TABLE 4.1
Drainage Areas

Monitoring Station	Basin	Land Surface (km²)	Monitored Lake Surface (km²)	Other Lakes		Total Lake Surface (km²)	Total Area (km²)	Ratio of Lake to Total Area
				Surface (km²)	#			
Third Portage Lake	Sub-Basin	49.4	36.0	3.4	55	39.5	88.9	0.444
Tern Lake	Sub-Basin	17.0	2.9	1.5	18	4.4	21.4	0.204
Drilltrail Lake	Sub-Basin	66.4	2.0	17.2	107	19.2	85.6	0.224
	Total Basin	83.4	4.9	18.7	125	23.6	107.0	0.221
Second Portage Lake	Sub-Basin	9.8	4.1	0.7	16	4.8	14.6	0.329
	Total Basin	142.6	45.0	22.8	196	67.9	210.5	0.323

4.1.2 Hydrologic Equipment and Methods

A detailed description of the hydrology equipment and methods can be found in AMEC's January 2003 report "Meadowbank Gold Project – Hydrologic Monitoring 2002 Data Report" and January 2004 report "Meadowbank Gold Project – Baseline Hydrology Report".

A station description and a gauge history for each station are provided in Appendix D. The gauge history is a history of the vertical control surveys at the station including descriptions and elevations of the benchmarks.

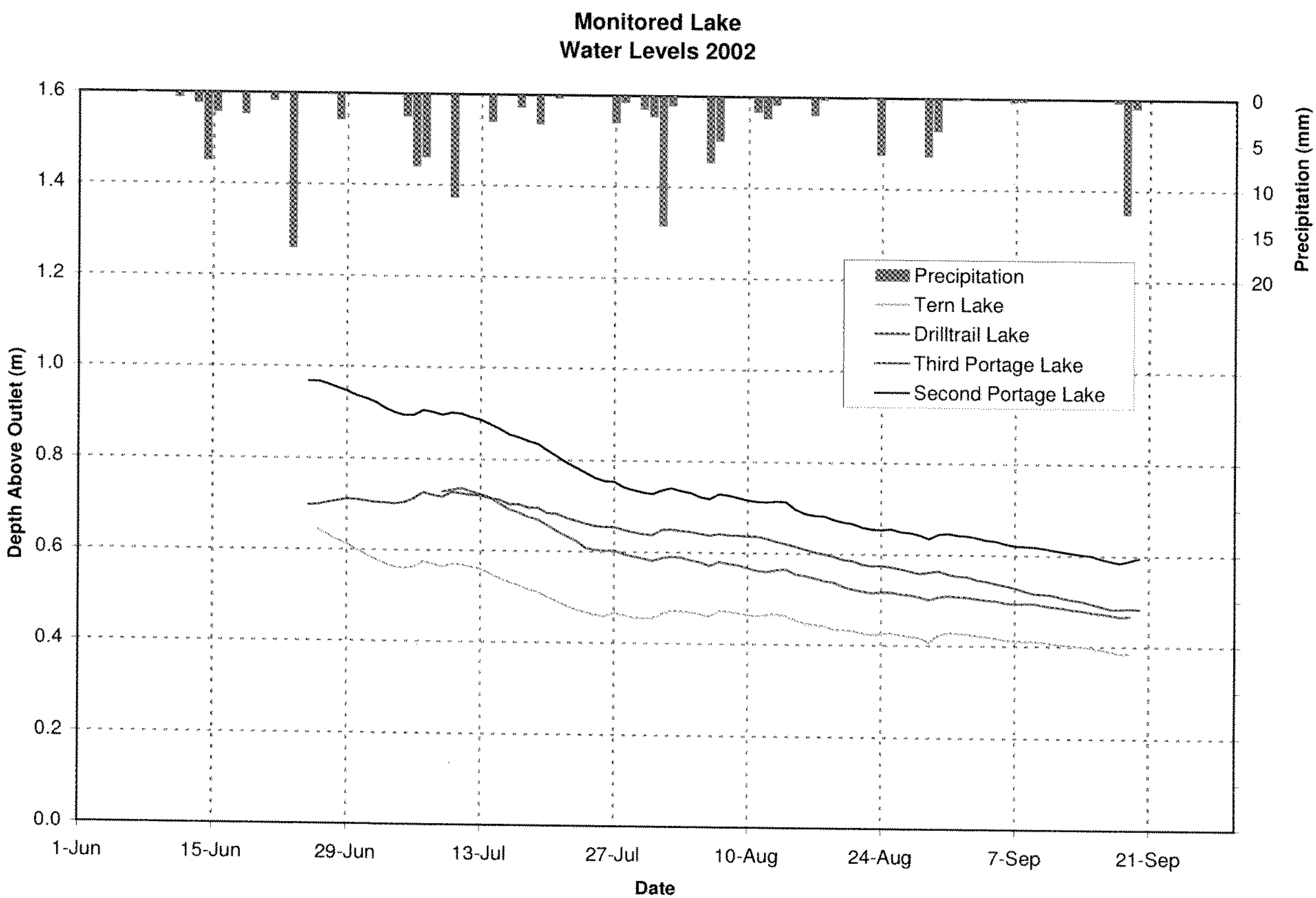
4.2 Project Monitoring Data Analysis

4.2.1 General

A compilation of the data collected at each of the monitoring stations is provided in Appendix C. The compiled data include tabulations of the direct water level surveys conducted to monitor relative bench mark movements and to define the shift corrections for the data logger traces. Explanations of the data and the adjustment procedures are included in Appendix C.

4.2.2 Water Levels

The adjusted mean daily water levels for the four lake stations are shown as combined plots on Figures 4.2, 4.3, and 4.4 for the 2002, 2003, and 2004 open water seasons, respectively. As the levels are not referenced to a common datum, they are shown relative to the zero outflow elevation for each lake. The precipitation data for Meadowbank are also shown to assist in interpretation of the water level fluctuations.



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Lake WL & Q.xls [WL2002]
02/03/05

