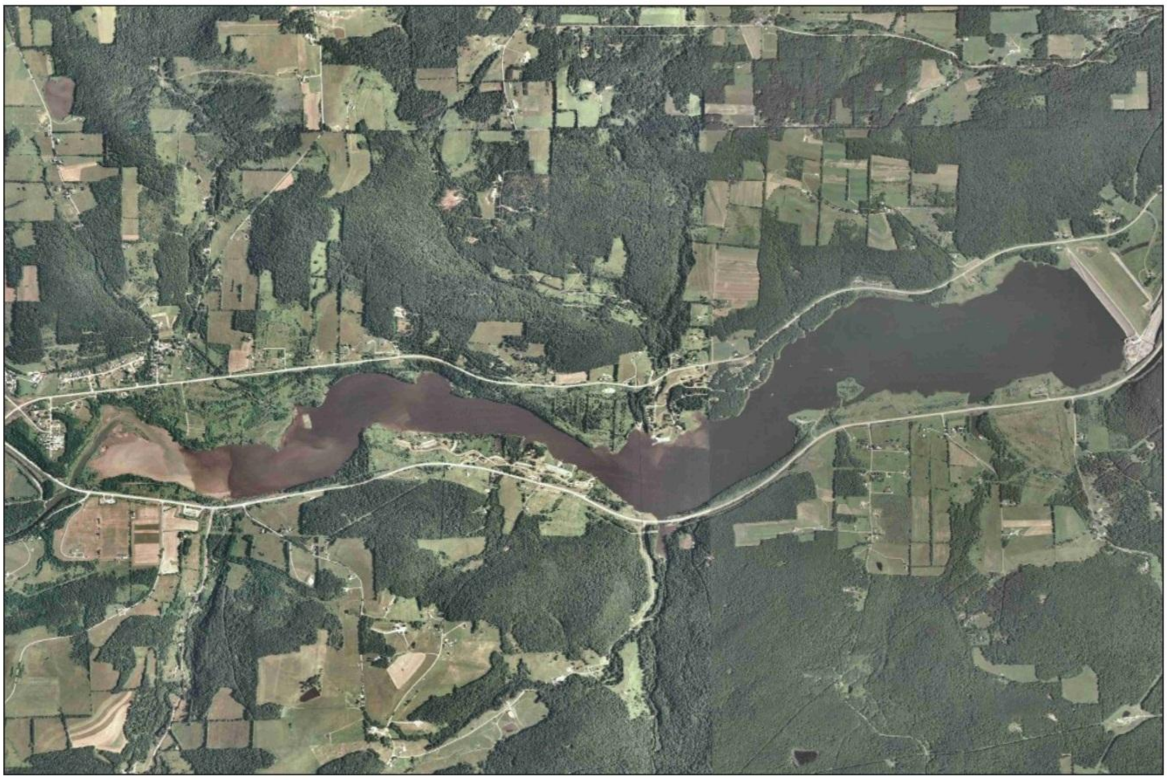
OPTIMIZING USE OF COMMISSION-OWNED WATER STORAGE AT COWANESQUE LAKE, PENNSYLVANIA



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EXECUTIVE SUMMARY

The purpose of this report is to present an evaluation of environmental and recreational impacts of potential new water supply operations at the U.S. Army Corps of Engineers' (USACE) Cowanesque Lake to allow the Susquehanna River Basin Commission (SRBC) to use the lake storage it owns to more effectively mitigate for consumptive water use in the basin. SRBC's objective is to further reduce the impact of human consumption on the natural flow regime and potentially improve the downstream ecosystem during critical low flow events.

Consumptive use mitigation is required when flow at selected locations in the Susquehanna River Basin drops below a low flow threshold called the "trigger" value. A "Q7-10" value has been used typically by SRBC for this purpose since the 1970s. The Q7-10 flow is the 7-day average low flow expected to occur at a 1-in-10-year frequency and has a 10 percent chance of occurring in any year, on average. SRBC is evaluating alternative trigger values for several reasons. First, the basis for the Q7-10 standard is the assimilation of wastewater discharges to protect water quality and it does not address the protection of aquatic habitat or other riparian needs. Second, the Q7-10 threshold has not triggered reservoir water supply releases during several recent significant droughts despite impacts in the Susquehanna River Basin. Third, the Q7-10 threshold inadequately supports minimum flow releases required at the Conowingo Hydroelectric Station for protecting the lowest reach of the Susquehanna River.

Prior to the current investigations, SRBC evaluated a range of preliminary alternative trigger values and locations based on both historical annual and monthly streamflow statistics. Trigger values based on annual streamflow data would be constant year round, whereas seasonal trigger values would vary by month. SRBC also determined that the majority of low flow events occur in August through October, which is also a period of high consumptive use. Each alternative low flow trigger considered requires the selection of one or more streamflow gages that would be used to determine when consumptive use mitigation releases should occur. Currently, the trigger gages for Cowanesque Lake are located at Harrisburg and Wilkes-Barre and these sites were retained. Because SRBC is involved with basin-wide water management, Marietta, Pennsylvania, was also identified as an alternative trigger location.

To determine the hydrologic impact on Cowanesque Lake from the use of alternative trigger values and locations, SRBC used the Operational Analysis and Simulation of Integrated Systems (OASIS) model. The primary data inputs into the model included daily time series flow data, consumptive use data, and operational rules for the lake. The flow input data used were historical records from 1930 through 2007. The primary outputs from the model include daily water releases from Cowanesque Lake, lake levels, and water supply and conservation storage volumes.

SRBC used an iterative process to screen alternatives and initially identified 43 different plans for model simulation. Further screening led to 12 plans being retained using five criteria: hydrology, reservoir storage, Commission objectives related to consumptive use mitigation, experience with Q7-10 trigger values, and significant environmental or recreational impacts. Six plans were dropped from further consideration because they had significant recreation impacts and significant or moderate environmental impacts, and they also did not meet one or more of

SRBC's low flow management objectives. Two additional plans were dropped from further consideration because they would not meet current and critical consumptive use mitigation needs for the major power plants located downstream in the basin.

The four plans remaining after the SRBC screening process plus the current operating procedure (the "Baseline Alternative") are evaluated as alternatives in this report and are listed below. One of the new alternatives will be selected as a proposed revised plan of operation for the SRBC-owned water supply storage.

Alternative	Trigger Value	Gage Location
Baseline	Q7-10 (annual)	Wilkes-Barre or Harrisburg
WBH97	P97 (seasonal) [a]	Wilkes-Barre or Harrisburg
WBH95	P95 (seasonal) [a]	Wilkes-Barre or Harrisburg
M97	P97 (seasonal) [a]	Marietta
M95	P95 (seasonal) [a]	Marietta

[a] P95 (P97) stands for the probability of a calculated flow for a designated month being exceeded 95% (97%) of the time based on historical monthly flow records.

The benefits to be gained from revised operations include more effective use of SRBC-owned water supply storage to offset downstream consumptive water use and support for the ecosystem flow needs identified by The Nature Conservancy in its 2010 report done for USACE and SRBC.

The following information summarizes the evaluation of in-lake impacts, presented in detail in this report, for the 78 years (1930-2007) analyzed.

Lake Drawdown Frequency, Duration, and Seasonality

For the Baseline Alternative and the four new alternatives:

* The lake would remain at normal pool for approximately 80 percent of all days.
* Drawdowns greater than 1 foot would differ no more than 4 percent in total days duration.
* Drawdowns in a median and extreme event differ by less than 1 foot.
* Duration of drawdowns during a median and extreme event differ by a few days.
* Median and extreme drawdown events occur during the same time of year.

Water Quality

For the Baseline Alternative and the four new alternatives:

* In 97 percent of years analyzed, it is expected that the drawdown threshold for potential adverse in-lake water quality effects would not be reached.
* In 3 percent of years analyzed the drawdown threshold may be reached or exceeded in the fall during the normal destratification of the lake, thereby minimizing any adverse in-lake or immediate downstream impacts.

Submerged Aquatic Vegetation (SAV)

For the Baseline Alternative and the four new alternatives:

* For 50 percent of years, lake drawdown is less than 1 foot and there would be no adverse impact to SAV.

* Drawdowns greater than 1 foot would differ no more than 4 percent in total days duration.
* Median event drawdowns may differ by 1 or 2 weeks in duration, but there would be no difference in long-term impact as SAV would recolonize the following spring.
* During severe drought events, there may be moderate impacts to SAV because the prolonged winter exposure may reduce SAV viability, but SAV would be expected to recover over 1 or 2 years.

Wetlands

For the Baseline Alternative and the four new alternatives:

* For 50 percent of years, lake drawdown would be less than 1 foot and there would be no adverse impact to wetlands.
* Drawdowns greater than 1 foot would differ no more than 4 percent in total days duration.
* There is little variability in the duration and time of year for drawdowns and it is expected all alternatives would result in moderate impacts on the emergent wetlands.

Terrestrial Resources

* Terrestrial resources will not be affected by lake level drawdowns for the Baseline Alternative and the four new alternatives.

Fish

For the Baseline Alternative and the four new alternatives:

* For 50 percent of years, lake drawdown would be less than 1 foot and there would be no adverse impact to fish.
* Drawdowns greater than 1 foot would differ no more than 4 percent in total days duration.
* The loss of established shallow water habitat caused by infrequent, moderate drawdowns can benefit the in-lake fishery.
* Water supply releases during low flow conditions can improve habitat for aquatic communities downstream in the Cowanesque River. These releases can also help improve the aquatic ecosystem in the Susquehanna River Basin during drought periods and help meet the ecosystem flow recommendations of The Nature Conservancy.

Recreational Resources

For the Baseline Alternative and the four new alternatives:

* Existing recreation facilities were designed for water supply operations, i.e., periodic drawdowns.
* Drawdowns would occur infrequently during the recreation season with the lake level remaining at normal recreation elevation (1080 feet) for over 80 percent of all recreation season days and at a level 1 foot lower for about 90 percent of the time.
* Drawdowns greater than 1 foot would differ no more than 4 percent in total days duration.
* Drawdowns greater than 10 feet would differ no more than 1 percent in total days duration.

Conclusion

The benefits to be gained from revised operations include more effective use of SRBC-owned water supply storage to offset downstream consumptive water use and support for the ecosystem flow needs identified by The Nature Conservancy in its 2010 report done for USACE and SRBC. The four optional trigger alternatives would have the same or at most minimal incremental adverse impacts when compared to the Baseline Alternative. Environmental resources would not be measurably more affected by the four optional trigger alternatives than by the Baseline Alternative. Recreational resources may be affected slightly more under the four optional trigger alternatives than the Baseline Alternative, but the effects would be minimal in the long-term. Project modifications to offset adverse in-lake impacts are not proposed because the four optional trigger alternatives would cause little increase in impacts to environmental or recreational resources beyond those caused by the Baseline Alternative.

ACKNOWLEDGEMENTS

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ACRONYMS

ADA	American Disabilities Act
°C	Celsius
cfs	Cubic Feet per Second
DEP	Department of Environmental Protection
DO	Dissolved Oxygen
EA	EA Engineering, Science, and Technology
°F	Fahrenheit
FACW	Facultative Wet Species
FERC	Federal Energy Regulatory Commission
GIS	Graphical Information Systems
mgd	Million Gallons per Day
mg/L	Milligrams per Liter
NGDV	National Geodetic Vertical Datum
N/A	Not Applicable
N.d	No Date
No.	Number
OASIS	Operational Analysis and Simulation of Integrated Systems
OBL	Obligate species
PFBC	Pennsylvania Fish and Boat Commission
SAV	Submerged Aquatic Vegetation
sq mi	Square Miles
SRBC	Susquehanna River Basin Commission
SSES	Susquehanna Steam Electric Station
SWH	Shallow Water Habitat
TMDL	Total Maximum Daily Load
TMI	Three Mile Island
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WCT	Water Control Team

1.0 INTRODUCTION

1.1 PROJECT BACKGROUND

Susquehanna River Basin Commission Consumptive Use Mitigation

The Susquehanna River Basin Commission (SRBC) was established in 1971 as an independent agency by a federal-interstate compact among the states of Maryland and New York, the Commonwealth of Pennsylvania, and the federal government. In creating SRBC, the Congress and state legislatures formally recognized the water resources of the Susquehanna River Basin as a regional asset vested with local, state, and national interests for which all the parties share responsibility. As a single federal-interstate water resources agency with basinwide authority, SRBC's goal is to coordinate the planning, conservation, management, utilization, development, and control of basin water resources among the public and private sectors.

Among its responsibilities, SRBC regulates surface water and groundwater withdrawals and consumptive water uses (SRBC, 2008b). The two primary SRBC regulations and their respective threshold quantities are:

- Consumptive use of 20,000 gallons per day or more (consecutive 30-day average) from any source, including users on public water supplies. Consumptive use includes diversions of any quantity of water into the basin and diversions of 20,000 gallons per day or more out of the basin. For all projects involving unconventional natural gas development, the threshold starts at gallon one.
- Withdrawals of 100,000 gallons per day (consecutive 30-day average) of surface water or groundwater or a combination of the two. For all projects involving unconventional natural gas development, the threshold starts at gallon one.

Consumptive use is defined broadly by SRBC as "the loss of water due to a variety of processes by which the water is not returned to the waters of the basin undiminished in quantity" (SRBC, 2008a). The primary categories of consumptive uses and the amount of consumptive use from July 2010 through June 2011 are summarized in Table 1-1.

Table 1-1 Reported Consumptive Uses in the Susquehanna River Basin, July 2010-June 2011

Consumptive Use Category	Average Daily Reported Consumptive Use (mgd[a])	Percentage of Total Average Daily Reported Consumptive Use
Electrical Generation	93.06	73
Water Supply Diversion	9.16	7
Manufacturing	9.14	7
Natural Gas Development	9.07	7
Recreation	4.14	3
Other	2.28	2
Mining	1.03	1
Total	127.88	100

[a] mgd = million gallons per day

SRBC's consumptive use regulation, first adopted in 1976, requires major consumptive water users in the Susquehanna River Basin that meet the threshold requirements for quantity of use to provide mitigation for their consumptive use during low flow conditions. In concert with SRBC's standards for withdrawals, which require passby flows[1] during low flow conditions, the consumptive use mitigation strategy is intended to maintain natural flow conditions and eliminate manmade impacts, to the degree possible, caused by consumptive use during low flows. Consumptive water users are expected to comply with the regulation generally by providing compensatory water or discontinuing consumptive use during low flow events (SRBC, 2008a).

On the mainstem of the Susquehanna River, there are two major consumptive users for energy production: Susquehanna Steam Electric Station (SSES) in Berwick and the Three Mile Island (TMI) nuclear power plant. A third major consumptive user is the coal-fired Montour power plant located on a tributary to the West Branch Susquehanna River. The owners of the SSES and TMI worked with SRBC to secure water storage for consumptive use mitigation at Cowanesque Lake, as described further in the subsection *Cowanesque Lake* below. This option, however, is impractical for most consumptive water users, and discontinuation of consumptive use is unreasonable for most facilities. In 1993, SRBC enacted a measure to allow payment of a consumptive use fee to SRBC in lieu of providing actual compensatory water. The payment of fees was intended to allow SRBC to undertake additional large-scale storage projects to provide low flow mitigation for consumptive use projects paying the fee. SRBC also purchased storage at Curwensville Lake in western Pennsylvania under this program.

In 2008, SRBC completed a Consumptive Use Mitigation Plan, which summarized the state of consumptive use in the Susquehanna basin, identified low flow mitigation needs, and introduced SRBC's plan for consumptive use mitigation (SRBC, 2008a). Including consumptive use projects that are not included in SRBC's database (e.g., agricultural use, small uses, grandfathered uses), SRBC estimated that the maximum potential consumptive use in 2005 was 883 mgd. SRBC further estimated that maximum potential consumptive use would increase to 1,202 mgd in 2025. Table 1-2 summarizes SRBC's estimate of the portion of consumptive use for which mitigation is currently provided and the portion for which mitigation is not currently available or will not be available if future mitigation is not provided.

Consumptive use mitigation during a drought is required from SRBC's water supply storage when flow in the Susquehanna River drops under a low flow threshold called the "trigger" value. Although there is no trigger value specified in SRBC's regulations, a Q7-10 value has been used typically for this purpose since the 1970s. Commonly used at the time as a standard for low flow planning, the Q7-10 flow is the lowest average 7-day flow expected to occur at a 1-in-10-year frequency or, stated differently, expected to have a 10 percent chance of occurring in any year, on average. However, the basis for the standard is the assimilation of wastewater discharges to protect water quality; it does not address the protection of aquatic habitat or other riparian needs.

[1]A passby flow is a prescribed quantity of flow that must be allowed to pass a prescribed point downstream from a water supply intake at any time during which a withdrawal is occurring. When the natural flow is equal to, or less than, the prescribed passby flow, no water may be withdrawn from the water source, and the entire natural flow shall be allowed to pass the point of withdrawal. (SRBC Policy No. 2003-01)

Table 1-2 Consumptive Use Mitigation Requirements

Time Period	Consumptive Use (mgd)				
	Total	Exempt from Mitigation Requirements	Mitigation Required	Mitigation Provided	Remaining Need for Mitigation
2005	882.5	313.6	568.9	452.2	116.7
Increase to 2025	319.7	42.0	277.7	4.1	273.6
2025	1,202.2	355.6	846.6	456.3	390.3

Source: (SRBC, 2008a)

SRBC uses U.S. Geological Survey (USGS) streamflow gauging stations at Harrisburg, Pennsylvania, and Wilkes Barre, Pennsylvania, to determine when river flow drops below the trigger value.

As summarized in the Consumptive Use Mitigation Plan (SRBC, 2008a), the Q7-10 threshold, however, has left several significant droughts unmitigated despite demonstrable impacts to the lower Susquehanna River Basin. In 1997, 1998, 1999, 2001, 2002, 2007, and 2010, one or more jurisdictions within the Susquehanna River Basin declared some level of drought condition, including drought emergency, in all or parts of the basin. Yet, in none of those years did river flow drop below the Q7-10 trigger flow at Harrisburg or Wilkes-Barre. While many industrial and commercial water uses had been approved by SRBC but were curtailed during droughts and public water suppliers were imposing mandatory restrictions on water usage in some years, no consumptive use mitigation occurred for the power plants on the Susquehanna mainstem.

An additional indicator that the Q7-10 threshold is limited in responding to low flow conditions can be observed in the frequent inability of the Conowingo Hydroelectric Station to meet the minimum release requirement specified in the facility's Federal Energy Regulatory Commission (FERC) license. The flows required below Conowingo Dam are higher and occur with greater frequency than Q7-10 flows. Consequently, there are instances when the Station, which has minimal storage in the Conowingo Pond above the dam, is responsible for protecting the lower Susquehanna River without the benefit of similar mitigation requirements in the 96 percent of the basin that lies upstream of Conowingo Pond. In fact, the Conowingo Hydroelectric Station needed and received variances from its FERC-mandated minimum release in 1999, 2001, 2002, 2005, and 2007 due to low river inflow into the Conowingo Pond (SRBC, 2008a).

In its 2006 Conowingo Pond Management Plan, SRBC recommended "investigation of the water supply storage owned by SRBC at the Federal Cowanesque and Curwensville Lakes projects for alternative operational strategies to provide more effective low flow augmentation, including benefits to the Conowingo Pond and instream resources below the dam" (SRBC, 2006). In its Consumptive Use Mitigation Plan, SRBC concluded:

> The Commission owns a combined 29,700 acre-feet of storage at the USACE's [U.S. Army Corps of Engineers'] Cowanesque and Curwensville projects, which can provide 95 mgd of flow augmentation for the purpose of mitigating downstream consumptive use. The existing reservoir operations include low flow releases equal to the consumptive use

> of several industrial facilities when a flow at the Wilkes-Barre and/or the Harrisburg USGS stream gages reaches a flow level of Q7-10, plus the designated consumptive use in the vicinity of the gages. These “trigger” flows occur infrequently and the Commission believes revised low flow operations, including greater and more frequent trigger flows at different locations, would be more effective in addressing the increasing consumptive use mitigation needs in the basin. An important component of the evaluation will be the assessment of potential in-lake impacts.

Subsequently, the SRBC Commissioners directed staff to implement the findings from the Consumptive Use Mitigation Plan.

Susquehanna River Basin Ecological Flow Management Study

SRBC and USACE jointly initiated the Susquehanna River Basin Ecological Flow Management Study in December 2008 (SRBC and USACE, 2009):

> The goal of the study is to gain an understanding of how the range of flows affects the aquatic ecosystem within the subwatersheds of the Susquehanna River Basin, with a particular emphasis on low flow conditions. The objective of the low flow management study is to provide essential information for use in considering long-term changes to flow release schemes for basin reservoirs, environmental restoration, flows to better sustain aquatic habitat, and conservation strategies to offset rising water demands.

As part of that study, The Nature Conservancy investigated ecosystem flow needs throughout the Susquehanna River Basin. Using SRBC’s monitoring data, including instream flow studies and extensive biological data for benthic (bottom-dwelling) macroinvertebrates (animals without backbones, such as worms, clams, and aquatic insects), The Nature Conservancy developed ecosystem flow recommendations to support ecologically sustainable water resource planning and management in the basin (The Nature Conservancy, 2010). The Nature Conservancy recommended maintaining different seasonal or monthly flow values depending on the flow scenario, stream size, and ecosystem specifics. The Nature Conservancy’s ecosystem flow findings for streams in the Susquehanna River Basin were used in the evaluation of revised operations for low flow augmentation releases from Cowanesque Lake to offset consumptive use and also benefit local downstream ecosystems.

Cowanesque Lake

Cowanesque Lake, which is owned and operated by the USACE is located in Tioga County, Pennsylvania, in the Chemung sub-basin of the Susquehanna River Basin (Figure 1-1). Cowanesque Dam is located on the Cowanesque River about 2.2 miles upstream from the confluence with the Tioga River near Lawrenceville, Pennsylvania. The USACE operates the Cowanesque Project in tandem with the Tioga-Hammond Project for the main purpose of providing flood protection for downstream communities along the Tioga, Chemung, and Susquehanna Rivers in south-central New York and northeastern Pennsylvania.

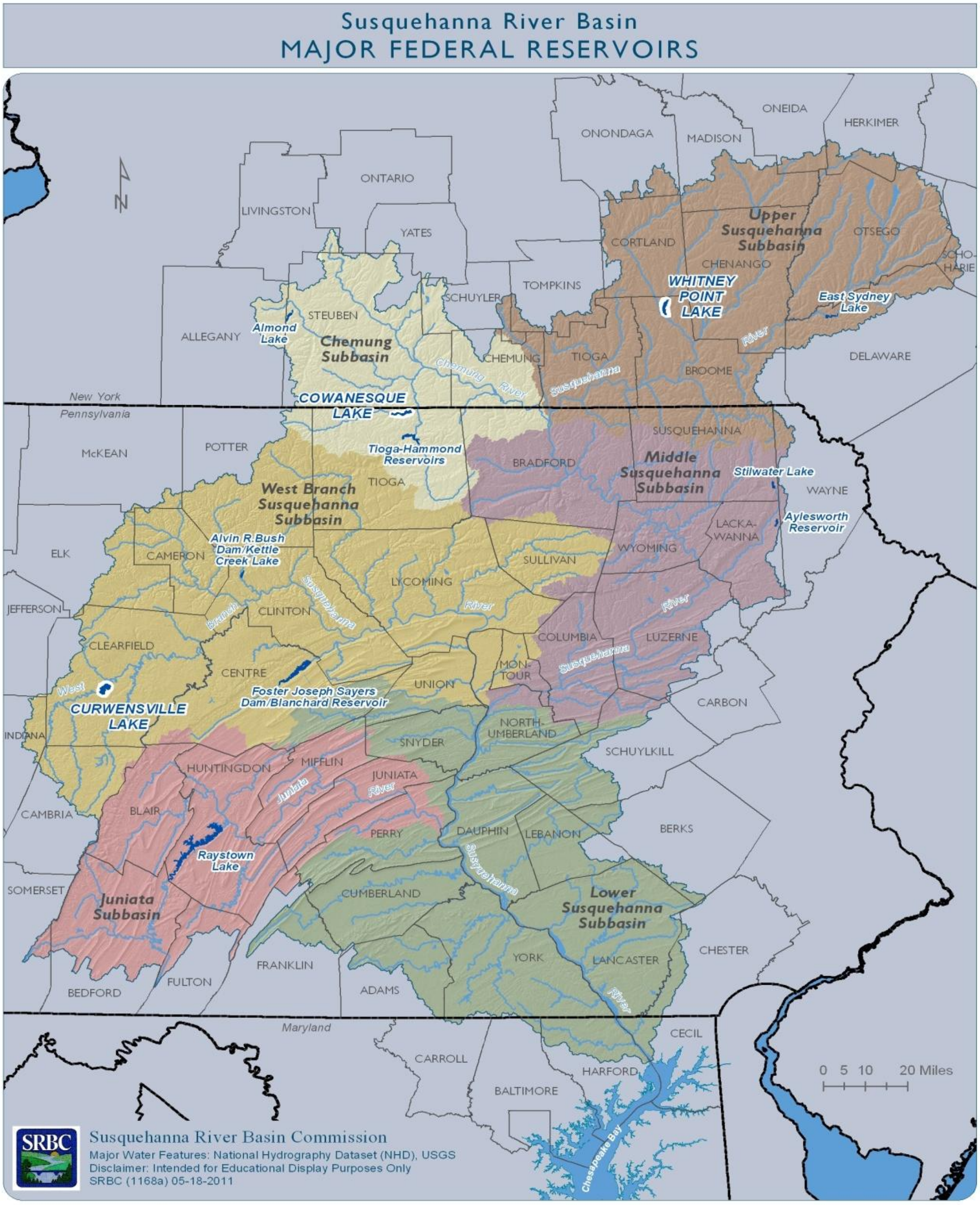

Figure 1-1 Watershed Map of Susquehanna River Basin

During the design phase of Cowanesque Lake, it was proposed that the lake also serve as a possible source for water supply. A short reconnaissance study was completed in 1972 that examined the hydrologic feasibility of storage reallocation at Cowanesque Lake for this purpose.

Reallocation of storage was not recommended prior to construction because no local sponsors wanted to assume non-federal costs for water supply storage. However, certain structural provisions in the dam and outlet tower were included during construction of Cowanesque Lake so as not to foreclose the opportunity for water supply storage in the future. USACE completed construction of the Cowanesque Project in 1980, and the normal summer pool elevation of 1045 feet[2] was reached in April 1981.

At the request of two electric generation facilities and SRBC, the USACE conducted a reformulation study to examine the feasibility of reallocating flood control storage to water supply storage at Cowanesque Lake (USACE, 1982). The two most important issues evaluated during the reformulation study were the retention of flood control capabilities and the use and availability of the recreation facilities. The reformulation study included the main report, an environmental impact statement satisfying USACE's requirement to comply with National Environmental Policy Act, and several technical reports. The study evaluated the impacts of raising the lake elevation for water supply storage, as well as the effects of water supply drawdowns on lake hydrology and hydraulics, water supply, water quality, recreation and natural resources, social and cultural resources, and economics. USACE concluded that raising the lake elevation for water supply storage would beneficially impact recreation, water quality, and warmwater fishery habitat in the lake and downstream. However, drawdowns due to water supply releases could result in "as much as 4 feet sometime during the recreation season (May to mid-September) approximately once in 10 years, exposing 80 acres of lake bottom. After the end of the prime recreation season, it is estimated that the drawdown could approach 10 feet later in the fall, exposing about 220 acres of lake bottom. The 'mudflats' associated with these drawdowns would be unsightly and detract from the quality of the aesthetic environments" (USACE, 1982).

A wildlife mitigation plan was recommended to mitigate for the inundation of existing terrestrial habitat. Existing day-use recreation facilities were moved to the current South Shore Day-Use recreation area, and new recreation facilities were recommended to accommodate increased visitation and overnight stay capabilities (USACE, 1982).

A general design memorandum was completed in 1985 (USACE ,1985). The memorandum described several modifications to the dam at Cowanesque Lake to support reallocation to water supply storage, including raising the lake level 35 feet from elevation 1045 feet to 1080 feet, modifying the intake tower, relocating and expanding the existing day-use recreation facilities, expanding the existing overnight-use recreation facilities, and implementing a wildlife mitigation plan. SRBC entered into an agreement with the USACE for water supply storage[3] at Cowanesque Lake in 1986 and, as the non-federal sponsor, provided 51 million dollars toward construction for water supply development and expanded recreation, which included a proportionate share of the project's original construction cost. Construction of these modifications was completed in the late 1980s, and the new normal pool level was reached in

[2] Topographic elevations in this report are referenced to the National Geodetic Vertical Datum (NGVD) of 1929.
[3]When the agreement was signed, water supply storage was estimated to be 24,355 acre-feet. Based on new bathymetry of the lake in 2010, water supply storage is now estimated to be 23,495 acre-feet. Sedimentation of the reservoir is thought to be responsible for the loss of storage volume.

May 1990 (Department of the Army and SRBC, 1986). Figure 1-2 shows the current facility layout.

At normal pool (1080 feet), the lake has a surface area of 1,050 acres, extends about 5 miles upstream from the dam, and stores 29,876 acre-feet[4] of water. The water stored at normal pool is designated conservation storage, and is allocated for USACE low flow regulation ("federal conservation storage"—6,377 acre-feet) and for SRBC's consumptive use mitigation ("water supply storage"—23,495 acre-feet). At normal pool, the lake also provides 54,871 acre-feet of vacant flood storage space.

With water supply storage available for consumptive use make-up, SRBC was able to provide compensation releases from Cowanesque Lake to industrial and municipal users. Due to the proximity of the industrial operations to Wilkes-Barre and Harrisburg, Pennsylvania, the U.S. Geological Survey (USGS) stream gage flow measurements at those locations were chosen to serve as indicators for initiating compensation releases. In accordance with SRBC policy at the time, the Q7-10 flow at the gages was defined as the flow level (i.e., "trigger") at which compensation releases would begin. SRBC policy also required that the compensatory water was to be available at the place of withdrawal at the time the observed river flow fell below the Q7-10 trigger and in an amount at least equal to the consumptive use. To help ensure that the compensatory water would offset the consumptive use, the trigger value was increased by a quantity equal to the consumptive use at the appropriate industrial operations.

Since completion of the storage reallocation project, limited water supply releases have been made two times at Cowanesque Lake: 1,280 acre-feet in 1991 and 2,630 acre-feet in 1995. The amount of water released during these two events is about 5 and 11 percent, respectively, of the total SRBC water supply storage.

1.2 PURPOSE AND NEED FOR THE PROPOSED ACTION

The purpose of the Proposed Action is to adopt a new low flow operation for Cowanesque Lake that will allow SRBC to use the water supply storage it owns to more effectively mitigate for consumptive water use in the Susquehanna River Basin. SRBC's objective is to further reduce the impact of human consumption on the natural flow regime and help protect and potentially improve the downstream environment during critical low flow events. The proposed action is necessary because SRBC believes its water supply storage at Cowanesque Lake can be used more effectively to mitigate for consumptive use. As explained in Section 1.1, the current low flow triggers set by the Q7-10 flow recorded at the Harrisburg or Wilkes-Barre streamflow monitoring gages are based on inadequate 1970s protocols, are believed to be insufficient for meeting ecosystem flow needs during low flow conditions, and have not triggered releases in the past during significant droughts.

The new low flow triggers would be consistent with recommendations in SRBC's 2008 Consumptive Use Mitigation Plan. The recommendations of The Nature Conservancy for desirable ecosystem flows in the Susquehanna River Basin are also a major consideration. Use of

[4] An acre-foot is the volume of water that would cover 1 acre of land 1 foot deep. One acre-foot is equal to 325,851 gallons.

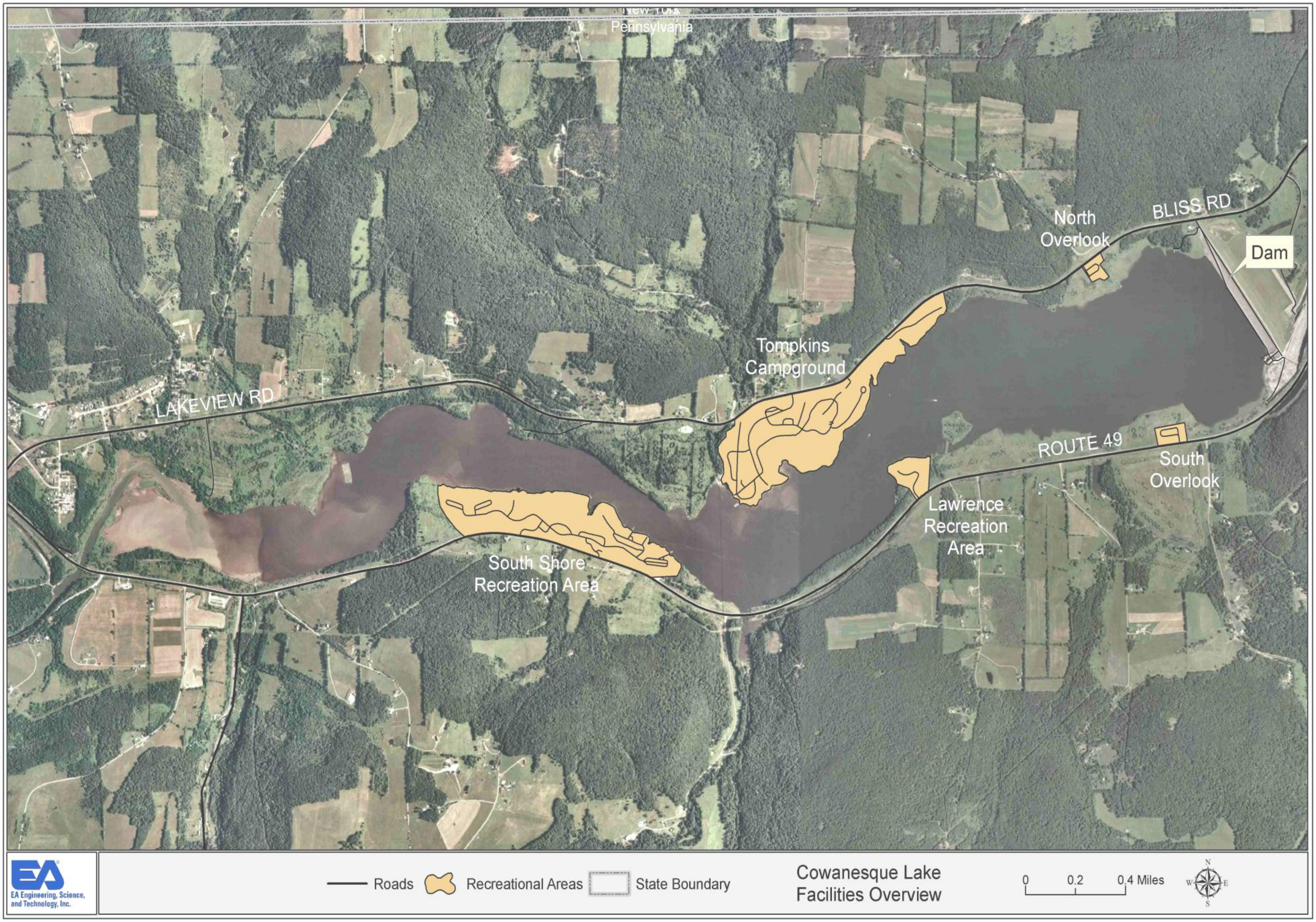

Figure 1-2 Site Layout Map

SRBC-owned water supply storage at Cowanesque Lake can thus be enhanced by meeting its consumptive use mitigation objective while providing benefit to the downstream aquatic ecosystem.

1.3 SCOPE OF THE INVESTIGATION

The purpose of this investigation is to evaluate the direct and indirect environmental and recreational impacts associated with potential modifications to low flow operations for water supply storage at Cowanesque Lake. As described further in Section 3, SRBC provided EA Engineering, Science, and Technology (EA) with the results of its hydrologic modeling of the current operation scenario and four alternative scenarios for operating the lake under low flow conditions. EA used those data to determine drawdown frequency, duration, and seasonality, and then used those analyses to evaluate the impacts of the five scenarios on the lake's natural features and its recreational use. Section 4 describes the existing natural environment and recreational use at Cowanesque Lake, and Section 5 describes the effects of the alternative scenarios on those features.

1.4 PUBLIC INVOLVEMENT

Cowanesque Lake is used heavily for recreation and, therefore, it is important to involve resource agencies and the public in the entire investigation process and subsequent implementation process. The public participation plan for this investigation included a public workshop to explain the history of the lake, its use as water supply storage, and the alternative scenarios being considered for triggering water supply releases from Cowanesque Lake.

SRBC sent public notices for the workshop to federal and state agencies and interested members of the public on June 3, 2011 (Appendix A). The workshop was held on June 28, 2011, at the Lawrenceville Fire Hall, Lawrenceville, Pennsylvania. Six members of the public attended.

Questions focused on water ownership, why changes to the trigger locations and values are being proposed, and the study process and post-study implementation.

- In response to a question regarding water ownership, SRBC staff explained that the water belongs to the people of the Commonwealth and that the riparian owners have certain rights. SRBC owns water supply storage in Cowanesque Lake but does not own the water.

- Another question focused on water releases and SRBC staff explained that water releases were being made on a continuous basis by USACE. USACE operates the dam with the objective of meeting the authorized project purposes while maintaining a stable pool elevation. A minimum flow from the dam of 15 cubic feet per second (cfs) is maintained. SRBC's requests for water supply releases are in addition to USACE releases.

- One attendee inquired why SRBC was investigating the change in trigger locations and trigger values at this time. SRBC staff explained that internally the changes have been considered since the early 2000s. SRBC explained further that there is better science now on the minimum flows needed to protect downstream aquatic ecosystems as well as an increase in consumptive use.

- Several questions were specific to the process surrounding the technical evaluation and post-study process. SRBC staff explained that the completed study will be submitted to USACE for review, and once a decision has been reached by USACE, it could take 2 to 3 years to implement the changes.

- One attendee inquired about the level of construction that will result from the proposed modifications. SRBC staff explained that the level of construction will be based on the required modifications and that will be determined by the evaluation.

- The final comments focused on the trigger locations. SRBC staff explained how the current trigger locations were identified and how the proposed locations were selected.

On August 4, 2011, SRBC also sent follow-up letters to several federal and state resource agencies requesting their comments on issues or concerns on modifications to low flow operations. The letter and the responses from the agencies are provided in Appendix A. The agency comments are addressed in the appropriate resource sections of this report.

2.0 PROPOSED ACTION

The proposed action would establish a new low flow operation plan for water supply releases at Cowanesque Lake that could offset consumptive use demands more effectively and provide potential benefit to downstream ecosystems. The proposed action would also identify the gaging station or stations that would be used to monitor river flow for application of the trigger flow. The proposed action will be selected from one of four action alternatives described in section 3 and evaluated in this investigation.

3.0 ALTERNATIVES

3.1 SUMMARY OF PREVIOUS SRBC ANALYSES

SRBC uses low flow triggers to implement water supply releases for consumptive use mitigation. The triggers are based on a low flow value as measured at a USGS gaging station. The following sections discuss the various trigger flow values and trigger locations considered by SRBC in its analysis.

Trigger Values

Prior to the investigation described in this report, SRBC developed and evaluated preliminary alternative trigger values based on historical annual and monthly streamflow statistics. Annual trigger values based on annual streamflow data would be constant year round, whereas seasonal trigger values would vary by month. SRBC evaluated a range of key flow statistics for trigger values, as summarized in Table 3-1.

Table 3-1 Alternative Trigger Flow Statistics

Statistic	Definition	Application Basis	
		Annual	Seasonal (Monthly)
Q7-10	7-day average low flow having a 10 percent chance of occurring in a given year or, on average, occurring once every 10 years	✓	
Q30-10	30-day average low flow having a 10 percent chance of occurring in a given year or, on average, occurring once every 10 years	✓	
P99	99th percentile monthly flow, which will be exceeded 99 percent of the time, on average; river flow would drop below P99 1 percent of the time, on average		✓
P97	97th percentile monthly flow, which will be exceeded 97 percent of the time, on average; river flow would drop below P97 3 percent of the time, on average		✓
P95	95th percentile monthly flow, which will be exceeded 95 percent of the time, on average; river flow would drop below P95 5 percent of the time, on average	✓	✓
P92	92nd percentile monthly flow, which will be exceeded 92 percent of the time, on average; river flow would drop below P92 8 percent of the time, on average	✓	✓
P90	90th percentile monthly flow, which will be exceeded 90 percent of the time, on average; river flow would drop below P90 10 percent of the time, on average	✓	✓
P83	83rd percentile monthly flow, which will be exceeded 83 percent of the time, on average; river flow would drop below P83 17 percent of the time, on average	✓	✓

For the seasonal trigger value analysis, SRBC determined from investigation of the historical flow records that the majority of low flow events occurred in August through October, which are also months with high rates of consumptive use. SRBC included P99 and P97 in the seasonal analysis because they are approximately the monthly counterparts of the Q7-10 and Q30-10, respectively, annual trigger values.

