Section 4

Hydrologic Methods

Station Number	Station Name	Period of Record	Q2 (cfs)	Q10 (cfs)	Q25 (cfs)	Q50 (cfs)	Q100 (cfs)
12446500	Salmon Creek Near Conconully, Wash	1911-22	160	350	479	592	720
12447200	Okanogan River at Malott, Wash	1959-92	16,300	26,300	31,600	35,600	39,700
12447300	Okanogan River Near Malott, Wash	1958-67	16,600	24,000	27,200	29,400	31,500
12447380	Pine Creek Near Mazama, Wash	1966-88	158	294	371	431	494
12447390	Andrews Creek Near Mazama, Wash	1969-92	381	702	902	1,070	1,250
12447400	Doe Creek Near Winthrop, Wash	1957-75	24	56	75	89	104
12447430	Ortell Creek Near Winthrop, Wash	1965-75	58	90	106	117	127
12448700	Williams Creek Near Twisp, Wash	1965-75	59	86	99	108	118
12448900	Little Bridge Creek Near Twisp, Wash	1965-75	132	232	281	318	354
12449500	Methow River at Twisp, Wash	1920-29 1934-62	11,100	18,800	22,200	24,500	26,700
12449600	Beaver Creek Blw South Fork, Near Twisp, Wash	1960-79	133	374	533	665	808
12449790	Rainy Creek Near Methow, Wash	1965-75	54.6	112	148	178	211
12449950	Methow River Near Pateros, Wash	1959-92	11,900	21,100	25,900	29,600	33,300
12450500	Methow River at Pateros, Wash	1904-20 1959-74	12,200	22,300	28,300	33,100	38,200
12450700	Columbia River Below Wells Dam, Wash	1968-92	227,000	324,000	370,000	405,000	438,000
12451000	Stehekin River at Stehekin, Wash	1927-92	9,550	14,200	16,200	17,700	19,200
12451500	Railroad Creek at Lucerne, Wash	1927-57	1,280	2,190	2,720	3,150	3,600

Table 4. Regression equations for estimating flood discharges at ungaged sites in Washington

[Q, flood magnitude, in cubic feet per second; A, total drainage area, in square miles; P, mean annual precipitation, in inches; F, forest cover, in percent of contributing drainage area; a, regression constant; b, c, and d, regression coefficients; --, regression coefficient not determined; <, less than]

Region	Number of stations used in analysis	Regression equation	Exceedance probability	Constant a	Coefficients b	Coefficients c	Equivalent years of record	Standard error of prediction, percent
1	61	$Q = aA^bP^c$	0.5	0.350	0.923	1.24	1	32
			.1	.502	.921	1.26	2	33
			.04	.590	.921	1.26	3	34
			.02	.666	.921	1.26	3	36
			.01	.745	.922	1.26	4	37
2	202	$Q = aA^bP^c$	.5	.090	.877	1.51	1	56
			.1	.129	.868	1.57	1	53
			.04	.148	.864	1.59	2	53
			.02	.161	.862	1.61	2	53
			.01	.174	.861	1.62	3	54
3	63	$Q = aA^bP^c$	.5	.817	.877	1.02	1	57
			.1	.845	.875	1.14	1	55
			.04	.912	.874	1.17	2	54
			.02	.808	.872	1.23	2	54
			.01	.801	.871	1.26	3	55
4	60	$Q = aA^bP^c$	.5	.025	.880	1.70	1	82
			.1	.179	.856	1.37	1	84
			.04	.341	.850	1.26	1	87
			.02	.505	.845	1.20	2	90
			.01	.703	.842	1.15	2	92
5	19	$Q = aA^b$	.5	14.7	.815	--	1	96
			.1	35.2	.787	--	2	63
			.04	48.2	.779	--	3	56
			.02	59.1	.774	--	5	53
			.01	71.2	.769	--	6	52
6	23	$Q = aA^bP^c$	.5	2.24	.719	.833	1	63
			.1	17.8	.716	.487	2	69
			.04	38.6	.714	.359	2	72
			.02	63.6	.713	.276	3	74
			.01	100	.713	.201	3	77
7	17	$Q = aA^b$	.5	8.77	.629	--	2	128
			.1	50.9	.587	--	7	63
			.04	91.6	.574	--	12	54
			.02	131	.566	--	15	53
			.01	179	.558	--	16	56
8	23	$Q = aA^b$	0.5	12.0	0.761	--	<1	133
			.1	32.6	.706	--	1	111
			.04	46.2	.687	--	1	114
			.02	57.3	.676	--	1	119
			.01	69.4	.666	--	1	126
9	36	$Q = aA^bP^c$	.5	0.803	.672	1.16	2	80
			.1	15.4	.597	.662	6	57
			.04	41.1	.570	.508	8	55
			.02	74.7	.553	.420	10	55
			.01	126	.538	.344	12	56

