60	224795	5.1606			
369.50	67274	1.5444	371.10	145367	3.3372	372.70	230442	5.2902			

TOP OF WATER QUALITY

Design Criteria

Sizing Wet Ponds

Wet ponds designed for treatment of conventional pollutants utilize a permanent pool of water to provide treatment and are to be designed using the hydrologic analysis methods presented in Chapter III-1.

Permanent Pool Volume

The permanent pool volume shall be equal to the runoff volume of the 6-month, 24-hour design storm. It is not necessary to vegetate the permanent pool, but establishment of a shallow marsh system can provide additional pollutant removal capabilities.

Surface Area-Pool Depth Relationships

The pond surface area is found by dividing the permanent pool volume by the depth, with a maximum depth of six (6) feet recommended. A minimum depth of three (3) feet is recommended so that resuspension of trapped pollutants is inhibited. Permanent pools deeper than six (6) feet could potentially contaminate ground water (should they intersect the existing ground water level). Also, deeper ponds can stratify and create anaerobic condition that can cause pollutants which are normally bound in the sediment (e.g., metals and phosphorus) to resolubilize; their release back to the water column can seriously affect the effectiveness of the BMP and also create nuisance conditions.

See Table III-4.2 for the surface area-pool depth relationship. Table III-4.3 illustrates typical surface area-to-drainage area ratios for this and other detention BMPs.

If the wet pond is also designed to provide streambank erosion control, then additional surface area and depth will be required for the "live storage" volume located above the permanent pool. There is no specific surface area-pool depth relationship for the "live storage" volume.

Ponds designed to provide streambank erosion control may be deeper than six feet as long as the permanent pool volume provided for runoff treatment does not exceed six feet.

Outlet Structure

The outlet structure must be designed to accomplish an extended detention time so that runoff can be released at the flow rates established by Minimum Requirement #5, Streambank Erosion Control (see Chapter I-2). Figure III-4.3 illustrates methods for extending detention time in wet ponds.

Pond Configuration and Geometry

Wet ponds shall be multi-celled with a least two cells, and preferably three. The cells should be approximately equal in size. The first cell should be three feet deep in order to effectively trap coarser sediments and reduce turbulence which can resuspend sediments. It should be easily accessible for maintenance purposes.

Long, narrow, and irregularly shaped ponds are preferred, as these configurations are less prone to short-circuiting and tend to maximize available treatment area. The length-to-width ratio should be at least 3:1 and preferably 5:1. Irregularly shaped ponds may perform more effectively and will have a more natural appearance.

The inlet and outlet should be at opposite ends of the pond where feasible. If this is not possible, then baffles can be installed to increase the flow path and water residence time (see BMP RD.10, Presettling Basin, for details).

Interior side slopes up to the maximum water surface shall be no steeper than 3H:1V. Exterior side slopes shall be no steeper than 2H:1V.

The pond bottom shall be level to facilitate sedimentation.

Pond walls may be retaining walls, provided that the design is prepared and stamped by a structural engineer registered in the State of Washington, that they are constructed of reinforced concrete per Section III-4.6.1, that a fence is provided along the top of the wall, and that at least 25 percent of the pond perimeter will be a vegetated soil slope of not greater than 3H:1V.

Other Design Considerations

Liner to Prevent Infiltration

Detention BMPs should have negligible infiltration rates through the bottom of the pond. Infiltration will impair the proper functioning of detention BMPs and can contaminate ground water. If infiltration is anticipated, then a detention facility must either not be used and an infiltration BMP used instead (see Chapter III-3) or a liner should be installed to prevent infiltration. If a liner is used, the specifications provided in Section III-3.7 (Filtration BMPs) can be used. When using a liner the following are recommended:

- A layer of (track) compacted top soil (minimum 18" thick shall be placed over the liner prior to seeding with an appropriate seed mixture (see BMP E1.35 in Chapter II-5).

- Other liners may be used provided the design engineer can supply support documentation that the material will provide the required performance.

Overflow and Emergency Spillway

If streambank erosion control is not required, a pond overflow system must provide controlled discharge of the 100-year, 24-hour design storm event for developed site conditions without overtopping any part of the pond embankment or exceeding the capacity of the emergency spillway. The design must provide controlled discharge directly into the downstream conveyance system. This assumes the pond will be full due to plugged control structure inflow pipe and/or plugged restrictor/orifices conditions.

