Attachment 7

DRIFT CREEK SITE A, NEAR SILVERTON OR

RUNOFF YIELD ANALYSIS

February 2007
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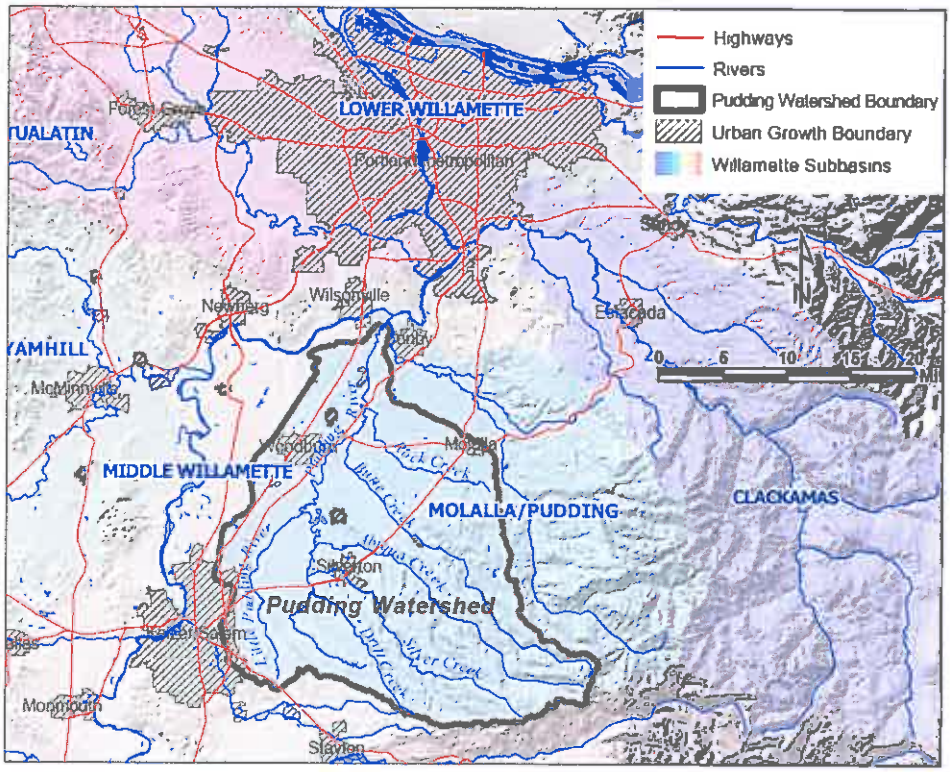

Report Prepared for

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RUNOFF YIELD ANALYSIS FOR DRIFT CREEK SITE A, NEAR SILVERTON OR

1. Introduction

A potential storage project site (Site A) has been identified on Drift Creek, a tributary of the Pudding River, about 6 miles south of Silverton. See Vicinity Map (Figure 1). The site controls a drainage area of about 15.8 square miles and could store runoff water during October through April for irrigation use during the following May through September period. The reservoir, if found feasible, would be in parts of the following sections: 7S, 1W, sec. 23, 26, 36; 8S, 1W, sec 1; and 8S, 1E, sec 6.

The analysis described in this report is to provide an estimate of the run-off volume that could be expected over the years at the project site. It starts with a review of existing hydro-meteorological records, determination of the stream(s) that best represent the precipitation and runoff characteristics of the Drift Creek's subbasin, and estimation of seasonal runoff volume based on pertinent historical data. It continues with development of rainfall-runoff model to extend the period of records and provide a longer and more representative basis for runoff volume estimates at the project site. The analysis concludes with development of frequency data that relate runoff volume to a probability of occurrence, and formulation of recommended steps to further enhance the reliability of the runoff volume estimates made.

Figure 1. Vicinity Map

2. Geographical Area

Drift Creek is a tributary of Pudding River and shares some of its runoff characteristics. See Figure 2. According to a draft report prepared in February 2005 by the Pudding River Watershed Council located in Aurora, OR "*the Pudding River, in the eastern region of the Willamette Basin, covers 531 square miles. Agriculture is the predominant land use in the drainage basin, and water from the basin is mainly used for agricultural production. There are eight major sub-basins that drain into the Pudding River. These include Silver Ck, Zollner Ck, Abiqua Ck, Butte Ck, Drift Ck, Little Pudding River, Rock Creek, and the Senecal/Mill Creek drainage area, ranging in size from the 10,043 acre Zollner Creek subbasin to the 54,764-acre Rock Creek subbasin.*" "*Elevations within the watershed range from 4,280 feet at the summit of Panther Rock in the upper end of Butte Creek to 66 feet where the river joins the Molalla River. Nearly three quarters of the watershed is within Marion County with the remainder within Clackamas County.*

The watershed's climate is characterized by cool, rainy winters, and hot, dry summers. Only 5% of the annual precipitation falls from July through September. Winter precipitation usually falls as rain in the lower elevations of the watershed while a transient snow pack can develop at higher elevations...Typical distribution of precipitation includes about 50 percent of the annual total from December through February, lesser amounts in the spring and fall, and very little during summer. Rainfall tends to vary inversely with temperatures -- the cooler months are the wettest, the warm summer months the driest".

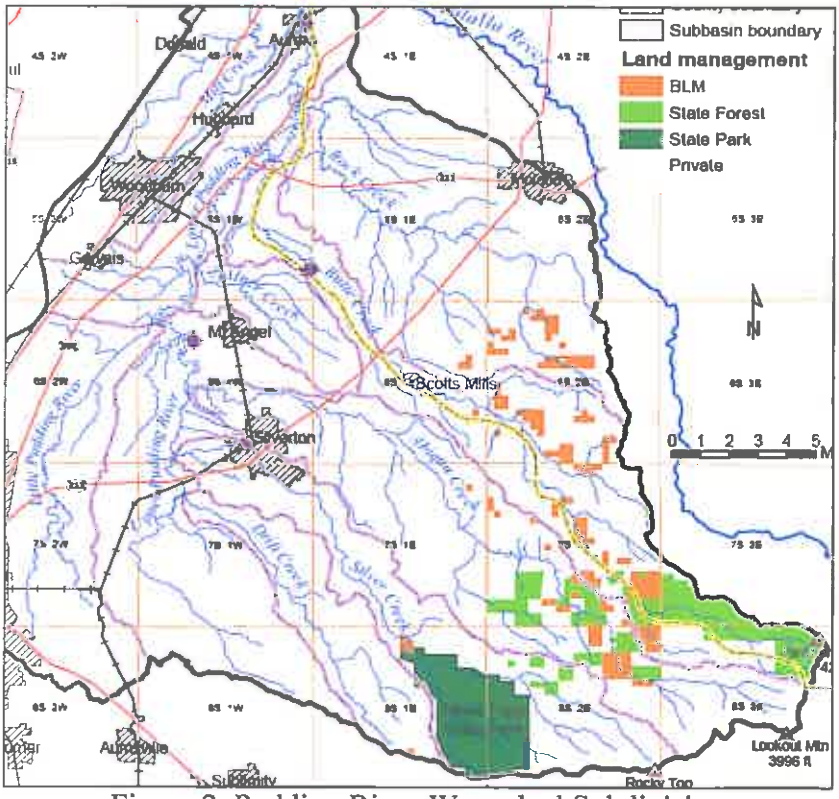


Figure 2. Pudding River Watershed Subdivision

3. Available Hydro-Meteorological Data

There are no stream flow records at the project site itself, but some gaging stations had operated or are still operating inside the Pudding River watershed. Table 1 contains the list of stream gages, the drainage areas controlled by those gages, and the period of records.

Agency	Site Number	Site Name, Drainage Area, Record Period
USGS	14200300	Silver Creek At Silverton, OR F=47.9 sq. mi. (1963-1969 and 1970-1979)
USGS	14200400	Little Abiqua Creek Near Scotts Mills, OR F=9.81 sq. mi. (1993-2004)
USGS	14201000	Pudding River Near Mt. Angel, OR F=203 sq. mi. (1939-1966)
USGS	14201300	Zollner Creek Near Mt. Angel, OR F=15.0 sq. mi. (1993-2005)
USGS	14201340	Pudding River Near Woodburn, OR F=314 sq. mi. (1997-2005)
USGS	14202000	Pudding River Near Aurora, OR F=479 sq. mi., (1928-1963 and 1993-2005)

Table 1. Stream Gages, Drainage Areas and Period of Records

For air temperature and precipitation (rainfall and snow), the Salem WSO Station near the airport has daily data stretching from 1928 to present (78 years). Climate Tables 2-a, 2-b, 2-c, 2-d and 2-e refer to data that are posted by Western Regional Climate Center, wrcc@dri.edu at the following website:

http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?or7500

During that period of records, the October-April snow precipitations in excess of 10 inches (snowy conditions) are somewhat infrequent. They occurred in the following 15 years: 1928, 1929, 1936, 1942, 1949, 1955, 1956, 1959, 1961, 1967, 1968, 1970, 1972, 1985 and 1992.

The Salem WSO Station recorded October-April rainfall amounts in excess of 40 inches (average years) in 1931, 1932, 1937, 1942, 1947, 1950, 1955, 1960, 1970, 1973, 1981, 1982, 1994, 1995, 1996, 1998 and 2005. The same station recorded October-April rainfall amounts less than 20 inches (very dry years) in 1976 (11.57"), 2000 (16.89"), and 2004 (18.22").

Salem WSO Airport	7500	5.8	5.1	4.2	2.8	2.1	1.5	0.6	0.7	1.4	3	6.39	6.46	40
Silver Creek Falls	7809	9.9	9.4	8.8	7	5	3.5	1.3	1.3	2.8	5.4	11.3	10.6	76.1
Silverton	7823	6.5	5.6	5	3.8	3	2.1	0.9	1	1.9	3.6	7.16	7.07	47.5

Table 2-a. Precipitation, Monthly and Annual Averages (1971-2000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
>.01"	17	16	17	14	11	8	3	4	7	11	18	18	144
>.10"	12	12	11	8	6	4	2	2	4	7	13	13	92.9
>.50"	4	3	2	1	1	1	0	0	1	2	4	5	24.7
>1.00"	1	1	0	0	0	0	0	0	0	0	1	2	6.1

Table 2-b. Average number of Days with Selected Precipitation Amounts
Salem WSO Airport, 1971-2000

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean max	47.0	51.2	56.3	61.1	67.5	74.0	81.5	81.9	76.6	64.5	52.4	46.4	63.4
Mean min	33.5	34.7	36.6	38.8	43.6	48.4	52.0	52.1	47.7	41.3	37.9	33.9	41.7
Mean temp	40.3	43.0	46.5	50.0	55.6	61.2	66.8	67.0	62.2	52.9	45.2	40.2	52.6
Extreme max	65	71	77	85	100	105	103	108	104	92	71	68	108
Extreme min	6	-1	12	26	28	32	38	36	26	23	11	-12	-12
Mean number of days													
Max >90	0	0	0	0	0.4	1.5	5.9	5.8	2.5	0.1	0	0	16.0
Min >32	13.4	10.5	8.1	4.4	0.6	0	0	0	0.1	2.4	7.3	13.0	59.9
Max <32	0.8	0.2	0	0	0	0	0	0	0	0	0.2	1.1	2.3
Min <0	0	0	0	0	0	0	0	0	0	0	0	0.2	0.2

Table 2-c. Monthly and Annual Average Temperatures (deg F)
Salem WSO Airport (1862), 1971-2000