Washington State Hydrology
USGS Regression Equations
Region 1

SR _____ Date _____

Project _____

Made By _____

Equations:

$Q_2 = 0.350A^{0.923}P^{1.24}$ (Standard Error : 32 %)

$Q_{10} = 0.502A^{0.921}P^{1.26}$ (Standard Error : 33 %)

$Q_{25} = 0.590A^{0.921}P^{1.26}$ (Standard Error : 34 %)

$Q_{50} = 0.666A^{0.921}P^{1.26}$ (Standard Error : 36 %)

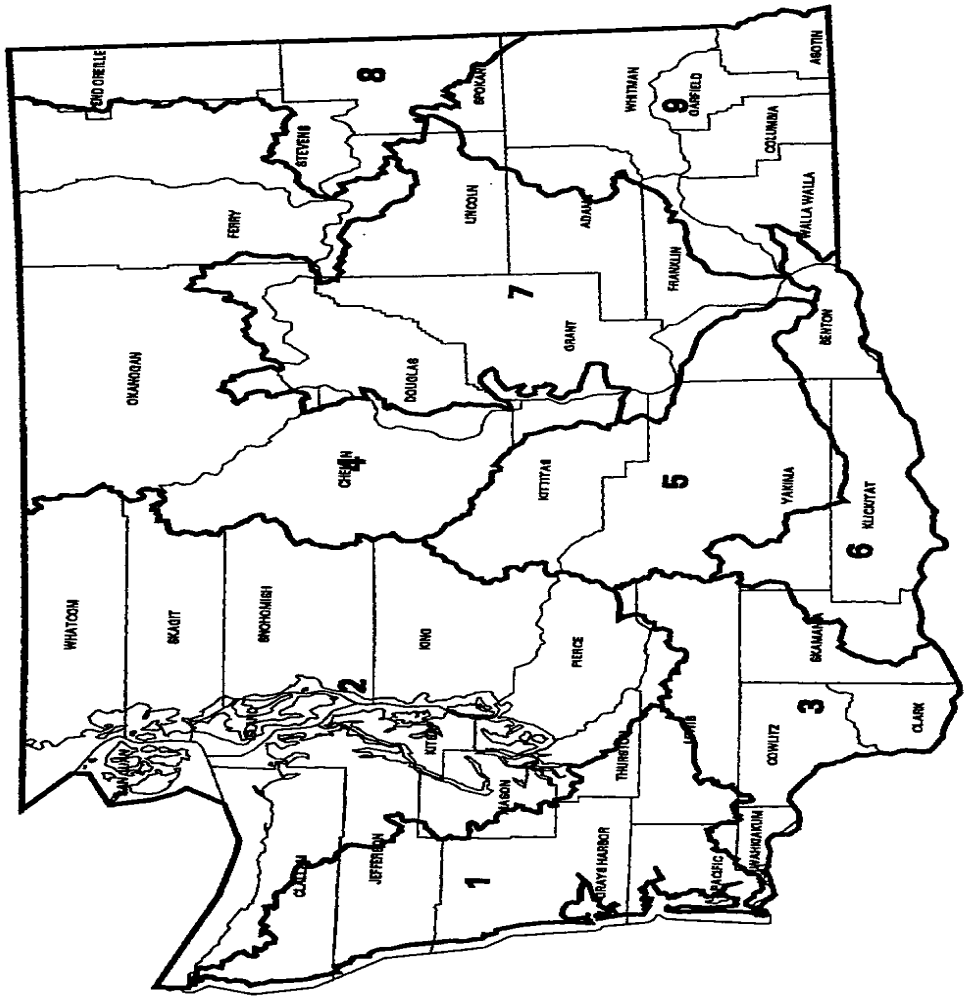
$Q_{100} = 0.745A^{0.922}P^{1.26}$ (Standard Error : 37 %)

Legend			Limits
Q	=	Flow (cfs)	
A	=	Drainage Basin Area (miles^2)	(0.15 miles^2 $\leq$ A $\leq$ 1,300 miles^2)
P2	=	2 Year, 24 Hour Precipitation (inches)	(2.5 in $\leq$ P2 $\leq$ 8.0 in)

