Ruzzo

Technical Memorandum No. 6.

Subject: Estimation of 1982 and Future Nonpoint Source Total Phosphorus Loads and Runoff Volumes in Cherry Creek and Chatfield Reservoir Basins.

Date: June 23, 1983.

Present and future nonpoint source loads of total phosphorus and runoff are required in the reservoir modeling effort to assess the present and future water quality of Cherry Creek and Chatfield Reservoirs. Nonpoint sources of total phosphorus can be a major component of the total phosphorus load entering each reservoir and may adversely impact reservoir water quality. It has been determined that phosphorus generated from land surfaces is substantial in the Cherry Creek and Chatfield Basins and that it is the limiting nutrient to reservoir productivity. Estimation of future phosphorus loading is critical in the evaluation of reservoir water quality, especially because as the basins develop, nonpoint loads of phosphorus will increase.

This technical memorandum explains the methodology used to predict future phosphorus loading and runoff formation from nonpoint sources. Future loads were predicted based upon the low and high growth scenarios of land use described in Technical Memorandum No. 2 on Land Use. Loads and runoff were also estimated for 1982 using land use measured from aerial photographs.

Data and models derived as a part of the Denver Regional Urban Runoff Program (DRURP) were used to predict total phosphorus loading and runoff by land use type. Scaling factors were applied to adjust the DRURP data to each reservoir sub-basin, and a storm-size distribution and frequency analysis was undertaken to provide needed rainfall information. Phosphorus loading and runoff volumes are entered into the reservoir water quality models.

The relationships between land use projections, DRURP models, predicted loads and runoff, and other components are shown in Figure 1. This figure summarizes the basis for the methodology discussed. It is useful as a guide in understanding the sources of information used and their relationships, upon which the predictions of nonpoint source effects are based.

Land Use

The quantity of runoff and total phosphorus generated from nonpoint sources depends greatly upon land use. In general, the more intense the development and amount of impervious surfaces, the greater the runoff volume and phosphorus loading for a given rainfall. Rainfall no longer soaks into soils or is intercepted by vegetation as pervious surfaces are replaced by impervious ones, but a greater portion of it runs off, remobilizing pollutants from impervious surfaces. A drainage conveyance system such as a rooftop, downspout, street gutter and storm sewer efficiently transports this runoff and pollutants to nearby receiving waters.

Land use data for 1982 and projections by low and high growth scenarios are presented in Table 2 and Appendix C of Technical Memorandum No. 2, respectively. This information was directly used to predict phosphorus loads and runoff by land use type within each sub-basin (Figure 1). Acres of land use were multiplied by loading constants discussed later in this document to give sub-basin loads and runoff volumes. Land use type is also a variable in the DRURP models, which provide estimates for commercial, multi-family, single family, and pervious area land uses. DRURP data and models are also discussed later in this report.

Rainfall Distribution Analysis

Prior to applying models and data from the DRURP to predict annual loads and runoff by land use type, an annual distribution of storm events by storm size had to be derived. Models from DRURP use rainfall as one of the inputs to predict loads of runoff. Not only is data needed pertaining to the size of storms expected during any given year, but also on how many storms of any size will occur per year.

An annual storm-size distribution was developed for the Cherry Creek Basin using daily precipitation records from Climatological Data reports by the National Oceanic and Atmospheric Administration (NOAA) from 1969-1982. The number of storms of specified storm-size intervals occurring per year during the period of record analyzed was determined for the Cherry Creek Dam raingage. Specified rainfall intervals were delineated based upon the range of storm sizes and requirements of the DRURP models. The distribution of storms within the Cherry Creek Basin was assumed to be similar to that analyzed at the reservoir dam raingage and is shown in Table 1.

A sufficient record of daily precipitation does not exist from the Chatfield Dam raingage, precluding a similar analysis in this basin. To develop a storm-size distribution for this basin, yearly rainfall totals were compared between the raingage at the Littleton Firehouse and the Cherry Creek Reservoir Dam raingage. The raingage at Littleton is the closest gage to Chatfield Dam with the longest and most complete precipitation record.

It was determined that the Littleton Firehouse raingage receives 82.2% of the precipitation recorded at Cherry Creek. A rainfall storm-size distribution was calculated for Chatfield Reservoir by assuming the relative distribution of storms between Cherry Creek and Chatfield is the same, but only 82.2% of the number of storms/year of any

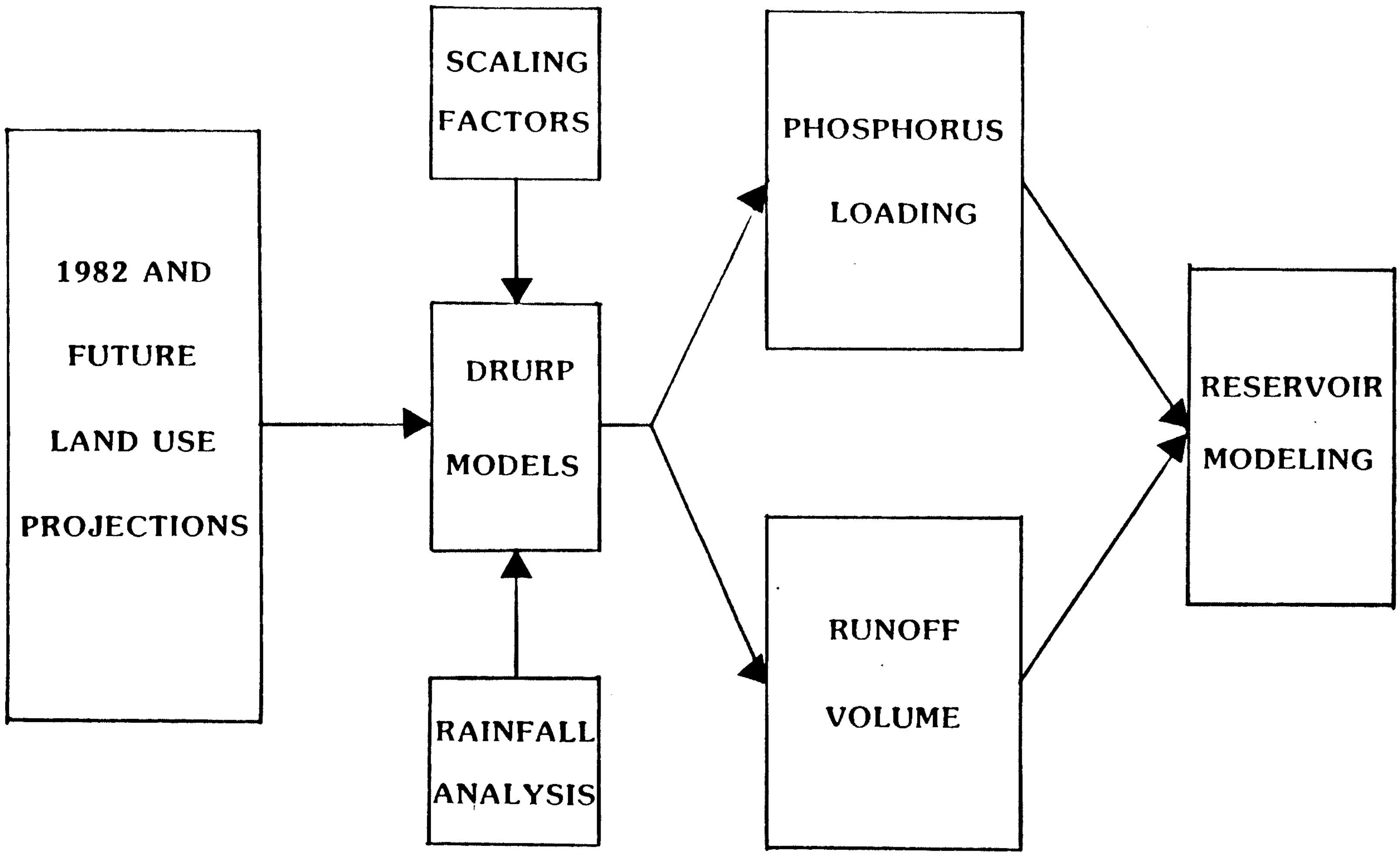

Figure 1. Relationships Between Information and Components Used in Methodology to Predict Phosphorus Loading and Runoff.

Table 1

Distribution of Annual Precipitation by Storm Size

Cherry Creek Dam Gage[1]

Amount of Precipitation (inches)	Number of Storms Expected per Year	%
0.02-0.09	20.93	36.49
0.10-0.19	11.86	20.68
0.20-0.29	5.93	10.34
0.30-0.39	4.21	7.34
0.40-0.49	3.21	5.60
0.50-0.59	2.07	3.61
0.60-0.69	1.79	3.12
0.70-0.79	1.00	1.74
0.80-0.89	1.29	2.25
0.90-0.99	0.71	1.24
1.00-1.45	2.07	3.61
1.50-1.99	1.43	2.49
2.00-2.49	0.50	0.87
>2.49	0.36	0.63
	57.36	100.01%

USING midpts = 19.72"

[1] - Based upon record from 1969-1982. Events separated by at least 12 hours of no precipitation considered to be different storms.

size occurring at Cherry Creek occur at Chatfield. The result is that, based upon the storm-size distribution, Chatfield receives 82.2% of the annual precipitation recorded at Cherry Creek. The annual storm size distribution at Chatfield is shown in Table 2.

As can be seen in Figure 1, the annual rainfall distribution by storm size was needed to use DRURP data and models to predict annual loads and runoff.

DRURP Models and Data

Models that predict unit-area total phosphorus loading (lbs/acre) and inches of runoff from rainfall (inches) based upon land use were used to predict 1982 and future nonpoint source loads and runoff. These models were derived as a part of the Denver Regional Runoff Program (DRURP). A detailed analysis of the development of these models which includes the measured data is contained in a technical report entitled "Predicting Urban Runoff Characteristics" (DRCOG, 1983). A more general overview of the effects of urban runoff on receiving waters, urban runoff characteristics, and control measures is discussed in the DRURP final report (DRCOG, 1983). The final report also contains specific examples of practical applications of the models and data used.

