Yale Hydroelectric Project
FERC Project No. 2071

Exhibit B - Project Operation and Resource Utilization

PacifiCorp
Portland, Oregon
April 1999

EXHIBIT B CONTENTS

APPENDIX

FIGURES

TABLES

1.0 INTRODUCTION

PacifiCorp owns and operates the Yale Hydroelectric Project, FERC Project No. 2071, under a federal license issued on April 30, 1951. The initial license was issued for a period of 50 years and expires on April 30, 2001. PacifiCorp seeks a new license for the project. This application for new license is submitted in 3 volumes which contain the following:

Volume I	Initial Statement and Exhibits A, B, C, D, F, G, and H.
Volume II	Exhibit E
Volume III	Appendices to Exhibit E

Exhibit B is a description of project operations and resource utilization. The information contained in this exhibit is organized into several sections and generally follows the list of information required in 18 CFR, Section 4.51(c).

2.0 PROJECT OPERATION

The Yale Hydroelectric Project is 1 of 4 hydroelectric projects on the North Fork of the Lewis River. Yale, in conjunction with the Swift No. 1, Swift No. 2, and Merwin projects, is normally operated during the day as a peaking project. Daily inflows to the North Fork of the Lewis River system are utilized by the hydroelectric projects to meet the generation system peaking requirements while maintaining project minimum flow, reservoir level, and storage constraints.

The Yale Project is visited daily. The powerhouse can be remotely operated from the Merwin control center. Merwin is staffed 24 hours a day with at least one operator per shift. The Yale operators live in a village near the Yale powerhouse and are available for local control on short notice.

Power schedule requirements are determined by the Portland Dispatch Center and relayed via the SCADA system to the Merwin control center. The Yale units are then operated from the Merwin control center in 1 of 3 control modes, as follows:

- Local Manual Operation - To start a unit on local manual, the operator verifies that the lube oil pump for the turbine guide bearing is operating and the bearing oil level is normal. The operator can then push the start button, and the unit will roll and come up to speed. Once up to speed, the operator turns on the synchroscope and manually synchronizes the unit to the line, and closes the breaker to connect the unit to the system. The output and voltage can then be adjusted manually as required by the Merwin or Yale operator.

- Local Auto Operation - To start a unit on local auto, the operator verifies that the lube oil pump for the turbine guide bearing is operating and the bearing oil level is normal. The operator can then push the start button, and the unit will roll, come up to speed, synchronize, and close the breaker automatically. The output and voltage can then be adjusted by the Merwin or Yale operator.

- Remote Auto Operation - To start in remote auto, the selector switch located at the Yale plant must be in the "remote auto" position, and the unit auxiliaries must be functioning normally. The Merwin operator can then send a start signal via the SCADA system, and the unit will roll, come up to speed, synchronize, and close the breaker automatically. The Merwin operator can then adjust the load as required or put the unit on load control. When the unit is on load control, the Portland Dispatch Center computer controls the load directly.

Yale Lake is operated in conjunction with Swift Reservoir and Lake Merwin following PacifiCorp's Standard Operating Procedures (SOP) Manual to schedule system generation and provide for flood storage during periods of high runoff. PacifiCorp further restricts Yale Lake level fluctuations during summer for recreational considerations. The Yale Lake operating levels are as follows:

- Maximum - 490.0 feet
- Minimum Summer - 480.0 feet
- Normal Minimum Operating - 470.0 feet
- Minimum Operating - 430.0 feet (per USGS)
- Minimum of Record (February 1957) - 435.65 feet
- Minimum Pool - 430.0 feet

Normal plant operation consists of receiving megawatt requirements on the load controller from the Portland Dispatch Center via the SCADA system at the Merwin control center. The Yale units are then operated from the Merwin control center to meet Portland's request. The load controller, if selected to run the units, can change the Yale plant output directly as required to meet the demand from Portland. When the Yale Project is no longer required to meet demand, Portland provides a zero megawatt requirement on the load controller and calls the Merwin control center to have the Yale units unloaded and taken off-line. During periods of high runoff and large streamflows, the plant is typically operated 24 hours a day to maintain reservoir level requirements.

3.0 DEPENDABLE CAPACITY AND ENERGY PRODUCTION

Total licensed plant capacity of the Yale Project is 134,000 kilowatts (kW). Current annual generation at Yale is approximately 611,370,000 kilowatt-hours, enough power for over 50,000 residential customers. Based on the estimated generation and the plant capacity of 134 MW, the plant factor is 47 percent, and the dependable capacity is 69 MW.

3.1 HYDROLOGY

The Yale Project is located on the North Fork Lewis River in the Cascade Mountain Range in southwestern Washington. The majority of the drainage basin lies within the Gifford Pinchot National Forest. The drainage area upstream of the Yale Project is approximately 596 square miles. Flows into Yale Lake are regulated by PacifiCorp's Swift Reservoir, also on the North Fork Lewis River, approximately 13.7 miles upstream of Yale dam and powerhouse.

The annual and monthly inflows to Yale Lake are based on average monthly flow data for the 1928 through 1989 period of record, obtained from the development of adjusted streamflow and storage records for the Columbia River and Coastal Basins by the Bonneville Power Administration (BPA). These data were published in July 1993. The adjusted streamflows were derived from project outflow and reservoir elevation and storage records from PacifiCorp for the Lewis River projects. The nearest USGS Gage Station (No. 14220500) on the Lewis River is located at Ariel, at RM 19, approximately 15 miles downstream of the Yale powerhouse.

Mean monthly inflows for the project generally peak during December and reach their lowest levels in August and September. Mean monthly inflows for each month of the period of record are shown in Table 3.1-1. A summary of the mean monthly inflows for the period of record is shown on Figure 3.1-1.

Maximum mean monthly flows for the Lewis River at the Yale powerhouse for the period 1928-1989 are as follows:

Month	**Flow (cfs)**
January	14,402
February	12,602
March	12,134
April	8,416
May	8,903
June	9,543
July	4,154
August	1,770
September	2,240
October	6,021
November	10,273
December	20,400

Project annual and monthly flow duration curves are included in Appendix B.3-1. Releases from Yale Lake are a function of inflow, available storage, and generation demands.

Table 3.1-1. Mean monthly flows (cfs).

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Mean
1929	1,788	3,226	3,599	2,637	1,555	3,732	4,903	5,802	3,978	1,569	970	750	2,876
1930	741	784	3,496	2,249	8,456	3,908	4,263	3,415	2,110	1,091	820	717	2,671
1931	848	1,491	1,935	4,310	4,582	6,538	6,886	3,390	1,910	1,323	832	794	2,903
1932	1,723	4,045	3,965	4,961	4,338	9,469	7,393	6,837	5,174	2,369	1,285	992	4,379
1933	1,362	8,518	5,483	5,991	2,511	5,344	5,259	7,428	9,543	4,154	1,714	1,988	4,941
1934	4,111	4,481	20,400	12,790	4,335	6,160	3,978	2,431	1,372	1,094	900	842	5,241
1935	3,365	9,503	6,712	5,397	5,032	3,948	4,078	5,971	4,128	1,894	1,087	992	4,342
1936	1,004	1,585	2,728	8,257	2,970	4,390	4,690	6,677	4,576	1,999	1,170	921	3,414
1937	841	809	4,288	1,606	2,214	5,195	7,921	6,396	6,903	2,320	1,177	974	3,387
1938	1,149	8,943	8,216	6,653	3,143	4,689	6,755	5,859	3,367	1,551	1,059	905	4,357
1939	1,147	2,826	4,539	5,547	3,970	4,102	4,704	4,231	2,625	1,519	1,031	907	3,096
1940	1,012	1,152	6,916	3,849	8,023	7,002	4,431	3,754	1,477	1,000	895	858	3,364
1941	1,277	3,245	4,729	4,708	3,136	2,707	2,408	2,951	1,714	1,022	869	1,967	2,561
1942	2,527	3,685	8,393	2,629	3,982	2,798	3,471	3,390	3,390	1,574	1,076	806	3,143
1943	942	7,605	6,453	3,738	4,676	4,792	8,416	4,982	4,369	2,136	1,161	933	4,184
1944	1,672	2,408	3,424	3,273	3,573	2,738	3,767	3,535	2,211	1,052	797	818	2,439
1945	874	2,878	2,823	6,284	6,536	4,578	4,147	7,794	3,033	1,348	914	1,200	3,534
1946	1,021	5,028	6,573	6,431	4,356	5,197	5,111	6,601	5,443	3,475	1,361	1,029	4,302
1947	2,016	6,486	11,600	4,488	6,508	4,580	5,000	3,091	2,220	1,375	1,000	1,195	4,130
1948	6,021	6,450	4,607	6,378	4,722	3,808	4,819	7,149	5,091	1,902	1,189	1,172	4,442
1949	1,829	4,612	4,690	1,607	4,754	5,433	6,065	8,903	4,564	2,223	1,166	1,062	3,909
1950	1,680	6,217	5,264	5,336	7,080	8,765	6,954	7,148	7,514	3,682	1,660	1,264	5,214
1951	4,314	8,445	9,984	6,222	8,738	3,307	5,640	6,167	3,401	1,688	1,128	1,105	5,012
1952	5,487	4,873	5,882	2,423	5,982	3,373	6,120	6,357	3,633	1,864	1,103	942	4,003
1953	722	783	2,427	14,402	7,242	3,462	3,844	5,715	4,195	2,483	1,196	998	3,956
1954	1,422	4,820	9,060	5,350	7,301	4,391	5,780	5,470	5,269	3,190	1,525	1,167	4,562
1955	1,708	4,819	4,464	3,673	4,397	2,357	4,583	5,472	7,116	3,398	1,491	1,315	3,733
1956	5,590	10,273	10,050	7,244	2,907	5,850	6,952	8,263	6,236	3,447	1,709	1,204	5,810
1957	2,820	3,940	7,430	2,425	4,177	7,010	6,159	5,245	2,447	1,299	1,015	807	3,731
1958	1,090	2,897	6,676	6,955	9,016	3,589	6,394	4,575	2,510	1,281	906	816	3,892
1959	1,269	9,155	7,357	9,212	3,669	4,268	5,622	4,779	3,914	1,612	1,016	2,240	4,509
1960	4,802	5,340	4,889	2,934	6,933	4,772	6,777	6,209	3,904	1,543	1,168	1,069	4,195
1961	1,734	9,076	4,505	7,247	12,602	7,347	5,063	5,648	3,402	1,418	1,038	934	5,001
1962	1,891	3,355	7,057	5,211	4,044	3,281	6,265	4,608	2,877	1,370	1,089	1,019	3,506
1963	2,860	8,768	5,602	3,410	6,401	3,278	5,926	4,515	1,837	1,213	892	788	3,791
1964	1,447	6,896	4,484	7,281	4,084	3,674	4,134	5,118	5,525	2,513	1,640	1,258	4,005
1965	1,532	4,373	10,794	6,980	5,642	3,584	5,578	4,497	2,785	1,272	978	759	4,064
1966	878	2,408	3,078	5,014	2,902	5,740	6,298	6,111	3,486	2,183	1,052	854	3,334
1967	1,396	3,548	8,783	8,254	4,919	3,942	3,196	5,232	4,397	1,575	919	769	3,911
1968	3,285	3,638	4,967	5,834	11,554	5,645	3,561	3,384	4,006	1,347	1,692	1,964	4,240
1969	3,986	7,153	5,943	5,553	2,350	3,371	6,350	7,924	4,032	1,633	1,009	1,494	4,233
1970	2,597	3,258	5,167	10,837	6,221	4,447	3,847	3,908	2,436	1,076	803	872	3,789
1971	1,666	4,919	5,917	8,991	6,168	4,549	5,334	7,957	6,212	3,954	1,633	1,476	4,898
1972	2,031	4,500	4,790	8,182	9,845	12,134	5,538	7,531	4,847	2,432	1,320	1,800	5,412
1973	1,272	3,365	9,202	5,571	2,453	3,619	2,988	3,091	2,074	1,270	836	1,079	3,068
1974	1,826	8,209	9,879	11,903	5,773	6,038	6,616	6,436	7,921	3,986	1,770	1,123	5,957

Table 3.1-1. Mean monthly flows (cfs) (continued).