Description of Area	Return Frequency	A	P2	Q

Figure 2-7.1
USGS Regression Equations — Region 1

4-4



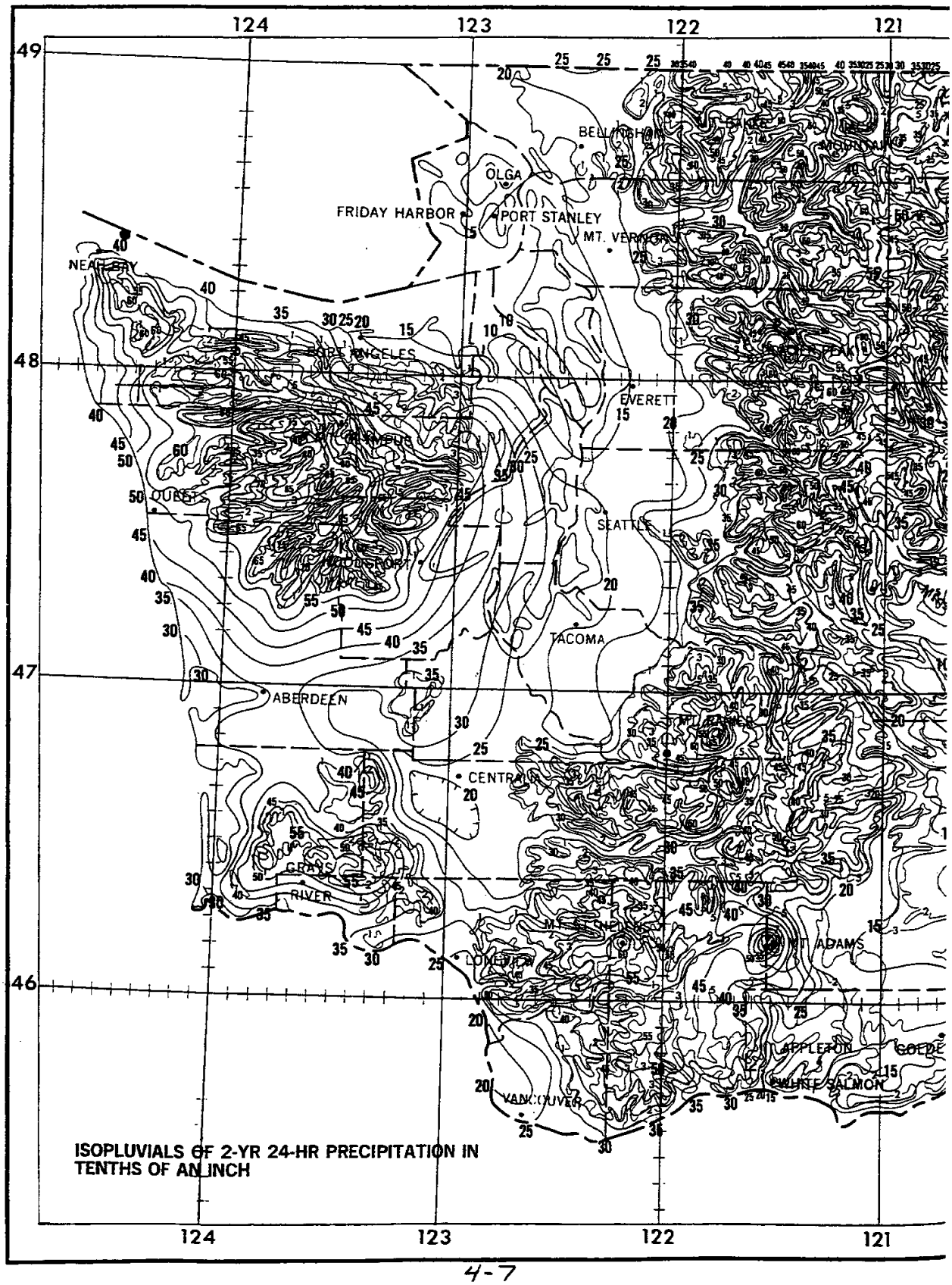
USGS Regression Equation Regions

Example: Determine the 25 year flow for a stream near Aberdeen. The total drainage area contributing is 57 mi^2.