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Figure 4.2

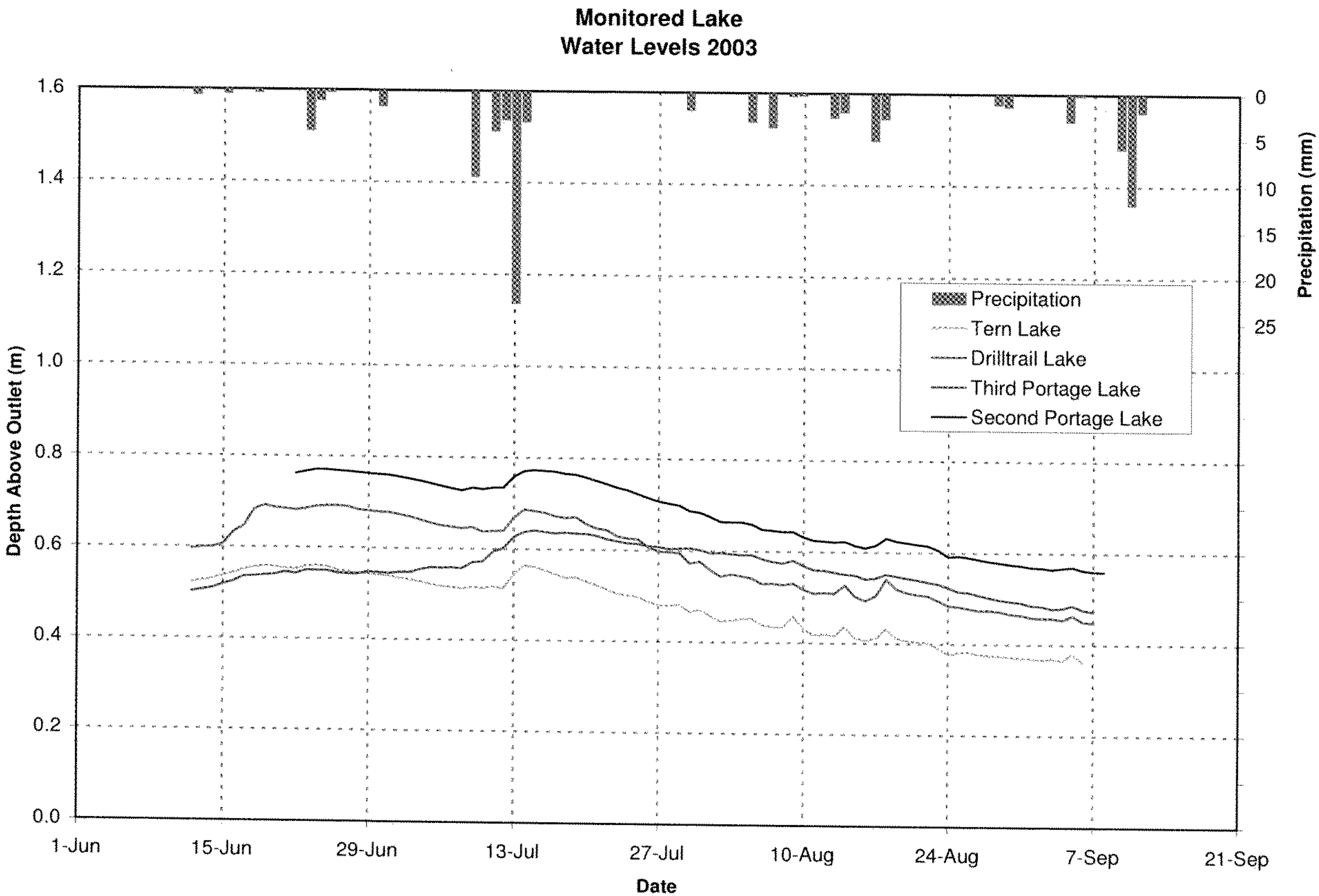

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Figure 4.3

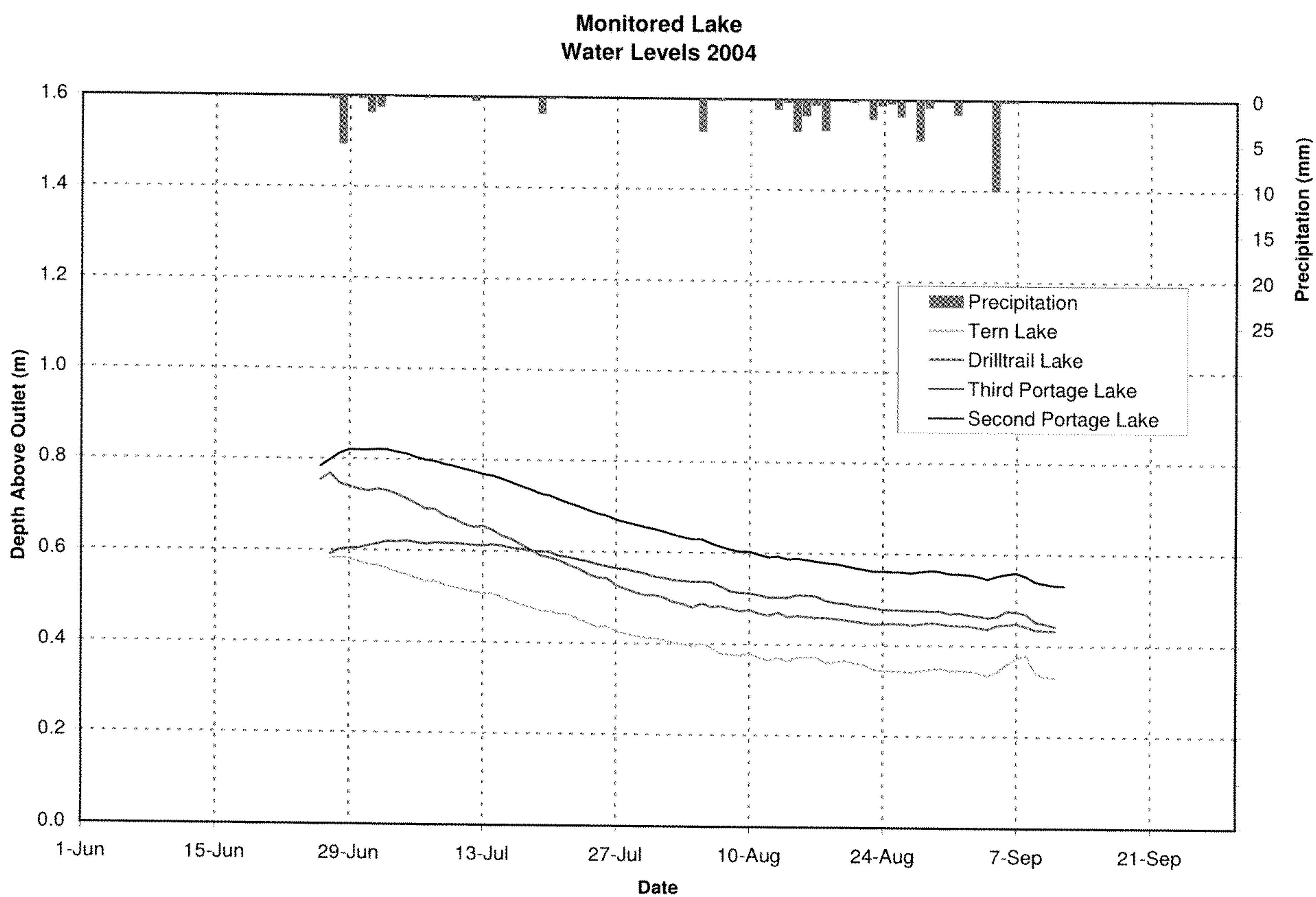

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Figure 4.4

A summary of the water level extremes observed over the 2002 – 2004 period is given in Table 4.2. Note that the levels are not referenced to a common datum and thus do not indicate the elevation differences between lakes.

