An Analysis of Potential Water Availability from the Atwood, Leesville, and Tappan Lakes in the Muskingum River Watershed, Ohio

Scientific Investigations Report 2013–5112
Version 1.1, January 2014

U.S. Department of the Interior
U.S. Geological Survey

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By G.F. Koltun

Prepared in cooperation with the Muskingum Watershed Conservancy District

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Conversion Factors and Abbreviations

Multiply	By	To obtain
Length		
foot (ft)	0.3048	meter (m)
Area		
square mile (mi^2)	259.0	hectare (ha)
square mile (mi^2)	2.590	square kilometer (km^2)
Volume		
million gallons (Mgal)	3,785.0	cubic meter (m^3)
Flow rate		
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
million gallons per day (Mgal/d)	0.04381	cubic meter per second (m^3/s)

Abbreviations

MWCD	Muskingum Watershed Conservancy District
SAS	Statistical Analysis System
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey

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Abstract

This report presents the results of a study to assess potential water availability from the Atwood, Leesville, and Tappan Lakes, located within the Muskingum River Watershed, Ohio. The assessment was based on the criterion that water withdrawals should not appreciably affect maintenance of recreation-season pool levels in current use. To facilitate and simplify the assessment, it was assumed that historical lake operations were successful in maintaining seasonal pool levels, and that any discharges from lakes constituted either water that was discharged to prevent exceeding seasonal pool levels or discharges intended to meet minimum in-stream flow targets downstream from the lakes. It further was assumed that the volume of water discharged in excess of the minimum in-stream flow target is available for use without negatively impacting seasonal pool levels or downstream water uses and that all or part of it is subject to withdrawal.

Historical daily outflow data for the lakes were used to determine the quantity of water that potentially could be withdrawn and the resulting quantity of water that would flow downstream (referred to as "flow-by") on a daily basis as a function of all combinations of three hypothetical target minimum flow-by amounts (1, 2, and 3 times current minimum in-stream flow targets) and three pumping capacities (1, 2, and 3 million gallons per day). Using both U.S. Geological Survey streamgage data and lake-outflow data provided by the U.S. Army Corps of Engineers resulted in analytical periods ranging from 51 calendar years for the Atwood Lake to 73 calendar years for the Leesville and Tappan Lakes.

The observed outflow time series and the computed time series of daily flow-by amounts and potential withdrawals were analyzed to compute and report order statistics (95th, 75th, 50th, 25th, 10th, and 5th percentiles) and means for the analytical period, in aggregate, and broken down by calendar month. In addition, surplus-water mass curve data were tabulated for each of the lakes.

Monthly order statistics of computed withdrawals indicated that, for the three pumping capacities considered, increasing the target minimum flow-by amount tended to reduce the amount of water that can be withdrawn.

The reduction was greatest in the lower percentiles of withdrawal; however, increasing the flow-by amount had no impact on potential withdrawals during high flow. In addition, for a given target minimum flow-by amount, increasing the pumping rate increased the total amount of water that could be withdrawn; however, that increase was less than a direct multiple of the increase in pumping rate for most flow statistics. Potential monthly withdrawals were observed to be more variable and more limited in some calendar months than others.

Monthly order statistics and means of computed daily mean flow-by amounts indicated that flow-by amounts generally tended to be lowest during June–October and February. Increasing the target minimum flow-by amount for a given pumping rate resulted in some small increases in the magnitudes of the mean and 50th percentile and lower order statistics of computed mean flow-by, but had no effect on the magnitudes of the higher percentile statistics. Increasing the pumping rate for a given target minimum flow-by amount resulted in decreases in magnitudes of higher-percentile flow-by statistics by an amount equal to the flow equivalent of the increase in pumping rate; however, some lower percentile statistics remained unchanged.

Introduction

The Muskingum Watershed Conservancy District (MWCD)—a political subdivision of the State of Ohio—was created in 1933 under the Conservancy Act (Ohio Revised Code, Chapter 6101) (LAWriter Ohio Laws and Rules, 2000). In addition to flood reduction and protection, other approved purposes of the MWCD include conserving and developing water supplies for domestic, industrial, and public use; treating wastewater; and providing recreational opportunities. In support of the MWCD's role in developing water supplies, a study was conducted by the U.S. Geological Survey (USGS), in cooperation with the MWCD, to assess potential water availability from the Atwood, Leesville, and Tappan Lakes, located within the Muskingum River Watershed, Ohio (fig. 1). These lakes, which have been operational since fall 1936, are operated by the U.S. Army Corps of Engineers (USACE) in partnership with the MWCD.
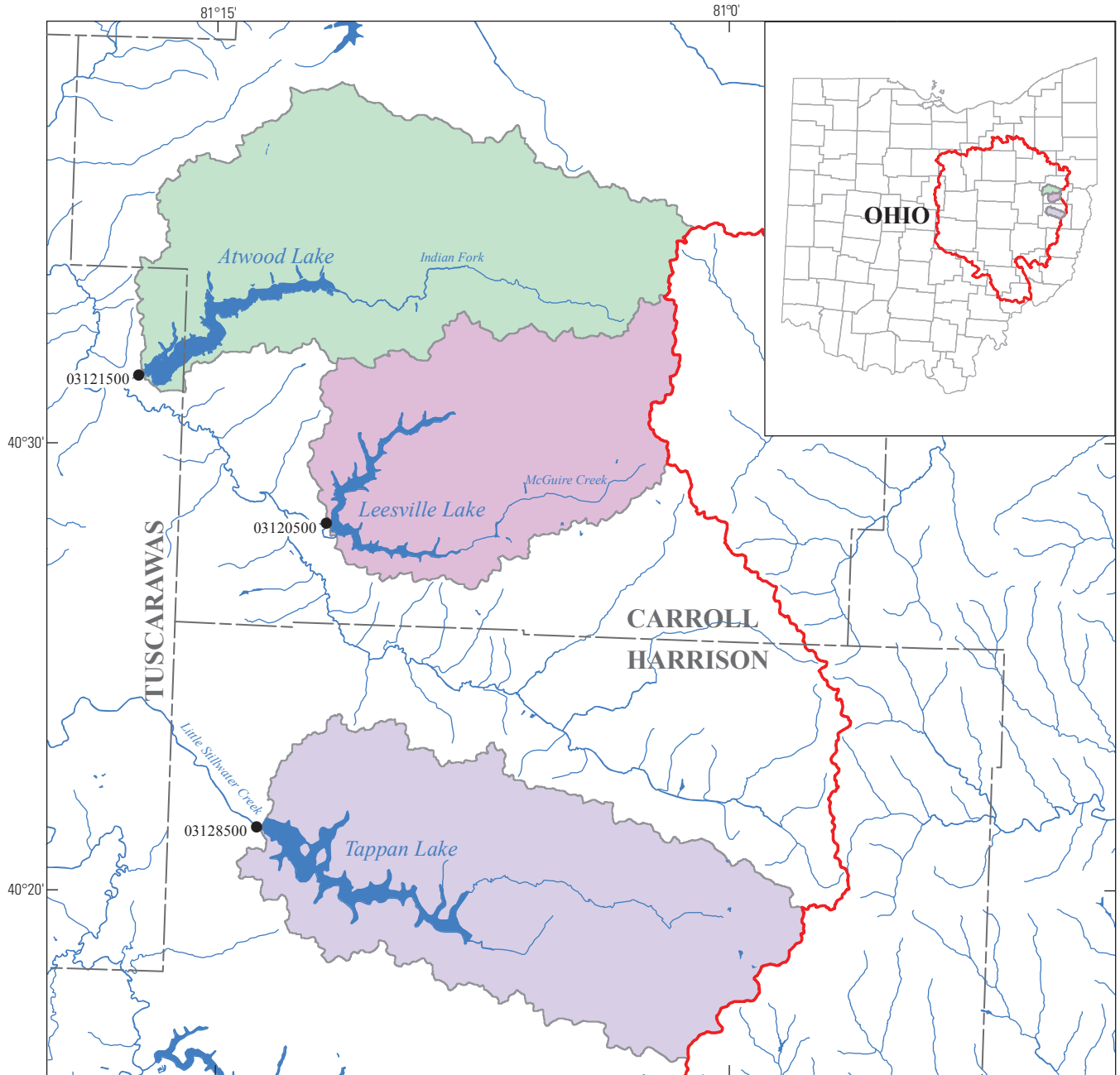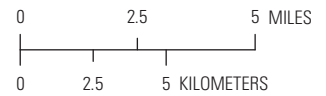
Figure 1.   Locations of lakes and streamgages in the Muskingum River Watershed, Ohio.

The MWCD stipulated that the water-availability assessment be based on the criterion that water withdrawals should not appreciably affect maintenance of recreation-season pool levels in current use. To facilitate and simplify the water-availability analyses, it was assumed that historical lake operations were successful in maintaining seasonal pool levels, and that any discharges from the lakes constituted either water that was discharged to prevent exceeding seasonal pool levels or discharges intended to meet minimum in-stream flow targets downstream from the lakes. It is assumed that volumes of water discharged in excess of minimum in-stream flow targets (hereafter referred to as "surplus water") are, by definition, available for use without negatively impacting seasonal pool levels or downstream water uses. The residual lake outflow (that is, the outflow minus withdrawals, if any) will be referred to as the "flow-by" because that water flows by (or through) the lake and is available for downstream uses.

Descriptions of the Lakes

The lakes addressed in this report include Atwood, Leesville, and Tappan. The dams that form these lakes were all completed in 1936. While the primary purpose of the lakes is flood control, they also were designed to provide storage for water conservation and recreation and to promote fish and wildlife enhancement.

Atwood Lake, which has a drainage area of about 70 square miles (mi^2), is located in Tuscarawas and Carroll Counties, Ohio, on the Indian Fork of Conotton Creek (fig. 1). The Atwood Dam is a 65 feet (ft) high rolled-earth fill with impervious core (U.S. Army Corps of Engineers, 2013a). The outlet works consist of an approach channel, intake structure, tri-channeled conduit, stilling basin, and outlet channel (U.S. Army Corps of Engineers, 2005).

Leesville Lake, which has a drainage area of about 48.3 mi^2, is located in southwest Carroll County, Ohio, on McGuire Creek (a tributary of Conotton Creek) (fig. 1). The Leesville Dam is a 74 ft high rolled-earth fill with impervious core (U.S. Army Corps of Engineers, 2013b). The outlet works consist of an approach channel, intake structure, horseshoe-shaped tunnel, open-cut conduit section, stilling basin, and outlet channel (U.S. Army Corps of Engineers, 2005).

Tappan Lake, which has a drainage area of about 71.1 mi^2, is located in northwest Harrison County, Ohio, on Little Stillwater Creek (fig. 1). The Tappan Dam is a 52 ft high rolled-earth fill with impervious core (U.S. Army Corps of

Engineers, 2013c). The outlet works consist of an approach channel, intake structure, horseshoe-shaped tunnel, stilling basin, and outlet channel (U.S. Army Corps of Engineers, 2005).

At each of the lakes previously discussed, normal flow (that is, when inflows to the lakes result in pool levels that are lower than emergency spillways present at each lake) is controlled by three 3.5 ft by 7 ft sluice gates. In addition, two ungated 1.5 ft diameter siphons are used at each lake to help maintain the minimum pool elevation. The USACE has set minimum in-stream flow targets, immediately downstream from the lakes, of 1.5 cubic feet per second (ft^3/s) for Atwood and Leesville and 2.0 ft^3/s for Tappan. It is worth noting that during very dry periods, it is possible to release less than the minimum in-stream flow target (if the lake level falls below the exposed circular intake to the siphons). Also, because of gate leakage, it is possible that flows as low as the minimum in-stream flow targets do not occur (Timothy Curran, U.S. Army Corps of Engineers, Huntington District, written commun., 2012).

Purpose and Scope

The purpose of this report is to describe analytical methods and present results of a study to assess potential water availability from the Atwood, Leesville, and Tappan Lakes in the Muskingum River Watershed, Ohio. The analysis involved determining the amounts of water that potentially could be withdrawn and the resulting amounts of water that would flow downstream on a daily basis as a function of all combinations of three hypothetical target minimum flow-by amounts (1, 2, and 3 times current minimum in-stream flow targets) and three pumping capacities (1, 2, and 3 million gallons per day (Mgal/d)). The analysis was based on an examination of the best available historical daily outflow data for the lakes.

Flow Data Used in the Analyses

Lake-outflow data used for this report came from either daily mean streamflows published by the USGS for streamgages located short distances downstream from the outlet works of the lakes (table 1 and fig. 1) or from daily mean outflow data provided by the USACE. The streamflow data published by the USGS were determined based on relations developed between water-level data and physical measurements of streamflow. The USACE stated that they typically

Table 1. U.S. Geological Survey streamgages and periods of gage record used in the water-availability analyses for the Muskingum River Watershed, Ohio.

Station number	Station name	Period of streamgage record used
03121500	Indian Fork below Atwood Dam near New Cumberland, Ohio	01/01/1961 – 09/30/1975
03120500	McGuire Creek near Leesville, Ohio	01/01/1939 – 09/30/1991
03128500	Little Stillwater Creek below Tappan Dam at Tappan, Ohio	01/01/1939 – 09/30/1991

used gate and siphon ratings to compute the outflows for the lakes and indicated that the accuracy of their reported flows may be poor during some low-flow periods (for example, due to unaccounted for gate leakages) (Timothy Curran, U.S. Army Corps of Engineers, Huntington District, written commun., June, 2012).

Pearson's correlation coefficient (r), which measures the strength of the linear relationship between two variables, was computed for each lake for the relation between same-day USGS-published streamflows and USACE-computed outflows. Pearson's r can range from −1 to 1 where an r of ±1 indicates a perfect linear relationship between variables and an r of 0 indicates no linear relationship between variables. When considering all concurrent flow data, the r values ranged from a low of 0.95 to a high of 0.96 for the three lake outflows. Correlation coefficients computed based on only those paired flow values where the USACE outflow was reported to be less than or equal to 10 ft^3/s, were considerably smaller (r ranging from 0.19 to 0.60), indicating poorer correlation than for the full data set. For all three lakes, the largest differences between the USGS-published streamflows and the USACE-computed outflows for flows less than or equal to 10 ft^3/s predominately were associated with times when the USGS-published stream-flows were larger than the USACE-computed outflows.

Because of the stated uncertainty surrounding the low-flow data supplied by the USACE, the USGS streamgage data were used whenever available; USACE data were used at other times. The resulting daily-mean-outflow time series will henceforth be referred to as the "observed" outflows.

The three USGS streamgages whose data were used in this report, along with the periods of record used, are shown in table 1. The USACE provided lake-outflow data for the period 01/01/1962 to 12/31/2011 for the Atwood, Leesville, and Tappan Lakes. Using both streamgage and outflow data provided by the USACE resulted in analytical periods ranging from 51 calendar years (1961–2011) for Atwood Lake to 73 calendar years (1939–2011) for the Leesville and Tappan Lakes.

Methods of Analysis

To assess potential future water availability, observed outflow data from the Atwood, Leesville, and Tappan Lakes were used to determine the amounts of water that potentially could be withdrawn and the resulting residual amounts of water that would flow downstream (referred to as "flow-by") on a daily basis as a function of all combinations of three hypothetical target minimum flow-by amounts and three pumping capacities. It is worth noting that the "target minimum flow-by amounts" represent targets (not regulatory mandates) for minimum daily mean flows immediately downstream from the lakes; however, there may be times when those targets cannot be met. The occasional inability to fulfill those targets in this analysis occurs because the flow-by comes from observed lake outflows, which at times was already less than the target.

This might occur, for example, during extended dry periods when lake outflows are completely controlled by the siphons. Irrespective of the actual outflows from the lakes, in no case does the analytical method used for this report yield flow-by amounts less than the observed lake outflows.

The target minimum flow-by amounts used in this analysis were 1, 2, and 3 times the current minimum in-stream flow targets for the lakes (1.5 ft^3/s for the Atwood and Leesville Lakes and 2.0 ft^3/s for Tappan Lake) as specified by the USACE. The pumping rates used in this analysis were 1, 2, and 3 Mgal/d. Pumping rates and multipliers for target minimum flow-by amounts used in this analysis were specified by the MWCD.

As illustrated in figure 2, for each day in the lake outflow time series, the outflow amount was compared to the target minimum flow-by amount. If the outflow amount did not exceed the target minimum flow-by amount, then there was no surplus water available for withdrawal and the total outflow was designated as flow-by. If instead the outflow amount exceeded the target minimum flow-by amount, then the amount of outflow in excess of that target minimum flow-by amount was said to be surplus water.

The amount of surplus water was compared to the amount of water that could be pumped (withdrawn) in 1 day at the specified pumping rate. If the amount of surplus water exceeds that which could be pumped, then the withdrawal was set equal to the product of time and the pumping rate. For example, if the pumping rate was 1 Mgal/d, then the amount of water that could be pumped over a 24 hour period equals 1 million gallons (Mgal). If instead the amount of surplus water did not exceed that which could be pumped in 1 day, then the withdrawal was set equal to the amount of surplus water (the assumption being that the pump would be operated only for the portion of the day required to pump the surplus amount). The resulting flow-by amount (that is the water that flows downstream) is equal to the outflow minus withdraw-als (if any). This approach ensures that the resulting flow-by amount equals or exceeds the target minimum flow-by amount whenever the outflow exceeds the target minimum flow by.