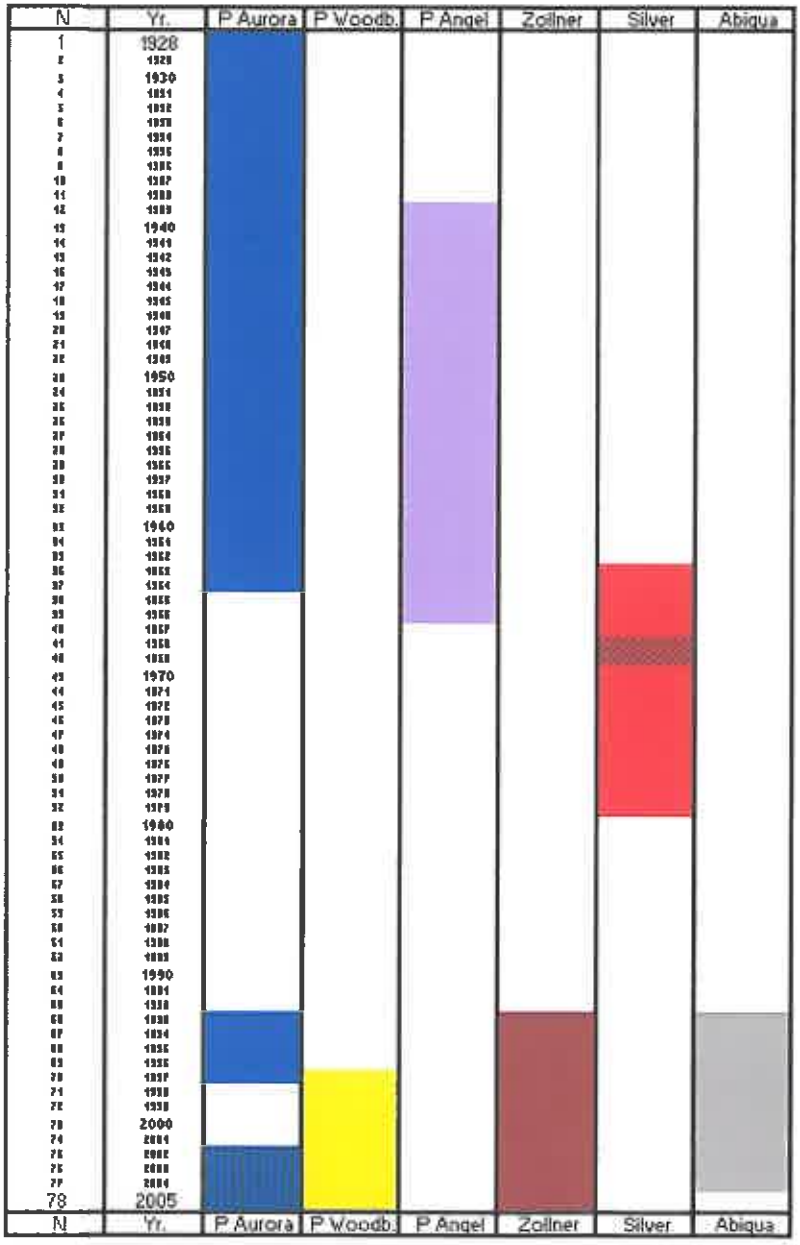
Name	Number	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Salem WSO Airport	7500	1.3	2.1	0.1	0	0	0	0	0	0	0	0.4	2.0	6.0
Silver Creek Falls	7809	3.0	3.4	1.7	0.4	0	0	0	0	0	0	1.3	2.2	14.3
Silverton	7823	1.0	1.3	0	0	0	0	0	0	0	0	0.3	1.3	3.2

Table 2-d. Snowfall, Monthly and Annual Averages (1971-2000)

Name	Number	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Salem WSO Airport	7500	769	623	576	451	301	140	39	35	116	376	596	771	4790
Silver Creek Falls	7809	844	711	700	564	410	244	121	124	218	480	702	863	5997
Silverton	7823	780	623	566	441	292	150	50	42	117	356	594	787	4795

Table 2-e. Monthly and Annual Average Heating Degree Days (base 65°F), 1971-2000

The longest stream gage records belong to Pudding River at Aurora with a combined total of 49 years of data, followed by Pudding River near Mt. Angel (28 years), Silver Creek at Silverton (16 years), Zollner Creek near Mt. Angel (13 years), Little Abiqua Creek near Scotts Mills (12 years), and Pudding River near Woodburn (9 years). Some of the periods of records overlap, but no stream gage has records that span the entire 1928-2005 period. See Table 3.



Note: (1) Pudding R. at Aurora; (2) Pudding R. nr. Woodburn; (3) Pudding R. nr. Mt. Angel; (4) Zollner Cr. Nr. Mt. Angel; (5) Silver Cr. At Silverton; (6) Little Abiqua Cr. Nr. Scotts Mills.

Table 3. Streamflow Records Lengths

Figure 3 shows a map of normal annual precipitation over the Pudding River basin as excerpted from a U.S. Corps of Engineers report entitled, "Procedure for Determination of Maximum Annual Flood Peak and Volume Frequencies for Portland District" dated February 1969. Based on that map, Salem receives about 40 inches of rain per year, which is confirmed by the 1971-2000 average precipitation data listed in Table 2-a. Also, areal distribution of precipitation generally follows the elevations differences as one moves from the headwater to the confluence of the Pudding River with the Willamette River.

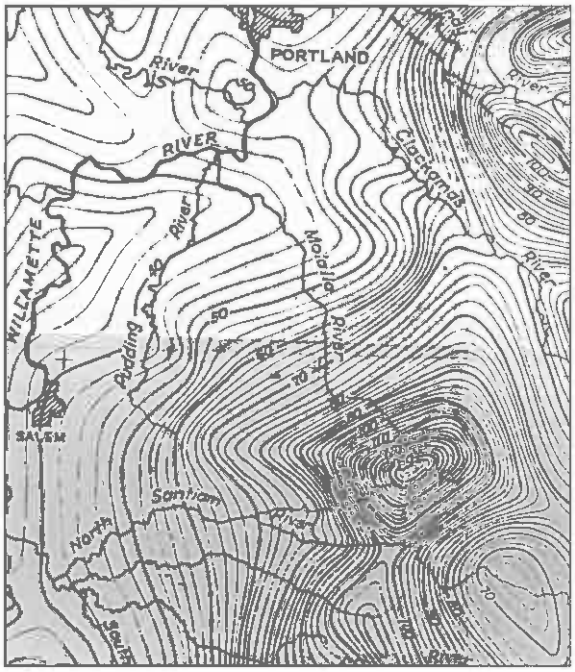


Figure 3. Normal Annual Precipitation

Table 4 contains the monthly averages of the historical streamflows recorded at the various gaging stations as posted on various Internet websites. Monthly values for each year of record are provided in the Appendix. Those data refer to the different record periods listed.

Sta.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
(1)	526	336	324	226	136	64	25	17	31	46	274	498
(2)	78	76	59	40	28	15	5.8	3.5	4	12	44	80
(3)	55	49	33	14	7.1	3	0.79	0.44	0.81	6.4	36	61
(4)	1,560	1,470	1,140	845	539	237	76	31	44	246	915	1,430
(5)	1,800	1,640	1,360	896	614	310	81	33	48	172	667	1,670
(6)	2,710	2,700	2,100	1,570	889	420	150	68	90	341	1,410	2,430

Stations:
(1): Silver Cr; 1963-68 and 1970-79;
(2): L. Abiqua nr Scotts Mills; 1993-2004
(3): Zollner nr. Mt Angel; 1993-2005

(4): Pudding nr. Mt Angel;1939-66
(5): Pudding nr. Woodburn; 1997-2005
(6): Pudding at Aurora 1928-63; and 1993-2005

Table 4. Historical Monthly Average Streamflows

4. October-April Runoff Volume Estimates Based on Existing Data

Since Drift Creek is ungaged, any runoff estimate for that stream can only be done through correlation with runoff data from other streams, preferably those that are part of the same watershed and thus have comparable runoff characteristics and are subject to the same type of hydro-meteorological conditions. Streams listed earlier in Table 1 meet those general criteria, although they do have different drainage sizes and receive different amounts of precipitation that need to be accounted for through appropriate adjustments.

Based on existing information alone, adjusted for differences in drainage area and normal annual precipitation distribution, the estimates of the October-April runoff expected at the project site A are listed in Table 5. October-April runoff values in Column (6) are total runoff volumes in acre-feet, and those in Column (7) are average discharges in cubic feet per second.

Stream	(2)	(3)	(4)	(5)	(6)	(7)
	Drainage Area (sq.mi.)	Normal Annual Precip. (inch)	Adjust. Factor	Oct-Apr Runoff (aft)	**Site A Oct-Apr Runoff (aft)**	**Site A Oct-Apr Runoff (cfs)**
Silver Cr; 1963-68 and 1970-79	47.9	73	0.294	133,951	**39,343**	**93.6**
L. Abiqua nr. Scotts Mills; 1993-2004	9.81	85	1.232	23,292	28,688	68.2
Zollner nr. Mt Angel; 1993-2005	15	42	1.630	15,280	24,909	59.3
Pudding nr. Mt Angel;1939-66	203	60	0.084	454,188	**38,296**	**91.1**
Pudding nr. Woodburn; 1997-2005	314	56	0.058	491,004	28,677	68.2
Pudding at Aurora 1928-63; 1993-2005	479	55	0.039	793,688	**30,940**	**73.6**
Drift Creek near Silverton (Site A)	15.8	65	1.000	--	--	--
Average					31,809	75.7

Table 5. Expected Average Oct-Apr Runoff at Project Site A
(based on available historical data)

The October-April runoff estimates for project Site A shown in Column (6) range from about 24,900 to 39,300 acre-feet, depending on which streams are used as the basis for the estimates, which in turn also reflects the period of records. Column (7) provides the same seasonal runoff volume through conversion of acre-feet units into cubic-feet per second units. The unit conversion is based on the following:

One acre = 43,560 square feet
One acre-foot is 43,560 square feet x 1 foot=43,560 cubic feet
One cubic foot per day= 1 (cubic foot) x 24 (hours) *3600 (seconds/hour) = 86,400 cubic feet= 86,400 cubic-feet / 43,560 acre-foot/cubic feet=1.983 acre-feet

Of the three creeks listed (Silver Creek, Little Abiqua and Zollner), Silver Creek is the stream physically the closest to Drift Creek. Except for the difference in drainage area, these two streams are roughly shaped the same way, most likely share the same runoff characteristics, and receive comparable rainfall distribution and amounts. The upper part of Silver Creek basin lies at higher elevations than Drift Creek basin and may experience more snow accumulation, but not by much. Therefore, the estimated average October-April runoff volume of 39,300 acre-feet derived from Silver Creek data for Site A appears to be the most reliable of the top three estimates shown in Table 5.

With regard to the Pudding River itself, runoff measured at the gage near Mt. Angel should be the most reliable source of information for Drift Creek. Because of their close proximity, runoff data recorded at that site is expected to reflect the contribution from Drift Creek in a more pronounced fashion than those recorded at gages located further downstream, such as Woodburn and Aurora. At Mt. Angel, Drift Creek basin represents 11 percent of the Pudding River watershed. The percentage drops to 7 percent at Woodburn, and to 4.6 percent at Aurora. On that basis, the October-April runoff volume of 38,300 acre-feet estimated for Site A appears to be a more reliable number than those derived from Woodburn or Aurora gages.

Note that the above 38,300 acre-feet estimate derived from Pudding River data at Mt. Angel is very close to the 39,300 acre-feet derived from Silver Creek data.

But Aurora has the longest period of record and thus also deserves to be looked at as a long-term index.