The DRURP models were used to estimate the inches of runoff and lbs/acre of total phosphorus for each storm-size interval defined in Tables 1 and 2. The load or runoff from a storm-size was multiplied by the average number of storms of that size expected per year in each reservoir basin. The load and runoff for all storm-sizes per year (Tables 1 and 2) were then summed to obtain the lbs/acre of total phosphorus and inches of runoff expected on one acre of each land use type during any year in each basin. These annual unit-area loading and runoff rates are contained in Table 3 and were used to estimate nonpoint source loads (lbs) and runoff (acre-feet) by land use and sub-basin. Multiplying annual unit-area loads or runoff by the number of acres of a specific land use will yield the annual load or runoff volume for that land use.

Table 2

Chatfield Reservoir
Distribution of Annual Precipitation by Storm Size[1]

Amount of Precipitation (inches)	Midpoint	Number of Storms Expected per Year
0.02-0.09	0.05	17.20
0.10-0.19	0.15	9.75
0.20-0.29	0.25	4.87
0.30-0.39	0.35	3.46
0.40-0.49	0.45	2.64
0.50-0.59	0.55	1.70
0.60-0.69	0.65	1.47
0.70-0.79	0.75	0.82
0.80-0.89	0.85	1.06
0.90-0.99	0.95	0.58
1.00-1.49	1.25	1.70
1.50-1.99	1.75	1.18
2.00-2.49	2.25	0.41
2.49	2.49	0.30

1 - Based on precipitation recorded at Cherry Creek Dam gage from 1969-1982. Distribution of storms was adjusted (Cherry Creek storm distribution x 0.822) based on precipitation information from Littleton, Colorado.

* PIA = $\frac{PEIA}{0.67}$ based on burp results.

Table 3

Annual Unit-Area Total Phosphorus Loading and Runoff Volume by Land Use for Basins

Land Use[1]

	C	MF	SF_{vll}	SF_{ll}	SF_s	PA
			< 1 du/ac	1-3 du/ac	> 3 du/ac	
lbs/tot.phosphorus/ PEIA			5	8.3	23.8	
acre/year: PIA*			7.5	12.4	35.5	
Cherry Creek	1.99	0.699	0.070	0.166	0.834	0.027
Chatfield	1.64	0.575	0.058	0.136	0.686	0.022
ac-ft runoff/ acre/year:						
Cherry Creek	11.95	7.60	0.38	0.87	3.17	0.014
Chatfield	9.82	6.25	0.31	0.72	2.61	0.012

1 - See footnotes to Appendix A and B for load use abbreviations. Loads and runoff could not be predicted from industrial and public land uses.

It is important to realize that the rates in Table 3 are constant for one acre of the same land use within a basin for the storm-size distribution used. That is, that one acre of commercial land use, for example, will produce equal lbs. of total phosphorus or acre-feet of runoff/year whether it is in the Shop Creek, Lone Tree Creek, or another drainage within the Cherry Creek basin. Likewise, one acre of commercial land use will produce equal load or runoff regardless of whether it is located within Massey Draw, Plum Creek, or another area within the Chatfield Reservoir Basin. Loading, then, becomes primarily a function of the distribution of land use within a sub-basin or basin.

The annual loading rate for a land use type (Table 3) was multiplied by the acres of that land use to obtain a total phosphorus load or runoff volume by land use. Loads from all land uses (that a load or runoff could be predicted from) were summed within a sub-basin to obtain a total load or runoff. This was done for 1982 using 1982 measured land use and for future low and high growth land use projections. Annual loading rates, acres of land use, and loads or runoff by each land use are shown for 1982 and future low and high growth conditions by sub-basin in Tables in Appendices A and B.

The total load or runoff produced within a sub-basin and shown on the Tables in Appendices A and B are not indicative of the quantity of a load or runoff that might actually be conveyed out of a sub-basin to either reservoir. Numerous factors, most of which are unquantifiable or unmeasured, will determine absolute loading within each sub-basin.

The DRURP data and models were derived from very small, developed basins within the Denver Region and are not directly applicable to the large, pervious sub-basins within Cherry Creek and Chatfield Reservoir Basins. After comparison of predicted loads and runoff by sub-basin from storms of the same size as those monitored by the United States Geological Survey (USGS) with measured loads, it was determined that factors were required to adjust total predicted loads to measured sub-basin loads. These factors account for numerous hydrological and basin characteristics that determine a sub-basin load and could not be accounted for in the DRURP data and models. They also account for the fact that loads and runoff could not be predicted from every land-use type. These factors and their derivation are described in the following section.

Scaling Factors

Factors adapting DRURP data and models to the Clean Lakes Study Basins were called scaling factors. These factors are required to adjust the DRURP models to each sub-basin and to account for the numerous variables which could not be studied, yet determine the relative differences between phosphorus loading and runoff formation going from small sites to large basins. Scaling factors are not indicative of the quantity of load or runoff generated within a sub-basin, but assess how much of that load will be conveyed out of the sub-basin to the reservoir, depending upon variables such as basin slope, channel efficiency, soil type, among others.

Scaling factors were calculated by sub-basin individually for phosphorus runoff and loading by comparing predicted to measured 1982 loads. Factors were applied by sub-basin to adjust loads and runoff to the particular sub-basin. The methodology used to derive scaling factors varied slightly between reservoir basins. Each methodology is described below.

Cherry Creek Reservoir

Storm loads were predicted by sub-basin using DRURP data and models for storms of the same size as those monitored. Predicted loads and runoff were compared to measured loads and runoff from the same storm within the same sub-basin. Ratios of meaured over predicted loads were calculated and these are called scaling factors (s_f). A mean scaling factor ($\bar{S}_f$) was then calculated for each sub-basin.

Measured and predicted loads, and runoff volumes and scaling factors for sub-basins within the Cherry Creek Basin are shown in Table 4. Only one storm was monitored for Happy Canyon Creek and it is not included in this analysis.

ɔle 4

Comparison of Measured vs. Predicted Storm Loads and Volumes
Cherry Creek Sub-basins*

Sub-basin	Storm Date	TP Load (lbs) Measured	TP Load (lbs) Predicted	Measured / Predicted	Runoff Vol. (Ft) Measured	Runoff Vol. (Ft) Predicted	Measured / Predicted
Cherry Creek	5/13-14/82	10.4	1,458	0.007	276,400	17,987,570	0.02
Cherry Creek	6/4/82	0.35	31.2	0.011	9,000	68,151	0.13
Cherry Creek	6/24-25/82	18.0	183.7	0.100	56,000	1,083,500	0.05
Cherry Creek	8/3-4/82	97.0	838.8	0.116	191,000	4,312,190	0.04
Piney Creek	8/17/82	5.6	3.2	1.74	15,500	70,990	0.22
Piney Creek	8/20/82	0.24	16.8	0.014	3,500	204,390	0.02
Lone Tree Creek	5/12-15/82	10.9	17.6	0.62	319,000	339,960	0.94
Lone Tree Creek	5/26/82	0.58	2.2	0.27	22,800	5,210	4.3
Cottonwood Creek	5/25-27/82	10.5	25.5	0.41	469,000	456,610	1.03
Cottonwood Creek	6/2-4/82	7.0	32.9	0.21	209,000	1,005,950	0.21
Cottonwood Creek	6/18-19/82	4.0	30.2	0.13	457,000	526,080	0.87
Cottonwood Creek	6/25/82	2.4	5.8	0.41	189,000	92,801	2.04
Cottonwood Creek	6/28-29/82	1.8	4.0	0.45	-	-	-
Cottonwood Creek	7/28-29/82	18.9	60.0	0.32	-	-	-
Cottonwood Creek	5/12-15/82	-	-	-	1,910,000	2,314,570	0.89
Shop Creek	5/12-14/82	322.0	33.1	9.7	1,120,000	550,790	2.0
Shop Creek	6/24/82	8.7	1.08	8.1	49,800	21,270	2.3
Shop Creek	7/28/82	520.0	36.5	14.2	1,083,000	639,690	1.7

* Only 1 storm monitored at Happy Canyon.

Mean scaling factors for sub-basins and accompanying statistics are contained in Table 5.

Table 5

Summary of Analysis of Mean Scaling Factors By Sub-Basin*
(Cherry Creek Basin)

Sub-Basin	Type	n	$\overline{S}_f$	$\hat{\sigma}_{sf}$	COV
Cherry Creek	Loading	4	0.06	0.06	100%
Cherry Creek	Runoff	4	0.06	0.04	67%
Piney Creek	Loading	2	0.87	1.20	138%
Piney Creek	Runoff	2	0.12	0.14	116%
Lone Tree Creek	Loading	2	0.45	0.24	53%
Lone Tree Creek	Runoff	2	2.67	2.43	91%
Cottonwood Creek	Loading	7	0.49	0.45	92%
Cottonwood Creek	Runoff	5	1.00	0.59	59%
Shop Creek	Loading	3	10.7	3.16	30%
Shop Creek	Runoff	3	2.01	0.27	13%

* - $\overline{S}_f$ = mean S_f, $\hat{\sigma}_{sf}$ = estimate of standard deviation of mean.

Differences between $\overline{S}_f$ for each sub-basin were investigated to determine if relationships existed between the degree of development in a sub-basin and $\overline{S}_f$.

Regression analysis was done between $\overline{S}_f$ by sub-basin and sub-basin percent effective imperviousness (PEI). PEI is discussed in both DRURP reports cited and in Technical Memorandum No. 2. It was hoped that significant equations would result which would:

1. Realistically predict mean scaling factors by sub-basin in 1982 based upon sub-basin PEI in 1982; and,

2. Allow for the prediction of scaling factors in the future based upon projected sub-basin PEIs.

A. TP Loading:

Data from Shop Creek and Piney Creek were omitted in this analysis. Linear regression analysis between $\overline{S}_f$ and sub-basin PEI yielded the following equation:

S_f = 0.116 PEI + 0.0039   r = 0.98 .

This equation was used to predict scaling factors for TP loading based on basin PEI for all sub-basins except Shop Creek. The $\overline{S}_f$ for Shop Creek was held constant and used for development scenarios in the future.

B. Runoff Volumes:

Data from all sub-basins except Lone Tree Creek were used in this analysis. Lone Tree had an unexplainably high $\overline{S}_f$ for its PEI. Linear regression analysis between $\overline{S}_f$ and sub-basin PEI yielded the following equation:

S_f = 0.185 PEI - 0.057   r = 0.98 .