TABLE 4.2
Lake Water Level Extremes 2002 – 2004

Lake	Seasonal Reference	2002	2003	2004
Tern	End of Winter	–	8.994	8.929
	Seasonal Change	–	-0.008	-0.049
	Summer Maximum	9.262	9.181	9.207
	Seasonal Change	–	0.187	0.278
	Fall	9.002	8.978	8.941
	Seasonal Change	-0.260	-0.203	-0.266
Drilltrail	End of Winter	–	7.981	7.935
	Seasonal Change	–	-0.275	-0.303
	Summer Maximum	8.526	8.481	8.598
	Seasonal Change	–	0.500	0.663
	Fall	8.256	8.238	8.214
	Seasonal Change	-0.270	-0.243	-0.384
Third Portage	End of Winter	–	8.790	9.057
	Seasonal Change	–	-0.365	-0.087
	Summer Maximum	9.399	9.312	9.303
	Seasonal Change	–	0.522	0.246
	Fall	9.155	9.144	9.104
	Seasonal Change	-0.244	-0.168	-0.199
Second Portage	End of Winter	–	7.733	7.488
	Seasonal Change	–	-0.124	0.344
	Summer Maximum	8.240	8.045	8.100
	Seasonal Change	–	0.312	0.612
	Fall	7.857	7.832	7.803
	Seasonal Change	-0.383	-0.213	-0.297

Note: Shaded data are anomalous and likely not representative.

The data in Table 4.2 show a similar pattern for all four lakes. In general the seasonal rise and fall in water level is in the order of 0.2 to 0.6 metres.

The observed end of winter water levels should be used with caution, as the possibility exists that the observed under-ice lake water level may not represent the water level of the lake as a whole. This is possible if freezing of the ice to the lake bottom occurs in shallow areas to the extent that isolated under-ice water pockets are formed. This is thought be the case for the Third Portage Lake end of winter 2003 and 2004 water levels, thus those data are identified as anomalous in Table 4.2.

4.2.3 Discharge Hydrographs

A combined plot of the discharges for the four lake outlet stations is provided on Figures 4.5, 4.6, and 4.7 for the 2002, 2003, and 2004 monitoring seasons, respectively.

The station water level sensors and data loggers could not be operated for the first week or two of the runoff period due to ice conditions. For those days regular observations of water levels and discharge measurements were made at intervals of one to two days, and the runoff hydrographs were estimated by interpolation between these observation points. The interpolated portions of the hydrographs are identified by dashed lines on the plots. The data in Appendix B provide further information on the basis for the interpolations. Table 4.3 summarizes the significant dates relating to the start of runoff for the monitoring stations for the two years of monitoring.

TABLE 4.3
Runoff Startup Dates

Location	Start of Runoff	First Discharge Measurement	Runoff Peak	Datalogge r Startup
2002 Monitoring Season				
Third Portage Lake Outlet	15 June	20 June	10 July	25 June
Tern Lake Outlet	15 June	20 June	24 June	26 June
Drilltrail Lake Outlet	15 June	21 June	25 June	9 July
Second Portage Lake Outlet	15 June	20 June	25 June	25 June
2003 Monitoring Season				
Third Portage Lake Outlet	30 May	4 June	15 July	10 June
Tern Lake Outlet	30 May	3 June	14 July	10 June
Drilltrail Lake Outlet	30 May	6 June	25 June	10 June
Second Portage Lake Outlet	30 May	3 June	15 July	22 June
2004 Monitoring Season				
Third Portage Lake Outlet	18 June	25 June	5 July	27 June
Tern Lake Outlet	18 June	24 June	28 June	27 June
Drilltrail Lake Outlet	16 June	24 June	27 June	26 June
Second Portage Lake Outlet	15 June	24 June	2 July	26 June

Figures 4.8, 4.9, and 4.10 show the 2002, 2003, and 2004 hydrographs, respectively, from the four lake outlet stations plotted on a unit area basis.