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Mean
1975	951	3,422	7,606	9,134	4,911	4,707	3,029	5,834	4,124	2,062	1,299	1,116	4,016
1976	2,717	6,597	12,484	7,838	4,523	3,460	4,635	6,500	3,583	2,177	1,417	1,059	4,749
1977	995	1,237	1,460	1,528	1,961	4,020	4,012	3,684	3,060	1,020	950	1,713	2,137
1978	1,754	8,570	13,386	5,307	4,637	3,624	4,428	4,667	2,474	1,364	1,076	1,480	4,397
1979	960	2,029	3,505	1,527	6,550	6,319	4,116	4,882	1,819	1,161	855	1,020	2,895
1980	1,634	1,884	8,512	5,198	5,740	4,250	6,359	3,248	1,869	1,176	835	828	3,461
1981	723	4,574	10,713	3,018	7,542	2,707	4,847	2,877	3,632	1,434	911	881	3,655
1982	2,494	4,593	7,598	5,561	12,125	5,533	4,957	5,267	3,479	1,542	1,015	1,009	4,598
1983	2,010	4,148	7,760	8,967	7,755	7,844	4,654	4,189	2,988	2,983	1,410	1,371	4,673
1984	1,039	9,693	4,411	7,129	5,053	6,141	4,441	5,566	3,936	1,829	1,060	1,052	4,279
1985	1,544	6,607	3,154	1,793	2,118	3,229	6,492	5,121	4,494	1,284	937	1,159	3,161
1986	2,469	4,373	2,417	6,204	7,875	5,785	3,342	3,561	1,709	1,025	771	928	3,372
1987	1,070	6,241	3,504	4,169	6,398	7,645	4,111	3,217	1,719	1,006	791	679	3,379
1988	588	948	5,663	3,643	4,237	5,217	6,524	4,360	2,733	1,280	827	747	3,064
1989	790	6,750	3,865	5,185	2,766	6,476	6,488	4,058	2,415	1,206	932	735	3,472
Mean	**1,940**	**4,860**	**6,316**	**5,679**	**5,409**	**4,916**	**5,187**	**5,229**	**3,757**	**1,857**	**1,117**	**1,094**	**3,947**
Min.	**588**	**783**	**1,460**	**1,527**	**1,555**	**2,357**	**2,408**	**2,431**	**1,372**	**1,000**	**771**	**679**	**1,411**
Max.	**6,021**	**10,273**	**20,400**	**14,402**	**12,602**	**12,134**	**8,416**	**8,903**	**9,543**	**4,154**	**1,770**	**2,240**	**9,238**

3.2 AREA CAPACITY CURVE AND TYPICAL OPERATIONAL CURVE

The reservoir formed by Yale and Saddle dams is approximately 10.5 miles long and has a surface area of 3,800 acres at the normal maximum operating level of 490 feet msl. The reservoir's gross and usable storage capacities at this elevation are 402,000 acre-feet and 190,000 acre-feet, respectively. Figure 3.2-1 shows the Yale Lake area-capacity curve, and a typical reservoir operational curve is presented in Figure 3.2-2.

3.3 HYDRAULIC CAPACITY

The Yale Project has a total estimated hydraulic capacity of 9,640 cfs composed of 4,820 cfs at a rated head of 240 feet from each of 2 identical Francis turbines.

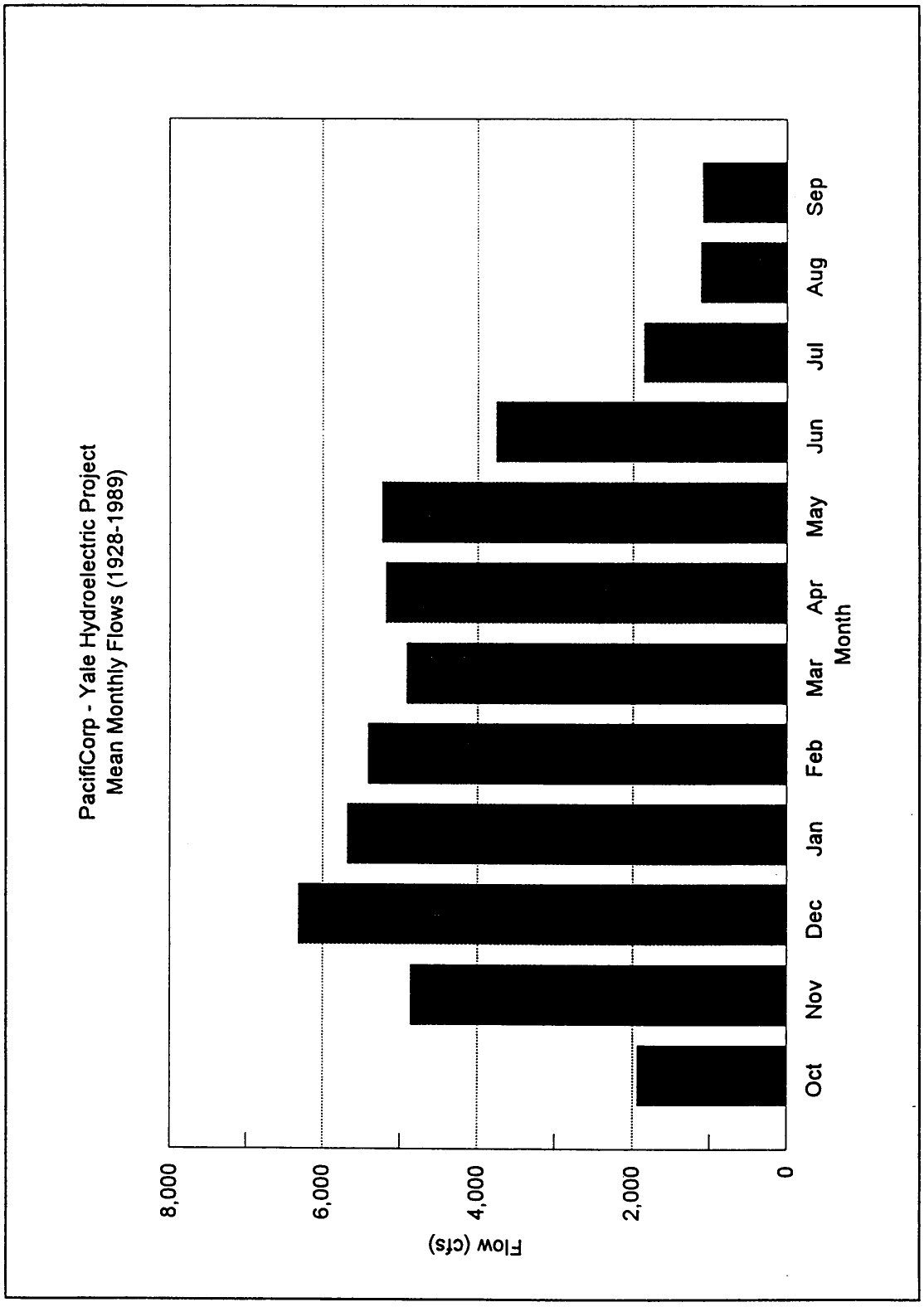

Figure 3.1-1. Mean monthly flows for the Lewis River at Yale powerhouse.

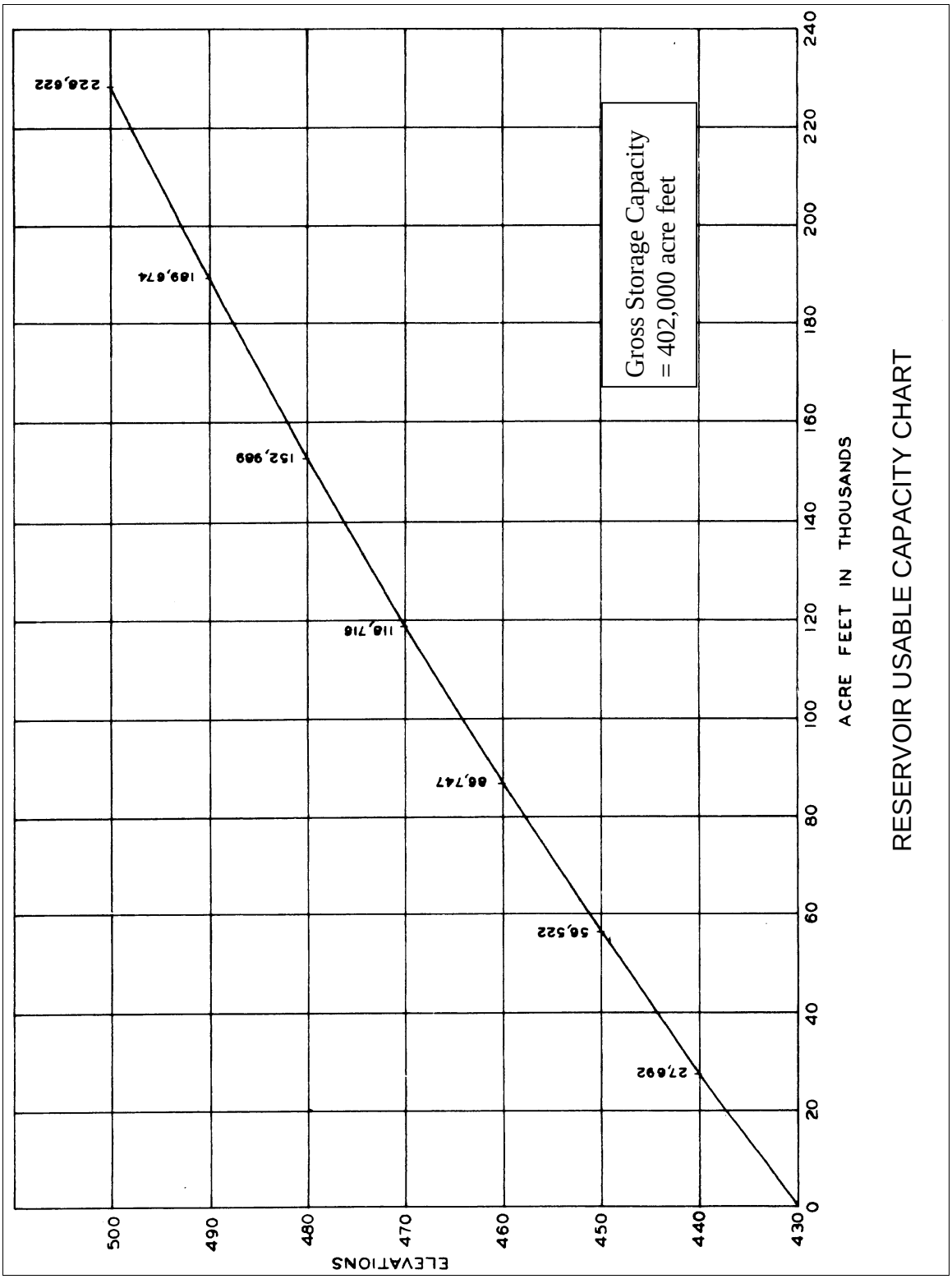

Figure 3.2-1. Yale Lake area capacity chart.