Trigger Locations

Each optional low flow trigger requires the identification of one or more streamflow gages that would be used to determine when consumptive use mitigation releases should occur. Currently, the trigger gages for Cowanesque Lake are located at Harrisburg and Wilkes-Barre—a water supply release would be triggered when the Q7-10 flow is reached at either location. Because SRBC is involved with the management and/or regulation of Conowingo Pond and a wide range of other facilities and projects based on the streamflow at Marietta, Pennsylvania, SRBC also identified this site as an alternative trigger location. Figure 3-1 shows these gage locations, and Table 3-2 shows the USGS gage number, drainage area, and when the daily streamflow record started for each trigger location. All gages have long-term continuous daily streamflow records.

Table 3-2 USGS Gage Number, Drainage Area, and Streamflow Record Start Date

	Wilkes-Barre	Harrisburg	Marietta
USGS Gage Number	01536500	01570500	01576000
Drainage Area (sq mi[a])	9,960	24,100	25,990
Record Start	1899	1891	1932

[a]sq mi = square miles

Table 3-3 shows the trigger flow in cubic feet per second associated with each of the statistical options at each of the gage locations options, as developed by SRBC in development of its hydrologic model discussed below.

Table 3-3 Alternative Trigger Flows

	Flow (cfs) at Wilkes-Barre Gage				Flow (cfs) at Harrisburg Gage			
		Seasonal				Seasonal		
Statistic	Annual	August	September	October	Annual	August	September	October
Q7-10	826	NA	NA	NA	2,631	NA	NA	NA
Q30-10	951	NA	NA	NA	3,070	NA	NA	NA
P99	NA	815	686	722	NA	2,880	2,210	2,320
P97	NA	892	795	885	NA	3,320	2,760	2,820
P95	1,280	970	860	970	4,150	3,620	3,100	3,240
P92	1,520	1,060	970	1,110	4,930	3,900	3,390	3,610
P90	1,670	1,090	1,040	1,170	5,460	4,120	3,520	3,750
P83	2,320	1,330	1,210	1,440	7,380	4,640	4,000	4,500

	Flow (cfs) at Marietta Gage			
		Seasonal		
Statistic	Annual	August	September	October
Q7-10	2,718	NA	NA	NA
Q30-10	3,313	NA	NA	NA
P99	NA	3,150	2,210	2,610
P97	NA	3,550	2,770	3,240
P95	4,730	3,870	3,100	3,750
P92	5,600	4,230	3,520	4,130
P90	6,080	4,460	3,790	4,320
P83	8,260	5,200	4,350	5,060

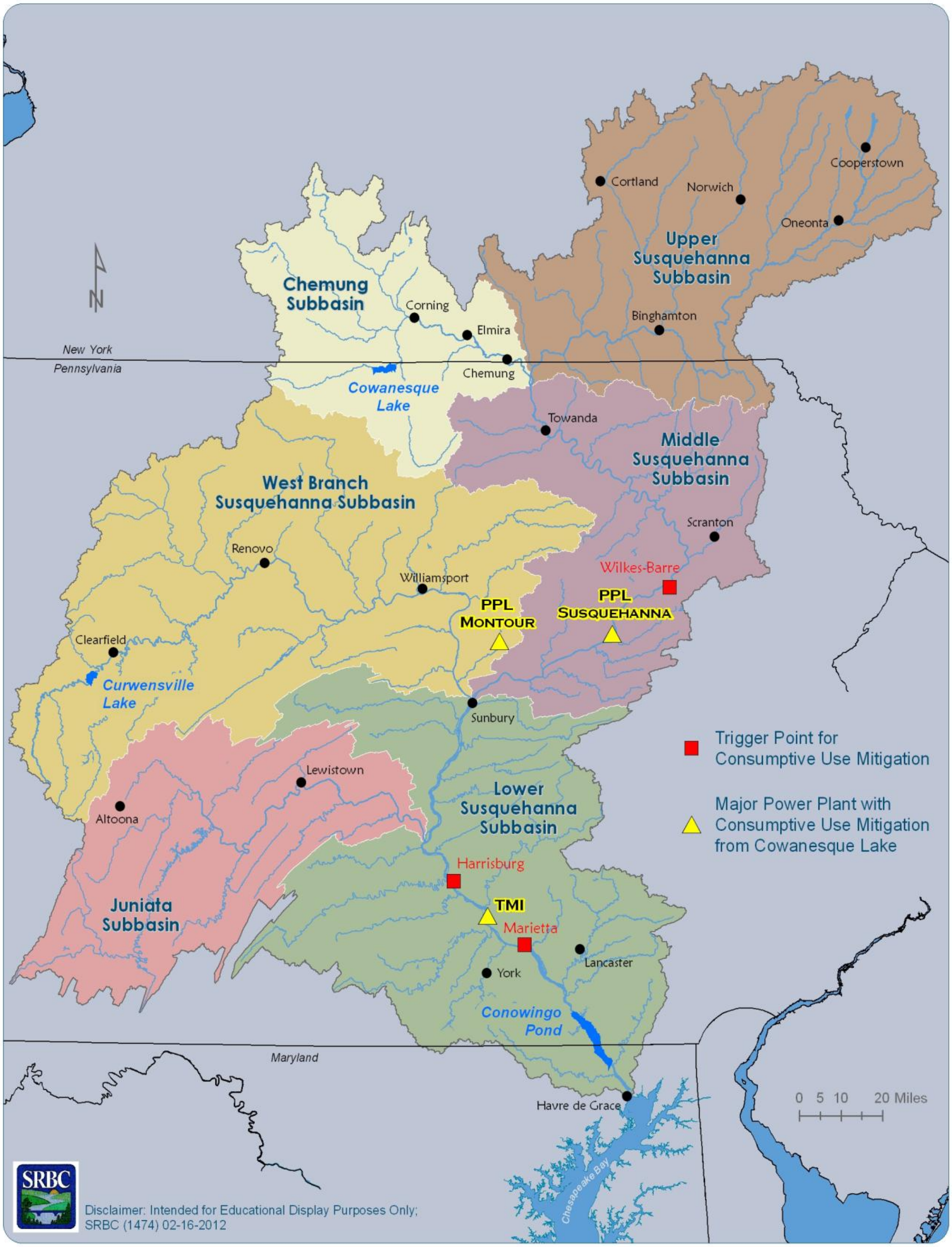

Figure 3-1 Trigger Locations in the Susquehanna River Basin

OASIS Model

To determine the hydrologic impact on Cowanesque Lake from these alternative trigger values and locations, SRBC used the Operational Analysis and Simulation of Integrated Systems (OASIS) model, which was initially developed by HydroLogics, Inc., in the 1970s and is now used to model watershed basins covering 15 percent of the U.S. population. SRBC previously used and verified the model to develop the Conowingo Pond Management Plan. For the analysis of Cowanesque Lake, SRBC ran the OASIS model to simulate the hydrology of the basin based on specific trigger locations, trigger values, and consumptive use needs locally and basinwide. The primary data inputs into the model included time series flow data (annual or seasonal) and operational rules for the reservoirs, streamflows, and delivery to meet demand. The primary time series data are inflows at nodes in the model network and include historical records from January 1, 1930, through December 31, 2007. A review of flow data for 2008 through 2011 determined that there were no low flow events in these 4 years that would have triggered the use of the water supply storage. The primary outputs from the model include daily time series of either USACE conservation releases or SRBC water supply releases from Cowanesque Lake, lake levels, SRBC water supply storage volume, and USACE conservation storage volume.

Alternatives Screening

SRBC initially identified 43 different plans for model simulation. The plans differed by trigger location, trigger value, type of trigger (annual or seasonal), and amount of consumptive use mitigation flow considered. SRBC screened the 43 plans down to 12 plans using five criteria: hydrology, reservoir storage, SRBC's emphasis on using seasonal (monthly) hydrologic analyses, SRBC's experience with historical Q7-10 occurrences, and environmental or recreational impacts. SRBC then evaluated the outputs from the OASIS model for each of these 12 plans to determine environmental and recreational effects. Six plans with trigger flows of P92 and P90 were dropped from further consideration because they had significant adverse recreation impacts and significant or moderate adverse environmental impacts, and they also did not meet one or more of SRBC's low flow management objectives. Two additional plans were dropped from further consideration because they would not meet current and important consumptive use mitigation needs for the major power plants located downstream in the basin. The remaining four plans are the optional trigger alternatives evaluated in this report.

3.2 ALTERNATIVES EVALUATED

Description of Alternatives

The four plans remaining after the SRBC screening process plus the current operating procedure (the "Baseline Alternative") are evaluated as alternatives in this report. The Baseline Alternative incorporates the current trigger components—Q7-10 as estimated with Wilkes-Barre or Harrisburg gage records. The other four alternatives incorporate future potential operating scenarios based on different trigger values—seasonal P95 or seasonal P97—and trigger gage locations—Wilkes-Barre/Harrisburg or Marietta. The following list summarizes the five alternatives evaluated here:

Alternative	Trigger Value	Gage Location
Baseline	Q7-10 (annual)	Wilkes-Barre or Harrisburg
WBH97	P97 (seasonal)	Wilkes-Barre or Harrisburg
WBH95	P95 (seasonal)	Wilkes-Barre or Harrisburg
M97	P97 (seasonal)	Marietta
M95	P95 (seasonal)	Marietta

Table 3-4 summarizes the primary parameters that define the Baseline Alternative and the four new alternatives evaluated in the study. Water supply releases in the OASIS model are simulated based on these parameters to examine the difference among alternatives.

The water supply releases from Cowanesque Lake are meant to help offset, to the greatest extent possible, the downstream ecosystem impacts caused by human activities consumptively using water. These releases are not intended to maintain or augment natural stream flows which can continue to drop during dry conditions, but to reduce man's impact to natural flows. For the Baseline Alternative, water supply releases at Cowanesque Lake are triggered by the Q7-10 value at the Wilkes-Barre and/or Harrisburg gages and are based on hydrologic analyses of annual flow records. When daily stream flow at the Wilkes-Barre gage is below Q7-10, water supply releases will be made in the amount of 58 cfs plus a surcharge flow (20 cfs for the first 3 days) and a transit loss flow (5 cfs continuously). If the stream flow at the Harrisburg gage is below Q7-10, water supply releases will be made in the amount of 22 cfs plus a surcharge flow (35 cfs for the first 3 days) and a transit loss flow (5 cfs continuously). If both Harrisburg and Wilkes-Barre flows are below the corresponding Q7-10 value, the water supply release would be the sum of the releases triggered by individual gages and shall be 125 cfs if the sum is greater than 125 cfs. The discharge rates were established for the current water supply operations and are in addition to minimum conservation flow releases made by USACE as part of their normal operations. The discharge rates were changed for the new alternatives by eliminating surcharge and transit loss flows as discussed below.

It is recognized that releases made at Cowanesque Lake would not reach Wilkes-Barre or Harrisburg for several days. However, releases from Cowanesque Lake would help offset consumptive uses in the Chemung and Upper Susquehanna Subbasins before reaching Wilkes-Barre and Harrisburg. Thus, the specific travel times for the releases to reach the trigger locations have not been considered in this study.

The water supply release operations for the four new alternatives are based on monthly trigger flows of P95 or P97 derived from hydrologic analyses of monthly, rather than annual, flow records at the trigger locations shown in Table 3-4. For example, Alternative WBH95 is set to release water when daily flow at the Wilkes-Barre and/or Harrisburg gages is below the corresponding monthly P95 value for August, September, and/or October. The months of August-October are considered the critical low flow period which coincides with high consumptive use in the basin. Since a portion of some critical low flow events can occur in July and November, trigger values were also established for these 2 months as a safeguard. The August trigger value is also used for July and the October trigger value is also used for November. If releases are triggered at Wilkes-Barre, the release amount would be 58 cfs and if the trigger location is Harrisburg, the release amount would be 22 cfs. If flows at both locations are below trigger values, the release amount would be 80 cfs. If releases are triggered at Marietta (alternatives M97 and M95), the release amount would be 80 cfs. Surcharge flows are not included for

Table 3-4 Water Supply Operations for Cowanesque Lake Alternatives

Parameter	Baseline	Alternative WBH97	Alternative WBH95	Alternative M97	Alternative M95
Trigger locations	Wilkes-Barre and/or Harrisburg	Wilkes-Barre and/or Harrisburg	Wilkes-Barre and/or Harrisburg	Marietta	Marietta
Trigger flows (see Table 3-3 for values)	Q7-10 value as year-round constant	P97 value for the current month	P95 value for the current month	P97 value for the current month	P95 value for the current month
Months considered for water supply releases	Year-round	July through November	July through November	July through November	July through November
Amount of water supply release	58 cfs if triggered by Wilkes-Barre; 22 cfs if triggered by Harrisburg; 80 cfs if triggered by both(1)	Same as Baseline (2)	Same as Baseline(2)	80 cfs	80 cfs
Surcharge release	First 3 days - 20 cfs if triggered at Wilkes-Barre or 35 cfs if triggered at Harrisburg(1)	None(2)	None(2)	None(2)	None(2)
Transit loss release	5 cfs continuously(1)	None(2)	None(2)	None(2)	None (2)
Corps' conservation flow release	15 cfs	15 cfs	15 cfs	15 cfs	15 cfs
Water supply release starts when stream flow is:	Below Q7-10+58 cfs at Wilkes-Barre and/or Q7-10+22 cfs at Harrisburg	Below P97+58 cfs at Wilkes-Barre and/or P97+22 cfs at Harrisburg	Below P95+58 cfs at Wilkes-Barre and/or P95+22 cfs at Harrisburg	Below P97+80 cfs at Marietta	Below P95+80 cfs at Marietta
Water supply release stops when stream flow is: (unless storage is depleted first)	Above Q7-10+58 cfs at Wilkes-Barre and/or Q7-10+22 cfs at Harrisburg for 3 consecutive days or is more than twice Q7-10 on any day.	Above P97+58 cfs at Wilkes-Barre and/or P97+22 cfs at Harrisburg for 3 consecutive days or is more than twice P97 on any day.	Above P95+58 cfs at Wilkes-Barre and/or P95+22 cfs at Harrisburg for 3 consecutive days or is more than twice P95 on any day.	Above P97+80 cfs for 3 consecutive days or is more than twice P97 on any day.	Above P95+80 cfs at Marietta for 3 consecutive days or is more than twice P95 on any day.
Reservoir storage: 1. Water supply 2. Corps conservation	 23,495 acre-feet 6,375 acre-feet	 23,495 acre-feet 6,375 acre-feet	 23,495 acre-feet 6,375 acre-feet	 23,495 acre-feet 6,375 acre-feet	 23,495 acre-feet 6,375 acre-feet

Notes: (1) For the Baseline, if the sum of the amount of water supply release, surcharge, and transit loss is greater than 125 cfs when triggered by both locations, the release shall be a maximum of 125 cfs.

(2) Water supply release rates do not include surcharge or transit flow losses and shall be a maximum of 80 cfs.

the four new alternatives because a slight decrease in travel time to a specified downstream location for flow releases is deemed not nearly as significant as compared to the value of preserving reservoir storage to offset additional consumptive use. Transit loss flow is considered unnecessary because losses due to evaporation or other causes are judged to be incidental.

The amount of water supply storage available for use at Cowanesque Lake is the same for the Baseline Alternative and all new alternatives considered. Based on surveys done in 2010, the storage available is 23,495 acre-feet.

3.3 SUMMARY OF SRBC MODELING DATA

The following sections provide a summary of previous SRBC analyses, discuss the alternatives evaluated in this report, and summarize the modeling data.

SRBC provided the modeling output data for the five alternatives to be considered in this analysis. Those data are summarized in this section to illustrate the different effects the alternatives would have on Cowanesque Lake, especially as it relates to drawdown and resulting lake level. The results for the Baseline Alternative reflect lake conditions that would have occurred over the 78-year modeling period (1930 through 2007) if the lake had been in existence for that full period and if the current trigger components were used to guide operation of the lake. The results of the four optional trigger alternatives show how the lake would have been affected if the alternative trigger value and/or location were in effect during the modeling period.

As its name implies, the Baseline Alternative represents SRBC's current operating guidelines and lake conditions that would occur in the future if those guidelines were strictly adhered to and did not change. The four optional trigger alternatives represent future lake conditions that would occur if the operating guidelines are changed. In this section and in Section 5, the conditions under the four optional trigger alternatives are compared to the Baseline Alternative to illustrate the lake level changes that would occur if the operating guidelines were changed. The following sections discuss the modeling data for the full period of record and the recreation season (May 20 through September 14).

Modeling Data for Full Period of Analysis

Figures 3-2 through 3-4 show the model's simulated minimum lake level, storage, and surface area in each year over the 78-year modeling period for the Baseline and four optional trigger alternatives. (Note: The overlap of much of the curves demonstrates the similarities in conditions among the alternatives. Annual plots of simulated lake levels in Appendix B1 provide greater resolution of the differences between the alternatives.) As discussed in more detail in Section 4.1, both USACE conservation releases and SRBC water supply releases contribute to lake level drawdowns. During prolonged droughts, lake levels would typically rise to more normal conditions each year in the winter/spring, but then drop again to a minimum level in the summer/fall. For several years in the 78-year modeling period, the minimum lake elevation occurred in January and was determined to be residual drawdown from the event starting in the previous year. For example, under all of the alternatives, the minimum lake elevation in 1965 occurred in January and as such, these levels are considered to be part of the 1964 drawdown event, which started in August of 1964; the minimum lake elevation for 1965 was determined to be the lowest lake elevation that occurred after the lake had returned to its normal elevation from the 1964 event. During the 1930 drawdown event, the minimum lake level occurred in January 1931. For this analysis, this level was considered to be the minimum lake level for 1930 and not 1931.

For further illustration of the annual variations among the plans, see Appendix B1, which contains graphs showing lake level throughout the year for each year in which there was a drawdown. Figures 3-2 through 3-4 show the effects on the lake for extreme drought events like those that occurred in 1930-1932 and 1962-1966. As shown in Table 3-5, maximum drawdown is essentially the same, 44.7-44.9 feet, for all alternatives except for M97, which has a maximum drawdown that is about 9 feet less than the Baseline.

Table 3-5 Simulated Maximum Drawdown for the Five Alternatives

Alternative	Maximum Drawdown (ft)	Additional Drawdown Relative to Baseline (ft)
Baseline	44.7	—
WBH97	44.9	0.2
WBH95	44.8	0.1
M97	36.1	-8.6
M95	44.8	0.1

Table 3-6 summarizes SRBC's model output data for number of years over the modeling period when the lake would be drawn down. Over the 78-year modeling period, the two P97 alternatives would result in drawdown in 4 or 5 more years than Baseline, and the two P95 alternatives would have 10 or 11 more years with drawdown than Baseline. This pattern occurs because the P95 trigger value is higher than the P97 trigger value; river flow would drop to the P95 value more frequently, thereby triggering water supply storage releases more frequently. Similarly, the P97 value is higher than the Q7-10 trigger value (Baseline Alternative) and would trigger more frequent releases than Q7-10.

Table 3-6 Simulated Number of Years with Drawdown for the Entire Modeling Period

Alternative	No. of Years with Drawdown	No. of Additional Years with Drawdown Relative to Baseline
Baseline	32	—
WBH97	37	5
WBH95	42	10
M97	36	4
M95	43	11

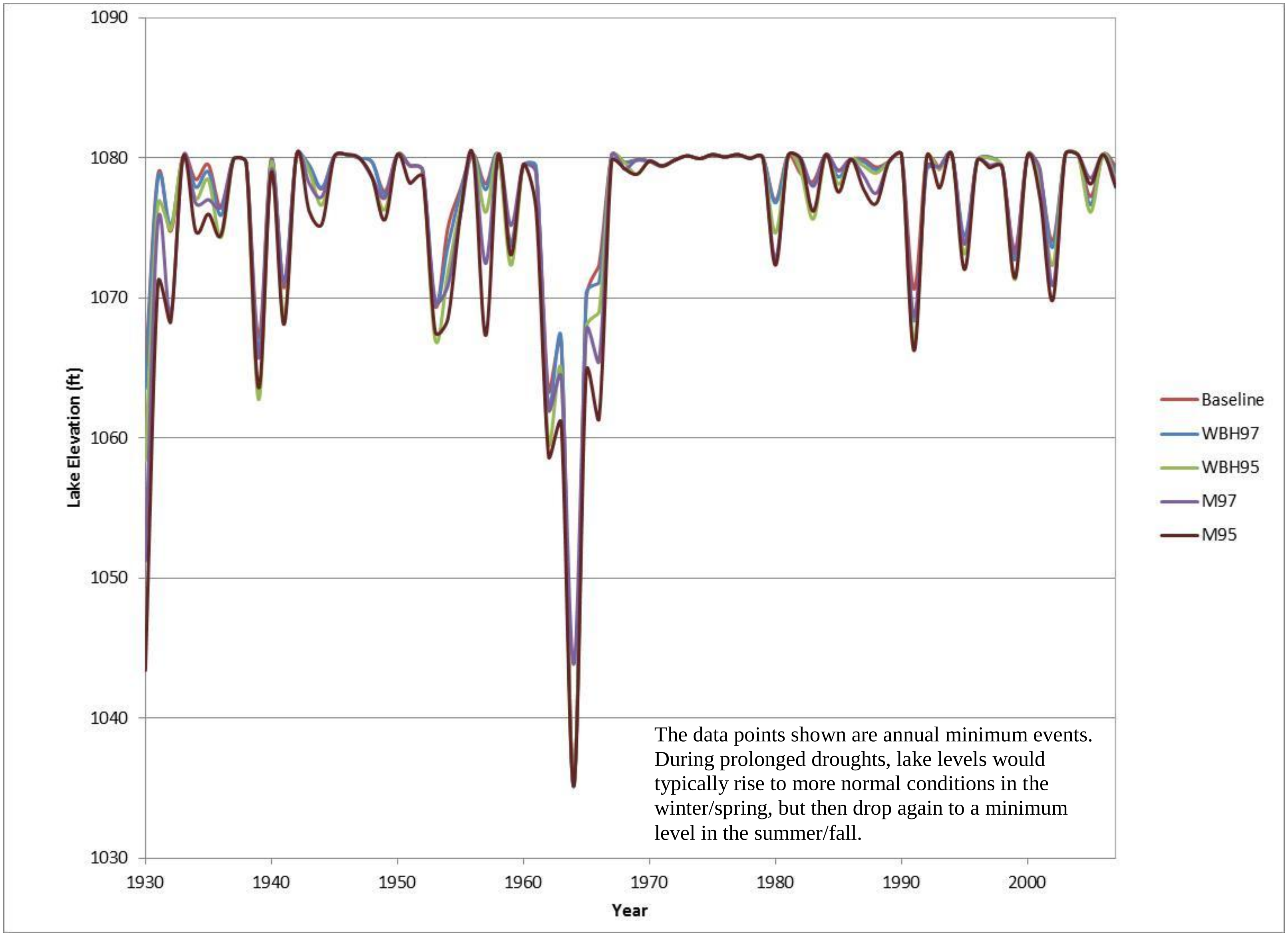

Figure 3-2 Simulated Minimum Lake Level in Each Year in 78-Year Modeling Period, 1930-2007

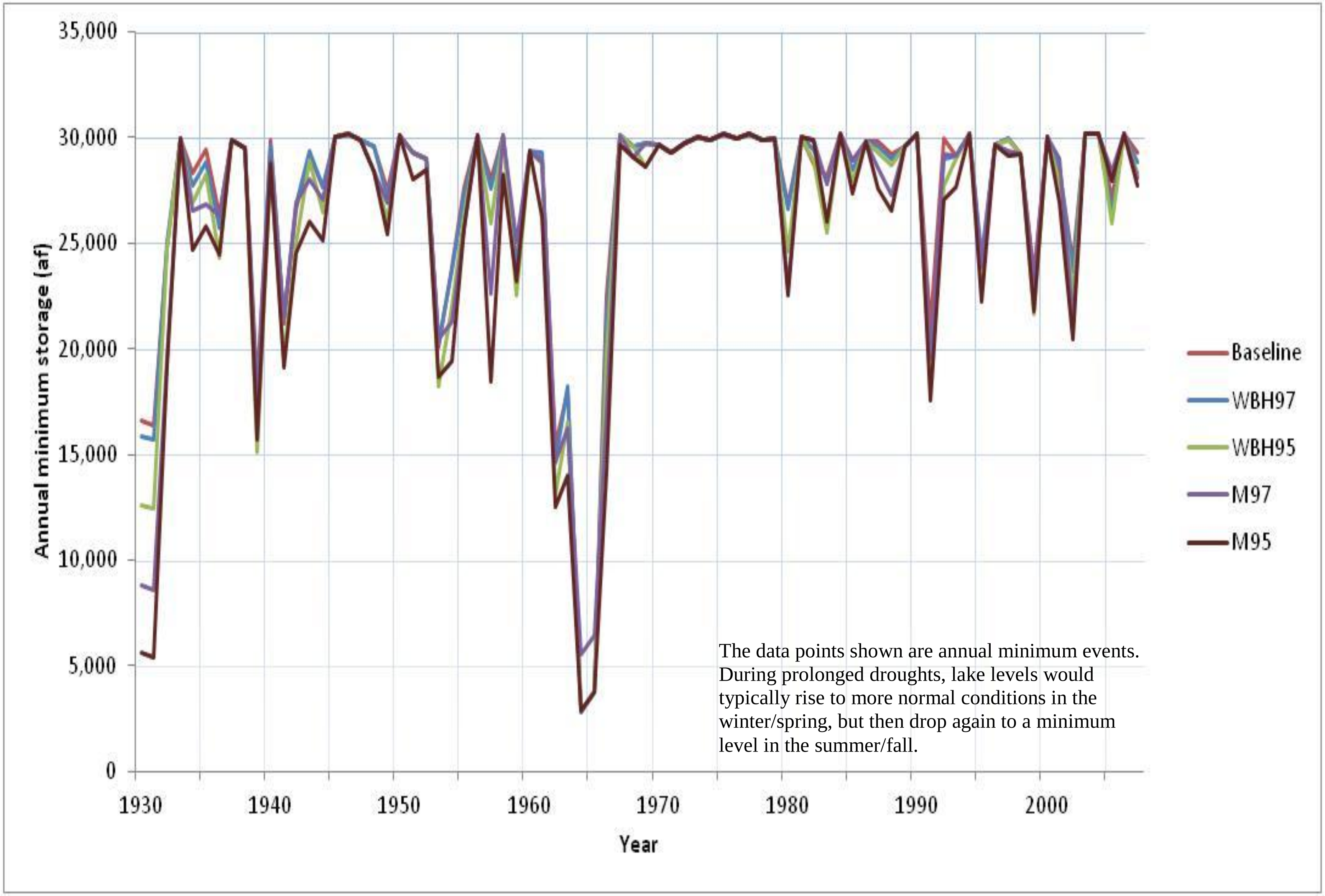

Figure 3-3 Simulated Minimum Lake Storage in Each Year in 78-Year Modeling Period, 1930-2007

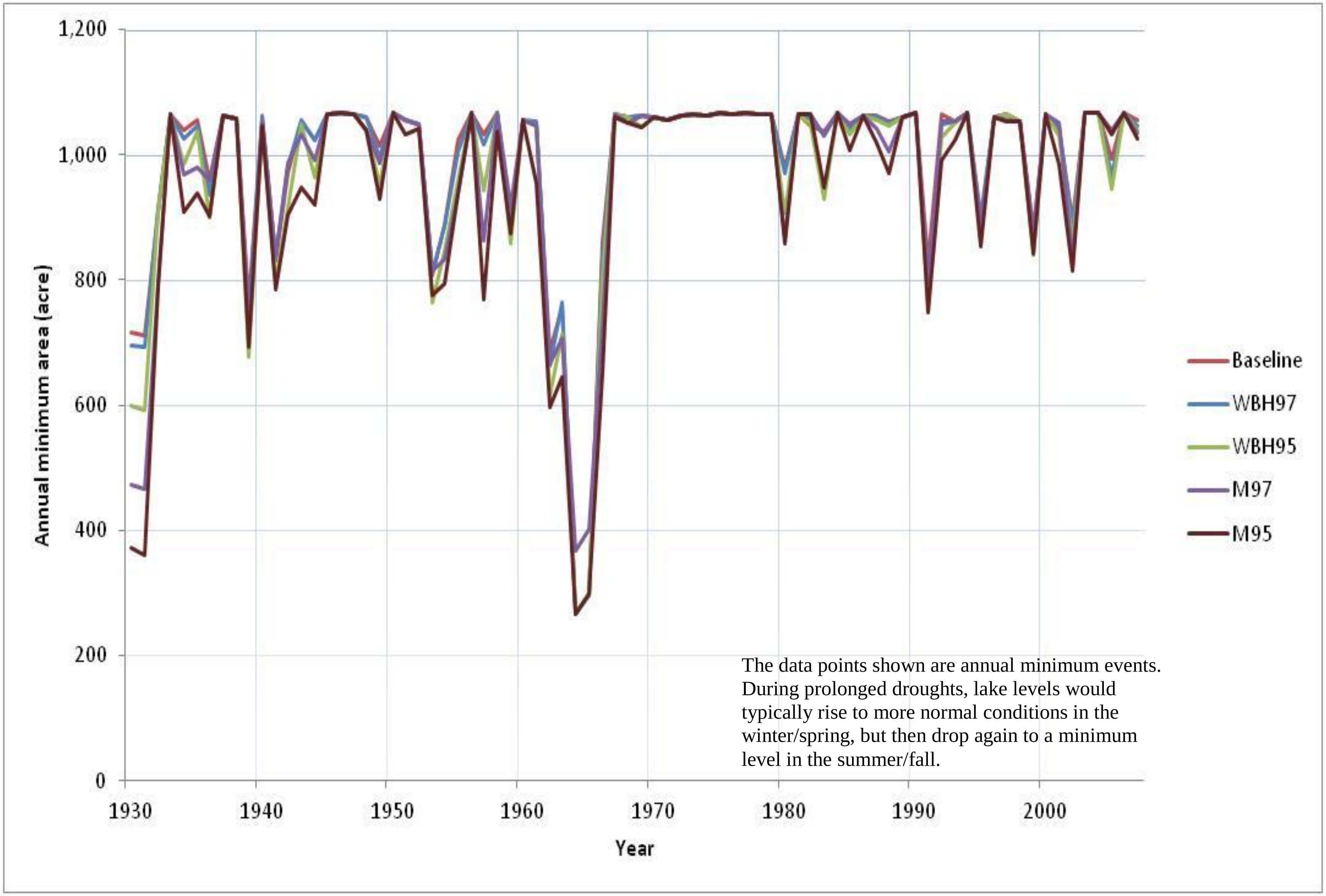

Figure 3-4 Simulated Minimum Lake Area in Each Year in 78-Year Modeling Period, 1930-2007

“The [USACE’s] Water Control Plan[, section 8-04,] for Cowanesque Lake includes regulation to maintain a normal pool elevation of 1080 feet, which creates a pool of 1,040 acres. The regulating objective for recreation is to maintain the pool within plus or minus 1 foot of 1080 feet. This fluctuation would have no effect on recreational operations (USACE, 2005).” Based on this assumption, SRBC’s model output data in Table 3-6 were reevaluated to determine how many years an SRBC release would contribute to a drawdown greater than 1 foot. Table 3-7 summarizes SRBC’s model output data for the number of years and days over the modeling period when SRBC releases would have contributed to a drawdown greater than 1 foot.

Table 3-7 Simulated Number of Years with Drawdown Greater than 1 Foot for the Entire Modeling Period

Alternative	No. of Years with Drawdown >1 ft	No. of Additional Years with Drawdown >1 ft Relative to Baseline
Baseline	28	—
WBH97	28	0
WBH95	34	6
M97	32	4
M95	40	12

Tables 3-8 and 3-9 further summarize SRBC’s model output data for number of years and days over the modeling period when the lake would be drawn down in selected drawdown intervals related to recreational use.

Table 3-8 Simulated Number of Years with Maximum Drawdown within Selected Drawdown Intervals for the Entire Modeling Period

	No. of Years with Maximum Drawdown of:							
	1-3 ft		3-5 ft		5-10 ft		>10 ft	
Alternative	Total	Additional Years Relative to Baseline	Total	Additional Years Relative to Baseline	Total	Additional Years Relative to Baseline	Total	Additional Years Relative to Baseline
Baseline	11	—	2	—	9	—	6	—
WBH97	9	-2	4	2	8	-1	7	1
WBH95	9	-2	7	5	8	-1	10	4
M97	10	-1	5	3	7	-2	10	4
M95	11	0	8	6	7	-2	14	8

Table 3-9 Simulated Number of Days with Maximum Drawdown within Selected Drawdown Intervals for the Entire Modeling Period

Alternative	No. of Days with Maximum Drawdown of: 1-3 ft Total	1-3 ft Additional Days Relative to Baseline	3-5 ft Total	3-5 ft Additional Days Relative to Baseline	5-10 ft Total	5-10 ft Additional Days Relative to Baseline	>10 ft Total	>10 ft Additional Days Relative to Baseline
Baseline	962	—	449	—	817	—	455	—
WBH97	992	30	415	-34	887	70	544	89
WBH95	872	-90	721	272	760	-57	887	432
M97	909	-53	464	15	952	135	764	309
M95	1,096	134	753	304	844	27	1,156	701

Figure 3-5 depicts the drawdown frequency over the entire period of record considered for Baseline and the four optional trigger alternatives. This graph demonstrates that about 82 percent of the time (i.e., to the right of the 17.5 percent line on the graph), the lake level is at normal pool elevation (1080 feet) or higher under all five alternatives, and there is no difference in lake level among the five alternatives. For the other 18 percent of the time, drawdown frequency under Alternative WBH97 would be similar to the Baseline Alternative, drawdown frequency would increase (relative to the Baseline) by about 1 to 2 percent under Alternatives WBH95 and M97, and drawdown frequency (relative to the Baseline) would increase by about 1 to 4 percent under Alternative M95.

Drawdown frequency is also summarized in Table 3-10 by the average frequency (percentage of days) that the lake elevation is within a given drawdown range.

In addition to the depth and frequency of drawdown, the duration of the drawdown is important to the evaluation of impacts in Section 5. Table 3-11 summarizes modeling data for average drawdown and the two longest drawdown events. Average drawdown durations for alternatives WBH95, M97, and M95 are 1-3 days shorter than average duration for the Baseline Alternative. Average drawdown for Alternative WBH97 is less than 4 days longer than the Baseline Alternative. Drawdown duration during the 1964 Event exceeds the Baseline Alternative by at least 8 days in all but one of the four optional trigger alternatives. Drawdown depth during the 1964 Event is roughly the same as the Baseline Alternative in all but one of the four optional trigger alternatives. Alternative M97 exhibits a decrease in both drawdown and duration during the 1964 Event relative to the Baseline Alternative.

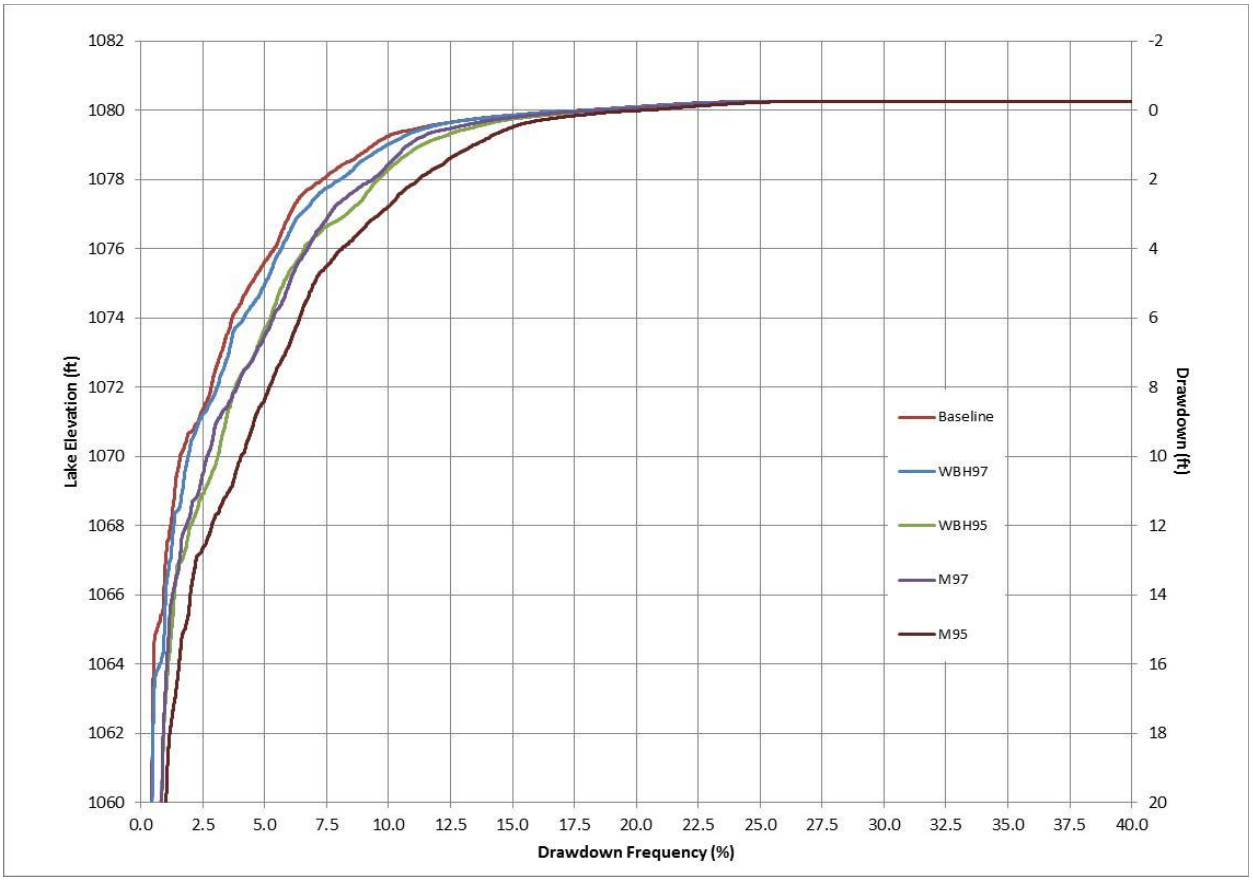

Figure 3-5 Simulated Drawdown Frequency Curve for Cowanesque Lake for the Entire Modeling Period

Table 3-10 Simulated Drawdown Frequency for Selected Drawdown Intervals for the Entire Modeling Period

Alternative	Frequency (% of Days) with Maximum Drawdown of:							
	1-3 ft		3-5 ft		5-10 ft		>10 ft	
	%[(a)]	Increased Percentage Relative to Baseline	%	Increased Percentage Relative to Baseline	%	Increased Percentage Relative to Baseline	%	Increased Percentage Relative to Baseline
Baseline	6.1	—	4.5	—	1.6	—	0.8	—
WBH97	6.5	0.4	5.0	0.6	1.9	0.3	1.0	0.2
WBH95	8.4	2.3	5.8	1.3	3.1	1.5	1.6	0.8
M97	7.7	1.6	6.0	1.5	2.7	1.1	1.3	0.5
M95	9.7	3.5	7.0	2.4	4.1	2.4	2.0	1.2

[(a)] The percentage shown in the table is for the maximum drawdown in the range.

Table 3-11 Simulated Average Drawdown Duration and Drawdown Duration for the Two Longest Drawdown Events, 1930 and 1964

Alternative	Average Drawdown Duration (days)	1964 Drawdown Event[(a)]		1930 Drawdown Event[(b)]	
		Max. Drawdown (ft)	Duration (days)	Max. Drawdown (ft)	Duration (days)
Baseline	95.8	44.7	218	15.3	230
WBH97	99.2	44.9	226	16.4	230
WBH95	95.3	44.8	235	21.6	232
M97	94.0	36.1	212	28.7	234
M95	93.0	44.8	228	36.6	235

[(a)]The 1964 event year refers to an event that began in fall of 1964 and lasted until 1965.
[(b)]The 1930 event year refers to an event that began in fall of 1930 and lasted until 1931.

Unlike the 1964 Event where duration was the key difference among the alternatives, the 1930 drawdown event exhibits a much wider disparity in magnitude of drawdown between the Baseline Alternative and the four optional trigger alternatives. Drawdown duration remains relatively the same in all of the five alternatives.

Modeling Data for the Recreation Season

Because of the importance of the lake for recreation use, SRBC also provided modeled results for the recreation season, defined as May 20 through September 14. Tables 3-12 and 3-13 summarize SRBC's model output data for number of years and days when the lakes would be drawn down in selected drawdown intervals during the recreation season.

Figure 3-6 shows the drawdown frequency for the recreation season only. This graph demonstrates that 77 percent of the recreation season (i.e., to the right of the 22.5 percent line on the graph), the lake level is at normal pool elevation (1080 feet) or higher under all five alternatives. For 85 percent of the recreation season, there is no difference in lake level among the five alternatives, and the lake level is at most drawn down about ½ foot. For the other 15 percent of the season, drawdown frequency under Alternative WBH97 would increase about 1 percent in comparison to the Baseline Alternative, drawdown frequency would increase by about another 1 percent under Alternatives WBH95 and M97, and drawdown frequency would increase by another 1-2 percent under Alternative M95. Drawdown frequency during the recreation season is also summarized in Table 3-14 by the average frequency (percentage of days) that the lake elevation is within a given drawdown range.