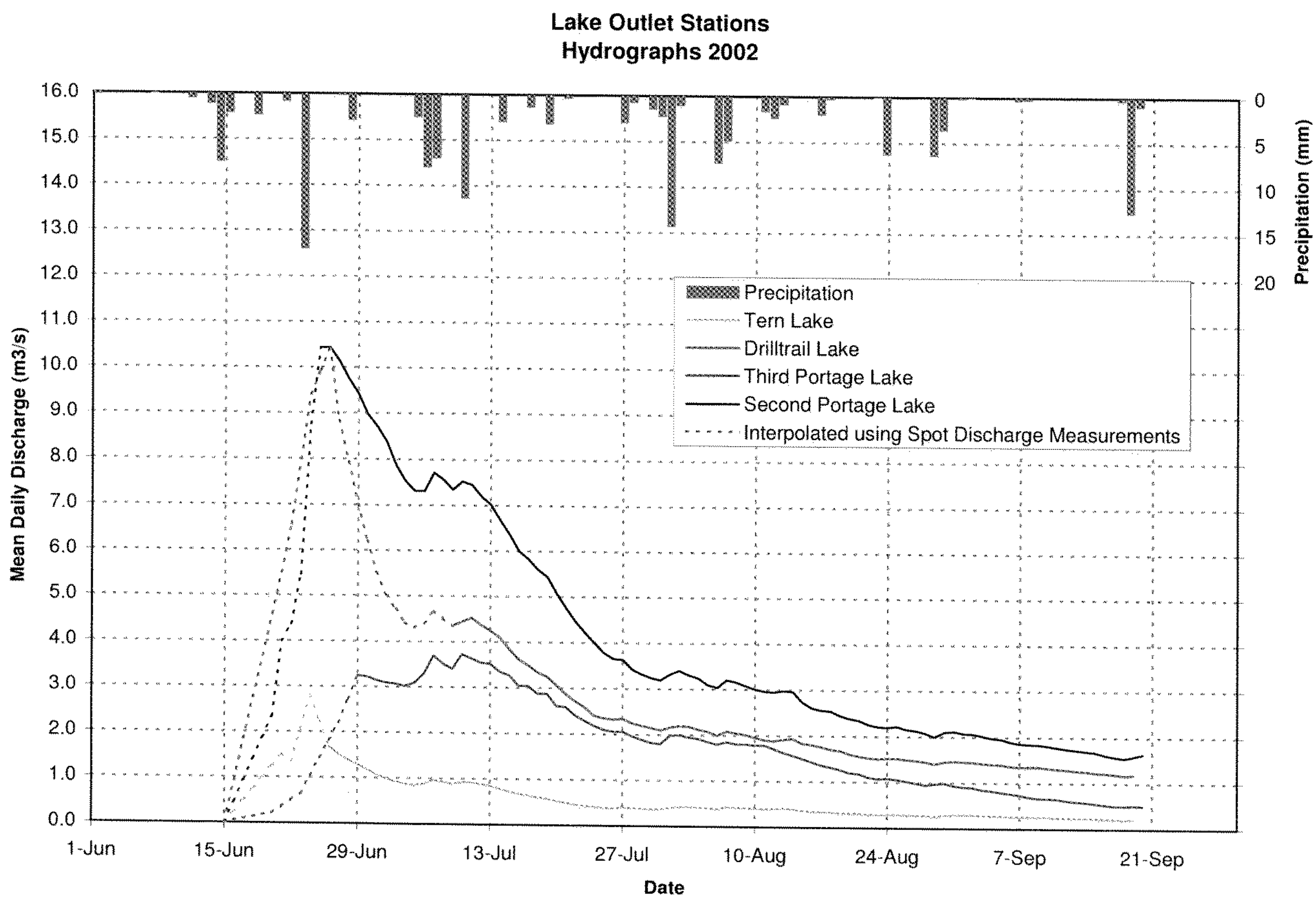

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Figure 4.5

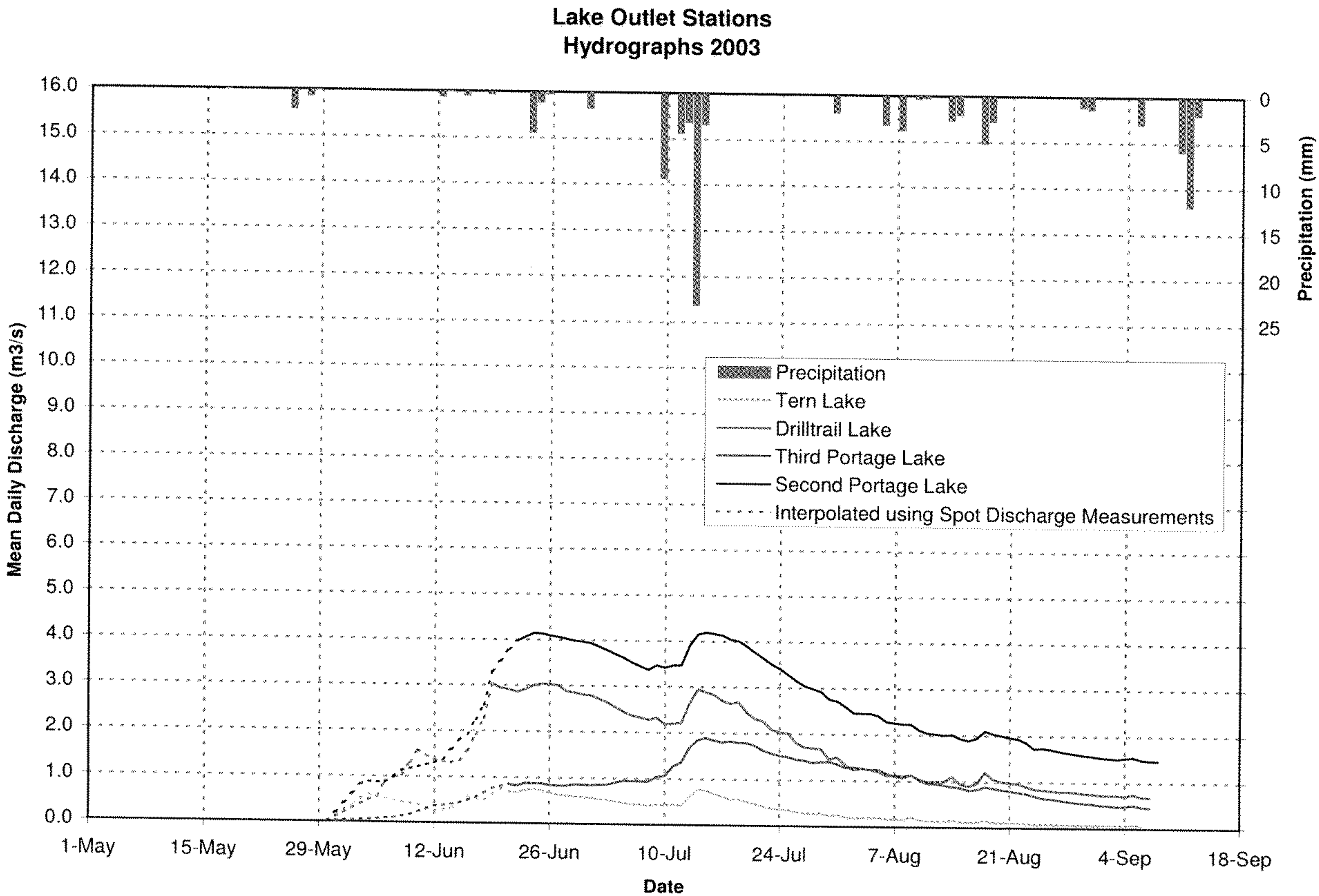

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Figure 4.6

Lake Outlet Stations
Hydrographs 2004

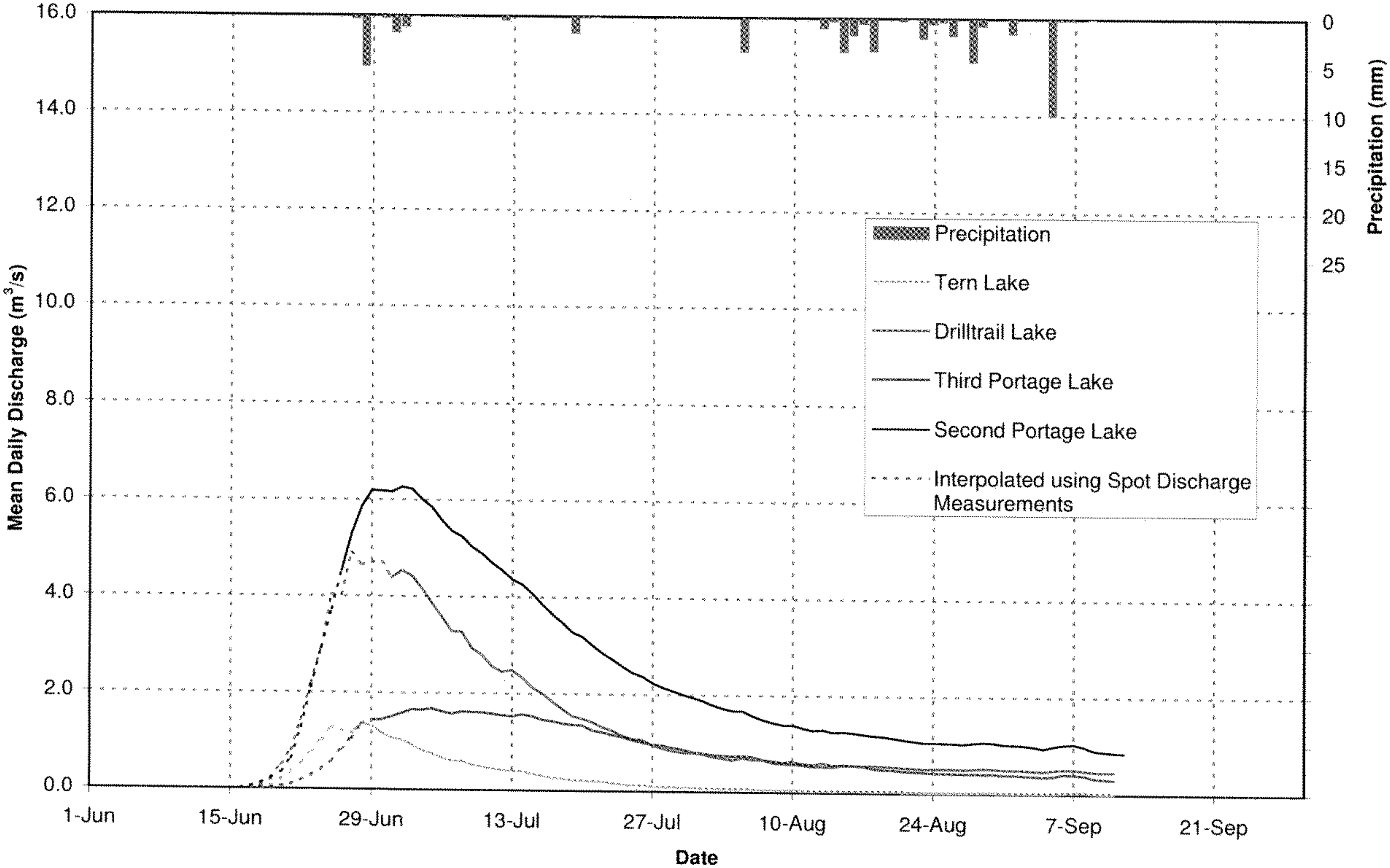