Open Type 2 catchbasins can function as weirs when used as pond overflow structures to control overtopping. The overflow structure, as shown in Figure III-4.5, may be required in some circumstances to protect embankments from overtopping.

In addition to the above overflow requirements, an emergency overflow spillway (secondary overflow) must be provided to safely pass the 100-year, 24-hour design storm event (for developed site conditions and assuming the pond is full to the crest of the spillway) over the pond embankment in the event of control structure failure or for storm/runoff events exceeding design. The spillway must be located to direct overflows safely towards the downstream conveyance system and shall be located in existing soil wherever feasible. The emergency overflow spill shall be armored with riprap in conformance with Table III-2.4 and shall extend to the toe of each face of the berm embankment.

- Design of emergency overflow spillways requires the analysis of a broad-crested trapezoidal weir. The following weir section is required for the emergency overflow spillway, as per Figure III-4.4.

PORTION OF SECTION 11 AND 12, TOWNSHIP 27 NORTH, RANGE 4 EAST, W.M.

MATCHLINE SEE SHEET C4.01

THE EXISTING TOPOGRAPHIC AND PHYSICAL FEATURES SHOWN ON THESE PLANS ARE BASED ON A COMBINATION OF:

AS-BUILTS AND FIELD SURVEY DATA FROM THE CITY OF LYNNWOOD
AERIAL PHOTOGRAPHY BY WALKER AND ASSOCIATES AND BY ENTRANCO SURVEY
FRANCHISE UTILITY COMPANY RECORDS
FIELD RECONNAISSANCE BY ENTRANCO

THIS WAS THE INFORMATION AVAILABLE AT THE TIME OF PLAN PREPARATION. ACTUAL CONDITIONS MAY BE DIFFERENT. THE CONTRACTOR MAY ENCOUNTER VARIATIONS BETWEEN ACTUAL CONDITIONS AND THOSE SHOWN. THESE VARIATIONS WILL NOT BE THE BASIS FOR A CLAIM OR EXTRA COMPENSATION.

THE LOCATIONS OF EXISTING UNDERGROUND UTILITIES ARE SHOWN IN AN APPROXIMATE WAY ONLY AND HAVE NOT BEEN INDEPENDENTLY VERIFIED BY THE OWNER OR ENTRANCO. THE CONTRACTOR SHALL DETERMINE THE EXACT LOCATION OF ALL EXISTING UTILITIES BEFORE COMMENCING WORK, AND AGREES TO BE FULLY RESPONSIBLE FOR ANY AND ALL DAMAGES WHICH MIGHT BE OCCASIONED BY THE CONTRACTOR'S FAILURE TO EXACTLY LOCATE AND PRESERVE ANY AND ALL UNDERGROUND UTILITIES.

CONSTRUCTION NOTES

1. GRADING FOR RING ROAD SHALL BE TO SUBGRADE ONLY (±0.10'). FINAL BASE AND PAVING SHALL BE DONE BY OTHERS (NIC). SEE PAVING SECTION DETAIL 2 ON SHEET C6.02
2. POND SHALL BE SEEDED IN ACCORDANCE WITH THE CITY OF LYNNWOOD STANDARDS.

RING ROAD

STORM DETENTION POND

STORMWATER FACILITY

RING ROAD CURB AND GUTTER AND ASSOCIATED GRADING TO BE CONSTRUCTED UNDER SEPARATE CONTRACT.

EARTHWORK/GRADING AREA (SEE GEOTECHNICAL REPORT)

EX. CB
IE 380.48 (S)
CAP & ABANDON.
EX. PIPE TO THE W (42") SE (48"), AND S (42") REMOVE IF NECESSARY
SEE SHEET C2.11

EX. CB
IE 378.66 (S)
CAP & ABANDON
EX. PIPE TO NORTH AND SOUTH. REMOVE IF NECESSARY
(SEE SHEET C2.21)