The observed outflow time series and the time series of daily flow-by amounts and potential withdrawals (computed as previously described) were analyzed to compute order statistics and means. The order statistics computed include the 95th, 75th, 50th, 25th, 10th, and 5th percentiles. In general, the Pth percentile refers to the value in the series that is greater than or equal to P percent of values in the series. Conversely, the Pth percentile value is less than or equal to 100-P percent of the values in the series. For example, the 5th percentile value is greater than or equal to 5 percent of the values in the series and less than or equal to 95 percent (100-5 percent) of the values.

Order statistics and means were computed for daily mean observed outflows and computed flow-by amounts, as well as for monthly and annual total withdrawals. The ultimate objective of computing order statistics is to provide information on the frequency with which outflows, flow-by amounts, and
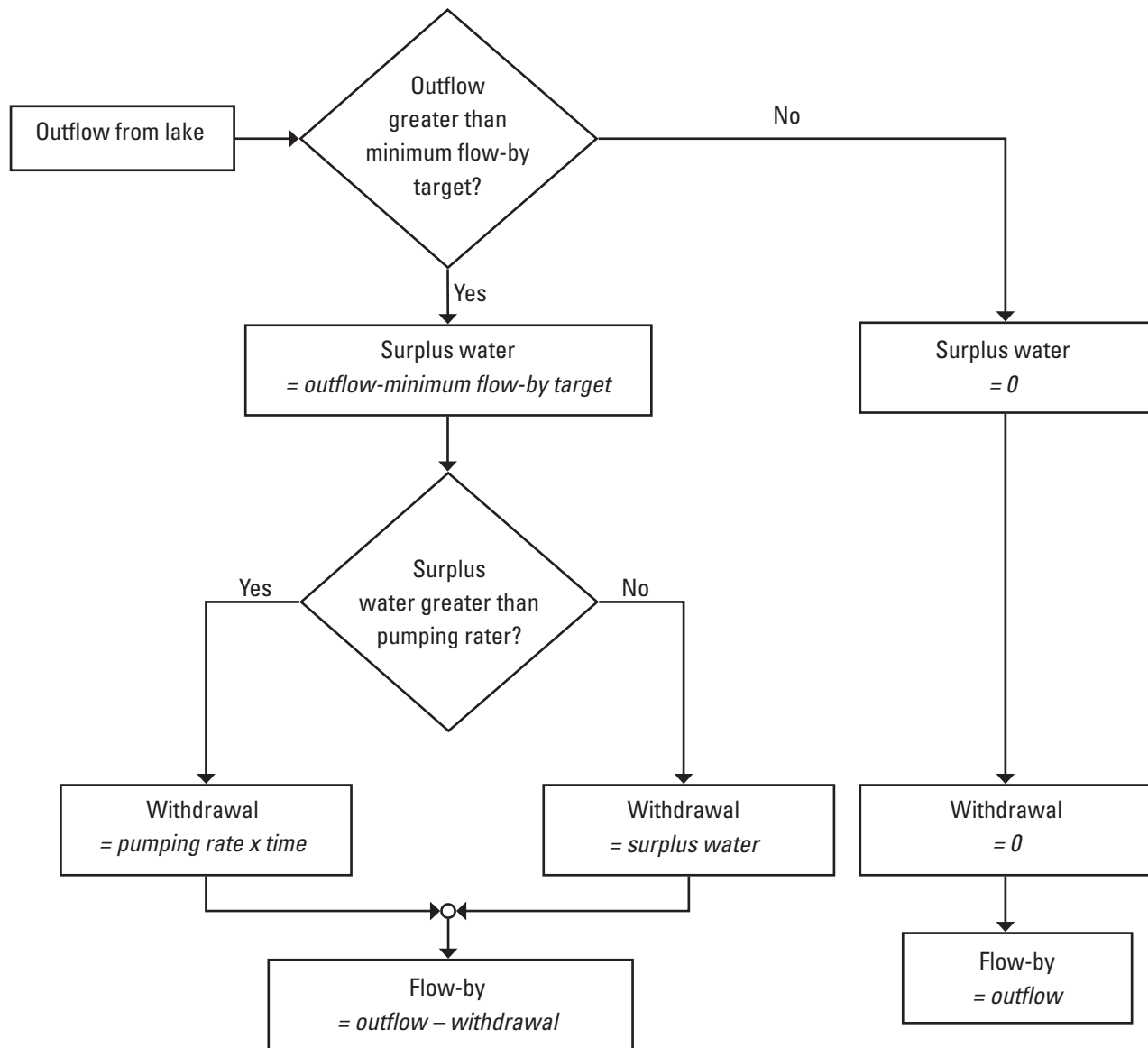
Figure 2.   Flowchart outlining the logic by which withdrawal and flow-by amounts were determined.

withdrawals with various magnitudes were exceeded (or not exceeded). Order statistics were computed with the Statistical Analysis System (SAS) (SAS Institute, Inc., 2011) using the SAS type 5 estimator (which calculates percentiles based on the empirical distribution function with averaging when the percentile boundary lies between two observations). For some tables presented in this report, statistics are reported for the aggregate analytical period; for other tables, order statistics were computed based on data further subdivided by calendar month. The aggregate analytical-period order statistics provide information on exceedance/nonexceedance without consideration for seasonality, whereas the monthly order statistics provide more information about seasonal variation in the flows and potential withdrawals.

Cumulative surplus-water volumes were tabulated as a function of time for the Atwood, Leesville, and Tappan Lakes based on target minimum outflows equal to 1, 2, and 3 times current target minimum outflows. When cumulative volumes are plotted as a function of time, they are called mass curves. Both tabular and graphical versions of surplus-water mass curves can be used to assess hypothetical water-demand rates to determine whether the demand could have been met at all times or, if not, to determine the maximum amount and duration of demand excess.

Results and Discussion

Order statistics and means of calendar-year and monthly total withdrawals are shown in tables 2–5 for the various combinations of pumping rates and target minimum flow-by amounts. The data presented in table 2 show some general trends in withdrawal statistics for the Atwood, Leesville, and Tappan Lakes. Specifically, for any of the given pumping rates, increasing the target minimum flow-by amount tends to reduce the amount of water that can be withdrawn. The reduction is greatest in the lower percentiles of withdrawal because increasing the flow-by amount has a large impact on water available for withdrawal during low-flow periods; however, increasing the flow-by amount has no impact on potential withdrawals during high-flow periods because the amount of surplus water (from which withdrawals are made) already far exceeds pumping rates.

For a given target minimum flow-by amount, increasing the pumping rate typically increases the total amount of water that can be withdrawn; however, that increase is less than a direct multiple of the increase in pumping rate for most statistics. This is because sufficient surplus water is available on some days to meet the demand associated with smaller pumping rates, but it may not be sufficient to meet the demand associated with larger pumping rates. When the amount of surplus water is not sufficient to meet the full demand associated with an increased pumping rate, the amount of additional withdrawal (beyond that which is associated with the lower pumping rate) will range from zero to some fraction of the difference in pump capacities.

Withdrawal data shown in tables 3–5 illustrate that potential monthly withdrawals are more variable and more limited in some calendar months than others. For example, withdrawal results for Atwood Lake (table 3) indicate that, irrespective of which target minimum flow-by amount is used, 1 Mgal of water could have been withdrawn daily at a pumping rate of 1 Mgal/d on at least 90 percent of the April months; however, that same amount of withdrawal was possible on a smaller percentage of the September months. For example, with a pumping rate of 1 Mgal/d and a target minimum flow-by amount of 4.5 ft^3/s, a daily withdrawal of 1 Mgal was not possible for Atwood Lake on at least 25 percent of September months. At that same pumping rate and target minimum flow-by amount, no water could be withdrawn from Atwood Lake on at least 5 percent of the September months.

Aggregate analytical-period order statistics and monthly order statistics of observed daily mean outflows are reported in tables 6 and 7, respectively. Data from these tables provide a base against which to compare flow-by statistics from the analyses employing the various combinations of pumping and target minimum flow-by amounts. An examination of the data presented in table 7 indicates that the daily mean observed outflows for the Atwood, Leesville, and Tappan Lakes tend to be lowest during June–October, although February also stands out as having relatively low mean outflows. The relatively low mean outflows for February likely reflect the fact that February typically is one of the driest months in Ohio (Ohio Department of Natural Resources, 2011).

Aggregate analytical-period order statistics and means of computed daily mean flow-by amounts are shown in table 8 for the Atwood, Leesville, and Tappan Lakes for the various combinations of pumping rates and target minimum flow-by amounts. The data show that increases in the target minimum flow-by amounts for a given pumping rate resulted in some small increases in the magnitudes of the means and 25th percentile and smaller order statistics, but had no effect on the magnitudes of the higher percentile statistics. Also, increases in the pumping rate for a given target minimum flow-by amount resulted in decreases in magnitudes of higher-percentile flow statistics by an amount equal to the flow equivalent of the increase in pumping rate; however, some lower-percentile flow statistics remained unchanged because they represent days during which there was no surplus water (and so withdrawals could not be increased on those days in spite of increases in pumping rate).

Monthly order statistics and means of computed daily mean flow-by amounts are shown in tables 9–11 for the Atwood, Leesville, and Tappan Lakes, respectively, for the various combinations of pumping rates and target minimum flow-by amounts. Similar to the observed outflows, computed mean flow-by amounts generally tended to be lowest during June–October and mean flow-by amounts for February also tended to be relatively low. The data in tables 9–11 show that increases in the target minimum flow-by amounts for a given pumping rate resulted in some small increases in the magnitudes of the mean and 50th percentile and lower order statistics, but had no effect on the magnitudes of the higher percentile statistics. As was observed with the aggregate analytical-period order statistics, increases in the pumping rate for a given target minimum flow-by amount resulted in decreases in magnitudes of higher-percentile flow statistics by an amount equal to the flow equivalent of the increase in pumping rate; however, some lower percentile statistics remained unchanged.

Table 2. Statistics of calendar-year potential withdrawals for the Atwood, Leesville, and Tappan Lakes in the Muskingum River Watershed, Ohio.

[Mgal/d, million gallons per day; minimum in-stream flow targets equal 1.5 cubic feet per second (ft³/s) for Atwood and Leesville Lakes and 2.0 ft³/s for Tappan Lake]

Statistic	Calendar-year potential withdrawals, in millions of gallons, for indicated lakes, pumping rates, and minimum in-stream flow-target multiples								
	Pumping rate, in Mgal/d								
	1			2			3		
	Minimum in-stream flow-target multiple								
	1	2	3	1	2	3	1	2	3
Atwood Lake									
95th percentile	365	365	365	730	730	730	1095	1095	1095
75th percentile	365	364	364	729	728	724	1092	1089	1085
mean	351	338	332	689	670	658	1020	995	978
50th percentile	361	358	355	719	714	708	1075	1063	1059
25th percentile	341	319	305	652	627	609	961	916	910
10th percentile	313	266	244	603	510	473	850	739	692
5th percentile	303	245	230	544	469	454	783	693	667
Leesville Lake									
95th percentile	365	362	354	726	716	705	1080	1066	1044
75th percentile	354	335	321	685	651	633	999	957	925
mean	321	293	276	613	568	535	887	827	782
50th percentile	331	301	276	632	577	522	905	828	762
25th percentile	293	256	241	548	498	461	793	723	666
10th percentile	276	227	204	505	421	390	708	616	569
5th percentile	240	209	186	448	394	365	646	573	534
Tappan Lake									
95th percentile	364	364	361	728	723	717	1088	1082	1075
75th percentile	349	331	320	677	654	625	1005	966	912
mean	316	292	277	612	572	546	895	843	805
50th percentile	331	296	287	636	588	558	914	877	822
25th percentile	292	254	234	549	491	463	814	709	685
10th percentile	254	230	201	482	438	396	702	625	586
5th percentile	244	203	179	452	388	351	650	558	513

Table 3.   Statistics of Atwood Lake, Ohio, total monthly potential withdrawals for indicated pumping rates and target minimum flow-by amounts.

[ft^3/s, cubic foot per second; Mgal/d, million gallons per day]

Target minimum flow-by (ft³/s)	Statistic	Total monthly potential withdrawals, in millions of gallons, for indicated months and pump rates											
		Month											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		Pumping rate = 1 Mgal/d											
	95th percentile	31.0	29.0	31.0	30.0	31.0	30.0	31.0	31.0	30.0	31.0	30.0	31.0
	75th percentile	31.0	28.0	31.0	30.0	31.0	30.0	31.0	31.0	30.0	31.0	30.0	31.0
	mean	30.6	25.8	30.2	29.7	31.0	29.8	29.8	29.2	27.3	28.8	28.5	30.2
1.5	50th percentile	31.0	28.0	31.0	30.0	31.0	30.0	31.0	31.0	30.0	31.0	30.0	31.0
	25th percentile	31.0	26.6	31.0	30.0	31.0	30.0	31.0	31.0	30.0	31.0	30.0	31.0
	10th percentile	29.5	15.3	27.9	30.0	31.0	30.0	26.3	24.5	16.0	22.5	24.7	29.0
	5th percentile	28.0	13.8	25.6	30.0	31.0	29.0	22.6	17.5	13.3	13.0	19.0	27.0
	95th percentile	31.0	29.0	31.0	30.0	31.0	30.0	31.0	31.0	30.0	31.0	30.0	31.0
	75th percentile	31.0	28.0	31.0	30.0	31.0	30.0	31.0	31.0	30.0	31.0	30.0	31.0
	mean	30.3	24.4	28.9	29.4	30.9	29.7	29.0	27.1	25.0	27.3	27.5	29.6
3.0	50th percentile	31.0	28.0	31.0	30.0	31.0	30.0	31.0	31.0	30.0	31.0	30.0	31.0
	25th percentile	30.5	24.0	28.0	30.0	31.0	30.0	31.0	29.5	27.9	31.0	30.0	31.0
	10th percentile	28.3	10.4	23.5	30.0	31.0	29.7	18.5	11.3	1.6	13.9	18.0	27.4
	5th percentile	27.0	1.0	16.0	28.7	31.0	29.0	16.0	5.7	0.0	3.6	14.9	22.3
	95th percentile	31.0	29.0	31.0	30.0	31.0	30.0	31.0	31.0	30.0	31.0	30.0	31.0
	75th percentile	31.0	28.0	31.0	30.0	31.0	30.0	31.0	31.0	30.0	31.0	30.0	31.0
	mean	30.1	24.3	28.6	29.3	30.9	29.6	28.6	26.7	24.7	26.9	27.4	29.5
4.5	50th percentile	31.0	28.0	31.0	30.0	31.0	30.0	31.0	31.0	30.0	31.0	30.0	31.0
	25th percentile	30.1	24.0	28.0	30.0	31.0	30.0	31.0	28.9	26.3	30.9	29.8	31.0
	10th percentile	28.2	10.2	22.4	30.0	31.0	29.5	16.1	8.8	1.0	10.5	17.0	26.3
	5th percentile	27.0	1.0	15.4	28.1	30.6	28.3	14.9	5.4	0.0	1.3	12.4	20.2
		Pumping rate = 2 Mgal/d											
	95th percentile	62.0	58.0	62.0	60.0	62.0	60.0	62.0	62.0	60.0	62.0	60.0	62.0
	75th percentile	62.0	56.0	62.0	60.0	62.0	60.0	62.0	62.0	60.0	62.0	60.0	62.0
	mean	60.9	50.2	59.0	59.1	61.9	59.5	58.7	56.3	52.2	56.1	56.0	59.7
1.5	50th percentile	62.0	56.0	62.0	60.0	62.0	60.0	62.0	62.0	60.0	62.0	60.0	62.0
	25th percentile	61.4	50.1	57.0	60.0	62.0	60.0	62.0	60.4	57.7	62.0	60.0	62.0
	10th percentile	57.0	23.6	50.5	60.0	62.0	59.7	43.8	35.5	21.3	33.7	42.3	55.5
	5th percentile	54.0	15.1	42.7	58.6	61.9	58.0	40.9	22.8	13.3	18.3	38.0	50.7
	95th percentile	62.0	58.0	62.0	60.0	62.0	60.0	62.0	62.0	60.0	62.0	60.0	62.0
	75th percentile	62.0	56.0	62.0	60.0	62.0	60.0	62.0	62.0	60.0	62.0	60.0	62.0
	mean	60.2	48.6	57.1	58.6	61.8	59.1	56.8	52.9	49.2	53.7	54.7	58.9
3.0	50th percentile	62.0	56.0	62.0	60.0	62.0	60.0	62.0	62.0	60.0	62.0	60.0	62.0
	25th percentile	60.3	47.3	56.0	60.0	62.0	60.0	61.9	56.5	51.9	59.9	58.5	62.0
	10th percentile	56.2	20.0	45.0	60.0	62.0	59.0	30.9	15.3	2.1	21.5	34.0	52.6
	5th percentile	54.0	2.0	27.3	55.7	59.8	55.5	26.3	10.2	0.0	3.6	24.3	41.7