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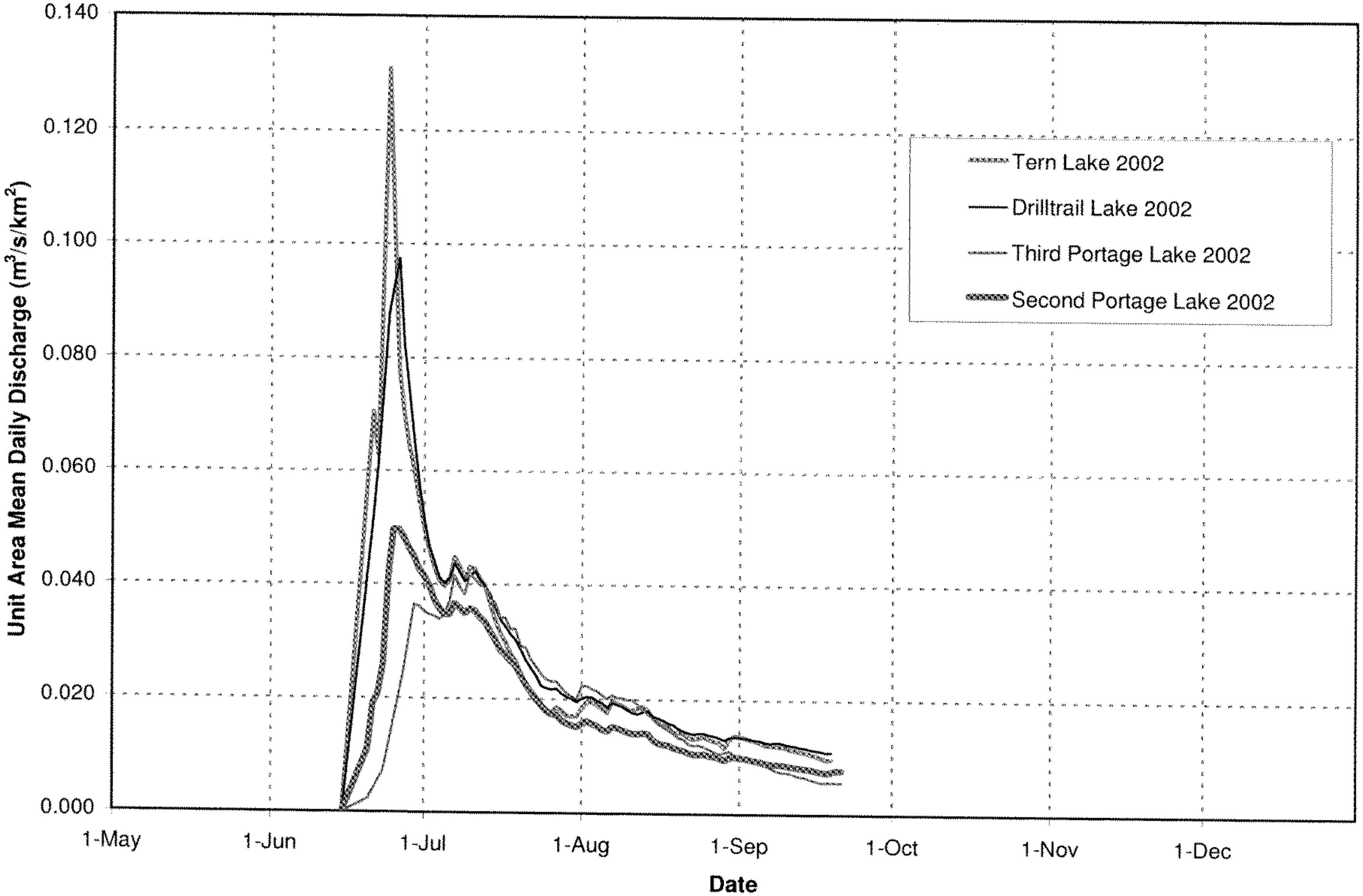
Figure 4.7

Lake Outlet Stations
Comparison of 2002 Unit Area Hydrographs



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mmm UnitQ.xls [Qunit 2002]
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Figure 4.8