CB TYPE I-C
CONCRETE INLET W/ THRU CURB INLET FRAME & GRATE
N 304977.83
E 1286459.91
GE 384.62
IE 381.62

CB TYPE I-C
CONCRETE INLET W/THRU CURB INLET FRAME AND GRATE
N 304900.20
E 1286219.02
GE 384.63
IE 381.63

CB TYPE I-C
CONCRETE INLET W/THRU CURB INLET FRAME AND GRATE
N 304899.49
E 1286136.85
GE 384.07
IE 381.07

CB TYPE I-C
CONCRETE INLET W/THRU CURB INLET FRAME AND GRATE
N 304914.78
E 1286379.38
GE 384.15
IE 381.15

CB TYPE I-C
CONCRETE INLET W/ THRU CURB INLET FRAME & GRATE
N 304892.67
E 1286291.40
GE 384.15
IE 381.15

CB TYPE I-C
CONCRETE INLET W/ THRU CURB INLET FRAME & GRATE
N 304862.68
E 1286411.77

INSTALL GABION BASKET, SEE DETAIL SHEET C4.3. TOP OF WALL=372.5 BOTTOM OF WALL=368.0

INSTALL GABION BASKET, SEE DETAIL SHEET C4.3. TOP OF WALL=372.5 BOTTOM OF WALL=368.0

CENTERLINE WALL
N 304807.54
E 1286204.24

CENTERLINE WALL
N 304802.93
E 1286409.67

CENTERLINE WALL
N 304860.45
E 1286498.13

CENTERLINE WALL
N 304871.98
E 1286206.50

SD OUTLET
IE 381.09
N 304903.74
E 1286384.61

SD OUTLET
IE 381.01
N 304887.64
E 1286339.85

SD OUTLET
IE 381.56
N 304970.10
E 1286469.38

SD OUTLET
IE 376.90
N 304878.19
E 1286210.55

SD OUTLET
IE 381.57
N 304888.64
E 1286215.90

SD OUTLET
IE 381.09
N 304880.46
E 1286292.01

EX. 60" SD
IE 372.26

EMERGENCY OVERFLOW DETAIL ON SHEET C4.3
N 304794.76
E 1286497.48

FLOW CONTROL STRUCTURE. SEE DETAIL ON SHEET C4.3
N 304788.28
E 1286487.00

12 LF, 30", S=1.0% SLOPE BACK TO POND

RIP RAP PAD (TYP.)

UTILIZE EX. OUTFALL, AVOID DAMAGING WHILE GRADING POND

NO VISIBLE SD CONNECTION FOUND

15' STORM DRAIN EASEMENT PER PLAT (TYP.)

STORM DETENTION EASEMENT 7910220232

SEE STORM STRUCTURE DETAIL

TEMPORARY 9' LF 12" SD 2.05%

MATCH EX. GRADE

12 LF 21" SD 0.50%

12 LF 12" SD 0.50%

2 LF 12" SD 2.05%

330 LF 12" SD 2.05%

STORMWATER FACILITY INFORMATION
TOP OF FREE BOARD: 382.00
100 YR 175 BASIN: 379.86
100 YR ON SITE: 377.58
TOP OF WATER QUALITY: 373.00
BOTTOM OF POND: 368.00

WATER QUALITY VOLUME REQUIRED = 217,000 CF
WATER QUALITY VOLUME PROVIDED = 242,500 CF

DETENTION VOLUME REQUIRED = 458,300 CF
DETENTION VOLUME PROVIDED = 462,105 CF

AS-BUILT
BAYLEY CONSTRUCTION

N 88°43'37" W 167.00'

N

0 10 20 40
Scale in Feet

entranco
WWW.ENTRANCO.COM
10900 N.E. 8th Street Suite 300
Bellevue, WA 98004
PH: 425.454.5600
FAX: 425.454.0220
Contact: Roger Cecil, P.E.