Table 3-12 Simulated Number of Years with Maximum Drawdown within Selected Drawdown Intervals for the Recreation Seasons in the Modeling Period

	No. of Years with Maximum Drawdown of:							
	1-3 ft		3-5 ft		5-10 ft		>10 ft	
Alternative	Total	Additional Years Relative to Baseline	Total	Additional Years Relative to Baseline	Total	Additional Years Relative to Baseline	Total	Additional Years Relative to Baseline
Baseline	10	—	5	—	7	—	2	—
WBH97	8	-2	5	0	8	1	3	1
WBH95	8	-2	8	3	6	-1	5	3
M97	7	-3	6	1	8	1	5	3
M95	10	0	6	1	9	2	6	4

Table 3-13 Simulated Number of Days with Maximum Drawdown within Selected Drawdown Intervals for the Recreation Seasons in the Modeling Period

	No. of Days with Maximum Drawdown of:							
	1-3 ft		3-5 ft		5-10 ft		>10 ft	
Alternative	Total	Additional Days Relative to Baseline	Total	Additional Days Relative to Baseline	Total	Additional Days Relative to Baseline	Total	Additional Days Relative to Baseline
Baseline	400	—	179	—	162	—	19	—
WBH97	409	9	175	4	228	66	31	12
WBH95	382	-18	250	71	237	75	68	49
M97	392	-8	228	49	247	85	51	32
M95	480	80	298	119	268	106	84	65

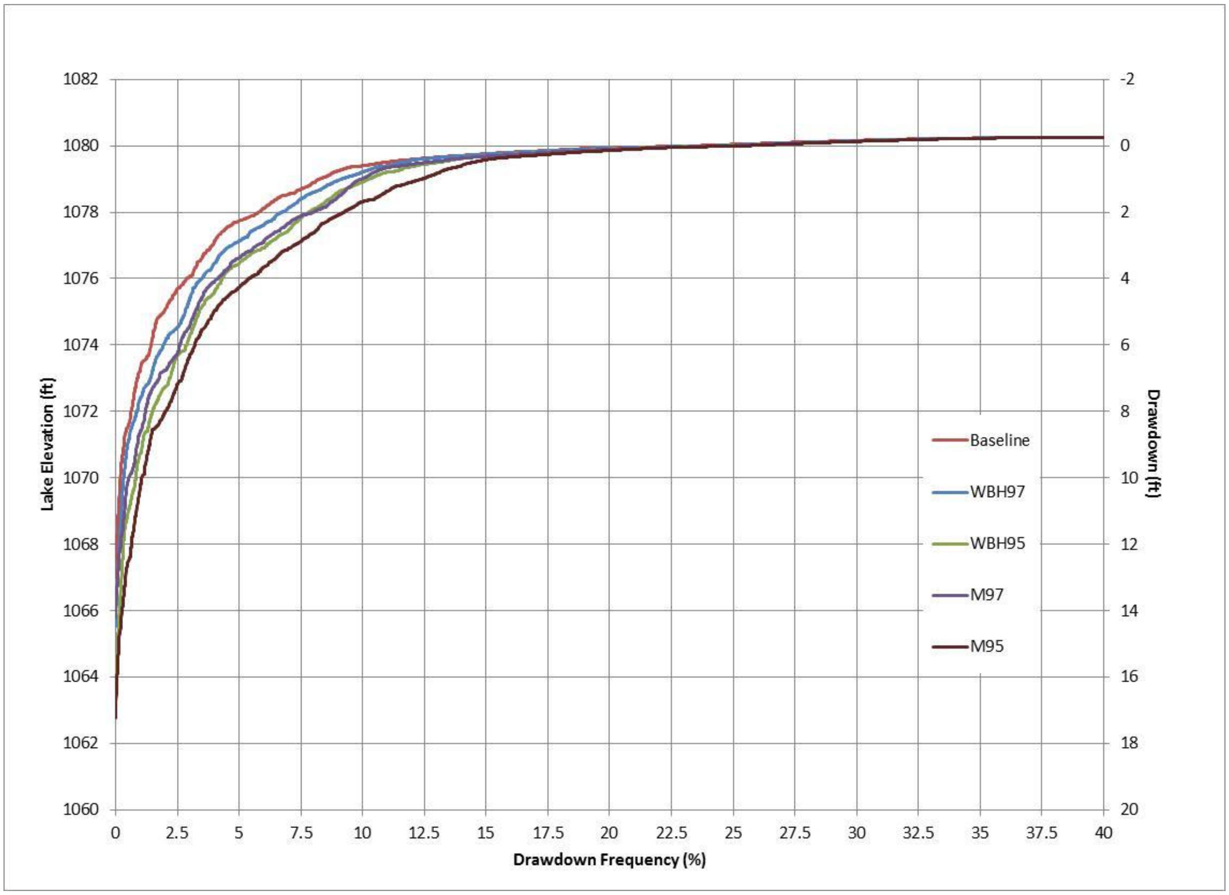

Figure 3-6 Simulated Drawdown Frequency Curve for the Recreation Season in the Modeling Period

Table 3-14 Simulated Drawdown Frequency for Selected Drawdown Intervals for the Recreation Seasons in the Modeling Period

	Frequency (% of Days) with Maximum Drawdown of:							
	1-3 ft		3-5 ft		5-10 ft		>10 ft	
Alternative	%[a]	Increased Percentage Relative to Baseline	%	Increased Percentage Relative to Baseline	%	Increased Percentage Relative to Baseline	%	Increased Percentage Relative to Baseline
Baseline	3.9	—	1.9	—	0.2	—	0.1	—
WBH97	4.6	0.7	2.8	0.9	0.3	0.1	0.2	0.1
WBH95	5.7	1.8	3.2	1.3	0.8	0.6	0.4	0.3
M97	5.6	1.7	3.2	1.3	0.5	0.3	0.3	0.2
M95	7.2	3.3	4.0	2.1	1.1	0.9	0.5	0.4

[a] The percentage shown in the table is for the maximum drawdown in the range.

4.0 AFFECTED ENVIRONMENT

4.1 HYDROLOGY

Susquehanna River Basin

The Susquehanna River extends 444 miles from Otsego Lake, New York, to the Chesapeake Bay, draining 27,500 square miles of the Susquehanna River Basin. The basin covers half of the land area of Pennsylvania and portions of New York and Maryland. There are six major sub-basins: the Upper Susquehanna, Chemung, Middle Susquehanna, West Branch, Juniata, and Lower Susquehanna (Figure 3-1). Most of the basin's headwaters originate on the Appalachian Plateau, and the river crosses the Ridge and Valley and Piedmont provinces before reaching the Bay. The basin encompasses more than 43 percent of the Chesapeake Bay's total drainage area and provides about 50 percent of its freshwater inflow.

Cowanesque Lake

Cowanesque Lake is located on the Cowanesque River in the Chemung Subbasin of the Susquehanna River Basin. The Cowanesque River flows eastward in Pennsylvania, parallel to and south of the New York State line. Roughly 2.2 miles downstream of Cowanesque Lake, the Cowanesque River meets the Tioga River at Lawrenceville, Pennsylvania (Figure 3-1). The drainage area above Cowanesque Lake is 298 square miles, and the total length of the river upstream of the dam is about 38 miles.

The climate of the upper Susquehanna River Basin can be generalized as moderate, subtemperate, and humid, with humid summers and cold, severe winters. Average annual temperature, precipitation, and snowfall range from 45 to 50 degrees Fahrenheit (°F), 30 to 34 inches, and 44 to 47 inches, respectively. Average annual runoff for the drainage area above Cowanesque Lake is 13.1 inches (1 inch of runoff corresponds to 15,893 acre-feet) (USACE, 2005).

The primary purpose of Cowanesque Lake is regional flood risk management. Cowanesque Lake is regulated in conjunction with Tioga-Hammond Lakes to reduce river stages at downstream damage centers along the Cowanesque, Tioga, Chemung, and Susquehanna Rivers.

Historical Drawdowns at Cowanesque Lake, 1991 - 2010

Daily historical elevation data for Cowanesque Lake were provided by USACE for the period from 1990-2010. Because Cowanesque Lake did not reach the current conservation pool (elevation 1080 feet) until May 1990, data from this year were excluded from further analysis. Daily lake elevations from 1991-2010 are shown in Figure 4-1.

The lowest historical elevation of the lake was 1065.0 feet (corresponding to a maximum drawdown of 15.0 feet), which occurred during a 39-day drawdown event in 1994 (March 12-April 19). USACE deliberately drew down Cowanesque Lake in order to provide extra flood

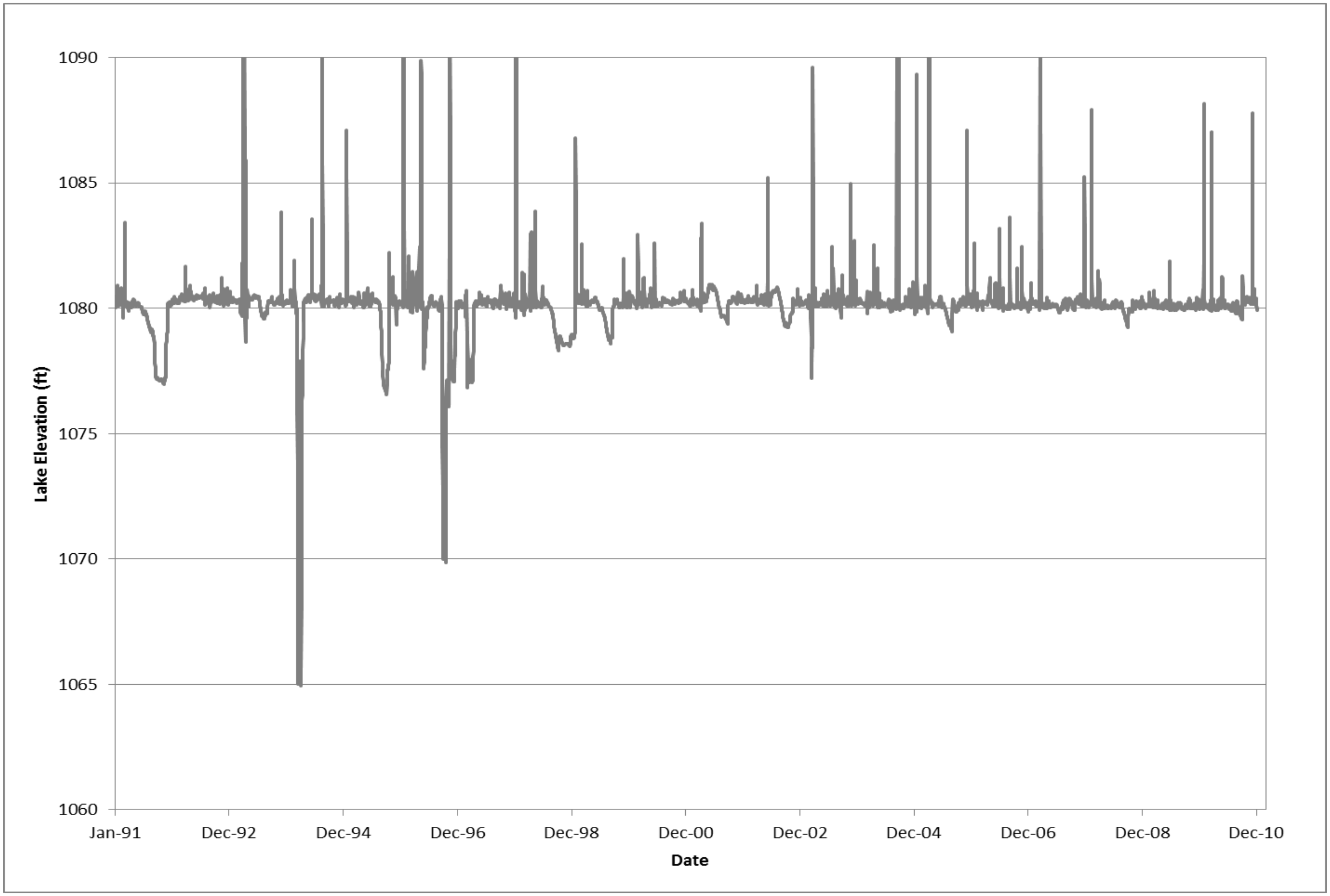

Figure 4-1 Daily Lake Elevations for Cowanesque Lake Using Historical Data, 1991-2010

control storage because of an unusually heavy snowpack in the upstream watershed. There were 9 years (1991, 1993-1999, and 2003) in which Cowanesque Lake was drawn down more than 1 foot.

During two of these event years (1991 and 1995), limited water supply releases were made from Cowanesque Lake at the request of SRBC to offset downstream consumptive use. Three unique events not related to water releases occurred in 1996: May 28-June 10 (14 days), September 24-November 7 (45 days), and from November 16-December 18 (33 days), totaling 92 drawdown days in the 1996 event year. The event that occurred in 1996 from September 24 to November 7 was the result of scheduled maintenance performed on Cowanesque Lake.

A summary of the historical data can be found in Table 4-1, which shows how many years and days Cowanesque Lake experienced drawdowns within certain ranges, the average drawdown the lake experienced over each drawdown range, and the average drawdown frequency for each selected drawdown range. The drawdown frequency is the percentage of days (out of the historical period of record) that the lake elevation is drawn down to a level within set drawdown ranges. Figure 4-2 depicts the drawdown frequency over the 20-year historical period of record. The graph shows that 82.5 percent of the time (i.e. to the right of the 17.5 percent line on the graph), the lake level is at normal pool elevation (1080 feet) or higher. This is consistent with the modeled results, as discussed in Section 3.2.

Table 4-1 Summary Table for Selected Drawdown Intervals for Cowanesque Lake, 1991-2010

	Drawdown Range:				
	1-3 ft	3-5 ft	5-10 ft	>10 ft	Total
Number of Years with Drawdown of:	4	3	0	2	9
Number of Days with Drawdown of:	375	57	24	25	481
Average Drawdown for Range of:	1.9	3.5	8.8	12.9	N/A[(a)]
Average Frequency (% of Days) in Range of:	4.0	1.1	0.50	0.16	N/A

[(a)] N/A = Not Applicable

From 1991 through 2010, the longest drawdown event lasted 125 days, starting on September 17, 1998, and concluding on January 19, 1999 (referred to as the 1998 drawdown event). The second longest drawdown event began on September 1, 1991, and concluded on November 30, 1991, lasting a total of 91 days. Additionally, a total of 92 drawdown days were experienced over three separate drawdown events in the 1996 event year. Table 4-2 summarizes information regarding these three event years.

Table 4-2 Average Drawdown Duration and Drawdown Duration for the Event Years with the Largest Number of Drawdown Days, 1991, 1996, and 1998

Event Year	Max. Drawdown (ft)	Average Drawdown (ft)	Total Drawdown Days in Event Year	Total Drawdown Days in Recreational Season
1991	3.0	2.46	91	14
1996	10.3	4.46	92	14
1998	1.7	1.31	124	0

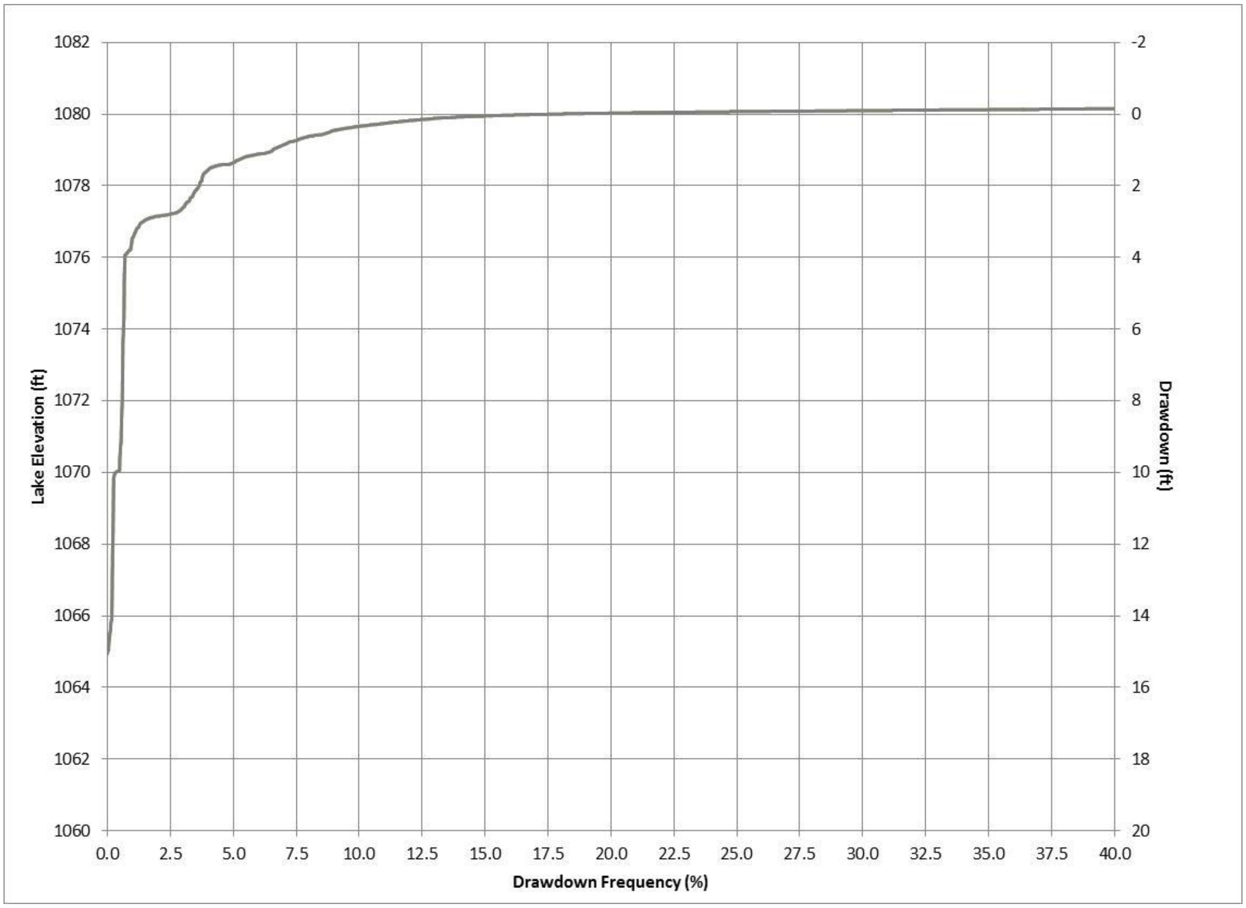

Figure 4-2 Drawdown Frequency Curve for Cowanesque Lake Using Historical Data, 1991-2010

4.2 WATER QUALITY

The primary water quality objectives for Cowanesque Lake are downstream temperature control to maintain a warmwater fishery; alleviation of acid mine pollution present in the Tioga River at Lawrenceville, Pennsylvania; recreational uses; fisheries development in the lake and downstream; and low-flow augmentation. Temperature, dissolved oxygen (DO), and pH are typically the primary water quality parameters of concern for lake and downstream waters (USACE, 2005).

Water Quality Standards

The Pennsylvania Department of Environmental Protection (DEP) enforces Pennsylvania's water quality standards pursuant to Chapter 93 of the Pennsylvania Code. Water use designations for Cowanesque Lake and Cowanesque River below the dam are: supporting aquatic life as a warm water fishery, potable water supply, recreation (boating, fishing, swimming), and fish consumption.

The applicable water quality standards for DO in Cowanesque Lake and Cowanesque River downstream of the dam are a minimum daily average of 5.0 milligrams per liter (mg/L) and an instantaneous minimum of 4.0 mg/L. The water quality standard for pH is 6.5 to 8.5 standard units. The state standard for water temperature, which only applies to waters receiving heated water discharges, is not applicable to Cowanesque Lake.

Water Quality Assessment

Biennial water quality assessments are required by Sections 305(b) and 303(d) of the Clean Water Act to determine the degree in which surface water resources are attaining their designated uses. The classifications used by DEP to describe use attainment are:

Category 1: Waters attaining all designated uses.
Category 2: Waters where some, but not all, designated uses are met. Attainment status of the remaining designated uses is unknown because data are insufficient to categorize the water.
Category 3: Waters for which there are insufficient or no data and information to determine if designated uses are met.
Category 4: Waters impaired for one or more designated uses but not needing a total maximum daily load (TMDL). These waters are placed in one of the following three subcategories:

- *Category 4A*: TMDL has been completed;
- *Category 4B*: Expected to meet all designated uses within a reasonable timeframe;
- *Category 4C*: Not impaired by a pollutant and not requiring TMDL.

Category 5: Waters impaired for one or more designated uses by any pollutant. Category 5 includes water shown to be impaired as the result of biological assessments used to evaluate aquatic life use. Category 5 constitutes the Section 303(d) list the Environmental Protection Agency will approve or disapprove under the Clean Water Act.

DEP prepares an *Integrated Water Quality Monitoring and Assessment Report*, which meets the requirements for the 305(b) report and 303(d) list of impaired waters (Pennsylvania DEP, 2010). Waters are designated as impaired if their water quality does not meet the applicable water quality standards and the water body is determined to not meet its designated uses. According to the *2010 Integrated Water Quality Monitoring and Assessment Report*, Cowanesque Lake is listed as Category 2 and Category 5 because it attains its designated use for aquatic life (maintaining a warmwater fishery) and potable water supply, but is impaired for its designated use of fish consumption because fish tissue mercury concentrations were found to be greater than the permissible once per week consumable limit. Category 5 impairment due to high fish tissue mercury concentrations is a statewide concern and is not isolated to Cowanesque Lake. Cowanesque River below Cowanesque Lake is impaired for its designated uses of aquatic life and fish consumption. Cowanesque River does not attain its designated use of aquatic life because of organic enrichment/low DO, nutrient loading, thermal modifications, and siltation.

Water Quality Data

Before 1990, water quality in Cowanesque Lake was fair, experiencing moderate eutrophication as a result of high nutrient inputs into the Cowanesque River from domestic pollution (USACE, 2005). The sewage treatment plant at Westfield upstream of the dam discharges its effluent into the Cowanesque River. Since 1990 when Cowanesque Lake was raised to provide water supply storage, water quality in the lake and downstream of the dam has improved, yet the lake is still classified as eutrophic (Pennsylvania Fish and Boat Commission [PFBC], 1998). Downstream of the dam, the pH at Tioga Junction occasionally falls below the state standard because the Tioga River is affected by acid mine drainage. The Tioga-Hammond projects located along the Tioga River and adjacent to Cowanesque Lake cannot maintain the state standard. Therefore, Cowanesque Lake releases water in coordination with Tioga-Hammond to neutralize acid mine pollution in the Tioga River (USACE, 2007).

Water quality at the lake is monitored by the USACE Baltimore District Water Control Team (WCT) during the months May through September. The WCT collects water quality samples at four in-lake stations, an inflow station, and an outflow station (Figure 4-3). Each sample is tested for DO, temperature, pH, specific conductance, acidity, alkalinity, total iron, sulfate, nitrate-nitrogen, ammonia-nitrogen, and phosphate. As mentioned above, the water quality parameters of concern are temperature, DO, and pH. Tables 4-3 through 4-4 summarize the data collected for these water quality parameters by sampling station, monthly average, and depth.

The May-September data exhibit a thermocline between 16 and 20 feet deep, which forms in June and lasts through September. Above the thermocline, temperature gradually decreases with depth and generally ranges from 59-77ºF, but below the thermocline, temperature ranges from 50-59ºF.

Table 4-3 Average Temperature (ºF) at Sampling Stations, 1997-2010

Station	Depth	May	June	July	August	September
COW1 (Outflow)	S	60.1	72.0	81.7	76.2	71.6
COW2	S	62.8	78.3	77.1	80.8	72.9
	M	58.8	62.9	68.1	70.2	69.9
	B	51.0	55.2	64.0	55.3	56.4
COW4	S	67.8	80.7	81.1	78.1	71.6
	M	56.3	62.4	67.1	69.0	70.3
	B	49.1	48.6	64.8	55.8	57.4
COW6	S	66.2	76.0	81.0	79.1	73.3
	M	55.8	63.3	68.5	69.5	68.8
COW9	S	64.5	73.2	80.4	78.5	73.1
	M	53.3	N/A	N/A	N/A	N/A
COW10 (Inflow)	S	65.9	71.3	76.6	74.8	74.8

S = Surface (0-16 ft); M = Middle (16-49 ft); B = Bottom (49-82 ft)

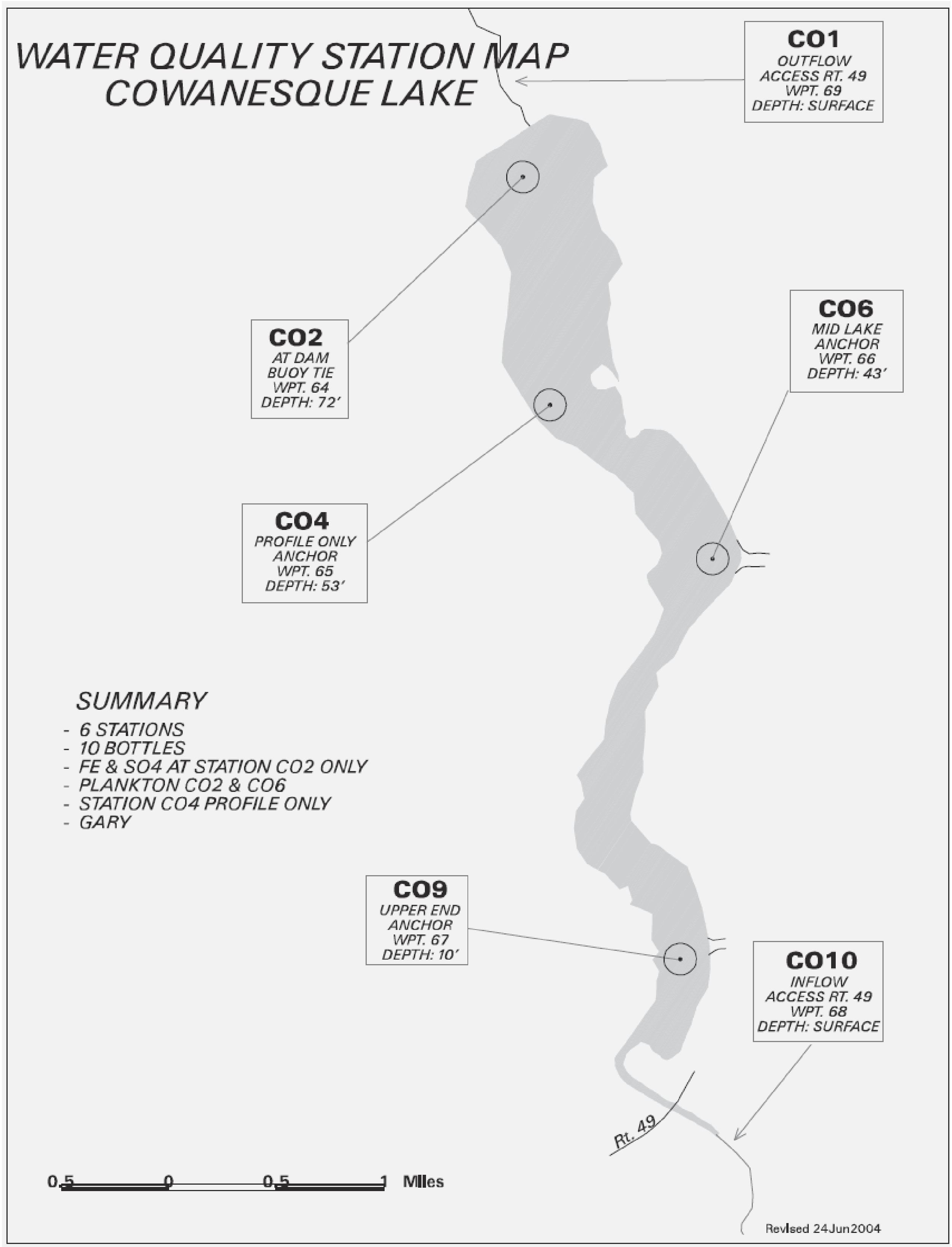

Figure 4-3 Water Quality Station Map at Cowanesque Lake

At the in-lake stations, DO was less than the instantaneous minimum for warmwater fisthery (4.0 mg/L) in 33.9 percent of the 1,512 samples. At the inflow and outflow stations, none of the samples was below the instantaneous minimum for warmwater fishery. Of the 33.9 percent of samples at the in-lake stations that were below the instantaneous minimum, 1.7 percent were at the surface (0-16 feet), 25.1 percent at mid-depth (16-49 feet), and 7.1 percent at the bottom (49-82 feet). The temperature gradient observed in the lake causes DO to exhibit similar stratification in the water column; this phenomenon is common in lakes of this region.

Table 4-4 Average DO (mg/L) at Sampling Stations, 1997-2010

Station	Depth	May	June	July	August	September
COW1 (Outflow)	S	9.8	7.4	11.0	9.6	12.1
COW2	S	10.1	8.3	9.3	8.2	8.7
	M	8.6	5.1	2.8	0.9	1.5
	B	7.5	3.1	0.7	0.2	0.2
COW4	S	10.1	8.9	9.0	7.5	9.2
	M	8.2	4.4	2.5	0.6	1.2
	B	7.4	1.8	0.6	0.1	0.2
COW6	S	10.0	9.2	8.7	7.8	8.1
	M	6.8	4.4	1.4	0.4	1.3
COW9	S	8.6	7.5	7.6	7.2	8.7
	M	8.9	N/A	N/A	N/A	N/A
COW10 (Inflow)	S	9.8	8.2	10.0	8.8	11.4

S = Surface (0-16 ft); M = Middle (16-49 ft); B = Bottom (49-82 ft)

The pH did not meet the state standard (6.5-8.5) in 15.6 percent of the 1,337 samples taken at the in-lake stations, in 11 percent of the 28 samples at the inflow station, and in 31 percent of the 29 samples at the outflow station. Nearly all of the samples that did not meet the pH standard exceeded the upper limit of 8.5. Only 1.8 percent of the samples at the in-lake stations were below the lower limit of 6.5.

4.3 VEGETATION

Vegetative communities addressed in this section include submerged aquatic vegetation (SAV) and emergent wetlands associated with the periphery of the lake. These two systems are dependent on the hydrology of the lake and, therefore, could potentially be affected by water level drawdowns. Several other natural communities occur within close proximity of the lake (e.g. forested uplands, scrub shrub wetlands), but they are not addressed because they are not hydrologically connected to the lake and, therefore, not as directly affected by water level alterations. Emergent wetlands evaluated in this section include the vegetative community that fits the description for a lacustrine emergent wetland according to the U.S. Fish and Wildlife Service's (USFWS's) *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin et al., 1979). This system includes all wetlands around the perimeter of the lake vegetated with emergent wetland species. This wetland system was differentiated from the SAV community by its primary vegetative composition. The SAV community includes submerged species, which generally includes rooted vascular plants that grow up to the water surface but not above it (Ohrel and Register, 2006).

4.3.1 Submerged Aquatic Vegetation

SRBC provided EA with a Graphical Information System (GIS) map showing a zone of SAV occurring in the shallow water 0-7 feet deep around the perimeter of the lake. This shallow water area covers approximately 178 acres (Figure 4-4) and is predominantly colonized with Eurasian watermilfoil (*Myriophyllum spicatum*).

During the wetlands investigation conducted in August 2011, EA wetland scientists confirmed that SAV was present within this depth range, but a complete quantitative survey including SAV bed boundaries, species composition, and total percent cover was not completed. EA scientists observed the SAV areas of highest density or 100 percent cover and marked those areas on an aerial photograph; see Figure 4-5. The areas that were omitted may still contain SAV, but at lower densities. These observations confirm that the 178 acres of lake above the 7-foot depth contour have the potential to support SAV, although actual coverage year-to-year may vary depending on annual environmental variations.

Although native species are likely present in small populations, the dominant species is Eurasian watermilfoil, an invasive species that can quickly colonize an area once established. Eurasian watermilfoil employs a combination of flowering and fragmentation to reproduce. In the spring, once water temperature is above 15°C or 59°F, spring shoots begin to grow. Once the shoots reach the surface they form a dense canopy and begin to flower. After flowering, fragmentation begins and in certain regions a second flowering cycle follows (Smith and Barko, 1990). As an opportunistic species, Eurasian watermilfoil is adapted for rapid growth early in spring. Its ability to spread rapidly by fragmentation and effectively block out sunlight needed for native plant growth often results in monotypic stands. Monotypic stands of Eurasian watermilfoil provide only a single habitat and threaten the integrity of aquatic communities in a number of ways; for example, the dense stands can preclude use by larger fish and reduce the number of nutrient-rich native plants available for waterfowl (Wisconsin Department of Natural Resources, 2011). Cold temperatures have little influence on growth except under reservoir drawdown conditions when plants are exposed to the air (Jacobs and Margold, 2009). Eurasian watermilfoil begins to senesce and go dormant once water temperature drops below 15°C (Smith and Barko, 1990). In Cowanesque Lake, water temperature declines to 15°C toward the end of October (USACE, 1982).

4.3.2 Wetlands

According to the National Wetlands Inventory, wetlands within Cowanesque Lake include open water lake habitat and several small freshwater forested/shrub and freshwater emergent wetlands along the southern shoreline (USFWS, 2011) (Figure 4-6).

USACE (2002) identified a few naturally formed wetlands and wetland mitigation areas within the vicinity of Cowanesque Lake. With funding from SRBC, USACE created two wetland mitigation areas during the 1990 construction associated with raising the lake elevation: Strait

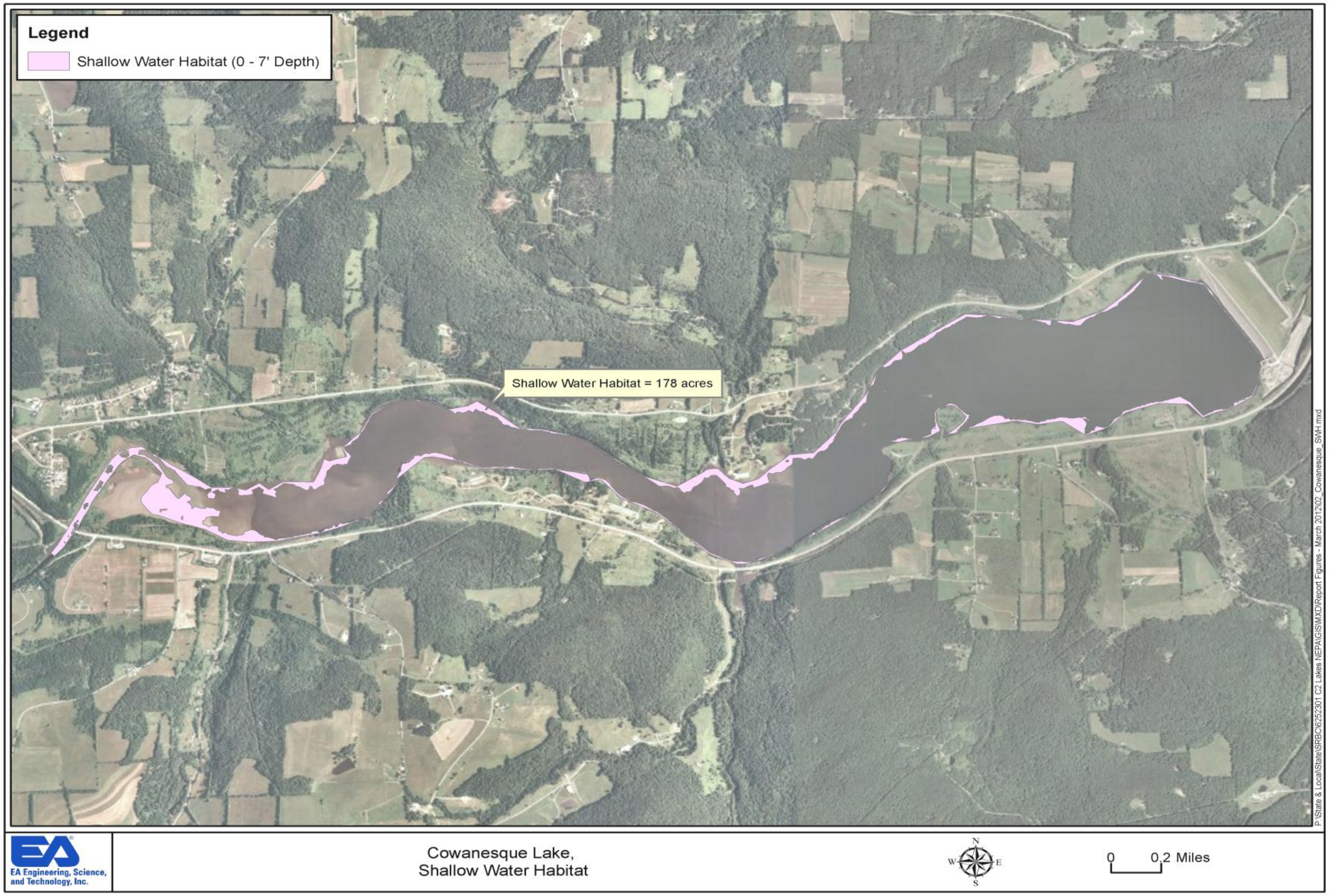

Figure 4-4 Shallow Water Habitat

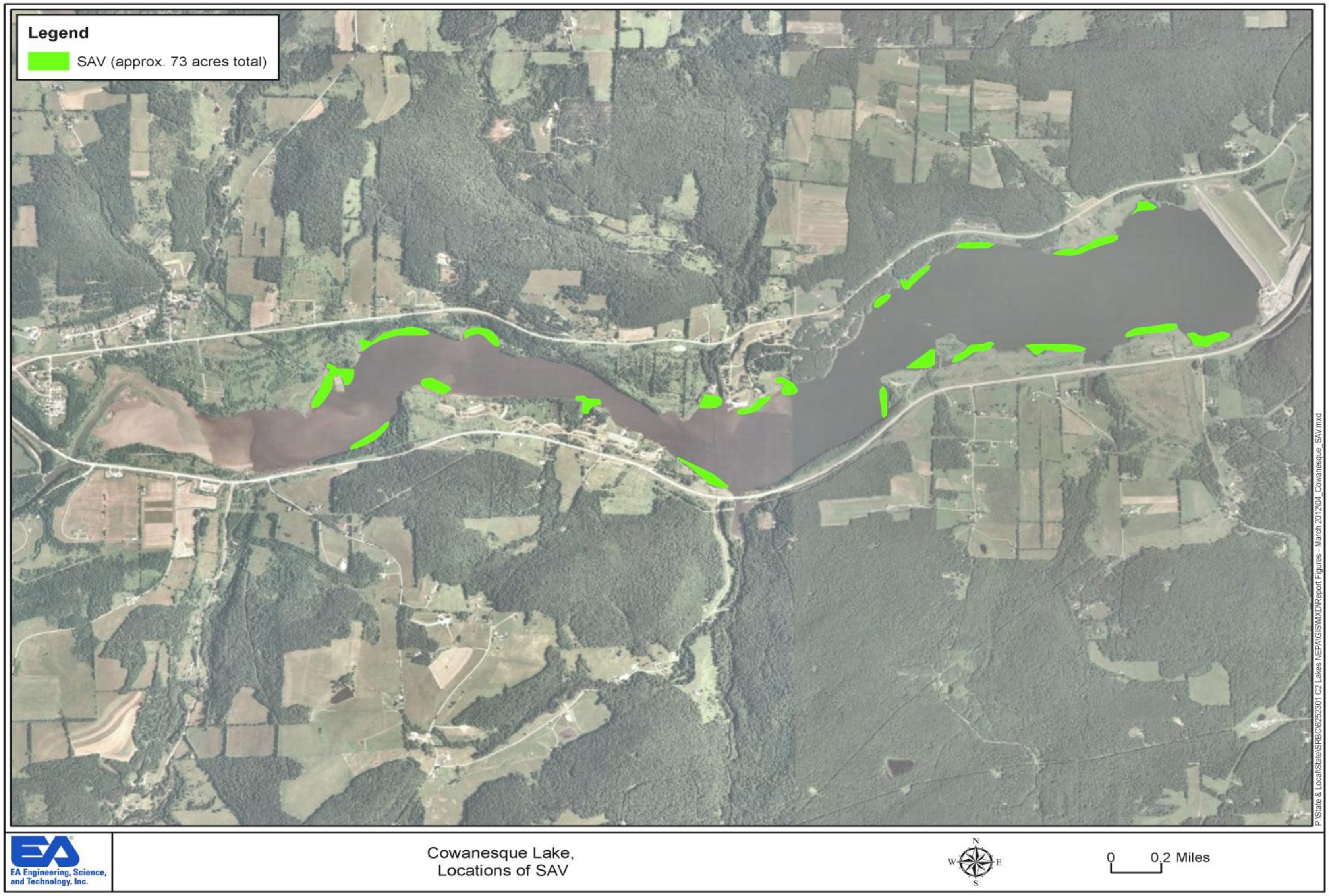

Figure 4-5 SAV Areas with High Density or 100 Percent Complete Cover, August 17-19, 2011

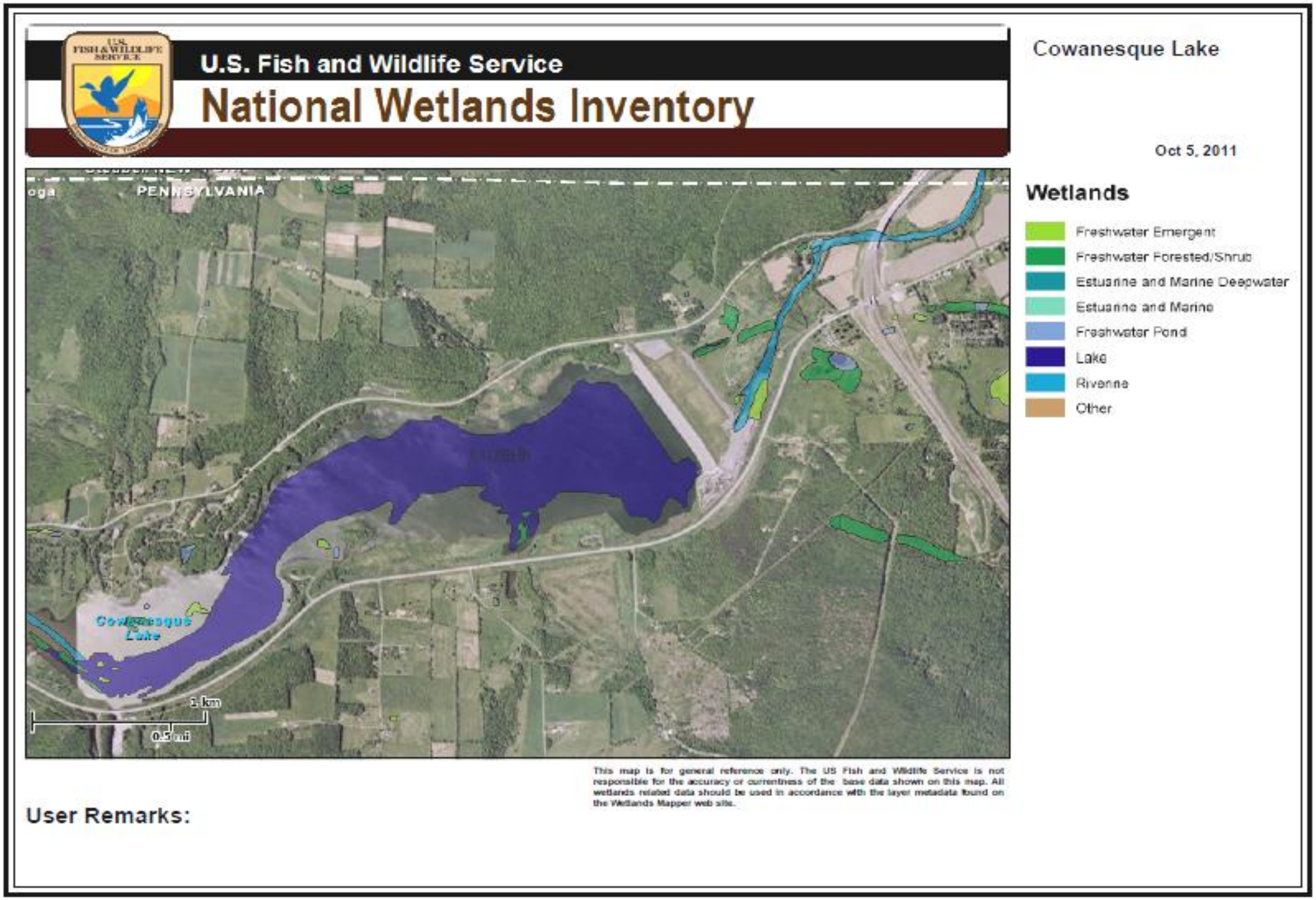

Figure 4-6 National Wetlands Inventory Map for Cowanesque Lake

Creek Duck Island, a 15-acre wetland area, and a 60-acre wetland area at Old Nelson (Bierly, 2012). Alkali bulrush, arrowhead, duck potato, giant smartweed, sago pondweed, wild celery, and giant wild rice were among the wetland plant species planted. After the lake level was raised in 1990, a wetland established itself naturally south of Route 49 and west of the Red House Campground. This wetland does not have a direct hydrologic connection to the lake but may be connected via groundwater.