This equation was used to predict a S_f for runoff for all sub-basins.

Both of these regression equations could predict 1982 mean scaling factors sufficiently well, and appeared to predict reasonable scaling factors by sub-basin in the future based upon sub-basin PEI.

Chatfield Reservoir

Scaling factors were derived by dividing measured storm loads and runoff by predicted loads and runoff as was done in the Cherry Creek Reservoir Basin. Mean scaling factors ($\overline{S}_f$) were also calculated for each sub-basin. Measured and predicted loads and runoff and scaling factors are shown in Table 6 for Chatfield.

Tab 6

Comparison of Measured vs. Predicted Storm Loads and Volumes
Chatfield Sub-basins

		TP Load (lbs)		Measured	Runoff Vol. (Ft^3)		Measured
Sub-Basin	Storm Date	Measured	Predicted	Predicted	Measured	Predicted	Predicted
Massey Draw	7/9-10/82	0.92	9.6	0.10	35,763	134,910	0.27
Massey Draw	7/28-29/82	6.8	26.5	0.26	261,550	332,070	0.79
Massey Draw	8/6-7/82	4.6	28.7	0.16	66,000	70,340	0.94
Massey Draw	8/17-18/82	8.8	15.8	0.56	152,000	201,450	0.75
Massey Draw	8/20-21/82	9.1	35.9	0.25	218,000	469,920	0.46
Massey Draw	9/13-14/82	5.6	72.0	0.08	131,000	925,470	0.14
Deer Creek	7/28-30/82	61.1	51.9	1.18	505,570	179,240	2.82
Deer Creek	8/6-7/82	0.40	2.0	0.20	9,079	28,207	0.32
Deer Creek	8/17-18/82	102.0	45.1	2.26	481,080	170,310	2.82
Deer Creek	8/20-21/82	130.0	77.9	1.67	513,500	179,240	2.86
Plum Creek	5/12-5/82	880.0	1,087.0	0.81	27,576,000	27,963,280	1.00
Plum Creek	5/26/82	330.0	362.8	0.91	2,835,000	1,185,410	2.39
Plum Creek	6/19/82	-	-	-	1,267,000	1,266,090	1.00
Plum Creek	6/25/82	15.0	7.5	2.00	-	-	-
Plum Creek	6/25-27/82	30.0	26.7	1.12	490,000	239,010	2.05
Plum Creek	7/28-30/82	1,500	1,487.0	1.01	-	-	-

Mean scaling factors were calculated by sub-basin and these are shown with accompanying statistics in Table 7.

Table 7

Summary of Analysis of Mean Scaling Factors by Sub-Basin*
(Chatfield Basin)

Sub-basin	Type	n	$\overline{S}_f$	$\hat{\sigma}_{sf}$	COV
Massey Draw	Loading	6	0.23	0.18	77%
Massey Draw	Runoff	6	0.56	0.32	57%
Deer Creek	Loading	4	1.33	0.87	66%
Deer Creek	Runoff	4	2.21	1.26	57%
Plum Creek	Loading	5	1.17	0.48	41%
Plum Creek	Runoff	4	1.61	0.72	45%

* - $\overline{S}_f$ = mean scaling factor, $\hat{\sigma}_{sf}$ = estimate of standard deviation of mean.

Mean scaling factors were not well related to sub-basin PEI. Pooling of $\overline{S}_f$'s with those from sub-basins in the Cherry Creek Basin did not yield any significant relationships. Mean scaling factors and sub-basin PEI did not show the same relationships as in the Cherry Creek Basin.

Because only three sub-basins were monitored within Chatfield, anomalous data or entire sub-basins couldn't be omitted from the analysis. Equations that predict future S_f by sub-basin based upon PEI could not be developed. Due to the small growth expected in this reservoir basin compared to Cherry Creek, and the limited number of sub-basins monitored, it was decided that 1982 mean scaling factors be used for all future development scenarios. That is, the scaling factors are constant within each sub-basin to the year 2010.

Scaling factors had to be derived for the unmonitored areas. These were not monitored so factors couldn't be calculated by comparing measured vs. predicted loads (volumes). Likewise, no reliable equations were developed that predict S_f's from sub-basin PEI. Scaling factors for the two unmonitored areas were derived by extrapolation.

The sources of scaling factors that were used to adjust total loads and runoff volumes to each sub-basin are listed in Table 8. The total load or runoff volume reported on the tables in Appendices A and B were multiplied by the appropriate scaling factor to yield an adjusted load. Adjusted loads were very similar to those measured for equal storm sizes.

Table 8

Summary of Scaling Factors (S_f) Used for Cherry Creek and Chatfield Reservoir Sub-basins

Cherry Creek Reservoir Sub-basins

Sub-basin	Tot. Phosphorus S_f	Runoff Vol. S_f
Shop Creek	10.7	$S_f = 0.185$ PEI-0.057
All Others	$S_f = 0.116$ PEI + 0.004	$S_f = 0.185$ PEI-0.057

Chatfield Reservoir Sub-basins

Sub-basin	Tot. Phosphorus S_f	Runoff Vol. S_f
Massey Draw	0.23	0.56
Deer Creek	1.33	2.21
Plum Creek	1.17	1.61
Unmonitored Area (west of Reservoir)	1.37	3.0
Unmonitored Area (below Plum Creek)	0.72	1.4

1982 and Future Phosphorus Loading and Runoff

Scaling factors were applied to total loads to give an adjusted load. Scaling factors and the adjusted loads are shown at the bottom of each table in Appendices A and B.

Adjusted sub-basin loads and runoff volumes using 1982 land use were summed for each reservoir and are shown in Tables 9 and 10. Loads and runoff were summed for all sub-basins for low and high growth development scenarios (Appendices A and B). The loading by sub-basin and total basin loads are shown in Tables 11 and 12 for Cherry Creek and Chatfield Reservoirs, respectively. Acre-feet of runoff for low and high growth scenarios by sub-basin and total basin are shown for both reservoirs in Tables 13 and 14.

The total phosphorus loads and runoff volumes shown in Tables 11-14 were used in the Clean Lakes modeling effort to assess the present and future water quality of Cherry Creek and Chatfield Reservoirs (Figure 1). These figures were derived from land use data and projections contained in Technical Memorandum No. 2 using a uniform, consistent methodology. This methodology incorporated numerous sources of information including storm size distributions and scaling factors. The resulting total phosphorus loads and runoff volumes are thought to be very reasonable for 1982 and the future.

Table 9

CHERRY CREEK RESERVOIR:
1982 PREDICTED TOTAL PHOSPHORUS LOAD (ANNUAL POUNDS)
AND ANNUAL RUNOFF VOLUME (ACRE-FEET)

	1982 Load	1982 Runoff Volume
Unmonitored Area	378	174
Cherry Creek (includes Happy Canyon)	596	74
Lone Tree Creek	36	6
Cottonwood Creek	343	181
Piney Creek	223	91
Shop Creek	2,429	159
TOTAL	4,010	685

Table 10

CHATFIELD RESERVOIR:
1982 PREDICTED TOTAL PHOSPHORUS LOAD (ANNUAL POUNDS)
AND ANNUAL RUNOFF VOLUME (ACRE-FEET)

	1982 Load	1982 Runoff Volume
Massey Draw	125	113
Deer Creek	791	179
Plum Creek	5,711	979
Unmonitored Area (west of Reservoir)	275	42
Unmonitored Area (Plum Creek below Louviers)	549	202
TOTAL	7,450	1,520

Table 11

CHERRY CREEK RESERVOIR
TOTAL PHOSPHORUS LOADING
(POUNDS/YEAR)

	1985		1990		2000		2010	
	L	H	L	H	L	H	L	H
Unmonitored Area	417	580	462	742	615	1,164	792	1,671
Cherry Creek	1,209	1,778	1,807	3,165	3,184	6,109	4,950	8,563
Happy Canyon Creek	143	347	318	1,057	831	2,030	1,406	2,588
Lone Tree Creek	169	502	436	1,491	1,786	5,514	3,957	12,465
Cottonwood Creek	144	299	388	1,640	1,196	3,367	2,547	5,421
Piney Creek	245	341	338	529	509	776	644	1,098
Shop Creek	2,429	2,975	2,429	3,488	2,429	4,719	2,429	4,719
TOTAL	4,750	6,820	6,180	12,110	10,560	23,680	16,730	36,530

Table 12

CHATFIELD RESERVOIR
TOTAL PHOSPHORUS LOADING
(POUNDS/YEAR)

	1985		1990		2000		2010	
	L	H	L	H	L	H	L	H
MASSEY DRAW	146	154	160	174	167	191	172	196
DEER CREEK	934	934	984	984	1,016	1,016	1,037	1,037
PLUM CREEK	6,471	6,771	6,956	7,793	7,614	10,112	8,231	10,517
UNMONITORED AREA (WEST OF RESERVOIR)	277	277	277	277	277	277	278	278
UNMONITORED AREA (PLUM CREEK, BELOW LOUVIERS)	585	608	622	666	651	726	687	780
TOTAL	8,410	8,740	9,000	9,890	9,730	12,320	10,400	12,810

Table 13

CHERRY CREEK RESERVOIR
RUNOFF VOLUME
(ACRE-FEET/YEAR)

	1985		1990		2000		2010	
	L	H	L	H	L	H	L	H
Unmonitored Area	83	285	166	399	199	679	561	1,033
Cherry Creek	315	524	538	1,196	1,200	2,898	2,152	4,402
Happy Canyon Creek	53	172	151	631	461	1,255	812	1,612
Lone Tree Creek	90	331	282	1,082	1,306	4,242	3,007	9,792
Cottonwood Creek	61	156	205	1,091	747	2,327	1,704	3,855
Piney Creek	104	153	152	263	256	427	343	658
Shop Creek	164	240	164	329	164	563	164	563
TOTAL	870	1,860	1,660	5,000	4,330	12,400	8,740	21,920

Table 14

CHATFIELD RESERVOIR
RUNOFF VOLUME (ACRE-FEET/YEAR)

	1985		1990		2000		2010	
	L	H	L	H	L	H	L	H
MASSEY DRAW	118	129	135	153	143	174	149	178
DEER CREEK	303	303	345	345	373	373	391	391
PLUM CREEK	1,343	1,526	1,658	2,140	2,056	3,357	2,407	3,653
UNMONITORED AREA (WEST OF RESERVOIR)	44	44	44	44	44	44	44	44
UNMONITORED AREA (PLUM CREEK, BELOW LOUVIERS)	234	251	265	300	294	356	325	400
TOTAL	2,040	2,250	2,450	2,980	2,910	4,300	3,320	4,670

Literature Cited and References Used

DRCOG. 1983 (in preparation) Predicting Urban Runoff Characteristics. (Technical Report from the Denver Regional Urban Runoff Program). DRCOG. Denver, Colorado.