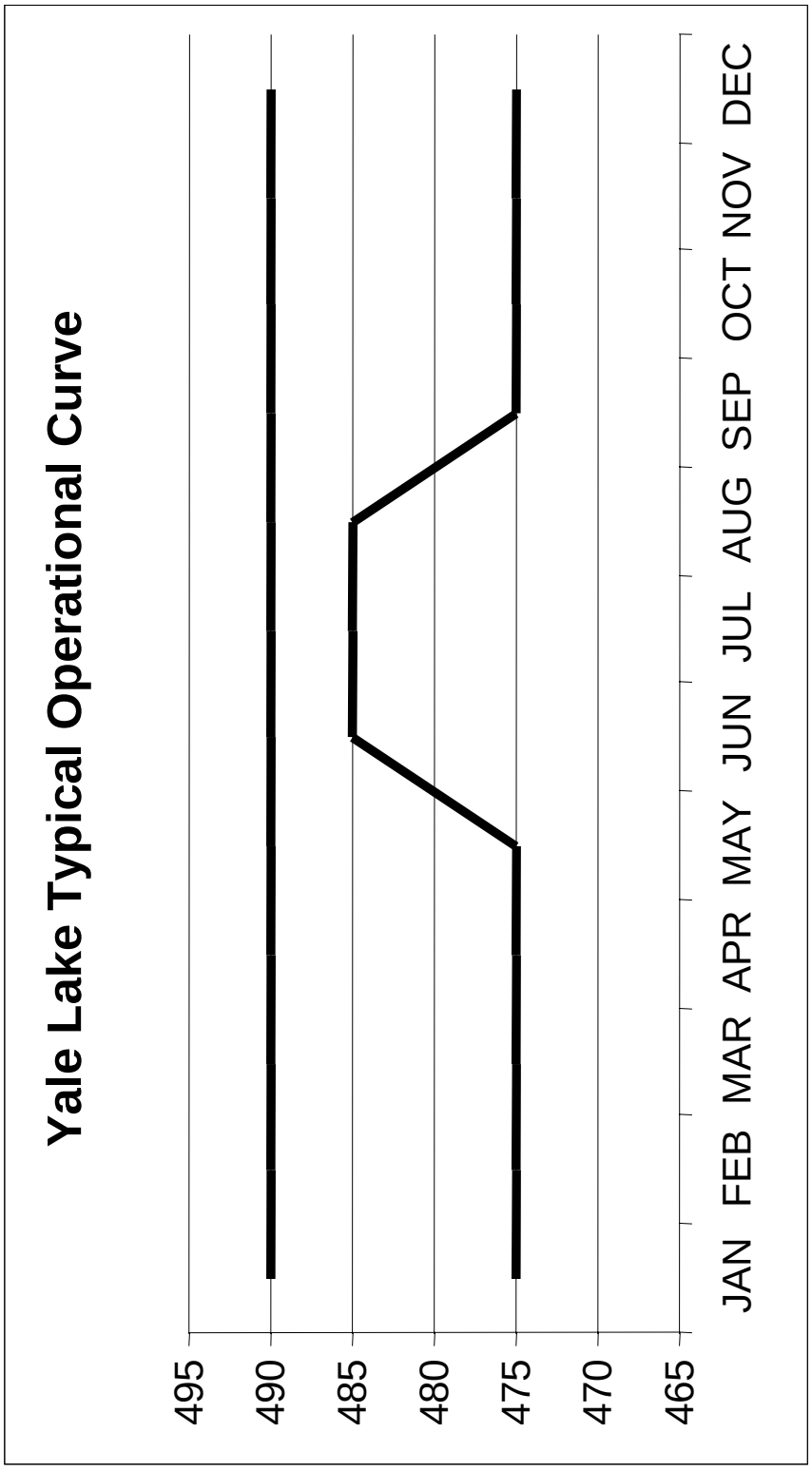

Figure 3.2-2. Yale Lake typical operational curve.

3.4 TAILWATER RATING CURVE

The Yale powerhouse discharges into the North Fork Lewis River channel downstream of the dam in the upper reach of Lake Merwin. The tailwater level is a function of the Yale powerhouse discharge, any spillway discharge, and the level of Lake Merwin. Based on a hydraulic model of the North Fork Lewis River channel downstream of the dam, it was determined that the Lake Merwin level has little effect on the Yale powerhouse tailwater level for plant operation when the reservoir level is below elevation 228 feet msl. The tailwater rating curve is shown on Figure 3.4-1 and the Yale powerhouse tailwater levels are as follows:

Merwin Elevation	Yale Operating Condition	Tailwater Elevation (feet msl)
239.6 feet	1 unit maximum output	240.0
	2 unit maximum output	240.4
220.0 feet	1 unit maximum output	231.0
	2 unit maximum output	234.0

3.5 PLANT CAPACITY

The plant capacity for the Yale Project is shown in Figure 3.5-1, which depicts the plant capability at minimum, normal, and maximum need.

4.0 PROJECT POWER UTILIZATION

The estimated average annual net generation at the Yale Project is approximately 611,370,000 kW hours. Approximately 576,000 kW hours are used annually for station service.

The Yale Project does not have a specific service territory. Electricity generated at the project goes into the regional transmission grid and serves PacifiCorp's customers throughout the Northwest. Approximately half of the company's sales are to industrial customers, about one-fourth to commercial, and one-fourth to residential customers.

5.0 FUTURE PROJECT DEVELOPMENT

PacifiCorp has studied the feasibility of upgrading existing project auxiliary equipment and systems to improve plant reliability, operation, and safety. However, none of the upgrades would change the plant output or generation, and no changes in reservoir operation or operating elevations are under consideration.

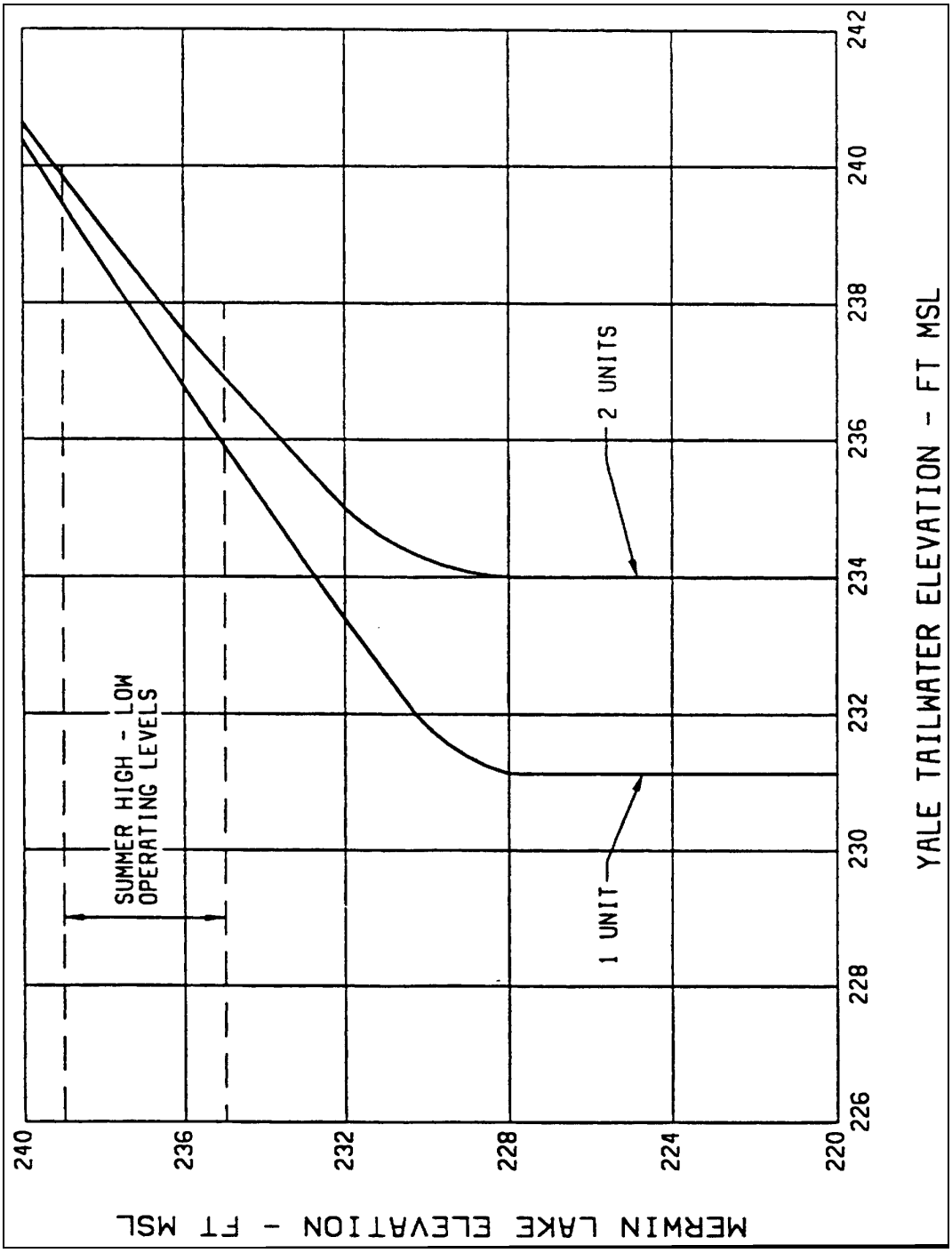

Figure 3.4-1. Yale tailwater rating curve.