Table 4-5 lists the hydric status of soils along the shoreline of Cowanesque Lake; a soils map is included in Appendix C. Hydric soils are one of the three primary indicators of a wetland. The soils maps were used during the field investigation as baseline information to determine which areas had hydric soils and should be the areas of focus.

Table 4-5 Soils Located Around the Perimeter of Cowanesque Lake.

Map Unit Symbol	Map Unit Name	Hydric Status
BvB	Braceville gravelly loan, 3 to 8% slopes	Yes
ChB	Chenango gravelly loam, 2 to 12% slopes	No
CkB	Chippewa silt loam, 3 to 8% slopes	Yes
LoB	Lordstown channery loam, 3 to 12% slopes	No
LoD	Lordstown channery loam, 20 to 30% slopes	No
Lsb	Lordstown very stoney loam, 3 to 12% slopes	No
MaD	Mardin channery silt loam, 15 to 25% slopes	No
OTF	Oquage and Lordstrom soils, very steep	No
Ph	Philo silt loam	Yes
Po	Pope soils	Yes
RxB	Rexford silt loam, 3 to 10% slopes	Yes
VoA	Volusia channery silt loam, 0 to 3% slopes	Yes
VoB	Volusia channery silt loam, 3 to 8% slopes	Yes
VoC	Volusia channery silt loam, 8 to 15% slopes	Yes
VoD3	Volusia channery silt loam, 15 to 25% slopes, eroded	Yes
VoE3	Volusia channery silt loam, 25 to 35% slopes, eroded	Yes
VvC	Volusia channery silt loam, silty substratum, 8 to 15% slopes	Yes
VvD3	Volusia channery silt loam, silty substratum, 15 to 25% slopes	Yes
WyC	Wyoming gravelly sandy loam, 12 to 20% slopes	No
WyD	Wyoming gravelly sandy loam, 20 to 30% slopes	No

EA wetland scientists completed a wetlands field investigation August 17-19, 2011, and documented the location and composition of emergent wetlands around Cowanesque Lake to a landward extent of 50 feet. Wetland communities that do not have a direct hydrologic connection to the lake were not assessed. At each wetland, the location was collected using a handheld GPS unit. Species were listed, and photographs were taken (see Appendix D2). Thirteen separate wetlands were identified along the perimeter of the lake, as shown in Figure 4-7; a larger image is available in Appendix D1.

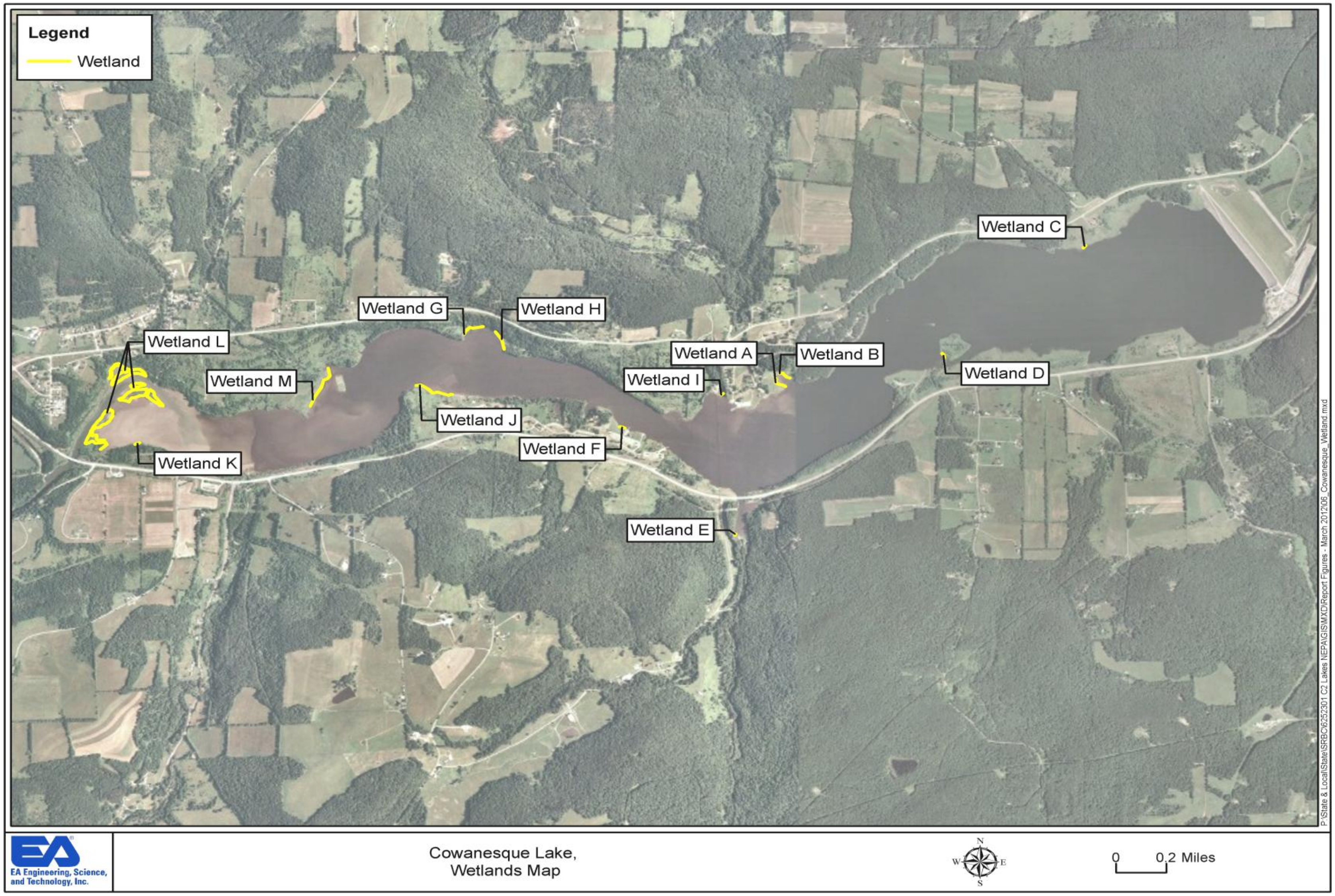

Figure 4-7 Emergent Wetland Areas Identified by EA Scientists

Wetlands A and B

Wetlands A and B are lacustrine emergent wetlands located on the northern shoreline of the lake within the boundaries of the Tompkins campground. They are narrow fringe systems approximately 10 to 15 feet wide. Wetland A is 0.11 acres in area, and Wetland B is 0.09 acres. Dominant species include soft stem bulrush, northern arrowwood, woolgrass, rice cut grass, and broadleaf cattail. A complete species list is presented in Table 4-6. All species observed, but one, are categorized by the USFWS as facultative wetland (FACW in the tables) or obligate wetland (OBL in the tables) species. A facultative wetland species usually occurs in wetlands (estimated probability 67-99 percent), but is occasionally found in non-wetlands. An obligate wetland species occurs almost always (estimated probability 99 percent) under natural conditions in wetlands (United States Department of Agriculture [USDA], n.d.).

Table 4-6 Vegetative Species Observed in Wetlands A and B

Scientific Name	Common Name	Status
Scirpus validus	Soft stem bulrush	OBL
Viburnum recognitum	Northern arrowwood	FACW
Scirpus cyperinus	Woolgrass	OBL
Mimulus alatus	Winged monkey flower	OBL
Cyperus esculentus	Yellow nutsedge	FACW
Carex lurida	Shallow sedge	OBL
Juncus effusus	Soft rush	FACW
Carex Scoparia	Broom sedge	FACW
Boehmeria cylindrica	Small spike false nettle	FACW
Ludwigia palustrus	Marsh seedbox	OBL
Bidens connata	Purplestem beggarticks	FACW
Hypericum mutilum	Dwarf St. Johns wart	FACW
Calystegia sepium	Hedge bindweed	FAC
Eleocharis ovata obtusa	Blunt spike rush	OBL
Asclepias incarnata	Swamp milkweed	OBL
Leersia oryzoides	Rice cut grass	OBL
Eupatorium perfoliatum	Common boneset	FACW
Verbena hastata	Blue verbena	FACW
Onoclea sensibilis	Sensitive fern	FACW
Carex vulpinoidea	Fox sedge	OBL
Pilea pumila	Clearweed	FACW
Lysimachia nummularia	Moneywort	FACW
Typha latifolia	Broadleaf cattail	OBL
Galium palustre	Marsh bedstraw	OBL
Polygonum hydropiper	Marsh water pepper	OBL
Phalaris arundinacea	Reed canary grass	FACW
Euthamia tenuifolia	Flat top fragrant goldenrod	FACU

Wetland C

Wetland C is a similar lacustrine emergent wetland system to wetlands A and B, but is comprised almost exclusively of cattails, which make up 99 percent of the vegetative cover. Soft stem bulrush was also noted within the wetland. Wetland C is located along the northern shoreline east of the Tompkins campground. Wetland C is a small system approximately 77 feet long and 20-25 feet wide (0.04 acres).

Wetland D

Wetland D is a very narrow, 508-foot long lacustrine emergent wetland fringe located on the southern boundary of the lake, east of the south shore recreation area. Dominant species within the wetland include northern arrowwood, black willow, and silky dogwood (Table 4-7).

Table 4-7 Vegetative Species Observed in Wetland D

Scientific Name	Common Name	Status
Bidens connata	Purplestem beggarticks	FACW
Viburnum recognitum	Northern arrowwood	FACW
Salix nigra	Black willow	FACW
Verbena hastata	Blue vervain	FACW
Cornus amomum	Silky dogwood	FACW

Wetland E

Wetland E is a lacustrine emergent wetland located along a small tributary that flows into the southern shoreline of the lake. This wetland is 20 to 30 feet wide and approximately 0.03 acres in area and is made up of both emergent species and standing tree snags. Dominant species include soft stem bulrush and broadleaf cattail (Table 4-8).

Table 4-8 Vegetative Species Observed in Wetland E

Scientific Name	Common Name	Status
Sparganium eurycarpum	Giant burreed	OBL
Viburnum recognitum	North arrowwood	FACW
Biddens connata	Purplestem beggarticks	FACW
Eupatorium purpureum	Joe-pye weed	FACW
Phalaris arundinacea	Reed canary grass	FACW
Typha latifolia	Broadleaf cattail	OBL
Eupatorium perfoliatum	Common boneset	FACW
Juncus effusus	Soft rush	FACW

Wetland F

Wetland F is a lacustrine emergent fringe wetland located on the southern shoreline within the south shore recreation area. This wetland is approximately 121 feet long by 30 feet wide (0.08 acres). This wetland has similar species composition to Wetlands A and B; see Table 4-6 for a complete species list.

Wetlands G and H

Wetlands G and H are very similar lacustrine fringe wetlands located on the northern shoreline east of the Tompkins campground. These wetlands contain predominantly bulrush and cattails but also contain great lobelia and spearmint. All of these species are classified as facultative wetland or obligate wetland species.

Wetland I

Wetland I is a combination lacustrine emergent wetland with a scrub shrub component located on the northern shoreline in close proximity to wetlands A and B. Dominant species within the wetland include soft stem bulrush, broadleaf cattails, green bulrush, and smooth alder (Table 4-9). All of the species within this wetland are classified as facultative wetland or obligate wetland species with the exception of flat top goldenrod, which is a facultative upland species. Smooth alder is a thicket-forming shrub or small tree with flexible stems and fibrous root system; therefore, it is often used for streambank stabilization.

Table 4-9 Vegetative Species Observed in Wetland I

Scientific Name	Common Name	Status
Alnus serrulata	Smooth alder	OBL
Scirpus atrovirens	Green bulrush	OBL
Populus deltiodes	Cottonwood saplings	FAC
Scirpus cyperinus	Woolgrass	FACW
Scirpus validus	Soft stem bullrush	OBL
Carex vulpinoidea	Fox sedge	OBL
eupatorium purpureum	Joe-pye weed	FACW
Typha latifolia	Broadleaf cattail	OBL
Eupatorium perfoliatum	Common boneset	FACW
Viburnum recognitum	Northern arrowwood	FACW
Lythrum salicaria	Purple loosestrife	FACW
Bacopa monnieri	Moneywort	OBL
Lycopus uniflorus	Northern bugleweed	OBL
Euthamia tenuifolia	Flat top fragrant goldenrod	FACU

Wetlands J, K, and M

Wetland J is an emergent fringe wetland located on the southern shoreline of the lake immediately adjacent to the western boundary of the south shore recreation area. It is one of the larger wetlands, approximately 868 linear feet long and 30-45 feet wide (0.89 acres). Wetland K is smaller in size (0.05 acres), but is also located along the southern shoreline and has similar characteristics. Wetland M is located on the northern shoreline and is 1,046 feet in length and more than 50 feet wide (1.2 acres). Wetlands J, K, and M have similar dominant species as the other emergent wetlands described above (Table 4-10).

Table 4-10 Vegetative Species Observed in Wetlands J, K, and M

Scientific Name	Common Name	Status
Scirpus validus	Soft stem bullrush	OBL
Bidens connata	Purplestem beggarticks	FACW
Verbena hastata	Blue verbena	FACW
Onoclea sensibilis	Sensitive fern	FACW
Phalaris arundinacea	Reed canary grass	FACW
Salix nigra	Black willow	FACW
Mentha spicata	Spearmint	FACW
Cornus amomum	Silky dogwood	FACW
Cicuta bulbifera	Bulblet bearing water hemlock	OBL
Eupatorium purpureum	Joe-pye weed	FACW
Xanthium strumarium	Clotbur	FAC

Wetland L

Wetland L is an emergent fringe wetland along the southeast side of the lake but also includes several small emergent wetland islands. The wetland contains large mud flats with shallow standing water. Vegetation observed is similar to species recorded for Wetlands J and K. Wetland L, including the wetland islands, covers approximately 8.6 acres.

Wetland Functions and Values

Wetland functions are the physical, chemical, and biological characteristics of a wetland. The processes that take place within a wetland include the storage of water, transformation of nutrients, and growth of living plant matter. Wetland values are those characteristics that are beneficial to society and surrounding ecosystems.

The fringe wetlands observed at Cowanesque Lake provide a variety of functions, such as reducing direct inputs of sediment into the lake; improving water quality by acting as a nutrient filter for water within the lake; stabilizing soil and controlling erosion; providing breeding and spawning grounds and nurseries for waterfowl, fish, and amphibians; and providing protective cover and food for wildlife.

4.4 TERRESTRIAL RESOURCES

The USACE document, dated July 2002, "Tioga, Hammond & Cowanesque Lakes Master Plan 2002 Update/Programmatic Environmental Assessment" lists the terrestrial mammals and birds found within the vicinity of Cowanesque Lake (USACE, 2002). Lowering lake levels generally has no effect on terrestrial resources (USACE, 2002), so no terrestrial survey was conducted for this project.

SRBC contacted USFWS by letter (Appendix A) on August 5, 2011, requesting USFWS to provide input and concerns on the project and list any federally threatened or endangered species at Cowanesque Lake. USFWS responded by letter (Appendix A) on August 30, 2011, stating that no federally listed threatened or endangered species are present at Cowanesque Lake. However, USFWS noted that three bald eagle nests are located in the vicinity of the project. Even though the Bald Eagle is no longer a federally listed threatened or endangered species, it is protected by the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act.

EA conducted a Pennsylvania Natural Diversity Inventory search on May 19, 2011. The search returned that USFWS, the PFBC, and the Pennsylvania Department of Conservation and Natural Resources determined there would be no known impact to threatened or endangered species in the vicinity of Cowanesque Lake. However, the Pennsylvania Game Commission determined that the project may have potential impact on a bat, the northern myotis (*Myotis septentrionalis*), and the osprey (*Pandion haliaetus*).

4.5 FISH

A total of 21 warmwater fish species, representing five families, have been documented in Cowanesque Lake (Table 4-11). The primary game fish species within Cowanesque Lake include black crappie (*Pomoxis nigromaculatus*), smallmouth bass (*Micropterus dolomieu*), largemouth bass (*Micropterus salmoides*), muskellunge (*Esox masquinongy*), tiger muskellunge (*Esox masquinongy x lucius*), and sunfish (*Lepomis spp.*). Other game fish include yellow perch (*Perca flavescens*), brown bullhead (*Ameiurus nebulosus*), and yellow bullhead (*Amerius natalis*). Non-games species are dominated by common carp (*Cyprinus carpio*), shiners, suckers, and the forage fish alewife (*Alosa pseudoharengus*). A creel census conducted in 2009 indicated that the most sought after gamefish is black bass (largemouth and smallmouth bass) (Soderberg, 2009). Recent surveys of the black bass population in Cowanesque Lake found relative low densities but growth rates at the state average of black bass populations in other Pennsylvania reservoirs (Soderberg, 2008). Additionally, the age structure of collected black bass indicated sufficient recruitment and low mortality. The PFBC has stocked several species of gamefish in Cowanesque Lake since 1980 including walleye (*Sander vitreus*), tiger muskellunge, purebred muskellunge, largemouth bass, channel catfish (*Ictalurus punctatus*), black crappie, rainbow trout (*Oncorhynchus mykiss*), and lake trout (*Salvelinus namaycush*) (USACE, 2009). Recent stocking efforts have focused on planting purebred and tiger muskellunge (USACE, 2009).

At normal pool, Cowanesque Lake is comprised of about 178 acres of shallow water (0 to 7 feet) and 872 acres of deep water (>7 feet) habitat. Surveys of fish habitat in 2009 found that SAV was the dominant habitat type in shallow areas and the remnant river bed was the dominant habitat type in the deepwater zone (Simonis, 2009). Other fish habitat features in Cowanesque Lake include dead trees, rip rap shorelines, and submerged creeks and road beds. In conjunction with the USFWS and the PFBC, USACE has conducted habitat management activities, including the planting of porcupine crib structures (Figure 4-8).

Habitat, spawning, and food requirements for Cowanesque Lake fish species are provided in Table 4-12. Many of the fish species in Cowanesque Lake—for example, sunfishes, yellow perch, largemouth bass, yellow bullhead, chain pickerel (*Esox niger*), and common carp—prefer shallow vegetated areas or woody debris as juveniles and adults. Smallmouth bass and walleye are common in areas of gravel and boulder habitat, which provides spawning and rearing substrate and refugia from predators. Most of the fish species in Cowanesque Lake build nests

Table 4-11 List of Common and Scientific Names of Fishes in Cowanesque Lake

Family	Scientific Name	Common Name	1998[a]	2010[b]
Clupeidae (Herrings)	*Alosa pseudoharengus*	Alewife		*
Cyprinidae (Carps and Minnows)	*Notropis hudsonius*	Spottail shiner	*	
	Cyprinella spiloptera	Spotfin shiner	*	
	Cyprinella analostana	Satinfin shiner	*	
	Notemigonus crysoleucas	Golden shiner	*	*
	Cyprinus carpio	Common carp	*	*
	Carassius auratus	Goldfish	*	
Catostomidae (Suckers)	*Hypentelium nigricans*	Northern hog sucker	*	
	Carpiodes cyprinus	Quillback	*	*
	Catostomus commersonii	White sucker	*	*
Ictaluridae (Bullhead Catfishes)	*Ameiurus natalis*	Yellow bullhead	*	*
	Ameiurus nebulosus	Brown bullhead	*	*
	Ictalurus punctatus	Channel catfish		*
Escocidae (Pikes)	*Esox masquinongy*	Muskellunge	*	
	Esox masquinongy x lucius	Tiger muskellunge	*	*
Centrarchidae (Sunfishes)	*Ambloplites rupestris*	Rock bass	*	
	Micropterus salmoides	Largemouth bass	*	*
	Lepomis macrochirus	Bluegill	*	*
	Lepomis gibbosus	Pumpkinseed	*	*
	Micropterus dolomieu	Smallmouth bass	*	*
	Lepomis cyanellus	Green sunfish	*	
	Pomoxis nigromaculatus	Black Crappie	*	*
Percidae (Perches)	*Perca flavescens*	Yellow perch	*	*
	Sander vitreus	Walleye	*	

[a] (Moase et al. , 1999)
[b] (Wnuk, 2010)

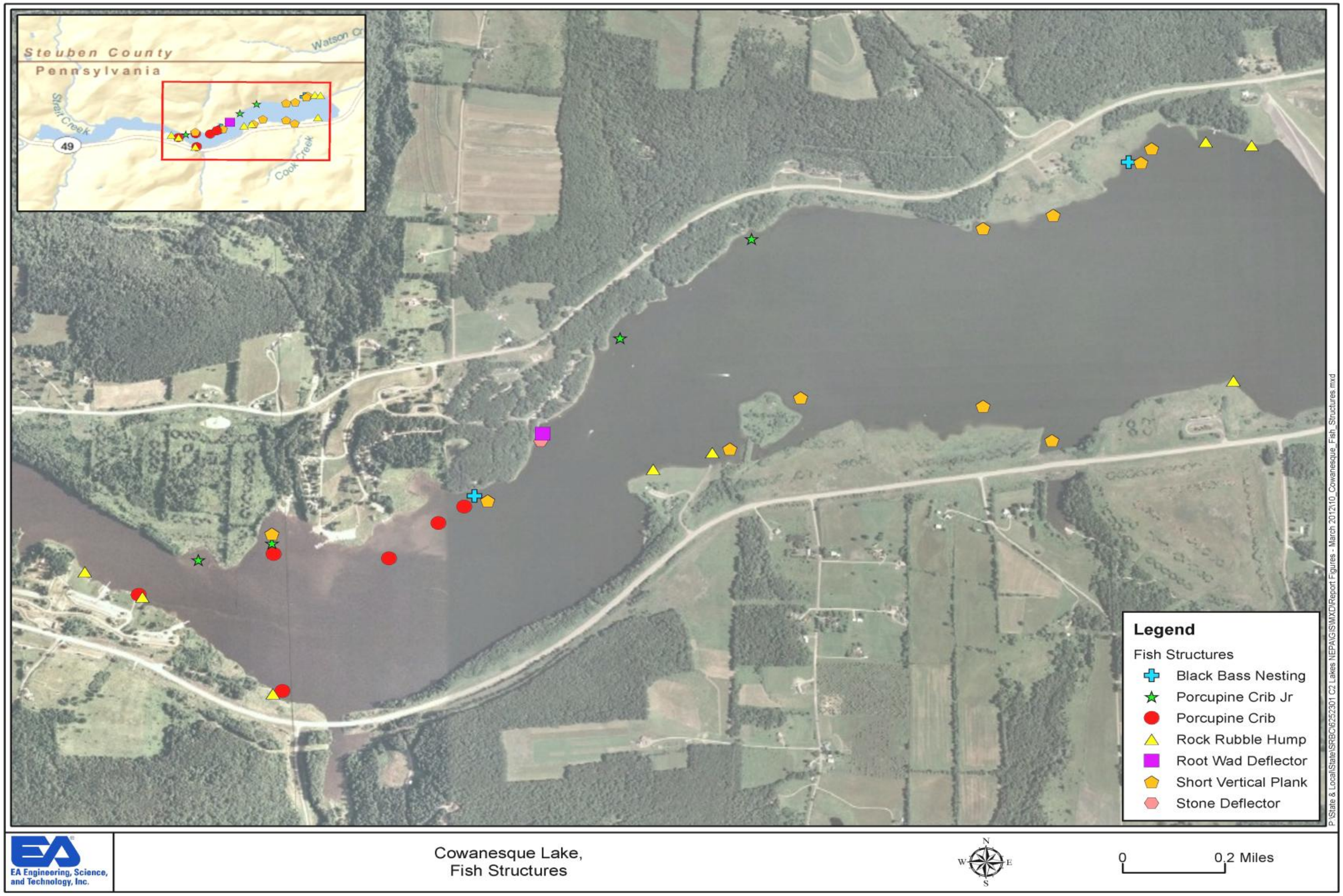

Figure 4-8 Locations of Fish Structures at Cowanesque Lake

Table 4-12 Life History Characteristics and Requirements of Fish Species in Cowanesque Lake

Common Name (Scientific Name)	Adult Habitat	Spawning Characteristics: Habitat	Depth	Temp.	Dates	Notes	Reference
Alewife *(Alosa pseudoharengus)*	Open water and deep areas; move inshore at night to feed	Shallow areas including beaches and ponds		>55°F	May to August	Broadcast spawner; eggs semi-adhesive	(Smith, 1985); (Jenkins and Burkhead, 1993)
Golden shiner (*Notemigonus crysoleucas)*	Shallow, slow moving, clear water , with abundant vegetation; feed primarily on zooplankton in mid-water	Shallow water over vegetation including filamentous algae and rooted aquatic plants		>68°F	May to August	Broadcast spawner; eggs adhesive	(Smith, 1985)
Common carp (*Cyprinus carpio)*	Abundant in dense aquatic vegetation; omnivores that feed on plant material and benthic animals	Over vegetation	1-5 ft	>63°F	April to August		(Smith, 1985)
Goldfish (*Carassius auratus)*	Slow-moving water with vegetation; omnivorous feeders that consume benthic organisms and aquatic vegetation	Over vegetation		77-85°F	May or June	Broadcast spawner; eggs adhesive; eggs often deposited on algae 1 to 2 inches below water surface	(Smith, 1985)
Spotfin shiner (*Cyprinella spiloptera)*	Sand and gravel substrate; tolerates some turbidity; feeds on terrestrial and aquatic insects	Horizontal crevices in rocks and logs			June to August	Fractional spawner	(Smith, 1985) (Jenkins and Burkhead, 1993) (Scott and Crossman, 1973)

Common Name (Scientific Name)	Adult Habitat	Spawning Characteristics					Reference
		Habitat	**Depth**	**Temp.**	**Dates**	**Notes**	
Satinfin shiner (*Cyprinella analostana)*	Rivers and streams; feeds primarily on aquatic insects	Crevices on wood and artificial substrates	0-3 ft	64-86°F	May to August	Fractional spawner; eggs demersal and adhesive	(Smith, 1985) (Jenkins and Burkhead, 1993)
Spottail Shiner *(Notropis hudsonius)*	Variety of habitats; abundant in clear open waters of lakes; feeds on zooplankton, algae, insect larvae, fish eggs and larvae	Sand bottom; sandy shoals; stream mouths	Shallow water		June to July		(Smith, 1985) (Scott and Crossman, 1973)
Northern hog sucker (*Hypentelium nigricans)*	Riffles and pools of clear, warmwater streams; found in lakes near stream mouth; feeds on insect larvae, crustaceans, and diatoms	Fine gravel in riffles or shallow side of pools	3 - 5 in.	>60°F	May	Broadcast spawner; eggs demersal	(Smith, 1985) (Scott and Crossman, 1973)
Quillback (*Carpiodes cyprinus)*	Large rivers and lakes	Bays of lakes over sand or mud bottom			April to July		
White sucker (*Catostomus commersoni)*	feed on insects and plant material	Gravel bottom streams or lake margins		>50°F	May to June	Migrates from lakes to gravelly streams to spawn; also known to spawn on lake margins; eggs adhere to substrate	(Smith, 1985) (Scott and Crossman, 1973)

Common Name (Scientific Name)	Adult Habitat	Spawning Characteristics					Reference
		Habitat	**Depth**	**Temp.**	**Dates**	**Notes**	
Yellow bullhead (*Ameiurus natalis)*	Bays of shallow, clear-water lakes with heavy vegetation; bottom feeder that preys on crustaceans, mollusks, aquatic insects, and small fish	Shallow depression or tunnel covered by overhanging bank or near logs, stones, or tree stumps			May to June	Builds nest	(Smith, 1985) (Scott and Crossman, 1973)
Brown bullhead (*Ameiurus nebulosus)*	Variety of habitats; feeds on or near bottom on crustaceans, leeches, worms, small fish, insects, and plant material	Mud or sand; among roots of aquatic vegetation; under overhanging bank or near obstruction such as logs and stones	0.5-several ft	>81°F	May to June	Builds nest	(Smith, 1985) (Scott and Crossman, 1973)
Channel catfish (*Ictalurus punctatus)*	Clear, deep water over sand, gravel or rubble bottoms; feeds on aquatic insects, crayfish, molluscs, worms, and plant material	Under logs, undercut banks, crevices, rubble and boulders along protected shorelines	6.5-13 ft	>75°F	May to July	Builds nest	(Smith, 1985) (Scott and Crossman, 1973) (McMahon and Terrell, 1982) (Jenkins and Burkhead, 1993)

Common Name (Scientific Name)	Adult Habitat	Spawning Characteristics					Reference
		Habitat	Depth	Temp.	Dates	Notes	
Tiger muskellunge *(Esox masquinongy x lucius*)	Clean, clear lakes with mixture of deep and shallow areas; feeds on fish, crayfish, and frogs	Sterile					
Rock bass (*Ambloplites rupestris)*	Gravel and rock shorelines; feed on zooplankton, insect larvae, crustaceans	Diverse; swamps and gravel shoals	1.5-4.5 ft	>68°F	May to June	Builds shallow nest; eggs adhesive	(Smith, 1985) (Scott and Crossman, 1973)
Green sunfish (*Lepomis cyanellus)*	Prefers aquatic vegetation; feeds on insects, mollusks, and small fish	Sheltered areas among rocks and logs	<1 ft	>68°F	May to August	Builds nest	
Pumpkinseed *(Lepomis gibbosus*)	feeds on insects, amphipods, mollusks, and small fish	Along shorelines near aquatic vegetation	0.5-1 ft	>65°F	May to August	Builds nest	(Smith, 1985)
Bluegill (*Lepomis macrochirus)*	Slow-moving water with vegetation or shelter; feed throughout water column on plant material and insects	Firm sand or mud with some debris and little vegetation	0-3 ft		May to August	Builds nest	(Smith, 1985)
Smallmouth bass (*Micropterus dolomieu)*	Sand, gravel, or rock bottom with sheltered areas; opportunistic predator	Gravel along shorelines	2-20 ft	>62°F	May to June	Builds nest; retreat to greater depth in summer	(Smith, 1985)
Largemouth bass *(Micropterus salmoides*)	Warm, vegetated areas of lakes; feeds on other fish, invertebrates	Gravelly sand, marl, or soft mud in reeds, bullrushes, or water lilies	1-4 ft	>60°F	late spring to mid-summer	Male builds nest; eggs demersal and adhesive	(Smith, 1985) (Scott and Crossman, 1973)

Common Name (Scientific Name)	Adult Habitat	Spawning Characteristics					Reference
		Habitat	Depth	Temp.	Dates	Notes	
Black Crappie (*Pomoxis nigromaculatus)*	Clear water with abundant vegetation; feed on insects and small fish	Sandy bottom in weedy areas	10-24 in.	>68°F	May to July	Builds nest; eggs adhesive	(Smith, 1985)
Yellow perch *(Perca flavescens*)	Abundant near vegetation; feeds on crayfish, small fish, and odonate nymphs	Sand, gravel, rubble, or vegetation	5-10 ft	>45°F	April to May	Eggs laid in gelatinous strands around aquatic vegetation and submerged tree branches	(Smith, 1985)
Walleye (*Sander vitreus)*	Hover near bottom during day and move into shallows at night	Shoals in lakes over rocks, gravel, or sand	0-4 ft	>35°F	April to May	Broadcast spawner	(Smith, 1985)

and spawn in shallow water areas generally less than 3 feet deep. Chain pickerel, a broadcast spawner, often uses aquatic vegetation in the shallow water zone as attachment sites for its adhesive eggs. Predatory fish including tiger muskellunge, walleye, and black crappie utilize the deeper, open water. Stream fishes including spotfin shiner (*Cyprinella spiloptera*) and satinfin shiner (*Cyprinella analostana*) also inhabit Cowanesque Lake, but are generally found near the mouths of tributaries entering the reservoir. A majority of the Cowanesque Lake fish community spawn between April and July, although some species, including alewife, golden shiner (*Notemigonus crysoleucas*), common carp, pumpkinseed (*Lepomis gibbosus*), and green sunfish (*Lepomis cyanellus*) may spawn into August.

Fish surveys conducted in the Cowanesque River in 1998 upstream and downstream of Cowanesque Lake found a diverse community of stream fishes composed of 25 species (11 upstream and 22 downstream), representing seven families (Brightbill and Bilger, 1998). Upstream of Cowanesque Lake, the fish community was in good condition although available habitat was determined to be suboptimal. Downstream of the lake, the fish community was in fair condition, with suboptimal habitat and high diversity. Several species of fish that prefer clean, clear water, including cutlips minnow, river chub, and northern hogsucker, were collected at the upstream location, but were not present downstream of the lake. Fish collected downstream of the lake were generally comprised of species typical of reservoirs and slower moving waters with aquatic vegetation, such as yellow perch, common carp, bluntnose minnow (*Pimephales notatus*), and pumpkinseed.

4.6 RECREATIONAL RESOURCES

Regional Recreational Resources

Cowanesque Lake is located in Tioga County in north central Pennsylvania near the New York state line. Tioga County lies within the Pennsylvania Wilds Tourism Region, a 12-county region that includes more than 2 million acres of public lands set aside for public access (Pennsylvania Department of Conservation and Natural Resources, 2011). There are abundant opportunities for recreation within the region surrounding Cowanesque Lake, including the Alleghany National Forest, which offers scenic beauty in addition to opportunities for biking, camping, climbing, fishing, hiking, horseback riding, hunting, skiing, snowmobiling, and white water rafting (Lakelubbers LLC, 2011).

Numerous outdoor recreation opportunities similar to those found at Cowanesque Lake are also provided throughout Tioga County, including Pine Creek Gorge (the "Grand Canyon of Pennsylvania" located in Tioga State Forest), Tioga State Forest, Pine Creek Rail Trail, the USACE Tioga-Hammond Lakes, and Hills Creek State Park. The fields and forests around Cowanesque Lake are popular destinations for hunters. Hunting is permitted on Cowanesque Lake project lands except in posted public use areas (USACE, 2011). In addition to the lands at Cowanesque Lake and nearby Tioga-Hammond Lakes, Pennsylvania Gameland 37 located adjacent to Tioga-Hammond Lakes provides opportunities for hunting (USACE, 2011).

The Finger Lakes Region of New York located less than 60 miles from Cowanesque Lake is a popular recreation and vacation destination that includes 11 lakes: Seneca, Cayuga, Keuka, Canandaigua, Skaneateles, Owasco, Conesus, Otisco, Hemlock, Honeoye, and Canadice Lakes (Lakelubbers LLC, 2011). The Finger Lakes Region provides opportunities for fishing, hiking, biking, boating, skiing, sailing, swimming, snowmobiling, tobogganing, canoeing, kayaking, wildlife viewing, water skiing, birding, golfing, camping, and picnicking.

Cowanesque Lake Recreational Resources

The rolling hills of the area surrounding Cowanesque Lake provide excellent aesthetic views from numerous viewpoints. Cowanesque Lake provides recreational opportunities for boating, speed boating/skiing, fishing, swimming, picnicking, and camping. The formal recreation areas at Cowanesque Lake are operated and maintained by the Baltimore District of USACE. There have been no recreation leases or concessions at the lake since 2009. The formal recreation areas provided at Cowanesque Lake are described below and the amenities at each recreation area are summarized in Table 4-13. The recreation areas and facilities at Cowanesque Lake are shown in Figure 4-9.

Tompkins Campground

Tompkins Campground consists of approximately 223.5 acres located on the north side of Cowanesque Lake between Bliss Road and the shoreline about 1.3 miles upstream from the dam. The campground accommodates tent and recreational vehicles and provides 106 reservable campsites in four camping loops (Knoll Camp, Cove Camp, Bench Camp, and Meadow Camp), 16 reservable primitive campsites in a hike-in campground, mooring docks, and a boat launch and beach area for camper use. Potable water and electricity are available at each campsite in the Knoll, Bench, and Cove Camp loops. Individual sewer hook-ups are available at each campsite in the Knoll and Bench Camp loops. No electricity or potable water is available at the hike-in campground.

Tompkins Campground is open from mid-May through September, however, the boat launch and Moccasin Trail side of the campground remains open as a day-use area from October through mid-May (USACE, 2007).

South Shore Day-use Area

The South Shore Day-use Area consists of approximately 51.6 acres located on the south side of Cowanesque Lake about 2 miles upstream of the dam. The day-use area provides opportunities for boating, fishing, swimming, and picnicking. A beach and a restroom/changing house are located on the west side of the day-use area. A concession building is located next to the changing house but it has been unoccupied since 2009 because of a lack of interest from concessionaires due to the low recreational use at the recreation area. Two boat launches, an accessible fishing pier, and parking lots are located on the east side of the day-use area. Facilities for picnicking lie between the beach area and the boat launch area. A seasonal Ranger Station is located at the entrance to the day-use area.