DRCOG. 1983 (in preparation) Urban Runoff Quality in the Denver Region. DRCOG. Denver, Colorado.

APPENDIX A

1982 and Future Total Phosphorus

Loading and Runoff Volume Calculation Tables

Cherry Creek Reservoir

(Tables A-1 through A-30)

Appendix A

Footnotes on 1982 and Future Total Phosphorus Loading and Runoff Volume Tables: Cherry Creek Reservoir

1. Abbreviations of land use are as follows:

   C = Commercial
   MF = Multi-Family
   SF_{vll} = Single Family, very large lot (1 du/ac)
   SF_{ll} = Single Family, large lot (1-3 du/ac)
   SF_s = Single Family, Subdivision (3 du/ac)
   PA = Pervious Area (land minus above land uses)

   Further descriptions of land uses are contained in Clean Lakes Technical Memorandum No. 2.

2. Calculated using DRURP models and data. Assumed constant for each land use type. That is, one acre of the same land use type will produce equal lbs. of total phosphorus or acre-feet of runoff/year regardless of which sub-basin it is in. Details of the calculation of these constants are provided in the main body of this document.

3. Scaling factor (S_f) based on sub-basin PEI and the following equation:

   $S_f = 0.110$ PEI $+ 0.004$.

4. Constant scaling factor used in Shop Creek for phosphorus loading.

5. Scaling factors (S_f) based upon sub-basin PEI and the following equation:

   $S_f = 0.185$ PEI $- 0.057$.

Table A-1

1982 Estimates of Total Phosphorus Loads (Annual lbs)
for Sub-basins in Cherry Creek Basin

Land Use[1]	lbs/ac/year[2]	Shop Creek		Cottonwood		Piney Creek		Lone Tree Creek		Cherry Creek*		Unmonitored Area	
		Acres	Load	Acres	Load	Acres	Load	Acres	Load	Acres	Load	Acres	Load
C	1.990	2.5	5	173	344	0	0	0	0	86	171	0	0
MF	0.699	17	12	3.6	2.5	0	0	0	0	21.5	15	62	43
SF_{vll}	0.070	0	0	0	0	2,022	142	0	0	9,083**	2,789**	0	0
SF_{ll}	0.166	19	3	68	11	2,008	333	96	16	-	-	621	103
SF_s	0.834	238	198	182	152	151	126	0	0	-	-	559	466
PA	0.027	335	9	5,126	138	9,569	258	2,749	74	205,142	5,539	5,383	144
Total			227		648		859		90		8,514		756
Basin PEI			11.5		4.5		2.2		3.4		0.60		4.3
Scaling Factor[3]			10.7[4]		0.53		0.26		0.40		0.07		0.50
Adjusted Load			2,429		343		223		36		596		378

* - Includes Happy Canyon Creek.
** - Breakdown of single family not possible. Used 0.288 lbs/ac/year average loading rate.

Table A-2

1982 Estimates of Runoff Volumes (acre-feet)
for Sub-basins in Cherry Creek Basin

Land Use[1]	Inches runoff[2] ac/year	Shop Creek		Cottonwood		Piney Creek		Lone Tree Creek		Cherry Creek*		Unmonitored Area	
		Acres	ac-ft.	Acres	ac-ft.	Acres	ac-ft.	Acres	ac-ft.	Acres	ac-ft.	Acres	ac-ft.
C	11.95	2.5	2	173	172	0	0	0	0	86	86	0	0
MF	7.60	17	11	3.6	2	0	0	0	0	21.5	14	62	39
SF_{vll}	0.38	0	0	0	0	2,022	64	0	0	9,683**	1,130**	0	0
SF_{ll}	0.87	19	1	68	5	2,008	147	96	7	-	-	621	45
SF_s	3.17	238	62	182	47	151	39	0	0	-	-	559	145
PA	0.014	335	1	5,126	6	9,569	11	2,749	3	205,142	246	5,383	6
Total			77		232		261		10		1,476		235
Basin PEI			11.5		4.5		2.2		3.4		0.60		4.3
Scaling Factor[5]			2.07		0.78		0.35		0.57		0.05		0.74
Adjusted Runoff			159		181		91		5.7		74		174

* - Includes Happy Canyon Creek
** - Breakdown of single family not possible. Used 1.4 ac-ft/ac/year average.

Table A-3

Shop Creek Total Phosphorus Loading (pounds/year)
Low Growth Scenario

		1985		1990		2000		2010	
Land Use[1]	lbs/acre[2] / Year	Acres	Load	Acres	Load	Acres	Load	Acres	Load
C	1.990	3	6	3	6	3	6	3	6
MF	0.699	17	12	17	12	17	12	17	12
SF_{vll}	0.070	0	0	0	0	0	0	0	0
SF_{ll}	0.166	19	3	19	3	19	3	19	3
SF_s	0.834	238	197	238	197	238	197	238	197
PA	0.027	333	9	333	9	333	9	333	9
Total Load			227		227		227		227
Basin PEI			11.5		11.5		11.5		11.5
Scaling Factor[4]			10.7		10.7		10.7		10.7
Adj. Load			2429		2429		2429		2429

Table A-4

Shop Creek Total Phosphorus Loading (pounds/year)
High Growth Scenario

Land Use[1]	lbs/acre[2] Year	1985 Acres	1985 Load	1990 Acres	1990 Load	2000 Acres	2000 Load	2010 Acres	2010 Load
C	1.990	3	6	3	6	3	6	3	6
MF	0.699	17	12	17	12	17	12	17	12
SF_{vll}	0.070	0	0	0	0	0	0	0	0
SF_{ll}	0.166	19	3	19	3	19	3	19	3
SF_s	0.834	300	250	360	299	490	407	490	407
PA	0.027	271	7	211	6	81	13	81	13
Total Load			278		326		441		441
Basin PEI			14.0		16.3		21.3		21.3
Scaling Factor[4]			10.7		10.7		10.7		10.7
Adj. Load			2975		3488		4719		4719

Table A-5

Cottonwood Creek Total Phosphorus Loading (pounds/year)
Low Growth Scenario

Land Use[1]	lbs/acre[2] / Year	1985 Acres	1985 Load	1990 Acres	1990 Load	2000 Acres	2000 Load	2010 Acres	2010 Load
C	1.990	80	159.2	180	358.2	380	756.2	600	1194.0
MF	0.699	4	2.8	4	2.8	4	2.8	4	2.8
SF_{vll}	0.070	0	0	0	0	0	0	0	0
SF_{ll}	0.166	60	10.0	60	10.0	60	10.0	60	10.0
SF_s	0.834	210	175.1	230	191.8	300	250.2	380	316.9
PA	0.027	5487	148.1	5277	142.5	4847	130.9	4417	119.3
Total Load			495		705		1150		1643
Basin PEI			2.5		4.7		8.9		13.3
Scaling Factor[3]			0.29		0.55		1.04		1.55
Adj. Load			144		388		1196		2547

Table A-6

Cottonwood Creek Total Phosphorus Loading (pounds/year)
High Growth Scenario

Land Use[1]	lbs/acre[2] Year	1985 Acres	1985 Load	1990 Acres	1990 Load	2000 Acres	2000 Load	2010 Acres	2010 Load
C	1.990	170	338.3	500	995.0	730	1452.7	950	1890.5
MF	0.699	4	2.9	4	2.8	4	2.8	4	2.8
SF_{vll}	0.070	0	0	0	0	0	0	0	0
SF_{ll}	0.166	60	10.0	60	10.0	60	10.0	60	10.0
SF_s	0.834	220	183.3	250	208.5	360	300.2	420	350.3
PA	0.027	5397	145.7	4767	128.7	4267	115.2	3841	103.7
Total Load			680		1345		1881		2357
Basin PEI			3.8		10.5		15.4		19.8
Scaling Factor[3]			0.44		1.22		1.79		2.3
Adj. Load			299		1640		3367		5421

Table A-7

Piney Creek Total Phosphorus Loading (pounds/year)
Low Growth Scenario

Land Use[1]	lbs/acre[2] Year	1985 Acres	1985 Load	1990 Acres	1990 Load	2000 Acres	2000 Load	2010 Acres	2010 Load
C	1.990	8	16	8	16	10	20	12	24
MF	0.699	0	0	0	0	0	0	0	0
SF_{vll}	0.070	2220	152	2580	177	3690	253	4860	332
SF_{ll}	0.166	1800	298	2050	340	2200	353	2470	410
SF_s	0.834	230	191	310	258	470	391	470	391
PA	0.027	9492	251	8802	233	7380	195	5938	157
Total Load			908		1024		1212		1314
Basin PEI			2.3		2.8		3.6		4.2
Scaling Factor[3]			0.27		0.33		0.42		0.49
Adj. Load			245		338		509		644

Table A-8

Piney Creek Total Phosphorus Loading (pounds/year)
High Growth Scenario

Land Use[1]	lbs/acre[2] Year	1985 Acres	1985 Load	1990 Acres	1990 Load	2000 Acres	2000 Load	2010 Acres	2010 Load
C	1.990	8	16	9	18	15	30	18	36
MF	0.699	0	0	0	0	0	0	0	0
SF_{vll}	0.070	2790	196	3540	248	5740	402	8070	565
SF_{ll}	0.166	1980	329	2440	405	2760	458	3300	548
SF_s	0.834	310	259	470	392	470	392	470	392
PA	0.027	8662	234	7291	197	4765	129	1892	51
Total Load			1034		1260		1411		1592
Basin PEI			2.8		3.6		4.7		5.9
Scaling Factor[3]			0.33		0.42		0.55		0.69
Adj. Load			341		529		776		1098