Table 3. Statistics of Atwood Lake, Ohio, total monthly potential withdrawals for indicated pumping rates and target minimum flow-by amounts.—Continued

[ft³/s, cubic foot per second; Mgal/d, million gallons per day]

Target minimum flow-by (ft³/s)	Statistic	Total monthly potential withdrawals, in millions of gallons, for indicated months and pump rates											
		Month											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		Pumping rate = 2 Mgal/d—Continued											
	95th percentile	62.0	58.0	62.0	60.0	62.0	60.0	62.0	62.0	60.0	62.0	60.0	62.0
	75th percentile	62.0	56.0	62.0	60.0	62.0	60.0	62.0	62.0	60.0	62.0	60.0	62.0
	mean	60.0	48.4	56.8	58.6	61.7	59.0	56.0	52.0	48.7	53.2	54.4	58.8
4.5	50th percentile	62.0	56.0	62.0	60.0	62.0	60.0	62.0	62.0	60.0	62.0	60.0	62.0
	25th percentile	60.0	47.0	56.0	60.0	62.0	60.0	61.4	54.5	51.3	58.9	57.6	62.0
	10th percentile	55.9	19.5	43.9	60.0	62.0	58.8	29.1	12.7	1.5	19.7	34.0	51.3
	5th percentile	54.0	1.8	25.8	54.3	58.3	53.7	21.2	5.8	0.0	1.3	23.6	39.2
		Pumping rate = 3 Mgal/d											
	95th percentile	93.0	87.0	93.0	90.0	93.0	90.0	93.0	93.0	90.0	93.0	90.0	93.0
	75th percentile	93.0	84.0	93.0	90.0	93.0	90.0	93.0	93.0	90.0	93.0	90.0	93.0
	mean	90.8	74.4	87.3	88.3	92.7	88.9	86.5	82.0	76.4	82.5	83.1	89.1
1.5	50th percentile	93.0	84.0	93.0	90.0	93.0	90.0	93.0	93.0	90.0	93.0	90.0	93.0
	25th percentile	91.3	72.6	84.9	90.0	93.0	90.0	92.9	87.3	81.0	90.8	88.4	93.0
	10th percentile	85.0	32.1	72.1	90.0	93.0	88.5	54.1	38.7	21.3	43.1	56.2	81.5
	5th percentile	81.0	15.1	54.9	85.6	90.7	85.4	49.4	22.8	13.3	23.9	47.5	70.1
	95th percentile	93.0	87.0	93.0	90.0	93.0	90.0	93.0	93.0	90.0	93.0	90.0	93.0
	75th percentile	93.0	84.0	93.0	90.0	93.0	90.0	93.0	93.0	90.0	93.0	90.0	93.0
	mean	89.8	72.4	85.3	87.8	92.5	88.2	83.2	77.2	72.6	79.9	81.6	88.2
3.0	50th percentile	93.0	84.0	93.0	90.0	93.0	90.0	93.0	92.5	90.0	93.0	90.0	93.0
	25th percentile	90.0	69.0	84.0	90.0	93.0	90.0	90.2	81.0	76.9	84.6	85.5	93.0
	10th percentile	83.2	29.0	66.5	90.0	93.0	86.6	41.8	16.9	2.6	30.9	51.0	77.6
	5th percentile	81.0	2.1	38.9	78.7	87.0	76.6	30.5	10.5	0.0	3.6	34.5	60.7
	95th percentile	93.0	87.0	93.0	90.0	93.0	90.0	93.0	93.0	90.0	93.0	90.0	93.0
	75th percentile	93.0	84.0	93.0	90.0	93.0	90.0	93.0	93.0	90.0	93.0	90.0	93.0
	mean	89.4	72.2	85.0	87.6	92.4	87.9	82.0	75.7	71.8	79.2	81.4	88.1
4.5	50th percentile	93.0	84.0	93.0	90.0	93.0	90.0	93.0	91.6	90.0	93.0	90.0	93.0
	25th percentile	89.4	64.5	84.0	90.0	93.0	90.0	87.7	78.0	76.2	84.0	84.6	93.0
	10th percentile	82.3	28.5	65.4	90.0	93.0	85.6	39.2	13.8	2.0	27.2	51.0	76.3
	5th percentile	80.8	1.8	37.1	77.4	87.0	72.7	24.6	5.8	0.0	1.3	33.6	58.2

Table 4.   Statistics of Leesville Lake, Ohio, total monthly potential withdrawals for indicated pumping rates and target minimum flow-by amounts.

[ft³/s, cubic foot per second; Mgal/d, million gallons per day]

Target minimum flow-by (ft³/s)	Statistic	Total monthly potential withdrawals, in millions of gallons, for indicated months and pump rates											
		Month											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		Pumping rate = 1 Mgal/d											
	95th percentile	31.0	29.0	31.0	30.0	31.0	30.0	31.0	31.0	30.0	31.0	30.0	31.0
	75th percentile	31.0	28.0	31.0	30.0	31.0	30.0	31.0	31.0	30.0	31.0	30.0	31.0
	mean	30.0	22.3	26.7	28.7	29.9	29.0	28.2	24.9	21.5	24.1	26.2	28.8
1.5	50th percentile	31.0	26.6	30.6	30.0	31.0	30.0	31.0	30.3	27.8	30.9	30.0	31.0
	25th percentile	30.6	17.2	25.0	30.0	31.0	30.0	30.1	22.1	13.0	17.9	26.7	29.9
	10th percentile	26.9	10.0	15.7	27.7	31.0	28.4	22.5	7.6	3.4	4.0	15.0	23.9
	5th percentile	25.0	6.4	12.3	18.2	20.0	23.5	11.0	5.0	2.5	0.7	6.2	21.1
	95th percentile	31.0	29.0	31.0	30.0	31.0	30.0	31.0	31.0	30.0	31.0	30.0	31.0
	75th percentile	31.0	28.0	31.0	30.0	31.0	30.0	31.0	31.0	30.0	31.0	30.0	31.0
	mean	28.5	18.9	24.5	28.3	29.8	28.0	25.3	20.5	16.9	20.3	24.7	27.1
3.0	50th percentile	31.0	23.9	30.0	30.0	31.0	30.0	31.0	24.2	20.1	29.0	30.0	30.3
	25th percentile	27.0	10.0	20.0	30.0	31.0	29.8	21.6	12.7	1.9	6.0	20.5	27.4
	10th percentile	23.4	1.0	11.0	25.0	30.4	24.3	10.8	0.0	0.0	0.0	7.1	15.4
	5th percentile	18.7	0.0	1.0	15.0	19.3	13.5	0.1	0.0	0.0	0.0	0.8	7.0
	95th percentile	31.0	29.0	31.0	30.0	31.0	30.0	31.0	31.0	30.0	31.0	30.0	31.0
	75th percentile	31.0	28.0	31.0	30.0	31.0	30.0	31.0	31.0	29.6	31.0	30.0	31.0
	mean	28.0	18.7	24.3	28.2	29.7	27.7	24.6	19.4	15.9	19.4	24.5	26.5
4.5	50th percentile	31.0	23.3	30.0	30.0	31.0	30.0	30.9	21.1	18.0	26.8	30.0	30.0
	25th percentile	26.6	9.7	20.0	30.0	31.0	29.3	20.7	10.7	0.3	4.4	20.1	25.2
	10th percentile	20.9	1.0	11.0	24.5	29.2	23.0	7.5	0.0	0.0	0.0	6.0	15.0
	5th percentile	17.0	0.0	1.0	15.0	19.0	12.7	0.0	0.0	0.0	0.0	0.0	7.0
		Pumping rate = 2 Mgal/d											
	95th percentile	62.0	58.0	62.0	60.0	62.0	60.0	62.0	62.0	60.0	62.0	60.0	62.0
	75th percentile	62.0	56.0	62.0	60.0	62.0	60.0	62.0	62.0	60.0	62.0	60.0	62.0
	mean	58.5	41.2	51.2	57.0	59.7	57.0	53.4	45.3	38.4	44.4	50.9	55.9
1.5	50th percentile	62.0	50.6	60.4	60.0	62.0	60.0	62.0	54.6	47.5	59.4	60.0	61.3
	25th percentile	56.4	24.2	44.9	60.0	62.0	59.8	51.2	34.3	17.5	24.2	46.2	57.6
	10th percentile	51.3	16.0	25.3	52.7	61.4	52.0	33.4	7.6	3.4	4.0	24.3	40.4
	5th percentile	46.5	7.2	15.7	33.2	39.2	38.8	11.5	5.1	2.5	0.7	7.6	25.7
	95th percentile	62.0	58.0	62.0	60.0	62.0	60.0	62.0	62.0	60.0	62.0	60.0	62.0
	75th percentile	62.0	56.0	62.0	60.0	62.0	60.0	62.0	61.2	57.7	62.0	60.0	62.0
	mean	55.6	37.0	48.5	56.4	59.4	55.0	48.3	37.6	30.9	37.8	48.8	52.6
3.0	50th percentile	61.0	46.7	58.5	60.0	62.0	60.0	60.6	39.8	33.8	52.1	60.0	59.4
	25th percentile	52.2	19.0	40.0	60.0	62.0	58.0	40.6	20.2	1.9	8.4	40.5	49.6
	10th percentile	41.5	2.0	22.0	48.6	57.3	42.8	15.3	0.0	0.0	0.0	12.0	28.3
	5th percentile	29.7	0.0	2.0	28.5	38.3	22.9	0.1	0.0	0.0	0.0	0.8	14.0

Table 4. Statistics of Leesville Lake, Ohio, total monthly potential withdrawals for indicated pumping rates and target minimum flow-by amounts.—Continued

[ft³/s, cubic foot per second; Mgal/d, million gallons per day]

Target minimum flow-by (ft³/s)	Statistic	Total monthly potential withdrawals, in millions of gallons, for indicated months and pump rates											
		Month											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		Pumping rate = 2 Mgal/d—Continued											
	95th percentile	62.0	57.9	62.0	60.0	62.0	60.0	62.0	62.0	60.0	62.0	60.0	62.0
	75th percentile	62.0	56.0	62.0	60.0	62.0	60.0	62.0	59.8	56.4	62.0	60.0	62.0
	mean	54.8	36.4	48.0	56.3	59.2	54.3	46.8	35.6	29.2	36.1	48.3	51.7
4.5	50th percentile	60.6	42.8	58.0	60.0	62.0	60.0	59.4	36.5	27.9	49.6	59.6	58.7
	25th percentile	50.0	18.7	39.7	60.0	62.0	57.7	37.2	16.8	0.3	4.4	40.1	47.3
	10th percentile	40.9	2.0	22.0	47.5	55.7	37.8	10.3	0.0	0.0	0.0	12.0	27.0
	5th percentile	23.5	0.0	1.9	28.2	37.8	19.4	0.0	0.0	0.0	0.0	0.0	10.1
		Pumping rate = 3 Mgal/d											
	95th percentile	93.0	87.0	93.0	90.0	93.0	90.0	93.0	93.0	90.0	93.0	90.0	93.0
	75th percentile	93.0	84.0	93.0	90.0	93.0	90.0	93.0	92.0	87.6	93.0	90.0	93.0
	mean	85.6	59.2	75.1	85.1	89.3	83.9	76.3	62.3	52.3	61.8	75.0	81.4
1.5	50th percentile	91.9	74.1	89.0	90.0	93.0	90.0	91.5	68.3	59.2	80.8	90.0	90.1
	25th percentile	81.2	29.0	64.8	90.0	93.0	87.7	64.7	39.6	17.5	29.4	64.9	79.4
	10th percentile	69.3	16.2	36.3	76.3	88.1	71.8	37.4	7.6	3.4	5.0	30.5	53.7
	5th percentile	59.5	7.2	15.7	46.4	58.2	43.4	11.5	5.1	2.5	0.7	7.6	28.7
	95th percentile	93.0	84.0	93.0	90.0	93.0	90.0	93.0	93.0	90.0	93.0	90.0	93.0
	75th percentile	93.0	84.0	93.0	90.0	93.0	90.0	93.0	86.2	81.6	91.5	90.0	93.0
	mean	81.8	54.2	71.6	84.3	88.8	80.8	69.0	52.1	42.8	52.8	71.9	77.2
3.0	50th percentile	89.3	63.9	87.0	90.0	93.0	90.0	85.4	51.4	40.7	70.1	88.4	88.4
	25th percentile	74.6	28.0	58.0	90.0	93.0	85.4	53.7	23.3	1.9	8.4	60.3	70.1
	10th percentile	60.3	3.0	33.0	70.6	83.3	52.6	15.3	0.0	0.0	0.0	18.0	39.3
	5th percentile	39.7	0.0	2.2	42.5	56.4	24.9	0.1	0.0	0.0	0.0	0.8	16.2
	95th percentile	93.0	84.0	93.0	90.0	93.0	90.0	93.0	93.0	90.0	93.0	90.0	93.0
	75th percentile	93.0	84.0	93.0	90.0	93.0	90.0	93.0	83.9	78.1	88.9	90.0	93.0
	mean	80.8	53.4	71.0	84.1	88.6	79.6	66.8	49.4	40.5	50.3	71.0	76.0
4.5	50th percentile	88.7	62.2	86.3	90.0	93.0	89.9	83.0	48.0	34.1	60.2	87.3	87.7
	25th percentile	73.6	27.7	51.5	90.0	93.0	83.9	48.7	16.8	0.3	4.4	57.9	68.3
	10th percentile	57.5	3.0	33.0	70.0	81.7	45.6	11.0	0.0	0.0	0.0	18.0	32.6
	5th percentile	33.5	0.0	1.9	42.2	55.8	20.2	0.0	0.0	0.0	0.0	0.0	10.1

Table 5. Statistics of Tappan Lake, Ohio, total monthly potential withdrawals for indicated pumping rates and target minimum flow-by amounts.

[ft³/s, cubic foot per second; Mgal/d, million gallons per day]

Target minimum flow-by (ft³/s)	Statistic	Total monthly potential withdrawals, in millions of gallons, for indicated months and pump rates											
		Month											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		Pumping rate = 1 Mgal/d											
	95th percentile	31.0	29.0	31.0	30.0	31.0	30.0	31.0	31.0	30.0	31.0	30.0	31.0
	75th percentile	31.0	28.0	31.0	30.0	31.0	30.0	31.0	31.0	30.0	31.0	30.0	31.0
	mean	29.0	21.9	25.5	27.4	29.6	28.6	28.1	24.2	21.6	24.4	27.1	28.7
2.0	50th percentile	31.0	27.0	30.5	30.0	31.0	30.0	31.0	31.0	28.7	31.0	30.0	31.0
	25th percentile	29.0	15.6	22.7	29.0	31.0	30.0	29.2	18.5	13.3	21.2	27.2	30.1
	10th percentile	26.0	8.0	11.6	23.0	31.0	24.0	20.5	9.1	1.8	4.6	18.6	23.2
	5th percentile	20.1	4.4	8.0	7.8	17.6	19.7	13.7	4.0	0.0	1.7	15.2	17.1
	95th percentile	31.0	29.0	31.0	30.0	31.0	30.0	31.0	31.0	30.0	31.0	30.0	31.0
	75th percentile	31.0	28.0	31.0	30.0	31.0	30.0	31.0	31.0	30.0	31.0	30.0	31.0
	mean	27.6	20.1	23.5	26.6	29.3	27.9	25.8	20.5	16.9	21.6	25.3	26.7
4.0	50th percentile	31.0	26.9	29.9	30.0	31.0	30.0	31.0	26.6	19.7	29.4	30.0	31.0
	25th percentile	27.0	13.0	15.3	27.3	31.0	30.0	23.9	9.6	3.0	14.2	22.0	25.0
	10th percentile	19.0	2.0	7.3	20.1	31.0	24.0	14.3	0.0	0.0	0.0	16.0	17.0
	5th percentile	15.1	0.4	1.6	5.1	13.3	15.1	0.0	0.0	0.0	0.0	4.0	2.0
	95th percentile	31.0	29.0	31.0	30.0	31.0	30.0	31.0	31.0	30.0	31.0	30.0	31.0
	75th percentile	31.0	28.0	31.0	30.0	31.0	30.0	31.0	31.0	30.0	31.0	30.0	31.0
	mean	26.8	19.4	23.0	26.3	29.1	27.1	24.0	17.8	14.4	19.1	24.1	25.9
6.0	50th percentile	31.0	25.0	28.0	30.0	31.0	30.0	30.6	21.1	10.8	24.0	30.0	31.0
	25th percentile	25.8	11.0	15.0	25.8	31.0	28.6	19.4	2.5	0.0	6.5	20.0	23.0
	10th percentile	17.0	1.0	5.7	18.1	30.7	17.1	11.0	0.0	0.0	0.0	13.2	15.0
	5th percentile	5.4	0.0	0.1	4.0	9.6	10.7	0.0	0.0	0.0	0.0	0.0	2.0
		Pumping rate = 2 Mgal/d											
	95th percentile	62.0	58.0	62.0	60.0	62.0	60.0	62.0	62.0	60.0	62.0	60.0	62.0
	75th percentile	62.0	56.0	62.0	60.0	62.0	60.0	62.0	62.0	60.0	62.0	60.0	62.0
	mean	56.9	42.1	49.2	54.2	59.0	56.6	54.4	45.4	39.3	46.5	52.7	55.8
2.0	50th percentile	62.0	54.0	60.0	60.0	62.0	60.0	62.0	57.6	50.5	61.2	60.0	62.0
	25th percentile	56.3	28.3	37.5	56.6	62.0	60.0	52.1	31.8	17.3	39.2	50.0	55.2
	10th percentile	45.6	13.3	18.7	44.4	62.0	48.0	36.0	11.3	1.8	4.6	33.6	39.1
	5th percentile	40.1	5.4	11.1	13.2	31.4	33.2	19.5	5.0	0.0	1.7	20.5	24.2
	95th percentile	62.0	58.0	62.0	60.0	62.0	60.0	62.0	62.0	60.0	62.0	60.0	62.0
	75th percentile	62.0	56.0	62.0	60.0	62.0	60.0	62.0	62.0	60.0	62.0	60.0	62.0
	mean	54.6	39.5	46.6	53.0	58.4	55.2	50.3	38.8	31.7	41.2	49.7	52.8
4.0	50th percentile	62.0	52.9	57.9	60.0	62.0	60.0	61.9	50.0	29.0	50.1	60.0	62.0
	25th percentile	52.6	25.3	30.3	53.6	62.0	59.2	44.1	15.4	3.2	15.9	42.0	46.0
	10th percentile	38.0	4.0	14.0	39.7	62.0	43.2	25.7	0.0	0.0	0.0	32.0	31.9
	5th percentile	25.1	0.4	1.9	9.4	23.8	29.6	0.0	0.0	0.0	0.0	5.4	4.0