5. Complementary Analysis

The two runoff volume estimates mentioned in the previous section refer to specific time periods --1963-68 and 1970-79 for Silver Creek, and 1939-66 for Pudding nr. Mt Angel. They represent only a small portion of the maximum possible total of a 78 year period starting in 1928. Complementary analysis is needed to:

(1) Increase their reliability by extending the period of records to cover a reasonably representative cycle of drought, flood, and average runoff conditions, and
(2) Develop a frequency of occurrence curve for various runoff volumes.

The normal process involves development of a rainfall/snow/runoff model and extrapolation of the runoff data of the shorter stream flow records using the longer precipitation records. Given the fact that the main objective of the study is related to cumulative runoff volume over a seven-month period, a seasonal multi-month time step model (as opposed to a more detailed daily or monthly time step model) is deemed adequate.

The steps involved in the analysis include the following:

Step 1. Develop a seasonal October-April rainfall-runoff model using rainfall, snow, and air temperature recorded at Salem as initial independent parameters. Parameters or combinations of parameters that yield the highest correlation coefficient will be retained. Based on the discussions outlined earlier, seasonal regression models are developed for Silver Creek at Silverton, Pudding near Mt. Angel, and Pudding River at Aurora using a neural network procedure.

Step 2. Use the calibrated seasonal models to synthetically extend the recorded data at the three gage locations, based on relevant historical data recorded at Salem. Following appropriate adjustment to account for differences in drainage areas and precipitation intensity and distribution, a 78 year series of sequential seasonal runoff volumes is developed for Drift Creek at Site A for the entire 1928-2005 period. Examination of the runoff pattern and the long-term averages is used to finalize the runoff estimates at that site, including the maximum, minimum, and average values of the seasonal runoff volume.

Step 3. Develop a flow frequency the expected May-September runoff volume frequency curve for Site A. This will show how often one can expected to see a seasonal October-April runoff volume equal to or greater than 10,000 acre-feet of runoff at Site A.

Model Calibration Results.

Table 6 provides the value of the correlation coefficient between computed and observed runoff volume at the various gage sites and using a combination of rain, snow, and air temperature as independent parameters.

Gage Site	Parameter 1	Parameter 2	Parameter 3	Correlation Coefficient	Comments
Silver Creek at Silverton	Rain	Snow	Air temperature	0.9479	
Ditto	Rain	Snow		0.9754	Best
Ditto	Rain			0.9260	
Pudding R nr. Mt Angel	Rain	Snow	Air Temperature	0.9337	Best
Ditto	Rain	Snow		0.9337	
Ditto	Rain			0.9131	
Pudding R. At Aurora	Rain	Snow	Air Temperature	0.9037	
Ditto	Rain	Snow		0.9097	Best
Ditto	Rain			0.8972	

Table 6. Correlation Coefficients from Model Calibration

Figures 4, 5 and 6 provide a graphical representation of the model calibration results based on plots of actual versus calculated October-April runoff volume at the three gage sites. Note that the values of the correlation coefficient shown on the plots are not exactly the same as those shown on Table 6 because the equations used for the regression

curves are expression as second degree polynomial (not as sophisticated as the multi-step regression equations developed by the neural network technique).

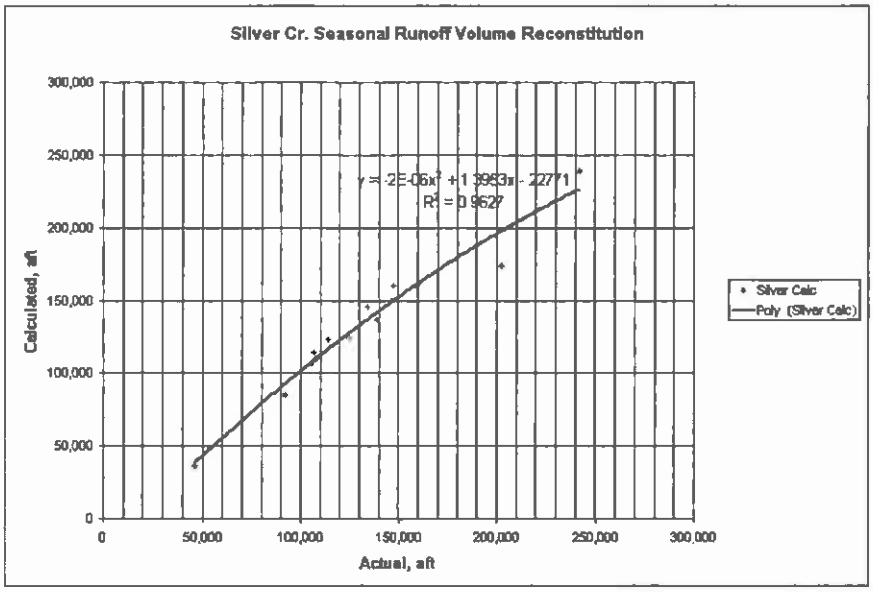


Figure 4. Silver Creek at Silverton. Actual vs. Calculated Seasonal Runoff Volume

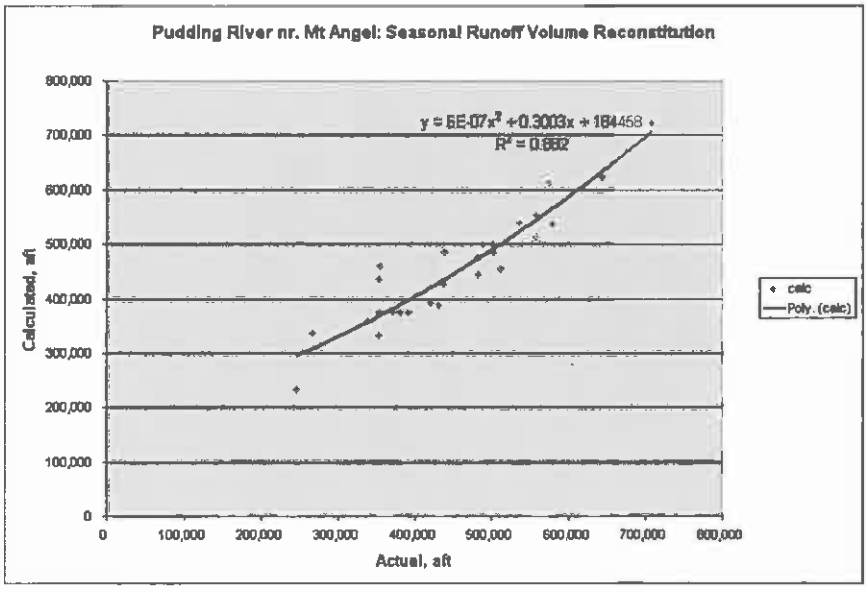


Figure 5. Pudding River nr. Mt. Angel. Actual vs. Calculated Seasonal Runoff Volume

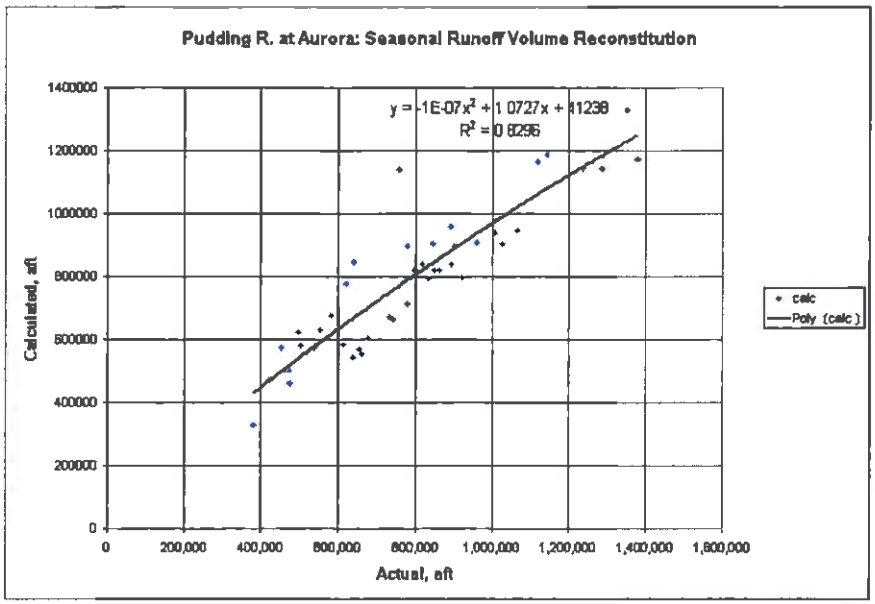


Figure 6. Pudding R. at Aurora: Actual vs. Calculated Seasonal Runoff Volume

Figure 7 shows a plot of the calculated and actual seasonal runoff volume versus time, a time-sequenced chronological plot of the October-April runoff volume for each of the 1928-2005 periods for the Pudding River at Aurora. The yellow and the black curves represent the observed and calculated runoff volumes respectively.

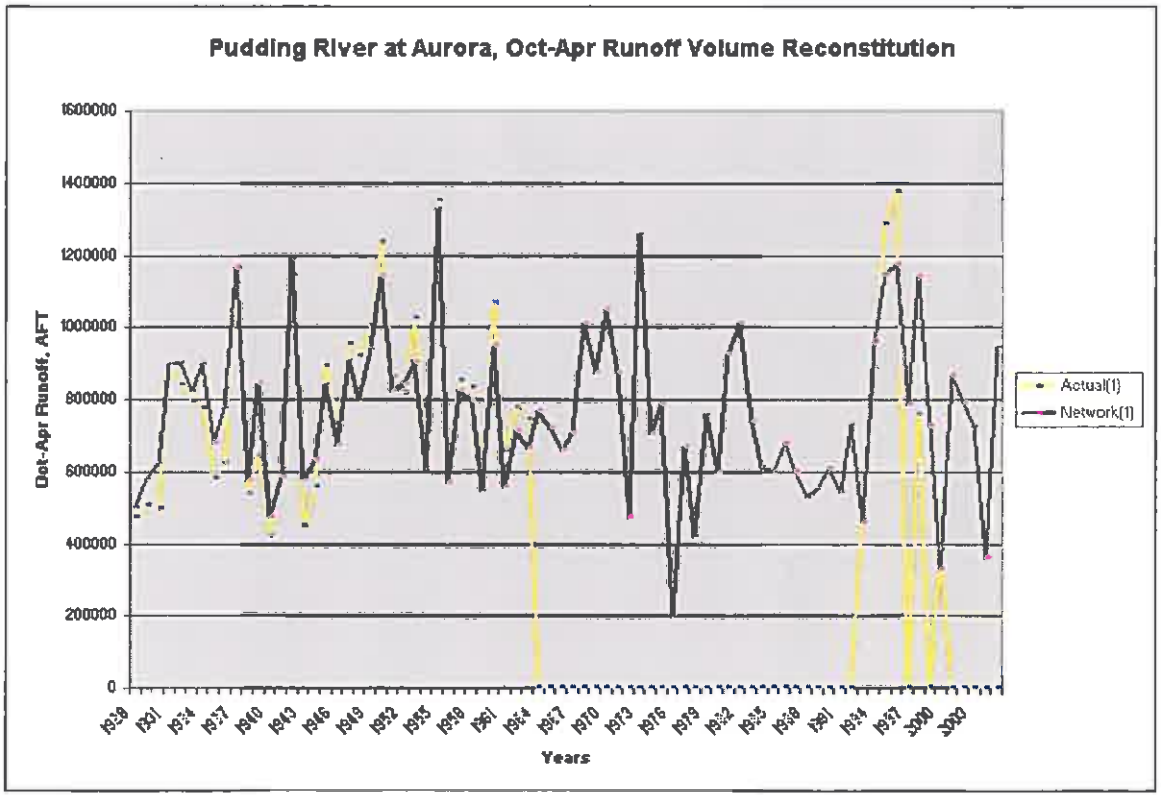


Figure 7. Hydrograph of Calculated and Actual October-April seasonal runoff volume for the Pudding River at Aurora.