Alderwood Mall Site Work Phase 2A

Design Team

Designed By:	Designed Date:
BMM, JJT	04/08/03
Drawn By:	Drawn Date:
VB	04/08/03
Checked By:	Checked Date:
RJC	04/08/03
Approved By:	Approved Date:
RJC	04/08/03

Project Number: 1-10-00151

Revisions

No.	Date	Description
1	07/31/02	CD SUBMITTAL
2	09/27/02	CD RE-SUBMITTAL
3	11/12/02	CD RE-SUBMITTAL
4	01/07/03	PROGRESS PRINT
5	02/21/03	BID SET SUBMITTAL
6	04/28/03	CONSTRUCTION PLANS

Registration

ROGER J. CECIL — STATE OF WASHINGTON — 34314 — REGISTERED PROFESSIONAL ENGINEER

EXPIRES: 01/21/04

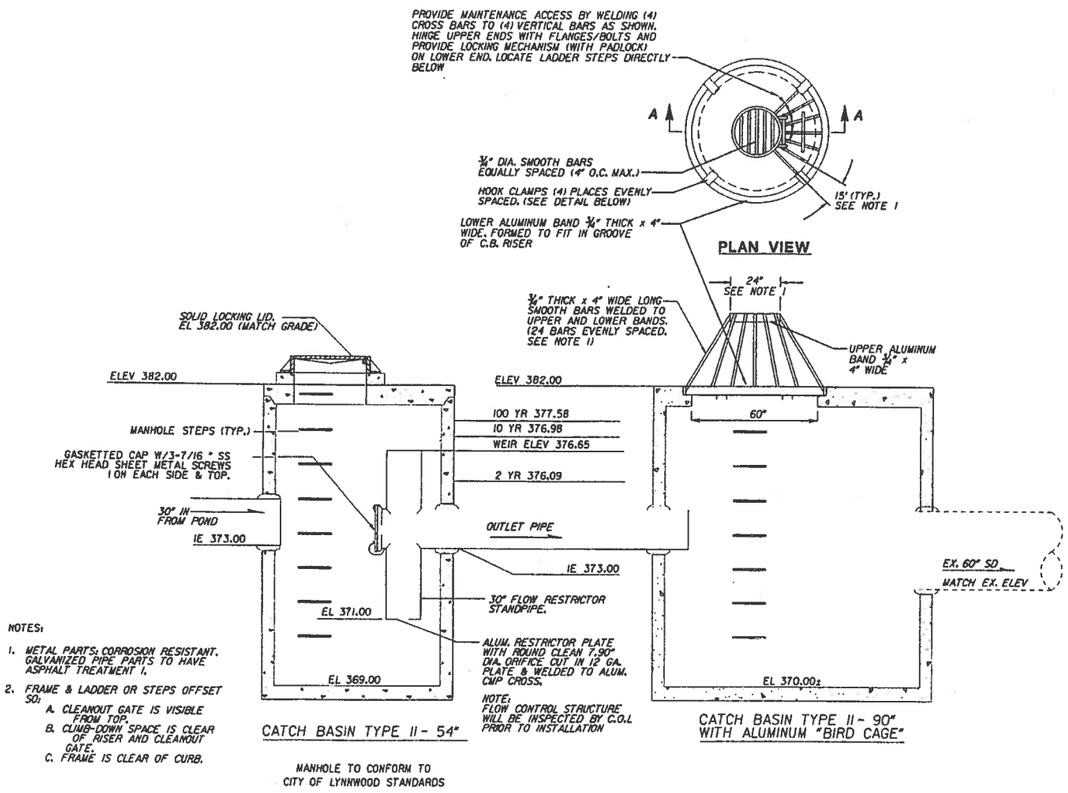
Key Map

Sheet Title

GRADING & DRAINAGE PLAN

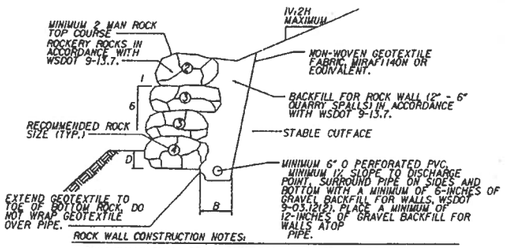
Section: SE CORNER 15

Sheet Number: **C4.2**



FLOW CONTROL STRUCTURE

NTS



ROCK WALL CONSTRUCTION NOTES:

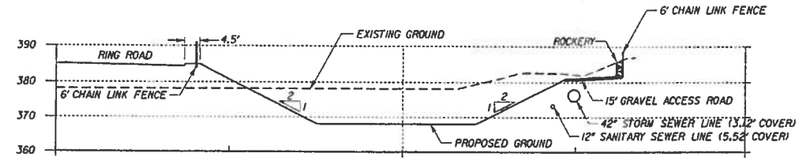
1. ROCK WALLS SHALL BE CONSTRUCTED IN GENERAL ACCORDANCE WITH THE ASSOCIATED ROCKERY CONTRACTORS (ARC) STANDARD ROCK WALL CONSTRUCTION GUIDELINES OR CITY OF MOUNT VERNON STANDARDS, WHICHEVER IS MORE STRINGENT
2. ROCK FOR ROCK WALLS AND CHINKING SHALL BE IN ACCORDANCE WITH SECTION 9-13.7 ROCK FOR ROCK WALL OF THE 2002 WSDOT STANDARD SPECIFICATIONS.
3. ROCKS SHALL BE SIZED IN ACCORDANCE WITH ROCK SIZE TABLES, THIS SHEET.
4. PLACE BOTTOM ROCK LAYER ON F IRM AND UNYIELDING SUBGRADE.
5. PLACE ROCKS TO GRADUALLY DECREASE IN SIZE WITH INCREASING WALL HEIGHT.
6. MINIMUM EMBEDMENT (D) SHALL BE 2 FEET.
7. MINIMUM THICKNESS OF BACKFILL B = 16 INCHES.
8. THE LONG DIMENSION OF THE ROCKS SHALL EXTEND PERPENDICULAR TO T HE ROCK FACE.
9. ROCKS SHALL BE PLACED TO AVOID CONTINUOUS JOINT PLANES IN VERTICAL OR LATERAL DIRECTIONS. EACH ROCK SHALL BEAR ON TWO OR MORE ROCKS BELOW IT, WITH GOOD FLAT-TO-FLAT CONTACT.
10. GEOTEXTILE TO CONSIST OF NON-WOVEN MATERIAL, MIRAFI 140N OR APPROVED EQUAL.

ROCK SIZE TABLES

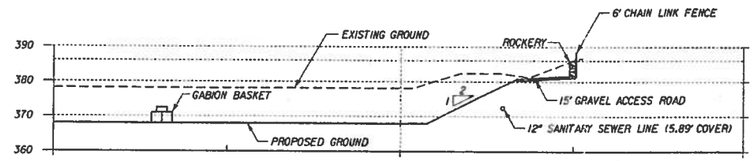
DEPTH FROM TOP OF WALL (FEET)	MINIMUM ROCK SIZE AT DEPTH FROM TOP OF WALL
5-6	THREE MAN
6-8	FOUR MAN
8-12	FIVE MAN

ROCK SIZE	ROCK WEIGHT (LBS)	AVERAGE DIMENSIONS (IN)
TWO MAN	200 - 700	18 - 28
THREE MAN	700 - 2,000	28 - 36
FOUR MAN	2,000 - 4,000	36 - 48
FIVE MAN	4,000 - 6,000	48 - 54
SIX MAN	6,000 - 8,000	54 - 60