Table 5. Statistics of Tappan Lake, Ohio, total monthly potential withdrawals for indicated pumping rates and target minimum flow-by amounts.—Continued

[ft³/s, cubic foot per second; Mgal/d, million gallons per day]

Target minimum flow-by (ft³/s)	Statistic	Total monthly potential withdrawals, in millions of gallons, for indicated months and pump rates

Target minimum flow-by (ft³/s)	Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		Pumping rate = 2 Mgal/d—Continued											
	95th percentile	62.0	58.0	62.0	60.0	62.0	60.0	62.0	62.0	60.0	62.0	60.0	62.0
	75th percentile	62.0	56.0	62.0	60.0	62.0	60.0	62.0	62.0	60.0	62.0	60.0	62.0
	mean	53.0	38.6	45.7	52.3	58.1	53.8	46.8	34.0	27.7	36.7	47.8	51.1
6.0	50th percentile	62.0	49.1	56.0	60.0	62.0	60.0	59.1	36.0	18.1	44.8	60.0	62.0
	25th percentile	46.8	22.0	30.0	50.6	62.0	53.9	34.9	4.0	0.0	11.7	40.0	44.0
	10th percentile	34.0	2.0	10.4	34.5	60.3	33.4	12.3	0.0	0.0	0.0	23.2	28.7
	5th percentile	8.0	0.0	0.1	8.0	18.6	18.7	0.0	0.0	0.0	0.0	0.0	3.2
		Pumping rate = 3 Mgal/d											
	95th percentile	93.0	87.0	93.0	90.0	93.0	90.0	93.0	93.0	90.0	93.0	90.0	93.0
	75th percentile	93.0	84.0	93.0	90.0	93.0	90.0	93.0	93.0	90.0	93.0	90.0	93.0
	mean	84.1	61.7	72.4	80.6	88.1	84.0	79.3	64.3	54.6	66.8	77.3	82.0
2.0	50th percentile	93.0	81.0	88.5	90.0	93.0	90.0	93.0	81.5	64.6	86.0	90.0	93.0
	25th percentile	81.5	39.6	47.8	83.6	93.0	89.7	75.5	36.1	20.3	48.5	71.6	78.2
	10th percentile	64.0	16.0	25.7	64.3	93.0	72.0	49.8	11.3	1.8	4.6	49.6	54.1
	5th percentile	57.0	6.4	11.8	17.8	42.9	48.0	19.5	5.0	0.0	1.7	22.4	36.0
	95th percentile	93.0	87.0	93.0	90.0	93.0	90.0	93.0	93.0	90.0	93.0	90.0	93.0
	75th percentile	93.0	84.0	93.0	90.0	93.0	90.0	93.0	93.0	90.0	93.0	90.0	93.0
	mean	80.9	58.8	69.4	79.1	87.4	82.0	73.4	55.5	45.4	59.2	73.5	78.2
4.0	50th percentile	93.0	76.9	84.9	90.0	93.0	90.0	90.8	64.9	37.0	73.0	90.0	93.0
	25th percentile	77.1	35.3	45.3	79.6	93.0	85.5	61.7	18.1	3.2	21.3	60.7	68.8
	10th percentile	54.3	6.0	21.0	57.1	91.9	59.5	34.8	0.0	0.0	0.0	48.0	46.9
	5th percentile	27.2	0.4	1.9	13.4	32.8	43.6	0.0	0.0	0.0	0.0	5.5	5.5
	95th percentile	93.0	87.0	93.0	90.0	93.0	90.0	93.0	93.0	90.0	93.0	90.0	93.0
	75th percentile	93.0	84.0	93.0	90.0	93.0	90.0	93.0	92.1	88.5	90.7	90.0	93.0
	mean	78.9	57.6	68.1	78.2	87.0	79.5	67.9	48.7	39.9	52.6	70.9	75.7
6.0	50th percentile	91.8	72.6	84.0	90.0	93.0	90.0	85.7	48.0	24.1	58.6	87.5	93.0
	25th percentile	69.0	33.0	45.0	75.6	93.0	78.4	45.9	6.0	0.0	16.7	59.0	62.5
	10th percentile	50.6	3.0	15.4	50.5	86.1	46.8	12.3	0.0	0.0	0.0	33.2	39.2
	5th percentile	12.0	0.0	0.1	12.0	26.6	26.7	0.0	0.0	0.0	0.0	0.0	4.2

Table 6. Analytical period statistics of observed daily mean outflows from the Atwood, Leesville, and Tappan Lakes in the Muskingum River Watershed, Ohio.

Statistic	Observed daily mean outflow amounts for indicated lakes (in cubic feet per second)		
	Atwood Lake	Leesville Lake	Tappan Lake
95th percentile	320.0	218.7	363.0
75th percentile	105.3	88.0	105.5
mean	85.4	58.8	80.8
50th percentile	52.9	24.4	25.6
25th percentile	13.0	5.5	7.5
10th percentile	6.2	2.0	2.2
5th percentile	2.6	1.6	1.7
Minimum in-stream flow target	1.5	1.5	2.0

Table 7. Statistics of observed daily mean outflows by month for the Atwood, Leesville, and Tappan Lakes in the Muskingum River Watershed, Ohio.

Statistic	Observed daily mean reservoir outflows, in cubic feet per second, for indicated month and lake											
	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	Atwood Lake											
95th percentile	320.0	364.5	413.0	400.0	343.0	291.0	146.4	119.6	131.0	155.0	268.1	392.0
75th percentile	110.5	73.1	143.0	180.5	122.8	88.6	73.0	55.7	50.1	63.0	161.0	183.6
mean	84.1	74.2	108.5	145.9	110.0	83.8	54.2	41.5	43.4	47.4	110.6	122.2
50th percentile	32.0	16.0	76.0	99.9	76.0	62.0	44.9	21.2	17.7	25.0	98.0	67.7
25th percentile	18.0	10.7	11.2	72.1	55.7	28.0	11.0	7.8	8.2	11.2	42.0	22.0
10th percentile	10.6	2.2	10.0	35.5	35.0	12.0	5.2	3.1	2.4	3.1	8.9	10.7
5th percentile	6.7	1.9	3.0	11.1	17.0	8.7	2.8	2.2	1.9	2.0	2.6	10.3
	Leesville Lake											
95th percentile	230.0	257.0	272.0	250.0	225.0	194.0	116.9	87.4	133.0	127.0	206.4	246.1
75th percentile	111.4	108.4	138.0	139.8	105.7	65.2	32.0	15.7	12.0	22.0	124.0	136.0
mean	70.6	69.0	91.8	101.2	75.5	51.3	29.2	18.8	20.7	25.6	73.3	80.3
50th percentile	43.0	24.0	67.0	82.7	52.0	22.0	11.0	6.2	4.8	6.5	59.0	47.0
25th percentile	13.0	2.3	6.5	45.0	22.0	9.8	5.1	2.6	2.0	2.4	7.8	11.0
10th percentile	4.4	1.8	1.9	16.6	11.0	5.2	2.3	1.7	1.5	1.5	1.8	2.8
5th percentile	2.8	1.6	1.7	2.6	7.3	3.1	1.8	1.5	1.2	1.2	1.2	1.9
	Tappan Lake											
95th percentile	428.5	432.0	426.0	418.0	387.0	284.0	154.0	87.0	82.0	195.0	374.0	425.6
75th percentile	155.0	141.0	162.0	187.0	124.0	60.0	34.0	18.2	17.0	25.0	213.1	192.0
mean	103.7	94.9	110.6	127.7	102.9	64.5	35.9	25.3	23.4	35.9	126.1	120.7
50th percentile	50.0	17.0	51.0	68.0	56.5	30.2	16.0	8.9	6.1	10.4	98.0	60.3
25th percentile	14.0	2.8	5.6	33.0	30.0	16.0	7.8	3.0	2.4	3.4	12.1	12.0
10th percentile	4.5	2.0	2.1	3.3	16.0	7.3	2.9	1.7	1.7	2.0	2.8	3.5
5th percentile	2.2	1.5	1.4	1.7	3.8	3.1	1.8	1.0	1.2	1.6	2.1	2.3

Table 8. Statistics of daily mean flow-by amounts for indicated pumping rates and target minimum flow-by multiples for the Atwood, Leesville, and Tappan Lakes in the Muskingum River.

[ft³/s, cubic foot per second; Mgal/d, million gallons per day; target minimum flow-bys equal 1.5 ft³/s for Atwood and Leesville Lakes and 2.0 ft³/s for Tappan Lake]

Statistic	Daily mean flow-by amounts, in ft³/s, for indicated lakes, pumping rates, and target minimum flow-by multiples								
	Pumping rate, in Mgal/d								
	1			2			3		
	Target minimum flow-by multiple								
	1	2	3	1	2	3	1	2	3
Atwood Lake									
95th percentile	318.5	318.5	318.5	316.9	316.9	316.9	315.4	315.4	315.4
75th percentile	103.8	103.8	103.8	102.2	102.2	102.2	100.7	100.7	100.7
mean	83.9	84.0	84.0	82.5	82.6	82.6	81.1	81.2	81.3
50th percentile	51.3	51.3	51.3	49.8	49.8	49.8	48.2	48.2	48.2
25th percentile	11.5	11.5	11.5	9.9	9.9	9.9	8.4	8.4	8.4
10th percentile	4.7	4.7	4.7	3.1	3.1	4.5	1.6	3.0	4.5
5th percentile	1.5	2.6	2.6	1.5	2.6	2.6	1.5	2.6	2.6
Leesville Lake									
95th percentile	217.1	217.1	217.1	215.6	215.6	215.6	214.0	214.0	214.0
75th percentile	86.5	86.5	86.5	84.9	84.9	84.9	83.4	83.4	83.4
mean	57.5	57.6	57.7	56.2	56.4	56.6	55.1	55.3	55.5
50th percentile	22.9	22.9	22.9	21.4	21.4	21.4	19.8	19.8	19.8
25th percentile	4.0	4.0	4.5	2.4	3.0	4.5	1.5	3.0	4.5
10th percentile	1.5	2.0	2.0	1.5	2.0	2.0	1.5	2.0	2.0
5th percentile	1.5	1.6	1.6	1.5	1.6	1.6	1.5	1.6	1.6
Tappan Lake									
95th percentile	361.5	361.5	361.5	359.9	359.9	359.9	358.4	358.4	358.4
75th percentile	104.0	104.0	104.0	102.4	102.4	102.4	100.9	100.9	100.9
mean	79.4	79.5	79.6	78.2	78.4	78.5	77.0	77.2	77.4
50th percentile	24.1	24.1	24.1	22.5	22.5	22.5	21.0	21.0	21.0
25th percentile	5.9	5.9	6.0	4.4	4.4	6.0	2.8	4.0	6.0
10th percentile	2.0	2.2	2.2	2.0	2.2	2.2	2.0	2.2	2.2
5th percentile	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7

Table 9.　Statistics of Atwood Lake, Ohio, daily mean flow-by amounts, by month, for indicated pumping rates and target minimum flow-by amounts.

[ft³/s, cubic foot per second; Mgal/d, million gallons per day]

Target minimum flow-by (ft³/s)	Statistic	Daily mean flow-by, in ft³/s, for indicated months and pump rates											
		Month											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		Pumping rate = 1 Mgal/d											
	95th percentile	318.5	363.0	411.5	398.5	341.5	289.5	144.9	118.1	129.5	153.5	266.6	390.5
	75th percentile	109.0	71.5	141.5	179.0	121.3	87.1	71.5	54.2	48.5	61.5	159.5	182.1
	mean	82.6	72.8	107.0	144.4	108.5	82.3	52.7	40.0	42.0	46.0	109.1	120.7
1.5	50th percentile	30.5	14.5	74.5	98.3	74.5	60.5	43.4	19.7	16.2	23.5	96.5	66.2
	25th percentile	16.5	9.2	9.7	70.6	54.1	26.5	9.5	6.3	6.7	9.6	40.5	20.5
	10th percentile	9.1	1.5	8.5	34.0	33.5	10.5	3.7	1.5	1.5	1.6	7.4	9.2
	5th percentile	5.2	1.5	1.5	9.5	15.5	7.2	1.5	1.5	1.5	1.5	1.5	8.7
	95th percentile	318.5	363.0	411.5	398.5	341.5	289.5	144.9	118.1	129.5	153.5	266.6	390.5
	75th percentile	109.0	71.5	141.5	179.0	121.3	87.1	71.5	54.2	48.5	61.5	159.5	182.1
	mean	82.6	72.9	107.1	144.4	108.5	82.3	52.8	40.1	42.1	46.1	109.1	120.7
3.0	50th percentile	30.5	14.5	74.5	98.3	74.5	60.5	43.4	19.7	16.2	23.5	96.5	66.2
	25th percentile	16.5	9.2	9.7	70.6	54.1	26.5	9.5	6.3	6.7	9.6	40.5	20.5
	10th percentile	9.1	2.2	8.5	34.0	33.5	10.5	3.7	3.0	2.4	3.0	7.4	9.2
	5th percentile	5.2	1.9	3.0	9.5	15.5	7.2	2.8	2.2	1.9	2.0	2.6	8.7
	95th percentile	318.5	363.0	411.5	398.5	341.5	289.5	144.9	118.1	129.5	153.5	266.6	390.5
	75th percentile	109.0	71.5	141.5	179.0	121.3	87.1	71.5	54.2	48.5	61.5	159.5	182.1
	mean	82.6	72.9	107.1	144.4	108.5	82.3	52.8	40.2	42.2	46.1	109.2	120.7
4.5	50th percentile	30.5	14.5	74.5	98.3	74.5	60.5	43.4	19.7	16.2	23.5	96.5	66.2
	25th percentile	16.5	9.2	9.7	70.6	54.1	26.5	9.5	6.3	6.7	9.6	40.5	20.5
	10th percentile	9.1	2.2	8.5	34.0	33.5	10.5	4.5	3.1	2.4	3.1	7.4	9.2
	5th percentile	5.2	1.9	3.0	9.5	15.5	7.2	2.8	2.2	1.9	2.0	2.6	8.7
		Pumping rate = 2 Mgal/d											
	95th percentile	316.9	361.4	409.9	396.9	339.9	287.9	143.3	116.5	127.9	151.9	265.0	388.9
	75th percentile	107.4	70.0	139.9	177.5	119.7	85.5	69.9	52.6	47.0	59.9	157.9	180.5
	mean	81.1	71.5	105.6	142.8	106.9	80.8	51.3	38.7	40.7	44.6	107.6	119.2
1.5	50th percentile	28.9	12.9	72.9	96.8	72.9	58.9	41.9	18.1	14.6	21.9	94.9	64.7
	25th percentile	14.9	7.6	8.1	69.0	52.6	24.9	7.9	4.7	5.1	8.1	38.9	18.9
	10th percentile	7.5	1.5	6.9	32.4	31.9	8.9	2.1	1.5	1.5	1.5	5.8	7.6
	5th percentile	3.6	1.5	1.5	8.0	13.9	5.6	1.5	1.5	1.5	1.5	1.5	7.2
	95th percentile	316.9	361.4	409.9	396.9	339.9	287.9	143.3	116.5	127.9	151.9	265.0	388.9
	75th percentile	107.4	70.0	139.9	177.5	119.7	85.5	69.9	52.6	47.0	59.9	157.9	180.5
	mean	81.1	71.6	105.7	142.9	106.9	80.8	51.4	38.8	40.9	44.8	107.7	119.2
3.0	50th percentile	28.9	12.9	72.9	96.8	72.9	58.9	41.9	18.1	14.6	21.9	94.9	64.7
	25th percentile	14.9	7.6	8.1	69.0	52.6	24.9	7.9	4.7	5.1	8.1	38.9	18.9
	10th percentile	7.5	2.2	6.9	32.4	31.9	8.9	3.0	3.0	2.4	3.0	5.8	7.6
	5th percentile	3.6	1.9	3.0	8.0	13.9	5.6	2.8	2.2	1.9	2.0	2.6	7.2