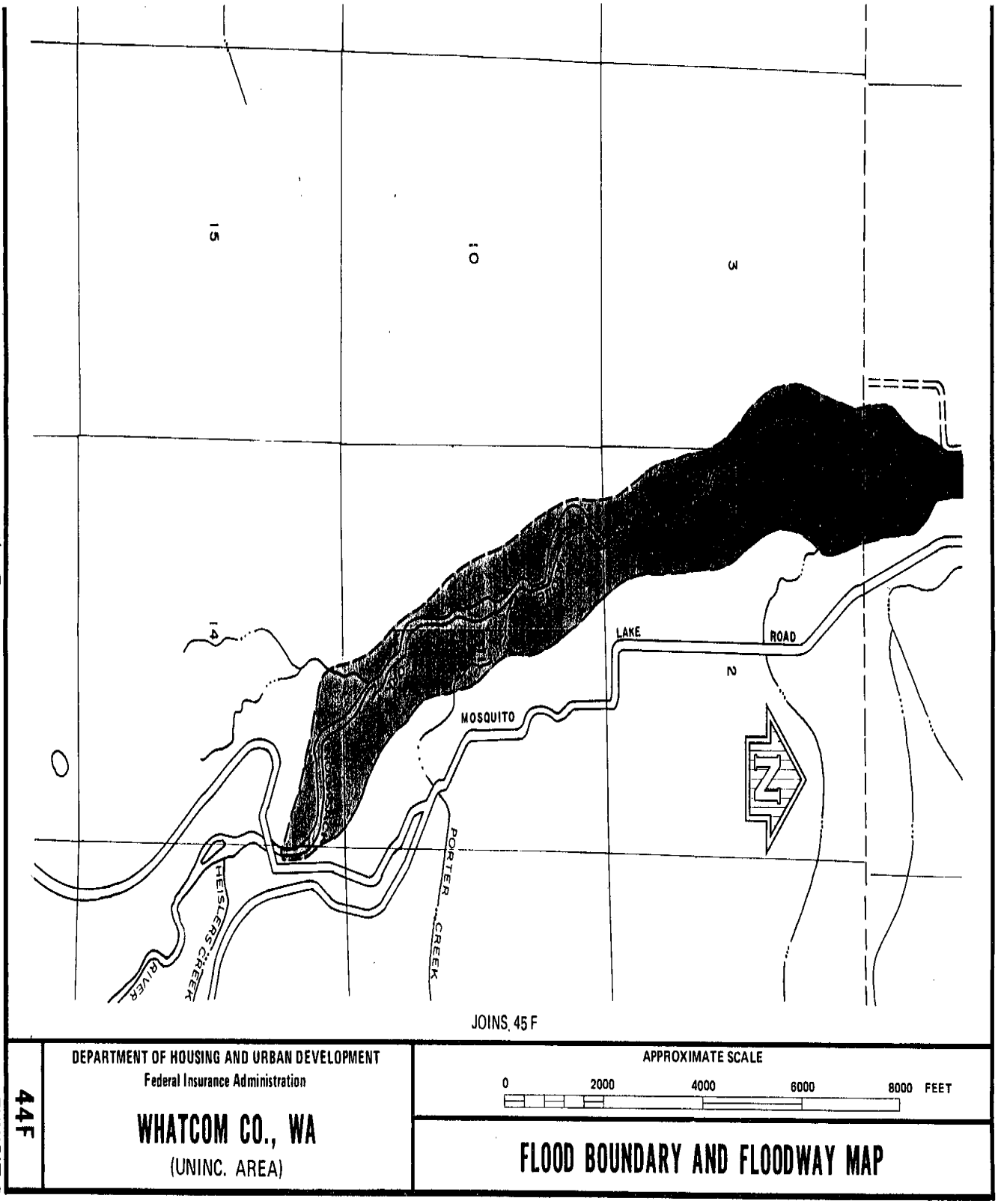
Problem: Determine the 25 year flow and 100 year flow for a stream near Chehalis. The total drainage area contributing is 113 mi^2.

Worksheet

4-6


124
123
122
121
49
48
47
46
FRIDAY HARBOR
PORT STANLEY
OLGA
MT. VERNON
NEAH BAY
PORT ANGELES
EVERETT
QUEEN
SEATTLE
TACOMA
ABERDEEN
CENTRALIA
GRAYS
RIVER
MT. ADAMS
APPLETON
WHITE SALMON
VANCOUVER
ISOPLUVIALS OF 2-YR 24-HR PRECIPITATION IN
TENTHS OF AN INCH

4-7


15
10
3
14
LAKE
ROAD
2
MOSQUITO
PORTER
CREEK
HEISLERS CREEK
RIVER
JOINS 45 F
DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
Federal Insurance Administration
WHATCOM CO., WA
(UNINC. AREA)
44F
APPROXIMATE SCALE
0
2000
4000
6000
8000 FEET
FLOOD BOUNDARY AND FLOODWAY MAP