Lake Outlet Stations
Comparison of 2003 Unit Area Hydrographs

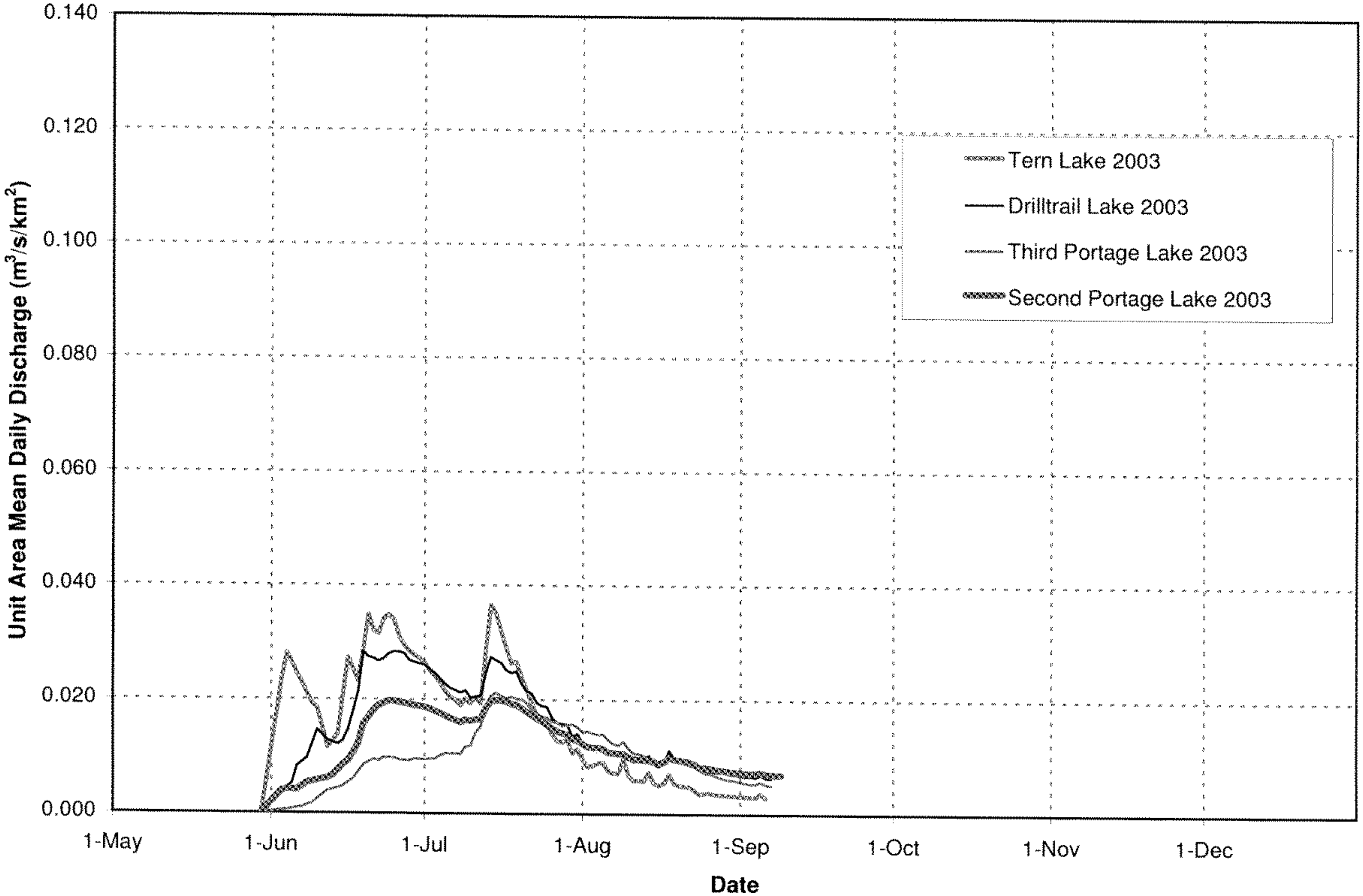

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Figure 4.9

Lake Outlet Stations
Comparison of 2004 Unit Area Hydrographs

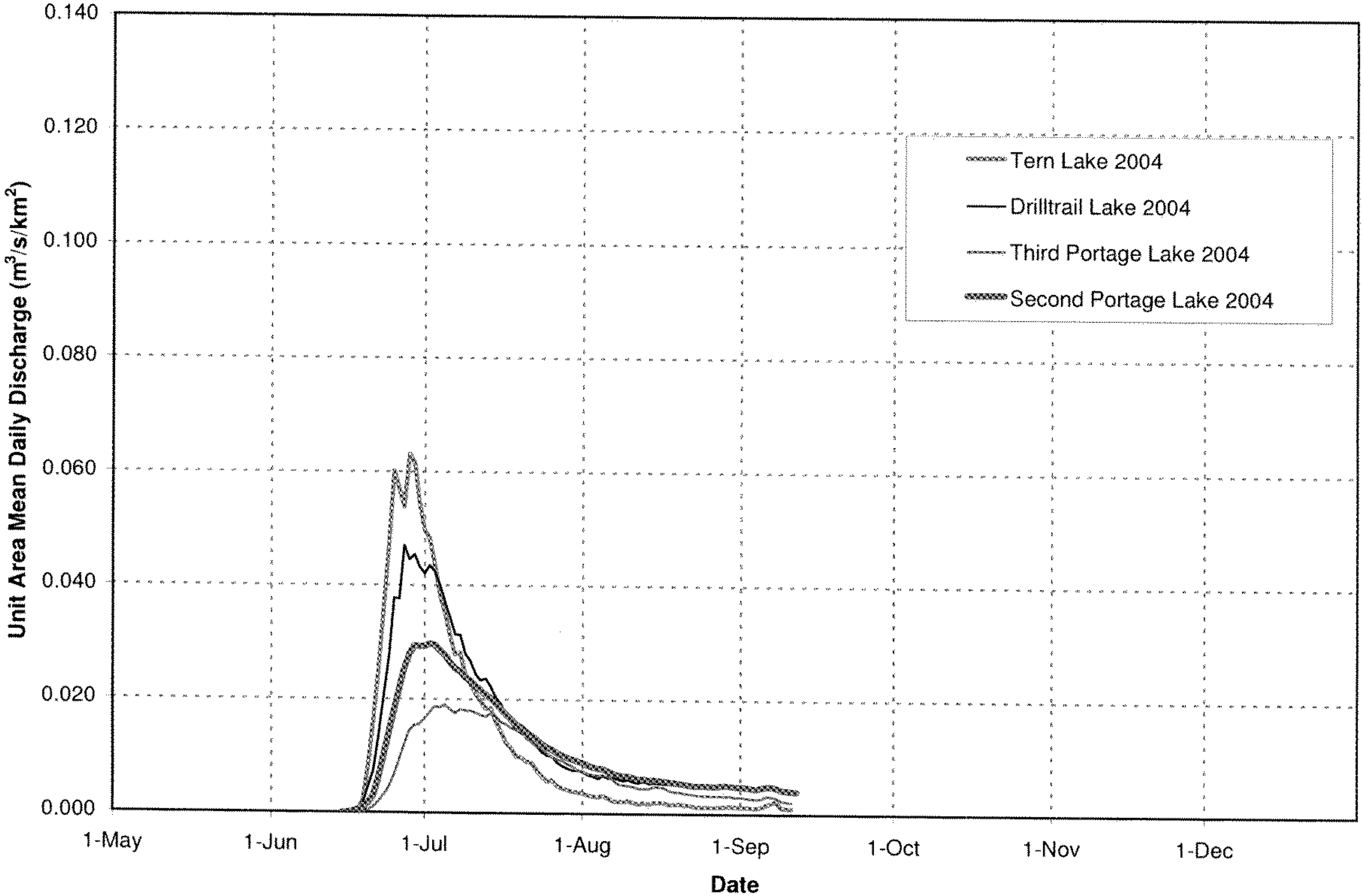

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Figure 4.10

4.2.4 Runoff Volume and Yield

4.2.4.1 Monitoring Data

During the 2002, 2003, and 2004 monitoring seasons, it was estimated that Tern Lake and Third Portage Lake continued to discharge to about the end of October and that Drilltrail Lake and Second Portage Lake continued to discharge to about the end of November and that after those dates zero flow conditions persisted through the winter. Hydrographs during the period from the last monitoring day to the estimated cessation of runoff was thus estimated by assuming a linear decrease in discharges, from the last date of monitoring (19-20 September 2002, 6-8 September 2003, and 11-12 September 2004) to zero discharge at the end of the period. The total runoff values for each of the four monitored basins for 2002, 2003, and 2004 are summarized in Table 4.4