Table 9. Statistics of Atwood Lake, Ohio, daily mean flow-by amounts, by month, for indicated pumping rates and target minimum flow-by amounts.—Continued

[ft³/s, cubic foot per second; Mgal/d, million gallons per day]

Target minimum flow-by (ft³/s)	Statistic	Daily mean flow-by, in ft³/s, for indicated months and pump rates											
		Month											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		Pumping rate = 2 Mgal/d—Continued											
	95th percentile	316.9	361.4	409.9	396.9	339.9	287.9	143.3	116.5	127.9	151.9	265.0	388.9
	75th percentile	107.4	70.0	139.9	177.5	119.7	85.5	69.9	52.6	47.0	59.9	157.9	180.5
	mean	81.2	71.6	105.7	142.9	107.0	80.8	51.5	39.0	41.0	44.8	107.8	119.2
4.5	50th percentile	28.9	12.9	72.9	96.8	72.9	58.9	41.9	18.1	14.6	21.9	94.9	64.7
	25th percentile	14.9	7.6	8.1	69.0	52.6	24.9	7.9	4.7	5.1	8.1	38.9	18.9
	10th percentile	7.5	2.2	6.9	32.4	31.9	8.9	4.5	3.1	2.4	3.1	5.8	7.6
	5th percentile	4.5	1.9	3.0	8.0	13.9	5.6	2.8	2.2	1.9	2.0	2.6	7.2
		Pumping rate = 3 Mgal/d											
	95th percentile	315.4	359.9	408.4	395.4	338.4	286.4	141.8	115.0	126.4	150.4	263.5	387.4
	75th percentile	105.9	68.4	138.4	175.9	118.2	84.0	68.4	51.1	45.4	58.4	156.4	179.0
	mean	79.6	70.2	104.2	141.3	105.4	79.2	49.9	37.4	39.5	43.3	106.2	117.7
1.5	50th percentile	27.4	11.4	71.4	95.2	71.4	57.4	40.3	16.6	13.1	20.4	93.4	63.1
	25th percentile	13.4	6.1	6.6	67.5	51.0	23.4	6.4	3.2	3.6	6.5	37.4	17.4
	10th percentile	6.0	1.5	5.4	30.9	30.4	7.4	1.5	1.5	1.5	1.5	4.3	6.1
	5th percentile	2.1	1.5	1.5	6.4	12.4	4.1	1.5	1.5	1.5	1.5	1.5	5.7
	95th percentile	315.4	359.9	408.4	395.4	338.4	286.4	141.8	115.0	126.4	150.4	263.5	387.4
	75th percentile	105.9	68.4	138.4	175.9	118.2	84.0	68.4	51.1	45.4	58.4	156.4	179.0
	mean	79.7	70.3	104.2	141.4	105.4	79.3	50.1	37.6	39.7	43.5	106.3	117.7
3.0	50th percentile	27.4	11.4	71.4	95.2	71.4	57.4	40.3	16.6	13.1	20.4	93.4	63.1
	25th percentile	13.4	6.1	6.6	67.5	51.0	23.4	6.4	3.2	3.6	6.5	37.4	17.4
	10th percentile	6.0	2.2	5.4	30.9	30.4	7.4	3.0	3.0	2.4	3.0	4.3	6.1
	5th percentile	3.0	1.9	3.0	6.4	12.4	4.1	2.8	2.2	1.9	2.0	2.6	5.7
	95th percentile	315.4	359.9	408.4	395.4	338.4	286.4	141.8	115.0	126.4	150.4	263.5	387.4
	75th percentile	105.9	68.4	138.4	175.9	118.2	84.0	68.4	51.1	45.4	58.4	156.4	179.0
	mean	79.7	70.3	104.3	141.4	105.4	79.3	50.2	37.8	39.8	43.6	106.4	117.7
4.5	50th percentile	27.4	11.4	71.4	95.2	71.4	57.4	40.3	16.6	13.1	20.4	93.4	63.1
	25th percentile	13.4	6.1	6.6	67.5	51.0	23.4	6.4	4.5	4.5	6.5	37.4	17.4
	10th percentile	6.0	2.2	5.4	30.9	30.4	7.4	4.5	3.1	2.4	3.1	4.5	6.1
	5th percentile	4.5	1.9	3.0	6.4	12.4	4.5	2.8	2.2	1.9	2.0	2.6	5.7

Table 10.   Statistics of Leesville Lake, Ohio, daily mean flow-by amounts, by month, for indicated pumping rates and target minimum flow-by amounts.

[ft³/s, cubic foot per second; Mgal/d, million gallons per day]

Target minimum flow-by (ft³/s)	Statistic	Daily mean flow-by, in ft³/s, for indicated months and pump rates											
		Month											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		Pumping rate = 1 Mgal/d											
	95th percentile	228.5	255.5	270.5	248.5	223.4	192.5	115.3	85.8	131.5	125.5	204.9	244.5
	75th percentile	109.9	106.8	136.5	138.3	104.2	63.7	30.5	14.1	10.5	20.5	122.5	134.5
	mean	69.1	67.8	90.4	99.8	74.0	49.8	27.8	17.5	19.6	24.4	71.9	78.9
1.5	50th percentile	41.5	22.5	65.5	81.1	50.5	20.5	9.5	4.7	3.2	5.0	57.5	45.5
	25th percentile	11.5	1.5	4.9	43.5	20.5	8.2	3.6	1.5	1.5	1.5	6.3	9.5
	10th percentile	2.9	1.5	1.5	15.0	9.5	3.7	1.5	1.5	1.5	1.5	1.5	1.5
	5th percentile	1.5	1.5	1.5	1.5	5.8	1.5	1.5	1.5	1.2	1.2	1.2	1.5
	95th percentile	228.5	255.5	270.5	248.5	223.4	192.5	115.3	85.8	131.5	125.5	204.9	244.5
	75th percentile	109.9	106.8	136.5	138.3	104.2	63.7	30.5	14.1	10.5	20.5	122.5	134.5
	mean	69.2	68.0	90.5	99.8	74.0	49.8	27.9	17.8	19.8	24.6	72.0	78.9
3.0	50th percentile	41.5	22.5	65.5	81.1	50.5	20.5	9.5	4.7	3.2	5.0	57.5	45.5
	25th percentile	11.5	2.3	4.9	43.5	20.5	8.2	3.6	2.6	2.0	2.4	6.3	9.5
	10th percentile	3.0	1.8	1.9	15.0	9.5	3.7	2.3	1.7	1.5	1.5	1.8	2.8
	5th percentile	2.8	1.6	1.7	2.6	5.8	3.0	1.8	1.5	1.2	1.2	1.2	1.9
	95th percentile	228.5	255.5	270.5	248.5	223.4	192.5	115.3	85.8	131.5	125.5	204.9	244.5
	75th percentile	109.9	106.8	136.5	138.3	104.2	63.7	30.5	14.1	10.5	20.5	122.5	134.5
	mean	69.3	68.0	90.6	99.8	74.0	49.9	28.0	17.9	20.0	24.7	72.0	79.0
4.5	50th percentile	41.5	22.5	65.5	81.1	50.5	20.5	9.5	4.7	4.5	5.0	57.5	45.5
	25th percentile	11.5	2.3	4.9	43.5	20.5	8.2	4.5	2.6	2.0	2.4	6.3	9.5
	10th percentile	4.4	1.8	1.9	15.0	9.5	4.5	2.3	1.7	1.5	1.5	1.8	2.8
	5th percentile	2.8	1.6	1.7	2.6	5.8	3.1	1.8	1.5	1.2	1.2	1.2	1.9
		Pumping rate = 2 Mgal/d											
	95th percentile	226.9	253.9	268.9	246.9	221.9	190.9	113.8	84.3	129.9	123.9	203.3	243.0
	75th percentile	108.3	105.3	134.9	136.7	102.6	62.1	28.9	12.6	8.9	18.9	120.9	132.9
	mean	67.7	66.8	89.2	98.3	72.5	48.3	26.5	16.5	18.7	23.4	70.6	77.5
1.5	50th percentile	39.9	20.9	63.9	79.6	48.9	18.9	7.9	3.1	1.7	3.4	55.9	43.9
	25th percentile	9.9	1.5	3.4	41.9	18.9	6.7	2.1	1.5	1.5	1.5	4.7	7.9
	10th percentile	1.5	1.5	1.5	13.5	7.9	2.1	1.5	1.5	1.5	1.5	1.5	1.5
	5th percentile	1.5	1.5	1.5	1.5	4.2	1.5	1.5	1.5	1.2	1.2	1.2	1.5
	95th percentile	226.9	253.9	268.9	246.9	221.9	190.9	113.8	84.3	129.9	123.9	203.3	243.0
	75th percentile	108.3	105.3	134.9	136.7	102.6	62.1	28.9	12.6	8.9	18.9	120.9	132.9
	mean	67.9	67.0	89.3	98.3	72.5	48.4	26.8	16.9	19.1	23.7	70.7	77.7
3.0	50th percentile	39.9	20.9	63.9	79.6	48.9	18.9	7.9	3.1	3.0	3.4	55.9	43.9
	25th percentile	9.9	2.3	3.4	41.9	18.9	6.7	3.0	2.6	2.0	2.4	4.7	7.9
	10th percentile	3.0	1.8	1.9	13.5	7.9	3.0	2.3	1.7	1.5	1.5	1.8	2.8
	5th percentile	2.8	1.6	1.7	2.6	4.2	3.0	1.8	1.5	1.2	1.2	1.2	1.9

Table 10. Statistics of Leesville Lake, Ohio, daily mean flow-by amounts, by month, for indicated pumping rates and target minimum flow-by amounts.—Continued

[ft³/s, cubic foot per second; Mgal/d, million gallons per day]

Target minimum flow-by (ft³/s)	Statistic	Daily mean flow-by, in ft³/s, for indicated months and pump rates											
		Month											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		Pumping rate = 2 Mgal/d—Continued											
	95th percentile	226.9	253.9	268.9	246.9	221.9	190.9	113.8	84.3	129.9	123.9	203.3	243.0
	75th percentile	108.3	105.3	134.9	136.7	102.6	62.1	28.9	12.6	8.9	18.9	120.9	132.9
	mean	68.0	67.1	89.4	98.4	72.5	48.5	27.0	17.2	19.4	24.0	70.8	77.8
4.5	50th percentile	39.9	20.9	63.9	79.6	48.9	18.9	7.9	4.5	4.5	4.5	55.9	43.9
	25th percentile	9.9	2.3	4.5	41.9	18.9	6.7	4.5	2.6	2.0	2.4	4.7	7.9
	10th percentile	4.4	1.8	1.9	13.5	7.9	4.5	2.3	1.7	1.5	1.5	1.8	2.8
	5th percentile	2.8	1.6	1.7	2.6	4.5	3.1	1.8	1.5	1.2	1.2	1.2	1.9
		Pumping rate = 3 Mgal/d											
	95th percentile	225.4	252.4	267.4	245.4	220.3	189.4	112.2	82.7	128.4	122.4	201.8	241.5
	75th percentile	106.8	103.7	133.4	135.2	101.1	60.6	27.4	11.0	7.4	17.4	119.4	131.4
	mean	66.4	65.8	88.0	96.9	71.0	46.9	25.4	15.7	18.0	22.5	69.4	76.2
1.5	50th percentile	38.4	19.4	62.4	78.0	47.4	17.4	6.4	1.6	1.5	1.9	54.4	42.4
	25th percentile	8.4	1.5	1.9	40.4	17.4	5.1	1.5	1.5	1.5	1.5	3.2	6.4
	10th percentile	1.5	1.5	1.5	11.9	6.4	1.5	1.5	1.5	1.5	1.5	1.5	1.5
	5th percentile	1.5	1.5	1.5	1.5	2.7	1.5	1.5	1.5	1.2	1.2	1.2	1.5
	95th percentile	225.4	252.4	267.4	245.4	220.3	189.4	112.2	82.7	128.4	122.4	201.8	241.5
	75th percentile	106.8	103.7	133.4	135.2	101.1	60.6	27.4	11.0	7.4	17.4	119.4	131.4
	mean	66.6	66.1	88.2	96.9	71.0	47.1	25.7	16.2	18.5	23.0	69.5	76.4
3.0	50th percentile	38.4	19.4	62.4	78.0	47.4	17.4	6.4	3.0	3.0	3.0	54.4	42.4
	25th percentile	8.4	2.3	3.0	40.4	17.4	5.1	3.0	2.6	2.0	2.4	3.2	6.4
	10th percentile	3.0	1.8	1.9	11.9	6.4	3.0	2.3	1.7	1.5	1.5	1.8	2.8
	5th percentile	2.8	1.6	1.7	2.6	3.0	3.0	1.8	1.5	1.2	1.2	1.2	1.9
	95th percentile	225.4	252.4	267.4	245.4	220.3	189.4	112.2	82.7	128.4	122.4	201.8	241.5
	75th percentile	106.8	103.7	133.4	135.2	101.1	60.6	27.4	11.0	7.4	17.4	119.4	131.4
	mean	66.7	66.2	88.3	96.9	71.1	47.3	26.0	16.6	18.8	23.4	69.7	76.6
4.5	50th percentile	38.4	19.4	62.4	78.0	47.4	17.4	6.4	4.5	4.5	4.5	54.4	42.4
	25th percentile	8.4	2.3	4.5	40.4	17.4	5.1	4.5	2.6	2.0	2.4	4.5	6.4
	10th percentile	4.4	1.8	1.9	11.9	6.4	4.5	2.3	1.7	1.5	1.5	1.8	2.8
	5th percentile	2.8	1.6	1.7	2.6	4.5	3.1	1.8	1.5	1.2	1.2	1.2	1.9

Table 11. Statistics of Tappan Lake, Ohio, daily mean flow-by amounts, by month, for indicated pumping rates and target minimum flow-by amounts.

[ft³/s, cubic foot per second; Mgal/d, million gallons per day]

Target minimum flow-by (ft³/s)	Statistic	Daily mean flow-by, in ft³/s, for indicated months and pump rates											
		Month											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		Pumping rate = 1 Mgal/d											
	95th percentile	427.0	430.5	424.5	416.5	385.5	282.5	152.5	85.5	80.5	193.5	372.5	424.0
	75th percentile	153.5	139.5	160.5	185.5	122.5	58.5	32.5	16.7	15.5	23.5	211.6	190.5
	mean	102.2	93.7	109.3	126.2	101.4	63.0	34.5	24.1	22.3	34.7	124.7	119.3
2.0	50th percentile	48.5	15.4	49.5	66.5	54.9	28.6	14.5	7.4	4.5	8.8	96.5	58.7
	25th percentile	12.5	2.0	4.1	31.5	28.5	14.5	6.3	2.0	2.0	2.0	10.5	10.5
	10th percentile	3.0	2.0	2.0	2.0	14.5	5.8	2.0	1.7	1.7	2.0	2.0	2.0
	5th percentile	2.0	1.5	1.4	1.7	2.3	2.0	1.8	1.0	1.2	1.6	2.0	2.0
	95th percentile	427.0	430.5	424.5	416.5	385.5	282.5	152.5	85.5	80.5	193.5	372.5	424.0
	75th percentile	153.5	139.5	160.5	185.5	122.5	58.5	32.5	16.7	15.5	23.5	211.6	190.5
	mean	102.3	93.8	109.4	126.3	101.4	63.0	34.6	24.3	22.6	34.8	124.8	119.4
4.0	50th percentile	48.5	15.4	49.5	66.5	54.9	28.6	14.5	7.4	4.5	8.8	96.5	58.7
	25th percentile	12.5	2.8	4.1	31.5	28.5	14.5	6.3	3.0	2.4	3.4	10.5	10.5
	10th percentile	4.0	2.0	2.1	3.3	14.5	5.8	2.9	1.7	1.7	2.0	2.8	3.5
	5th percentile	2.2	1.5	1.4	1.7	3.8	3.1	1.8	1.0	1.2	1.6	2.1	2.3
	95th percentile	427.0	430.5	424.5	416.5	385.5	282.5	152.5	85.5	80.5	193.5	372.5	424.0
	75th percentile	153.5	139.5	160.5	185.5	122.5	58.5	32.5	16.7	15.5	23.5	211.6	190.5
	mean	102.4	93.8	109.4	126.3	101.4	63.1	34.7	24.4	22.7	34.9	124.8	119.4
6.0	50th percentile	48.5	15.4	49.5	66.5	54.9	28.6	14.5	7.4	6.0	8.8	96.5	58.7
	25th percentile	12.5	2.8	5.6	31.5	28.5	14.5	6.3	3.0	2.4	3.4	10.5	10.5
	10th percentile	4.5	2.0	2.1	3.3	14.5	6.0	2.9	1.7	1.7	2.0	2.8	3.5
	5th percentile	2.2	1.5	1.4	1.7	3.8	3.1	1.8	1.0	1.2	1.6	2.1	2.3
		Pumping rate = 2 Mgal/d											
	95th percentile	425.4	428.9	422.9	414.9	383.9	280.9	150.9	83.9	78.9	191.9	370.9	422.5
	75th percentile	151.9	137.9	158.9	183.9	120.9	56.9	30.9	15.1	13.9	21.9	210.0	188.9
	mean	100.9	92.6	108.1	124.9	99.9	61.5	33.2	23.0	21.4	33.6	123.4	117.9
2.0	50th percentile	46.9	13.9	47.9	64.9	53.4	27.1	12.9	5.8	3.0	7.3	94.9	57.2
	25th percentile	10.9	2.0	2.5	29.9	26.9	12.9	4.7	2.0	2.0	2.0	9.0	8.9
	10th percentile	2.0	2.0	2.0	2.0	12.9	4.2	2.0	1.7	1.7	2.0	2.0	2.0
	5th percentile	2.0	1.5	1.4	1.7	2.0	2.0	1.8	1.0	1.2	1.6	2.0	2.0
	95th percentile	425.4	428.9	422.9	414.9	383.9	280.9	150.9	83.9	78.9	191.9	370.9	422.5
	75th percentile	151.9	137.9	158.9	183.9	120.9	56.9	30.9	15.1	13.9	21.9	210.0	188.9
	mean	101.0	92.7	108.2	124.9	99.9	61.6	33.4	23.4	21.8	33.8	123.5	118.1
4.0	50th percentile	46.9	13.9	47.9	64.9	53.4	27.1	12.9	5.8	4.0	7.3	94.9	57.2
	25th percentile	10.9	2.8	4.0	29.9	26.9	12.9	4.7	3.0	2.4	3.4	9.0	8.9
	10th percentile	4.0	2.0	2.1	3.3	12.9	4.2	2.9	1.7	1.7	2.0	2.8	3.5
	5th percentile	2.2	1.5	1.4	1.7	3.8	3.1	1.8	1.0	1.2	1.6	2.1	2.3