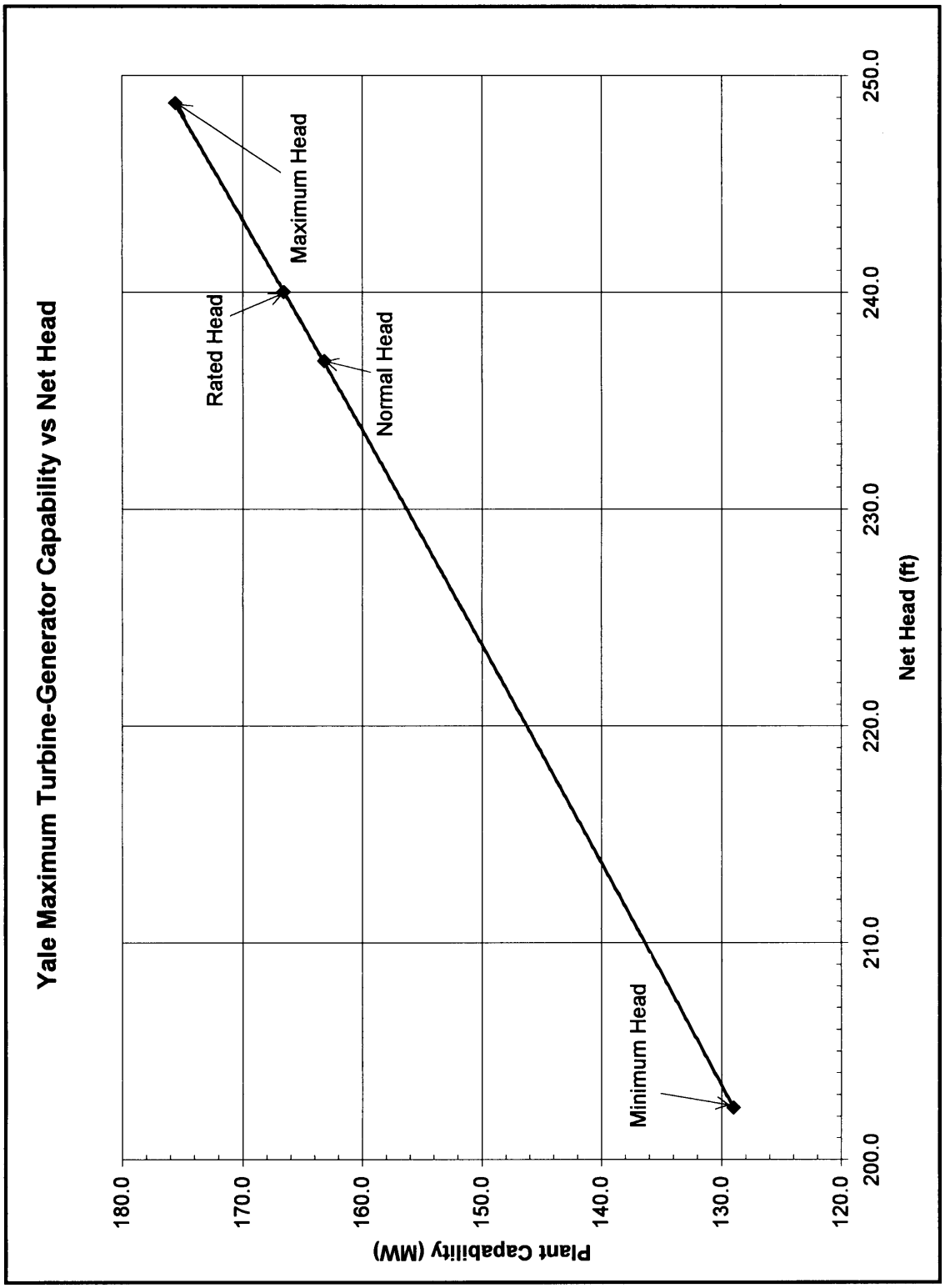

Figure 3.5-1. Plant capacity curve.

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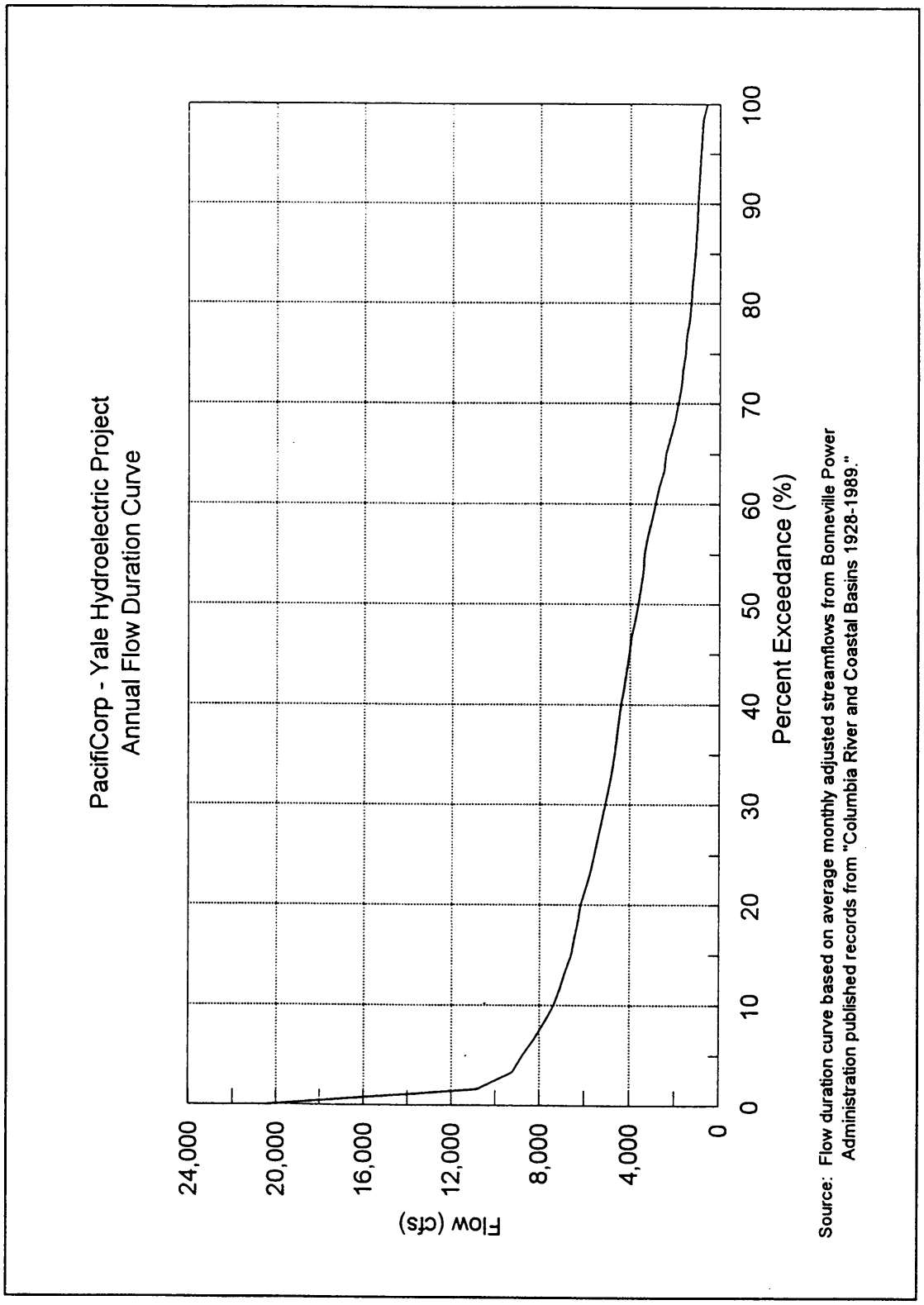
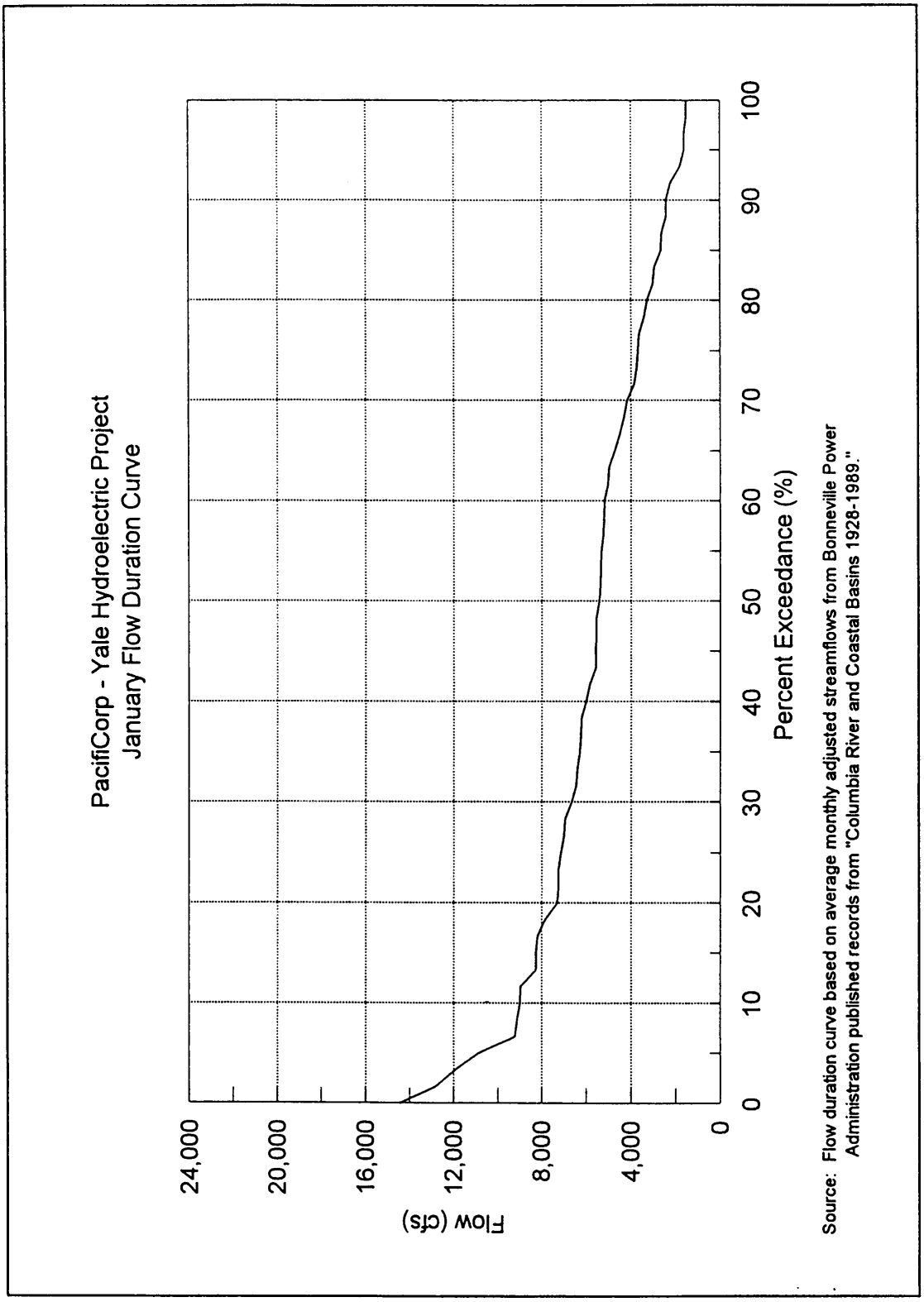
Appendix B.3-1 Yale Flow Duration Curves