In summary, the calculated average October-April runoff volumes at Site A for the period 1928-2005 are listed in Table 7, along with the equivalent actual averages derived from a shorter historical period of streamflow records.

Reference Gage Sites	**Calculated Oct.-Apr. average runoff volumes for the 1928-2005 period,** in aft (with max. and min)	**Actual Historical Oct.-Apr. average runoff volumes ,** in aft (shorter period of records)
Silver Creek at Silverton	76,600 (max 510,900 in 1968; min 15,200 in 1976)	55,700 (max 101,100 in 1973; min 19,300 in 1976)
Pudding R. nr Mt Angel	53,500 (max 86,700 in 1955; min 13,000 in 1976)	54,500 (max 84,900 in 1955; min 29,400 in 1940)
Pudding R. at Aurora	42,500 (max 74,400 in 1955, min 11,100 in 1976)	44,400 (1928-63 and 1993-2005) max=77,100 in 1955; min=21,400 in 2000
Drift Cr. Site A	57,500 (average of the above 3 averages)	54,900

Table 7. Seasonal Runoff Volume Average, Maximum, and Minimum

6. Seasonal Runoff Volume Sequence

The seasonal runoff volume sequence for Drift Creek Site A are based on the estimated 1928-2005 average of 57,500 acre-feet. See Table 8 and Figure 8. This average could be as high as 76,600 acre-feet (133%) and as low as 42,500 acre-feet (74%).

Year	Drift Site A	Year	Drift Site A	Year	Drift Site A
1928	37,906	1961	42,081	1994	72,594
1929	44,015	1962	54,001	1995	86,680
1930	47,192	1963	50,341	1996	89,055
1931	68,180	1964	58,107	1997	59,698
1932	68,519	1965	54,665	1998	86,330
1933	62,221	1966	49,807	1999	55,056
1934	67,952	1967	53,696	2000	24,796
1935	51,276	1968	76,709	2001	65,720
1936	58,954	1969	66,235	2002	59,992
1937	88,397	1970	79,356	2003	54,817
1938	43,589	1971	66,185	2004	27,246
1939	63,915	1972	35,649	2005	71,743
1940	35,681	1973	95,433		
1941	44,193	1974	53,625		
1942	90,159	1975	59,615		
1943	43,472	1976	14,998		

1944	47,708	1977	50,650	aver=	57,500
1945	63,755	1978	31,732		
1946	50,942	1979	57,366		
1947	68,867	1980	45,295		
1948	60,534	1981	70,181		
1949	71,226	1982	76,697		
1950	86,521	1983	56,122		
1951	62,425	1984	46,433		
1952	63,657	1985	45,244		
1953	68,589	1986	51,410		
1954	45,753	1987	45,417		
1955	100,647	1988	40,138		
1956	43,111	1989	41,682		
1957	62,460	1990	45,961		
1958	60,285	1991	41,261		
1959	41,305	1992	55,153		
1960	71,835	1993	34,787		

Table 8. Estimated Seasonal October-April Runoff Volume at Site A

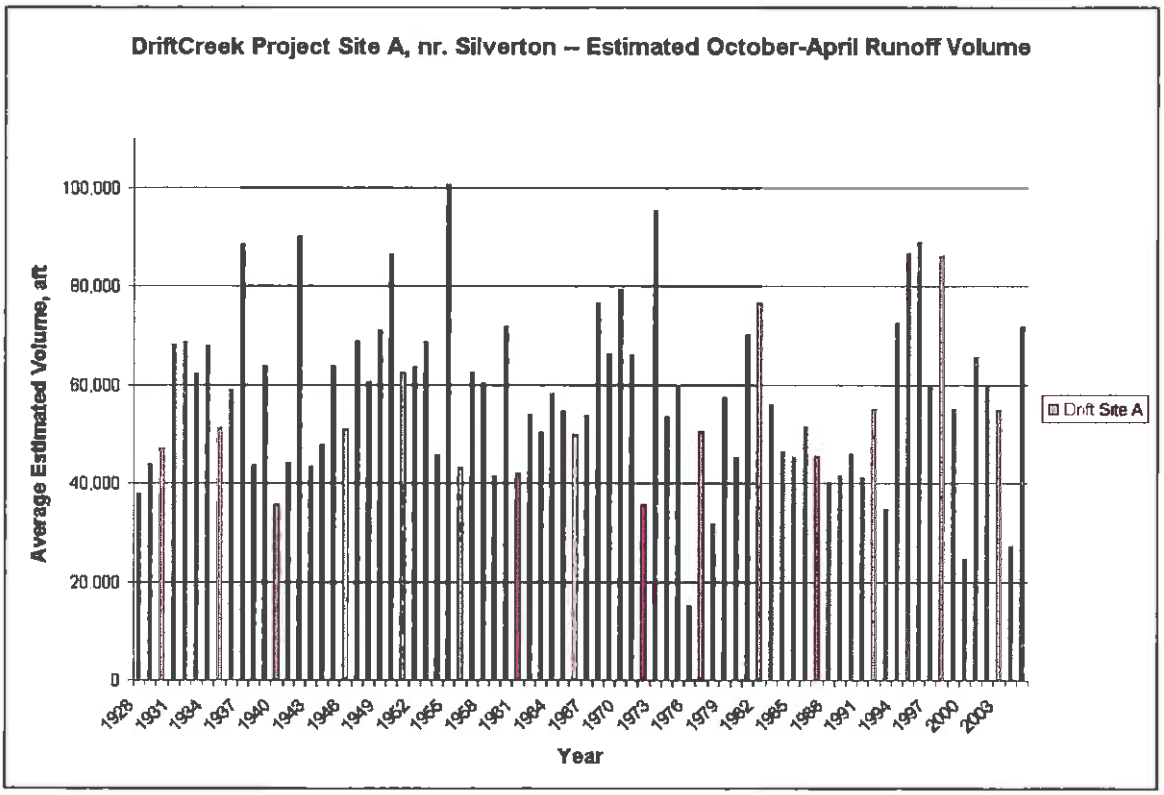


Figure 8. Hydrograph of Calculated and Actual October-April seasonal runoff volume for Drift Creek Site A.

7. Annual Array and Flow Frequency Curve

The two approaches outlined in a 1962 Corps of Engineers publication by Leo R. Beard, "Statistical Methods in Hydrology", are used in probability analysis to estimate or infer the parent population from the 1928-2005 sample data.

Annual Array by Order of Magnitude

The October-April runoff volumes are arranged in the order of magnitude to form a frequency array. Table 9 lists the runoff volumes in descending order, along with the years of occurrence. Figure 9 shows the plotted data as estimates of the parent population from which the probabilities of future events can be determined.

Magnitude Order	Oct-Apr Vol (aft)	Year		Magnitude Order	Oct-Apr Vol (aft)	Year
1	100,647	1955		40	55,153	1992
2	95,433	1973		41	55,056	1999
3	90,159	1942		42	54,817	2003
4	89,055	1996		43	54,665	1965
5	88,397	1937		44	54,001	1962
6	86,680	1995		45	53,696	1967
7	86,521	1950		46	53,625	1974
8	86,330	1998		47	51,410	1986
9	79,356	1970		48	51,276	1935
10	76,709	1968		49	50,942	1946
11	76,697	1982		50	50,650	1977
12	72,594	1994		51	50,341	1963
13	71,835	1960		52	49,807	1966
14	71,743	2005		53	47,708	1944
15	71,226	1949		54	47,192	1930
16	70,181	1981		55	46,433	1984
17	68,867	1947		56	45,961	1990
18	68,589	1953		57	45,753	1954
19	68,519	1932		58	45,417	1987
20	68,180	1931		59	45,295	1980
21	67,952	1934		60	45,244	1985
22	66,235	1969		61	44,193	1941
23	66,185	1971		62	44,015	1929
24	65,720	2001		63	43,589	1938
25	63,915	1939		64	43,472	1943
26	63,755	1945		65	43,111	1956
27	63,657	1952		66	42,081	1961
28	62,460	1957		67	41,682	1989
29	62,425	1951		68	41,305	1959
30	62,221	1933		69	41,261	1991
31	60,534	1948		70	40,138	1988
32	60,285	1958		71	37,906	1928
33	59,992	2002		72	35,681	1940

34	59,698	1997	73	35,649	1972
35	59,615	1975	74	34,787	1993
36	58,954	1936	75	31,732	1978
37	58,107	1964	76	27,246	2004
38	57,366	1979	77	24,796	2000
39	56,122	1983	78	14,998	1976

Table 9. October-April Runoff Volumes Arranged by Order of Magnitude

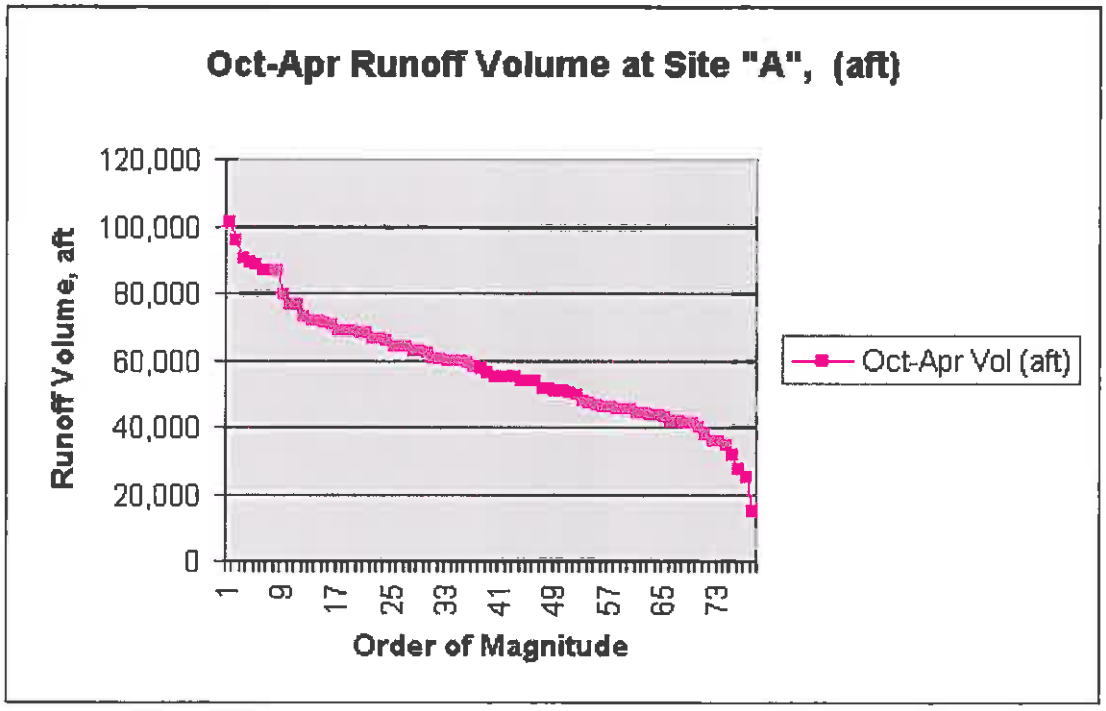


Figure 9. October-April Runoff Volume Frequency Array, Site "A"

Flow Frequency Using Statistics

Calculation of a flow frequency curve that relates the magnitude of an event to the frequency with which that magnitude is exceeded as events occur at random is based on data general statistics. These include the average magnitude of the flows, the variability from that average, and other pertinent statistics relating frequency to magnitude as indicated by the data. The October-April runoff volume is treated as a random annual event. For example, if 25 October-April runoff volumes at Site A exceed 10,000 acre-feet in 100 years, on the average, then the value of 10,000 acre-feet on the frequency curve will correspond to an exceedence probability of 0.25 in any 1 year or an exceedence frequency of 25 times per 100 years, or simply 25 percent. Details of the statistical calculation are shown in Table 10, and the resulting frequency curve is shown in Figure 10.