Table 11. Statistics of Tappan Lake, Ohio, daily mean flow-by amounts, by month, for indicated pumping rates and target minimum flow-by amounts.—Continued

[ft³/s, cubic foot per second; Mgal/d, million gallons per day]

Target minimum flow-by (ft³/s)	Statistic	Daily mean flow-by, in ft³/s, for indicated months and pump rates											
		Month											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		Pumping rate = 2 Mgal/d—Continued											
	95th percentile	425.4	428.9	422.9	414.9	383.9	280.9	150.9	83.9	78.9	191.9	370.9	422.5
	75th percentile	151.9	137.9	158.9	183.9	120.9	56.9	30.9	15.1	13.9	21.9	210.0	188.9
	mean	101.0	92.8	108.3	125.0	100.0	61.7	33.6	23.6	22.0	34.1	123.6	118.2
6.0	50th percentile	46.9	13.9	47.9	64.9	53.4	27.1	12.9	6.0	6.0	7.3	94.9	57.2
	25th percentile	10.9	2.8	5.6	29.9	26.9	12.9	6.0	3.0	2.4	3.4	9.0	8.9
	10th percentile	4.5	2.0	2.1	3.3	12.9	6.0	2.9	1.7	1.7	2.0	2.8	3.5
	5th percentile	2.2	1.5	1.4	1.7	3.8	3.1	1.8	1.0	1.2	1.6	2.1	2.3
		Pumping rate = 3 Mgal/d											
	95th percentile	423.9	427.4	421.4	413.4	382.4	279.4	149.4	82.4	77.4	190.4	369.4	420.9
	75th percentile	150.4	136.4	157.4	182.4	119.4	55.4	29.4	13.6	12.4	20.4	208.5	187.4
	mean	99.5	91.5	106.9	123.5	98.5	60.1	31.9	22.1	20.6	32.6	122.1	116.6
2.0	50th percentile	45.4	12.3	46.4	63.4	51.8	25.6	11.4	4.3	2.0	5.7	93.4	55.6
	25th percentile	9.4	2.0	2.0	28.4	25.4	11.4	3.2	2.0	2.0	2.0	7.4	7.4
	10th percentile	2.0	2.0	2.0	2.0	11.4	2.7	2.0	1.7	1.7	2.0	2.0	2.0
	5th percentile	2.0	1.5	1.4	1.7	2.0	2.0	1.8	1.0	1.2	1.6	2.0	2.0
	95th percentile	423.9	427.4	421.4	413.4	382.4	279.4	149.4	82.4	77.4	190.4	369.4	420.9
	75th percentile	150.4	136.4	157.4	182.4	119.4	55.4	29.4	13.6	12.4	20.4	208.5	187.4
	mean	99.7	91.7	107.1	123.6	98.5	60.2	32.2	22.5	21.1	32.9	122.3	116.8
4.0	50th percentile	45.4	12.3	46.4	63.4	51.8	25.6	11.4	4.3	4.0	5.7	93.4	55.6
	25th percentile	9.4	2.8	4.0	28.4	25.4	11.4	4.0	3.0	2.4	3.4	7.4	7.4
	10th percentile	4.0	2.0	2.1	3.3	11.4	4.0	2.9	1.7	1.7	2.0	2.8	3.5
	5th percentile	2.2	1.5	1.4	1.7	3.8	3.1	1.8	1.0	1.2	1.6	2.1	2.3
	95th percentile	423.9	427.4	421.4	413.4	382.4	279.4	149.4	82.4	77.4	190.4	369.4	420.9
	75th percentile	150.4	136.4	157.4	182.4	119.4	55.4	29.4	13.6	12.4	20.4	208.5	187.4
	mean	99.8	91.7	107.2	123.6	98.5	60.4	32.5	22.9	21.4	33.3	122.4	116.9
6.0	50th percentile	45.4	12.3	46.4	63.4	51.8	25.6	11.4	6.0	6.0	6.0	93.4	55.6
	25th percentile	9.4	2.8	5.6	28.4	25.4	11.4	6.0	3.0	2.4	3.4	7.4	7.4
	10th percentile	4.5	2.0	2.1	3.3	11.4	6.0	2.9	1.7	1.7	2.0	2.8	3.5
	5th percentile	2.2	1.5	1.4	1.7	3.8	3.1	1.8	1.0	1.2	1.6	2.1	2.3

Table 12 shows the computed aggregate analytical-period flow-by statistics from table 8 reported as a percentage of the corresponding observed outflow statistics from table 6. The cells of table 12 have been color-coded according to a gradient, where the maximum value in the table (100 percent) is colored dark green and the minimum value (27.3 percent) is colored red. Values that lie between these two extremes are graded in color from light green to dark orange as a function of their magnitude. The objective of coloring the table cells is to make it easier to visualize the conditions and flow percentiles that deviate most from the corresponding observed outflow statistics. Clearly, with the exception of some of the lower percentiles (10 percent and smaller), the flow-by amounts tend to represent an increasingly smaller proportion of the observed outflows as pumping rates are increased. Increasing the target minimum flow-by amount mitigates the effect of increased pumping for some order statistics. The reason that some low-percentile flow-by amounts were unchanged from observed outflows after increases in pump capacities and target minimum flow-by amounts is that the observed outflows were already less than or equal to the smallest flow-by amount considered, so no additional water was available for pumping and (or) to be reserved as flow-by.

Tables 13–15 show the computed monthly flow-by statistics from tables 9–11 reported as percentages of the corresponding observed outflow statistics from table 7. Similar to table 12, the cells in these tables have been colored-coded according to a gradient, where the maximum value in each table is colored dark green and the minimum value is colored red. As was observed with the aggregate analytical-period results (table 12), with the exception of some of the lower percentiles, the monthly flow-by amounts tend to represent an increasingly smaller proportion of the observed outflows as pumping rates are increased. Clearly, for some order statistics, flow-by amounts tend to represent proportionally smaller amounts of the observed outflows in certain months (for example, July–October) than in others. Increasing flow-by amounts mitigate some of these reductions in flow; however, that mitigation comes at the expense of smaller potential withdrawals.

Mass-curve data are reported for the Atwood, Leesville, and Tappan Lakes in appendix 1 (table 1-1). Figure 3 shows an example plot of the surplus-water mass curves for the Atwood, Leesville, and Tappan Lakes based on current target minimum outflows. The mass curve for Atwood Lake is based on 51 years of data whereas the mass curves for Leesville and Tappan Lakes are each based on 73 years of data. The slope of a line that connects the first and last point on a mass curve for a given lake in figure 3 represents the average daily surplus-water volume for that lake. It is evident from figure 3 that the Leesville Lake has an average daily surplus-water volume that is considerably smaller than that of the Atwood and Tappan Lakes. That seems reasonable given that the drainage area of the Leesville Lake is considerably smaller than that of the Atwood and Tappan Lakes.

Limitations

Direct use of the data presented in this report to make decisions about future water uses requires assumptions about the extent to which historical outflow characteristics will be representative of future outflow characteristics. Those assumptions could be in error depending on the degree to which there are changes in future climate or other factors that affect inflows to, or water losses from, the lakes.

Computed withdrawals represent maximum values given the combination of pumping rate and target minimum flow-by amounts, and assume that the observed outflow data are accurate. The ability to actually capture these maximum withdrawals will depend on how the pumps are operated, the maximum amount of storage for pumped water, and on the rate and (or) timing of removal of water from storage.

The term "surplus water," as used in this report, is not meant to imply judgment about the value of the water for any particular use, but is used merely to signify the amount of water that potentially is available for withdrawal while still meeting the minimum flow-by target immediately downstream from the lake.

Table 12. Daily mean flow-by statistics for the Atwood, Leesville, and Tappan Lakes, Muskingum River Watershed, Ohio, expressed as a percentage of observed outflow statistics.

[Mgal/d, million gallons per day; minimum in-stream flow targets equal 1.5 cubic feet per second (ft^3/s) for Atwood and Leesville Lakes and 2.0 ft^3/s for Tappan Lake; color scale is gradient from maximum value, in green, to minimum value, in red]

Statistic	Daily mean flow-by amounts expressed as a percentage of observed outflow statistics, for indicated lakes, pumping rates, and minimum in-stream flow-target multiples								
	Pumping rate, in Mgal/d								
	1			2			3		
	Minimum in-stream flow-target multiple								
	1	2	3	1	2	3	1	2	3
	Atwood Lake								
95th percentile	99.5%	99.5%	99.5%	99.0%	99.0%	99.0%	98.5%	98.5%	98.5%
75th percentile	98.5%	98.5%	98.5%	97.1%	97.1%	97.1%	95.6%	95.6%	95.6%
mean	98.3%	98.3%	98.4%	96.6%	96.7%	96.7%	94.9%	95.1%	95.1%
50th percentile	97.1%	97.1%	97.1%	94.1%	94.1%	94.1%	91.2%	91.2%	91.2%
25th percentile	88.1%	88.1%	88.1%	76.2%	76.2%	76.2%	64.3%	64.3%	64.3%
10th percentile	75.0%	75.0%	75.0%	50.1%	50.1%	72.6%	25.1%	48.4%	72.6%
5th percentile	57.7%	100.0%	100.0%	57.7%	100.0%	100.0%	57.7%	100.0%	100.0%
	Leesville Lake								
95th percentile	99.3%	99.3%	99.3%	98.6%	98.6%	98.6%	97.9%	97.9%	97.9%
75th percentile	98.2%	98.2%	98.2%	96.5%	96.5%	96.5%	94.7%	94.7%	94.7%
mean	97.7%	97.9%	98.0%	95.6%	95.9%	96.1%	93.6%	94.0%	94.4%
50th percentile	93.7%	93.7%	93.7%	87.3%	87.3%	87.3%	81.0%	81.0%	81.0%
25th percentile	71.9%	71.9%	81.8%	43.7%	54.5%	81.8%	27.3%	54.5%	81.8%
10th percentile	75.0%	100.0%	100.0%	75.0%	100.0%	100.0%	75.0%	100.0%	100.0%
5th percentile	93.8%	100.0%	100.0%	93.8%	100.0%	100.0%	93.8%	100.0%	100.0%
	Tappan Lake								
95th percentile	99.6%	99.6%	99.6%	99.1%	99.1%	99.1%	98.7%	98.7%	98.7%
75th percentile	98.5%	98.5%	98.5%	97.1%	97.1%	97.1%	95.6%	95.6%	95.6%
mean	98.3%	98.5%	98.5%	96.8%	97.0%	97.1%	95.3%	95.6%	95.8%
50th percentile	94.0%	94.0%	94.0%	87.9%	87.9%	87.9%	81.9%	81.9%	81.9%
25th percentile	79.3%	79.3%	80.2%	58.6%	58.6%	80.2%	38.0%	53.5%	80.2%
10th percentile	90.9%	100.0%	100.0%	90.9%	100.0%	100.0%	90.9%	100.0%	100.0%
5th percentile	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 13.   Monthly statistics of Atwood Lake, Ohio, daily mean flow-by amounts for indicated pumping rates and target minimum flow-by amounts, expressed as a percentage of corresponding statistic based on observed outflows.

[ft³/s, cubic foot per second; Mgal/d, million gallons per day; color scale is gradient from maximum value, in green, to minimum value, in red]

Target minimum flow-by (ft³/s)	Statistic	Daily mean flow-by amounts expressed as a percentage of observed outflow statistics, for indicated months and pumping rates											
		Month											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		Pumping rate = 1 Mgal/d											
1.5	95th percentile	99.5%	99.6%	99.6%	99.6%	99.5%	99.5%	98.9%	98.7%	98.8%	99.0%	99.4%	99.6%
	75th percentile	98.6%	97.9%	98.9%	99.1%	98.7%	98.3%	97.9%	97.2%	96.9%	97.5%	99.0%	99.2%
	mean	98.2%	98.1%	98.6%	98.9%	98.6%	98.2%	97.3%	96.5%	96.8%	97.0%	98.7%	98.8%
	50th percentile	95.2%	90.3%	98.0%	98.5%	98.0%	97.5%	96.6%	92.7%	91.3%	93.8%	98.4%	97.7%
	25th percentile	91.4%	85.6%	86.2%	97.9%	97.2%	94.5%	85.9%	80.2%	81.1%	86.2%	96.3%	93.0%
	10th percentile	85.4%	68.2%	84.5%	95.6%	95.6%	87.1%	70.2%	49.8%	62.5%	50.1%	82.6%	85.6%
	5th percentile	76.9%	78.9%	50.0%	86.0%	90.9%	82.2%	53.6%	68.2%	78.9%	75.0%	57.7%	85.0%
3.0	95th percentile	99.5%	99.6%	99.6%	99.6%	99.5%	99.5%	98.9%	98.7%	98.8%	99.0%	99.4%	99.6%
	75th percentile	98.6%	97.9%	98.9%	99.1%	98.7%	98.3%	97.9%	97.2%	96.9%	97.5%	99.0%	99.2%
	mean	98.2%	98.2%	98.7%	99.0%	98.6%	98.2%	97.3%	96.7%	97.0%	97.2%	98.7%	98.8%
	50th percentile	95.2%	90.3%	98.0%	98.5%	98.0%	97.5%	96.6%	92.7%	91.3%	93.8%	98.4%	97.7%
	25th percentile	91.4%	85.6%	86.2%	97.9%	97.2%	94.5%	85.9%	80.2%	81.1%	86.2%	96.3%	93.0%
	10th percentile	85.4%	100.0%	84.5%	95.6%	95.6%	87.1%	70.2%	98.0%	100.0%	96.8%	82.6%	85.6%
	5th percentile	76.9%	100.0%	100.0%	86.0%	90.9%	82.2%	100.0%	100.0%	100.0%	100.0%	100.0%	85.0%
4.5	95th percentile	99.5%	99.6%	99.6%	99.6%	99.5%	99.5%	98.9%	98.7%	98.8%	99.0%	99.4%	99.6%
	75th percentile	98.6%	97.9%	98.9%	99.1%	98.7%	98.3%	97.9%	97.2%	96.9%	97.5%	99.0%	99.2%
	mean	98.2%	98.2%	98.7%	99.0%	98.6%	98.2%	97.4%	96.9%	97.1%	97.3%	98.7%	98.8%
	50th percentile	95.2%	90.3%	98.0%	98.5%	98.0%	97.5%	96.6%	92.7%	91.3%	93.8%	98.4%	97.7%
	25th percentile	91.4%	85.6%	86.2%	97.9%	97.2%	94.5%	85.9%	80.2%	81.1%	86.2%	96.3%	93.0%
	10th percentile	85.4%	100.0%	84.5%	95.6%	95.6%	87.1%	86.5%	100.0%	100.0%	100.0%	82.6%	85.6%
	5th percentile	76.9%	100.0%	100.0%	86.0%	90.9%	82.2%	100.0%	100.0%	100.0%	100.0%	100.0%	85.0%
		Pumping rate = 2 Mgal/d											
1.5	95th percentile	99.0%	99.2%	99.3%	99.2%	99.1%	98.9%	97.9%	97.4%	97.6%	98.0%	98.8%	99.2%
	75th percentile	97.2%	95.8%	97.8%	98.3%	97.5%	96.5%	95.8%	94.4%	93.8%	95.1%	98.1%	98.3%
	mean	96.4%	96.3%	97.3%	97.9%	97.2%	96.3%	94.6%	93.2%	93.8%	94.1%	97.4%	97.5%
	50th percentile	90.3%	80.7%	95.9%	96.9%	95.9%	95.0%	93.1%	85.4%	82.5%	87.6%	96.8%	95.4%
	25th percentile	82.8%	71.1%	72.4%	95.7%	94.4%	88.9%	71.9%	60.3%	62.3%	72.3%	92.6%	85.9%
	10th percentile	70.8%	68.2%	69.1%	91.3%	91.2%	74.2%	40.5%	49.0%	62.5%	48.4%	65.2%	71.2%
	5th percentile	53.8%	78.9%	50.0%	72.1%	81.8%	64.4%	53.6%	68.2%	78.9%	75.0%	57.7%	69.9%
3.0	95th percentile	99.0%	99.2%	99.3%	99.2%	99.1%	98.9%	97.9%	97.4%	97.6%	98.0%	98.8%	99.2%
	75th percentile	97.2%	95.8%	97.8%	98.3%	97.5%	96.5%	95.8%	94.4%	93.8%	95.1%	98.1%	98.3%
	mean	96.5%	96.5%	97.4%	97.9%	97.2%	96.4%	94.8%	93.6%	94.2%	94.4%	97.4%	97.6%
	50th percentile	90.3%	80.7%	95.9%	96.9%	95.9%	95.0%	93.1%	85.4%	82.5%	87.6%	96.8%	95.4%
	25th percentile	82.8%	71.1%	72.4%	95.7%	94.4%	88.9%	71.9%	60.3%	62.3%	72.3%	92.6%	85.9%
	10th percentile	70.8%	100.0%	69.1%	91.3%	91.2%	74.2%	57.7%	98.0%	100.0%	96.8%	65.2%	71.2%
	5th percentile	53.8%	100.0%	100.0%	72.1%	81.8%	64.4%	100.0%	100.0%	100.0%	100.0%	100.0%	69.9%