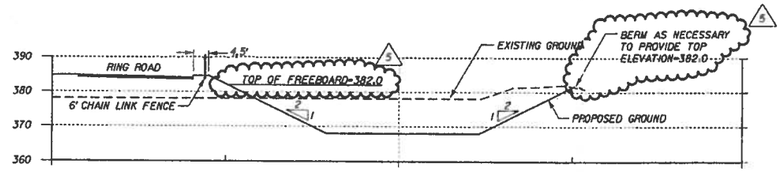
SECTION A-A



POND SECTION 1 (C4.1)
1" = 20' HORIZONTAL
1" = 20' VERTICAL

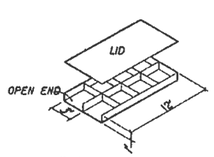


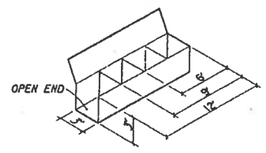
POND SECTION 2 (C4.2)
1" = 20' HORIZONTAL
1" = 20' VERTICAL

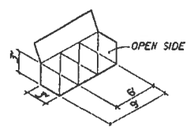


POND SECTION 3 (C4.2)
1" = 20' HORIZONTAL
1" = 20' VERTICAL

AS-BUILT
BAYLEY CONSTRUCTION

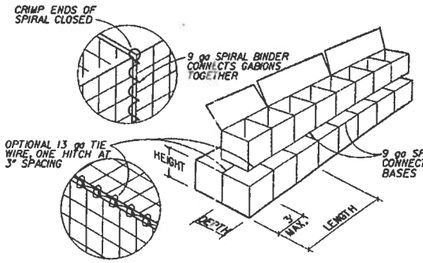






STANDARD GABION SIZES

SIZE LxWxH	CU.YD.	SIZE LxWxH	CU.YD.
3 x 3 x 3	1	3 x 3 x 1.5	0.5
6 x 3 x 3	2	6 x 3 x 1.5	1
9 x 3 x 3	3	9 x 3 x 1.5	1.5
12 x 3 x 3	4	12 x 3 x 1.5	2
6 x 6 x 3	4	6 x 6 x 1.5	2
9 x 6 x 3	6	9 x 6 x 1.5	3
12 x 6 x 3	8	12 x 6 x 1.5	4
24 x 6 x 3	16	24 x 6 x 1.5	8



ASSEMBLY DETAILS

NOTES

1. GABION SIZES ARE EXPRESSED IN FEET.
2. MATTRESSES AND CUSTOM SIZES PROVIDED ON REQUEST.
3. GABIONS WHICH ARE TO BE CONNECTED TOGETHER SIDE TO SIDE, OR END TO END, MAY BE PROVIDED OPEN-SIDE OR OPEN-END AS SHOWN, TO REDUCE WEIGHT, COST AND ASSEMBLY TIME.
4. GABIONS ARE MANUFACTURED OF 3" X 3" WELDED WIRE MESH, 9 GA. WITH 0.9 OZ/S.F. ZINC COATING, OR 11 GA. WITH 0.85 OZ/S.F. ZINC COATING. OPTIONAL 2.0 OZ/S.F. ZINC COATING IS AVAILABLE ON REQUEST.

GABION BASKET DETAILS

NTS

entranco
WWW.ENTRANCO.COM
10900 N.E. 8th Street Suite 300
Bellevue, WA 98004
PH: 425.454.8800
FAX: 425.454.0220
Contact: Roger Cecil, P.E.

Alderwood Mall Site Work Phase 2A

Design Team

Designed By:	Designed Date:
SMM, JJT	04/08/03
Drawn By:	Drawn Date:
VS	04/08/03
Checked By:	Checked Date:
RJC	04/08/03
Approved By:	Approved Date:
RJC	04/08/03
Project Number:	
1-10-00151	

Revisions

No.	Date	Description
1	07/31/02	CD SUBMITTAL
2	09/27/02	CD RE-SUBMITTAL
3	11/12/02	CD RE-SUBMITTAL
4	01/07/03	PROGRESS PRINT
5	03/21/03	BID SET SUBMITTAL
6	04/28/03	CONSTRUCTION PLANS