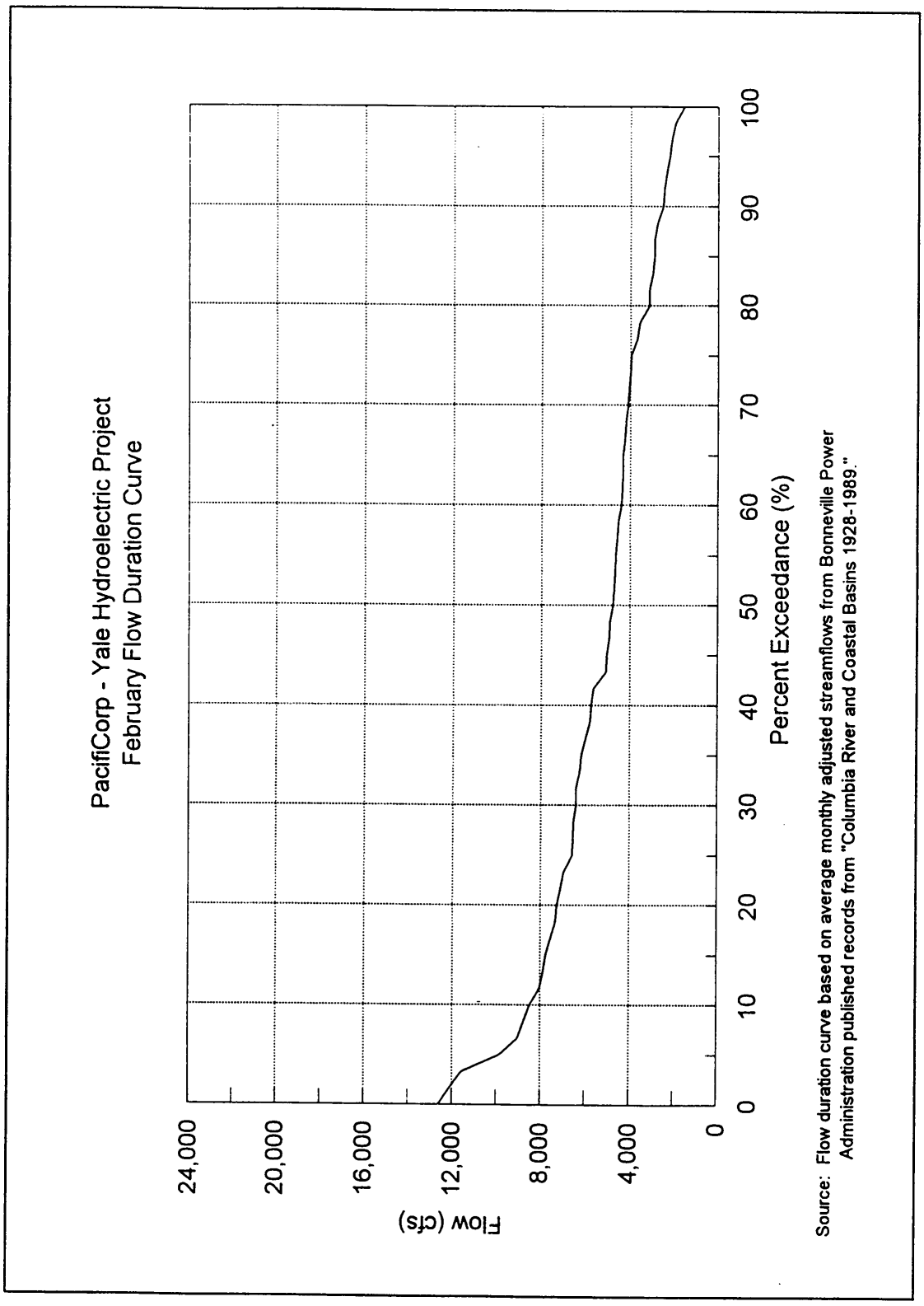
PacifiCorp
Portland, Oregon
April 1999



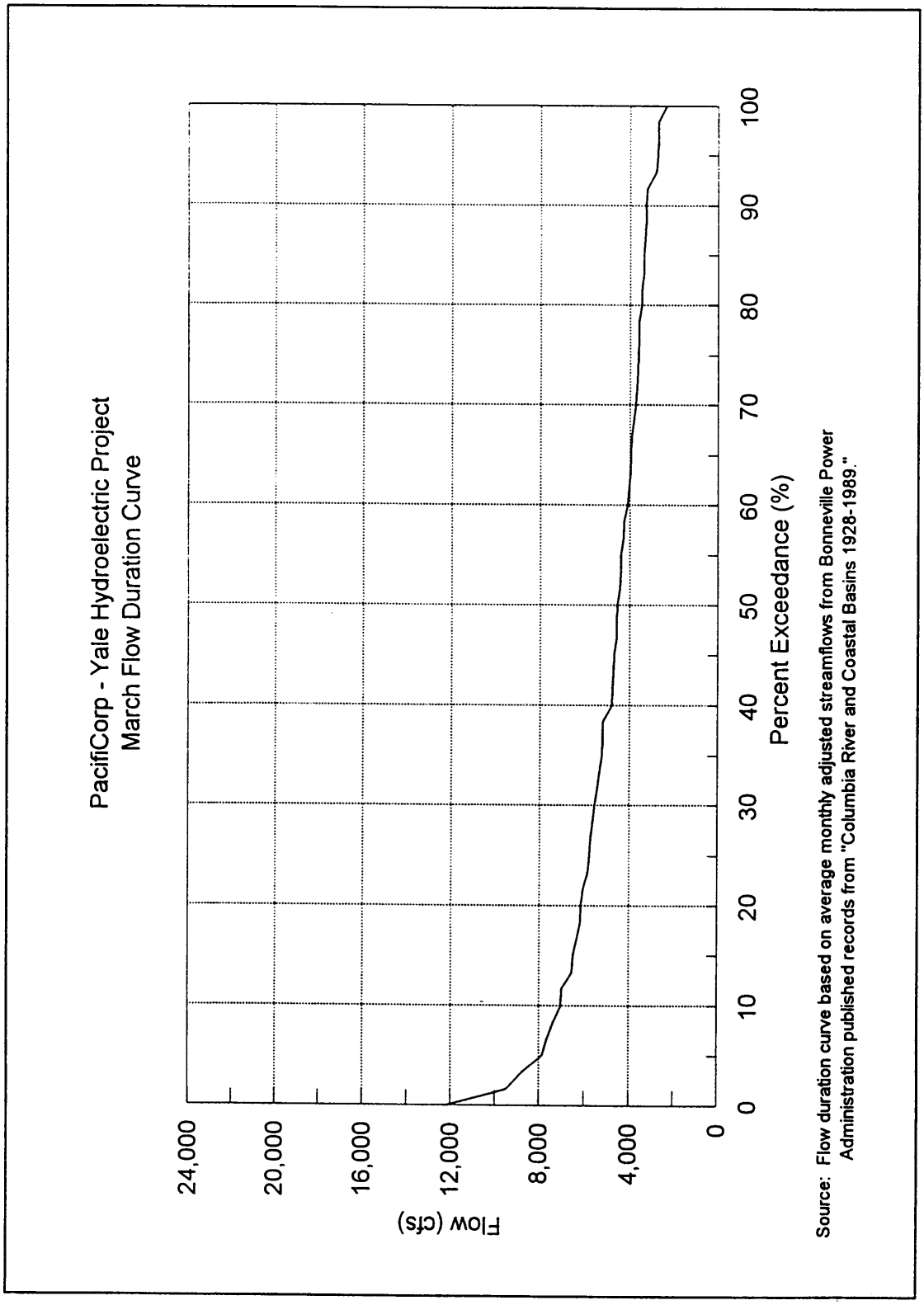
Yale annual flow duration curve



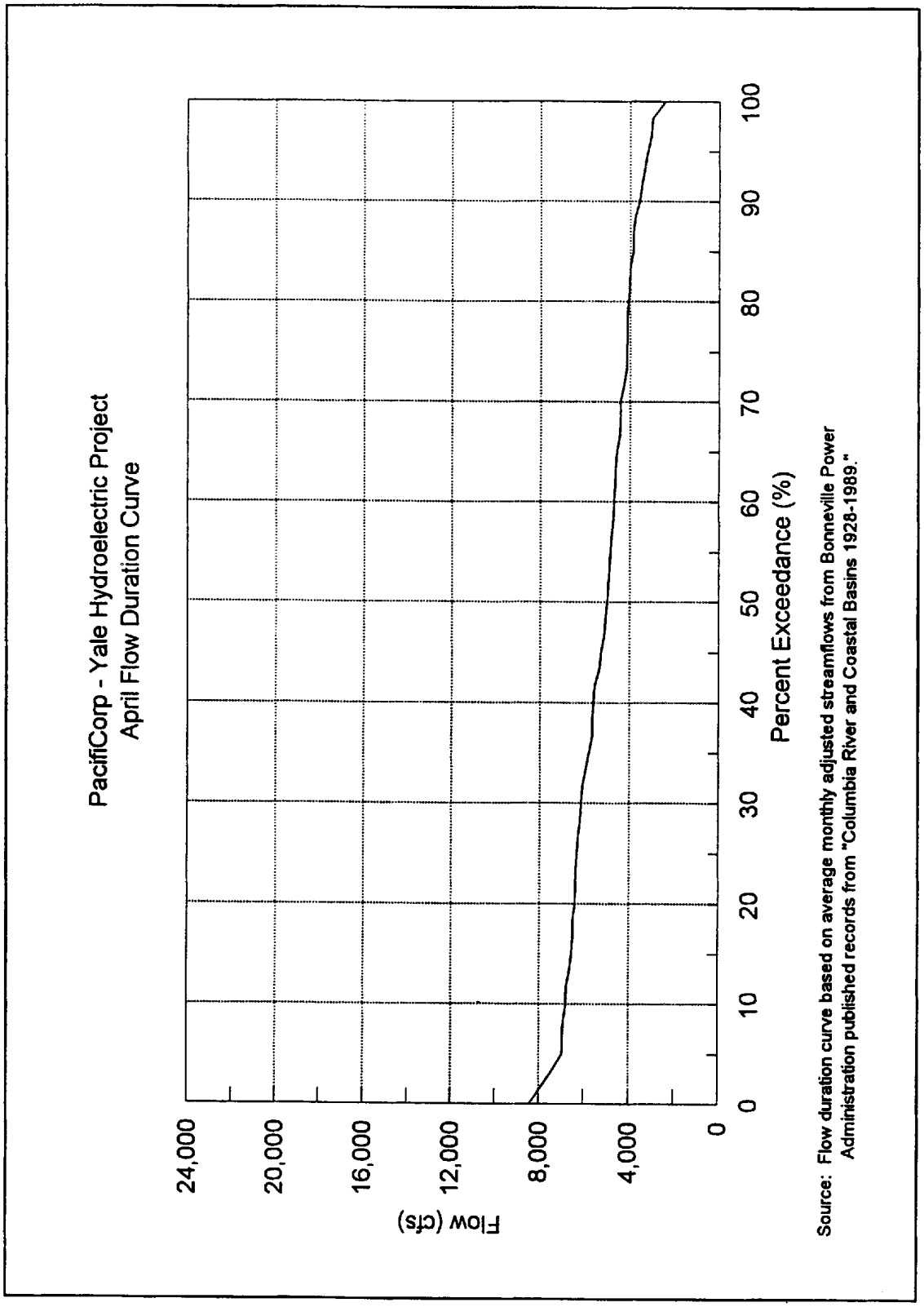