Table 13.   Monthly statistics of Atwood Lake, Ohio, daily mean flow-by amounts for indicated pumping rates and target minimum flow-by amounts, expressed as a percentage of corresponding statistic based on observed outflows.—Continued

[ft³/s, cubic foot per second; Mgal/d, million gallons per day; color scale is gradient from maximum value, in green, to minimum value, in red]

Target minimum flow-by (ft³/s)	Statistic	Daily mean flow-by amounts expressed as a percentage of observed outflow statistics, for indicated months and pumping rates											
		Month											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		Pumping rate = 2 Mgal/d—Continued											
	95th percentile	99.0%	99.2%	99.3%	99.2%	99.1%	98.9%	97.9%	97.4%	97.6%	98.0%	98.8%	99.2%
	75th percentile	97.2%	95.8%	97.8%	98.3%	97.5%	96.5%	95.8%	94.4%	93.8%	95.1%	98.1%	98.3%
	mean	96.5%	96.5%	97.4%	97.9%	97.2%	96.4%	95.0%	93.9%	94.4%	94.6%	97.5%	97.6%
4.5	50th percentile	90.3%	80.7%	95.9%	96.9%	95.9%	95.0%	93.1%	85.4%	82.5%	87.6%	96.8%	95.4%
	25th percentile	82.8%	71.1%	72.4%	95.7%	94.4%	88.9%	71.9%	60.3%	62.3%	72.3%	92.6%	85.9%
	10th percentile	70.8%	100.0%	69.1%	91.3%	91.2%	74.2%	86.5%	100.0%	100.0%	100.0%	65.2%	71.2%
	5th percentile	67.2%	100.0%	100.0%	72.1%	81.8%	64.4%	100.0%	100.0%	100.0%	100.0%	100.0%	69.9%
		Pumping rate = 3 Mgal/d											
	95th percentile	98.5%	98.7%	98.9%	98.8%	98.6%	98.4%	96.8%	96.1%	96.5%	97.0%	98.3%	98.8%
	75th percentile	95.8%	93.6%	96.8%	97.4%	96.2%	94.8%	93.6%	91.7%	90.7%	92.6%	97.1%	97.5%
	mean	94.6%	94.6%	96.0%	96.9%	95.8%	94.5%	92.0%	90.1%	90.9%	91.4%	96.1%	96.3%
1.5	50th percentile	85.5%	71.0%	93.9%	95.4%	93.9%	92.5%	89.7%	78.1%	73.8%	81.4%	95.3%	93.1%
	25th percentile	74.2%	56.7%	58.6%	93.6%	91.7%	83.4%	57.8%	40.5%	43.4%	58.5%	88.9%	78.9%
	10th percentile	56.3%	68.2%	53.6%	86.9%	86.7%	61.3%	28.8%	49.0%	62.5%	48.4%	47.8%	56.7%
	5th percentile	30.7%	78.9%	50.0%	58.1%	72.7%	46.6%	53.6%	68.2%	78.9%	75.0%	57.7%	54.9%
	95th percentile	98.5%	98.7%	98.9%	98.8%	98.6%	98.4%	96.8%	96.1%	96.5%	97.0%	98.3%	98.8%
	75th percentile	95.8%	93.6%	96.8%	97.4%	96.2%	94.8%	93.6%	91.7%	90.7%	92.6%	97.1%	97.5%
	mean	94.7%	94.7%	96.1%	96.9%	95.8%	94.6%	92.3%	90.7%	91.4%	91.7%	96.2%	96.4%
3.0	50th percentile	85.5%	71.0%	93.9%	95.4%	93.9%	92.5%	89.7%	78.1%	73.8%	81.4%	95.3%	93.1%
	25th percentile	74.2%	56.7%	58.6%	93.6%	91.7%	83.4%	57.8%	40.5%	43.4%	58.5%	88.9%	78.9%
	10th percentile	56.3%	100.0%	53.6%	86.9%	86.7%	61.3%	57.7%	98.0%	100.0%	96.8%	47.8%	56.7%
	5th percentile	44.8%	100.0%	100.0%	58.1%	72.7%	46.6%	100.0%	100.0%	100.0%	100.0%	100.0%	54.9%
	95th percentile	98.5%	98.7%	98.9%	98.8%	98.6%	98.4%	96.8%	96.1%	96.5%	97.0%	98.3%	98.8%
	75th percentile	95.8%	93.6%	96.8%	97.4%	96.2%	94.8%	93.6%	91.7%	90.7%	92.6%	97.1%	97.5%
	mean	94.8%	94.8%	96.1%	96.9%	95.8%	94.6%	92.7%	91.2%	91.7%	91.9%	96.2%	96.4%
4.5	50th percentile	85.5%	71.0%	93.9%	95.4%	93.9%	92.5%	89.7%	78.1%	73.8%	81.4%	95.3%	93.1%
	25th percentile	74.2%	56.7%	58.6%	93.6%	91.7%	83.4%	57.8%	57.7%	54.9%	58.5%	88.9%	78.9%
	10th percentile	56.3%	100.0%	53.6%	86.9%	86.7%	61.3%	86.5%	100.0%	100.0%	100.0%	50.6%	56.7%
	5th percentile	67.2%	100.0%	100.0%	58.1%	72.7%	51.7%	100.0%	100.0%	100.0%	100.0%	100.0%	54.9%

Table 14. Monthly statistics of Leesville Lake, Ohio, daily mean flow-by amounts for indicated pumping rates and target minimum flow-by amounts, expressed as a percentage of corresponding statistic based on observed outflows.

[ft³/s, cubic foot per second; Mgal/d, million gallons per day; color scale is gradient from maximum value, in green, to minimum value, in red]

Target minimum flow-by (ft³/s)	Statistic	Daily mean flow-by amounts expressed as a percentage of observed outflow statistics, for indicated months and pumping rates											
		Month											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		Pumping rate = 1 Mgal/d											
1.5	95th percentile	99.3%	99.4%	99.4%	99.4%	99.3%	99.2%	98.7%	98.2%	98.8%	98.8%	99.3%	99.4%
	75th percentile	98.6%	98.6%	98.9%	98.9%	98.5%	97.6%	95.2%	90.1%	87.1%	93.0%	98.8%	98.9%
	mean	97.9%	98.2%	98.5%	98.5%	98.0%	97.1%	95.2%	93.4%	94.6%	95.3%	98.1%	98.2%
	50th percentile	96.4%	93.6%	97.7%	98.1%	97.0%	93.0%	85.9%	75.0%	67.5%	76.2%	97.4%	96.7%
	25th percentile	88.1%	64.4%	76.2%	96.6%	93.0%	84.2%	70.0%	57.7%	75.0%	62.5%	80.2%	85.9%
	10th percentile	64.8%	83.3%	78.9%	90.7%	85.9%	70.5%	65.2%	88.2%	100.0%	100.0%	83.3%	53.6%
	5th percentile	53.6%	93.8%	88.2%	57.7%	78.8%	49.4%	83.3%	100.0%	100.0%	100.0%	100.0%	78.1%
3.0	95th percentile	99.3%	99.4%	99.4%	99.4%	99.3%	99.2%	98.7%	98.2%	98.8%	98.8%	99.3%	99.4%
	75th percentile	98.6%	98.6%	98.9%	98.9%	98.5%	97.6%	95.2%	90.1%	87.1%	93.0%	98.8%	98.9%
	mean	98.0%	98.5%	98.7%	98.6%	98.0%	97.2%	95.7%	94.5%	95.8%	96.0%	98.3%	98.3%
	50th percentile	96.4%	93.6%	97.7%	98.1%	97.0%	93.0%	85.9%	75.0%	67.5%	76.2%	97.4%	96.7%
	25th percentile	88.1%	100.0%	76.2%	96.6%	93.0%	84.2%	70.0%	100.0%	100.0%	100.0%	80.2%	85.9%
	10th percentile	68.2%	100.0%	100.0%	90.7%	85.9%	70.5%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
	5th percentile	100.0%	100.0%	100.0%	100.0%	78.8%	98.1%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
4.5	95th percentile	99.3%	99.4%	99.4%	99.4%	99.3%	99.2%	98.7%	98.2%	98.8%	98.8%	99.3%	99.4%
	75th percentile	98.6%	98.6%	98.9%	98.9%	98.5%	97.6%	95.2%	90.1%	87.1%	93.0%	98.8%	98.9%
	mean	98.1%	98.6%	98.7%	98.6%	98.0%	97.3%	96.1%	95.4%	96.5%	96.6%	98.3%	98.4%
	50th percentile	96.4%	93.6%	97.7%	98.1%	97.0%	93.0%	85.9%	75.0%	94.7%	76.2%	97.4%	96.7%
	25th percentile	88.1%	100.0%	76.2%	96.6%	93.0%	84.2%	87.4%	100.0%	100.0%	100.0%	80.2%	85.9%
	10th percentile	100.0%	100.0%	100.0%	90.7%	85.9%	85.8%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
	5th percentile	100.0%	100.0%	100.0%	100.0%	78.8%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
		Pumping rate = 2 Mgal/d											
1.5	95th percentile	98.7%	98.8%	98.9%	98.8%	98.6%	98.4%	97.4%	96.5%	97.7%	97.6%	98.5%	98.7%
	75th percentile	97.2%	97.1%	97.8%	97.8%	97.1%	95.3%	90.3%	80.2%	74.2%	85.9%	97.5%	97.7%
	mean	95.9%	96.7%	97.2%	97.1%	96.1%	94.3%	90.9%	87.9%	90.4%	91.4%	96.4%	96.5%
	50th percentile	92.8%	87.1%	95.4%	96.3%	94.0%	85.9%	71.9%	50.1%	34.9%	52.4%	94.8%	93.4%
	25th percentile	76.2%	64.4%	52.4%	93.1%	85.9%	68.3%	39.9%	57.7%	75.0%	62.5%	60.3%	71.9%
	10th percentile	34.1%	83.3%	78.9%	81.3%	71.9%	41.0%	65.2%	88.2%	100.0%	100.0%	83.3%	53.6%
	5th percentile	53.6%	93.8%	88.2%	57.7%	57.6%	49.1%	83.3%	100.0%	100.0%	100.0%	100.0%	78.1%
3.0	95th percentile	98.7%	98.8%	98.9%	98.8%	98.6%	98.4%	97.4%	96.5%	97.7%	97.6%	98.5%	98.7%
	75th percentile	97.2%	97.1%	97.8%	97.8%	97.1%	95.3%	90.3%	80.2%	74.2%	85.9%	97.5%	97.7%
	mean	96.1%	97.1%	97.4%	97.1%	96.1%	94.5%	91.7%	90.0%	92.3%	92.6%	96.6%	96.7%
	50th percentile	92.8%	87.1%	95.4%	96.3%	94.0%	85.9%	71.9%	50.1%	63.1%	52.4%	94.8%	93.4%
	25th percentile	76.2%	100.0%	52.4%	93.1%	85.9%	68.3%	58.3%	100.0%	100.0%	100.0%	60.3%	71.9%
	10th percentile	68.2%	100.0%	100.0%	81.3%	71.9%	57.2%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
	5th percentile	100.0%	100.0%	100.0%	100.0%	57.6%	98.1%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 14. Monthly statistics of Leesville Lake, Ohio, daily mean flow-by amounts for indicated pumping rates and target minimum flow-by amounts, expressed as a percentage of corresponding statistic based on observed outflows.—Continued

[ft³/s, cubic foot per second; Mgal/d, million gallons per day; color scale is gradient from maximum value, in green, to minimum value, in red]

Target minimum flow-by (ft³/s)	Statistic	Daily mean flow-by amounts expressed as a percentage of observed outflow statistics, for indicated months and pumping rates											
		Month											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		Pumping rate = 2 Mgal/d—Continued											
4.5	95th percentile	98.7%	98.8%	98.9%	98.8%	98.6%	98.4%	97.4%	96.5%	97.7%	97.6%	98.5%	98.7%
	75th percentile	97.2%	97.1%	97.8%	97.8%	97.1%	95.3%	90.3%	80.2%	74.2%	85.9%	97.5%	97.7%
	mean	96.2%	97.2%	97.4%	97.1%	96.1%	94.7%	92.5%	91.5%	93.5%	93.6%	96.7%	96.9%
	50th percentile	92.8%	87.1%	95.4%	96.3%	94.0%	85.9%	71.9%	72.6%	94.7%	69.2%	94.8%	93.4%
	25th percentile	76.2%	100.0%	69.3%	93.1%	85.9%	68.3%	87.4%	100.0%	100.0%	100.0%	60.3%	71.9%
	10th percentile	100.0%	100.0%	100.0%	81.3%	71.9%	85.8%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
	5th percentile	100.0%	100.0%	100.0%	100.0%	61.6%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
		Pumping rate = 3 Mgal/d											
1.5	95th percentile	98.0%	98.2%	98.3%	98.1%	97.9%	97.6%	96.0%	94.7%	96.5%	96.3%	97.8%	98.1%
	75th percentile	95.8%	95.7%	96.6%	96.7%	95.6%	92.9%	85.5%	70.4%	61.3%	78.9%	96.3%	96.6%
	mean	94.0%	95.3%	95.9%	95.7%	94.1%	91.6%	86.9%	83.4%	87.0%	88.0%	94.7%	94.9%
	50th percentile	89.2%	80.7%	93.1%	94.4%	91.1%	78.9%	57.8%	25.1%	31.6%	28.6%	92.1%	90.1%
	25th percentile	64.3%	64.4%	28.6%	89.7%	78.9%	52.5%	29.1%	57.7%	75.0%	62.5%	40.5%	57.8%
	10th percentile	34.1%	83.3%	78.9%	72.0%	57.8%	28.6%	65.2%	88.2%	100.0%	100.0%	83.3%	53.6%
	5th percentile	53.6%	93.8%	88.2%	57.7%	36.4%	49.1%	83.3%	100.0%	100.0%	100.0%	100.0%	78.1%
3.0	95th percentile	98.0%	98.2%	98.3%	98.1%	97.9%	97.6%	96.0%	94.7%	96.5%	96.3%	97.8%	98.1%
	75th percentile	95.8%	95.7%	96.6%	96.7%	95.6%	92.9%	85.5%	70.4%	61.3%	78.9%	96.3%	96.6%
	mean	94.2%	95.7%	96.1%	95.7%	94.1%	91.9%	88.2%	86.1%	89.3%	89.7%	94.9%	95.2%
	50th percentile	89.2%	80.7%	93.1%	94.4%	91.1%	78.9%	57.8%	48.4%	63.1%	46.2%	92.1%	90.1%
	25th percentile	64.3%	100.0%	46.2%	89.7%	78.9%	52.5%	58.3%	100.0%	100.0%	100.0%	40.5%	57.8%
	10th percentile	68.2%	100.0%	100.0%	72.0%	57.8%	57.2%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
	5th percentile	100.0%	100.0%	100.0%	100.0%	41.1%	98.1%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
4.5	95th percentile	98.0%	98.2%	98.3%	98.1%	97.9%	97.6%	96.0%	94.7%	96.5%	96.3%	97.8%	98.1%
	75th percentile	95.8%	95.7%	96.6%	96.7%	95.6%	92.9%	85.5%	70.4%	61.3%	78.9%	96.3%	96.6%
	mean	94.4%	95.9%	96.2%	95.7%	94.2%	92.2%	89.3%	88.2%	91.0%	91.2%	95.1%	95.4%
	50th percentile	89.2%	80.7%	93.1%	94.4%	91.1%	78.9%	57.8%	72.6%	94.7%	69.2%	92.1%	90.1%
	25th percentile	64.3%	100.0%	69.3%	89.7%	78.9%	52.5%	87.4%	100.0%	100.0%	100.0%	57.7%	57.8%
	10th percentile	100.0%	100.0%	100.0%	72.0%	57.8%	85.8%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
	5th percentile	100.0%	100.0%	100.0%	100.0%	61.6%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 15. Monthly statistics of Tappan Lake, Ohio, daily mean flow-by amounts for indicated pumping rates and target minimum flow-by amounts, expressed as a percentage of corresponding statistic based on observed outflows.