Table A-9

Lone Tree Creek Total Phosphorus Loading (pounds/year)
Low Growth Scenario

Land Use[1]	lbs/acre[2] / Year	1985 Acres	1985 Load	1990 Acres	1990 Load	2000 Acres	2000 Load	2010 Acres	2010 Load
C	1.990	70	139	160	318	400	796	630	1254
MF	0.699	0	0	0	0	0	0	0	0
SF_{vll}	0.070	0	0	0	0	0	0	0	0
SF_{ll}	0.166	100	17	100	17	100	17	100	17
SF_s	0.834	3	3	3	3	3	3	3	3
PA	0.027	2577	70	2437	66	2047	55	1657	45
Total Load			229		404		871		1319
Basin PEI			6.3		9.3		17.6		25.8
Scaling Factor[3]			0.74		1.08		2.05		3.00
Adj. Load			169		436		1786		3957

Table A-10

Lone Tree Creek Total Phosphorus Loading (pounds/year)
High Growth Scenario

Land Use[1]	lbs/acre[2] Year	1985 Acres	1985 Load	1990 Acres	1990 Load	2000 Acres	2000 Load	2010 Acres	2010 Load
C	1.990	180	358	360	716	760	1512	1180	2348
MF	0.699	0	0	0	0	0	0	0	0
SF_{vll}	0.070	0	0	0	0	0	0	0	0
SF_{ll}	0.166	100	17	100	17	100	17	100	17
SF_s	0.834	3	3	3	3	3	3	3	3
PA	0.027	2430	66	2117	57	1447	39	747	20
Total Load			444		793		1571		2388
Basin PEI			9.7		16.2		30.2		45
Scaling Factor[3]			1.13		1.88		3.51		5.22
Adj. Load			502		1491		5514		12465

Table A-11

Happy Canyon Total Phosphorus Loading (pounds/year)
Low Growth Scenario

Land Use[1]	lbs/acre[2] Year	1985 Acres	1985 Load	1990 Acres	1990 Load	2000 Acres	2000 Load	2010 Acres	2010 Load
C	1.990	40	80	90	179	210	418	290	577
MF	0.699	2	1.4	5	3.5	8	5.6	8	5.6
SF_{vll}	0.070	160	11.2	200	14	240	16.8	260	18.2
SF_{ll}	0.166	1090	181	1250	208	1340	222	1500	249
SF_s	0.834	100	83.4	180	150	390	325	610	509
PA	0.027	7980	215	7487	202	6824	184	6274	169
Total Load			572		756		1171		1528
Basin PEI			2.1		3.6		6.1		7.9
Scaling Factor[3]			0.25		0.42		0.71		0.92
Adj. Load			143		318		831		1406

Table A-12

Happy Canyon Total Phosphorus Loading (pounds/year)
High Growth Scenario

Land Use[1]	lbs/acre[2] / Year	1985 Acres	1985 Load	1990 Acres	1990 Load	2000 Acres	2000 Load	2010 Acres	2010 Load
C	1.990	130	259	310	617	420	836	460	915
MF	0.699	4	2.8	9	6.3	10	7	11	7.7
SF_{vll}	0.070	220	15.4	300	21	360	25.2	400	28
SF_{ll}	0.166	1180	196	1450	241	1600	266	1820	302
SF_s	0.834	180	150	270	225	570	475	750	626
PA	0.027	7568	204	6643	179	5792	156	5281	143
Total Load			827		1289		1765		2022
Basin PEI			3.6		7.0		9.9		11.0
Scaling Factor[3]			0.42		0.82		1.15		1.28
Adj. Load			347		1057		2030		2588

Table A-13

Cherry Creek Total Phosphorus Loading (pounds/year)
Low Growth Scenario

Land Use[1]	lbs/acre[2] Year	1985 Acres	1985 Load	1990 Acres	1990 Load	2000 Acres	2000 Load	2010 Acres	2010 Load
C	1.990	440	875.6	580	1,154.2	1,190	2,368.1	1,650	3,283.5
MF	0.699	58	40.5	105	73.4	172	120.2	422	295.0
SF_{vll}	0.070	10,980	7,686	12,840	898.8	14,440	1,010.8	15,550	1,088.5
SF_{ll}	0.166	10,410	1,728.1	12,620	2,094.9	14,580	2,420.3	15,960	2,649.4
SF_s	0.834	1,160	967.4	1,950	1,626.3	3,260	2,718.8	5,190	4,328.5
PA	0.027	182,278	4,921.5	177,081	4,781.2	171,364	4,626.8	160,114	4,323.1
Total Load			9,302		10,629		13,265.0		15,968.0
Basin PEI			1.1		1.4		2.0		2.6
Scaling Factor[3]			0.13		0.17		0.24		0.31
Adj. Load			1,209		1,807		3,184		4,950

Table A-14

Cherry Creek Total Phosphorus Loading (pounds/year)
High Growth Scenario

Land Use[1]	lbs/acre[2] Year	1985 Acres	1985 Load	1990 Acres	1990 Load	2000 Acres	2000 Load	2010 Acres	2010 Load
C	1.990	520	1,035	880	1,751	1,810	3,602	2,520	5,015
MF	0.699	76	53	161	113	390	273	649	454
SF_{vll}	0.070	13,440	941	17,270	1,209	19,990	1,399	22,280	1,560
SF_{ll}	0.166	13,160	2,185	17,650	2,930	20,650	3,428	23,230	3,856
SF_s	0.834	1,780	1,485	3,250	2,710	5,430	4,529	6,560	5,471
PA	0.027	176,280	4,760	165,785	4,476	156,426	4,223	149,347	4,032
Total Load			10,459		13,189		17,454		20,388
Basin PEI			1.4		2.0		3.0		3.6
Scaling Factor[3]			0.17		0.24		0.35		0.42
Adj. Load			1,778		3,165		6,109		8,563

Table A-15

Unmonitored Area Total Phosphorus Loading (pounds/year)
Low Growth Scenario

Land Use[1]	lbs/acre[2] Year	1985 Acres	1985 Load	1990 Acres	1990 Load	2000 Acres	2000 Load	2010 Acres	2010 Load
C	1.990	15	29.9	35	69.7	90	179.1	140	278.6
MF	0.699	60	41.9	60	41.9	60	41.9	60	41.9
SF_{vll}	0.070	0	0	0	0	0	0	0	0
SF_{ll}	0.166	620	102.9	620	102.9	620	102.9	620	102.9
SF_s	0.834	560	467.0	560	467.0	560	467.0	560	467.0
PA	0.027	5355	144.6	5325	143.8	5230	141.2	5140	138.8
Total Load			786		825		932		1029
Basin PEI			4.5		4.8		5.7		6.6
Scaling Factor[3]			0.53		0.56		0.66		0.77
Adj. Load			417		462		615		792

Table A-16

Unmonitored Area Total Phosphorus (pounds/year)
High Growth Scenario

Land Use[1]	lbs/acre[2] Year	1985 Acres	1985 Load	1990 Acres	1990 Load	2000 Acres	2000 Load	2010 Acres	2010 Load
C	1.990	30	59.7	70	139.3	180	358.2	290	577.1
MF	0.699	70	48.9	95	66.4	95	66.4	95	66.4
SF_{vll}	0.070	0	0	0	0	0	0	0	0
SF_{ll}	0.166	620	102.9	620	102.9	620	102.9	620	102.9
SF_s	0.834	700	583.8	700	583.8	710	592.1	710	592.1
PA	0.027	5180	139.9	5085	137.3	4895	132.2	4705	127.0
Total Load			935		1030		1252		1466
Basin PEI			5.3		6.2		8.0		9.8
Scaling Factor[3]			0.62		0.72		0.93		1.14
Adj. Load			580		742		1164		1671

Table A-17

Shop Creek Annual Runoff Volume (Acre-feet)
Low Growth Scenario

Land Use [1]	In. R.O./Ac.[2] Per Year	1985 Acres	1985 Ac-ft.	1990 Acres	1990 Ac-ft.	2000 Acres	2000 Ac-ft.	2010 Acres	2010 Ac-ft.
C	11.95	3	3	3	3	3	3	3	3
MF	7.60	17	11	17	11	17	11	17	11
SF_{vll}	0.38	0	0	0	0	0	0	0	0
SF_{ll}	0.87	19	1	19	1	19	1	19	1
SF_s	3.17	238	63	238	63	238	63	238	63
PA	0.014	333	1	333	1	333	1	333	1
Total			79		79		79		79
Basin PEI			11.5		11.5		11.5		11.5
Scaling Factor [5]			2.07		2.07		2.07		2.07
Adjusted Volume			164		164		164		164

Table A-18

Shop Creek Annual Runoff Volume (Acre-feet)
High Growth Scenario

Land Use [1]	In. R.O./Ac.[2] Per Year	1985 Acres	1985 Ac-ft.	1990 Acres	1990 Ac-ft.	2000 Acres	2000 Ac-ft.	2010 Acres	2010 Ac-ft.
C	11.95	3	3	3	3	3	3	3	3
MF	7.60	17	11	17	11	17	11	17	11
SF_{vll}	0.38	0	0	0	0	0	0	0	0
SF_{ll}	0.87	19	1	19	1	19	1	19	1
SF_s	3.17	300	79	360	95	490	129	490	129
PA	0.014	271	1	211	1	81	1	81	1
Total			95		111		145		145
Basin PEI			14.0		16.3		21.3		21.3
Scaling Factor [5]			2.53		2.96		3.88		3.88
Adjusted Volume			240		329		563		563

Table A-19

Cottonwood Creek Annual Runoff Volume (Acre-feet)
Low Growth Scenario

Land Use [1]	In. R.O./Ac.[2] Per Year	1985 Acres	1985 Ac-ft.	1990 Acres	1990 Ac-ft.	2000 Acres	2000 Ac-ft.	2010 Acres	2010 Ac-ft.
C	11.95	80	80	180	179	380	378	600	598
MF	7.60	4	3	4	3	4	3	4	3
SF_{vll}	0.38	0	0	0	0	0	0	0	0
SF_{ll}	0.87	60	4	60	4	60	4	60	4
SF_s	3.17	210	55	230	61	300	79	380	100
PA	0.014	5487	6	5277	6	4847	6	4417	5
Total			148		253		470		710
Basin PEI			2.5		4.7		8.9		13.3
Scaling Factor [5]			0.41		0.81		1.59		2.4
Adjusted Volume			61		205		747		1704