Registration

ROGER J. CECIL STATE OF WASHINGTON 34314 REGISTERED PROFESSIONAL ENGINEER
EXPIRES: 01/21/04

Key Map

Sheet Title

GRADING & DRAINAGE DETAILS

Section

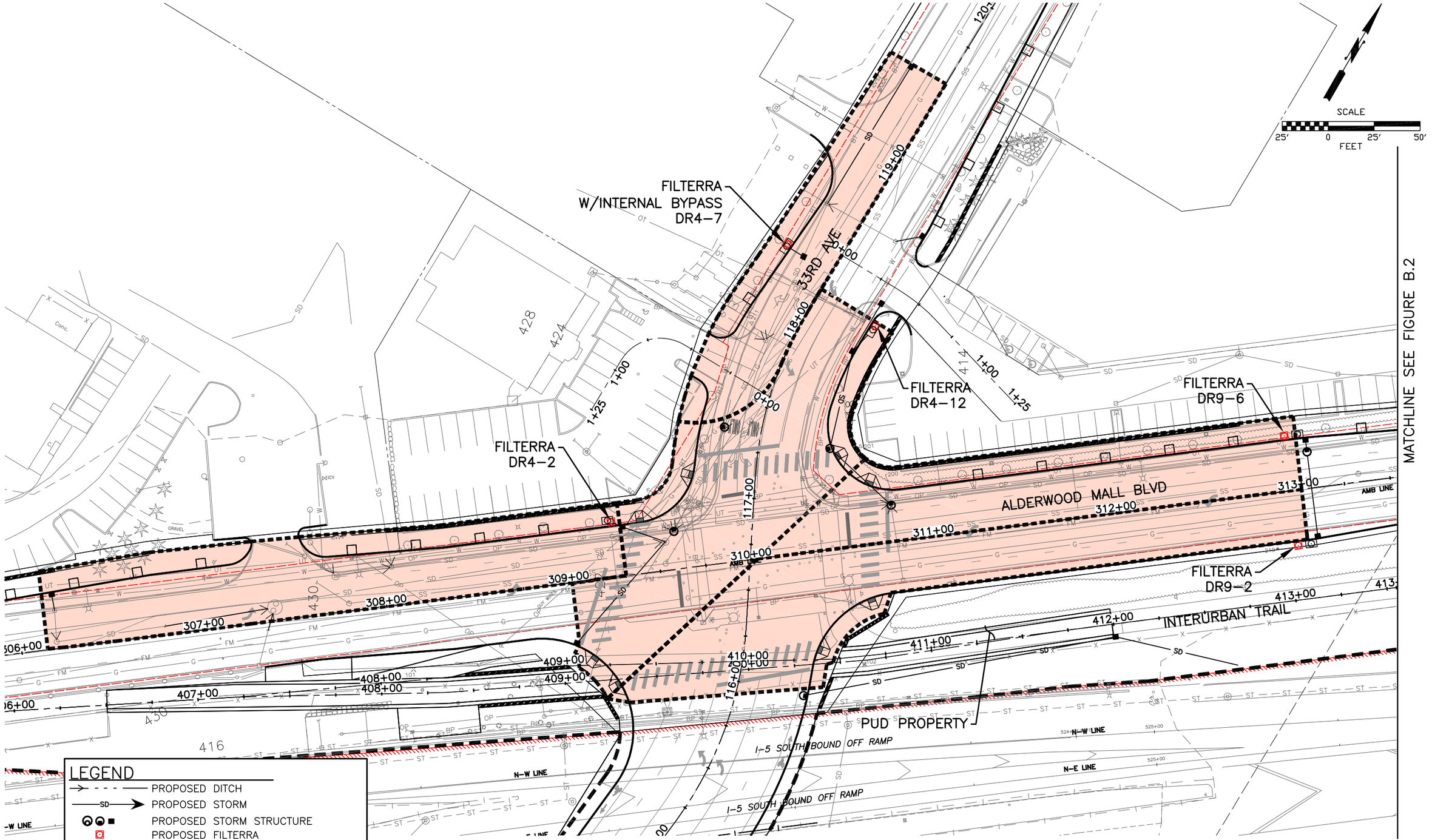
SE CORNER 15

Sheet Number

C4.3

Appendix H

Filterra Catchment Area Maps



LEGEND

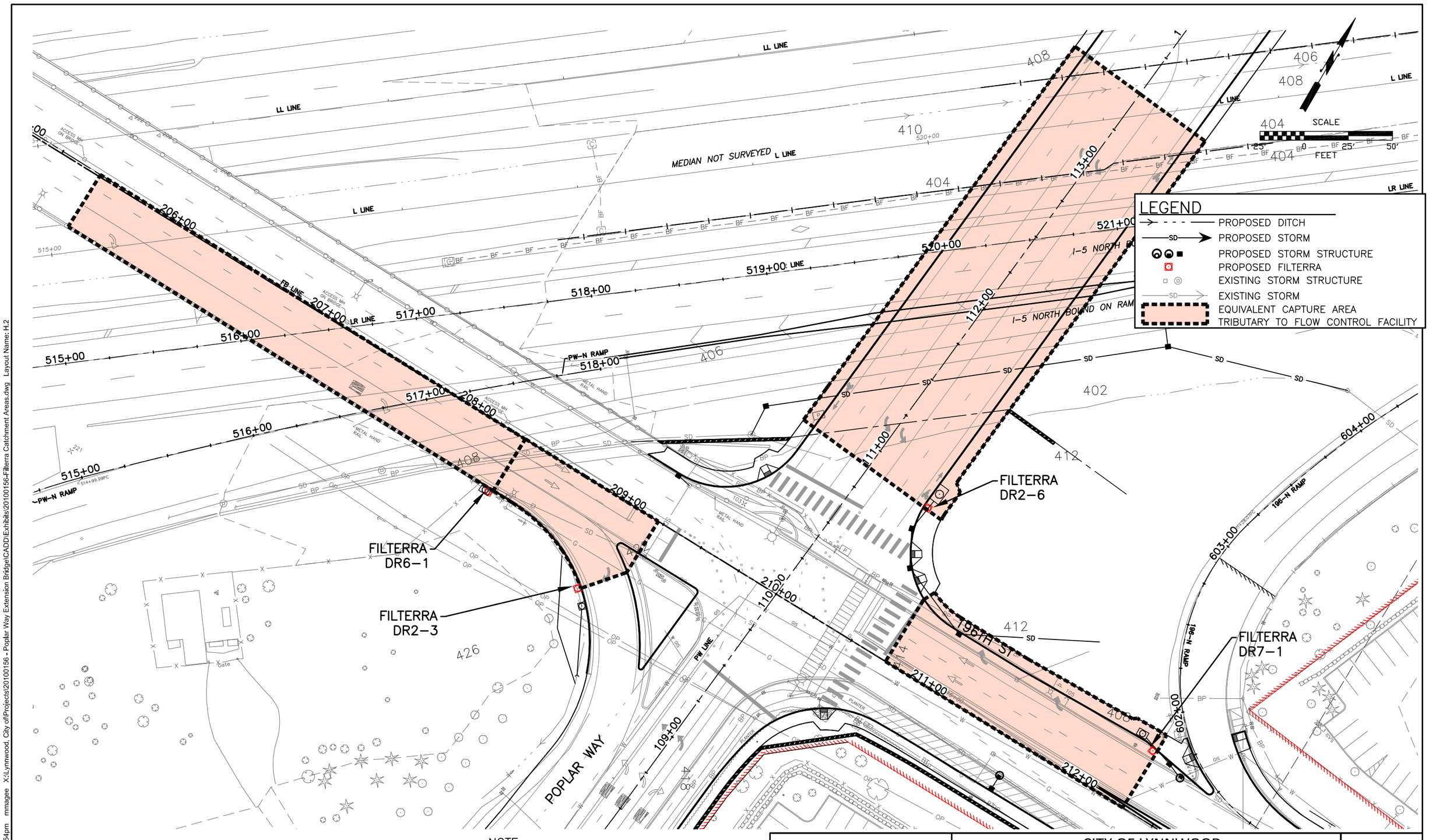
- PROPOSED DITCH
- PROPOSED STORM
- PROPOSED STORM STRUCTURE
- PROPOSED FILTERRA
- EXISTING STORM STRUCTURE
- EXISTING STORM
- EQUIVALENT CAPTURE AREA TRIBUTARY TO FLOW CONTROL FACILITY

NOTE:
THE DRAINAGE FEATURES SHOWN ON THIS MAP ARE A COMBINATION OF GIS RECORDS FROM THE CITY OF LYNNWOOD, LIMITED FIELD RECONNAISSANCE WITHIN THE RIGHT–OR–WAY, AND TOPOGRAPHIC SURVEY INFORMATION. AS SUCH, THE DRAINAGE INFORMATION SHOWN HERE ON IS APPROXIMATE AND BASED UPON BEST AVAILABLE INFORMATION.

Perteet Inc.
425-252-7700 | 1-800-615-9900
2707 Colby Avenue, Suite 900
Everett, Washington 98201

CITY OF LYNNWOOD
POPLAR WAY EXTENSION
FILTERRA CATCHMENT AREAS

FIGURE H.1



NOTE:
THE DRAINAGE FEATURES SHOWN ON THIS MAP ARE A COMBINATION OF GIS RECORDS FROM THE CITY OF LYNNWOOD, LIMITED FIELD RECONNAISSANCE WITHIN THE RIGHT-OR-WAY, AND TOPOGRAPHIC SURVEY INFORMATION. AS SUCH, THE DRAINAGE INFORMATION SHOWN HERE ON IS APPROXIMATE AND BASED UPON BEST AVAILABLE INFORMATION.

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FILTERRA CATCHMENT AREAS

FIGURE H.2