[ft³/s, cubic foot per second; Mgal/d, million gallons per day; color scale is gradient from maximum value, in green, to minimum value, in red]

Target minimum flow-by (ft³/s)	Statistic	Daily mean flow-by amounts expressed as a percentage of observed outflow statistics, for indicated months and pumping rates											
		Month											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		Pumping rate = 1 Mgal/d											
2.0	95th percentile	99.6%	99.6%	99.6%	99.6%	99.6%	99.5%	99.0%	98.2%	98.1%	99.2%	99.6%	99.6%
	75th percentile	99.0%	98.9%	99.0%	99.2%	98.8%	97.4%	95.4%	91.5%	90.9%	93.8%	99.3%	99.2%
	mean	98.6%	98.7%	98.8%	98.9%	98.6%	97.7%	96.1%	95.2%	95.3%	96.6%	98.9%	98.8%
	50th percentile	96.9%	90.9%	97.0%	97.7%	97.3%	94.9%	90.3%	82.7%	74.6%	85.1%	98.4%	97.4%
	25th percentile	88.9%	71.4%	72.4%	95.3%	94.8%	90.3%	80.2%	66.7%	83.3%	58.8%	87.2%	87.1%
	10th percentile	65.6%	100.0%	95.2%	59.8%	90.3%	78.8%	69.0%	100.0%	100.0%	100.0%	71.4%	57.1%
	5th percentile	90.9%	100.0%	100.0%	100.0%	59.3%	64.5%	100.0%	100.0%	100.0%	100.0%	95.2%	87.0%
4.0	95th percentile	99.6%	99.6%	99.6%	99.6%	99.6%	99.5%	99.0%	98.2%	98.1%	99.2%	99.6%	99.6%
	75th percentile	99.0%	98.9%	99.0%	99.2%	98.8%	97.4%	95.4%	91.5%	90.9%	93.8%	99.3%	99.2%
	mean	98.7%	98.8%	98.9%	98.9%	98.6%	97.8%	96.4%	96.0%	96.3%	97.0%	99.0%	98.9%
	50th percentile	96.9%	90.9%	97.0%	97.7%	97.3%	94.9%	90.3%	82.7%	74.6%	85.1%	98.4%	97.4%
	25th percentile	88.9%	100.0%	72.4%	95.3%	94.8%	90.3%	80.2%	100.0%	100.0%	100.0%	87.2%	87.1%
	10th percentile	88.9%	100.0%	100.0%	100.0%	90.3%	78.8%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
	5th percentile	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
6.0	95th percentile	99.6%	99.6%	99.6%	99.6%	99.6%	99.5%	99.0%	98.2%	98.1%	99.2%	99.6%	99.6%
	75th percentile	99.0%	98.9%	99.0%	99.2%	98.8%	97.4%	95.4%	91.5%	90.9%	93.8%	99.3%	99.2%
	mean	98.7%	98.9%	99.0%	98.9%	98.6%	97.8%	96.7%	96.5%	96.8%	97.3%	99.0%	98.9%
	50th percentile	96.9%	90.9%	97.0%	97.7%	97.3%	94.9%	90.3%	82.7%	98.5%	85.1%	98.4%	97.4%
	25th percentile	88.9%	100.0%	100.0%	95.3%	94.8%	90.3%	80.2%	100.0%	100.0%	100.0%	87.2%	87.1%
	10th percentile	100.0%	100.0%	100.0%	100.0%	90.3%	82.2%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
	5th percentile	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
		Pumping rate = 2 Mgal/d											
2.0	95th percentile	99.3%	99.3%	99.3%	99.3%	99.2%	98.9%	98.0%	96.4%	96.2%	98.4%	99.2%	99.3%
	75th percentile	98.0%	97.8%	98.1%	98.3%	97.5%	94.8%	90.9%	83.0%	81.8%	87.6%	98.5%	98.4%
	mean	97.3%	97.6%	97.8%	97.8%	97.1%	95.5%	92.4%	91.0%	91.4%	93.5%	97.8%	97.7%
	50th percentile	93.8%	81.8%	93.9%	95.4%	94.5%	89.8%	80.7%	65.3%	49.2%	70.1%	96.8%	94.9%
	25th percentile	77.9%	71.4%	44.7%	90.6%	89.7%	80.7%	60.3%	66.7%	83.3%	58.8%	74.3%	74.2%
	10th percentile	44.4%	100.0%	95.2%	59.8%	80.7%	57.6%	69.0%	100.0%	100.0%	100.0%	71.4%	57.1%
	5th percentile	90.9%	100.0%	100.0%	100.0%	52.6%	64.5%	100.0%	100.0%	100.0%	100.0%	95.2%	87.0%
4.0	95th percentile	99.3%	99.3%	99.3%	99.3%	99.2%	98.9%	98.0%	96.4%	96.2%	98.4%	99.2%	99.3%
	75th percentile	98.0%	97.8%	98.1%	98.3%	97.5%	94.8%	90.9%	83.0%	81.8%	87.6%	98.5%	98.4%
	mean	97.4%	97.7%	97.9%	97.9%	97.2%	95.6%	93.0%	92.4%	93.0%	94.3%	98.0%	97.8%
	50th percentile	93.8%	81.8%	93.9%	95.4%	94.5%	89.8%	80.7%	65.3%	65.7%	70.1%	96.8%	94.9%
	25th percentile	77.9%	100.0%	71.4%	90.6%	89.7%	80.7%	60.3%	100.0%	100.0%	100.0%	74.3%	74.2%
	10th percentile	88.9%	100.0%	100.0%	100.0%	80.7%	57.6%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
	5th percentile	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 15. Monthly statistics of Tappan Lake, Ohio, daily mean flow-by amounts for indicated pumping rates and target minimum flow-by amounts, expressed as a percentage of corresponding statistic based on observed outflows.—Continued

[ft³/s, cubic foot per second; Mgal/d, million gallons per day; color scale is gradient from maximum value, in green, to minimum value, in red]

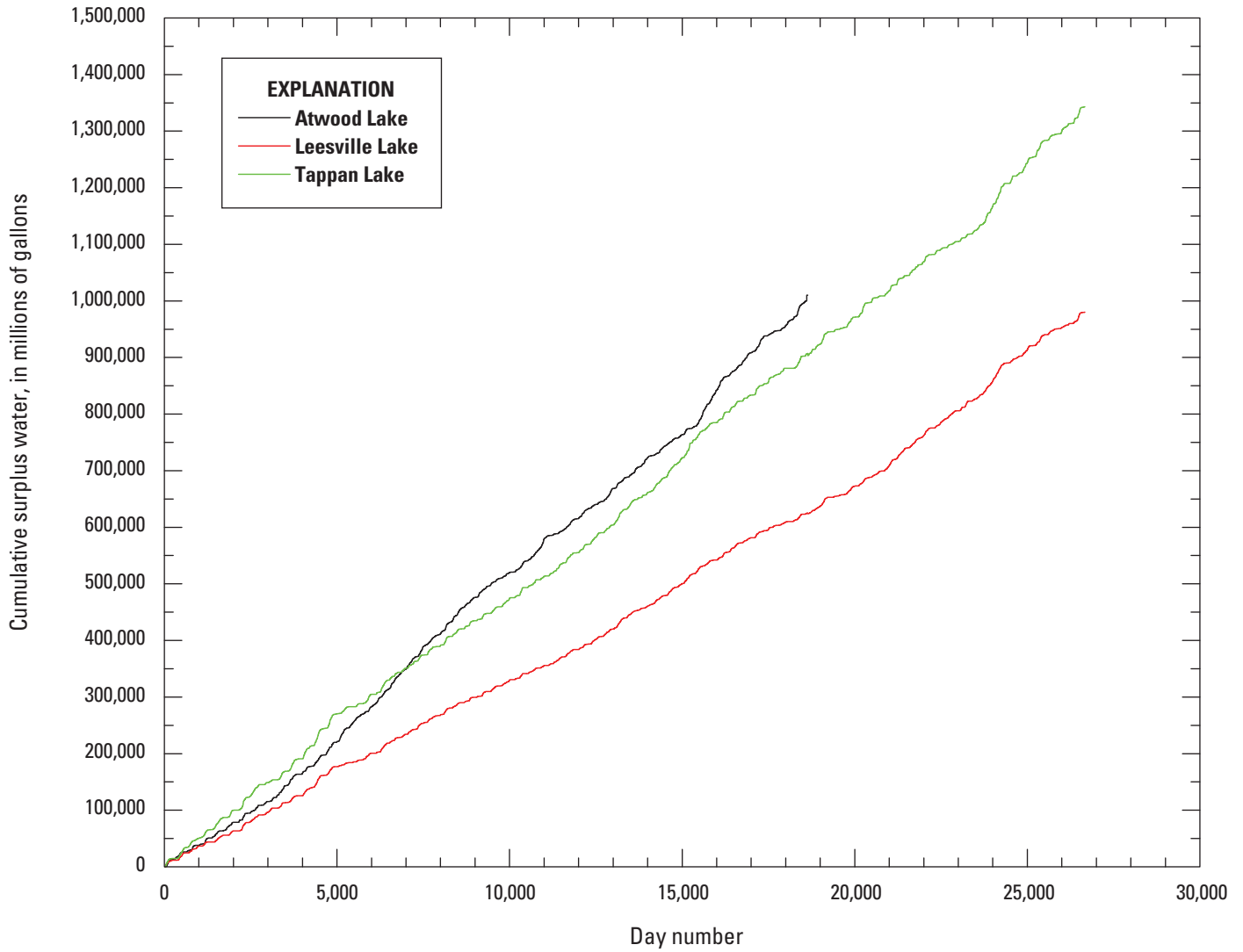| Target minimum flow-by (ft³/s)	Statistic	Daily mean flow-by amounts expressed as a percentage of observed outflow statistics, for indicated months and pumping rates											
		Month											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		Pumping rate = 2 Mgal/d—Continued											
	95th percentile	99.3%	99.3%	99.3%	99.3%	99.2%	98.9%	98.0%	96.4%	96.2%	98.4%	99.2%	99.3%
	75th percentile	98.0%	97.8%	98.1%	98.3%	97.5%	94.8%	90.9%	83.0%	81.8%	87.6%	98.5%	98.4%
	mean	97.4%	97.8%	97.9%	97.9%	97.2%	95.7%	93.5%	93.3%	93.9%	94.9%	98.0%	97.9%
6.0	50th percentile	93.8%	81.8%	93.9%	95.4%	94.5%	89.8%	80.7%	67.2%	98.5%	70.1%	96.8%	94.9%
	25th percentile	77.9%	100.0%	100.0%	90.6%	89.7%	80.7%	76.9%	100.0%	100.0%	100.0%	74.3%	74.2%
	10th percentile	100.0%	100.0%	100.0%	100.0%	80.7%	82.2%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
	5th percentile	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
		Pumping rate = 3 Mgal/d											
	95th percentile	98.9%	98.9%	98.9%	98.9%	98.8%	98.4%	97.0%	94.7%	94.3%	97.6%	98.8%	98.9%
	75th percentile	97.0%	96.7%	97.1%	97.5%	96.3%	92.3%	86.3%	74.5%	72.7%	81.4%	97.8%	97.6%
	mean	95.9%	96.4%	96.7%	96.7%	95.7%	93.3%	89.0%	87.3%	88.0%	90.7%	96.8%	96.6%
2.0	50th percentile	90.7%	72.7%	90.9%	93.2%	91.8%	84.6%	71.0%	48.0%	32.8%	55.2%	95.3%	92.3%
	25th percentile	66.8%	71.4%	35.7%	85.9%	84.5%	71.0%	40.5%	66.7%	83.3%	58.8%	61.5%	61.3%
	10th percentile	44.4%	100.0%	95.2%	59.8%	71.0%	36.4%	69.0%	100.0%	100.0%	100.0%	71.4%	57.1%
	5th percentile	90.9%	100.0%	100.0%	100.0%	52.6%	64.5%	100.0%	100.0%	100.0%	100.0%	95.2%	87.0%
	95th percentile	98.9%	98.9%	98.9%	98.9%	98.8%	98.4%	97.0%	94.7%	94.3%	97.6%	98.8%	98.9%
	75th percentile	97.0%	96.7%	97.1%	97.5%	96.3%	92.3%	86.3%	74.5%	72.7%	81.4%	97.8%	97.6%
	mean	96.1%	96.6%	96.9%	96.8%	95.8%	93.4%	89.8%	89.1%	90.0%	91.8%	97.0%	96.8%
4.0	50th percentile	90.7%	72.7%	90.9%	93.2%	91.8%	84.6%	71.0%	48.0%	65.7%	55.2%	95.3%	92.3%
	25th percentile	66.8%	100.0%	71.4%	85.9%	84.5%	71.0%	51.3%	100.0%	100.0%	100.0%	61.5%	61.3%
	10th percentile	88.9%	100.0%	100.0%	100.0%	71.0%	54.8%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
	5th percentile	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
	95th percentile	98.9%	98.9%	98.9%	98.9%	98.8%	98.4%	97.0%	94.7%	94.3%	97.6%	98.8%	98.9%
	75th percentile	97.0%	96.7%	97.1%	97.5%	96.3%	92.3%	86.3%	74.5%	72.7%	81.4%	97.8%	97.6%
	mean	96.2%	96.7%	96.9%	96.8%	95.8%	93.6%	90.6%	90.4%	91.2%	92.7%	97.1%	96.9%
6.0	50th percentile	90.7%	72.7%	90.9%	93.2%	91.8%	84.6%	71.0%	67.2%	98.5%	57.9%	95.3%	92.3%
	25th percentile	66.8%	100.0%	100.0%	85.9%	84.5%	71.0%	76.9%	100.0%	100.0%	100.0%	61.5%	61.3%
	10th percentile	100.0%	100.0%	100.0%	100.0%	71.0%	82.2%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
	5th percentile	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Figure 3. Graph showing surplus-water mass curves based on current target minimum outflows for the Atwood, Leesville, and Tappan Lakes in the Muskingum River Watershed, Ohio.

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Glossary

flow-by   The computed net flow in the stream immediately downstream from a lake or reservoir, after accounting for withdrawals. The flow-by amount equals the outflow minus any withdrawals. Flow-by amounts are, by definition, available to support water uses downstream from the lake or reservoir.

minimum in-stream flow-target multiple   A multiplier applied to established minimum in-stream flow targets to compute new hypothetical target minimum flow-by amounts.

outflow   The total amount of water discharged from a lake or reservoir before withdrawals.

seasonal pool levels   Target water levels for a lake or reservoir that vary as a function of season. In Ohio, winter pool levels typically are set lower than summer pool levels to facilitate greater flood control.

surplus water   The lake or reservoir outflow minus the target minimum flow-by amount. Surplus water represents the amount of water that potentially is available for withdrawal while still meeting the minimum flow-by target immediately downstream from the lake or reservoir.

surplus water mass curve   A curve produced by plotting the cumulative amount of surplus water as a function of time. Mass curves can be used to determine whether hypothetical water demands can be met at all times or, if not, to determine the maximum amount and duration of demand excess.

target minimum flow-by   Minimum in-stream flow targets downstream from the lake or reservoir, after accounting for withdrawals. Target minimum flow-by amounts represent goals for minimum in-stream flows; however, they are not legal mandates and may not be achievable during extended low-flow periods.

withdrawals   Water removed for some purpose from a lake, reservoir, or their outflows. Withdrawals are not part of the flow-by and as such are not available to support in-stream water uses downstream from the lake or reservoir.

Appendix 1.

Table 1-1. Cumulative surplus water at the Atwood, Leesville, and Tappan Lakes as a function of target minimum flow-by amount.

This table is a separate document, available for downloading at *http://pubs.usgs.gov/sir/2013/5112/.*