Table 4-13 Cowanesque Lake Recreation Areas

Facility	Parking Area	Boat Launch	Boat Mooring Docks	Shoreline Fishing Area	Accessible Fishing Pier	Swimming Area	Picnic Tables	Picnic Pavilion	Hiking Trail	Biking Trail	Interpretive Trail	Amphitheater	Playground	Ball Field	Horseshoe Pits	Ranger Station	Barbecue Pits	Osprey Sites	Campsites	Vault Toilet	Flush Toilets	Potable Water Spigot	Potable Water at Sites	Electricity at Sites	Sanitary Hook-up at Sites	Showers	Sanitary Dumping Station	Camp Store/Concession
Tompkins Camp-ground																												
Entrance Area	X																										X	
Knoll Camp	X			X			X					X	X		X				33		X		X	X	X	X		
Cove Camp	X						X								X				31		X		X	X		X		
Bench Camp	X		19	X			X						X		X				18		X		X	X	X			
Meadow Camp	X						X	X	X					X	X				24	X		2						
Hike-in Camp-ground	X			X			X												16	X								
Boat Launch and Beach Area	X	1	15	X		X																						
South Shore Day-use Area	X	2		X	X	X	X	3	X				X		X	X	X	X		1	2					X		X
Lawrence Picnic Area	X			X			X	1							X		X			1								
North Tail-race Access Area	X			X			X													X								
South Tail-race Access Area	X			X														X										
North Overlook	X																											
South Overlook	X																	X										
Moccasin Trail	X								X	X	X																	

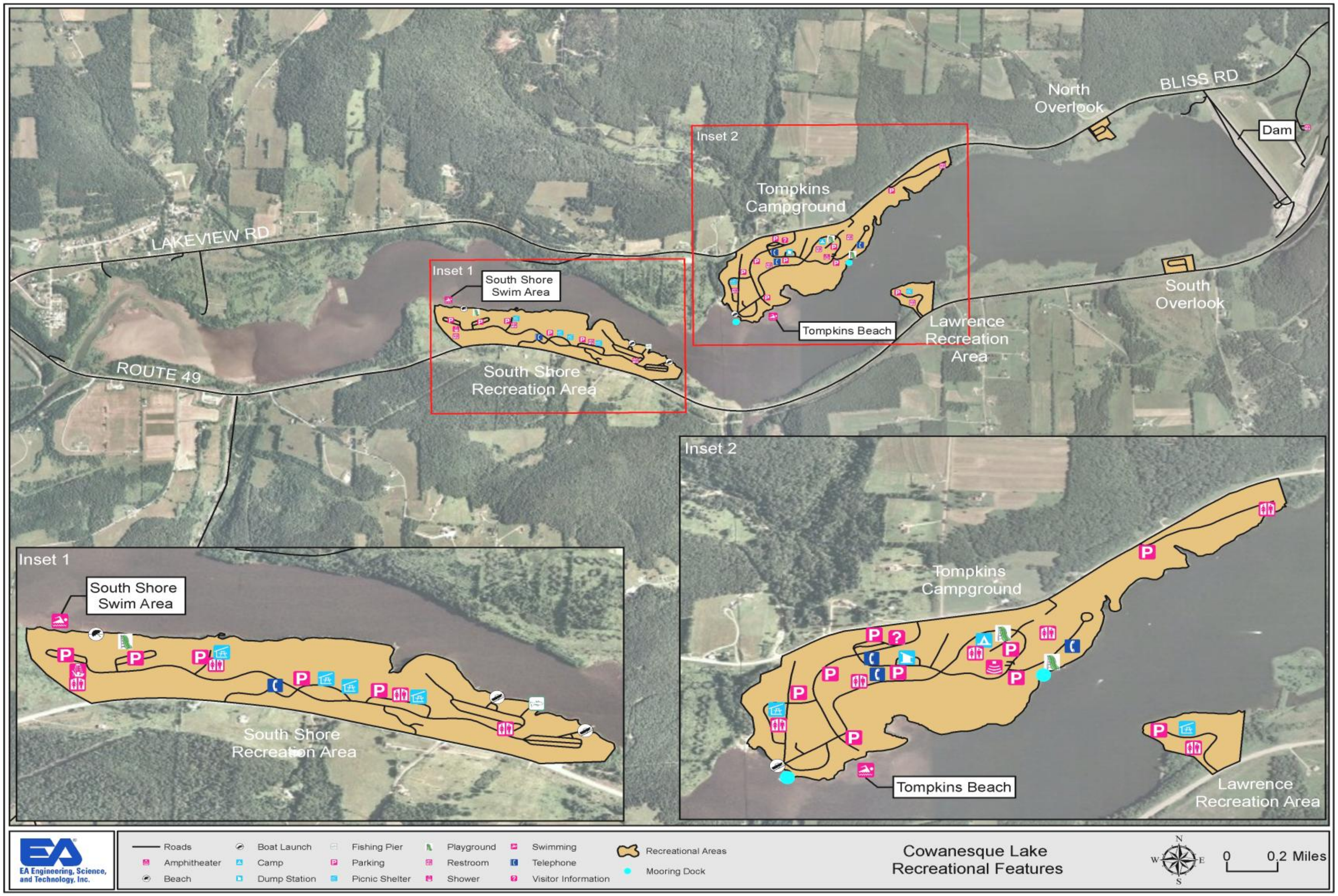

Figure 4-9 Cowanesque Lake Recreational Facilities

Lawrence Picnic Area

The Lawrence Picnic Area is located adjacent to PA Route 49 on the south side of Cowanesque Lake about one mile upstream from the dam. The picnic area provides a picnic pavilion.

North and South Tailrace Access Areas

Shoreline access for fishing is provided at the north (accessed from Bliss Road) and south (accessed from PA Route 49) tailrace areas below Cowanesque Dam. The north access area also provides picnic tables.

Overlooks at Cowanesque Lake

There is an overlook on the north side of Cowanesque Lake (accessed from Bliss Road) and one on the south side of the reservoir (accessed from PA Route 49). Both overlooks have parking and provide scenic views of Cowanesque Dam and Cowanesque Lake.

Trails

The Moccasin Trail is located along a portion of the north shore of Cowanesque Lake. The Moccasin Trail is approximately 4 miles long and has four access points with suitable parking areas, including one access point located inside Tompkins Campground (USACE, 2011). Two access points are located off of Bliss Road and one is located off of PA Route 49 in Nelson. The trail is popular for hiking, dog walking, biking, and hunting.

In addition to the Moccasin Trail, the Mid-State Trail links the trails at Cowanesque and Hammond Lakes into a trail that will in the future extend through Pennsylvania from Maryland to New York (USACE, 2011).

Recreational Use

Recreational uses at Cowanesque Lake include swimming, fishing, boating, picnicking, sightseeing, water skiing, camping, cross country skiing, hiking, and hunting. Numerous fishing tournaments are held at Cowanesque Lake each year, with trophy size muskellunge, catfish, crappie, and largemouth bass as the most popular catches (Lakelubbers LLC, 2011).

The reservoir provides opportunities for pleasure boats, bass boats, sailboats, and canoes/kayaks and currently has no limit on boat size or horsepower (Lakelubbers LLC, 2011; USACE, 2011). The water surface zoning on Cowanesque Lake was established in cooperation with the PFBC to reduce conflicts of use. Under the current Memorandum of Understanding, the USACE and the PFBC must jointly agree upon any major alterations to buoy placement (USACE, 2007). The majority of the reservoir is zoned to permit unrestricted use such as pleasure boating, water skiing, sightseeing, and transportation from location to location. Some areas have been zoned to prohibit unrestricted use depending on terrain, congestion, or other reasons in accordance with U.S. Coast Guard regulations (USACE, 2007). Pennsylvania regulations limit boats to slow, no wake speed in the following areas at Cowanesque Lake: Mapes Creek Cove, Baldwins Creek Cove, between the buoy lines across the reservoir in the vicinity of East and West Boat Launch areas, and from the buoy line west of the South Shore Day-use Area upstream to the headwaters of the reservoir (58 Pa. Code 111.59). Roughly 37 percent of lake area at normal pool elevation of 1080 feet is designated as slow, no wake areas.

Recreational use data at Cowanesque Lake is collected by the USACE from mechanical traffic counters, counts made during registration at Tompkins Campground, and visitor surveys. Recreational use at the reservoir generally occurs at the formal recreation areas but Cowanesque Lake contains areas that are impractical to accurately monitor through mechanical visitation counters, such as walk-in areas used by hunters, anglers, and hikers; lands used by adjacent landowners; and areas where visitors can access the reservoir from adjacent roadways. Although this visitation is currently not being captured in recreational use surveys, USACE estimates that less than 2 percent of the total project visitation could be attributed to this dispersed use visitation (USACE, 2007).

Total yearly visitation[5] to Cowanesque Lake is consistently estimated at between 90,000 and 100,000 (USACE, 2007). The USACE reported a total of 579,825 visits and 210,088 campers at Cowanesque Lake during the 6-year span from 2005 through 2010. Recreational use generated a total of $866,110 in revenues during this 6-year period, with campground fees accounting for almost 91 percent of these revenues. Day-use fees accounted for approximately 5 percent of the revenues, while picnic shelter fees and fishing tournaments accounted for almost 4 percent and 0.4 percent, respectively.

USACE uses the Visitation Estimation and Reporting System to estimate and report recreation use on USACE projects. USACE monthly visitor hour[6] estimates for Cowanesque Lake demonstrate that the peak months for recreational use at the reservoir are May through September, with the highest monthly visitor hours in July and August (Table 4-14). Recreational use from November through April is generally low. Annual reservoir visitation for the past 13 years is summarized in Table 4-15.

Most of the recreational use at Cowanesque Lake occurs at Tompkins Campground, followed by the South Shore Day-use Area and Lawrence Picnic Area, respectively. Tompkins Campground receives close to double the use as the South Shore Day-use Area. Table 4-16 summarizes the estimated recreational visits at the recreation areas in 2007 through 2009.

Population and Recreation Demand

The population of Tioga County, Pennsylvania, has increased slightly in recent years, while the population in the immediate vicinity of Cowanesque Lake has slightly decreased. The population of Tioga County increased by about 2 percent from 1990 to 2010 and by 1.5 percent from 2000 to 2010. The U.S. Census figures for the population of Tioga County are

[5] A “visit” is the entry of one person into a recreation area or site to carry on one or more recreation activities.
[6]A visitor hour is defined as one or more persons on an area of land or water engaging in one or more recreation activities during continuous, intermittent, or simultaneous periods of time aggregating 60 minutes.

Table 4-14 Monthly Visitor Hours (2005-2009) at Cowanesque Lake

Month	2005	2006	2007	2008	2009
January	833	1,792	1,521	4,607	1,920
February	1,031	1,513	1,285	4,266	2,065
March	830	1,984	1,880	5,677	3,083
April	1,999	3,994	3,496	12,469	6,477
May	98,227	86,179	96,492	74,992	103,610
June	164,675	182,682	226,096	131,808	168,788
July	352,296	386,444	386,845	285,060	272,972
August	292,439	338,381	338,653	260,721	241,143
September	113,581	94,355	113,716	86,257	109,547
October	7,119	6,663	47,588	7,991	8,517
November	2,760	2,350	3,982	3,761	4,483
December	1,904	2,978	6,085	2,835	3,578

Table 4-15 Visitor Hours (1998-2009) at Cowanesque Lake

Year	Visitor Hours	Year	Visitor Hours
1998	782,000	2004	1,082,018
1999	773,600	2005	1,028,913
2000	673,100	2006	1,066,103
2001	694,987	2007	1,173,294
2002	727,186	2008	917,544
2003	1,005,679	2009	916,041

Table 4-16 Cowanesque Lake Estimated Distribution of Recreational Visits (2007-2009)

Recreation Area	2007	2008	2009
Tompkins Campground	147,821	92,891	103,715
Tompkins Hike-in Campground	0	8,989	5,768
Lawrence Picnic Area	40,623	28,263	24,856
South Tailrace Access Area	2,037	1,922	2,536
North Tailrace Access Area	3,844	4,041	4,152
South Overlook	8,078	7,737	8,160
North Overlook	5,621	5,790	4,534
South Shore Day-use Area	56,379	53,652	57,089

as follows: 41,126 in 1990; 41,372 in 2000 (a 0.6 percent increase from 1990); and 41,981 in 2010 (USACE, 2002; U.S. Census Bureau, 2011c). The 2010 Census figures for the population of two boroughs and two townships surrounding Cowanesque Lake totaled 4,691: Elkland Borough, 1,821; Nelson Township, 571; Lawrenceville Borough, 581; and Lawrence Township, 1,718 (USACE, 2002; U.S. Census Bureau, 2011b; Ohrel and Register, 2006). The 2010 population for these boroughs and townships decreased by about 0.6 percent from the 2000 population of 4,721 (USACE, 2002; U.S. Census Bureau, 2011b; U.S. Census Bureau, 2011a).

Prior to the 2010 U.S. Census, the Pennsylvania State Data Center produced state and county population projections for Pennsylvania in consultation with a statewide advisory committee. The Pennsylvania State Data Center projected a slight decrease in the population of Tioga County by 2020 and 2030 from the 2000 Census. The Pennsylvania State Data Center projected the 2020 population of Tioga County as 39,772, which is a 3.9 percent decrease from 2000 (The Pennsylvania Bulletin, 2008). The 2030 population of Tioga County was projected as 39,680, a 4.1 percent decrease in population from 2000 (The Pennsylvania Bulletin, 2008). Similar patterns would likely be seen in the future demand for recreational resources at Cowanesque Lake.

The USACE master plan (2002) for Cowanesque Lake recommends that future development to meet recreation demand emphasize water-based recreation. The master plan recommends the clustering of future development around the existing Tompkins Campground and South Shore Day-use Area since these locations already support medium to high intensity development with minimal impacts. In addition, several recreation facilities for future development are recommended in the master plan: cabins, upgraded campsites, additional boat slips, and universally-accessible fishing pier at Tompkins Campground; and a fish cleaning station and water spigots at the vault restrooms at the South Shore Day-use Area (USACE, 2002).

Regional Economy

The USACE reports a total of 95,486 visits to Cowanesque Lake in 2006 that resulted in significant economic benefits to the local economy (USACE, 2011). Visitors to the reservoir in 2006 spent a total of $2.64 million in the local area (within 30 miles of the project), of which 54 percent was captured be the local economy as direct sales effects (USACE, 2011). With multiplier effects, visitor spending resulted in $2.16 million in total sales and $1.10 million in value added (wages and salaries, payroll benefits, profits and rents, and indirect business taxes), and it supported 34 jobs in the community surrounding the reservoir (USACE, 2011).

The USACE also reports significant regional economic benefits in 1999 resulting from reservoir visitors spending a total of $1.88 million in 1999 in the local area (within 30 miles of the project), of which 66 percent ($1.24 million) was calculated to have been captured locally as direct sales effects (Chang et al., 2003). Direct effects are the changes in sales, income, and jobs in those businesses or agencies that initially receive the visitor spending (e.g., parks, motels, campgrounds, restaurants, grocery stores, attractions, and retail stores). These direct sales accounted for another $220,000 in indirect sales and $590,000 in induced sales for a total sales effect of $2.05 million (Chang et al., 2003).

In addition, Cowanesque Lake visitor spending in 1999 generated $640,000 in income and 39 jobs in sectors directly serving visitors (Chang et al., 2003). Another $120,000 in income and three jobs were associated with backward-linked industries through indirect effects, and $320,000 in income and 10 jobs were associated with induced effects. Total income and job effects including direct, indirect, and induced effects of the $1.88 million in Cowanesque Lake visitor spending in 1999 were $1.08 million in income and 53 jobs in the local region.

5.0 ENVIRONMENTAL CONSEQUENCES

The environmental consequences of operating Cowanesque Lake under the five alternatives described in Section 3.2 are evaluated in this chapter. For the purpose of these analyses, environmental consequences include those to both natural and recreation resources. The Baseline Alternative represents conditions that would occur if the current authorized procedure for SRBC's consumptive use mitigation were continued in the future. The other four alternatives represent conditions that would occur if the trigger flow value and/or gage location were changed for future operations. The basis for assessing the consequences of the five alternatives is the lake level output data from SRBC's OASIS model, as described in Chapter 3. These data represent simulated conditions in the lake over the 78-year modeling period, i.e., how the lake level would change in response to the actual hydrologic conditions during the modeling period coupled with the different operating procedures under each of the five alternatives.

In Section 5.1, the hydrologic differences among the five alternatives are discussed, with a focus on differences in lake drawdown. The effects of the different lake drawdown scenarios are then discussed on the main resource areas that could be affected: water quality (Section 5.2), SAV and wetlands (Section 5.3), terrestrial resources (Section 5.4), fish (Section 5.5), and recreation (Section 5.6).

As its name implies, the Baseline Alternative is the baseline to which the four optional trigger alternatives are compared. An analysis of impacts from the Baseline Alternative was completed by USACE in the 1982 reformulation study and environmental impact statement that led to the authorization for water supply storage. The objective of the analysis in this chapter, therefore, is to determine how future operations under the four optional trigger alternative would differ from the Baseline Alternative. To make these comparisons, however, each section discusses the impacts that would be expected under the Baseline Alternative and then discusses how the impacts from each of the four optional trigger alternatives differ from the Baseline Alternative. Comparisons are made not only for the depth of drawdown, but also for how often the drawdown occurs (frequency), the length of the drawdown (duration), and the time of year in which the drawdown occurs (seasonality).

The comparative assessment of impacts for the Baseline Alternative versus new alternatives is largely based on in-lake impacts. But, it is important to recognize that the new alternatives would be more responsive to downstream ecosystem flow needs as set forth by The Nature Conservancy. The current trigger flow, Q 7-10, is based on a constant and infrequently occurring, year-round value. The new trigger flows being considered are based on seasonal (i.e., monthly) and more frequently occurring values that match well with the desirable flows identified by The Nature Conservancy.

5.1 HYDROLOGY

5.1.1 General Trends in Drawdown Data

The duration and magnitude of all drawdown events in the 78-year modeling period (1930-2007) were evaluated for the Baseline Alternative and the four optional trigger alternatives. For this analysis, drawdowns of 1 foot or less were not considered because they occur fairly routinely under normal annual operating fluctuations and they have little or no environmental or recreational impact. Any year that experienced a drawdown of greater than 1 foot for at least 1 day (i.e., the lake elevation dropped below 1079 feet[7] at least once) was considered an event year.[8] Table 5-1 summarizes the number and percentage of *years* in which the *maximum* drawdown reached selected intervals. The number of event years was 51 percent or less of all model-period years for all alternatives. Table 5-2 shows the number and percentage of *days* in which the lake was drawn down within the same selected intervals. Drawdowns of less than 1 foot are not included in Tables 5-1 and 5-2 as previously discussed. However, it is worth noting that the Baseline Alternative results in the same or more drawdown events of less than 1 foot in both total years and days than the new alternatives. This data confirms the lack of additional impact in the 0-1 foot drawdown range caused by the new alternatives.

5.1.2 Normal Operation of Cowanesque Lake

The 78-year modeling period was evaluated to determine how severe each drawdown event was under the baseline and four alternatives. Under the baseline and each of the optional trigger alternatives, the event years summarized in Table 5-1 were ranked from the lowest annual lake elevation (greatest drawdown) to the highest annual lake elevation (least drawdown). The lowest annual lake elevation is the extreme drawdown event for each alternative, as summarized in Table 5-3. For each of the five plans evaluated, the extreme event occurred in 1964, which is discussed further in Section 5.1.4.

Using this ranking system, the median year in which the lake experienced drawdown greater than 1 foot was determined for each alternative. The median event year represents the magnitude of drawdown that would occur in a "normal event year."[9] A summary of these median event years is presented in Table 5-4. Although the year in which the normal drawdown event occurred varies among the alternatives, the minimum lake elevation for each of the optional trigger alternatives is within 1 foot of the minimum lake elevation for the baseline alternative.

In addition, this ranking system was used to determine the median lake elevation for the entire 78-year modeling period (i.e., the years with the 39th and 40th lowest minimum lake elevations), as shown in Table 5-5. Although the median years vary among each alternative, the minimum lake elevation for each of the optional trigger alternatives is within 1 foot of the minimum lake elevation for the baseline alternative.

A complete summary of the median drawdown events is presented in Appendix B2. The tables presented in Appendix B2 list the event years that occurred under the four optional trigger

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[7] One foot below the normal pool elevation of 1080 feet, as defined in the USACE water control manual, although USACE has historically operated the lake at an elevation of 1080.25 feet.

[8] Drawdown event years are named for the year in which the event started. For example, the extreme low flow event that started on August 1, 1964, and ended on March 5, 1965, is considered to be the "1964 event," not the "1965 event."

[9] Because there is an even number of event years under all of the alternatives, there are two median event years for each of these alternatives. When there are two median event years, the minimum lake elevation was determined by averaging the minimum lake elevations for the two median event years.

alternatives, ranked from the lowest annual lake elevation (greatest drawdown) to the highest annual lake elevation (least drawdown). These tables include the minimum lake elevation each year under the optional trigger alternative, the minimum lake elevation for the same year under the Baseline Alternative, and the difference in elevations between the two alternatives.

Table 5-1 Simulated Number of Years (Percentage of Years) Maximum Drawdown Occurs within Selected Drawdown Intervals for the Entire Modeling Period

	Alternative				
Drawdown (ft)	Baseline	WBH97	WBH95	M97	M95
1 < Drawdown ≤ 3	11 (14.1)	9 (11.5)	9 (11.5)	10 (12.8)	11 (14.1)
3 < Drawdown ≤ 5	2 (2.6)	4 (5.1)	7 (9.0)	5 (6.4)	8 (10.3)
5 < Drawdown ≤ 7	5 (6.4)	4 (5.1)	4 (5.1)	2 (2.6)	3 (3.9)
7 < Drawdown ≤ 10	4 (5.1)	4 (5.1)	4 (5.1)	5 (6.4)	4 (5.1)
10 < Drawdown ≤ 15	3 (3.9)	4 (5.1)	5 (6.4)	6 (7.7)	8 (10.3)
15 < Drawdown ≤ 20	2 (2.6)	2 (2.6)	2 (2.6)	2 (2.6)	3 (3.9)
20 < Drawdown ≤ 25	0 (0.0)	0 (0.0)	2 (2.6)	0 (0.0)	1 (1.3)
25 < Drawdown ≤ 30	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.3)	0 (0.0)
30 < Drawdown ≤ 35	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
35 < Drawdown ≤ 40	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.3)	1 (1.3)
40 < Drawdown ≤ 45	1 (1.3)	1 (1.3)	1 (1.3)	0 (0.0)	1 (1.3)
45 < Drawdown	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Total	28 (35.9)	28 (35.9)	34 (43.6)	32 (41.0)	40 (51.3)

Table 5-2 Simulated Number of Days (Percentage of Days) that Drawdown Occurs within Specified Drawdown Levels for the Entire Modeling Period

	Alternative				
Drawdown Level (ft)	Baseline	WBH97	WBH95	M97	M95
1< Drawdown ≤ 3	962 (3.4)	992 (3.5)	872 (3.1)	909 (3.2)	1,096 (3.9)
3 < Drawdown ≤ 5	449 (1.6)	415 (1.5)	721 (2.5)	464 (1.6)	753 (2.6)
5 < Drawdown ≤ 7	346 (1.2)	417 (1.5)	329 (1.2)	383 (1.3)	329 (1.2)
7 < Drawdown ≤ 10	471 (1.7)	470 (1.7)	431 (1.5)	569 (2.0)	515 (1.8)
10 < Drawdown ≤ 15	267 (1.0)	275 (1.0)	534 (1.9)	439 (1.5)	652 (2.3)
15 < Drawdown ≤ 20	64 (0.2)	141 (0.5)	124 (0.4)	86 (0.3)	212 (0.7)
20 < Drawdown ≤ 25	13 (0.1)	16 (0.1)	107 (0.4)	44 (0.2)	60 (0.2)
25 < Drawdown ≤ 30	12 (0.0)	14 (0.1)	14 (0.1)	135 (0.5)	35 (0.1)
30 < Drawdown ≤ 35	25 (0.1)	25 (0.1)	26 (0.1)	29 (0.1)	43 (0.2)
35 < Drawdown ≤ 40	24 (0.1)	25 (0.1)	25 (0.1)	31 (0.1)	106 (0.4)
40 < Drawdown ≤ 45	50 (0.2)	48 (0.2)	57 (0.2)	0 (0.0)	48 (0.2)
45 < Drawdown	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Total	2,683 (9.6)	2,838 (10.3)	3,240 (11.5)	3,089 (10.8)	3,849 (13.5)

Table 5-3 Comparison of Simulated Annual Minimum Elevation Data between all Alternatives for the Extreme Drawdown Event

Alternative	Year	Minimum Lake Elevation (ft)	Maximum Drawdown (ft)	
			Event	Difference from Baseline
Baseline	1964	1035.3	44.7	—
WBH97	1964	1035.1	44.9	0.2
WBH95	1964	1035.2	44.8	0.1
M97	1964	1043.9	36.1	-8.6
M95	1964	1035.2	44.8	0.1

Table 5-4 Comparison of Simulated Annual Minimum Elevation Data between all Alternatives for Median Event Years

Alternative	Year	Minimum Lake Elevation (ft)	Maximum Drawdown (ft)	
			Event	Difference from Baseline
Baseline	1932, 2002	1074.4	5.6	—
WBH97	1959, 1995	1074.1	5.9	0.3
WBH95	1932, 1980	1074.8	5.2	-0.4
M97	1995, 1999	1073.5	6.5	0.9
M95	1934, 1936	1074.5	5.5	-0.1

Table 5-5 Comparison of Simulated Annual Minimum Elevation Data between all Alternatives for Median Years over 78-Year Modeling Period

Alternative	Year	Min. Lake Elevation (ft)	Maximum Drawdown (ft)	
			Event	Difference from Baseline
Baseline	1935, 1960	1079.5	0.5	—
WBH97	1943, 1960	1079.5	0.5	0
WBH95	1987, 1998	1079.4	0.6	0.1
M97	1993, 1998	1079.3	0.7	0.2
M95	1940, 1969	1078.9	1.1	0.6

5.1.3 1930-1931 Drought

As shown in Figure 5-1 and Tables 5-6 and 5-7, the model predicts that Cowanesque Lake would have experienced a significant drawdown period in the early 1930s under the Baseline Alternative and the four optional trigger alternatives. Under all of the alternatives, the drawdown event would have begun in August 1930 and ended in March 1931. For the first few weeks of drawdown, the differences in drawdown levels would have been small, but starting in late September, drawdown would have been greater under the four optional trigger alternatives. The duration of the drawdown event would have been essentially the same for all five alternatives: 230-235 days. Drawdown under WBH97, WBH95, and M97 would have begun on the same day as the Baseline, and M95 would have begun 1 day earlier. The four optional trigger alternatives would have ended 0-5 days later than it would have under the Baseline Alternative. During this time, the lake elevation would have dropped to its lowest levels outside of the drought period in the early 1960s, discussed in Section 5.1.4. Maximum drawdown would have increased from 15.3 feet under the Baseline Alternative to 36.6 feet under Alternative M95.

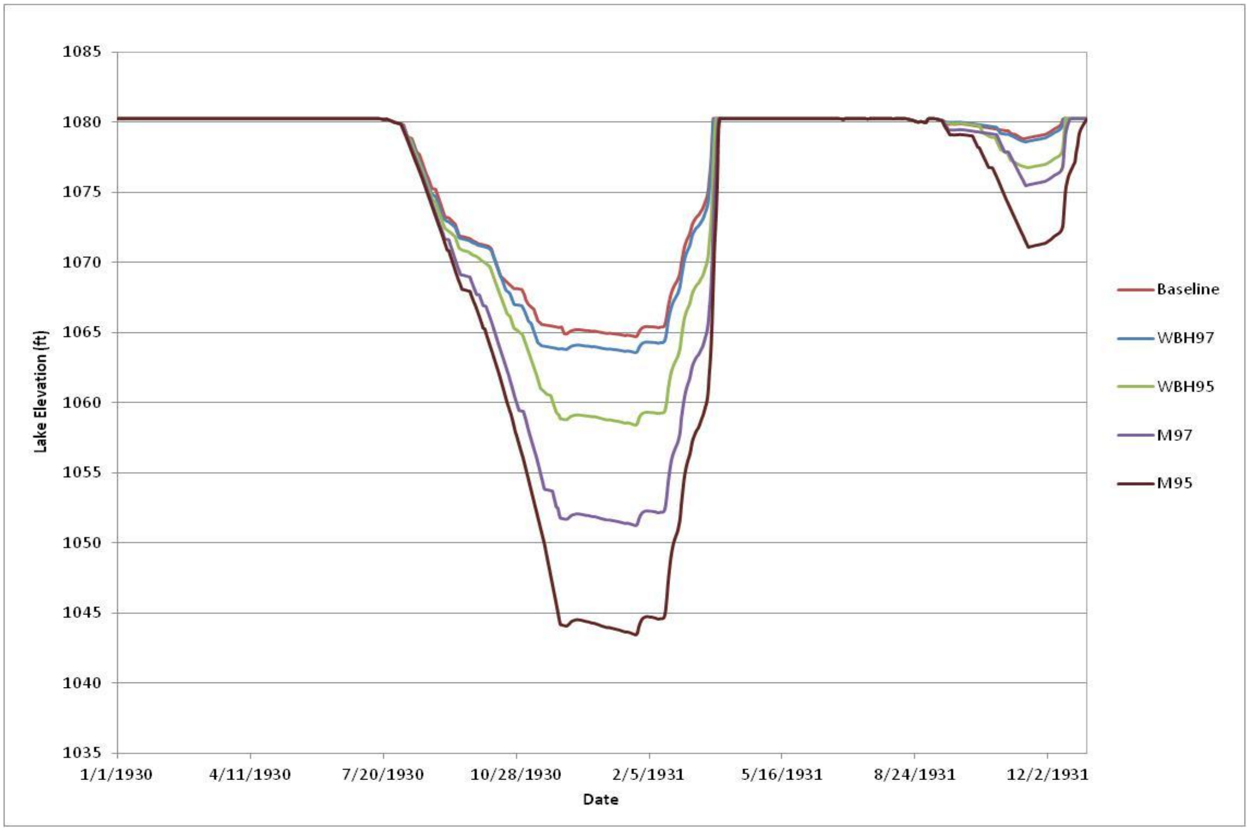

Figure 5-1 Simulated Daily Lake Elevations for Cowanesque Lake from 1930 through 1931

Table 5-6 Summary of Simulated 1930-1931 Drawdown Event—Duration

Alternative	Start Date	End Date	Duration (days)	
			Event	Difference from Baseline
Baseline	Aug. 7, 1930	March 24, 1931	230	—
WBH97	Aug. 7, 1930	March 24, 1931	230	0
WBH95	Aug. 7, 1930	March 26, 1931	232	2
M97	Aug. 7, 1930	March 28, 1931	234	4
M95	Aug. 6, 1930	March 28, 1931	235	5

Table 5-7 Summary of Simulated 1930-1931 Drawdown Event—Maximum Drawdown

Alternative	Date of Max. Drawdown	Min. Lake Elevation (ft)	Maximum Drawdown (ft)	
			Event	Difference from Baseline
Baseline	Jan. 26, 1931	1064.7	15.3	—
WBH97	Jan. 26, 1931	1063.6	16.4	1.1
WBH95	Jan. 26, 1931	1058.4	21.6	6.3
M97	Jan. 26, 1931	1051.3	28.8	13.5
M95	Jan. 26, 1931	1043.4	36.6	21.3

5.1.4 1962-1966 Drought

The most significant drought during the modeling period occurred from 1962–1966. This 5-year period was evaluated to determine the effects of different operating scenarios on the lake's elevation during a severe drought.

As shown in Figure 5-2 and Tables 5-8 and 5-9, the model predicts that the elevation of Cowanesque Lake would have dropped in the late summer/fall of each year from 1962 through 1966; but, in between each of these drawdown periods, the lake would have returned to its normal operating level of 1080 feet. The differences in drawdown duration between the Baseline Alternative and the four optional trigger alternatives would have been:

	1962	1963	1964	1965	1966
Duration under Baseline Alt.	134 days	109 days	218 days	151 days	129 days
Additional duration—Alt. WBH97	+ 3 days	+ 3 days	+ 8 days	- 3 days	+ 6 days
Additional duration—Alt. WBH95	+ 9 days	+ 16 days	+ 17 days	+ 17 days	+ 8 days
Additional duration—Alt. M97	+ 3 days	+ 23 days	- 6 days	+ 14 days	+ 19 days
Additional duration—Alt. M95	+ 11 days	+ 39 days	+ 10 days	+ 28 days	+ 31 days

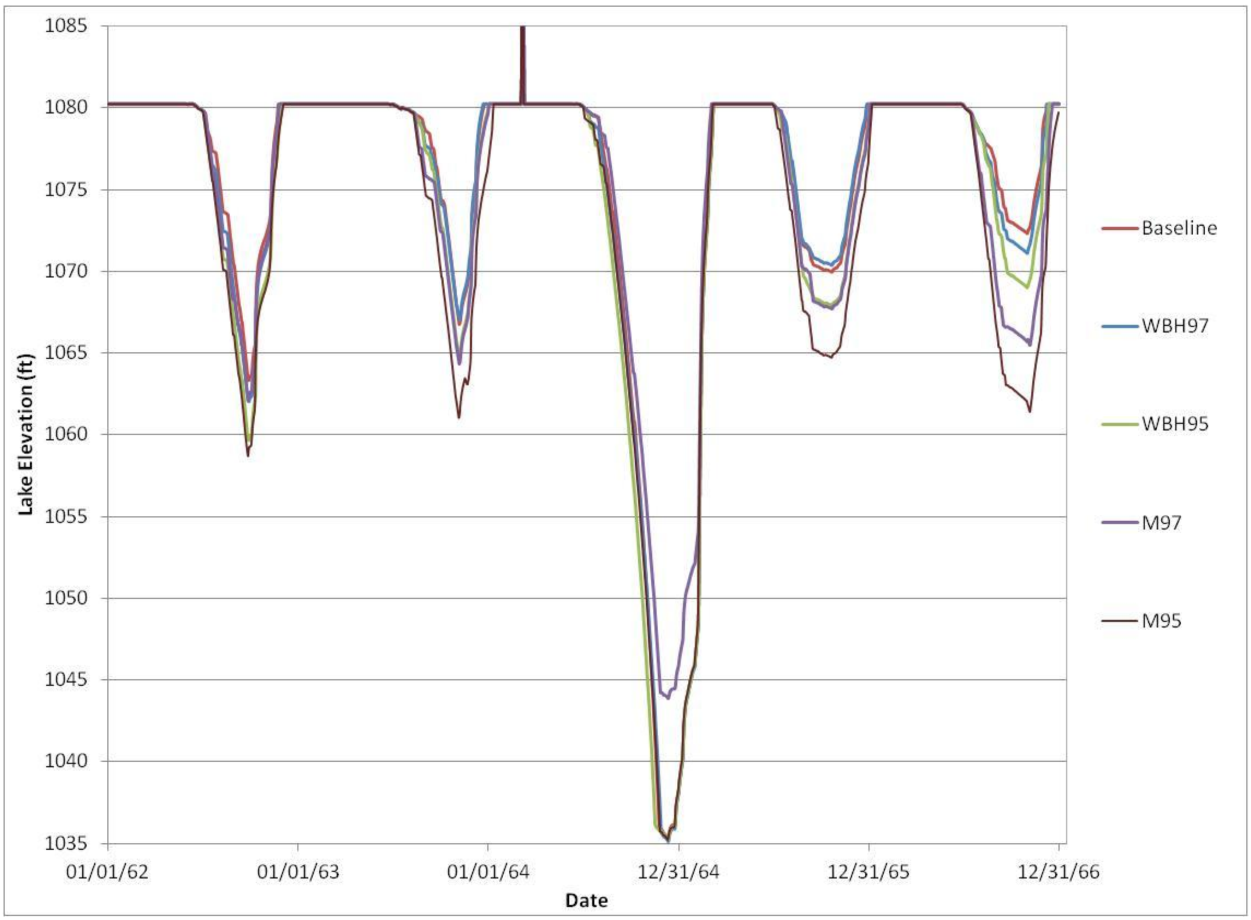

Figure 5-2 Simulated Daily Lake Elevations for Cowanesque Lake from 1962 through 1966

Table 5-8 Summary of Simulated 1962-1966 Drawdown Events—Duration

Alternative	Start Date	End Date	Duration (days)	
			Event	Difference from Baseline
1962 Drawdown Event				
Baseline	7/10/1962	11/20/1962	134	—
WBH97	7/9/1962	11/22/1962	137	3
WBH95	7/7/1962	11/26/1962	143	9
M97	7/9/1962	11/22/1962	137	3
M95	7/7/1962	11/28/1962	145	11
1963 Drawdown Event				
Baseline	8/30/1963	12/16/1963	109	—
WBH97	8/25/1963	12/14/1963	112	3
WBH95	8/22/1963	12/24/1963	125	16
M97	8/16/1963	12/25/1963	132	23
M95	8/15/1963	1/9/1964	148	39
1964 Drawdown Event				
Baseline	8/1/1964	3/6/1965	218	—
WBH97	7/23/1964	3/5/1965	226	8
WBH95	7/14/1964	3/5/1965	235	17
M97	8/1/1964	2/28/1965	212	-6
M95	7/21/1964	3/5/1965	228	10
1965 Drawdown Event				
Baseline	7/26/1965	12/23/1965	151	—
WBH97	7/26/1965	12/20/1965	148	-3
WBH95	7/16/1965	12/30/1965	168	17
M97	7/19/1965	12/30/1965	165	14
M95	7/10/1965	1/4/1966	179	28
1966 Drawdown Event				
Baseline	7/25/1966	11/30/1966	129	—
WBH97	7/25/1966	12/6/1966	135	6
WBH95	7/25/1966	12/8/1966	137	8
M97	7/20/1966	12/14/1966	148	19
M95	7/19/1966	12/25/1966	160	31

Table 5-9 Summary of Simulated 1962-1966 Drawdown Events—Maximum Drawdown

Alternative	Date of Max. Drawdown	Minimum Lake Elevation (ft)	Maximum Drawdown (ft)	
			Event	Difference from Baseline
1962 Drawdown Event				
Baseline	9/28/1962	1063.4	16.6	—
WBH97	9/28/1962	1062.0	18.0	1.4
WBH95	9/28/1962	1059.6	20.4	3.8
M97	9/28/1962	1062.1	17.9	1.3
M95	9/28/1962	1058.7	21.3	4.7
1963 Drawdown Event				
Baseline	11/6/1963	1066.8	13.2	—
WBH97	11/6/1963	1067.0	13.0	-0.2
WBH95	11/6/1963	1064.7	15.3	2.1
M97	11/6/1963	1064.3	15.7	2.5
M95	11/6/1963	1061.0	19.0	5.8
1964 Drawdown Event				
Baseline	12/11/1964	1035.3	44.7	—
WBH97	12/11/1964	1035.1	44.9	0.2
WBH95	12/11/1964	1035.2	44.8	0.1
M97	12/11/1964	1043.9	36.1	-8.6
M95	12/11/1964	1035.2	44.8	0.1
1965 Drawdown Event				
Baseline	10/21/1965	1070.0	10.0	—
WBH97	10/21/1965	1070.4	9.6	-0.4
WBH95	10/21/1965	1067.9	12.1	2.1
M97	10/21/1965	1067.7	12.3	2.3
M95	10/21/1965	1064.7	15.3	5.3
1966 Drawdown Event				
Baseline	10/31/1966	1072.3	7.7	—
WBH97	10/31/1966	1071.1	8.9	1.2
WBH95	10/31/1966	1069.0	11.0	3.3
M97	11/5/1966	1065.5	14.5	6.8
M95	11/6/1966	1061.4	18.6	10.9

Table 5-10 Simulated Number of Days (Percentage of Days) that Drawdown Would Have Exceeded Specified Drawdown Levels over 1962–1966 Drought Period

	Alternative				
Drawdown Level (ft)	Baseline	WBH97	WBH95	M97	M95
1 < Drawdown ≤ 3	123 (6.7)	110 (6.0)	110 (6.0)	92 (5.0)	81 (4.4)
3 < Drawdown ≤ 5	85 (4.7)	93 (5.1)	88 (4.8)	88 (4.8)	81 (4.4)
5 < Drawdown ≤ 7	100 (5.5)	79 (4.3)	69 (3.8)	65 (3.6)	82 (4.5)
7 < Drawdown ≤ 10	194 (10.6)	224 (12.3)	116 (6.4)	132 (7.2)	96 (5.3)
10 < Drawdown ≤ 15	80 (4.4)	82 (4.5)	234 (12.8)	252 (13.8)	200 (11.0)
15 < Drawdown ≤ 20	35 (1.9)	42 (2.3)	47 (2.6)	51 (2.8)	179 (9.8)
20 < Drawdown ≤ 25	13 (0.7)	16 (0.9)	22 (1.2)	16 (0.9)	28 (1.5)
25 < Drawdown ≤ 30	12 (0.7)	14 (0.8)	14 (0.8)	38 (2.1)	14 (0.8)
30 < Drawdown ≤ 35	25 (1.4)	25 (1.4)	26 (1.4)	29 (1.6)	25 (1.4)
35 < Drawdown ≤ 40	24 (1.3)	25 (1.4)	25 (1.4)	31 (1.7)	26 (1.4)
40 < Drawdown ≤ 45	50 (2.7)	48 (2.6)	57 (3.1)	0 (0.0)	48 (2.6)
45 < Drawdown	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Total	741 (40.6)	758 (41.5)	808 (44.2)	794 (43.5)	860 (47.1)

The differences in maximum drawdown between the Baseline Alternative and the four optional trigger alternatives would have been:

	1962	1963	1964	1965	1966
Maximum drawdown under Baseline Alt.	16.6 ft	13.2 ft	44.7 ft	10.0 ft	7.7 ft
Additional drawdown—Alt. WBH97	+ 1.3 ft	- 0.2 ft	+0.1 ft	- 0.4 ft	+ 1.2 ft
Additional drawdown—Alt. WBH95	+ 3.7 ft	+ 2.1 ft	+ 0.0 ft	+ 2.1 ft	+ 3.3 ft
Additional drawdown—Alt. M97	+ 1.2 ft	+ 2.4 ft	- 8.6 ft	+ 2.3 ft	+ 6.9 ft
Additional drawdown—Alt. M95	+ 4.7 ft	+ 5.8 ft	+ 0.1 ft	+ 5.3 ft	+ 10.9 ft

Further detail on the duration of each of the drawdown events from 1962 to 1966 is presented in Tables B4-1 through B4-5 in Appendix B4, which show the number of days that the lake would have experienced selected intervals of drawdown.