Table A-20

Cottonwood Creek Annual Runoff Volume (Acre-feet)
High Growth Scenario

Land Use [1]	In. R.O./Ac.[2] Per Year	1985 Acres	1985 Ac-ft.	1990 Acres	1990 Ac-ft.	2000 Acres	2000 Ac-ft.	2010 Acres	2010 Ac-ft.
C	11.95	170	169	500	498	730	727	950	946
MF	7.60	4	3	4	3	4	3	4	3
SF_{vll}	0.38	0	0	0	0	0	0	0	0
SF_{ll}	0.87	60	4	60	4	60	4	60	4
SF_s	3.17	220	58	250	66	360	95	420	111
PA	0.014	5397	6	4767	6	4267	5	3841	4
Total			240		577		834		1068
Basin PEI			3.8		10.5		15.4		19.8
Scaling Factor [5]			0.65		1.89		2.79		3.61
Adjusted Volume			156		1091		2327		3855

Table A-21

Piney Creek Runoff Volume (Acre-feet)
Low Growth Scenario

Land Use [1]	In. R.O./Ac.[2] Per Year	1985		1990		2000		2010	
		Acres	Ac-ft.	Acres	Ac-ft.	Acres	Ac-ft.	Acres	Ac-ft.
C	11.95	8	8	8	8	10	10	12	12
MF	7.60	0	0	0	0	0	0	0	0
SF_{vll}	0.38	2220	70	2580	82	3690	117	4860	154
SF_{ll}	0.87	1800	130	2050	149	2200	160	2470	179
SF_{s}	3.17	230	61	310	82	470	124	470	124
PA	0.014	9492	11	8802	10	7380	9	5938	7
Total			280		331		420		476
Basin PEI			2.3		2.8		3.6		4.2
Scaling Factor [5]			0.37		0.46		0.61		0.72
Adjusted Volume			104		152		256		343

Table A-22

Piney Creek Runoff Volume (Acre-feet)
High Growth Scenario

Land Use [1]	In. R.O./Ac.[2] Per Year	1985 Acres	1985 Ac-ft.	1990 Acres	1990 Ac-ft.	2000 Acres	2000 Ac-ft.	2010 Acres	2010 Ac-ft.
C	11.95	8	8	9	9	15	15	18	18
MF	7.60	0	0	0	0	0	0	0	0
SF_{vll}	0.38	2790	88	3540	112	5740	182	8070	256
SF_{ll}	0.87	1980	144	2440	177	2760	200	3300	239
SF_s	3.17	310	82	470	124	470	124	470	124
PA	0.014	8662	10	7291	9	4765	6	1892	2
Total			332		431		527		639
Basin PEI			2.8		3.6		4.7		5.9
Scaling Factor [5]			0.46		0.61		0.81		1.03
Adjusted Volume			153		263		427		658

Table A-23

Lone Tree Annual Runoff Volume (Acre-feet)
Low Growth Scenario

Land Use [1]	In. R.O./Ac.[2] Per Year	1985 Acres	1985 Ac-ft.	1990 Acres	1990 Ac-ft.	2000 Acres	2000 Ac-ft.	2010 Acres	2010 Ac-ft.
C	11.95	70	70	160	159	400	398	630	627
MF	7.60	0	0	0	0	0	0	0	0
SF_{vll}	0.38	0	0	0	0	0	0	0	0
SF_{ll}	0.87	100	7	100	7	100	7	100	7
SF_s	3.17	3	1	3	1	3	1	3	1
PA	0.014	2577	3	2437	3	2047	2	1657	2
Total			81		170		408		637
Basin PEI			6.3		9.3		17.6		25.8
Scaling Factor [5]			1.11		1.66		3.2		4.72
Adjusted Volume			90		282		1306		3007

Table A-24

Lone Tree Annual Runoff Volume (Acre-feet)
High Growth Scenario

Land Use [1]	In. R.O./Ac.[2] Per Year	1985 Acres	1985 Ac-ft.	1990 Acres	1990 Ac-ft.	2000 Acres	2000 Ac-ft.	2010 Acres	2010 Ac-ft.
C	11.95	180	179	360	358	760	757	1180	1175
MF	7.60	0	0	0	0	0	0	0	0
SF_{vll}	0.38	0	0	0	0	0	0	0	0
SF_{ll}	0.87	100	7	100	7	100	7	100	7
SF_s	3.17	3	1	3	1	3	1	3	1
PA	0.014	2430	3	2117	2	1447	2	747	1
Total			190		368		767		1184
Basin PEI			9.7		16.2		30.2		45.0
Scaling Factor [5]			1.74		2.94		5.53		8.27
Adjusted Volume			331		1082		4242		9792

Table A-25

Happy Canyon Runoff Volume (Acre-feet)
Low Growth Scenario

Land Use[1]	In. R.O./Ac.[2] Per Year	1985 Acres	1985 Ac-ft.	1990 Acres	1990 Ac-ft.	2000 Acres	2000 Ac-ft.	2010 Acres	2010 Ac-ft.
C	11.95	40	40	90	90	210	210	290	290
MF	7.60	2	1	5	3	8	5	8	5
SF_{vll}	0.38	160	5	200	6	240	8	260	8
SF_{ll}	0.87	1090	79	1250	91	1340	97	1500	109
SF_s	3.17	100	26	180	48	390	103	610	161
PA	0.014	7980	9	7487	9	6824	8	6274	7
Total			160		247		431		580
Basin PEI			2.1		3.6		6.1		7.9
Scaling Factor[5]			0.33		0.61		1.07		1.4
Adjusted Volume			53		151		461		812

Table A-26

Happy Canyon Runoff Volume (Acre-feet)
High Growth Scenario

Land Use [1]	In. R.O./Ac.[2] Per Year	1985		1990		2000		2010	
		Acres	Ac-ft.	Acres	Ac-ft.	Acres	Ac-ft.	Acres	Ac-ft.
C	11.95	130	129	310	309	420	418	460	458
MF	7.60	4	3	9	6	10	6	11	7
SF_{vll}	0.38	220	7	300	10	360	11	400	13
SF_{ll}	0.87	1180	86	1450	105	1600	116	1820	132
SF_s	3.17	180	48	270	71	570	151	750	198
PA	0.014	7568	9	6643	8	5792	7	5281	6
Total			282		509		709		814
Basin PEI			3.6		7.0		9.9		11.0
Scaling Factor[5]			0.61		1.24		1.77		1.98
Adjusted Volume			172		631		1255		1612

Table A-27

Cherry Creek Annual Runoff Volume (Acre-feet)
Low Growth Scenario

Land Use [1]	In. R.O./Ac.[2] Per Year	1985 Acres	1985 Ac-ft.	1990 Acres	1990 Ac-ft.	2000 Acres	2000 Ac-ft.	2010 Acres	2010 Ac-ft.
C	11.95	440	438	580	578	1,190	1,185	1,650	1,643
MF	7.60	58	37	105	66	172	109	422	267
SF_{vll}	0.38	10,980	348	12,840	407	14,440	457	15,550	492
SF_{ll}	0.87	10,410	755	12,620	915	14,580	1,057	15,960	1,157
SF_s	3.17	1,160	306	1,950	515	3,260	862	5,190	1,371
PA	0.014	182,278	213	177,081	207	171,364	200	166,114	194
Total			2,097		2,688		3,870		5,124
Basin PEI			1.1		1.4		2.0		2.6
Scaling Factor [5]			0.15		0.20		0.31		0.42
Adjusted Volume			315		538		1,200		2,152

Table A-28

Cherry Creek Annual Runoff Volume (Acre-feet)
High Growth Scenario

Land Use[1]	In. R.O./Ac.[2] Per Year	1985 Acres	1985 Ac-ft.	1990 Acres	1990 Ac-ft.	2000 Acres	2000 Ac-ft.	2010 Acres	2010 Ac-ft.
C	11.95	520	518	880	876	1,810	1,802	2,520	2,509
MF	7.60	76	48	161	102	390	247	649	411
SF_{vll}	0.38	13,440	426	17,270	547	19,990	633	22,280	706
SF_{ll}	0.87	13,160	954	17,650	1,280	20,650	1,497	23,230	1,684
SF_s	3.17	1,780	470	3,250	859	5,430	1,434	6,560	1,733
PA	0.014	176,280	206	165,785	193	156,426	182	149,347	174
Total			2,620		3,857		5,795		7,217
Basin PEI			1.4		2.0		3.0		3.6
Scaling Factor[5]			0.2		0.31		0.5		0.61
Adjusted Volume			524		1,196		2,898		4,402

Table A-29

Unmonitored Area Runoff Volume (Acre-feet)
Low Growth Scenario

Land Use[1]	In. R.O./Ac.[2] Per Year	1985 Acres	1985 Ac-ft.	1990 Acres	1990 Ac-ft.	2000 Acres	2000 Ac-ft.	2010 Acres	2010 Ac-ft.
C	11.95	15	15	35	35	90	90	140	139
MF	7.60	60	38	60	38	60	38	100	63
SF_{vll}	0.38	0	0	0	0	0	0	0	0
SF_{ll}	0.87	620	45	620	45	620	45	620	45
SF_s	3.17	560	148	560	148	560	148	560	148
PA	0.014	5,355	6	5,325	6	5,230	6	5,140	6
Total			252		272		327		401
Basin PEI			2.1		3.6		6.1		7.9
Scaling Factor[5]			0.33		0.61		0.61		1.4
Adjusted Volume			83		166		199		561

Table A-30

Unmonitored Area Runoff Volume (Acre-feet)
High Growth Scenario

Land Use [1]	In. R.O./Ac. [2] Per Year	1985 Acres	1985 Ac-ft.	1990 Acres	1990 Ac-ft.	2000 Acres	2000 Ac-ft.	2010 Acres	2010 Ac-ft.
C	11.95	30	30	70	70	180	179	290	289
MF	7.60	70	44	95	60	95	60	95	60
SF_{vll}	0.38	0	0	0	0	0	0	0	0
SF_{ll}	0.87	620	45	620	45	620	45	620	45
SF_s	3.17	700	185	700	185	710	188	710	188
PA	0.014	5,180	6	5,085	6	4,895	6	4,705	5
Total			310		366		478		587
Basin PEI			5.3		6.2		8.0		9.8
Scaling Factor [5]			0.92		1.09		1.42		1.76
Adjusted Volume			285		399		679		1,033

APPENDIX B

1982 and Future Total Phosphorus

Loading and Runoff Volume Calculation Tables

Chatfield Reservoir

(Tables B-1 through B-18)

Appendix B

Footnotes on 1982 and Future Total Phosphorus Loadings and Runoff Volume Tables: Chatfield Reservoir

1 - Abbreviations of Land Use are as follows:

C = Commercial
MF = Multi-Family
SF_{vll} = Single Family, very large lot (< 1 du/ac)
SF_{ll} = Single Family, large lot (1-3 du/ac)
SF_s = Single Family, Subdivision (> 3 du/ac)
PA = Pervious Area (land minus above land uses)

Further descriptions of land uses are contained in Clean Lakes Technical Memorandum No. 2.