Year	Oct-Apr Runoff	Log(X)	X^2	(4) Dev x	(5) x^2
1928	37,906	4.5787	20.9646	0.1605	0.0258
1929	44,015	4.6436	21.5630	0.0956	0.0091
1930	47,192	4.6739	21.8450	0.0654	0.0043
1931	68,180	4.8337	23.3642	-0.0944	0.0089
1932	68,519	4.8358	23.3851	-0.0966	0.0093
1933	62,221	4.7939	22.9818	-0.0547	0.0030
1934	67,952	4.8322	23.3502	-0.0930	0.0086
1935	51,276	4.7099	22.1833	0.0293	0.0009
1936	58,954	4.7705	22.7578	-0.0313	0.0010
1937	88,397	4.9464	24.4672	-0.2072	0.0429
1938	43,589	4.6394	21.5238	0.0999	0.0100
1939	63,915	4.8056	23.0938	-0.0664	0.0044
1940	35,681	4.5524	20.7247	0.1868	0.0349
1941	44,193	4.6454	21.5793	0.0939	0.0088
1942	90,159	4.9550	24.5521	-0.2158	0.0466
1943	43,472	4.6382	21.5130	0.1010	0.0102
1944	47,708	4.6786	21.8892	0.0606	0.0037
1945	63,755	4.8045	23.0834	-0.0653	0.0043
1946	50,942	4.7071	22.1566	0.0322	0.0010
1947	68,867	4.8380	23.4064	-0.0988	0.0098
1948	60,534	4.7820	22.8675	-0.0428	0.0018
1949	71,226	4.8526	23.5481	-0.1134	0.0129
1950	86,521	4.9371	24.3752	-0.1979	0.0392
1951	62,425	4.7954	22.9955	-0.0561	0.0032
1952	63,657	4.8038	23.0769	-0.0646	0.0042
1953	68,589	4.8363	23.3894	-0.0970	0.0094
1954	45,753	4.6604	21.7195	0.0788	0.0062
1955	100,647	5.0028	25.0280	-0.2636	0.0695
1956	43,111	4.6346	21.4794	0.1046	0.0109
1957	62,460	4.7956	22.9978	-0.0564	0.0032
1958	60,285	4.7802	22.8504	-0.0410	0.0017
1959	41,305	4.6160	21.3075	0.1232	0.0152
1960	71,835	4.8563	23.5840	-0.1171	0.0137
1961	42,081	4.6241	21.3822	0.1151	0.0133
1962	54,001	4.7324	22.3956	0.0068	0.0000
1963	50,341	4.7019	22.1081	0.0373	0.0014
1964	58,107	4.7642	22.6979	-0.0250	0.0006
1965	54,665	4.7377	22.4459	0.0015	0.0000
1966	49,807	4.6973	22.0645	0.0419	0.0018
1967	53,696	4.7299	22.3724	0.0093	0.0001
1968	76,709	4.8848	23.8617	-0.1456	0.0212
1969	66,235	4.8211	23.2429	-0.0819	0.0067
1970	79,356	4.8996	24.0059	-0.1603	0.0257
1971	66,185	4.8208	23.2397	-0.0815	0.0066
1972	35,649	4.5520	20.7211	0.1872	0.0350
1973	95,433	4.9797	24.7974	-0.2405	0.0578

1974	53,625	4.7294	22.3669	0.0099	0.0001
1975	59,615	4.7754	22.8040	-0.0361	0.0013
1976	14,998	4.1760	17.4393	0.5632	0.3172
1977	50,650	4.7046	22.1331	0.0347	0.0012
1978	31,732	4.5015	20.2635	0.2377	0.0565
1979	57,366	4.7587	22.6448	-0.0194	0.0004
1980	45,295	4.6561	21.6788	0.0832	0.0069
1981	70,181	4.8462	23.4858	-0.1070	0.0114
1982	76,697	4.8848	23.8611	-0.1455	0.0212
1983	56,122	4.7491	22.5543	-0.0099	0.0001
1984	46,433	4.6668	21.7793	0.0724	0.0052
1985	45,244	4.6556	21.6742	0.0837	0.0070
1986	51,410	4.7110	22.1940	0.0282	0.0008
1987	45,417	4.6572	21.6897	0.0820	0.0067
1988	40,138	4.6036	21.1927	0.1357	0.0184
1989	41,682	4.6199	21.3439	0.1193	0.0142
1990	45,961	4.6624	21.7379	0.0768	0.0059
1991	41,261	4.6155	21.3032	0.1237	0.0153
1992	55,153	4.7416	22.4825	-0.0023	0.0000
1993	34,787	4.5414	20.6245	0.1978	0.0391
1994	72,594	4.8609	23.6284	-0.1217	0.0148
1995	86,680	4.9379	24.3830	-0.1987	0.0395
1996	89,055	4.9497	24.4991	-0.2104	0.0443
1997	59,698	4.7760	22.8098	-0.0367	0.0013
1998	86,330	4.9362	24.3657	-0.1969	0.0388
1999	55,056	4.7408	22.4752	-0.0016	0.0000
2000	24,796	4.3944	19.3106	0.3448	0.1189
2001	65,720	4.8177	23.2102	-0.0785	0.0062
2002	59,992	4.7781	22.8302	-0.0389	0.0015
2003	54,817	4.7389	22.4573	0.0003	0.0000
2004	27,246	4.4353	19.6719	0.3039	0.0924
2005	71,743	4.8558	23.5786	-0.1165	0.0136

N=		78		0.0000	1.5090
SUM X=		369.6599	1753.4123		
M=		4.7392298	1751.9033		

S(X^2)=		1753.4123
SX*SX/N=		1751.9033
S(x^2)=		1.5090
S^2/N=		0.0195974
S=		0.1399907

(20)	Pn	0.25	1	10	50	90	99	99.75
(21)	K	2.92	2.36	1.29	0	-1.29	-2.36	-2.92
(22)	Log V	5.1480	5.0696	4.9198	4.7392	4.5586	4.4089	4.3305
(23)	V, aft	140,606	117,384	83,141	54,857	36,194	25,636	21,402

Log V= M + kS

Table 10. Analytical Computation of October-April Runoff Volume Frequency Curve

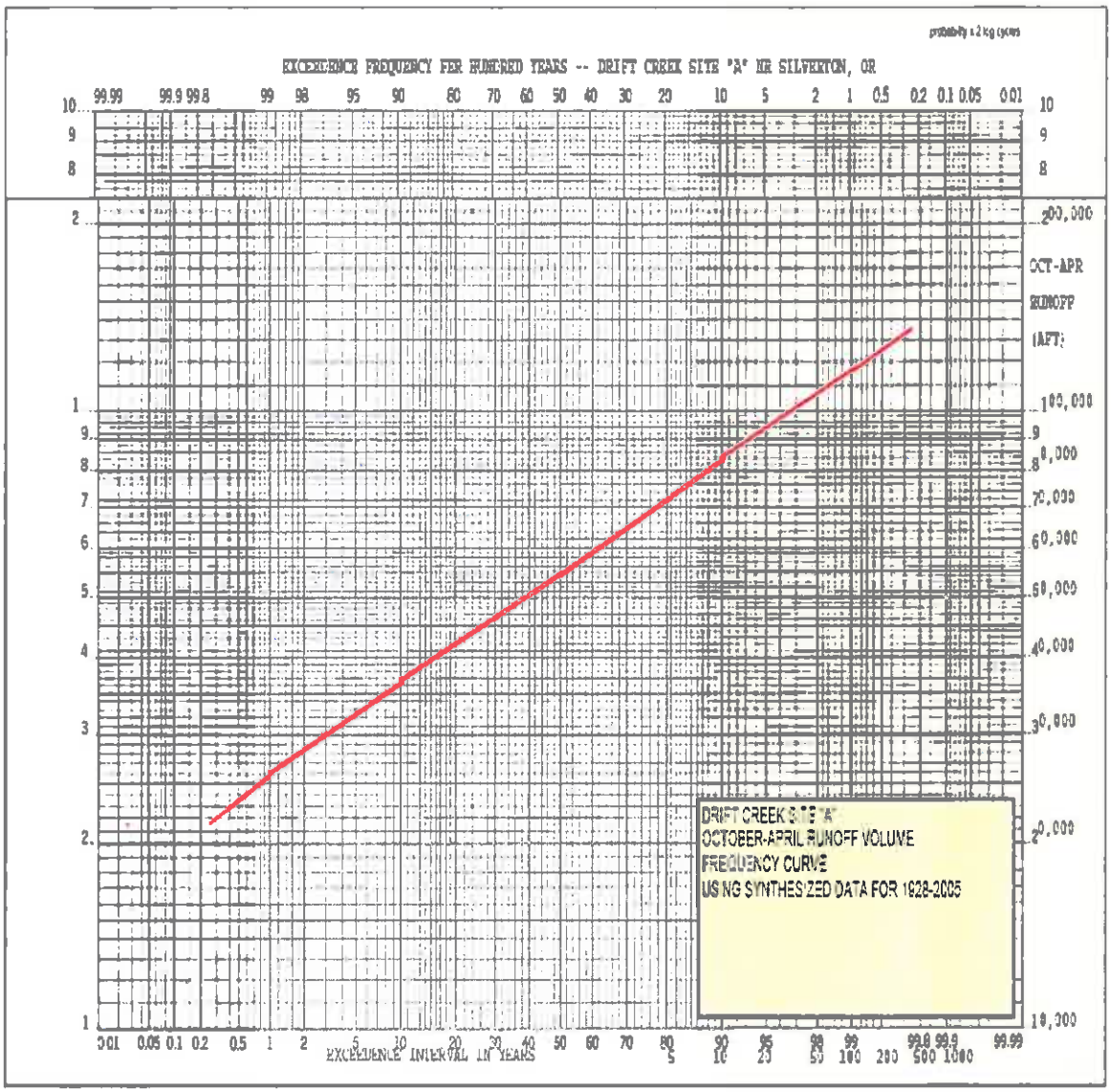


Figure 10. Graphical Frequency Curve – October-April Runoff Volume, Site "A"

8. Conclusions

1. A chronological sequence of the runoff volume reconstituted for the 78 years period shows volumes at Site "A" fluctuating between a maximum of close to 511,000 acre-feet and a little over 11,000 acre-feet depending on the year and which base station to use as index. Since Drift Creek has no known gaged data, it is recommended that a stream gage be set up at the project site (Site A) and operated for at least a couple of years to help narrow the range between maximum and minimum, and at the same time, validate the results of this hydrologic and statistical analysis.

2. In the meantime, it is recommended that the average October-April seasonal runoff volume for Drift Creek Site "A" of 57,500 acre-feet be used for planning purposes. This estimate is based on an analysis of existing hydromet data and flow synthesis that allows for the development of uninterrupted volume estimates for the entire 1928-2005 period. This 57,500 acre-foot number is close to the 54,900 acre-feet average calculated by using historical observed data. It also led to a flow array shown in Table 9 and statistically derived probabilistic estimates listed in Table 10.