4-8

EXHIBIT 3

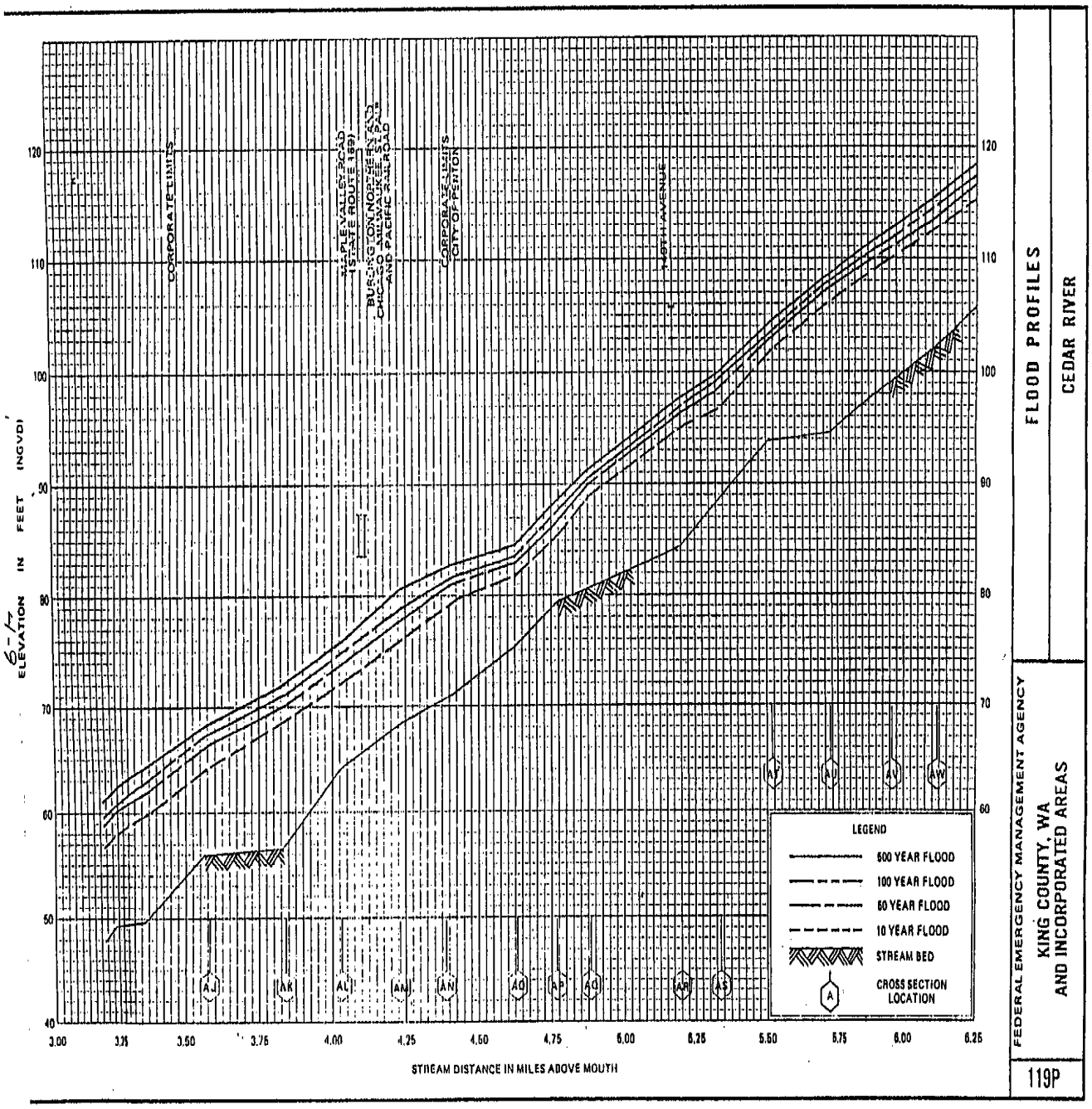

ELEVATION IN FEET (NGVD)
STREAM DISTANCE IN MILES ABOVE MOUTH
CORPORATE LIMITS
MAPLE VALLEY ROAD (STATE ROUTE 169)
BURLINGTON NORTHERN AND CHICAGO MILWAUKEE ST PAUL AND PACIFIC RAILROAD
CORPORATE LIMITS CITY OF RENTON
148TH AVENUE
LEGEND
500 YEAR FLOOD
100 YEAR FLOOD
50 YEAR FLOOD
10 YEAR FLOOD
STREAM BED
CROSS SECTION LOCATION
FLOOD PROFILES
CEDAR RIVER
FEDERAL EMERGENCY MANAGEMENT AGENCY
KING COUNTY, WA
AND INCORPORATED AREAS
119P