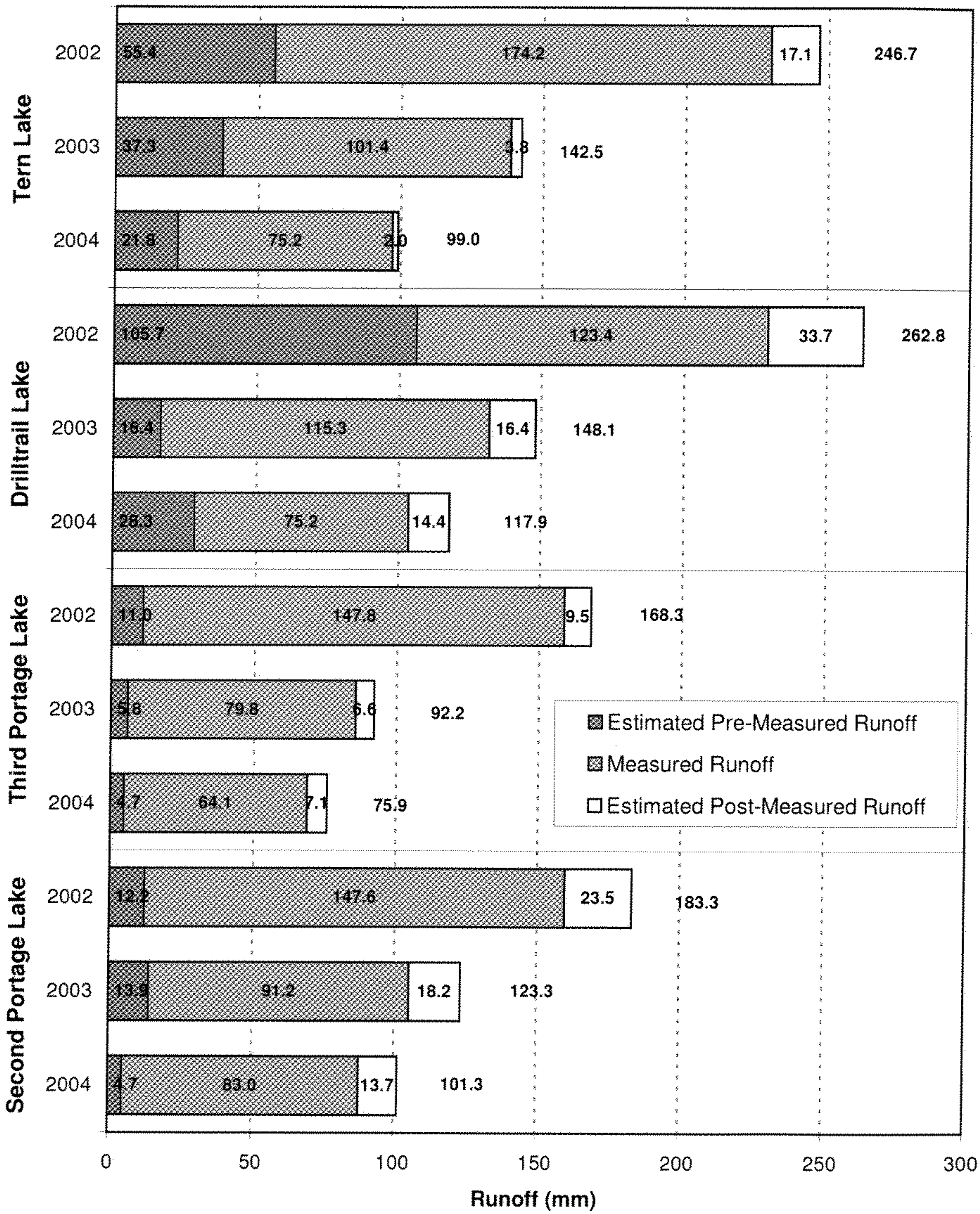
TABLE 4.4
Runoff and Basin Yield Summary

Station Name	Catchment Area	Period of Record	Estimated Pre-Record Volume	Measured Volume	Estimated Post-Record Volume	Total Runoff	
						Volume	Depth
	(km^2)		(dam^3)	(dam^3)	(dam^3)	(dam^3)	(mm)
2002 Monitoring Season							
Third Portage Lake Outlet	88.9	25 June – 20 Sept	975	13140	847	14962	168
Tern Lake Outlet	21.4	26 June – 19 Sept	1185	3727	367	5279	247
Drilltrail Lake Outlet	107.0	9 July – 19 Sept	11313	13206	3610	28129	263
Second Portage Lake Outlet	210.5	25 June – 20 Sept	2558	31077	4957	38592	183
2003 Monitoring Season							
Third Portage Lake Outlet	88.9	10 June – 7 Sept	512	7096	586	8194	92
Tern Lake Outlet	21.4	10 June – 6 Sept	797	2169	82	3048	142
Drilltrail Lake Outlet	107.0	10 June – 7 Sept	1755	12337	1760	15852	148
Second Portage Lake Outlet	210.5	22 June – 8 Sept	2929	19194	3827	25950	123
2004 Monitoring Season							
Third Portage Lake Outlet	88.9	27 June – 11 Sept	415	5699	629	6743	76
Tern Lake Outlet	21.4	27 June – 11 Sept	467	1610	44	2120	99
Drilltrail Lake Outlet	107.0	26 June – 11 Sept	3032	8043	1540	12615	118
Second Portage Lake Outlet	210.5	26 June – 12 Sept	986	17469	2886	21340	101

The total volume is reported above both in cubic decametres (dam^3) and in mm of depth over the catchment area. Note that 1 dam^3 of runoff volume is equivalent to a yield of 1 mm of runoff depth from a catchment area of 1 km^2. The runoff depths are shown graphically in Figure 4.11. It is evident that 2004 was a year of low runoff.

The runoff volumes and yields of the four basins range from 168 mm for Third Portage Lake to 263 mm for Drilltraill Lake for the 2002 monitoring season, from 92 mm for Third Portage Lake to 148 mm for Drilltrail Lake for the 2003 monitoring season, and from 66 mm for Third Portage Lake to 118 mm for Drilltrail Lake for the 2004 monitoring season. The magnitude of runoff correlates roughly with the relative percentage of lake surface area in the basins as listed in Table 4.1. This relationship is shown graphically in Figure 4.12. The relationship trend is consistent for all three years and is thought to reflect the fact that a greater proportion of lake area will result in a relatively higher evaporation loss, leaving less water available for discharge at the lake outlet.

Runoff Summary



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Water Levels\Lake WL & Q.xls [2004 Runoff]
02/04/2005