2 - Calculated using DRURP data and models. Assumed constant for each land use type. That is, one acre of the same land use type will produce equal lbs. of total phosphorus/year regardless of which sub-basin it is in. Details of the calculation of these figures are provided in the main body of this document.

3 - Calculated using DRURP data and models. Assumed constant for each land use type. That is, one acre of the same land use type will produce equal inches of runoff/year regardless of the sub-basin it is in.

4 - A constant scaling factor representing the sub-basin mean ($\overline{S}f$) was used for each sub-basin within the Chatfield Basin. Scaling factors did not change with time.

5 - Growth was minimal or consistent between projections within sub-basin so that low and high growth scenarios were equal.

Ta B-1

1982 Estimates of Total Phosphorus Loads (Annual lbs.)
for Sub-basins in Chatfield Basin

Land Use[1]	lbs/ac/year[2]	Massey Draw		Deer Creek		Plum Creek		Unmonitored Areas West of Res.		Unmonitored Areas Below Plum Creek	
		Acres	Load	Acres	Load	Acres	Load	Acres	Load	Acres	Load
C	1.640	0	0	66	108	182	298	0	0	99	162
MF	0.575	61	35	0	0	36	21	0	0	0	0
SFvll	0.058	0	0	22	1	2,732*	647*	0	0	0	0
SFll	0.136	6	1	66	9	-	-	8	1	667	91
SFs	0.686	565	388	0	0	-	-	25	17	0	0
PA	0.022	5,369	118	21,662	477	177,972	3,915	8,315	183	23,180	510
Total			542		595		4,881		201		763
Basin PEI			3.1		0.30		0.50		0.1		1.8
Scaling Factor[4]			0.23		1.33		1.17		1.37		0.72
Adjusted Load			125		791		5,711		275		549

* - Breaddown of single family not possible. Used 0.237 lbs/ac/year average.

Ta. B-2

1982 Estimates of Runoff Volumes (Acre-feet)
for Sub-basins in Chatfield Basin

Land Use[1]	inches runoff[3] ac/year	Massey Draw		Deer Creek		Plum Creek		Unmonitored Areas West of Res.		Unmonitored Areas Below Plum Creek	
		Acres	ac-ft.	Acres	ac-ft.	Acres	ac-ft.	Acres	ac-ft.	Acres	Ac-ft.
C	9.82	0	0	66	54	182	149	0	0	99	81
MF	6.25	61	74	0	0	36	19	0	0	0	0
SF_{vll}	0.31		0	22	0.6	2,732*	262*	0	0	0	0
SF_{ll}	0.72	6	0.4	66	4	-	-	8	0.5	667	40
SF_s	2.61	565	123	0	0	-	-	25	5	0	0
PA	0.012	5,369	5	21,662	22	177,972	178	8,315	8	23,180	23
Total			202		81		608		14		144
Basin PEI			3.1		0.3		0.5		0.1		1.8
Scaling Factor[4]			0.56		2.21		1.61		3.0		1.4
Adjusted Runoff			113		179		979		42		202

* - Breakdown of single family not possible. Used 1.15 inches runoff/ac/year average.

Tab' B-3

MASSEY DRAW TOTAL PHOSPHORUS LOADING (POUNDS/YEAR)
LOW GROWTH SCENARIO

Land-Use[1]	lbs/acre[2] Year	1985 Acres	1985 Load	1990 Acres	1990 Load	2000 Acres	2000 Load	2010 Acres	2010 Load
C	1.64	35	57.4	55	90.2	70	115	80	131
MF	0.575	70	40.2	80	46	80	46	80	46
SF_{vll}	0.058	190	11.0	220	12.8	220	12.8	220	12.8
SF_{ll}	0.136	196	26.7	226	30.7	226	30.7	226	30.7
SF_s	0.686	570	391	600	412	610	418	620	425
PA	0.022	4,892	108	4,707	104	4,622	102	4,552	100
Total Load			634		696		724		746
Basin PEI			3.1		3.1		3.1		3.1
Scaling Factor[4]			0.23		0.23		0.23		0.23
Adjusted Load			146		160		167		172

Table B-4

MASSEY DRAW TOTAL PHOSPHORUS LOADING (POUNDS/YEAR)
HIGH GROWTH SCENARIO

Land-Use[1]	lbs/acre[2] Year	1985		1990		2000		2010	
		Acres	Load	Acres	Load	Acres	Load	Acres	Load
C	1.64	50	82	80	131	120	197	120	197
MF	0.575	75	43	90	51.8	90	51.8	90	51.8
SF_{vll}	0.058	215	12.5	250	14.5	250	14.5	250	14.5
SF_{ll}	0.136	220	30	260	35.4	260	35.4	260	35.4
SF_s	0.686	580	398	620	425	640	439	670	460
PA	0.022	4,758	105	4,488	98.7	4,208	92.6	4,178	91.9
Total Load			670		756		830		851
Basin PEI			3.1		3.1		3.1		3.1
Scaling Factor[4]			0.23		0.23		0.23		0.23
Adjusted Load			154		174		191		196

Table B-5

DEER CREEK TOTAL PHOSPHORUS LOADING (POUNDS/YEAR)
LOW AND HIGH GROWTH SCENARIO[5]

Land-Use[1]	lbs/acre[2] Year	1985 Acres	1985 Load	1990 Acres	1990 Load	2000 Acres	2000 Load	2010 Acres	2010 Load
C	1.64	115	189	130	213	145	238	155	254
MF	0.575	10	5.8	13	7.5	13	7.5	13	7.5
SF_{vll}	0.058	175	10.1	200	11.6	200	11.6	200	11.6
SF_{ll}	0.136	180	24.5	240	32.6	240	32.6	240	32.6
SF_s	0.686	6	4.1	13	8.9	13	8.9	13	8.9
PA	0.022	21,304	469	21,179	466	21,154	465	21,144	465
Total Load			702		740		764		780
Basin PEI			0.3		0.3		0.3		0.3
Scaling Factor[4]			1.33		1.33		1.33		1.33
Adjusted Load			934		984		1,016		1,037

Table ' 5

PLUM CREEK TOTAL PHOSPHORUS LOADING (POUNDS/YEAR)
LOW GROWTH SCENARIO

Land-Use[1]	lbs/acre[2] Year	1985		1990		2000		2010	
		Acres	Load	Acres	Load	Acres	Load	Acres	Load
C	1.64	305	500	370	607	410	672	410	672
MF	0.575	106	61	150	86	230	132	290	167
SF_{vll}	0.058	3,165	184	3,710	215	4,140	240	4,560	264
SF_{ll}	0.136	2,250	306	3,130	426	3,970	540	4,870	662
SF_s	0.686	580	398	830	569	1,350	926	1,920	1,317
PA	0.022	185,530	4,082	183,735	4,042	181,705	3,998	179,685	3,953
Total Load			5,531		5,945		6,508		7,035
Basin PEI			0.5		0.5		0.5		0.5
Scaling Factor[4]			1.17		1.17		1.17		1.17
Adjusted Load			6,471		6,956		7,614		8,231

Tab B-7

PLUM CREEK TOTAL PHOSPHORUS LOADING (POUNDS/YEAR)
HIGH GROWTH SCENARIO

Land-Use[1]	lbs/acre[2] Year	1985 Acres	1985 Load	1990 Acres	1990 Load	2000 Acres	2000 Load	2010 Acres	2010 Load
C	1.64	340	558	390	640	460	754	610	1,000
MF	0.575	130	74.8	230	132	280	161	300	172
SF_{vll}	0.058	3,850	223	4,880	283	5,430	315	6,030	350
SF_{ll}	0.136	2,450	333	3,950	537	6,920	941	7,500	1,020
SF_s	0.686	790	542	1,590	1,091	3,830	2,627	3,840	2,624
PA	0.022	184,365	4,056	180,836	3,978	174,760	3,845	173,325	3,813
Total Load			5,787		6,661		8,643		8,989
Basin PEI			0.5		0.5		0.5		0.5
Scaling Factor[4]			1.17		1.17		1.17		1.17
Adjusted Load			6,771		7,793		10,112		10,517

Tal B-8

UNMONITORED AREA WEST OF RESERVOIR TOTAL PHOSPHORUS LOADING (POUNDS/YEAR)
HIGH AND LOW GROWTH SCENARIO[5]

Land-Use[1]	lbs/acre[2] Year	1985 Acres	1985 Load	1990 Acres	1990 Load	2000 Acres	2000 Load	2010 Acres	2010 Load
C	1.64	0	0	0	0	0	0	0	0
MF	0.575	0	0	0	0	0	0	0	0
SF_{vll}	0.058	0	0	0	0	0	0	0	0
SF_{ll}	0.136	10	1.4	10	1.4	12	1.6	20	2.7
SF_s	0.686	25	17.2	25	17.2	25	17.2	25	17.2
PA	0.022	8,313	183	8,313	183	8,311	183	8,303	183
Total Load			202		202		202		203
Basin PEI			0.1		0.1		0.1		0.1
Scaling Factor[4]			1.37		1.37		1.37		1.37
Adjusted Load			277		277		277		278