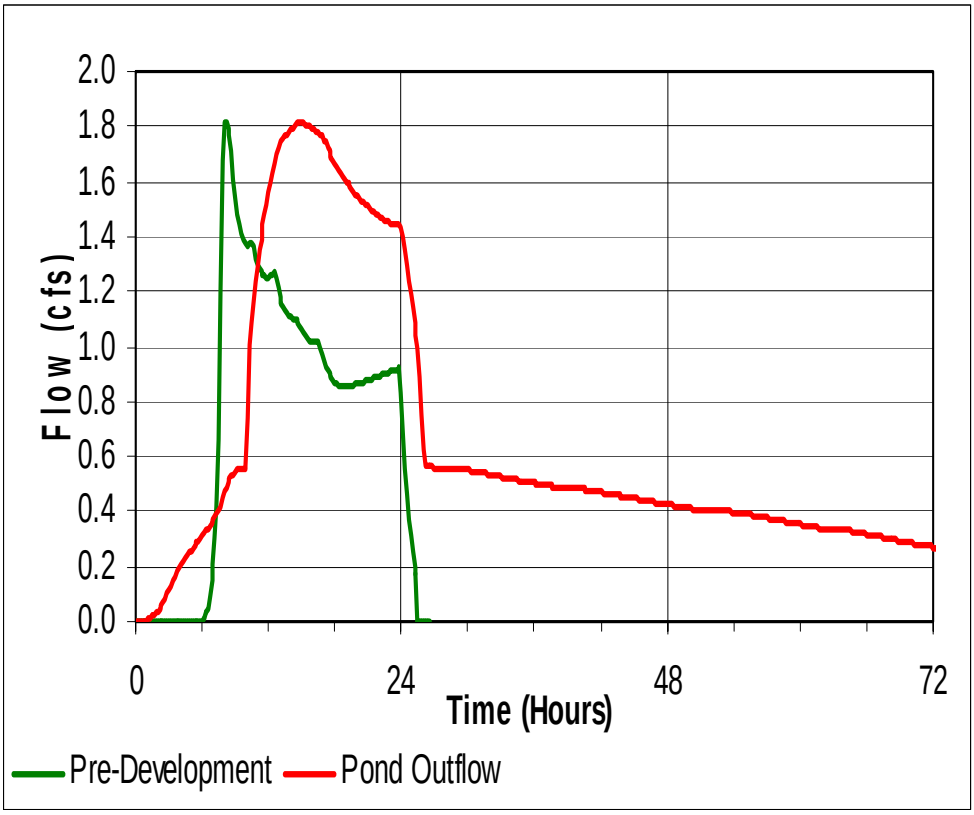
TABLE 1 - SUMMARY OF DISCHARGES (Cont'd)

Flooding Source and Location	Drainage Area (sq. miles)	Peak Discharges (cfs) 10-Year	50-Year	100-Year	500-Year
Cedar River					
At USGS gage 12-119000	186.0	5,460	7,580	8,530	10,900
Mercer Creek (Including both main and right channel)					
At mouth	17.79	490	628	686	819
At confluence with Kelsey and Richards Creeks	13.75	393	510	560	675
Richards Creek					
At mouth	3.63	122	170	191	241
At Interstate Highway 90	1.11	44	65	75	99
At S.E. Newport Way	0.80	33	50	58	78
Richards Creek West Tributary					
At mouth	0.91	37	55	64	85
Richards Creek East Tributary					
Approximately 325 feet upstream of S.E. 26th Street[1]	0.06	4	36	47	81
Kelsey Creek					
At mouth	10.10	301	398	439	536
At 140th Avenue N.E.	6.69	211	285	317	393
At Lake Hills Boulevard	2.25	84	121	138	179
West Tributary Kelsey Creek					
At mouth	1.75	64	92	104	135
At upstream confluence of East Branch	0.34	16	25	29	41
East Branch of West Tributary (Kelsey Creek)					
At mouth	0.92	37	56	64	86