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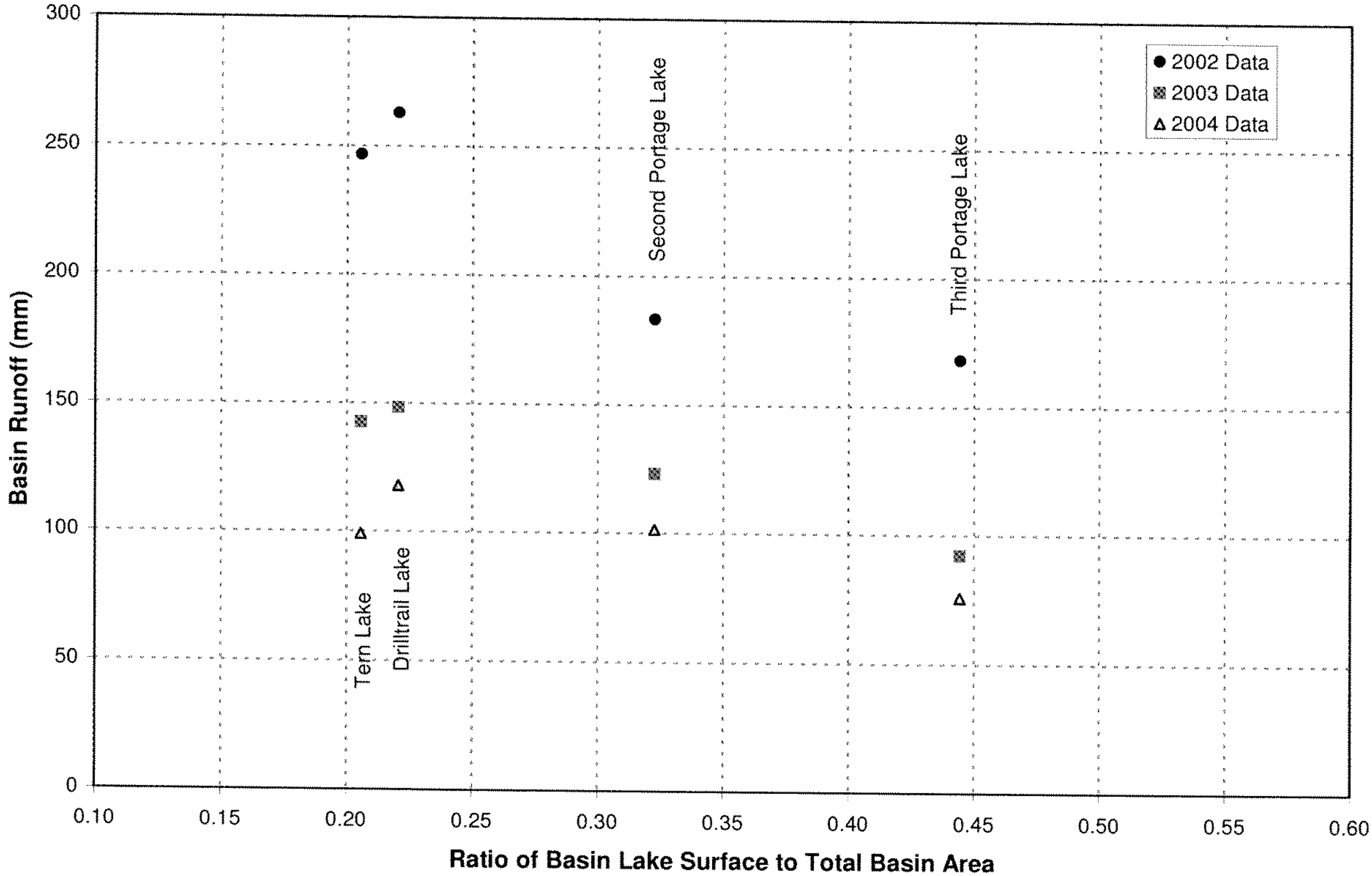
Figure 4.11

Comparison of Basin Runoff to Lake Surface Area
2002 - 2004



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Lake WL & Q.xls [Runoff v Lake Ratio]
02/04/2005

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Figure 4.12

Comparison of the project basins runoff with the project precipitation for 2002 to 2004, adjusted for undercatch, on a hydrologic year basis, is provided in Table 4.5. Note that the adjusted precipitation values in Table 4.5 were updated from those given in the AMEC 2004 Baseline Hydrology Report (Table 3.7) using the same methodology as described therein.

TABLE 4.5
Precipitation – Runoff Comparison

Period	Meadowbank Adjusted Total Precipitation		Third Portage		Tern		Drilltrail		Second Portage	
	Depth (mm)	Fraction of Mean	Runoff (mm)	Runoff Ratio	Runoff (mm)	Runoff Ratio	Runoff (mm)	Runoff Ratio	Runoff (mm)	Runoff Ratio
Long-Term Mean	291.5	1.00								
2002	349.0	1.20	168.3	0.48	246.7	0.70	262.8	0.75	183.3	0.52
2003	254.3	0.87	92.2	0.36	142.5	0.61	148.1	0.63	123.3	0.53
2004	206.8	0.71	66.2	0.32	99.1	0.48	117.9	0.57	101.4	0.49
Average 2002-2004	270.0	0.93	108.9	0.40	162.8	0.60	176.3	0.65	136.0	0.50

Review of the data in Table 4.5 shows that in terms of precipitation, 2002 was a wet year while 2003 and 2004 were dry years, with the three-year precipitation average less than the long-term average. The three-year average runoff values range from 109 mm for Third Portage Lake to 177 mm for Drilltrail Lake. Tern Lake runoff at 163 mm is similar to that of Drilltrail Lake (into which it flows), while the Second Portage Lake runoff averages 136 mm. The long-term average runoff values for the regional stations are in the range of 190 mm to 250 mm. Thus the Tern Lake and Drilltrail Lake runoff values of 163 mm and 177 mm are somewhat below the range found for the regional stations; the Second and Third Portage lake runoff values of 136 mm and 109 mm are well below the range found for the regional stations. However, such divergence is to be expected as the project runoff values reflect an overall dry period.

Runoff ratios for the four project watersheds show that the Tern and Drilltrail watersheds have similar average values, in the range of 0.60 to 0.65, while Third Portage has the lowest average runoff ratio at 0.40. The Second Portage average runoff ratio is 0.50. Comparison of the above runoff ratio values with the runoff ratio values for regional streams (0.49 to 0.62) indicates that the Second Portage average value is very similar to the regional values, while the Tern and Drilltrail runoff ratios are somewhat high and the Third Portage runoff ratio is relatively low.

The implication of the runoff ratio comparison, that Driltrail and Tern runoff ratios are high, contrary to the runoff depth comparison, suggests that the estimated annual precipitation amounts may be underestimated. This is considered to be very possible, as the estimates for snowfall and thus also of total precipitation are subject to a significant error margin, as discussed in the AMEC 2004 Baseline Hydrology Report.

5.0 SPRING SNOW WATER EQUIVALENT

5.1 Transect Locations

Study of the NTS mapping indicated that the steepness and orientation of terrain slopes was approximately similarly distributed throughout the watershed areas, and that snow survey transects located in any convenient sub-area should provide data representative of the entire study area. The transects were therefore located in the area covered by the more detailed mapping, to allow the best possible resolution of snow survey data with respect to terrain types.

Terrain types were selected to include the various degrees of slope, type of cover and orientation with respect to the dominant winter wind direction. The prevailing wind direction in the region is from the northwest. Transects were therefore selected to cover various slopes both parallel to this direction and across this direction. Sixteen transects were selected on the above basis, laid out in the field and surveyed. Transect start and end points were determined by GPS coordinate survey. The locations and numbering of the transects are shown in Figure 5.1. The transect start and end points for the 2004 survey was located as close as possible to those used for the 2003 survey. The total length of transects surveyed was 7710 metres for the 2003 survey and 7680 metres for the 2004 survey. Individual transect lengths varied from 250 metres to 750 metres.

5.2 Field Procedures and Equipment

Horizontal control on the ground was obtained using hand held GPS units. Transect alignment was maintained by line of sight using range poles. Transect stationing was controlled by using a 300 metre kevlar tagline marked every 5 metres. The snow depth was measured along each transect at 10 metre intervals using an aluminium probe and recorded on a field data sheet. Snow density was measured at intervals of 30 metres using a Utah Snow Kit. The Utah Snow Kit is the standard kit used by Environment Canada for measuring snow density. Basic topographic features were noted such as the crests of ridges, valley flats, lake surfaces and the edges of lakes. Slope data were extracted subsequently from the topographic mapping.

Where snow depths were less than about 250 mm, a bulk sampling procedure was used in which samples were accumulated in a plastic bag and weighed when enough snow had been collected to give a significant scale reading. The resulting density was then assigned to all of the points used to make up the bulk sample.

5.3 Field Data Summary

The 2004 snow depth and density for each transect are summarized in graphical form on Figures 5.2 through 5.17. A complete tabulation of the 2004 survey data sheets is provided in Appendix E. Note that all snow depths were measured and recorded in inches; density measurements are reported as a percentage of the density of water.