3. It should also be noted that not all the volume amounts indicated will be available for irrigation use starting in May. Storage losses include the need to maintain a minimum in-stream flow requirement, and losses due to evaporation and seepage. While evaporation (about 30 inches for year in the Pudding River area) and seepage (varies with the geology of the basin) may be reduced or compensated by rain and snow falling directly on the reservoir water surface, a minimum in-stream flow requirement of 5 cubic feet per second (discharge based on other streams of comparable size) during the 212 days of the October-April period would reduce the storage volume by 2,100 acre-feet every year.

APPENDIX 1. Available Hydromet Data

YEAR	Monthly mean in cfs (Calculation Period: 1963-10-01 -> 1979-09-30) Silver Creek at Silverton, OR Period-of-record for statistical calculation restricted by user											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1963										35.0	355.3	202.6
1964	728.5	257.1	304.1	192.2	128.4	87.6	33.8	19.8	14.8	18.0	207.7	968.0
1965	720.5	268.6	116.4	105.6	94.6	35.0	12.4	9.38	6.56	14.8	98.9	227.6
1966	617.8	218.4	400.6	191.3	62.0	26.4	25.5	6.65	10.3	27.0	254.6	374.2
1967	509.2	295.4	231.4	206.0	99.8	35.7	10.2	4.04	5.36	135.5	130.8	390.9
1968	304.4	529.3	180.9	146.3	115.9	115.0	24.8	58.6	82.3			
1970										42.0	263.2	431.9
1971	784.8	320.9	454.0	345.1	137.8	100.7	45.0	15.1	65.7	83.4	450.2	644.7
1972	752.6	521.7	583.7	340.5	193.2	54.2	15.8	7.61	23.2	12.6	93.4	462.2
1973	432.3	124.9	225.3	157.1	68.3	57.3	27.2	10.1	26.2	59.3	937.4	973.0
1974	737.0	498.4	577.5	410.9	120.1	69.2	29.7	9.49	6.99	9.53	120.9	527.6
1975	616.2	372.3	389.5	193.3	220.5	43.1	23.3	19.8	32.7	83.5	310.2	566.6
1976	579.4	345.1	299.5	263.3	111.0	72.7	27.3	22.6	17.0	20.8	40.0	36.6
1977	57.2	85.4	366.3	158.4	215.5	99.4	20.9	12.7	50.5	78.5	465.9	805.7
1978	388.0	247.1	104.5	215.7	183.9	75.8	36.3	33.1	70.5	29.0	107.6	359.7
1979	139.1	614.4	295.4	240.6	146.5	28.9	12.7	5.63	15.6			
Mean of monthly Discharge	526	336	324	226	136	64	25	17	31	46	274	498

Silver Cr
** No Incomplete Data is used for Statistical Calculation

YEAR	00060, Discharge, cubic feet per second, Monthly mean in cfs (Calculation Period: 1993-10-01 -> 2004-09-30) Little Abiqua nr. Scott Mills Period-of-record for statistical calculation restricted by user											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1993										3.06	5.09	27.4
1994	50.5	50.6	46.0	37.8	12.7	15.0	5.87	2.57	3.05	25.3	85.4	75.4
1995	63.2	89.9	36.5	41.1	27.2	12.5	6.39	3.80	4.88	17.9	89.1	92.1
1996	89.8	143.2	53.4	51.3	45.8	14.3	5.98	3.71	4.05	20.1	79.4	141.1
1997	84.6	60.4	95.7	45.1	24.8	14.4	6.98	4.19	7.18	43.0	38.7	33.3
1998	94.3	60.8	62.2	34.8	46.1	19.5	6.18	3.57	3.75	6.39	51.8	107.8

1999	88.0	97.5	63.4	36.3	37.7	12.8	7.34	4.61	3.23	4.36	46.6	95.8
2000	88.2	76.0	52.7	20.1	35.3	16.4	5.31	2.68	2.62	5.60	11.1	34.2
2001	23.1	21.6	29.3	44.7	23.8	13.1	4.99	3.41	2.70	6.18	47.2	132.5
2002	76.4	90.1	76.4	42.0	14.4	9.49	5.86	2.93	2.08	2.33	12.2	55.5
2003	83.3	78.0	96.0	70.8	28.2	7.66	3.32	2.15	2.32	3.20	14.2	81.8
2004	117.7	69.0	34.4	21.2	13.1	24.5	5.72	4.55	8.38			
Mean of monthly Discharge	78	76	59	40.	28	15	5.8	3.5	4.0	12	44	80.

** No Incomplete Data is used for Statistical Calculation

00060, Discharge, cubic feet per second,

Monthly mean in cfs (Calculation Period: 1939-10-01 -> 1966-03-30)

Pudding River nr. Mt Angel

Period-of-record for statistical calculation restricted by user

YEAR	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1939										99.9	91.1	1,057
1940	755.0	1,898	1,308	794.6	398.3	77.9	29.1	13.2	36.3	144.5	749.7	1,035
1941	1,044	469.4	331.1	283.0	430.1	194.4	56.8	42.6	150.1	198.5	752.6	1,862
1942	989.2	1,293	524.6	299.0	599.8	425.5	132.5	39.2	22.3	38.8	1,918	2,144
1943	1,723	1,883	603.0	1,331	389.0	341.7	117.6	55.1	37.0	340.9	458.1	699.5
1944	784.8	849.7	633.0	689.0	278.0	174.1	47.0	17.7	24.4	25.5	254.0	297.5
1945	1,018	1,412	1,460.	1,172	1,006	233.3	54.2	29.7	68.4	47.8	1,233	1,730
1946	1,813	1,413	1,567	571.6	235.4	138.8	84.1	22.5	29.9	234.4	1,365	1,993
1947	913.5	1,090.	782.9	823.3	173.1	298.5	103.7	37.5	40.5	1,121	1,483	839.6
1948	1,875	1,316	1,265	1,052	746.6	214.5	69.3	41.6	60.4	184.0	923.1	2,087
1949	616.2	2,961.	1,023	609.4	604.8	128.5	45.5	22.3	36.0	151.8	474.2	1,144
1950	2,656	2,454	1,572	928.9	612.6	255.3	68.0	31.1	31.6	864.4	2,483	1,663
1951	2,558	1,413	1,214	520.9	435.5	106.7	30.3	14.7	19.6	601.8	901.2	1,769
1952	1,239	1,897	1,105	687.0	313.9	195.4	193.9	32.6	21.8	21.2	41.4	472.1
1953	3,011	1,889	1,197	650.8	697.5	514.3	92.2	48.2	40.2	147.9	1,095	2,483
1954	2,040	1,771	842.1	939.1	230.8	442.9	158.2	56.9	82.7	231.5	619.6	1,122
1955	1,052	753.2	1,015	1,736	813.5	325.8	115.9	37.4	49.0	684.4	1,783	2,952
1956	2,777	1,026	1,602	884.4	412.9	207.5	68.8	29.0	20.4	217.6	459.2	945.3
1957	638.5	1,119	2,094	701.8	355.4	196.8	57.7	31.2	15.6	102.4	289.7	1,889
1958	1,830.	2,128	736.1	1,129	305.7	170.3	51.8	10.5	26.1	52.3	1,274	1,136
1959	2,358	1,588	940.6	748.8	627.2	262.7	71.6	16.7	114.9	402.1	339.0	527.8
1960	708.3	1,522	1,394	1,061	1,014	292.2	45.3	26.5	29.1	84.8	1,760.	952.4
1961	1,117	2,879	2,192	715.1	705.4	163.2	39.2	10.4	40.1	175.6	521.3	1,668
1962	764.9	695.1	1,531	966.5	781.8	233.6	46.3	38.6	42.8	252.2	1,383	1,239

1963	460.5	1,277	981.5	1,750.	1,135	166.2	104.5	29.5	45.4	113.9	1,146	751.4
1964	2,558	909.1	954.7	563.5	396.7	265.2	79.5	52.2	45.1	55.5	570.7	3,401
1965	2,516	1,115	423.5	364.6	302.1	125.8	23.6	15.1	11.8	39.5	330.1	855.5
1966	2,402	691.8	1,514									
Mean of monthly Discharge	1,560	1,470	1,140	845	539	237	76	31	44	246	915	1,430

00060, Discharge, cubic feet per second,

Monthly mean in cfs (Calculation Period: 1993-10-01 -> 2005-09-30)

Zollner nr. Mt Angel

Period-of-record for statistical calculation restricted by user

YEAR	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1993										1.67	1.89	35.6
1994	51.4	55.5	16.0	11.2	2.05	4.75	0.237	0.275	0.294	16.8	70.7	61.6
1995	62.8	48.2	30.7	9.05	4.86	2.60	1.12	0.795	1.00	9.65	86.6	82.0
1996	103.4	113.8	24.5	25.9	21.8	3.65	1.12	0.598	1.70	23.1	121.3	186.9
1997	78.2	45.0	91.5	20.0	6.35	6.60	1.66	0.932	2.54	12.4	24.4	26.1
1998	40.6	33.1	38.6	8.14	10.0	4.91	1.59	0.522	1.22	3.67	55.2	91.8
1999	77.2	102.6	43.4	10.0	4.40	1.53	0.631	0.404	0.239	0.934	27.8	42.1
2000	49.6	57.9	29.2	5.80	5.26	2.05	0.771	0.264	0.698	1.78	3.09	10.9
2001	7.47	9.27	10.4	9.32	3.58	1.67	0.381	0.142	0.185	0.976	33.6	97.6
2002	66.5	37.2	35.9	6.15	2.88	0.950	0.712	0.278	0.434	0.798	1.51	35.0
2003	58.7	37.1	49.9	38.5	7.87	1.63	0.548	0.590	0.686	1.39	5.48	46.6
2004	51.4	40.1	13.7	2.75	2.11	2.41	0.376	0.156	0.278	3.05	5.13	20.8
2005	8.83	6.99	17.5	21.0	14.5	2.67	0.342	0.307	0.450			
Mean of monthly Discharge	55	49	33	14	7.1	3.0	0.79	0.44	0.81	6.4	36	61

00060, Discharge, cubic feet per second,

Monthly mean in cfs (Calculation Period: 1997-10-01 -> 2005-09-30)

Pudding River nr. Woodburn

Period-of-record for statistical calculation restricted by user

YEAR	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1997										599.7	936.3	1,024
1998	2,318	1,564	1,613	718.8	846.2	459.5	112.0	39.6	43.5	174.4	1,394	2,845
1999	2,842	2,835	2,082	924.8	812.4	293.5	98.0	52.9	33.4	61.3	1,025	2,023
2000	1,881	1,920.	1,346	504.5	677.5	350.5	72.9	25.0	36.9	101.7	202.0	716.9

2001	477.8	460.2	581.5	774.1	429.5	171.2	54.1	25.5	19.9	64.3	787.2	2,507
2002	2,062	1,850.	1,639	947.5	353.5	188.7	94.1	22.1	24.3	28.5	173.4	1,059
2003	1,792	2,050.	2,117	1,670.	694.7	145.1	34.5	13.5	23.4	58.2	314.5	1,964
2004	2,445	2,062	966.3	503.8	278.1	424.4	65.4	56.8	182.7	288.5	505.1	1,195
2005	603.2	386.6	561.0	1,123	819.3	450.2	115.5	28.1	23.3			
Mean of monthly Discharge	1,800	1,640	1,360	896	614	310.	81	33	48	172	667	1,670