Table 5-10 shows the number of total days and the percentage of total days in 1962–1966 where the lake would have experienced drawdown below certain specified drawdown levels.

5.2 WATER QUALITY

5.2.1 Background

Impacts to water quality due to water level drawdowns in lakes are well documented in the scientific literature (Naselli-Flores and Barone, 2005; Naselli-Flores, 2003; Wantzen et al., 2008; Changnon et al., 1989; White et al., 2008; Geraldes and Boavida, 2005; Lourantou et al., 2007). Generally, during the late summer and early fall months when lakes are dewatered because of lower inflows, higher evaporation rates, and increased consumptive use, water quality begins to degrade. The extent of degradation depends on the magnitude and duration of the drawdown, as well as other chemical and biotic factors such as nutrient and phytoplankton concentrations in the water column. Naselli-Flores (2003) and Naselli-Flores and Barone (2005) explain that in lakes at least 50 feet deep that are drawn down 25 feet or less during the late summer/early fall season maintain normal stratification in the water column (Naselli-Flores, 2003; Naselli-Flores and Barone, 2005). However, in years when there is substantial drawdown of the lake (i.e., greater than 25 feet), stratification within the water column is disrupted, and water quality exhibits greater uniformity. Temperature tends to decrease uniformly throughout the water column, whereas DO and pH remain fairly constant. Additionally, increased drawdown of the water level increases water turbulence, which causes the release of particulate material from the sediment, increasing total phosphorus and total nitrogen concentrations (Geraldes and Boavida, 2005). Increased temperature and eutrophic conditions during the late summer/early fall season provide optimal conditions for phytoplankton growth within the reservoir (Geraldes and Boavida, 2005). The die-off of this phytoplankton can cause bottom DO to be depressed.

In the Cowanesque Lake Reformulation Study, USACE evaluated water quality impacts of raising the lake elevation from 1045 to 1080 feet (USACE, 1982). USACE used a thermal model to predict temperature regimes in Cowanesque Lake under a normal year, wet year, and dry year. The model also predicted changes to water quality by analyzing stream water quality parameters and extrapolating changes that would occur in the lake. The model incorporated inflow water quality parameters and general decay rates likely to occur in Cowanesque Lake. The decay rates were related to retention time, which was calculated based on the following assumptions: (1) inflow completely mixes, but only above the thermocline, (2) the first water entering the reservoir is the first released, (3) from March through August all outflow comes from the surface, and (4) after August all outflow comes from the bottom. Practical experience gained over the past 20 years has been used to modify the operations so that releases are currently made from the surface of Cowanesque Lake from May through October.

In a normal year, Cowanesque Lake would be thermally stratified in the summer with a thermocline approximately 15-20 feet deep. DO would follow a similar trend, remaining fairly constant at 8 mg/L until the chemocline approximately 15 to 20 feet deep, and then rapidly decreasing to 1 mg/L. In a dry year, USACE concluded that the lake would be drawn down approximately 22 feet, normal stratification would be disrupted, and the overall temperature of the lake would decrease. DO would exhibit similar stratification in summer to the normal year. Because the stratification is disrupted and the overall temperature profile in the lake decreases, the USACE determined that it would be more difficult to achieve downstream temperature control to maintain a warmwater fishery.

Additionally, the USACE predicted that eutrophic conditions are more likely to occur at lake elevation 1080 feet because of increased retention time within the higher elevation lake (USACE, 1982). Under these conditions, the USACE determined that there would be excessive biological activity (i.e., algae and phytoplankton growth) in the upstream portion of the lake and moderate activity close to the dam. If phytoplankton blooms occurred when the lake is at its minimum elevation this could have a moderately adverse effect on Cowanesque Lake because the phytoplankton die off could cause bottom DO to be severely depressed. However, this would be mitigated by the colder temperatures in October and November when the model predicted Cowanesque Lake reaches its minimum elevation.

As discussed in Section 4.2 of this report, historical water quality data (1997-2010) from Cowanesque Lake shows that the lake exhibits full stratification beginning in July with a thermocline and chemocline approximately 16-20 feet deep (DO and pH rapidly decrease at this depth as well). In August, the thermocline and chemocline are more pronounced with a greater disparity between surface, middle, and bottom DO, temperature, and pH. In September, the water column exhibits less distinct thermal and pH stratification, but the water column remains thoroughly stratified in DO. During the period for which water quality data are available, the lake was never drawn down more than 3 feet, so there are no data to show water quality effects from large drawdowns. Additionally, no data are available past September to determine when the lake turns over.

As discussed in Chapter 4 of this report, the primary water objectives for Cowanesque Lake are: downstream temperature control to maintain a warmwater fishery; alleviation of acid mine pollution present in the Tioga River at Lawrenceville, Pennsylvania; recreational uses; fisheries development in the lake and downstream; and low-flow augmentation. Based on these objectives, DO, temperature, and pH are the primary water quality parameters of concern for in-lake and downstream waters. In the Water Control Plan for Cowanesque Lake, USACE describes the methodology it uses to maintain in-lake and downstream water quality. USACE can manage releases through six inlet ports at four withdrawal levels (centerline elevations at 1073.5, 1059, 1037, and 1015 feet) to regulate the temperature and pH downstream of the dam.

Downstream temperature during the spring and summer is regulated by releasing water from a pair of the upper ports (centerline elevation 1073.5 feet). However, in the fall, releases are made by blending waters withdrawn from the different port levels. The USACE determines the water temperature at the four inlet port elevations, and selects the coldest and warmest temperatures. The flow released from each port is determined based on the following equation:

$$aX + bY = cQ$$

Where, X and Y are the desired flow releases from the coldest and warmest ports, respectively, Q is the desired combined downstream outflow, and a, b, and c are the temperatures at each location. When the lake is drawn down and the water temperature throughout the water column is cooler and exhibits greater uniformity, it would be more difficult for the USACE to regulate downstream temperatures to maintain a warmwater fishery.

Downstream pH at the Tioga Junction is regulated by releasing additional flow from Cowanesque Lake. If the pH at Tioga Junction falls below the water quality standard of 6.5 SU, then in addition to the existing outflow at Cowanesque Lake, the USACE releases 35 percent of the flow at Tioga Junction.

In summary, the primary effects of drawdown on water quality potentially would be: (1) in-lake changes in water quality resulting from destratification of the lake prior to normal lake turnover or (2) downstream changes in water quality resulting from loss of withdrawal level control if the lake elevation falls below critical operating port elevations. Each of these two potential effects is discussed in the following sections.

5.2.2 Potential In-Lake Water Quality Effects

Based on the USACE (1982) thermal model, drawdowns greater than 22 feet could potentially have water quality impacts by disrupting normal stratification and decreasing the overall temperature of the lake. The following section uses the water quality impacts from a 22-foot drawdown to evaluate the water quality effects of drawdown from the Baseline and four optional trigger alternatives.

Non-Drought Operation

The SRBC hydrologic model predicts that drawdown under all five alternatives would have been less than 22 feet in all but the two severe drought events, i.e., 97 percent of years (76 of 78). For the vast majority of the time, therefore, water quality of the lake would not be affected by the Baseline Alternative or any of the four optional trigger alternatives.

Severe Drought Event Operation

The SRBC model predicts that drawdown would have exceeded 22 feet under two of the four optional trigger alternatives in the drought period of 1930-1931 and under all five alternatives in the 1964-1965 drought period:

	Drawdown (ft)	
Alternative	1930-31	1964-65
Baseline	15.3	44.7
WBH97	16.4	44.9
WBH95	21.6	44.8
M97	28.8	36.1
M95	36.6	44.8

1964-1965 Event

The 1964 drawdown event began in late July to early August 1964 and lasted until early March in 1965. Drawdown did not reach 22 feet until early-October, when the drawdown may have begun to destroy stratification. However, this is the same time of year when normal lake turnover would occur and stratification would be destroyed normally. Moreover, drawdown is similar under all five alternatives, so the four optional trigger alternatives would not result in any different water quality effects than the Baseline Alternative, which in turn, would not result in any different water quality effects than normal conditions. Drawdown continued until mid-December before the lake began to fill again, and the lake was filled by early March, which would allow normal stratification to reform in the following summer.

1930-1931 Event

The 1930 drawdown event began in early August 1930 and lasted until late March 1931. This event differs from the 1964 event in that drawdown would have been great enough to destroy stratification—i.e., greater than 22 feet—only under Alternatives M97 and M95. For these alternatives, drawdown would not have reached 22 feet until early-November and late-October, respectively, when the drawdown may have begun to destroy stratification. However, this is the same time of year when normal lake turnover would occur and stratification would be destroyed normally. Although it is possible that Alternatives M97 and M95 could cause water quality effects different from the other four alternatives, this possibility is considered small because of the occurrence of the peak drawdown in late fall and early winter. Drawdown continued until mid-February before the lake began to fill again, and the lake was filled by late-March, which would allow normal stratification to reform in the following summer.

5.2.3 Potential Downstream Water Quality Effects

Water quality effects would be expected downstream only if drawdown brought the lake elevation down far enough to reduce USACE's ability to use all withdrawal ports to manage releases, and if the lake is stratified so that water quality at the bottom of the lake is different from the surface layer.

Non-Drought Operation

For all years except the severe drought events (1930-31, 1964-65), the SRBC hydrologic model predicts that Cowanesque Lake would remain above the USACE's upper ports (centerline elevation 1073.5) in all but four years (i.e., 95 percent of years) under the Baseline Alternative. Table 5-11 compares the number of years drawdown was large enough for Cowanesque Lake to fall below the upper ports and the maximum drawdown during those years, under the Baseline Alternative and the four optional trigger alternatives.

Table 5-11 Simulated Number of Years Cowanesque Lake Is Below Upper Ports[a]

Alternative	No. of Years	Relative to Baseline	Max. Drawdown (ft)
Baseline	4	--	16.6
WBH97	5	+1	18.0
WBH95	9	+5	20.4
M97	7	+3	17.9
M95	12	+8	21.3

[a] Not including severe droughts in years 1930-1931 and 1964-1965.

During the years when Cowanesque Lake is below the upper ports, drawdown under all five alternatives would have been less than 22 feet. Therefore, for the vast majority of time the Baseline Alternative or any of the four optional trigger alternatives would not affect the water quality of Cowanesque Lake.

Severe Drought Event Operation

The SRBC hydrologic model predicts that under all five alternatives Cowanesque Lake would only drop below the USACE's second port during the 1964-1965 drought. The lake would also drop below the second port during the 1930-1931 drought period under Alternatives M97 and

M95 only. Table 5-12 compares the maximum drawdown during the drought periods, under the Baseline Alternative and the four optional trigger alternatives.

Table 5-12 Simulated Maximum Drawdown when Cowanesque Lake Is Below Second Port

Alternative	1930-31	Max. Drawdown (ft)	1964-65	Max Drawdown (ft)
Baseline	--	--	✓	44.7
WBH97	--	--	✓	44.9
WBH95	--	--	✓	44.8
M97	✓	28.8	✓	36.1
M95	✓	36.6	✓	44.8

As discussed in the previous section, the 1930 drawdown event would have been great enough to destroy stratification only under Alternatives M97 and M95. However, as discussed in Section 5.2.2, the stratification would be destroyed at the same time as normal lake turnover. As a result, the vertical temperature profile would be the same under all alternatives, and there would be little difference among the alternatives in the USACE's ability to regulate temperature for a warmwater fishery downstream.

During the 1964 event, the Baseline Alternative would render the two uppermost water inlet ports unusable to the USACE for downstream temperature and pH regulation. Furthermore, as discussed in the previous section, the drawdown would have been great enough to cause a disruption in normal stratification and there is an overall decrease in water temperature (USACE, 1982). Therefore, it would be more difficult for the USACE to regulate temperature for a warmwater fishery downstream under the Baseline Alternative.

The four optional trigger alternatives draw the lake down to minimum elevations approximately equal to or less than the Baseline Alternative. More importantly, the optional trigger alternatives reach minimum elevations after the Baseline Alternative and return to normal pool within a day or two before or after the Baseline Alternative. Therefore, the other alternatives would not cause more adverse effects on water quality or the USACE's ability to regulate temperature and pH downstream than the Baseline Alternative.

5.2.4 Summary and Conclusion

In the 1982 environmental impact statement for proposed water supply storage at Cowanesque Lake, USACE concluded that release of water supply storage during low flow periods would have no effect on water quality in the lake or in the Cowanesque River downstream of the lake (USACE, 1982). In 97 percent of years, it is expected that none of the alternatives would have a drawdown greater than 22 feet, which USACE established as a threshold for potential in-lake water quality effects from drawdown. The other 3 percent of years are severe drought events, where all or some of the alternatives may exceed the 22-foot threshold, but at a date in the fall during the normal destratification time of the lake, thereby minimizing any effects of drawdown. Drawdown of the lake greater than 20 feet or so can affect USACE's ability to control the elevation from which releases are drawn, which in turn can affect its ability to meet optimum warmwater fishery temperatures downstream. Although the four optional trigger alternatives would have greater drawdown depth than the Baseline Alternative, they would have no incremental affect on downstream water temperature because the additional depth will still be above the second port or the additional drawdown would occur around the time the lake normally destratifies and temperature gradients are broken down.

5.3 VEGETATION

5.3.1 Submerged Aquatic Vegetation

As described in Section 4.3.1, SAV generally occurs within Cowanesque Lake in an elevation range from 1080 to 1073 or from 0 to 7.0 feet in drawdown, and Eurasian milfoil is the dominant SAV species within the lake. Eurasian milfoil is an invasive species; therefore, negative impacts to this species may be considered beneficial for restoring a natural ecosystem. On the other hand, Eurasian milfoil provides better habitat for juvenile fish and invertebrates than the open water portion of the littoral zone, and it has a habitat value similar to native species (Smith and Barko, 1990). Eurasian milfoil is an adaptable species and can tolerate a wide range of water depth, temperature, and light level. Its ability to grow and photosynthesize at low temperatures contributes to its high growth rates in the spring and may increase its ability to out compete other species. Eurasian milfoil photosynthesizes and grows when water temperature is above 15°C or 59°F (Smith and Barko, 1990); therefore, drawdowns that occur after the SAV has senesced are not expected to affect the species as greatly. The Cowanesque Reformulation Study presented the results of a thermal model that predicted that Cowanesque Lake would have a surface temperature of 18°C (64.4°F) in September and drop to 15°C (59°F) by the end of October (USACE, 1982). Therefore, Eurasian milfoil will begin to senesce at the end of October. Eurasian milfoil does not form specialized overwintering structures and stores carbohydrates in both the remaining shoots and in the roots (Smith and Barko, 1990).

Impacts to SAV due to water supply drawdowns would vary depending on magnitude, frequency, duration, and seasonality. Additionally, drawdown impacts would vary depending on the SAV species composition and water temperature of Cowanesque Lake. The following qualitative impact threshold definitions were used to describe the degree of impact on SAV:

- **Minor**: Drawdown could cause a decrease in vegetative health or total cover; however these effects would be short term and not permanent.

- **Moderate**: Drawdown could cause a change in species composition or a shift in the shallow water habitat zone. A moderate impact may result in a temporary loss of habitat but is not permanent.

- **Major**: Drawdown could cause a permanent loss of SAV cover or composition or change in species composition.

Table 5-13 presents the area of shallow water habitat at each foot of drawdown between 1080 and 1073 feet (0 to 7 feet). Because percent coverage of SAV within the shallow water habitat has not been quantitatively surveyed and because percent coverage can vary from year to year depending on environmental conditions, Table 5-13 also presents the acres of SAV based on 100, 75, and 50 percent coverage. The last column in Table 5-13 shows the percentage of area of shallow water habitat or SAV lost for each foot of drawdown.

Table 5-13 Effect of Drawdown on Area of Shallow Water Habitat and SAV

Lake Elevation (ft)	Draw-down (ft)	Lake Area (acres)	Area of SWH[(a)] (acres)	Area of SAV at 100% Cover (acres)	Area of SAV at 75% Cover (acres)	Area of SAV at 50% Cover (acres)	Area of SWH/SAV Lost with Drawdown (%)
1080	0	1,050	178	178	133.5	89.0	—
1079	1	1,030	158	158	118.5	79.0	11
1078	2	1,005	133	133	99.8	66.5	25
1077	3	975	103	103	77.3	51.5	42
1076	4	940	68	68	51.0	34.0	62
1075	5	913	41	41	30.8	20.5	77
1074	6	892	20	20	15.0	10.0	89
1073	7	872	0	0	0.0	0.0	100

[(a)] SWH = shallow water habitat, 0-7-ft depth

To assess the variability of drawdown events, both extreme and median event years were used to compare the potential impacts of each optional trigger alternative to the Baseline Alternative. The median event year is the event year where the minimum annual lake elevation was the median drawdown for the entire modeling period (i.e., a “normal” drawdown event year). An extreme event year is the event year in which the minimum annual lake elevation was the lowest during the entire modeling period. The extreme event represents severely dry conditions (i.e., a “worst-case scenario”). For the Baseline Alternative and all four optional trigger alternatives, this extreme event is the 1964 event, when the model predicts that lake elevation would have dropped to its lowest elevation. Drawdown would have begun in late July or early August 1964, and the lake would have returned to normal pool elevation in late February or early March 1965.

5.3.1.1 Baseline Alternative

Under the Baseline Alternative, drawdown events (> 1 foot drawdown) would have occurred in about 36 percent of years. Drawdown events typically begin in July, August, and September and end in October, November, and December. Extreme drawdown events typically begin in late-July and end in early-March of the following year. Therefore, drawdown events under the Baseline Alternative could overlap with the later part of the Eurasian milfoil growing season and could potentially cause some of the SAV to senesce prematurely.

The median drawdown event (2002) under the Baseline Alternative would result in drawdown up to 5.9 feet for a duration of 100 days and temporarily dewatering a maximum of 88 percent of the established shallow water habitat (Table 5-14).

Table 5-14 Simulated Drawdown Parameters for the Baseline Alternative during a Median Low Flow Trigger Event (2002)

Alternative	Dates of Drawdown Event	Duration >1 Foot Drawdown (days)	Maximum Drawdown (ft)	Loss of Established Shallow Water Habitat at Max. Drawdown (%)[a]
Baseline	8/23/2002-11/30/2002	100	5.9	88

[a]Based on 178 acres of shallow water habitat (0-7 foot depth) at normal pool elevation of 1080 feet.

Under the Baseline Alternative, drawdown events during an extreme dry period (1964-1965) would cause a loss of 100 percent of shallow water habitat (greater than 7 feet) from late-August1964 to early-March 1965 for a duration of 179 days (Figure 5-3, Table 5-15).

Table 5-15 Simulated Drawdown Parameters for the Baseline Alternative during an Extreme Low Flow Trigger Event (1964-1965)

	Dates of Drawdown Event	Duration >1 Foot Drawdown (days)	Duration >7 Foot Drawdown (days)	Maximum Drawdown (ft)	Loss of Established Shallow Water Habitat at Max. Drawdown (%)[a]
Baseline	8/1/1964 – 3/6/1965	218	179	44.7	100

[a]Based on 178 acres of shallow water habitat (0-7 foot depth) at normal pool elevation of 1080 feet.

Impact Analysis

The Baseline Alternative would likely result in negligible to short term minor adverse impacts to SAV in Cowanesque Lake during drawdown events. The time of year of drawdowns under the Baseline Alternative could overlap with the latter part of the growing season for SAV. Median low flow trigger events would likely result in a 6-foot drawdown and an 88 percent loss of established shallow water habitat, and short term moderate adverse impacts. An extreme drawdown event under the Baseline Alternative may result in short term moderate adverse impacts to SAV in the lake because of premature die-off due to dewatering of the shallow water habitat. It has been demonstrated in the Tennessee Valley reservoirs that extended drawdowns coupled with freezing temperatures can eliminate Eurasian milfoil and the effects can extend into the next two growing seasons. Therefore, recovery may occur in the spring or it may take up to two growing seasons, but the SAV is expected to recolonize.

5.3.1.2 Alternative WBH97

Under Alternative WBH97, drawdown events (> 1 foot drawdown) would have occurred in about 36 percent of years, the same percentage of years predicted for the Baseline Alternative.

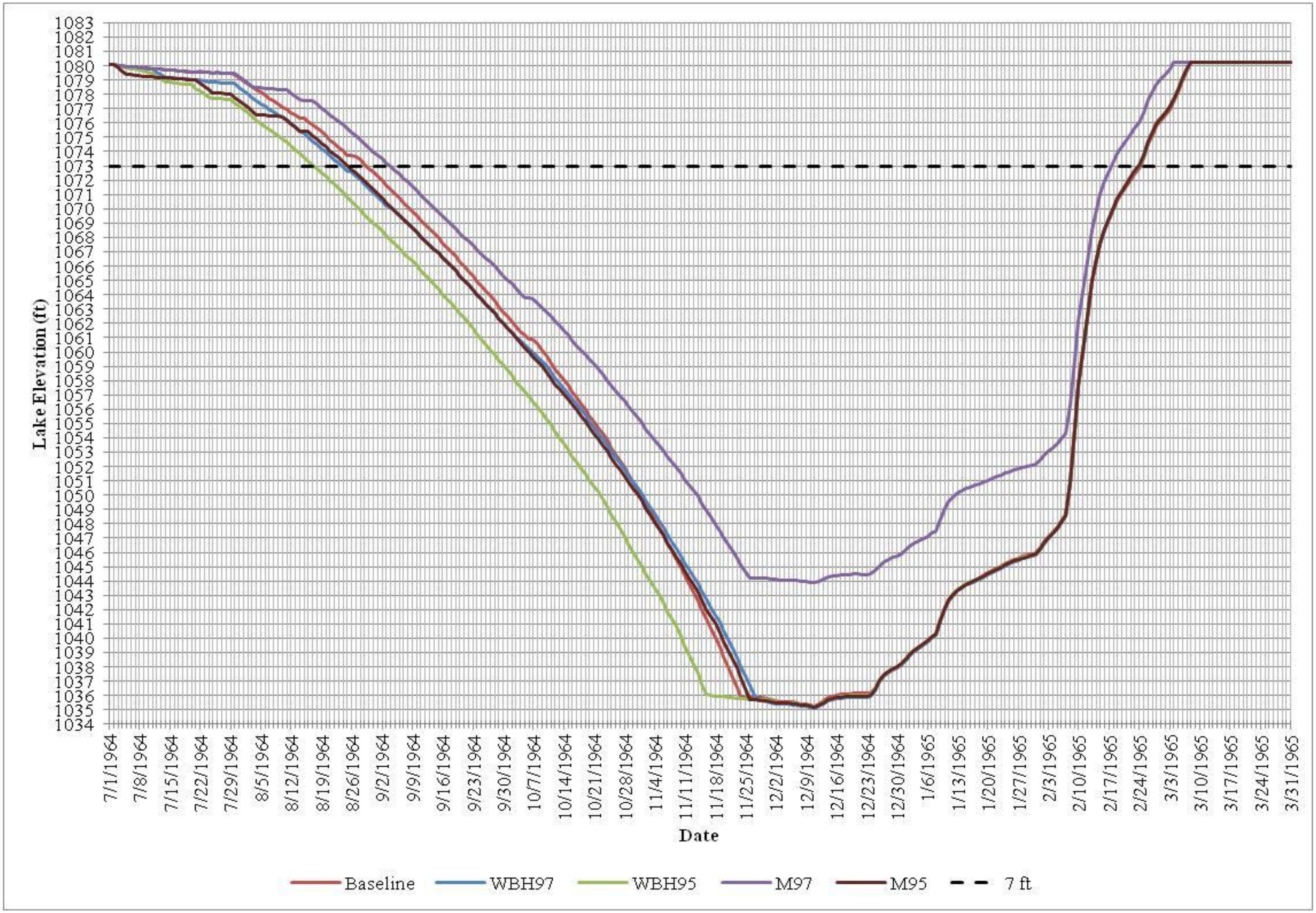

Figure 5-3 Simulated Daily Elevation Curves for the 1964 Event

Drawdown events typically begin in July, August, and September and end in October, November, and December. Extreme drawdown events typically begin in mid-July and end in early-March of the following year. Therefore, drawdown events could overlap with part of the growing season of SAV in Cowanesque Lake. Because potential drawdown events under the Baseline Alternative could occur over the same months, no additional impacts would be expected under Alternative WBH97. The median drawdown event (1959) under Alternative WBH9 would result in drawdown up to 6.3 feet for a duration of 75 days and temporarily dewatering a maximum of 92 percent of the established shallow water habitat (Table 5-16). This temporary loss of established shallow water habitat in Cowanesque Lake compared to the Baseline Alternative (Alternative WBH97) for the same median drawdown event year would equate to only a 3 percent increase under Alternative WBH97. Further, compared to the Baseline Alternative, the median drawdown event under Alternative WBH97 would result in a 0.3-foot increase in drawdown magnitude and a 2-day increase in drawdown duration. Neither of these impacts would cause a measurable difference in impacts from the Baseline Alternative.

Table 5-16 Comparison of Simulated Drawdown Parameters for the Baseline Alternative and Alternative WBH97 during a Median Low Flow Trigger Event (1959)

Alternative	Dates of Drawdown Event	Duration >1 Foot Drawdown (days)	Maximum Drawdown (ft)	Loss of Established Shallow Water Habitat at Max. Drawdown (%)[a]
Baseline	8/1/1959 – 10/12/1959	73	6.0	89
WBH97	7/31/1959 – 10/13/1959	75	6.3	92
Increases	Start 1 day earlier	2	0.3	3

[a]Based on 178 acres of shallow water habitat (0-7 foot depth) at normal pool elevation of 1080 feet.

Under Alternative WBH97, drawdown events during an extreme dry period (1964-1965) would cause a loss of 100 percent of shallow water habitat (greater than 7 feet) from late-August 1964 to late-February1965 for a duration of 185 days (Figure 5-3, Table 5-17). Similarly, modeled drawdown conditions under the Baseline Alternative for the same extreme dry period, indicate 100 percent of shallow water habitat would have been lost from late-August to late-February for a duration of 179 days. Although Alternative WBH97 could result in 5 additional days of 100 percent dewatered shallow water habitat compared to the Baseline Alternative, the magnitude

Table 5-17 Comparison of Simulated Drawdown Parameters for the Baseline Alternative and Alternative WBH97 during an Extreme Low Flow Trigger Event (1964-1965)

Alternative	Dates of Drawdown Event	Duration >1 Foot Drawdown (days)	Duration >7 Foot Drawdown (days)	Maximum Drawdown (ft)	Loss of Established Shallow Water Habitat at Max. Drawdown (%)[a]
Baseline	8/1/1964 – 3/6/1965	218	179	44.7	100
WBH97	7/23/1964 – 3/5/1965	226	185	44.9	100
Increases	Start 9 days earlier	8	6	0.2	0

[a]Based on 178 acres of Shallow water habitat (0-7 foot depth) at normal pool elevation of 1080 feet.

and duration of the drawdown would be so substantial that slight differences between the alternatives would provide no additional impact.

Impact Analysis

Like the Baseline Alternative, under Alternative WBH97 there would be no drawdown events in about two-thirds (64 percent) of all years. In the other one-third of all years, Alternative WBH97 would likely result in no additional impacts to SAV compared to the Baseline Alternative because the depth, duration, and seasonality of events is similar between the two alternatives. The magnitude, duration, and temporary loss of established shallow water habitat from drawdowns under Alternative WBH97 would be similar to those experienced under the Baseline Alternative during both median and extreme low flow trigger events in Cowanesque Lake. The time of year of drawdowns under Alternative WBH97 could overlap with the latter part of the SAV growing season Further, drawdown events under Alternative WBH97 would likely occur during the same seasonal timeframe as the Baseline Alternative and, therefore, there would be no additional impacts to SAV in Cowanesque Lake. Median low flow trigger events would likely result in nearly a 0.3-foot increase in lake level drawdown and about 3 percent more loss of established shallow water habitat compared to the Baseline Alternative, and therefore, would likely have negligible impacts on SAV. Impacts to SAV from an extreme drawdown event under Alternative WBH97 would not result in any additional impacts compared to the Baseline Alternative since the overall duration and magnitude of the drawdown would be nearly the same.

5.3.1.3 Alternative WBH95

Under Alternative WBH95, drawdown events (> 1 foot drawdown) would occur in about 44 percent of years at Cowanesque Lake. Drawdown events typically begin in July, August, and September and end in October, November, and December. An extreme drawdown event typically begins in mid-July and ends in early-March of the following year. These time periods illustrate that drawdown events would overlap with SAV growing season in Cowanesque Lake; however, drawdown events were predicted to have the potential to occur during the same months under the Baseline Alternative. The median drawdown event (1980) under Alternative WBH95 would result in drawdown up to 5.3 feet for a duration of 95 days and temporarily dewater a maximum of 81 percent of the established shallow water habitat (Table 5-18). This temporary

Table 5-18 Comparison of Simulated Drawdown Parameters for the Baseline Alternative and Alternative WBH95 during a Median Low Flow Trigger Event (1980)

Alternative	Dates of Drawdown Event	Duration >1 Foot Drawdown (days)	Maximum Drawdown (ft)	Loss of Established Shallow Water Habitat at Max. Drawdown (%)[a]
Baseline	9/14/1980 – 11/25/1980	73	3.0	42
WBH95	9/4/1980 – 12/7/1980	95	5.3	81
Increases	Start 10 days earlier	12	2.3	39

[a]Based on 178 acres of shallow water habitat (0-7 foot depth) at normal pool elevation of 1080 feet.

loss of established shallow water habitat in Cowanesque Lake compared to the Baseline Alternative for the same median drawdown event year would equate to a 39 percent increase under Alternative WBH95. Further, compared to the Baseline Alternative, the median drawdown event under Alternative WBH95 would result in a 2.3-foot increase in drawdown magnitude and 22-day increase in drawdown duration.

Under Alternative WBH95, modeled water levels for extreme dry events (1964-1965) predict a drawdown event occurring between mid-August and late-February with potential maximum drawdown of 44.9 feet and total drawdown duration of 235 days (Figure 5-3, Table 5-19). This extreme dry drawdown event would have resulted in the temporary loss of 100 percent of the established shallow water habitat for a total of 192 days. Compared to the Baseline Alternative for the same drawdown event, this temporary unavailability of 100 percent established shallow water habitat represents an increase of 13 days in duration.

Table 5-19 Comparison of Simulated Drawdown Parameters for the Baseline Alternative and Alternative WBH95 during an Extreme Low Flow Trigger Event (1964-1965)

Alternative	Dates of Drawdown Event	Duration >1 Foot Drawdown (days)	Duration >7 Foot Drawdown (days)	Maximum Drawdown (ft)	Loss of Established Shallow Water Habitat at Max. Drawdown (%)[a]
Baseline	8/1/1964 – 3/5/1965	218	179	44.7	100
WBH95	7/14/1964 – 3/5/1965	235	192	44.9	100
Increases	Start 18 days earlier	17	13	0.2	0

[a]Based on 178 acres of Shallow water habitat (0-7 foot depth) at normal pool elevation of 1080 feet.

Impact Analysis

Under Alternative WBH97 there would be no drawdown event in more than half (56 percent) of all years. In general, the modeled water level data for Cowanesque Lake predict that the duration and magnitude of drawdown events would increase under Alternative WBH95 compared to the Baseline Alternative. A median drawdown event under Alternative WBH95, which would occur roughly once every 4 years on average, would start 10 days earlier and result in about a 2-foot increase in drawdown magnitude compared to the Baseline Alternative. These changes would likely have a short-term minor adverse impact on SAV in Cowanesque Lake because a portion of the SAV would dry up sooner. However, the SAV would be expected to recolonize in the following year, so there would be no long-term effect. The extreme drawdown event would begin 18 days earlier under Alternative WBH95 compared to the Baseline Alternative, which would have a short-term minor adverse impact to SAV areas drying up earlier. In the long-term; however, there would be no difference between the two alternatives because of the long duration of drawdown greater than 7 feet in both cases.

5.3.1.4 Alternative M97

Under Alternative M97, water level data for the modeling period indicate drawdown events in Cowanesque Lake would occur in about 41 percent of years and range in magnitude up to 36.1 feet. This occurrence of drawdowns under Alternative M97 represents a 5 percent increase in potential drawdown years compared to the Baseline Alternative; however, the maximum drawdown under Alternative M97 (36.1 feet) was 8.6 feet lower in magnitude than the maximum drawdown predicted for the Baseline Alternative (44.7 feet). Modeled water level data for Alternative M97 predicts drawdown events typically begin in July, August, and September and end in October, November, and December. A typical extreme drawdown event begins in mid-July and ends in early-March of the following year. Although this time period for drawdowns overlaps with the SAV growing season, it is consistent with the potential drawdown period under the Baseline Alternative. For a median drawdown event (1999) under Alternative M97, water level drawdown up to 6.8 feet for a duration of 104 days could occur resulting in a maximum temporary loss of about 98 percent of the established shallow water habitat (Table 5-20). Comparatively, under the Baseline Alternative for the same year, drawdown up to 6.5 feet for a duration of 94 days would have occurred and resulted in a maximum temporary loss of about 94 percent of established shallow water habitat.

Table 5-20 Comparison of Simulated Drawdown Parameters for the Baseline Alternative and Alternative M97 during a Median Low Flow Trigger Event (1999)

Alternative	Dates of Drawdown Event	Duration >1 Foot Drawdown (days)	Maximum Drawdown (ft)	Loss of Established Shallow Water Habitat at Max. Drawdown (%)[a]
Baseline	8/5/1999 – 11/6/1999	94	6.5	94
M97	7/27/1999 – 11/7/1999	104	6.8	98
Increases	Start 9 days earlier	10	0.3	4

[a]Based on 178 acres of shallow water habitat (0-7 foot depth) at normal pool elevation of 1080 feet.

Modeled water levels for extreme dry events (1964-1965) under Alternative M97 indicate potential maximum drawdown of 36.1 feet and total drawdown duration of 212 days (Figure 5-3, Table 5-21). This extreme drawdown event would occur from early-August to late-February and

Table 5-21 Comparison of Simulated Drawdown Parameters for the Baseline Alternative and Alternative M97 during an Extreme Low Flow Trigger Event (1964-1965)

Alternative	Dates of Drawdown Event	Duration >1 Foot Drawdown (days)	Duration >7 Foot Drawdown (days)	Maximum Drawdown (ft)	Loss of Established Shallow Water Habitat at Max. Drawdown (%)[a]
Baseline	8/1/1964 – 3/6/1965	218	179	44.7	100
M97	8/1/1964 – 2/28/1965	212	168	36.1	100
Increases	Start on the same day	-16	-11	-8.6	0

[a]Based on 178 acres of Shallow water habitat (0-7 foot depth) at normal pool elevation of 1080 feet.

could result in dewatering of 100 percent of the existing shallow water habitat for 168 days. For comparative purposes, the same modeled extreme dry event under the Baseline Alternative would have occurred over generally the same time period but would have resulted in the temporary loss of 100 percent of shallow water for a total of 179 days.

Impact Analysis

Under Alternative WBH97 there would be no drawdown event in more than half (59 percent) of all years. Alternative M97 would likely result in no additional impacts to SAV in Cowanesque Lake compared to the Baseline Alternative. Drawdown events under Alternative M97 would likely occur between late-July through March, which overlaps with the SAV growing season in Cowanesque Lake; however, because drawdowns have the potential to occur during the same time period under the Baseline Alternative no additional impacts to SAV would occur. For the median event discussed in this analysis (1999), the drawdown under Alternative M97 would only represent a 0.3-foot increase in magnitude and a 10 day increase in duration compared to the Baseline Alternative and would likely have negligible to minor adverse impacts on SAV. No additional impacts are expected to occur under Alternative M97 during extreme dry events since the magnitude and duration were less severe compared to the Baseline Alternative.

5.3.1.5 Alternative M95

Under Alternative M95, drawdown events (> 1 foot drawdown) occurred in about 51 percent of years over the 78-year modeling period for modeled water level data at Cowanesque Lake. Compared to the Baseline Alternative, this frequency of drawdown events represents an increase of nearly 15 percent. Typically, drawdown events under Alternative M95 begin in July, August, or September, and end in October, November, and December. An extreme drawdown event typically begins in mid-July and ends in early-March of the following year. The median drawdown event (1936) under Alternative M95 would result in drawdown up to 5.5 feet for a duration of 108 days and temporarily dewater a maximum of 84 percent of the established shallow water habitat (Table 5-22). Compared to the Baseline Alternative, the median drawdown event under Alternative M95 would result in a 1.9-foot increase in drawdown magnitude and a 13 day increase in drawdown duration. The temporary loss of established shallow water habitat

Table 5-22 Comparison of Simulated Drawdown Parameters for the Baseline Alternative and Alternative M95 during a Median Low Flow Trigger Event (1936)

Alternative	Dates of Drawdown Event	Duration >1 foot Drawdown (days)	Maximum Drawdown (ft)	Loss of Established Shallow Water Habitat at Max. Drawdown (%)[(a)]
Baseline	7/25/1936 – 10/28/1936	96	3.6	54
M95	7/20/1936 – 11/4/1936	108	5.5	84
Increases	Start 5 days earlier	12	1.9	30

[(a)]Based on 178 acres of shallow water habitat (0-7 foot depth) at normal pool elevation of 1080 feet.

in Cowanesque Lake compared to the Baseline Alternative for the same median drawdown event year would have resulted in a 30 percent increase under Alternative M95.

Modeled water levels for an extreme dry event (1964-1965) under Alternative M95 indicate potential maximum drawdown of 44.8 feet and total drawdown duration of 228 days occurring from late-July through early March (Figure 5-3, Table 5-23). An extreme drawdown event of this magnitude and duration could potentially result in the temporary unavailability of 100 percent of shallow water habitat (more than 7 feet) for duration of 184 days. Compared to the Baseline Alternative, this extreme drawdown event would result in a 0.1-foot increase in drawdown magnitude and about 10 more days in duration under Alternative M95. Further, compared to the Baseline Alternative, 100 percent of shallow water habitat would be temporarily unavailable for 5 more days under Alternative M95.

Table 5-23 Comparison of Simulated Drawdown Parameters for the Baseline Alternative and Alternative M95 during an Extreme Low Flow Trigger Event (1964-1965)

Alternative	Dates of Drawdown Event	Duration >1 foot Drawdown (days)	Duration >7 Foot Drawdown (days)	Maximum Drawdown (ft)	Loss of Established Shallow Water Habitat at Max. Drawdown (%)[a]
Baseline	8/1/1964 – 3/6/1965	218	179	44.7	100
M95	7/21/1964 – 3/5/1965	228	184	44.8	100
Increases	Start 11 days earlier	10	5	0.1	0

[a]Based on 178 acres of Shallow water habitat (0-7 foot depth) at normal pool elevation of 1080 feet.

Impact Analysis

Under Alternative WBH97 there would be no drawdown event in almost half (49 percent) of all years. A median drawdown event under Alternative WBH95, which would occur roughly once every 4 years on average, would start 5 days earlier and result in about a 2-foot increase in drawdown magnitude compared to the Baseline Alternative. These changes would likely have a short-term minor adverse impact on SAV in Cowanesque Lake because a portion of the SAV would dry up sooner. However, the SAV would be expected to recolonize in the following year, so there would be no long-term effect. The extreme drawdown event would begin 11 days earlier under Alternative WBH95 compared to the Baseline Alternative, which would have a short-term minor adverse impact to SAV areas drying up earlier. In the long-term, however, there would be no difference between the two alternatives because of the long and essentially equal duration of drawdown greater than 7 feet in both cases.

5.3.1.6 Summary and Conclusion

For 50 percent of years, lake drawdown is less than 1 foot under all alternatives, and there would be no impact to SAV. Under the four optional trigger alternatives, drawdown events would occur in fewer than 4 percent more days than under the Baseline Alternative, so there is not a large increase in drawdown under the four alternatives in the long term. In median event years, the drawdown event may begin 1 or 2 weeks earlier under the four alternatives than it would under the Baseline Alternative, which would cause earlier drying out of portions of the SAV area. However, there would be no difference in impact in the long term, because the SAV would recolonize in the following spring. During severe drought events, there may be moderate impacts to the SAV because the prolonged winter exposure may reduce SAV viability, but the SAV would be expected to recover over 1 or 2 years. This moderate impact would occur under all alternatives, so there is no increased impact from the four optional trigger alternatives compared to the Baseline Alternative. Impact modifications are not proposed for SAV because, in comparison to the Baseline Alternative, the four optional trigger alternatives are not expected to alter the level of impact—i.e., a minor effect changed to a moderate effect or a moderate effect changed to a major effect—to the SAV community.

5.3.2 Wetlands

Emergent wetlands occur in Cowanesque Lake at the interface between the water's edge and land and are, therefore, susceptible to water level fluctuations. The emergent wetlands at Cowanesque Lake are located at elevation 1079 and above, so at normal pool the emergent wetlands have water depths between 0 and 1 foot. The majority of the wetlands begin at elevation 1080 and extend landward 15-50 feet; therefore, they have saturated soils and are supporting wetland vegetation but do not have standing water. Typical of emergent wetlands, these systems have colonized the shoreline right along the edge of the normal pool in areas where the slope is accommodating.