Yale January flow duration curve



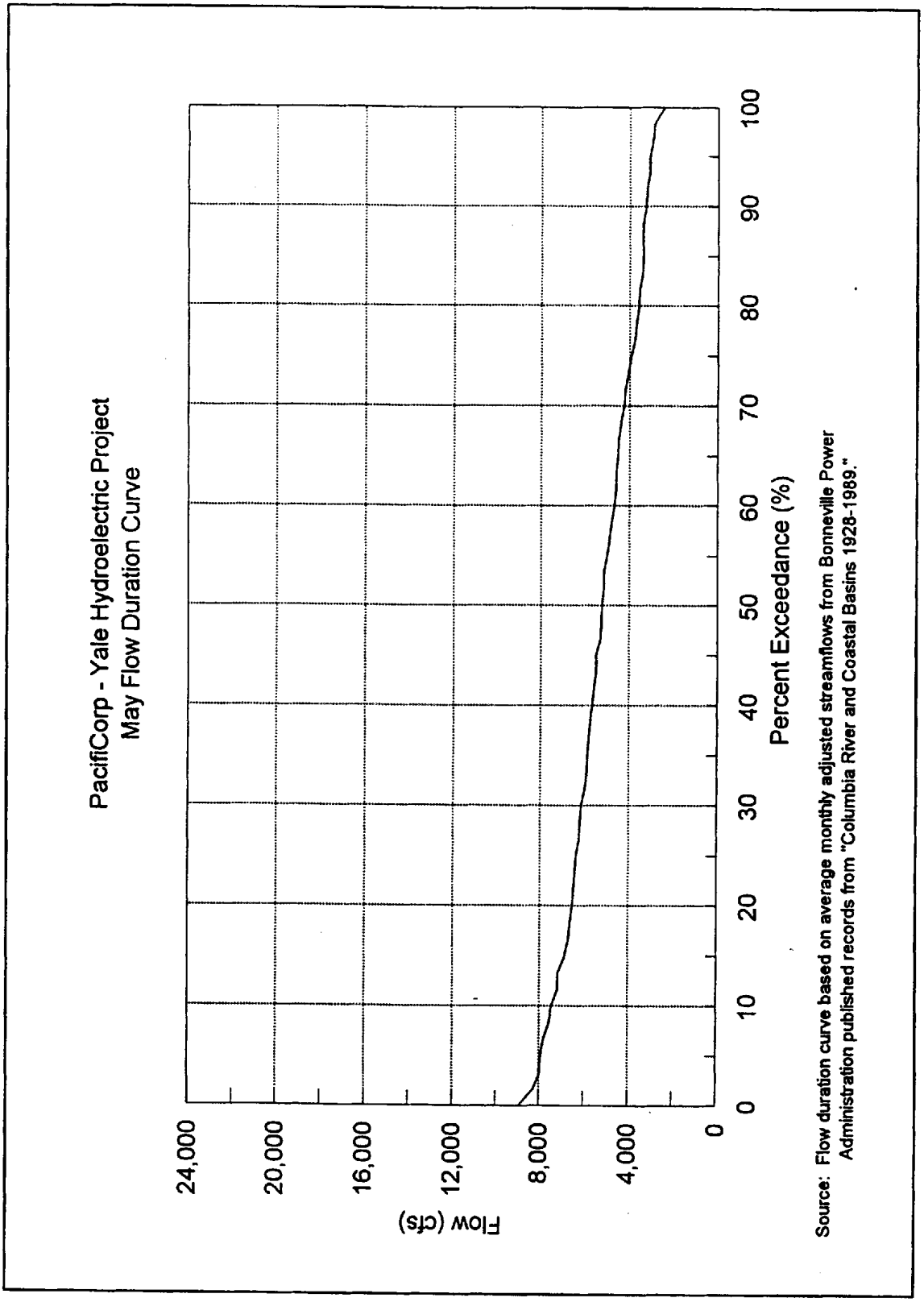
Yale February flow duration curve



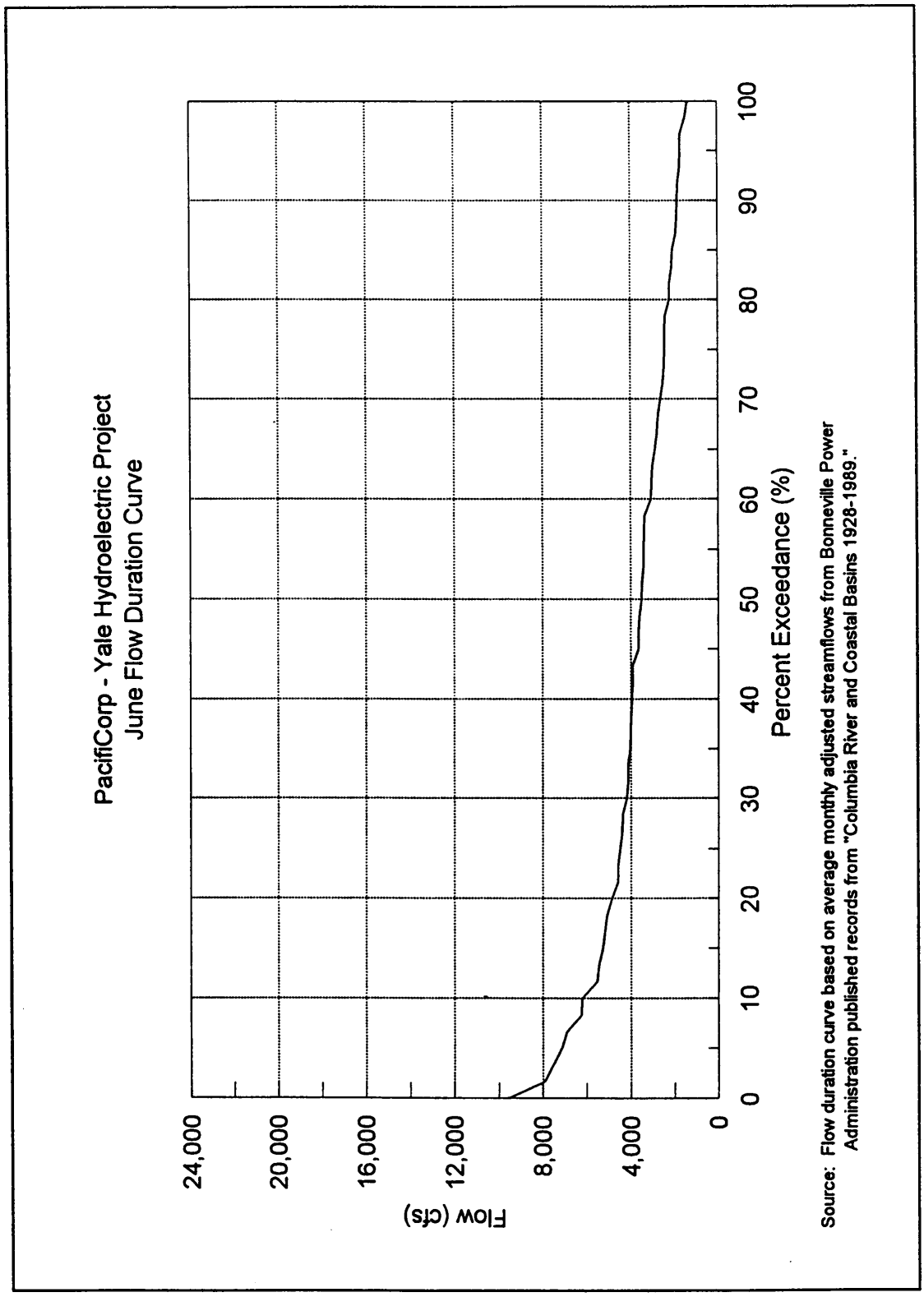
Yale March flow duration curve.