00060, Discharge, cubic feet per second,												
YEAR	Monthly mean in cfs (Calculation Period: 1928-10-01 -> 2005-09-30) Pudding River at Aurora Period-of-record for statistical calculation restricted by user											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1928										162.0	605.2	1,273
1929	1,875	1,066	1,097	1,752	757.1	374.1	125.0	67.1	57.3	68.5	81.5	1,907
1930	962.2	3,868	1,073	682.9	828.4	374.9	128.1	71.0	79.6	123.4	460.5	573.4
1931	1,464	956.7	1,652	3,086	327.2	349.1	181.2	74.4	70.0	204.6	1,780.	2,593
1932	3,304	2,010.	3,312	1,754	743.7	332.4	123.1	74.6	60.0	161.3	1,613	2,168
1933	3,574	2,263	2,937	1,262	1,361	1,101	206.9	97.0	205.3	295.5	699.7	5,170.
1934	3,633	864.4	1,325	1,142	695.5	207.2	101.8	68.2	62.2	355.4	1,975	2,842
1935	2,992	1,535	1,996	1,217	551.1	183.6	124.3	64.6	72.4	135.9	318.7	668.3
1936	4,352	1,773	1,428	1,002	858.9	489.3	191.2	68.5	79.9	66.1	78.9	662.4
1937	766.5	3,563	2,100.	3,239	901.5	730.1	265.7	97.1	109.6	305.1	3,039	3,904
1938	3,670.	2,990.	3,121	1,668	682.1	216.5	99.0	54.8	60.7	120.3	888.6	1,204
1939	1,853	2,679	1,702	638.3	241.9	294.2	124.3	51.9	64.9	149.7	151.0	1,679
1940	1,353	3,532	2,491	1,477	671.6	158.0	66.7	49.6	81.0	205.1	1,110.	1,863
1941	1,885	831.5	598.5	456.3	638.3	337.2	116.8	73.2	212.9	298.2	1,138	3,408
1942	1,719	2,277	916.2	498.4	929.1	661.7	242.7	94.1	60.6	78.1	3,098	4,624
1943	3,768	3,916	1,035	2,713	720.4	616.8	217.2	119.8	94.0	543.8	783.8	1,130.
1944	1,463	1,466	1,047	1,120.	474.4	283.3	97.3	54.2	58.5	70.9	373.2	435.9
1945	1,517	2,466	2,527	1,879	1,623	414.6	116.4	72.3	142.5	108.2	1,801	2,955
1946	3,488	2,507	3,000.	1,028	466.5	263.8	179.1	71.0	83.1	353.0	2,006	3,452
1947	1,572	1,999	1,421	1,448	322.5	475.2	196.6	102.3	96.3	1,774	2,482	1,518
1948	3,664	2,311	2,454	1,730	1,416	395.6	146.1	109.2	116.4	295.3	1,508	3,661
1949	1,209	5,600.	2,067	1,086	1,081	250.3	112.5	66.7	90.4	245.0	699.7	2,004
1950	4,735	4,263	3,310.	1,638	990.8	471.5	143.4	78.7	77.5	1,170.	4,643	3,239
1951	4,853	3,208	2,624	887.2	703.1	203.3	79.5	50.6	64.1	914.4	1,497	3,283
1952	2,241	3,474	1,905	1,130.	618.3	327.5	364.0	69.4	64.1	63.8	104.3	792.7
1953	5,576	3,743	2,142	1,179	1,171	897.6	183.2	97.5	91.9	326.7	1,770.	4,772

1954	3,721	3,375	1,506	1,656	418.0	707.9	282.5	112.5	157.9	390.6	1,028	1,808
1955	1,895	1,255	1,795	3,054	1,193	500.5	224.4	76.7	107.5	1,036	3,039	5,704
1956	5,722	2,127	3,115	1,630.	682.1	365.3	116.4	71.0	76.9	331.8	755.7	1,421
1957	1,108	1,872	3,945	1,361	658.7	360.2	91.2	58.5	41.3	153.1	404.8	2,959
1958	2,982	4,384	1,459	2,011	567.4	305.5	95.2	33.9	60.0	103.3	1,846	1,874
1959	4,017	3,067	1,716	1,347	1,061	441.8	123.1	39.4	180.0	578.6	515.3	879.6
1960	1,374	2,789	2,543	2,037	1,820.	532.5	84.2	54.3	73.5	142.4	2,775	1,883
1961	2,006	5,550.	4,235	1,264	1,214	271.8	78.9	35.4	86.3	258.6	776.9	2,880.
1962	1,322	1,242	2,589	1,882	1,454	417.9	85.7	75.1	77.6	461.1	2,163	2,302
1963	819.2	2,458	1,548	3,355	2,192	287.1	187.3	57.5	85.2	185.3	1,940.	1,289
1964	4,513	1,840.	1,656	939.9	687.7	467.2	131.0	83.5	84.6			
1993							290.4	116.5	73.6	79.5	99.1	1,114
1994	2,050.	1,590.	1,741	1,225	375.3	373.1	59.1	11.3	32.8	346.5	2,557	2,957
1995	3,017	3,335	1,595	1,123	812.2	329.4	111.8	54.8	67.8	520.0	2,233	4,323
1996	3,888	6,948	1,988	1,867	1,552	523.5	158.5	38.7	106.2	606.6	3,387	6,090.
1997	4,643	2,875	3,728	1,446	727.9	498.3	178.6	63.9	197.6			
2002										86.6	255.4	1,383
2003	2,565	2,973	3,116	2,345	1,034	291.8	53.2	13.1	53.7			
2004										428.9	617.0	1,579
2005	758.5	496.7	824.6	1,620.	1,132	570.2	180.7	35.0	44.5			
Mean of monthly Discharge	2,710	2,700	2,100	1,570	889	420.	150.	68	90.	341	1,410	2,430

SALEM WSO AIRPORT, OREGON

Monthly Average Temperature (Degrees Fahrenheit)

(357500)

Years	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	*Season*
1928	39.5	42.5	50.1	50.3	61.0	60.4	68.0	65.4	60.6	54.1	45.0	38.0	52.9	*43*
1929	34.1	36.0	46.9	47.4	55.9	61.2	65.2	66.8	61.8	56.2	42.9	45.1	51.6	*45*
1930	27.4	45.9	47.6	51.9	52.1	57.8	62.4	66.6	61.3	51.3	43.3	38.9	50.5	*45*
1931	42.7	42.2	47.1	51.8	58.7	60.0	66.6	66.2	60.7	53.1	42.1	38.6	52.5	*44*
1932	38.4	39.6	45.9	50.3	54.7	63.8	63.7	66.8	61.6	55.7	47.1	36.1	52.0	*44*
1933	38.8	37.8	45.7	49.5	52.1	60.6	65.0	66.9	57.8	54.2	43.8	46.2	51.5	*49*
1934	45.7	45.9	52.0	56.0	58.3	62.3	64.5	66.6	60.0	55.5	50.1	42.3	54.9	*46*
1935	40.0	43.3	43.4	49.9	54.4	62.0	65.9	65.9	63.6	51.3	41.0	39.1	51.6	*44*
1936	42.7	35.4	44.1	53.5	58.3	62.6	65.6	66.0	60.6	55.3	41.2	42.7	52.3	*44*
1937	30.1	41.6	48.6	50.0	57.2	62.7	65.7	64.8	60.9	56.0	48.8	42.4	52.4	*47*
1938	39.3	42.6	45.3	51.8	57.0	63.1	69.2	64.1	65.2	54.0	42.5	41.9	53.0	*46*
1939	41.9	39.8	47.5	52.9	57.5	59.7	67.8	67.0	63.2	54.3	47.1	44.8	53.6	*48*
1940	39.7	45.3	49.4	52.4	59.2	64.0	66.5	68.5	63.9	56.6	43.5	42.7	54.3	*48*

1941	42.0	45.3	51.2	53.0	56.6	62.2	72.0	68.0	60.3	53.9	46.6	42.1	54.4	*46*
1942	35.6	43.0	45.7	51.9	55.9	60.2	68.6	69.3	63.2	55.3	45.8	43.9	53.2	*46*
1943	33.8	44.0	45.3	53.3	54.5	60.3	67.0	66.1	65.5	54.6	45.7	39.2	52.4	*45*
1944	39.2	42.8	45.8	50.8	56.4	61.4	67.7	66.2	65.3	57.4	45.2	38.4	53.1	*46*
1945	42.1	44.6	44.5	49.7	58.0	61.7	68.1	67.3	60.2	53.3	45.8	41.1	53.0	*46*
1946	40.3	42.6	46.1	50.3	58.5	60.4	67.3	67.4	60.5	50.2	43.5	41.6	52.4	*46*
1947	37.0	45.5	49.0	53.4	60.6	60.7	65.7	64.7	63.0	54.4	46.7	42.1	53.6	*45*
1948	39.5	40.6	44.0	47.6	55.2	65.0	65.5	65.0	61.0	51.7	43.2	37.5	51.3	*43*
1949	29.5	40.7	46.7	52.8	58.9	62.1	66.0	66.2	63.3	48.7	49.2	40.2	52.0	*43*
1950	29.6	41.3	44.8	48.4	55.2	62.2	67.3	68.7	61.7	51.9	46.8	47.4	52.1	*46*
1951	39.8	43.1	40.9	52.5	55.8	64.0	66.7	64.7	62.7	53.1	45.2	37.6	52.2	*44*
1952	38.5	40.6	44.2	50.4	55.4	59.3	67.3	66.0	63.8	57.4	38.6	41.0	51.9	*46*
1953	46.9	43.0	44.9	49.1	54.1	57.5	64.6	65.4	62.5	54.2	47.6	42.5	52.7	*46*
1954	40.2	42.9	42.9	48.8	55.6	57.0	62.7	63.1	59.0	51.3	49.0	40.1	51.0	*44*
1955	39.2	40.0	41.4	45.2	53.1	59.7	62.5	64.5	60.4	53.2	43.0	41.1	50.3	*44*
1956	41.1	37.0	43.9	51.3	58.6	58.5	68.0	65.2	61.7	51.6	42.4	40.0	51.6	*44*
1957	32.9	42.7	46.9	51.8	58.4	61.7	64.6	63.7	65.3	53.2	42.9	43.0	52.3	*46*
1958	42.9	48.3	45.0	50.2	61.0	65.0	71.2	70.2	62.4	55.4	46.9	45.5	55.3	*47*
1959	42.8	42.9	46.0	50.8	54.0	61.6	67.9	65.4	60.2	54.3	44.2	39.6	52.5	*44*
1960	36.6	41.6	44.3	49.6	52.5	60.7	67.6	64.8	62.4	54.8	46.9	40.1	51.8	*47*
1961	43.0	46.1	46.3	49.1	54.0	63.3	67.5	69.3	58.3	52.5	41.2	41.0	52.6	*44*
1962	37.1	40.7	43.9	50.8	51.4	59.3	64.3	64.8	62.5	52.6	46.7	41.7	51.3	*45*
1963	33.7	47.7	44.4	47.0	55.2	59.1	61.9	65.6	65.7	53.7	46.1	39.9	51.7	*45*
1964	41.6	40.3	43.6	48.0	53.6	60.3	66.4	63.8	58.8	53.2	41.9	39.5	50.9	*45*
1965	40.5	43.0	46.6	50.3	52.2	58.9	67.2	66.7	59.6	55.3	47.9	37.8	52.2	*45*
1966	39.6	40.5	44.6	50.5	54.9	61.8	65.2	66.9	63.2	52.6	47.1	44.2	52.6	*46*
1967	44.1	42.6	43.1	44.6	54.3	64.1	67.6	71.6	64.9	54.3	46.4	42.0	53.3	*46*
1968	39.6	48.1	47.3	46.9	54.5	59.6	66.1	65.2	60.5	51.4	45.3	37.0	51.8	*43*
1969	33.0	40.3	46.2	49.1	58.9	65.4	64.9	63.5	61.1	49.9	44.1	41.9	51.5	*45*
1970	41.6	44.9	45.5	45.8	54.2	64.4	67.2	65.4	58.3	50.6	43.6	39.0	51.7	*43*
1971	39.1	39.4	41.9	47.1	53.3	58.2	67.3	69.1	59.1	50.6	44.5	39.5	50.8	*44*
1972	38.3	43.2	47.9	45.9	56.5	60.0	67.6	68.2	57.6	50.1	46.4	35.1	51.4	*44*
1973	38.8	43.8	44.6	49.1	55.7	61.1	67.4	63.6	62.1	51.9	44.0	43.4	52.1	*45*
1974	37.5	41.2	46.1	49.3	52.8	61.8	65.8	67.4	65.7	53.0	46.4	43.0	52.5	*45*
1975	42.6	41.9	43.6	45.3	54.2	59.8	67.1	63.1	63.5	51.6	43.9	41.9	51.5	*44*
1976	40.7	40.2	42.5	47.1	53.2	56.9	65.3	64.2	62.0	52.1	45.9	38.7	50.7	*45*
1977	37.6	44.5	44.5	50.6	51.8	61.8	64.6	70.1	58.9	52.1	44.6	43.2	52.0	*46*
1978	41.4	45.3	48.2	48.9	54.8	65.2	68.8	68.3	61.0	54.1	39.4	34.7	52.5	*43*
1979	31.2	42.6	49.0	50.4	56.8	61.7	67.9	65.7	62.9	54.6	41.7	44.8	52.4	*45*
1980	35.5	43.1	44.6	50.7	53.7	57.5	65.5	62.7	62.5	53.6	47.3	42.8	51.6	*46*
1981	40.6	43.1	46.5	50.6	54.5	59.0	65.1	68.7	61.9	50.4	44.5	42.9	52.3	*44*
1982	38.5	41.6	44.5	45.8	54.7	65.1	65.7	66.4	61.4	53.3	42.3	41.1	51.7	*46*
1983	43.2	46.0	48.9	50.1	57.3	60.3	64.3	67.7	60.3	52.7	49.3	38.4	53.2	*46*
1984	43.2	44.2	48.6	47.8	52.9	57.4	65.4	66.8	61.3	51.4	44.4	37.4	51.7	*43*
1985	34.2	39.6	42.7	51.4	55.1	61.2	70.1	65.4	58.3	51.2	37.3	33.2	50.0	*44*
1986	43.2	44.3	50.2	48.4	55.2	64.2	63.5	69.8	58.9	53.7	46.6	39.6	53.1	*46*
1987	39.5	43.8	47.3	51.9	58.0	64.0	64.8	67.8	62.7	56.1	46.9	38.9	53.5	*46*
1988	39.3	43.3	45.6	51.1	53.7	60.5	66.8	65.8	62.3	56.6	46.8	40.5	52.7	*46*
1989	41.6	34.7	46.4	54.6	56.2	63.3	64.6	64.9	63.1	53.0	47.4	39.6	52.4	*46*
1990	42.8	41.3	47.8	52.7	55.2	62.3	69.6	69.1	64.9	51.2	46.9	34.4	53.2	*45*