[1]Includes overflow from Richards Creek for 50-, 100-, and 500-year discharges

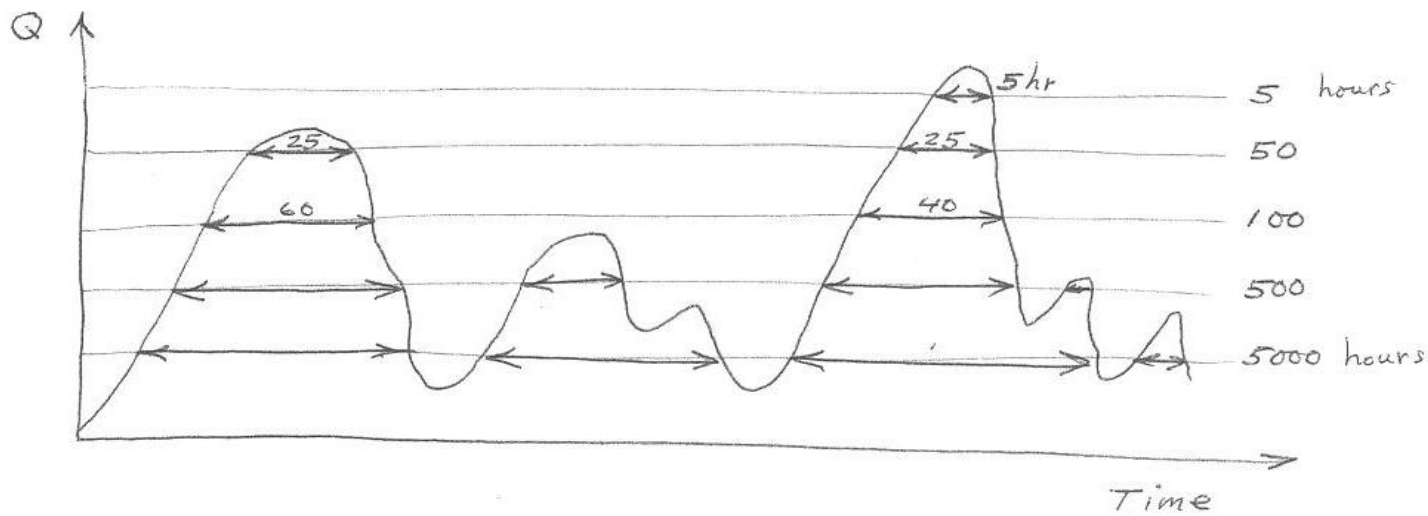
4-10

Single Event Pond Design



(Hydrographs Computed Using SBUH)

- Flood Peak is Reduced to Predeveloped Level, but higher Runoff Volume Extends Length of Flood
- Results in More Erosive Work done on Stream Channel than in Predeveloped Condition

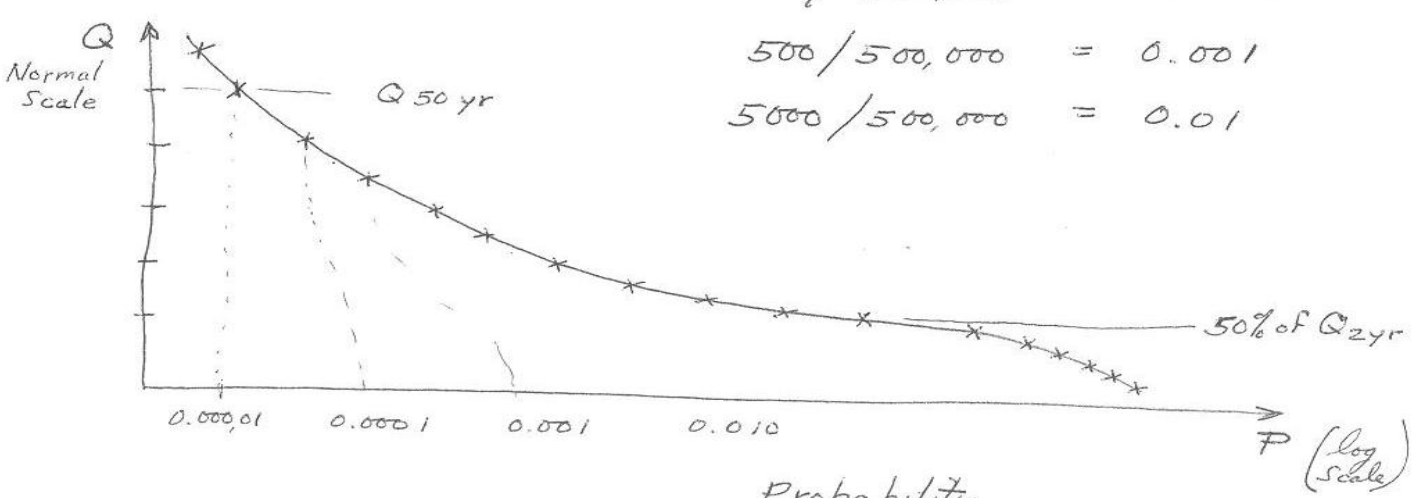


57 years of Record

$57 \times 365 \times 24 =$ ~~500,000 hours~~ $= 500{,}000$ hours

Ratio $\frac{hrs}{hrs}$		Probability
5 / 500,000	=	0.000,01
50 / 500,000	=	0.0001
100 / 500,000	=	0.0002
500 / 500,000	=	0.001
5000 / 500,000	=	0.01