Table B-9

UNMONITORED AREA, PLUM CREEK BELOW LOUVIERS · TOTAL PHOSPHORUS LOADING (POUNDS/YEAR)
LOW GROWTH SCENARIO

Land-Use[1]	lbs/acre[2] Year	1985 Acres	1985 Load	1990 Acres	1990 Load	2000 Acres	2000 Load	2010 Acres	2010 Load
C	1.64	110	180	120	197	120	197	120	197
MF	0.575	3	1.7	7	4.0	17	9.8	25	14.4
SF_{vll}	0.058	0	0	0	0	0	0	0	0
SF_{ll}	0.136	770	105	820	112	970	132	1,130	154
SF_s	0.686	30	20.6	70	48	100	68.6	140	96
PA	0.022	23,007	506	22,863	503	22,613	497	22,395	493
Total Load			813		864		904		954
Basin PEI			1.8		1.8		1.8		1.8
Scaling Factor[4]			0.72		0.72		0.72		0.72
Adjusted Load			585		622		651		687

Table B-10

UNMONITORED AREA, PLUM CREEK BELOW LOUVIERS TOTAL PHOSPHORUS LOADING (POUNDS/YEAR)
HIGH GROWTH SCENARIO

Land-Use[1]	lbs/acre[2] Year	1985 Acres	1985 Load	1990 Acres	1990 Load	2000 Acres	2000 Load	2010 Acres	2010 Load
C	1.64	110	180	120	197	120	197	120	197
MF	0.575	5	2.9	15	8.6	30	17.2	40	23
SF_{vll}	0.058	0	0	0	0	0	0	0	0
SF_{ll}	0.136	810	110	910	124	1,200	163	1,390	189
SF_s	0.686	70	48	140	96	210	144	282	193
PA	0.022	22,915	504	22,665	499	22,190	488	21,918	482
Total Load			845		925		1,009		1,084
Basin PEI			1.8		1.8		1.8		1.8
Scaling Factor[4]			0.72		0.72		0.72		0.72
Adjusted Load			608		666		726		780

Tab B-11

MASSEY DRAW ANNUAL RUNOFF VOLUME (ACRE-FOOT)
LOW GROWTH SCENARIO

Land Use[1]	In R.O./ac[3] Per Year	1985 Acres	1985 Ac-Ft.	1990 Acres	1990 Ac-Ft.	2000 Acres	2000 Ac.Ft.	2010 Acres	2010 Ac-Ft.
C	9.82	35	29	55	45	70	57	80	65
MF	6.25	70	36	80	42	80	42	80	42
SF_{vll}	0.31	190	4.9	220	5.7	220	5.7	220	5.7
SF_{ll}	0.72	196	11.8	226	13.6	226	13.6	226	13.6
SF_s	2.61	570	124	600	130	610	133	620	135
PA	0.012	4892	4.9	4707	4.8	4622	4.6	4552	4.6
Total			211		241		256		266
Basin PEI			3.1		3.1		3.1		3.1
Scaling Factor[4]			0.56		0.56		0.56		0.56
Adjusted Value			118		135		143		149

Table B-12

MASSEY DRAW ANNUAL RUNOFF VOLUME (ACRE-FEET)
HIGH GROWTH SCENARIO

Land Use[1]	In R.O./ac[3] Per Year	1985 Acres	1985 Ac-Ft.	1990 Acres	1990 Ac-Ft.	2000 Acres	2000 Ac.Ft.	2010 Acres	2010 Ac-Ft.
C	9.82	50	41	80	65	120	98	120	98
MF	6.25	75	39	90	47	90	47	90	47
SF_{vll}	0.31	215	5.6	250	6.5	250	6.5	250	6.5
SF_{ll}	0.72	220	13.2	260	15.6	260	15.6	260	15.6
SF_s	2.61	580	126	620	135	640	139	670	146
PA	0.012	4758	4.8	4488	4.5	4208	4.2	4178	4.2
Total			230		274		310		317
Basin PEI			3.1		3.1		3.1		3.1
Scaling Factor[4]			0.56		0.56		0.56		0.56
Adjusted Value			129		153		174		178

Tab' B-13

DEER CREEK ANNUAL RUNOFF VOLUME (ACRE-FEET)
HIGH AND LOW GROWTH SCENARIO[5]

Land Use[1]	In R.O./ac[3] Per Year	1985 Acres	1985 Ac-Ft.	1990 Acres	1990 Ac-Ft.	2000 Acres	2000 Ac.Ft.	2010 Acres	2010 Ac-Ft.
C	9.82	115	94	130	106	145	119	155	127
MF	6.25	10	5.2	13	6.8	13	6.8	13	6.8
SFvll	0.31	175	4.5	200	5.2	200	5.2	200	5.2
SFll	0.72	180	10.8	240	14.4	240	14.4	240	14.4
SF_s	2.61	6	1.3	13	2.8	13	2.8	13	2.8
PA	0.012	21,304	21	21,179	21	21,154	21	21,144	21
Total			137		156		169		177
Basin PEI			0.3		0.3		0.3		0.3
Scaling Factor[4]			2.21		2.21		2.21		2.21
Adjusted Value			303		345		373		391

Tab' B-14

PLUM CREEK ANNUAL RUNOFF VOLUME (ACRE-FEET)
LOW GROWTH SCENARIO

Land Use[1]	In R.O./ac[3] Per Year	1985 Acres	1985 Ac-Ft.	1990 Acres	1990 Ac-Ft.	2000 Acres	2000 Ac.Ft.	2010 Acres	2010 Ac-Ft.
C	9.82	305	250	370	303	410	336	410	336
MF	6.25	106	55.2	150	78	230	120	290	151
SFvll	0.31	3,165	81.8	3,710	95.8	4,140	107	4,560	118
SFll	0.72	2,250	135	3,130	188	3,970	238	4,870	292
SFs	2.61	580	126	830	181	1,350	294	1,920	418
PA	0.012	185,530	186	183,735	184	181,705	182	179,685	180
Total			834		1,030		1,277		1,495
Basin PEI			0.5		0.5		0.5		0.5
Scaling Factor[4]			1.61		1.61		1.61		1.61
Adjusted Value			1,343		1,658		2,056		2,407

Tab'- B-15

PLUM CREEK ANNUAL RUNOFF VOLUME (ACRE-FEET)
HIGH GROWTH SCENARIO

Land Use[1]	In R.O./ac[3] Per Year	1985 Acres	1985 Ac-Ft.	1990 Acres	1990 Ac-Ft.	2000 Acres	2000 Ac.Ft.	2010 Acres	2010 Ac-Ft.
C	9.82	340	278	390	319	460	376	610	499
MF	6.25	130	67.7	230	120	280	146	300	156
SF_{vll}	0.31	3,850	99.5	4,880	126	5,430	140	6,030	156
SF_{ll}	0.72	2,450	147	3,950	237	6,920	415	7,500	450
SF_s	2.61	790	172	1,590	346	3,830	833	3,840	835
PA	0.012	184,365	184	180,836	181	174,760	175	173,325	173
Total			948		1,329		2,085		2,269
Basin PEI			0.5		0.5		0.5		0.5
Scaling Factor[4]			1.61		1.61		1.61		1.61
Adjusted Value			1,526		2,140		3,357		3,653

Table B-16

UNMONITORED AREA WEST OF RESERVOIR ANNUAL RUNOFF (ACRE-FEET)
HIGH AND LOW GROWTH SCENARIO[5]

Land Use[1]	In R.O./ac[3] Per Year	1985 Acres	1985 Ac-Ft.	1990 Acres	1990 Ac-Ft.	2000 Acres	2000 Ac.Ft.	2010 Acres	2010 Ac-Ft.
C	9.82	0	0	0	0	0	0	0	0
MF	6.25	0	0	0	0	0	0	0	0
SFvll	0.31	0	0	0	0	0	0	0	0
SFll	0.72	10	1.0	10	1.0	12	1.0	20	1.2
SFs	2.61	25	5.4	25	5.4	25	5.4	25	5.4
PA	0.012	8313	8.3	8313	8.3	8311	8.3	8303	8.3
Total			14.7		14.7		14.7		14.9
Basin PEI			0.1		0.1		0.1		0.1
Scaling Factor[4]			3.0		3.0		3.0		3.0
Adjusted Value			44.1		44.1		44.1		44.1

Ta B-17

UNMONITORED AREA, PLUM CREEK BELOW LOUVIERS ANNUAL RUNOFF VOLUME (ACRE-FEET)
LOW GROWTH SCENARIO

Land Use[1]	In R.O./ac[3] Per Year	1985 Acres	1985 Ac-Ft.	1990 Acres	1990 Ac-Ft.	2000 Acres	2000 Ac.Ft.	2010 Acres	2010 Ac-Ft.
C	9.82	110	90	120	98.2	120	98.2	120	98.2
MF	6.25	3	1.6	7	3.6	17	8.9	25	13.0
SFvll	0.31	0	0	0	0	0	0	0	0
SFll	0.72	770	46.2	820	49.2	970	58.2	1,130	67.8
SF_s	2.61	30	6.5	70	15.2	100	21.8	140	30.4
PA	0.012	23,007	23	22,863	22.9	22,613	22.6	22,395	22.4
Total			167		189		210		232
Basin PEI			1.8		1.8		1.8		1.8
Scaling Factor[4]			1.4		1.4		1.4		1.4
Adjusted Value			234		265		294		325

Ta' B-18

UNMONITORED AREA, PLUM CREEK BELOW LOUVIERS ANNUAL RUNOFF VOLUME (ACRE-FEET)
HIGH GROWTH SCENARIO

Land Use[1]	In R.O./ac[3] Per Year	1985 Acres	1985 Ac-Ft.	1990 Acres	1990 Ac-Ft.	2000 Acres	2000 Ac.Ft.	2010 Acres	2010 Ac-Ft.
C	9.82	110	90	120	98.2	120	98.2	120	98.2
MF	6.25	5	2.6	15	7.8	30	15.6	40	20.8
SF_{vll}	0.31	0	0	0	0	0	0	0	0
SF_{ll}	0.72	810	48.6	910	54.6	1,200	72	1,390	83.4
SF_s	2.61	70	15.2	140	30.4	210	45.7	282	61.3
PA	0.012	22,915	22.9	22,665	22.6	22,190	22.2	21,918	21.9
Total			179		214		254		286
Basin PEI			1.8		1.8		1.8		1.8
Scaling Factor[4]			1.4		1.4		1.4		1.4
Adjusted Value			251		300		356		400