As was discussed in the hydrology section (Section 5.1), drawdowns in the range of 0–1 foot (1080-1079 feet lake elevation) occur fairly routinely under normal lake operating conditions, and consequently, the existing wetlands will have adapted to this normal fluctuation. In addition, the Baseline Alternative results in the same or more drawdown events of 0–1 foot in both total years and days during March 1 – November 30 than the new alternatives. This data confirms the lack of additional impact in the 0-1 foot drawdown range caused by the new alternatives. Any year that experienced a drawdown of greater than 1 foot for at least 1 day (e.g., the lake elevation dropped below 1079 feet at least once) was considered to be an event year. Emergent wetlands occur along the edge of the normal pool and are dependent on the lake hydrology; therefore, any event with a drawdown greater than the normal 1-foot fluctuation was assessed for impacts on the wetlands. The degree of impact depends on the extent of the drawdown (magnitude), the length of time the water is drawn down (duration), and the seasonality or time of year of drawdown.

A drawdown event could have a range of adverse impacts on the emergent wetland habitat ranging from minor impacts to major impacts. Minor impacts to wetland are defined as stress on the system not resulting in long-term or permanent negative impacts to the vegetation, hydrology, or soils. Stress could result in a decrease in vegetative health or a decrease in coverage due to loss of foliage. Moderate impacts to the emergent wetland habitat could include shifts in species composition or movement of the wetland zone. These impacts are temporary because the overall value of the system is eventually replaced. Major impacts would include permanent loss of the habitat, which could occur where environmental conditions prohibit the system from shifting or changing. Beneficial impacts include increase in native species, increase in plant diversity and decrease in nuisance exotic species.

As was stated above, the emergent wetlands currently exist at elevation 1079.0 feet and above; therefore, during normal pool conditions the wetlands have at the most 1.0 foot of standing water. Most of the wetland area is not inundated, but the soils are saturated often enough to support wetland vegetation. This decrease in soil saturation is expected to have the greatest effect on obligate species. Primary wetland species observed within the emergent wetlands are soft stem bulrush, northern arrowwood, woolbrush, rice cut grass, broadleaf cattails, black willow, silky dogwood, and smooth alder. The two dominant species observed within the emergent wetlands are bulrush and cattails, which are obligate wetland species and depend on standing water or saturation throughout the year. Bulrush is usually found in areas regularly to permanently inundated with up to 1 foot of standing water or saturated (approximately 26 to 100 percent of the growing season). It typically grows in poorly drained or continuously saturated soils (Thurnhorst, 1993). Broadleaf cattail is usually found in areas irregularly, seasonally, regularly, or permanently inundated up to 1 foot or saturated (up to approximately 100 percent of the growing season) (Thurnhorst, 1993). Table 5-24 summarizes the dominant species observed at Cowanesque Lake, their wetland status and flowering and fruiting period. All of the dominant species observed are either obligate or facultative wetland species.

Table 5-24 Dominant Vegetative Species Observed within Emergent Wetland Systems, August 17-19, 2011

Scientific Name	Common Name	Status	Flowering Period	Fruiting Period
Scirpus validus	Soft stem bulrush	OBL	June to September	
Viburnum recognitum	Northern arrowwood	FACW	June to September	
Scirpus cyperinus	Woolbrush	OBL	August to September	
Leersia oryzoides	Rice cut grass	OBL	August to June	
Typha latifolia	Broadleaf cattail	OBL	May to June	
Salix nigra	Black willow	FACW	Mid March-Early April	Late April-Mid May
Cornus amomum	Silky dogwood	FACW	May-June	Early-Late August
Alnus serrulata	Smooth alder	OBL	Mid-Late March	Early August-February

A drawdown of any kind will have an impact on the wetland but the extent of the effect is determined by several factors including species composition, time of year, water and air temperature, soil composition and other stressors preceding the drawdown.

General Trends

As was summarized in Section 5.1.1, the model predicted that under the Baseline Alternative and the four optional trigger alternatives less than half of the years in the modeling period experienced drawdowns greater than 1 foot. More specifically, Table 5-25 presents the total number of years that experienced a drawdown for each alternative.

As is evident in Table 5-25, the Baseline Alternative and Alternative WBH97 have the least number of years with a drawdown greater than 1 foot (28 years). Alternative M95 has the most event years (40 years). As shown in the last row of Table 5-2 in Section 5.1, however, the frequency of drawdowns under the four optional trigger alternatives increases by less than 4 percent relative to the Baseline. To evaluate the effects of the drawdowns associated with the alternatives, it is necessary to review the duration and time of year for each of the events in comparison to the Baseline Alternative.

Table 5-25 Simulated Total Number of Event Years with a Drawdown Greater than 1 Foot

Alternative	No. of Years with Drawdown >1 ft	No. of Additional Years with Drawdown >1 ft Relative to Baseline
Baseline	28	—
WBH97	28	0
WBH95	34	6
M97	32	4
M95	40	12

The time of year during which the drawdown occurs is important because wetland plants will be affected differently if they are dormant or are flowering and growing. As was discussed above, the majority of the drawdown events began in August or September and reaches a minimum elevation, on average, in mid-October. The drawdown events begin when several of the dominant wetland species are in flower and conclude after they are dormant. It is expected that the predicted drawdown duration and time of year at which drawdown occurs for the Baseline Alternative and all four optional trigger alternatives would result in moderate impacts on the emergent wetlands. The wetland vegetation is expected to return the following growing season; therefore, the impact is not permanent. Table 5-26 presents the average number of days with a drawdown greater than 1 foot for the event years.

Table 5-26 Simulated Average Drawdown Duration for the Event Years

Alternative	Average Drawdown Duration (days)	Increase Relative to Baseline (%)[a]
Baseline	91.7	---
WBH97	96.9	1.4
WBH95	91.6	0.0
M97	95.6	1.1
M95	93.0	0.4

[a]Increase calculated by dividing the average duration by the 365 days in a year.

Overall, there is no large difference in mean days when comparing the four optional trigger alternatives to the Baseline Alternative. The average duration of drawdown predicted under the Baseline Alternative is 91.7 days or approximately 17 weeks. The four optional trigger alternatives increase the mean duration by 5 days (1.4 percent) or less. This difference would not add measurably to the impact of a 17-week drawdown.

1962–1966 Drought

As described in the hydrology section (Section 5.1), an extreme drought occurred in the years 1962-1966. Model predictions for those years were examined to determine the effects of the different operating alternatives on the emergent wetlands during such a drought. Figure 5-3 shows the model's predicted lake elevations for the 1962 event as a typical year during this series of years, and Figure 5-3 shows lake elevations for the 1964 event, which was the most extreme drought year.

For both events, the beginning of the drawdown period begins within a range of a few days for all five alternatives, and all five alternatives result in drawdowns that would draw the lake below 1 foot for an extended period of time. As summarized in Table 5-27, there are minor differences in the date on which drawdown goes below 1 foot and the number of days it takes to get back to that level.

For the all of the alternatives including the Baseline Alternative, the drawdown begins during the time of year when several of the dominant species are growing and flowering and does not return to normal pool until after the plants have gone dormant. As was discussed for the non-drought years, the length of the drawdown will have a moderate effect on the emergent wetlands. There will be a loss of wetland habitat for the year, but the plants are expected to regrow the subsequent spring. The impact is expected to be the same for the four optional trigger alternatives since the majority of the durations, start and end dates, and durations are all very similar. In 1964, Alternative WBH95 has the earliest start date, but the additional 18 days is not expected to have more than a minimal incremental effect on the wetlands because of the long duration (218 days) of the Baseline Alternative.

Table 5-27 Simulated Start and End Dates of the 1962 and 1964 Events

Alternative	Start Date (<1 foot drawdown)	No. of Days	End Date (>1 foot drawdown)	Seasonality Increase Relative to Baseline (weeks) [(a)]
1962 Event				
Baseline	7/10/1962	134	11/20/1962	---
WBH97	7/9/1962	137	11/22/1962	0.1
WBH95	7/7/1962	143	11/26/1962	0.3
M97	7/9/1962	137	11/22/1962	0.1
M95	7/7/1962	145	11/28/1962	0.3
1964 Event				
Baseline	8/1/1964	218	3/6/1965	---
WBH97	7/23/1964	226	3/5/1965	1.3
WBH95	7/14/1964	235	3/5/1965	2.4
M97	8/1/1964	212	2/28/1965	0.0
M95	7/21/1964	228	3/5/1965	1.4

[(a)]Increase calculated based on the start date

Summary and Conclusion

In the 1982 environmental impact statement, USACE concluded that release of water supply storage during low flow periods "could cause an adverse but short-term effect" on wetlands because "water supply drawdowns would dewater these wetland areas occasionally" (USACE, 1982). However, "water supply drawdowns in combination with a normally stable pool would permit the growth of emergent wetlands due to the expected infrequent nature of the water supply drawdowns" (USACE, 1982). In comparison to the Baseline Alternative, the four optional trigger alternatives are not expected to alter the level of impact—i.e., a minor effect changed to a moderate effect or a moderate effect changed to a major effect—to the emergent wetland habitat. For 50 percent of years, lake drawdown is less than 1 foot under all alternatives, and there would be no impact to wetlands. For the event years, there is little variability for the duration and time of year between the Baseline Alternative and the four optional trigger alternatives. It is expected that the predicted drawdown duration and time of year at which drawdown occurs for all alternatives would result in moderate impacts on the emergent wetlands. The expected impacts for the four optional trigger alternatives is similar to the impact of the Baseline Alternative, so impact modifications are not proposed.

5.4 TERRESTRIAL RESOURCES

Terrestrial resources would not be affected by lake level drawdowns under any of the five alternatives. As discussed in Section 4.5, USFWS identified three bald eagle nests in the vicinity of Cowanesque Lake, and the Pennsylvania Game Commission identified two species that may be affected by the project: northern myotis and osprey. The proposed action would require no construction or land-side activities, so there would be no disturbance near bald eagle or osprey nests or northern myotis nesting or roosting trees. Drawdown of the lake under drought conditions would reduce the surface area of the lake available for foraging by bald eagles and osprey, but foraging area would still be available and the four optional trigger alternatives would be minimally different from the Baseline Alternative.

5.5 FISH

Water level fluctuation is one of the most important disturbances affecting aquatic ecosystems in surface waters (Turner and Mason, 2002). The effects of water level fluctuations on aquatic ecosystems are dependent on species, magnitude, duration, and time of year. For fish communities, fluctuating water levels can affect water quality, food availability, spawning success, predator-prey dynamics, and habitat. In particular, drawdown of water level affects fish communities primarily from the reduction in overall surface area and volume of a reservoir. A reduction in shallow water habitat could force littoral zone fish, including forage species, into the deeper channels and pools of the lake. Concentration of fish species within a smaller reservoir area could result in increased predation by piscovorous fish. Additionally, juvenile fish could be more vulnerable to predation during drawdown because of a higher density of predators and lack of cover from dewatered SAV and other shallow water habitat features. With the exception of a few fish species, drawdown during spring and early summer months could affect overall spawning success of fish and result in a reduction in recruitment and food availability. Prolonged drawdown during warmer months can result in substantially higher water temperatures and depressed DO concentrations. Indirectly, these degraded water quality conditions can also affect fish communities in the lake and tailwaters downstream of the lake.

In some cases, lake drawdown has been found to be beneficial to both gamefish and forage species. This benefit to fish populations is thought to be the result of the refilling of the lake after the drawdown, also known as the “new lake effect,” where newly re-inundated areas of a reservoir increase spawning sites, habitat, and food, thereby increasing productivity and fish densities (Greening and Doyon, 1990). Drawdowns can also benefit fish by reducing overabundant aquatic vegetation that inhibits predation of shallow water forage species (Turner and Mason, 2002). In particular, late summer drawdowns have been shown to improve growth rates of some gamefish resulting from concentration of predators and forage fish (Jacobs et al., 1999). However, benefits of drawdown are generally experienced only when reservoirs water levels are allowed to remain stable for several years following a regulated drawdown event.

The ability to accurately model direct impacts of drawdown on aquatic resources in Cowanesque Lake is limited by the extent and variability of environmental factors that influence fish populations and the lack of comprehensive fish population data for the reservoir. Instead, potential impacts to the fish community resulting from each alternative were evaluated according to magnitude, frequency, seasonal timing, and duration of drawdown events. The following qualitative impact threshold definitions were used to describe the degree of impact on aquatic resources.

- **Negligible:** No measurable or perceptible changes would occur to the amount, distribution, connectivity, or integrity of aquatic resource habitat or populations. There would be no observable or measurable impacts on aquatic species, their habitats, or the natural processes sustaining them. Impacts would be well within natural fluctuations.

- **Minor**: Impacts would be detectable but would not be outside the natural range of variability. Small changes to population numbers, population structure, genetic variability, and other demographic factors might occur. Effects would not affect population stability or viability. Occasional responses to disturbance by some individuals could be expected but without interference to factors affecting population levels. Sufficient habitat would remain functional to maintain viability of all aquatic species. Impacts would be outside critical reproduction periods for sensitive native species.

- **Moderate**: Impacts to aquatic species, their habitats, or the natural processes sustaining them would be detectable over a larger area and could affect the overall amount, integrity, and connectivity of habitat in the study area. Habitat alterations and disturbance as well as loss of individuals could affect the overall size of aquatic populations, but reductions in population size would not be permanent and would not threaten the continued existence of a species within the lake. Changes to population numbers, population structure, genetic variability, and other demographic factors would occur, but species would remain stable and viable. Frequent responses to disturbance by some individuals could be expected, with some negative impacts on factors affecting population levels. Sufficient habitat would remain functional to maintain the viability of all native species. Some impacts might occur during critical periods of reproduction or in key habitat. Impacts could be mitigated by implementation of avoidance/minimization measures and/or restoration or enhancement of habitat.

- **Major**: Effects would be permanent over a relatively large area and would have drastic consequences to the amount, integrity, or connectivity of aquatic species habitat. Impacts to native species, their habitats, or the natural processes sustaining them would be detectable, outside the natural range of variability, and extensive. Population numbers, population structure, genetic variability, and other demographic factors might experience large declines. Frequent responses to disturbance by some individuals would be expected, with negative impacts on factors resulting in a decrease in population levels. Loss of habitat might affect the viability of at least some native species. Impacts to aquatic species habitat and populations could not be fully mitigated.

To assess the variability of drawdown events, both extreme and median event years were used to compare the potential impacts of each optional trigger alternative to the Baseline Alternative. The median event year is the event year where the minimum annual lake elevation was the median drawdown for the entire modeling period (i.e., a "normal" drawdown event year). An extreme event year is the event year in which the minimum annual lake elevation was the lowest during the entire modeling period. The extreme event represents severely dry conditions (i.e., a "worst-case scenario"). For the Baseline Alternative and all four optional trigger alternatives, this extreme event is the 1964 event, when the model predicts that lake elevation would have dropped to its lowest elevation. Drawdown would have begun in late July or early August 1964, and the lake would have returned to normal pool elevation in late February or early March 1965.

5.5.1 Baseline Alternative

Under the Baseline Alternative, drawdown events (> 1 foot drawdown) would have occurred in about 36 percent of years. Drawdown events typically begin in July, August, and September and end in October, November, and December. Extreme drawdown events typically begin in late-July and end in early-March of the following year. Therefore, drawdown events could overlap with part of the spawning season of some fish species in Cowanesque Lake.

The modeled water level data for a median drawdown event (2002) under the Baseline Alternative could result in drawdown up to 5.9 feet for a duration of 100 days and temporarily dewatering a maximum of 88 percent of the established shallow water habitat for fish (Table 5-28). (Note: During drawdown events, the shallow water zone from 0-7 feet deep will move to lower elevations as the lake level drops. Discussion in this section of "loss of established shallow water habitat" refers to the existing zone vegetated with SAV and incorporating other habitat enhancing features such as detritus, macroinvertebrates, etc.)

Under the Baseline Alternative, drawdown events during an extreme dry period (1964-1965) indicate potential loss of 100 percent of shallow water habitat (greater than 7 feet) from late-August1964 to early-March 1965 for a duration of 179 days (Figure 5-3, Table 5-29).

Table 5-28 Simulated Drawdown Parameters for the Baseline Alternative during a Median Low Flow Trigger Event (2002)

Alternative	Dates of Drawdown Event	Duration >1 Foot Drawdown (days)	Maximum Drawdown (ft)	Loss of Established Shallow Water Habitat at Max. Drawdown (%)[a]
Baseline	8/23/2002-11/30/2002	100	5.9	88

[a]Based on 178 acres of shallow water habitat (0-7 foot depth) at normal pool elevation of 1080 feet.

Table 5-29 Simulated Drawdown Parameters for the Baseline Alternative during an Extreme Low Flow Trigger Event (1964-1965)

	Dates of Drawdown Event	Duration >1 Foot Drawdown (days)	Duration >7 Foot Drawdown (days)	Maximum Drawdown (ft)	Loss of Established Shallow Water Habitat at Max. Drawdown (%)[a]
Baseline	8/1/1964 – 3/6/1965	218	179	44.7	100

[a]Based on 178 acres of shallow water habitat (0-7 foot depth) at normal pool elevation of 1080 feet.

Impact Analysis

The Baseline Alternative would likely result in negligible to short term minor adverse impacts to fish communities in Cowanesque Lake during drawdown events. The time of year of drawdowns under the Baseline Alternative could overlap with the latter part of the spawning season for a few species of fish including alewife, common carp, golden shiner, green sunfish and pumpkinseed; however, these begin spawning as early as May and adverse impacts, if any, to recruitment success would be short term minor. Although median low flow trigger events would likely result in a 6-foot drawdown and a 88 percent loss of established shallow water habitat, adverse impacts to fish populations, if any, would be short term minor. An extreme drawdown event under the Baseline Alternative may result in short term moderate adverse impacts to fish communities in the lake because of increased temperature and potentially depressed DO; however, these events only occur in 1 percent of the years in the 78-year modeling period. Downstream fish communities would benefit from lake level drawdowns for consumptive use mitigation because water supply releases would increase downstream flows during low flow events. Therefore, the Baseline Alternative would have negligible to short term minor adverse impacts on reservoir fish communities and short term minor beneficial impacts on downstream fish communities.

5.5.2 Alternative WBH97

Under Alternative WBH97, drawdown events (> 1 foot drawdown) would have occurred in about 36 percent of years, the same percentage of years predicted for the Baseline Alternative. Drawdown events typically begin in July, August, and September and end in October, November, and December. Extreme drawdown events typically begin in mid-July and end in early-March of the following year. Therefore, drawdown events could overlap with part of the spawning season of some fish species in Cowanesque Lake. Because potential drawdown events under the Baseline Alternative could occur over the same months, no additional impacts would be expected under Alternative WBH97. The modeled water level data for a median drawdown event (1959) under Alternative WBH97 could result in drawdown up to 6.3 feet for a duration of 75 days and temporarily dewatering a maximum of 92 percent of the established shallow water habitat for fish (Table 5-30). This temporary loss of established shallow water habitat in Cowanesque Lake compared to the Baseline Alternative (Alternative WBH97) for the same median drawdown event year would equate to only a 3 percent increase under Alternative WBH97. Further, compared to the Baseline Alternative, the median drawdown event under Alternative WBH97 would result in a 0.3-foot increase in drawdown magnitude and a 2-day increase in drawdown duration.

Table 5-30 Comparison of Simulated Drawdown Parameters for the Baseline Alternative and Alternative WBH97 during a Median Low Flow Trigger Event (1959)

Alternative	Dates of Drawdown Event	Duration >1 Foot Drawdown (days)	Maximum Drawdown (ft)	Loss of Established Shallow Water Habitat at Max. Drawdown (%)[a]
Baseline	8/1/1959 – 10/12/1959	73	6.0	89
WBH97	7/31/1959 – 10/13/1959	75	6.3	92
Increases	Start 1 day earlier	2	0.3	3

[a]Based on 178 acres of shallow water habitat (0-7 foot depth) at normal pool elevation of 1080 feet.

Under Alternative WBH97, drawdown events during an extreme dry period (1964-1965) indicate potential loss of 100 percent of shallow water habitat (greater than 7 feet) from late-August 1964 to late-February1965 for a duration of 185 days (Figure 5-3, Table 5-31). Similarly, modeled drawdown conditions under the Baseline Alternative for the same extreme dry period, indicate 100 percent of shallow water habitat would have been unavailable to the fish community from late August to late February for a duration of 179 days. Although Alternative WBH97 could result in 6 additional days of 100 percent dewatered shallow water habitat compared to the Baseline Alternative, the magnitude and duration of the drawdown would be so substantial that slight differences between the alternatives would provide no additional impact.

Table 5-31 Comparison of Simulated Drawdown Parameters for the Baseline Alternative and Alternative WBH97 during an Extreme Low Flow Trigger Event (1964-1965)

Alternative	Dates of Drawdown Event	Duration >1 Foot Drawdown (days)	Duration >7 Foot Drawdown (days)	Maximum Drawdown (ft)	Loss of Established Shallow Water Habitat at Max. Drawdown (%)[a]
Baseline	8/1/1964 – 3/6/1965	218	179	44.7	100
WBH97	7/23/1964 – 3/5/1965	226	185	44.9	100
Increases	Start 9 days earlier	8	6	0.2	0

[a]Based on 178 acres of Shallow water habitat (0-7 foot depth) at normal pool elevation of 1080 feet.

Impact Analysis

Compared to the Baseline Alternative, Alternative WBH97 would likely result in no additional impacts to fish communities in Cowanesque Lake during drawdown events. The magnitude, duration, and temporary loss of established shallow water habitat from drawdowns under Alternative WBH97 would be similar to those experienced under the Baseline Alternative during both median and extreme low flow trigger events in Cowanesque Lake. The time of year of drawdowns under Alternative WBH97 could overlap with the latter part of the spawning season for a few species of fish including alewife, common carp, golden shiner, green sunfish and pumpkinseed; however, these begin spawning as early as May and adverse impacts, if any, to recruitment success would be short term minor. Further, drawdown events under Alternative WBH97 would likely occur during the same seasonal timeframe as the Baseline Alternative and, therefore, there would be no additional impacts to fish spawning in Cowanesque Lake. Median low flow trigger events would likely result in nearly a 0.3-foot increase in lake level drawdown and about 3 percent more loss of established shallow water habitat compared to the Baseline Alternative, and therefore, would likely have negligible impacts on fish populations. Impacts to fish communities from an extreme drawdown event under Alternative WBH97 would not result in any additional impacts compared to the Baseline Alternative since the overall duration and magnitude of the drawdown would be nearly the same. Downstream fish communities would benefit more under Alternative WBH97 compared to the Baseline Alternative because the higher trigger flow causes slightly longer water supply releases during low flow events.

5.5.3 Alternative WBH95

Under Alternative WBH95, drawdown events (> 1 foot drawdown) would occur in about 44 percent of years at Cowanesque Lake. Drawdown events typically begin in July, August, and September and end in October, November, and December. An extreme drawdown event typically begins in mid-July and ends in early-March of the following year. These time periods illustrate that drawdown events would overlap with critical spawning periods for a few species of fish inhabiting Cowanesque Lake; however, drawdown events were predicted to have the potential to occur during the same months under the Baseline Alternative. Modeled water level data for a median drawdown event (1980) under Alternative WBH95 could result in drawdown up to 5.3 feet for a duration of 95 days and temporarily dewater a maximum of 81 percent of the established shallow water habitat (Table 5-32). This temporary loss of established shallow water habitat in Cowanesque Lake compared to the Baseline Alternative for the same median drawdown event year would equate to a 39 percent increase under Alternative WBH95. Further, compared to the Baseline Alternative, the median drawdown event under Alternative WBH95 would result in a 2.3-foot increase in drawdown magnitude and 22-day increase in drawdown duration.

Table 5-32 Comparison of Simulated Drawdown Parameters for the Baseline Alternative and Alternative WBH95 during a Median Low Flow Trigger Event (1980)

Alternative	Dates of Drawdown Event	Duration >1 Foot Drawdown (days)	Maximum Drawdown (ft)	Loss of Established Shallow Water Habitat at Max. Drawdown (%)[a]
Baseline	9/14/1980 – 11/25/1980	73	3.0	42
WBH95	9/4/1980 – 12/7/1980	95	5.3	81
Increases	Start 10 days earlier	12	2.3	39

[a]Based on 178 acres of shallow water habitat (0-7 foot depth) at normal pool elevation of 1080 feet.

Under Alternative WBH95, modeled water levels for extreme dry events (1964-1965) predict a drawdown event occurring between mid-August and late-February with potential maximum drawdown of 44.9 feet and total drawdown duration of 235 days (Figure 5-3, Table 5-33). This extreme dry drawdown event would have resulted in the temporary loss of 100 percent of the established shallow water habitat for a total of 192 days. Compared to the Baseline Alternative for the same drawdown event, this temporary unavailability of 100 percent established shallow water habitat represents an increase of 13 days in duration.

Table 5-33 Comparison of Simulated Drawdown Parameters for the Baseline Alternative and Alternative WBH95 during an Extreme Low Flow Trigger Event (1964-1965)

Alternative	Dates of Drawdown Event	Duration >1 Foot Drawdown (days)	Duration >7 Foot Drawdown (days)	Maximum Drawdown (ft)	Loss of Established Shallow Water Habitat at Max. Drawdown (%)[a]
Baseline	8/1/1964 – 3/5/1965	218	179	44.7	100
WBH95	7/14/1964 – 3/5/1965	235	192	44.9	100
Increases	Start 18 days earlier	17	13	0.2	0

[a]Based on 178 acres of Shallow water habitat (0-7 foot depth) at normal pool elevation of 1080 feet.

Impact Analysis

The modeled water level data for Cowanesque Lake predict that the duration and magnitude of drawdown events would increase under Alternative WBH95 compared to the Baseline Alternative. A median drawdown event under Alternative WBH95 could result in about a 2-foot increase in drawdown magnitude compared to the Baseline Alternative. This increase in magnitude under Alternative WBH95, coupled with a 10 percent greater probability of a low flow trigger event, would likely have short-term minor adverse impacts on the fish community in Cowanesque Lake. The seasonal timing of modeled drawdown events were similar for both Alternative WBH95 and the Baseline Alternative, therefore, no additional impacts to fish spawning would be expected. The magnitude and duration of extreme drawdown events would increase under Alternative WBH95 compared to the Baseline Alternative; however, the slight increase of drawdown magnitude and duration is not expected to result in any additional impacts to fish. Downstream fish communities would benefit more under Alternative WBH95 than under the Baseline Alternative because the higher trigger flow would cause more water supply releases during low flow events.

5.5.4 Alternative M97

Under Alternative M97, water level data for the modeling period indicate drawdown events in Cowanesque Lake would occur in about 41 percent of years and range in magnitude up to 36.1 feet. This occurrence of drawdowns under Alternative M97 represents a 5 percent increase in potential drawdown years compared to the Baseline Alternative; however, the maximum drawdown under Alternative M97 (36.1 feet) was 8.6 feet lower in magnitude than the maximum drawdown predicted for the Baseline Alternative (44.7 feet). Modeled water level data for Alternative M97 predicts drawdown events typically begin in July, August, and September and end in October, November, and December. A typical extreme drawdown event begins in mid-July and ends in early-March of the following year. Although this time period for drawdowns overlaps with the spawning period of fish it is consistent with the potential drawdown time period under the Baseline Alternative. For a median drawdown event (1999) under Alternative M97, water level drawdown up to 6.8 feet for a duration of 104 days could occur resulting in a maximum temporary loss of about 98 percent of the established shallow water habitat (Table 5-34). Comparatively, under the Baseline Alternative for the same median drawdown event year, drawdown up to 6.5 feet for a duration of 94 days would have occurred and resulted in a maximum temporary loss of about 94 percent of established shallow water habitat.

Table 5-34 Comparison of Simulated Drawdown Parameters for the Baseline Alternative and Alternative M97 during a Median Low Flow Trigger Event (1999)

Alternative	Dates of Drawdown Event	Duration >1 Foot Drawdown (days)	Maximum Drawdown (ft)	Loss of Established Shallow Water Habitat at Max. Drawdown (%)[a]
Baseline	8/5/1999 – 11/6/1999	94	6.5	94
M97	7/27/1999 – 11/7/1999	104	6.8	98
Increases	Start 9 days earlier	10	0.3	4

[a]Based on 178 acres of shallow water habitat (0-7 foot depth) at normal pool elevation of 1080 feet.

Modeled water levels for extreme dry events (1964-1965) under Alternative M97 indicate potential maximum drawdown of 36.1 feet and total drawdown duration of 212 days (Table 5-35). This extreme drawdown event would occur from early August to late February and could result in dewatering of 100 percent of the existing shallow water habitat for 168 days. For comparative purposes, the same modeled extreme dry event under the Baseline Alternative would have occurred over generally the same time period but would have resulted in the temporary loss of 100 percent of shallow water for a total of 179 days.

Table 5-35 Comparison of Simulated Drawdown Parameters for the Baseline Alternative and Alternative M97 during an Extreme Low Flow Trigger Event (1964-1965)

Alternative	Dates of Drawdown Event	Duration >1 Foot Drawdown (days)	Duration >7 Foot Drawdown (days)	Maximum Drawdown (ft)	Loss of Established Shallow Water Habitat at Max. Drawdown (%)[a]
Baseline	8/1/1964 – 3/6/1965	218	179	44.7	100
M97	8/1/1964 – 2/28/1965	212	168	36.1	100
Increases	Start on the same day	-16	-11	-8.6	0

[a]Based on 178 acres of Shallow water habitat (0-7 foot depth) at normal pool elevation of 1080 feet.

Impact Analysis

Alternative M97 would likely result in no additional impacts to fish communities in Cowanesque Lake compared to the Baseline Alternative. Although there is potential for a 5 percent increase in drawdown events under Alternative M97 compared to the Baseline Alternative, the difference is not substantial considering the uncertainty in predicting future drawdown events. Drawdown events under Alternative M97 would likely occur between late-July through March, which overlaps with the spawning season for some resident fish species in Cowanesque Lake; however, because drawdowns have the potential to occur during the same time period under the Baseline Alternative no additional impacts to fish spawning would occur. For the median event discussed in this analysis (1999), the drawdown under Alternative M97 would only represent a 0.3-foot increase in magnitude and a 10-day increase in duration compared to the Baseline Alternative and would likely have negligible to minor adverse impacts on the resident fish community. No impacts are expected to occur under Alternative M97 during extreme dry events since the magnitude and duration were less severe compared to the Baseline Alternative. Downstream fish communities would benefit more under Alternative M97 than under the Baseline Alternative because the higher trigger flow would cause more water supply releases during low flow events.

5.5.5 Alternative M95

Under Alternative M95, drawdown events (> 1 foot drawdown) occurred in about 51 percent of years over the 78-year modeling period for modeled water level data at Cowanesque Lake. Compared to the Baseline Alternative, this frequency of drawdown events represents an increase of nearly 15 percent. Typically, drawdown events under Alternative M95 begin in July, August, or September, and end in October, November, and December. An extreme drawdown event typically begins in mid-July and ends in early-March of the following year. Modeled water level data for a median drawdown event (1936) under Alternative M95 could result in drawdown up to 5.5 feet for a duration of 108 days and temporarily dewater a maximum of 84 percent of the established shallow water habitat for fish (Table 5-36). Compared to the Baseline Alternative, the median drawdown event under Alternative M95 would result in a 1.9-foot increase in drawdown magnitude and a 13-day increase in drawdown duration. The temporary loss of established shallow water habitat in Cowanesque Lake compared to the Baseline Alternative for the same median drawdown event year would have resulted in a 30 percent increase under Alternative M95.

Table 5-36 Comparison of Simulated Drawdown Parameters for the Baseline Alternative and Alternative M95 during a Median Low Flow Trigger Event (1936)

Alternative	Dates of Drawdown Event	Duration >1 foot Drawdown (days)	Maximum Drawdown (ft)	Loss of Established Shallow Water Habitat at Max. Drawdown (%)[a]
Baseline	7/25/1936 – 10/28/1936	96	3.6	54
M95	7/20/1936 – 11/4/1936	108	5.5	84
Increases	Start 5 days earlier	12	1.9	30

[a]Based on 178 acres of shallow water habitat (0-7 foot depth) at normal pool elevation of 1080 feet.

Modeled water levels for an extreme dry event (1964-1965) under Alternative M95 indicate potential maximum drawdown of 44.8 feet and total drawdown duration of 228 days occurring from late-July through early March (Figure 5-3, Table 5-37). An extreme drawdown event of this magnitude and duration could potentially result in the temporary unavailability of 100 percent of shallow water habitat (more than 7 feet) for duration of 184 days. Compared to the Baseline Alternative, this extreme drawdown event would result in a 0.1-foot increase in drawdown magnitude and about 10 more days in duration under Alternative M95. Further, compared to the Baseline Alternative, 100 percent of shallow water habitat would be temporarily unavailable for 5 more days under Alternative M95.

Table 5-37 Comparison of Simulated Drawdown Parameters for the Baseline Alternative and Alternative M95 during an Extreme Low Flow Trigger Event (1964-1965)

Alternative	Dates of Drawdown Event	Duration >1 foot Drawdown (days)	Duration >7 Foot Drawdown (days)	Maximum Drawdown (ft)	Loss of Established Shallow Water Habitat at Max. Drawdown (%)[a]
Baseline	8/1/1964 – 3/6/1965	218	179	44.7	100
M95	7/21/1964 – 3/5/1965	228	184	44.8	100
Increases	Start 11 days earlier	10	5	0.1	0

[a]Based on 178 acres of Shallow water habitat (0-7 foot depth) at normal pool elevation of 1080 feet.

Impact Analysis

Under Alternative M95, a 15 percent increase in the potential drawdown event years compared to the Baseline Alternative, coupled with 2-foot increase of the predicted median drawdown event, could result in short-term minor adverse impacts to the fish community. Short-term minor adverse impacts could result from a greater frequency of disturbance to shallow water habitat and fish spawning for some species, which could negatively alter recruitment success. Modeled water levels for extreme drawdown events under Alternative M95 did not indicate any additional impacts to the fish community compared to the Baseline Alternative. Downstream fish communities would benefit more under Alternative M95 than under the Baseline Alternative because the higher trigger flow would cause more water supply releases during low flow events.

5.5.6 Summary and Conclusion

In the 1982 environmental impact statement for proposed water supply storage at Cowanesque Lake, USACE concluded that release of water supply storage during low flow periods would have no effect on "the fishery [in the lake or in the Cowanesque River downstream of the lake] since the expected drawdown period (August-November) would not conflict with the spawning of the game fish (March to June). Furthermore, evidence from the Pennsylvania Fish [and Boat] Commission indicates that infrequent, moderate drawdowns can benefit a lake fishery by forcing small fish away from protective cover in the shallow reaches of a reservoir, making them more vulnerable to adult game fish predators" (USACE, 1982). The four optional trigger alternatives exhibit minor incremental differences compared to the Baseline Alternative. Under the four optional trigger alternatives, drawdown events occur in less than 4 percent more days in the period of record than the Baseline Alternative. Additionally, as the 1982 environmental impact statement explained, loss of established shallow water habitat caused by infrequent, moderate drawdowns can benefit the in-lake fishery. The four optional trigger alternatives could cause a slight increase in loss of established shallow water habitat; however, the incremental difference compared to the Baseline is minor. Lastly, increased water supply releases under the four optional trigger alternatives during low flow conditions are expected to improve habitat for aquatic communities downstream in the Cowanesque River. These releases would also improve the aquatic ecosystem in the Susquehanna River during drought periods and help meet the ecosystem flow recommendations from The Nature Conservancy study. No impact modifications for fisheries are recommended because the four optional trigger alternatives have similar impacts to the Baseline Alternative.

5.6 RECREATIONAL RESOURCES

Cowanesque Lake is presently maintained at a normal recreation pool elevation of 1080 feet during normal hydrologic conditions. Assuming normal hydrologic conditions, outflow is adjusted to maintain the lake surface elevation as close as possible to this normal pool. Water-based recreation facilities are constructed to take maximum advantage of the lake at this elevation. During low flow periods, the lake surface will slowly fall below elevation 1080 feet as water is released to satisfy downstream minimum flow target or downstream water supply needs.

The duration and magnitude of all drawdown events in the modeling period (1930–2007) were evaluated for the Baseline Alternative (the baseline under SRBC's current operating guidelines) and four optional trigger alternatives. As discussed in the hydrology section (Section 5.1), drawdowns in the range of 0-1 foot (1080-1079 feet lake elevation) occur fairly routinely under current normal lake operating conditions. In addition, the Baseline Alternative results in the same or more 0-1 foot drawdown events in both total years and days during the recreation season than the new alternatives. This data confirms the lack of additional impact in the 0-1 foot drawdown range caused by the new alternatives.

The analysis in this section focuses on the recreation season at Cowanesque Lake, which is defined as May 20 through September 14, with the highest visitation in July and August. The modeling predicts that drawdown events for the 78-year modeling period would occur in 24 to

31 years, depending on the alternative, during the recreation season (Table 5-38). Regardless of the alternative, most of the events would begin late in the summer (August-September) during the recreation season with most extending until the end of the year (December).

The degree of impact of drawdown events on recreational resources at Cowanesque Lake depends on the extent of the drawdown, the length of time the water is drawn down, and the time of year the drawdown occurs. To determine a general severity of impacts on each facility, the increase in drawdown frequency percentage over the Baseline Alternative was calculated for the total number of years for each drawdown range analyzed. The percentage increase, for the years of drawdown, ranged from 0 to 9 percent. To analyze the potential impacts of the alternatives on recreation facilities and the need for modifications to the recreation facilities, the recreation facility elevations and the reservoir level fluctuations (elevation and duration) during the recreation season for each optional trigger alternative were compared to the Baseline Alternative and the percentage increase in drawdown frequency over the Baseline Alternative was calculated for each month during the recreation season. The percent change over the Baseline Alternative was then identified as minor, moderate, or significant impacts according to the following ranges:

- Minor Impact: 0 to 5 percent increase in drawdown compared to Baseline Alternative
- Moderate Impact: 5 to 10 percent increase in drawdown compared to Baseline Alternative
- Significant Impact: >10 percent increase in drawdown compared to Baseline Alternative

Table 5-38 Simulated Number of Years with Maximum Drawdowns within a Given Range during the Recreation Season

	Alternative								
	Baseline	WBH97		WBH95		M97		M95	
Drawdown (ft)	Years	Years	Diff. from Baseline	Years	Diff. from Baseline	Years	Diff. from Baseline	Years	Diff. from Baseline
1 < Drawdown ≤ 3	10	8	-2	8	-2	7	-3	10	0
3 < Drawdown ≤ 5	5	5	0	8	+3	6	+1	6	+1
5 < Drawdown ≤ 10	7	8	+1	6	-1	8	+1	9	+2
10 < Drawdown ≤ 15	2	3	+1	3	+1	5	+3	4	+2
15 < Drawdown	0	0	0	2	+2	0	0	2	+2
Total	24	24	0	27	+3	26	+2	31	+7

To compare the potential impacts of each optional trigger alternative to the Baseline Alternative, the duration of drawdowns within a given range was also compared. The mean number of days of drawdown within a given range for the drawdown events occurring during the recreation season was compared between each optional trigger alternative and the Baseline Alternative.

To assess the variability of drawdown events, both extreme and median event years were used to compare the potential impacts of each optional trigger alternative to the Baseline Alternative. The median event year is the event year where the minimum annual lake elevation was the median drawdown for the entire modeling period (i.e., a “normal” drawdown event year). An extreme event year is the event year in which the minimum annual lake elevation was the lowest during the entire modeling period. The extreme event represents severely dry conditions (i.e., a "worst-case scenario"). For the Baseline Alternative and all four optional trigger alternatives, this extreme event is the 1964 event, when the model predicts that lake elevation would have dropped to its lowest elevation. Drawdown would have begun in late July or early August 1964, and the lake would have returned to normal pool elevation in late February or early March 1965.

The water-based recreation facilities at Cowanesque Lake can tolerate modest drawdowns but the recreation facilities at Tompkins Campground and the South Shore Day-use Area could be directly affected by a change in drawdown frequency, duration, and time of year. In the late 1980s, new facilities were constructed at the South Shore Day-use Area and the existing facilities at Tompkins Campground and the Lawrence Recreation Area were modified to accommodate a once in 10-year drawdown that was predicted to range between 4 and 6 feet. Since the modifications, other facilities (e.g., boat mooring slips) that would be affected by drawdowns less than 4 feet have been added.

Table 5-39 summarizes the elevations of the water-based recreation facilities at Cowanesque Lake and the impacts that drawdowns would have on these facilities. With a drawdown of 3 feet, most of the recreation facilities would be open and fully operational except for the beaches, the Tompkins Campground boat launch, and the floating mooring slips at the Tompkins Campground and boat launch. A drawdown of more than 3 feet would result in the following impacts to recreation facilities: the floating docks at the boat launches would be removed at a 5-foot drawdown; the beaches would be closed at a 6-foot drawdown; the American Disabilities Act (ADA) fishing pier would generally be closed with a drawdown greater than 3 feet; the majority of the floating mooring slips at the Tompkins Campground and boat launch would become unusable at drawdowns more than 4 feet; the Tompkins Campground boat ramp would become unusable for some boats at a drawdown of 3 feet; and the South Shore boat ramps would become unusable for some boats at a drawdown of 10-11 feet.