30-200 cells

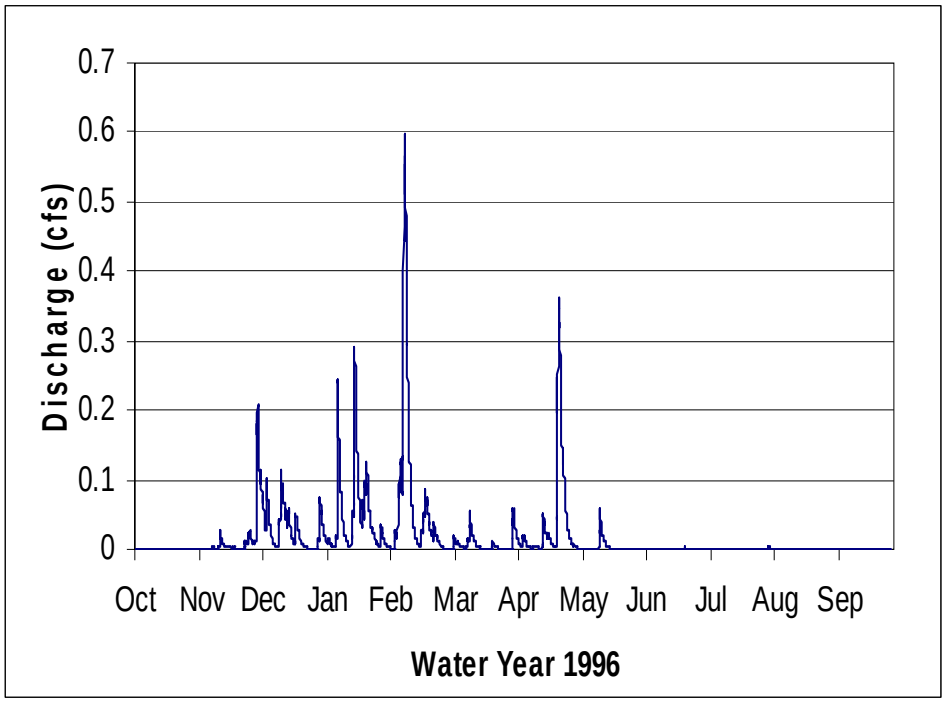


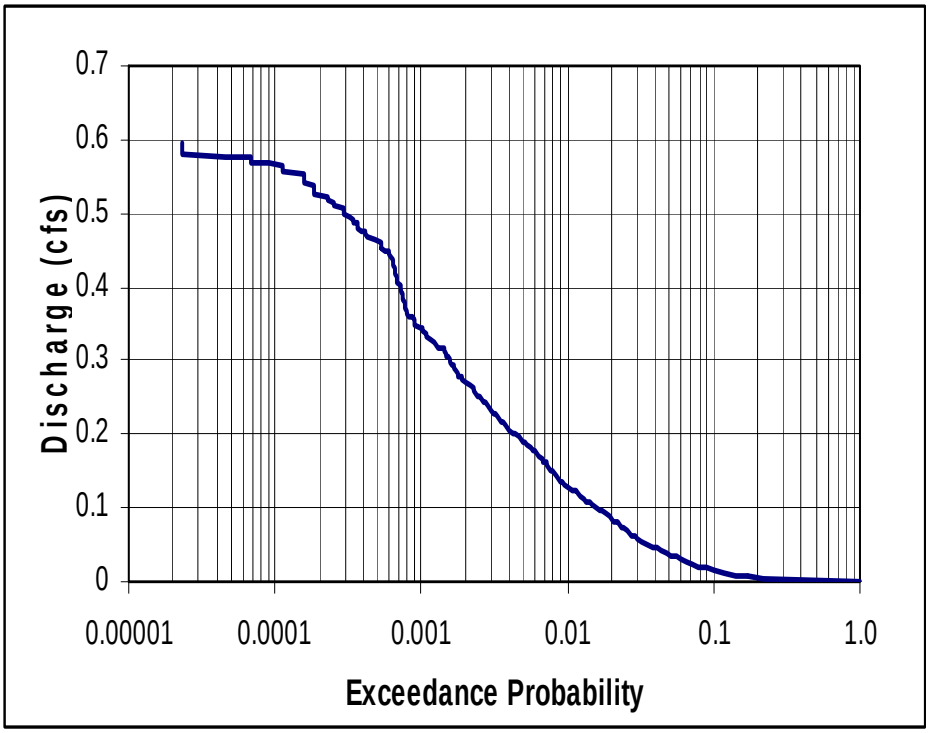
Probability

Fraction ~~(%)~~? of Time of Occurance

Flow Duration Definition:

Track the Fraction of Time that a Flow is Equaled or Exceeded





Detention Standards and the New State Requirements

	Current Practice	New Approach
Design Goal	Flood Control	Stream Channel Stability
Design Standard	Peak Flow 2-year & 10-year	Match Flow Duration
Model Type	Single Event (SCS, SBUH)	Continuous (MGSFlood, HSPF)