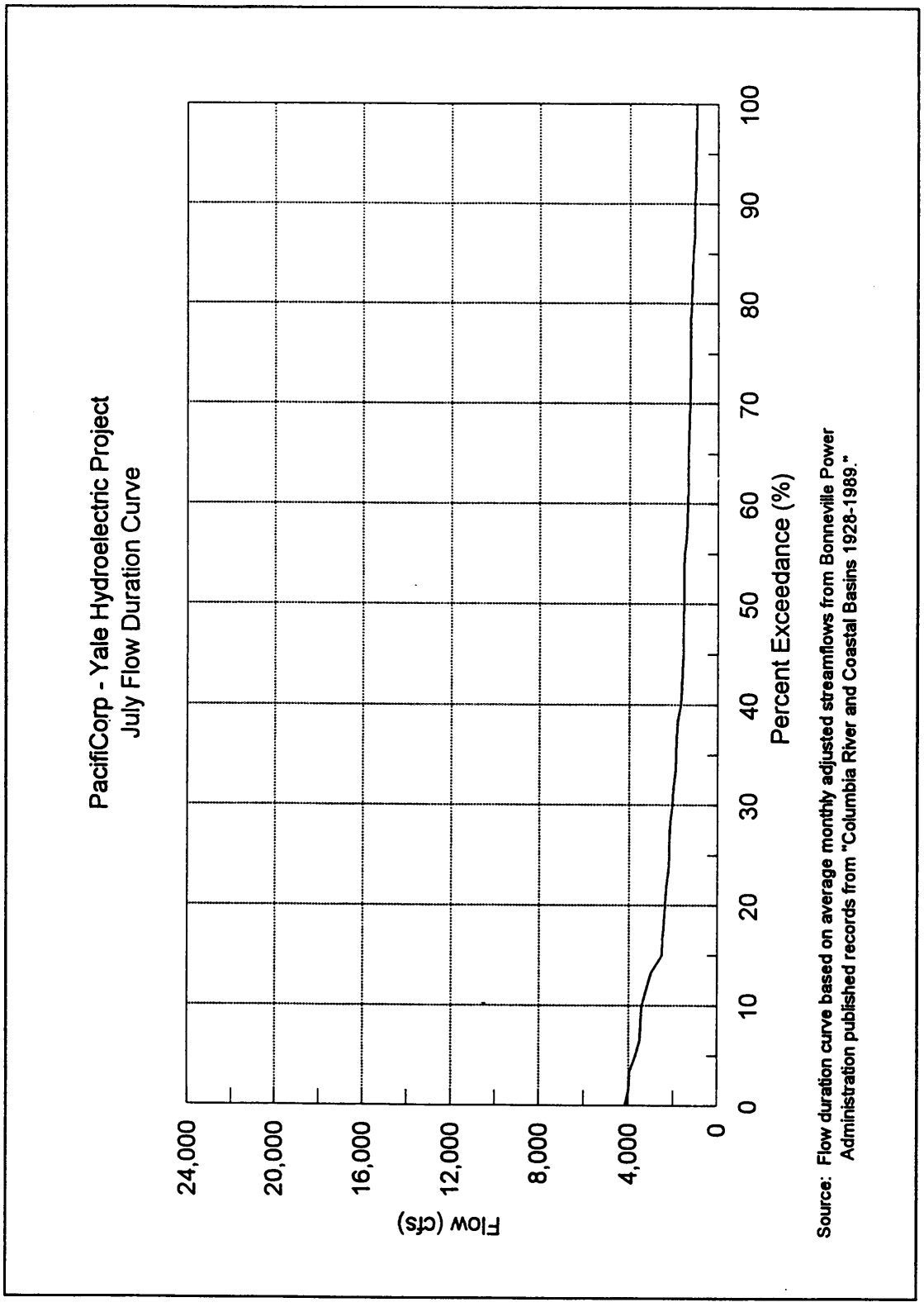
Yale April flow duration curve.



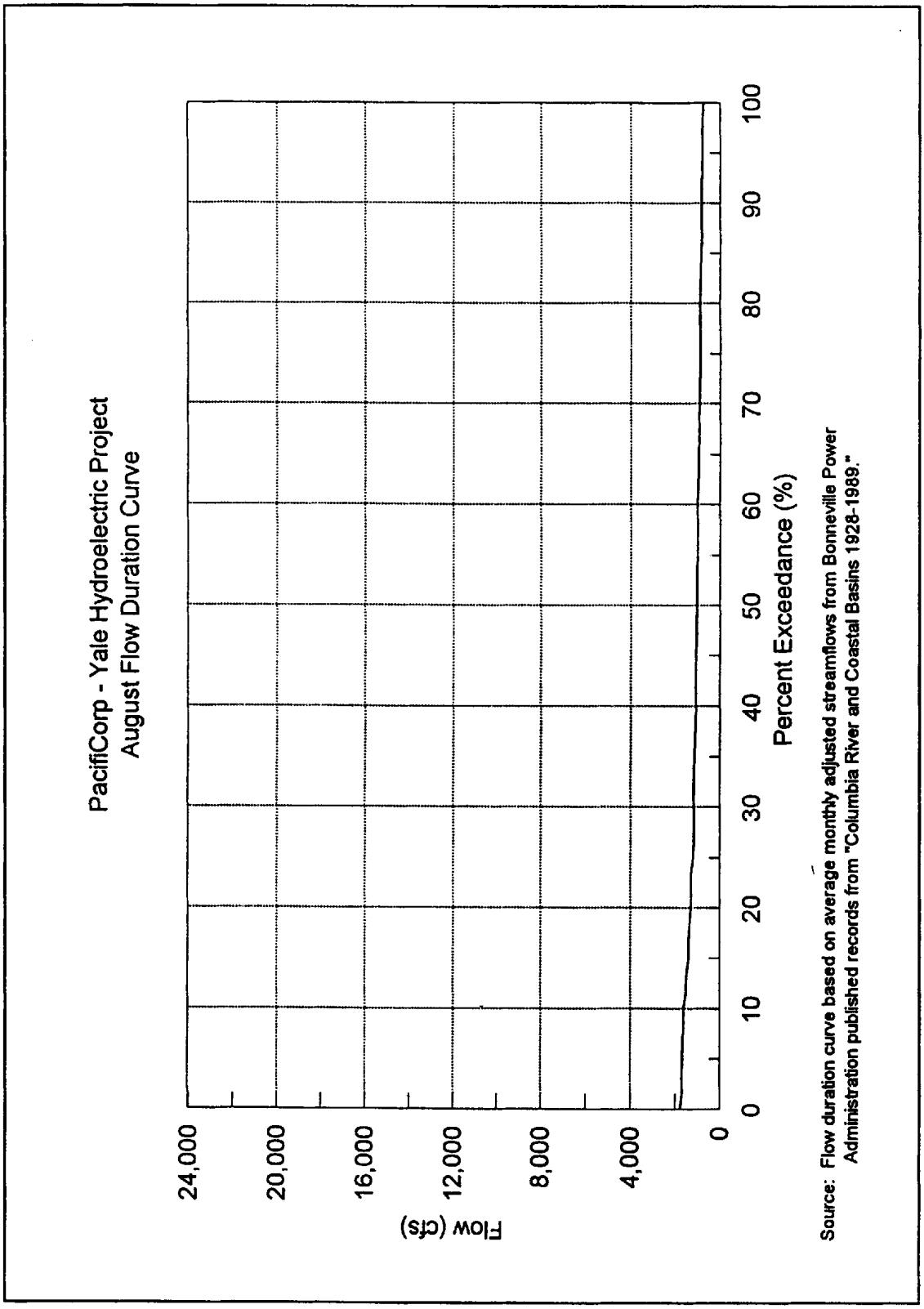
Yale May flow duration curve.



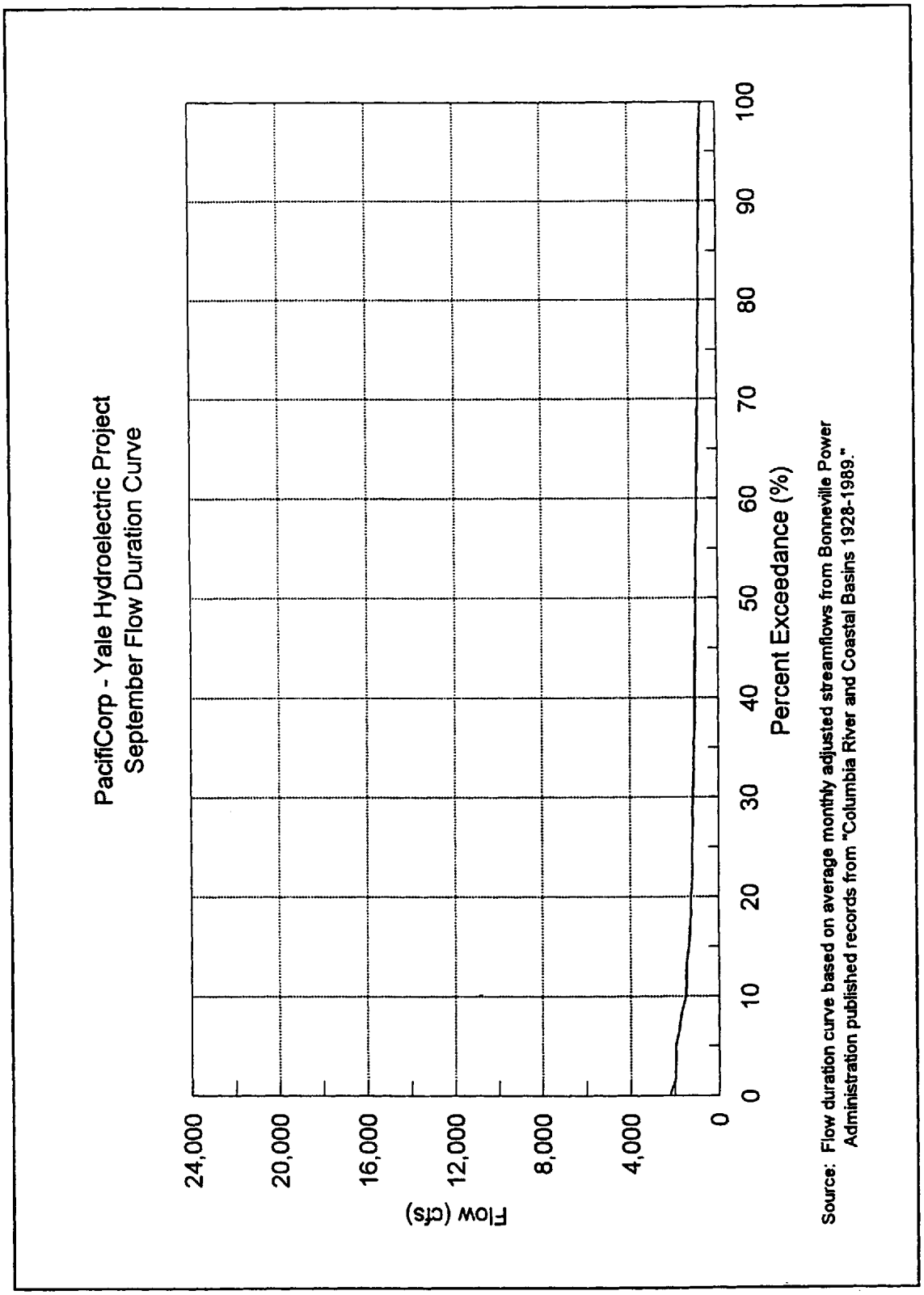
Yale June flow duration curve.