1991	39.5	48.6	44.6	49.2	53.1	57.9	68.0	67.8	65.4	54.2	47.3	41.6	53.1	*48*
1992	44.1	47.6	50.5	53.8	60.8	65.8	68.9	68.2	62.0	55.1	46.1	39.2	55.2	*45*
1993	36.3	39.4	49.1	52.3	60.5	61.2	63.2	67.2	63.3	56.5	40.5	41.1	52.5	*47*
1994	44.3	43.0	50.2	53.2	59.2	61.7	69.1	67.0	65.2	52.6	41.7	42.2	54.1	*46*
1995	44.4	46.5	47.4	49.9	59.0	62.6	68.5	65.1	64.6	52.3	51.1	42.2	54.5	*47*
1996	41.9	42.2	47.2	51.9	53.1	60.9	70.2	67.8	60.0	52.4	45.2	42.5	52.9	*46*
1997	40.9	42.3	46.4	49.4	60.4	60.5	66.9	69.8	64.1	52.0	48.0	39.5	53.4	*47*
1998	44.0	45.5	47.3	50.4	54.6	61.3	69.6	69.0	64.5	52.4	47.7	39.9	53.8	*46*
1999	41.7	43.1	44.7	49.3	53.3	59.9	66.1	67.9	63.2	53.9	49.4	42.5	52.9	*46*
2000	40.1	44.0	44.2	51.3	55.7	63.6	66.0	65.6	62.2	53.2	41.3	40.5	52.3	*45*
2001	40.6	41.8	46.7	47.9	57.3	58.6	66.0	67.2	63.6	52.6	47.6	41.2	52.6	*46*
2002	41.1	43.2	43.7	50.4	54.0	62.0	68.8	67.1	63.2	52.1	46.4	43.1	52.9	*47*
2003	44.9	43.6	49.0	49.5	55.8	64.1	70.2	68.8	64.8	56.9	43.7	41.7	54.4	*47*
2004	39.5	43.6	49.2	52.5	56.7	63.1	70.0	70.1	60.6	54.2	43.8	42.5	53.8	*46*
2005	41.8	41.4	48.6	50.2	57.9	59.7	68.9	68.9	60.6	54.2	42.5	39.8	52.9	*45*
2006	44.4	41.4	44.6	50.9	57.1	64.3	69.8	67.4	63.4	52.0	46.9	39.7	53.5	
2007	38.3	36.5	---	---	---	---	---	---	---	---	---	---	38.3	

Period of Record Statistics

MEAN	39.5	42.6	46.1	50.1	55.8	61.3	66.7	66.7	62.0	53.3	45.1	40.7	52.5
S.D.	3.9	2.8	2.4	2.3	2.4	2.2	2.1	1.9	2.1	1.9	2.7	2.7	1.1
SKEW	-1.0	-0.4	0.2	-0.2	0.4	0.0	0.0	0.2	-0.1	0.1	-0.4	-0.3	0.3
MAX	46.9	48.6	52.0	56.0	61.0	65.8	72.0	71.6	65.7	57.4	51.1	47.4	55.3
MIN	27.4	34.7	40.9	44.6	51.4	56.9	61.9	62.7	57.6	48.7	37.3	33.2	50.0

APPENDIX 2. INPUT DATA FOR THE NEURAL NETWORK MODEL "NSHELL 2"

Snow	Temp	Year	Rain	Silver	Zolln	Abiqu	PAngel	PWBurn	PAurora
19.2	43	1928	2695	*	*	*	*	*	471729
18.7	45	1929	2918	*	*	*	*	*	506024
0.0	45	1930	2905	*	*	*	*	*	497731
0.5	44	1931	4036	*	*	*	*	*	899161
3.4	44	1932	4007	*	*	*	*	*	843334
0.0	49	1933	3721	*	*	*	*	*	797114
9.8	46	1934	3897	*	*	*	*	*	777125
8.2	44	1935	3160	*	*	*	*	*	580883
34.0	44	1936	3446	*	*	*	*	*	622332
1.2	47	1937	5091	*	*	*	*	*	1120548
1.0	46	1938	2724	*	*	*	*	*	538713
0.0	48	1939	3813	*	*	*	355473	*	640708
0.0	48	1940	2280	*	*	*	245097	*	420160
1.0	46	1941	2756	*	*	*	353539	*	612674
23.6	46	1942	4543	*	*	*	574134	*	1145699
0.0	45	1943	2703	*	*	*	266129	*	451162
0.0	46	1944	2933	*	*	*	337707	*	554707
1.0	46	1945	3793	*	*	*	502116	*	893283
2.9	46	1946	3123	*	*	*	431257	*	733253
1.0	45	1947	4064	*	*	*	536613	*	955900
6.2	43	1948	3590	*	*	*	501059	*	919554
31.5	43	1949	3828	*	*	*	558445	*	1007046
11.0	46	1950	4680	*	*	*	643426	*	1235908
8.5	44	1951	3663	*	*	*	488903	*	860760
0.0	46	1952	3799	*	*	*	438149	*	817454
8.3	46	1953	3943	*	*	*	557398	*	1024406
2.0	44	1954	2850	*	*	*	391630	*	673490
15.2	44	1955	5140	*	*	*	707310	*	1351376
10.6	44	1956	2815	*	*	*	372316	*	650962
0.0	46	1957	3734	*	*	*	481986	*	850157
5.5	47	1958	3582	*	*	*	483599	*	832957
15.4	44	1959	2787	*	*	*	353656	*	636159
0.0	47	1960	4243	*	*	*	579103	*	1065989
13.5	44	1961	2800	*	*	*	380994	*	659500
6.6	45	1962	3282	*	*	*	436937	*	778939
0.0	45	1963	3076	124740	*	*	420666	*	742221
5.7	45	1964	3477	145923	*	*	512167	*	*
9.9	45	1965	3314	106734	*	*	353261	*	*
0.0	46	1966	3047	113820	*	*	*	*	*
10.3	46	1967	3272	107902	*	*	*	*	*
34.9	43	1968	3967	*	*	*	*	*	*
0.2	45	1969	3936	*	*	*	*	*	*
21.5	43	1970	4198	159049	*	*	*	*	*
3.0	44	1971	3895	202604	*	*	*	*	*
15.3	44	1972	2562	91558	*	*	*	*	*

0.5	45	1973	5498	241767	*	*	*	*	*
1.6	45	1974	3257	134003	*	*	*	*	*
1.8	44	1975	3569	147048	*	*	*	*	*
0.0	45	1976	1157	46206	*	*	*	*	*
6.1	46	1977	3123	138688	*	*	*	*	*
7.2	43	1978	2253	105273	*	*	*	*	*
1.8	45	1979	3452	*	*	*	*	*	*
0.0	46	1980	2802	*	*	*	*	*	*
5.0	44	1981	4064	*	*	*	*	*	*
0.0	46	1982	4507	*	*	*	*	*	*
4.3	46	1983	3384	*	*	*	*	*	*
4.9	43	1984	2913	*	*	*	*	*	*
12.1	44	1985	2919	*	*	*	*	*	*
0.0	46	1986	3134	*	*	*	*	*	*
6.8	46	1987	2882	*	*	*	*	*	*
9.6	46	1988	2674	*	*	*	*	*	*
9.6	46	1989	2742	*	*	*	*	*	*
1.2	45	1990	2852	*	*	*	*	*	*
0.0	48	1991	2583	*	*	*	*	*	*
32.0	45	1992	3333	*	*	*	*	*	*
0.4	47	1993	2242	*	10279	13146	*	*	472750
5.1	46	1994	4179	*	17961	24799	*	*	889338
0.0	47	1995	5049	*	26468	31820	*	*	1286669
0.0	46	1996	5178	*	34283	31825	*	*	1377012
0.0	47	1997	3584	*	10992	22026	*	525969	*
0.0	46	1998	5030	*	22823	26940	*	782475	758191
0.0	46	1999	3332	*	12684	22972	*	523305	*
0.0	45	2000	1689	*	3145	10214	*	198759	381814
0.0	46	2001	3911	*	16759	28185	*	590599	*
0.0	47	2002	3600	*	13297	23810	*	529835	*
0.0	47	2003	3319	*	9653	20481	*	496433	*
0.0	46	2004	1822	*	5020	*	*	280658	*
0.0	45	2005	4238	*	*	*	*	*	*