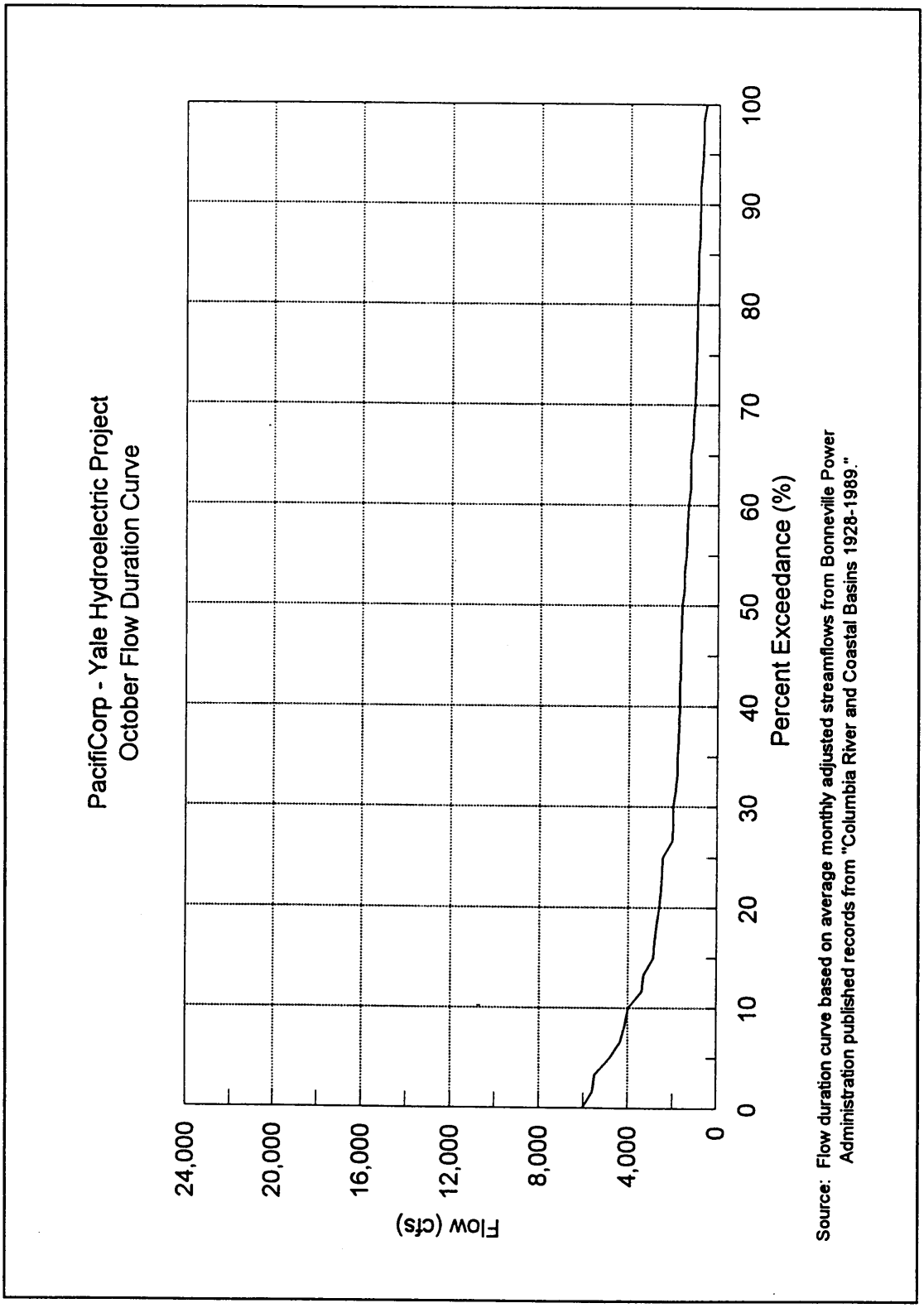
Yale July flow duration curve.



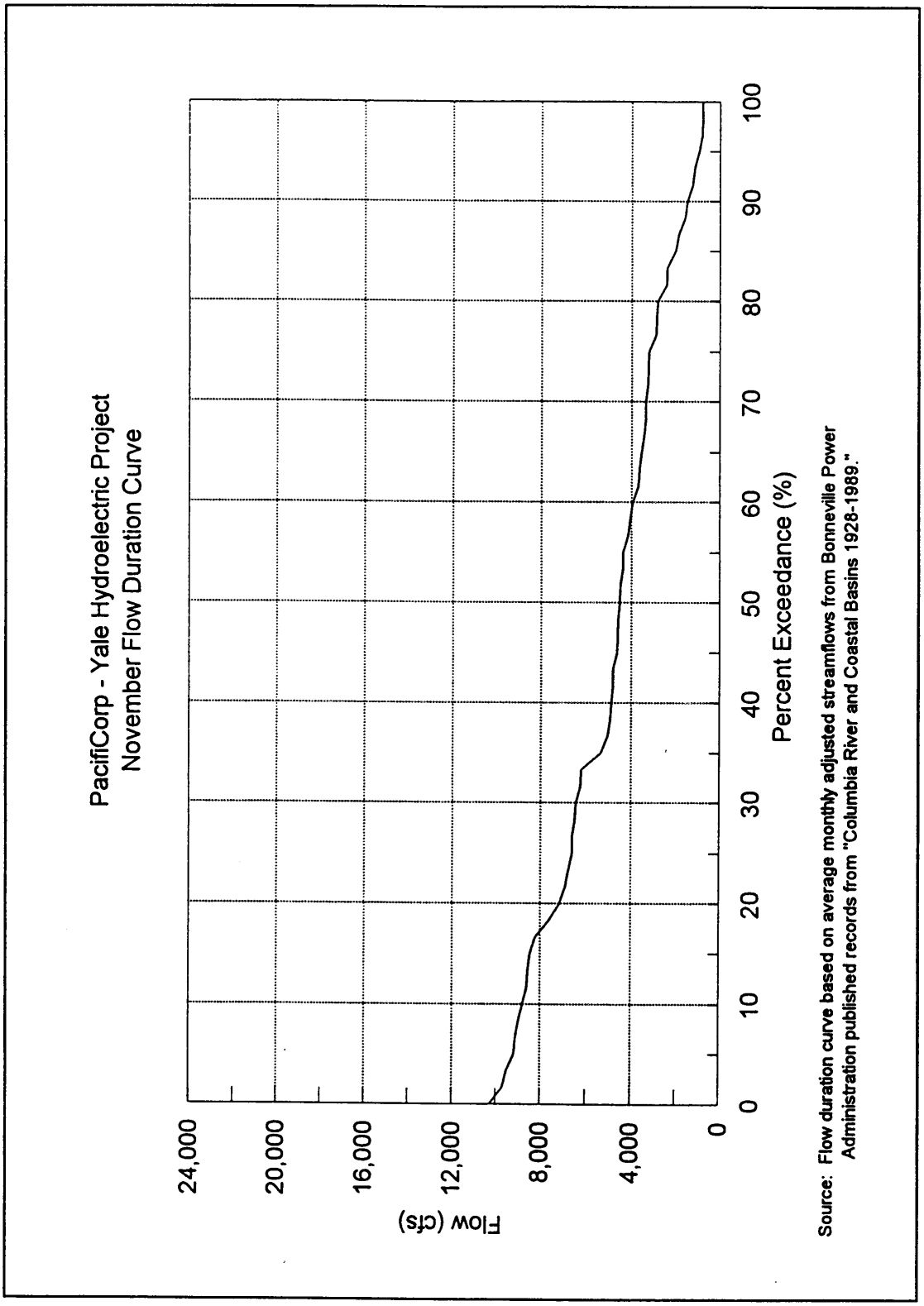
Yale August flow duration curve.



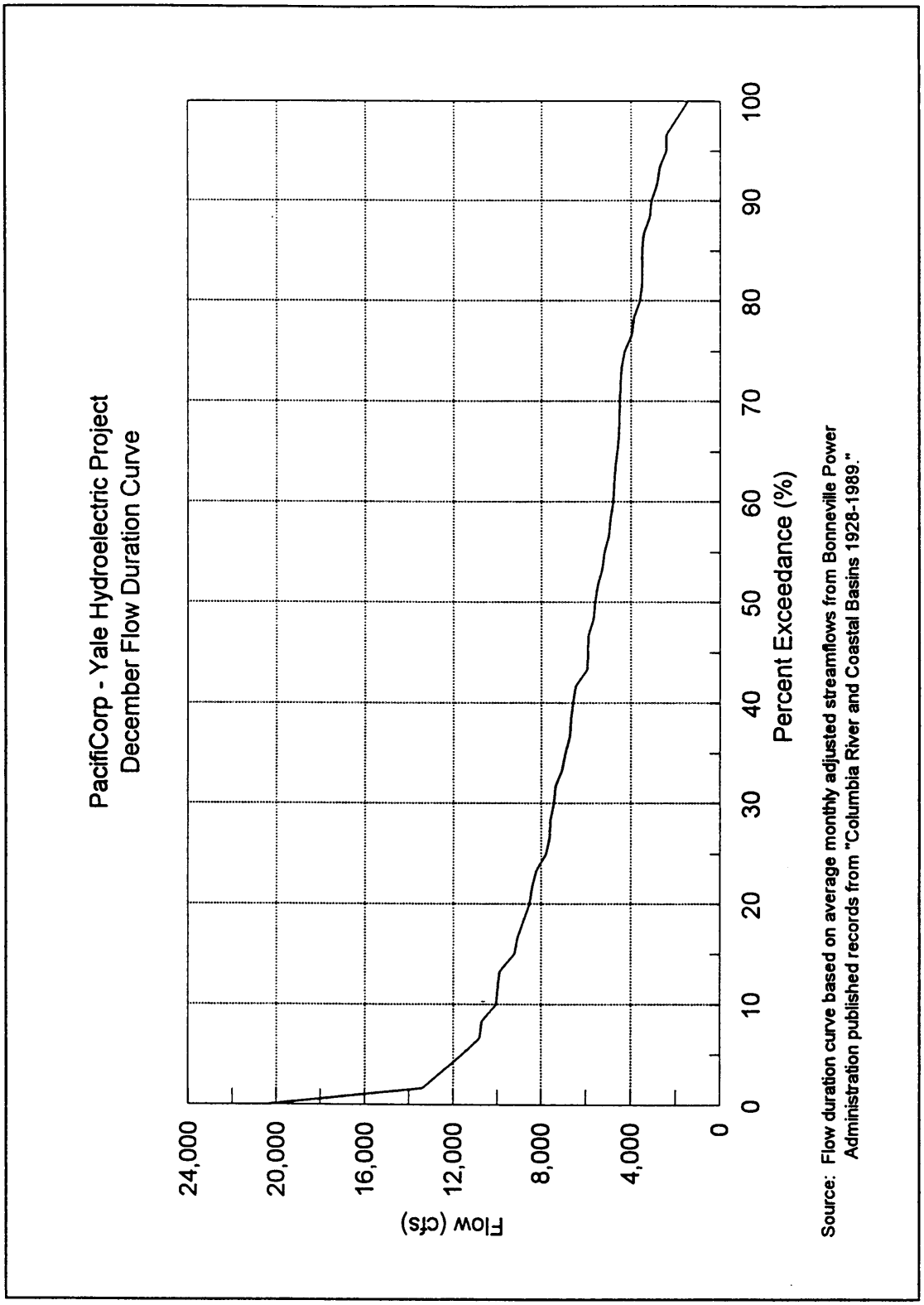
Yale September flow duration curve.



Yale October flow duration curve.



Yale November flow duration curve.



Yale December flow duration curve.