5.6.1 Baseline Alternative

If no action is taken to alter the water release operations at Cowanesque Lake, implementation of the Baseline Alternative would continue. Current visitation trends at the project and the project's economic benefits to the region would continue. The recreation season would be expected to continue from May 20 through September 14 with July and August having the peak visitation. With no action taken to alter the water release operations at Cowanesque Lake, normal operation and maintenance would continue and the existing slow, no-wake zones (but no horsepower restrictions) would be expected to remain the same.

Table 5-39 Summary of Elevation Impacts on Cowanesque Lake Recreation Facilities

Recreation Facility	Elevation (Top/Bottom)	Drawdown Closure	Impacts
Tompkins Campground			
Boat Launch Concrete Pad	1083 ft / 1074 ft	• 1078 ft would allow 4-ft depth on pad for launching boats • 1077 ft would allow 3-ft depth on pad for launching boats	• Fully operational from 1080-1078 ft.
Boat Launch Dock Concrete Bulkhead	1083 ft / 1080 ft	• Floating dock extensions removed at 1075 ft. • Boat launch ramps can remain open.	• Fully operational from 1080-1075 ft.
Beach Concrete Pad	1080 ft / 1073 ft	• Closed at 1075 ft when visitors have approximately 2 ft of water for wading. May be closed as necessary due to slippery surface.	• A drawdown of any kind will affect the area available for swimming. • As the drawdown level increases, the amount of swim area lost at the beaches could range from approximately 30 – 80 percent with complete closure at 1074 ft[(a)].
Floating Mooring Slips at Boat Launch and Campground	1082 ft (deck) / NA	• 1078 will impact slips closest to shore, particularly at the campground.	• Majority are operational from 1080 to 1076. • The walkway to slips may be extended as necessary to push floating dock into deeper water.
South Shore Day-use Area			
East Boat Launch Concrete Pad	1099 ft / 1066 ft	• 1070 ft would allow 4-ft depth on pad for launching boats • 1069 ft would allow 3-ft depth on pad for launching some boats	• Fully operational from 1080-1070 ft.
West Boat Launch Concrete Pad	1090 ft / 1066 ft	• 1070 ft would allow 4-ft depth on pad for launching boats • 1069 ft would allow 3-ft depth on pad for launching boats	• Fully operational from 1080-1070 ft.
East Boat Launch Dock Concrete Bulkhead	1084 ft / 1080 ft	• Floating dock extensions removed at 1075 ft. • Boat launch ramps can remain open.	• Fully operational from 1080-1075 ft.
West Boat Launch Dock Concrete Bulkhead	1084 ft / 1080 ft	• Floating dock extensions removed at 1075 ft. • Boat launch ramps can remain open.	• Fully operational from 1080-1075 ft.
Beach Concrete Pad	1080 ft / 1073 ft	• Closed at 1075 ft when visitors have approximately 2 ft of water for wading. May be closed as necessary due to slippery surface.	• A drawdown of any kind will affect the area available for swimming. • As the drawdown level increases, the amount of swim area lost at the beaches could range from approximately 30 – 80 percent with complete closure at 1074 ft[(a)].
ADA Fishing Pier	1085.5 ft / NA	Generally, closed below 1077 ft.	• Fully operational from 1080-1077 ft.

[(a)]Areas estimated from January 4, 1988 Cowanesque Lake Recreation Modification As-built drawings and 2010 bathymetry survey data.

The modeled lake elevation data indicate that drawdown events would occur during the recreation season under the Baseline Alternative in 24 years during the 78-year modeling period. There would be no drawdowns greater than 1 foot during May or June for the entire modeling period. Cowanesque Lake would experience a total of 760 days during the recreation season for the 78-year modeling period (76, 398, and 286 days during the months of July, August and September, respectively) with drawdowns greater than 1 foot (Tables 5-40 and 5-41). Cowanesque Lake would experience a total of 534 days during the recreation season during the 78-year modeling period with drawdowns greater than 2 feet that would affect some of the boat mooring slips at Tompkins Campground, the launching of some boats at the Tompkins Campground boat launch and the beaches, 360 days with drawdowns greater than 3 feet that would affect the ADA fishing pier, 266 days with drawdowns greater than 4 feet that would affect the usability of the majority of the boat mooring slips at Tompkins Campground and the boat launch, 132 days with drawdowns greater than 6 feet resulting in the closure of the beaches, and only 19 days with drawdowns greater than 10 feet, which would affect the launching of some boats at the South Shore boat launches. Table 5-42 illustrates the predicted duration of a drawdown within a given range for a drawdown event during the recreation season.

Table 5-40 Simulated Number of Days during the Recreation Season that Drawdown Exceeds Certain Drawdown Levels

	Alternative								
	Base line	WBH97		WBH95		M97		M95	
Drawdown (ft)	Days	Days	Diff. from Base line	Days	Diff. from Base line	Days	Diff. from Base line	Days	Diff. from Base line
1 < Drawdown ≤ 2	226	224	-2	227	1	180	-46	292	66
2 < Drawdown ≤ 3	174	185	11	155	-19	212	38	188	14
3 < Drawdown ≤ 4	94	111	17	165	71	147	53	167	73
4 < Drawdown ≤ 5	85	64	-21	85	0	81	-4	131	46
5 < Drawdown ≤ 6	49	79	30	48	-1	57	8	70	21
6 < Drawdown ≤ 7	50	49	-1	63	13	77	27	48	-2
7 < Drawdown ≤ 8	23	51	28	64	41	51	28	61	38
8 < Drawdown ≤ 9	27	34	7	38	11	31	4	59	32
9 < Drawdown ≤ 10	13	15	2	24	11	31	18	30	17
1 0< Drawdown ≤ 11	7	8	1	28	21	17	10	19	12
11 < Drawdown ≤ 12	7	8	1	18	11	13	6	18	11
12 < Drawdown	5	15	10	30	25	21	16	61	56
Total >1 Foot	760	843	83	945	185	918	158	1,144	384
Total >2 Feet	534	619	85	718	184	738	204	852	318

Table 5-41 Simulated Number of Days by Month during the Recreation Season that Drawdown Exceeds Certain Drawdown Levels

Drawdown (ft)	Alternative				
	Baseline	WBH97	WBH95	M97	M95
July					
1 < Drawdown ≤ 2	52	53	58	52	62
2 < Drawdown ≤ 3	21	27	37	30	47
3 < Drawdown ≤ 4	3	9	16	13	19
4 < Drawdown ≤ 5	0	4	5	5	10
5 < Drawdown ≤ 6	0	0	5	5	5
6 < Drawdown ≤ 7	0	0	2	0	4
7 < Drawdown	0	0	0	0	0
Total July	76	93	123	105	147
August					
1 < Drawdown ≤ 2	105	115	102	100	146
2 < Drawdown ≤ 3	105	84	67	124	99
3 < Drawdown ≤ 4	79	87	93	95	126
4 < Drawdown ≤ 5	40	43	60	34	54
5 < Drawdown ≤ 6	23	46	40	34	32
6 < Drawdown ≤ 7	21	28	40	49	31
7 < Drawdown ≤ 8	9	21	31	20	39
8 < Drawdown ≤ 9	12	13	11	17	24
9 < Drawdown ≤ 10	4	3	17	17	19
10 < Drawdown ≤ 11	0	4	13	4	9
11 < Drawdown ≤ 12	0	2	3	6	10
12 < Drawdown	0	0	5	0	16
Total August	398	446	482	500	605
September					
1 < Drawdown ≤ 2	69	56	67	28	84
2 < Drawdown ≤ 3	48	74	51	58	42
3 < Drawdown ≤ 4	12	15	56	39	22
4 < Drawdown ≤ 5	45	17	20	42	67
5 < Drawdown ≤ 6	26	33	3	18	33
6 < Drawdown ≤ 7	29	21	21	28	13
7 < Drawdown ≤ 8	14	30	33	31	22
8 < Drawdown ≤ 9	15	21	27	14	35
9 < Drawdown ≤ 10	9	12	7	14	11
1 0< Drawdown ≤ 11	7	4	15	13	10
11 < Drawdown ≤ 12	7	6	15	7	8
12 < Drawdown	5	15	25	21	45
Total September	286	304	340	313	392
Total	760	843	945	918	1,144

Table 5-42 Mean Number of Simulated Drawdown Days within a Given Range for a Drawdown Event during the Recreation Season

Drawdown (ft)	Alternative								
	Base line	WBH97		WBH95		M97		M95	
	Days	Days	Diff. from Base line	Days	Diff. from Base line	Days	Diff. from Base line	Days	Diff. from Base line
1 < Drawdown ≤ 3	16.7	17.0	0.3	14.1	-2.6	15.1	-1.6	15.5	-1.2
3 < Drawdown ≤ 5	7.5	7.3	-0.2	9.3	1.8	8.8	1.3	9.6	2.1
5 < Drawdown ≤ 10	6.8	9.5	2.7	8.8	2.0	9.5	2.7	8.6	1.8
10 < Drawdown ≤ 15	0.8	1.3	0.5	2.5	1.7	2.0	1.2	2.7	1.9
15 < Drawdown	0	0	0	0.3	0.3	0	0	0.5	0.5
Total	31.8	35.1	3.3	35.0	3.2	35.4	3.6	36.9	5.1

Figure 3-6 in Section 3 illustrates the drawdown frequency for the recreation season for the entire modeling period. In any given year, the chance that Cowanesque Lake would be drawn down under the Baseline Alternative would be:

Drawdown (ft):	1	2	3	4	6	10
Frequency (%):	8.2	5.7	3.9	2.9	1.4	0.2

The lake level would be at normal recreation elevation (1080 feet) for almost 80 percent of all recreation season days and within 1 foot of normal pool (1079-1080 feet) for 92 percent of all recreation season days.

Under the Baseline Alternative, the modeled water level data indicate that the extreme 1964 drawdown event would begin on August 1, 1964, and last until March 6, 1965. Under the Baseline Alternative, the modeling predicts that the drawdown during an extremely dry period (1964 event) would extend for 45 days during the recreation season (the entire month of August through September 14) with 5 days drawn down from 1 to 2 feet, 5 days drawn down from 2 to 3 feet, 6 days drawn down from 3 to 4 feet, 8 days drawn down from 4 to 6 feet, 15 days drawn down from 6 to 10 feet, and 6 days with drawdowns greater than 10 feet (Tables 5-43 and 5-44). Under the Baseline Alternative, the maximum drawdown during the recreation season for the 1964 event would be 1068.3 feet (almost a 12-foot drawdown), which would occur at the end of the recreation season (September 14).

Table 5-43 Simulated Total Number of Days during the Recreation Season that Drawdown Exceeds Certain Drawdown Levels for the 1964 Event

	Alternative								
	Base line	WHB97		WBH95		M97		M95	
Drawdown (ft)	Days	Days	Diff. from Base line	Days	Diff. from Base line	Days	Diff. from Base line	Days	Diff. from Base line
1 < Drawdown ≤ 2	5	11	6	10	5	12	7	9	4
2 < Drawdown ≤ 3	5	4	-1	8	3	7	2	4	-1
3 < Drawdown ≤ 4	6	5	-1	4	-2	4	-2	9	3
4 < Drawdown ≤ 5	4	5	1	5	1	4	0	6	2
5 < Drawdown ≤ 6	4	3	-1	4	0	3	-1	4	0
6 < Drawdown ≤ 7	5	4	-1	4	-1	4	-1	4	-1
7 < Drawdown ≤ 8	3	5	2	4	1	4	1	3	0
8 < Drawdown ≤ 9	4	3	-1	3	-1	3	-1	4	0
9 < Drawdown ≤ 10	3	4	1	3	0	4	1	3	0
10< Drawdown ≤ 11	3	3	0	4	1	0	-3	3	0
11 < Drawdown ≤ 12	3	4	1	3	0	0	-3	4	1
12 < Drawdown	0	3	3	11	11	0	0	3	3
Total	45	54	9	63	18	45	0	56	11

Pennsylvania regulations do not limit boat horsepower at Cowanesque Lake, which attracts boaters to the lake because this is one of the few lakes in the area with no horsepower restrictions. Pennsylvania regulations do limit boats to slow, no-wake speed in the following areas at Cowanesque Lake: Mapes Creek Cove, Baldwins Creek Cove, between the buoy lines across the reservoir in the vicinity of East and West Boat Launch areas, and from the buoy line west of the South Shore Day-use Area upstream to the headwaters of the reservoir. Table 5-45 summarizes the available surface area at Cowanesque Lake under various drawdowns and the area where the water would be greater than 3 feet deep. In extreme drawdown event years, the modeled water level data predict that the maximum drawdown of Cowanesque Lake under the existing Baseline Alternative would be about 12 feet during the recreation season, which would result in about a 25 percent loss of area where the lake is greater than 3 feet deep, mainly in the upstream portion of the lake. Areas of shallow water less than 3 feet deep would increase the hazard to boaters from submerged objects.

In summary, under the Baseline Alternative, drawdowns would occur during the recreation season but they would occur infrequently and the lake level would remain at normal recreation elevation (1080 feet) for about 80 percent of all recreation season days. There would be a less than 1 percent chance that the lake would be drawn down by more than 10 feet during the recreation season, which would affect the South Shore boat launches, and there would be a 92 percent chance that the lake would be drawn down less than 1 foot.

Table 5-44 Simulated Number of Days by Month during the Recreation Season that Drawdown Exceeds Certain Drawdown Levels for the 1964 Event

Drawdown (ft)	Alternative				
	Baseline	WBH97	WBH95	M97	M95
July					
1 < Drawdown ≤ 2	0	9	10	0	9
2 < Drawdown ≤ 3	0	0	8	0	2
3 < Drawdown	0	0	0	0	0
Total July	0	9	18	0	11
August					
1 < Drawdown ≤ 2	5	2	0	12	0
2 < Drawdown ≤ 3	5	4	0	7	2
3 < Drawdown ≤ 4	6	5	4	4	9
4 < Drawdown ≤ 5	4	5	5	4	6
5 < Drawdown ≤ 6	4	3	4	3	4
6 < Drawdown ≤ 7	5	4	4	1	4
7 < Drawdown ≤ 8	2	5	4	0	3
8 < Drawdown ≤ 9	0	3	3	0	3
9 < Drawdown ≤ 10	0	0	3	0	0
10< Drawdown ≤ 11	0	0	4	0	0
11 < Drawdown ≤ 12	0	0	0	0	0
12<Drawdown	0	0	0	0	0
Total August	31	31	31	31	31
September					
1 < Drawdown ≤ 2	0	0	0	0	0
2 < Drawdown ≤ 3	0	0	0	0	0
3 < Drawdown ≤ 4	0	0	0	0	0
4 < Drawdown ≤ 5	0	0	0	0	0
5 < Drawdown ≤ 6	0	0	0	0	0
6 < Drawdown ≤ 7	0	0	0	3	0
7 < Drawdown ≤ 8	1	0	0	4	0
8 < Drawdown ≤ 9	4	0	0	3	1
9 < Drawdown ≤ 10	3	4	0	4	3
10 < Drawdown ≤ 11	3	3	0	0	3
11 < Drawdown ≤ 12	3	4	3	0	4
12 < Drawdown	0	3	11	0	3
Total September	14	14	14	14	14
Total	45	54	63	45	56

Table 5-45 Surface Area of Cowanesque Lake under Various Drawdown Levels and Potential Impacts to Boating

Elevation (ft)	Drawdown (ft)	Surface Area of Lake (acres)	Area Where Water is > 3-ft Deep (acres)	Percent Loss of Water > 3-ft Deep
1080	0	1,050	975	0.0
1079	1	1,030	940	3.6
1078	2	1,005	913	6.4
1077	3	975	892	8.5
1076	4	940	872	10.6
1075	5	913	852	12.6
1074	6	892	835	14.4
1073	7	872	818	16.1
1072	8	852	803	17.6
1071	9	835	783	19.7
1070	10	818	763	21.7
1035	45	266	227	76.7

5.6.2 Alternative WBH97

Cowanesque Lake modeled water level data for the 78-year modeling period indicate that under Alternative WBH97 drawdown events greater than 1 foot would have occurred in about 31 percent of the years, the same percentage predicted for the Baseline Alternative. The modeled lake elevation data indicate that drawdown events would occur during the recreation season under Alternative WBH97 in a total of 24 years during the modeling period but only 11 of these years would have drawdowns greater than 5 feet, a slight increase over the number of years that would occur under the Baseline Alternative (see Table 5-38). Under Alternative WBH97, the model predicts a similar number of years with drawdown events for various drawdown ranges with only a slight increase in the number of years as compared to the existing Baseline Alternative. The increase in frequency for all drawdown ranges would be less than 5 percent.

Similar to the Baseline Alternative, the modeled water level data do not indicate any drawdowns greater than 1 foot during May or June for the entire 78-year modeling period. In any given year, the chance that Cowanesque Lake would be drawn down under Alternative WBH97 would be:

Drawdown (ft):	1	2	3	4	6	10
Frequency (%):	9.1	6.7	4.6	3.5	1.9	0.3

Figure 3-6 in Section 3 illustrates the drawdown frequency for the recreation season for the entire modeling period. The lake level is at normal recreation elevation (1080 feet) under Alternative WBH97 for almost 80 percent of all recreation season days and within 1 foot of normal pool (1079-1080 feet) for 91 percent of all recreation season days.

The modeled water level data indicate that Cowanesque Lake would experience a total of 843 days during the recreation season (93, 446, and 304 days during the months of July, August and September, respectively) for the modeling period with drawdowns greater than 1 foot (Tables 5-

40 and 5-41). Compared to the Baseline Alternative, the modeled lake level data indicate that Cowanesque Lake would, under Alternative WBH97, experience an additional 83 days during the recreation season for the modeling period with drawdowns greater than 1 foot and an additional 85 days with drawdowns greater than 2 feet that would affect the usability of some of the boat mooring slips at Tompkins Campground, the launching of some boats at the Tompkins Campground boat launch, and reduce the swim area at the beaches. The ADA fishing pier, located at the South Shore Day-use Area, which receives low recreational use (about one-half the recreational use as Tompkins Campground), would be affected by drawdowns greater than 3 feet an additional 74 days under WBH97 and the usability of the majority of the boat mooring slips at Tompkins Campground and the boat launch would be affected by drawdowns greater than 4 feet an additional 57 days. The beaches would be closed at drawdowns of 6 feet an additional 48 days and the South Shore boat launches would be affected by drawdowns of 10 feet or more an additional 12 days as compared to the Baseline Alternative.

The modeled water level data indicate that drawdown events during the recreation season under Alternative WBH97 would be similar in duration to those that would occur under the Baseline Alternative. The modeled water level data predict that the mean number of days for a drawdown event under Alternative WBH97 would be 3.3 days more than under the Baseline Alternative and the duration of drawdowns within a given range would also be similar to the Baseline Alternative (Table 5-42).

Table 5-46 compares the predicted number of days with drawdowns during the recreation season for a given range between the alternatives and the Baseline Alternative. Under Alternative WBH97, there would be less than a 5 percent increase of drawdown frequency from the Baseline Alternative at varying drawdowns for each month during the recreation season. Impacts to the recreation facilities would be minor when comparing the frequency of the drawdown events to the Baseline Alternative during the recreation season.

Under Alternative WBH97, the modeled water level data predict that the median drawdown event (i.e., a normal drawdown event under Alternative WBH97) year (1959) would last from July 31, 1959, through October 13, 1959. Compared to the Baseline Alternative, the median drawdown event under Alternative WBH97 would reach a maximum drawdown of 1074.3 feet (0.5-foot increase in drawdown over the Baseline Alternative) during the recreation season. The modeling predicts that during the recreation season Alternative WBH97 would result in drawdowns greater than 1 foot for 2 days more than the Baseline Alternative, drawdowns greater than 2 feet for 4 additional days, drawdowns greater than 3 feet for 9 additional days, drawdowns greater than 4 feet for 3 additional days, and drawdowns greater than 5 feet for 3 additional days.

Table 5-46 Comparison of Simulated Number of Days with Drawdown within a Given Range during the Recreation Season

Alternative		July Impacted Days					August Impacted Days					September Impacted Days				
		Drawdown (ft)					Drawdown (ft)					Drawdown (ft)				
		1-3	3-5	5-10	10-15	>15	1-3	3-5	5-10	10-15	>15	1-3	3-5	5-10	10-15	>15
Baseline	# Days of Drawdown	73	3	0	0	0	210	119	69	0	0	117	57	93	19	0
WBH97	# Days of Drawdown	80	13	0	0	0	199	130	111	6	0	130	32	117	25	0
	% Increase Compared to Baseline Alternative[1]	0.29	0.41	0	0	0	-0.45	0.45	1.74	0.25	0	1.19	-2.29	2.20	0.55	0
WBH95	# Days of Drawdown	95	21	7	0	0	169	153	139	21	0	118	76	91	47	8
	% Increase Compared to Baseline Alternative	0.91	0.74	0.29	0	0	-1.70	1.41	2.89	0.87	0	0.09	1.74	-0.18	2.56	0.73
M97	# Days of Drawdown	82	18	5	0	0	224	129	137	10	0	86	81	105	41	0
	% Increase Compared to Baseline Alternative	0.37	0.62	0.21	0	0	0.58	0.41	2.81	0.41	0	-2.84	2.20	1.10	2.01	0
M95	# Days of Drawdown	109	29	9	0	0	245	180	145	35	0	126	89	114	49	14
	% Increase Compared to Baseline Alternative	1.49	1.08	0.37	0	0	1.45	2.52	3.14	1.45	0	0.82	2.93	1.92	2.75	1.28

[1]Percent increase compared to Baseline Alternative was calculated by calculating the difference in number of days of drawdown between the Baseline and each of the four optional trigger alternatives, and then dividing that difference by the number of days in each month for the entire period of record. For example, the difference in July impacted days between WBH97 and the Baseline for 1-3 feet of drawdown is 7 days. The total number of July days in the period of record would be the 31 days per month of July multiplied by the 78 years in the period of record, which equals 2,418 July days in the period of record. The difference in July impacted days, 7 days, is divided by the total number July days in the period of record, 2,418, which equals a 0.29 percent increase over the Baseline.

Under Alternative WBH97, the modeled water level data indicate that the extreme 1964 drawdown event would begin on July 23, 1964, and last until March 5, 1965. The maximum drawdown under Alternative WBH97 for the entire 1964 event would be 1035.1 feet, which would occur outside the recreation season. Tables 5-43 and 5-44 summarize the number of days during the recreation season that drawdowns would exceed certain levels under Alternative WBH97. Compared to the Baseline Alternative, the extreme 1964 drawdown event under Alternative WBH97 would reach a maximum drawdown of 1067.2 feet (a 1.1-foot increase in drawdown over the Baseline Alternative) during the recreation season, which would impact all of the recreation facilities at Cowanesque Lake under both Alternative WBH97 and the Baseline Alternative. The modeling predicts that during the recreation season Alternative WBH97 would result in drawdowns greater than 1 foot for 9 days more than the Baseline Alternative, drawdowns greater than 2 feet for 3 additional days over the Baseline Alternative, drawdowns greater than 3 feet for 4 additional days, drawdowns greater than 5 feet for 4 additional days, and drawdowns greater than 10 feet for 4 additional days.

Increased drawdowns of Cowanesque Lake would reduce the surface area from 1,050 acres at the normal recreation pool of 1080 feet and decrease the area where the lake is greater than 3 feet deep, mainly in the upstream portion of the lake (Table 5-45). Areas of shallow water less than 3 feet deep would increase navigation hazards to boaters from submerged objects and potentially warrant slower boating speeds. Under Alternative WBH97, drawdown frequency and duration would likely remain similar to that predicted under the Baseline Alternative with similar minor, short-term adverse impacts to boating under drawdown events.

In summary, Alternative WBH97 would likely result in similar drawdown frequencies, magnitude, and duration as the Baseline Alternative and the slight differences between Alternative WBH97 and the Baseline Alternative would not likely result in significant additional impacts to the recreation facilities. Alternative WBH97 would likely result in minor, short-term adverse impacts to the water-based recreation facilities at Cowanesque Lake as compared to the Baseline Alternative. Table 5-39 summarizes the elevations of the water-based recreation facilities at Cowanesque Lake and the impacts that drawdowns would have on these facilities. Based on this analysis, no impact modifications are recommended under Alternative WBH97.

5.6.3 Alternative WBH95

Cowanesque Lake modeled water level data for the 78-year modeling period indicate that under Alternative WBH95 drawdown events greater than 1 foot would have occurred in about 35 percent of the years. The modeled lake elevation data indicate that drawdown events would occur during the recreation season under Alternative WBH95 in a total of 27 years during the modeling period but only 11 of these years would have drawdowns greater than 5 feet, a slight increase over the number of years that would occur under the Baseline Alternative (see Table 5-38). Under Alternative WBH95, the model predicts similar number of years with drawdown events for various drawdown ranges with only a slight increase in the number of years as compared to the existing Baseline Alternative. The percent increase in frequency for all drawdown ranges would be less than 5 percent.

Similar to the Baseline Alternative, the modeled water level data do not indicate any drawdowns greater than 1 foot during May or June for the entire 78-year modeling period. In any given year, the chance that Cowanesque Lake would be drawn down under Alternative WBH95 would be:

Drawdown (ft):	1	2	3	4	6	10
Frequency (%):	10.2	7.8	6.1	4.3	2.9	0.8

Figure 3-6 in Section 3 illustrates the drawdown frequency for the recreation season for the entire modeling period. The lake level is at normal recreation elevation (1080 feet) under Alternative WBH95 for almost 80 percent of all recreation season days and within 1 foot of normal pool (1079-1080 feet) for 90 percent of all recreation season days.

The modeled water level data indicate that Cowanesque Lake would experience a total of 945 days during the recreation season (123, 482, and 340 days during the months of July, August and September, respectively) for the modeling period with drawdowns greater than 1 foot (Tables 5-40 and 5-41). Compared to the Baseline Alternative, the modeled lake level data indicate that Cowanesque Lake would, under Alternative WBH95, experience an additional 185 days during the recreation season for the modeling period with drawdowns greater than 1 foot and an additional 184 days with drawdowns greater than 2 feet that would affect the usability of some of the boat mooring slips at Tompkins Campground, the launching of some boats at the Tompkins Campground boat launch, and reduce the swim area at the beaches. The ADA fishing pier would be affected by drawdowns greater than 3 feet an additional 203 days under WBH95 and the usability of the majority of the boat mooring slips at Tompkins Campground and the boat launch would be affected by drawdowns greater than 4 feet an additional 132 days. The beaches would be closed at drawdowns of 6 feet an additional 133 days and the South Shore boat launches would be affected by drawdowns of 10 feet or more an additional 57 days as compared to the Baseline Alternative.

The modeled water level data indicate that drawdown events during the recreation season under Alternative WBH95 would be similar in duration to those that would occur under the Baseline Alternative. The modeled water level data predict that the mean number of days for a drawdown event under Alternative WBH95 would be 3.2 days more than under the Baseline Alternative and the duration of drawdowns within a given range would also be similar to the Baseline Alternative (Table 5-42).

Table 5-46 compares the predicted number of days with drawdowns during the recreation season for a given range between the alternatives and the Baseline Alternative. Under Alternative WBH95, there would be less than a 5 percent increase of drawdown frequency from the Baseline Alternative at varying drawdowns for each month during the recreation season. Impacts to the recreation facilities would be minor when comparing the frequency of the drawdown events to the Baseline Alternative during the recreation season.

Under Alternative WBH95, the modeled water level data predicts that the median drawdown event (i.e., a normal drawdown event under Alternative WBH95) year (1932) would last from August 23, 1932, through November 3, 1932. Compared to the Baseline Alternative, the median drawdown event under Alternative WBH95 would reach a maximum drawdown of 1077.5 feet

(0.2-foot increase in drawdown over the Baseline Alternative) during the recreation season. The modeling predicts that during the recreation season Alternative WBH95 would result in drawdowns greater than 1 foot for 6 days more than the Baseline Alternative and drawdowns greater than 2 feet for 3 additional days.

Under Alternative WBH95, the modeled water level data indicate that the extreme 1964 drawdown event would begin on July 14, 1964, and last until March 5, 1965. The maximum drawdown under Alternative WBH95 for the entire 1964 event would be 1035.2 feet, which would occur outside the recreation season. Tables 5-43 and 5-44 summarize the number of days during the recreation season that drawdowns would exceed certain levels under Alternative WBH95. Compared to the Baseline Alternative, the extreme 1964 drawdown event under Alternative WBH95 would reach a maximum drawdown of 1064.7 feet (a 3.6-foot increase in drawdown over the Baseline Alternative) during the recreation season, which would impact all the recreation facilities at Cowanesque Lake under both Alternative WBH95 and the Baseline Alternative. The magnitude and duration of extreme drawdown events would likely increase under Alternative WBH95 (more so than any of the other alternatives) compared to the Baseline Alternative, but in any given year, there is only a 0.8 percent chance Cowanesque Lake would be drawn down more than 10 feet under Alternative WBH95 (see Figure 3-6 in Section 3).

Increased drawdowns of Cowanesque Lake would reduce the surface area from 1,050 acres at the normal recreation pool of 1080 feet and decrease the area where the lake is greater than 3 feet deep, mainly in the upstream portion of the lake (Table 5-45). Areas of shallow water less than 3 feet deep would increase navigation hazards to boaters from submerged objects and potentially warrant slower boating speeds. Under Alternative WBH95, drawdown frequency and duration would be somewhat similar to that predicted under the Baseline Alternative, except during extreme drawdown events, with similar minor, short-term adverse impacts to boating under drawdown events.

In summary, Alternative WBH95 would likely result in similar drawdown frequencies, magnitude, and duration as the Baseline Alternative. Although there would be a slight increase in the frequency of years with drawdowns in the 3-5-foot range under Alternative WBH95, this would only occur in 3 additional years during the modeling period—4 percent of years. The differences between Alternative WBH95 and the Baseline Alternative overall would not likely result in significant additional impacts to the recreation facilities. Alternative WBH95, as compared to the Baseline Alternative, would likely result in minor, short-term adverse impacts to the water-based recreation facilities at Cowanesque Lake. Table 5-39 summarizes the elevations of the water-based recreation facilities at Cowanesque Lake and the impacts that drawdowns would have on these facilities. Based on this analysis, no impact modifications are recommended under Alternative WBH95.

5.6.4 Alternative M97

Cowanesque Lake modeled water level data for the 78-year modeling period indicate that under Alternative M97 drawdown events greater than 1 foot would have occurred in about 33 percent of the years. The modeled lake elevation data indicate that drawdown events would occur during the recreation season under Alternative M97 in a total of 26 years during the modeling period but only 13 of these years would have drawdowns greater than 5 feet, a slight increase over the number of years that would occur under the Baseline Alternative (see Table 5-38). Under Alternative M97, the model predicts a similar number of years with drawdown events for various drawdown ranges with only a slight increase in the number of years as compared to the existing Baseline Alternative. The percent increase in frequency for all drawdown ranges would be less than 5 percent.

Similar to the Baseline Alternative, the modeled water level data do not indicate any drawdowns greater than 1 foot during May or June for the entire 78-year modeling period. In any given year, the chance that Cowanesque Lake would be drawn down under Alternative M97 would be:

Drawdown (ft):	1	2	3	4	6	10
Frequency (%):	10.5	8.0	6.0	4.0	2.5	0.5

Figure 3-6 in Section 3 illustrates the drawdown frequency for the recreation season for the entire modeling period. The lake level is at normal recreation elevation (1080 feet) under Alternative M97 for almost 80 percent of all recreation season days and within 1 foot of normal pool (1079-1080 feet) for 89.5 percent of all recreation season days.

The modeled water level data indicate that Cowanesque Lake would experience a total of 918 days during the recreation season (105, 500, and 313 days during the months of July, August and September, respectively) for the modeling period with drawdowns greater than 1 foot (Tables 5-40 and 5-41). Compared to the Baseline Alternative, the modeled lake level data indicate that Cowanesque Lake would, under Alternative M97, experience an additional 158 days during the recreation season for the modeling period with drawdowns greater than 1 foot and an additional 204 days with drawdowns greater than 2 feet that would affect the usability of some of the boat mooring slips at Tompkins Campground, the launching of some boats at the Tompkins Campground boat launch, and reduce the swim area at the beaches. The ADA fishing pier would be affected by drawdowns greater than 3 feet an additional 166 days under M97 and the usability of the majority of the boat mooring slips at Tompkins Campground and the boat launch would be affected by drawdowns greater than 4 feet an additional 113 days. The beaches would be closed at drawdowns of 6 feet an additional 109 days and the South Shore boat launches would be affected by drawdowns of 10 feet or more an additional 32 days as compared to the Baseline Alternative.

The modeled water level data indicate that drawdown events during the recreation season under Alternative M97 would be similar in duration to those that would occur under the Baseline Alternative. The modeled water level data predicts that the mean number of days for a drawdown event under Alternative M97 would be 3.6 days more than under the Baseline Alternative and the duration of drawdowns within a given range would also be similar to the Baseline Alternative (Table 5-42).

Table 5-46 compares the predicted number of days with drawdowns during the recreation season for a given range between the alternatives and the Baseline Alternative. Under Alternative M97, there would be a less than 5 percent increase of drawdown frequency from the Baseline Alternative at varying drawdowns for each month during the recreation season. Impacts to the recreation facilities would be minor when comparing the frequency of the drawdown events to the Baseline Alternative by month during the recreation season.

Under Alternative M97, the modeled water level data predict that the median drawdown event (i.e., a normal drawdown event under Alternative M97) year (1995) would last from August 26, 1995 through October 21, 1995. Compared to the Baseline Alternative, the median drawdown event under Alternative M97 would reach a maximum drawdown of 1074.6 (0.8-foot increase in drawdown over the Baseline Alternative) during the recreation season. The modeling predicts that during the recreation season Alternative M97 would result in drawdowns greater than 1 foot for 2 days more than the Baseline Alternative, drawdowns greater than 2 feet for 2 additional days, drawdowns greater than 3 feet for 2 additional days, drawdowns greater than 4 feet for 2 additional days, and drawdowns greater than 5 feet for 2 additional days.

Under Alternative M97, the modeled water level data indicate that the extreme 1964 drawdown event would begin on August 1, 1964 and last until February 28, 1965. The maximum drawdown under Alternative M97 for the entire 1964 event would be 1035.2 feet, which would occur outside the recreation season. Tables 5-43 and 5-44 summarize the number of days during the recreation season that drawdowns would exceed certain levels under Alternative M97. Compared to the Baseline Alternative, the extreme 1964 drawdown event under Alternative M97 would have the same number of days of drawdown greater than 1 foot but fewer days as the drawdown increases and reaches a maximum drawdown of 1070.1 feet (1.8 foot less drawdown compared to the Baseline Alternative) during the recreation season. Although all the recreation facilities would be affected, the South Shore boat launches would still be usable. During extreme dry periods, Alternative M97 would likely result in fewer impacts to most of the recreation facilities than the Baseline Alternative.

Increased drawdowns of Cowanesque Lake would reduce the surface area from 1,050 acres at the normal recreation pool of 1080 feet and decrease the area where the lake is greater than 3 feet deep, mainly in the upstream portion of the lake (Table 5-45). Areas of shallow water less than 3 feet deep would increase navigation hazards to boaters from submerged objects and potentially warrant slower boating speeds. Under Alternative M97, drawdown frequency and duration would be somewhat similar to that predicted under the Baseline Alternative with similar minor, short-term adverse impacts to boating under drawdown events.

In summary, Alternative M97 would likely result in overall similar drawdown frequency, magnitude, and duration as the Baseline Alternative. Although there would be a minor increase in the frequency of years with drawdowns in the 10-15-foot range under Alternative M97, this would only be 3 additional years during the modeling period. The differences between Alternative M97 and the Baseline Alternative overall would not likely result in significant additional impacts to the recreation facilities. Alternative M97, as compared to the Baseline Alternative, would likely result in minor, short-term adverse impacts to the water-based recreation facilities at Cowanesque Lake. Table 5-39 summarizes the elevations of the water-based recreation facilities at Cowanesque Lake and the impacts that drawdowns would have on these facilities. Based on this analysis, no impact modifications are recommended under Alternative M97.

5.6.5 Alternative M95

Cowanesque Lake modeled water level data for the 78-year modeling period indicate that under Alternative M95 drawdown events greater than 1 foot would have occurred in about 40 percent of the years. The modeled lake elevation data indicate that drawdown events would occur during the recreation season under Alternative M95 in a total of 31 years during the modeling period but only 15 of these years would have drawdowns greater than 5 feet, a slight increase over the number of years that would occur under the Baseline Alternative (see Table 5-38). Under Alternative M95, the model predicts moderate increases in the number of years with drawdown events for various drawdown ranges as compared to the existing Baseline Alternative. The percent increase in frequency from the existing Baseline Alternative for all drawdown ranges would be less than 5 percent.

Similar to the Baseline Alternative, the modeled water level data do not indicate any drawdowns greater than 1 foot during May or June for the entire 78-year modeling period. In any given year, the chance that Cowanesque Lake would be drawn down under Alternative M95 would be:

Drawdown (ft):	1	2	3	4	6	10
Frequency (%):	13.0	9.0	7.5	5.5	3.25	1.0

Figure 3-6 in Section 3 illustrates the drawdown frequency for the recreation season for the entire modeling period. The lake level is at normal recreation elevation (1080 feet) under Alternative M95 for almost 80 percent of all recreation season days and within 1 foot of normal pool (1079-1080 feet) for 87 percent of all recreation season days.

The modeled water level data indicate that Cowanesque Lake would experience a total of 1,144 days during the recreation season (147, 605, and 392 days during the months of July, August and September, respectively) for the modeling period with drawdowns greater than 1 foot (Tables 5-40 and 5-41). Compared to the Baseline Alternative, the modeled lake level data indicate that Cowanesque Lake would, under Alternative M95, experience an additional 384 days during the recreation season for the modeling period with drawdowns greater than 1 foot and an additional 318 days with drawdowns greater than 2 feet that would affect the usability of some of the boat mooring slips at Tompkins Campground, the launching of some boats at the Tompkins Campground boat launch, and reduce the swim area at the beaches. The ADA fishing pier would be affected by drawdowns greater than 3 feet an additional 304 days under M97 and the usability of the majority of the boat mooring slips at Tompkins Campground and the boat launch would be affected by drawdowns greater than 4 feet an additional 231 days. The beaches would be closed at drawdowns of 6 feet an additional 164 days and the South Shore boat launches would be affected by drawdowns of 10 feet or more an additional 79 days as compared to the Baseline Alternative.

The modeled water level data indicate that drawdown events during the recreation season under Alternative M95 would be similar in duration to those that would occur under the Baseline Alternative, although the duration of the events would be longer under Alternative M95 than under any of the other alternatives. The modeled water level data predicts that the mean number of days for a drawdown event under Alternative M95 would be 5.1 days more than under the

Baseline Alternative and the duration of drawdowns within a given range would also be similar to the Baseline Alternative (Table 5-42).

Table 5-46 compares the predicted number of days with drawdowns during the recreation season for a given range between the alternatives and the Baseline Alternative. Under Alternative M95, there would be less than a 5 percent increase of drawdown frequency from the Baseline Alternative at varying drawdowns for each month during the recreation season. Impacts to the recreation facilities would be minor when comparing the frequency of the drawdown events to the Baseline Alternative during the recreation season.

Under Alternative M95, the modeled water level data predict that the median drawdown event (i.e., a normal drawdown event under Alternative M95) year (1936) would last from July 20, 1936, through November 4, 1936. Compared to the Baseline Alternative, the median drawdown event under Alternative M95 would reach a maximum drawdown of 1076.1 feet (a 0.3-foot increase in drawdown over the Baseline Alternative) during the recreation season. The modeling predicts that during the recreation season Alternative M95 would result in drawdowns greater than 1 foot for 5 days more than the Baseline Alternative, drawdowns greater than 2 feet for 4 additional days, and drawdowns greater than 3 feet for 10 additional days.

Under Alternative M95, the modeled water level data indicate that the extreme 1964 drawdown event would begin on July 21, 1964, and last until March 5, 1965. The maximum drawdown under Alternative M95 for the entire 1964 event would be 1043.9 feet, which would occur outside the recreation season. Tables 5-43 and 5-44 summarize the number of days during the recreation season that drawdowns would exceed certain levels under Alternative M95. Compared to the Baseline Alternative, the extreme 1964 drawdown event under Alternative M95 would reach a maximum drawdown of 1067.2 feet (a 1.1-foot increase in drawdown over the Baseline Alternative) during the recreation season, which would impact all the recreation facilities at Cowanesque Lake. The magnitude and duration of extreme drawdown events would likely increase under Alternative M95 compared to the Baseline Alternative, but this would likely not result in any additional significant impacts to recreation since the increase in duration would be small.

Increased drawdowns of Cowanesque Lake would reduce the surface area from 1,050 acres at the normal recreation pool of 1080 feet and decrease the area where the lake is greater than 3 feet deep, mainly in the upstream portion of the lake (Table 5-45). Areas of shallow water less than 3 feet deep would increase navigation hazards to boaters from submerged objects and potentially warrant slower boating speeds. Under Alternative M95, drawdown frequency and duration would be greater than that predicted under the Baseline Alternative with similar minor, short-term adverse impacts to boating under drawdown events.

In summary, Alternative M95 would likely result in overall similar drawdown frequency, magnitude, and duration as the Baseline Alternative. The differences between Alternative M95 and the Baseline Alternative overall would not likely result in significant additional impacts to the recreation facilities. Alternative M95, as compared to the Baseline Alternative, would likely result in minor, short-term adverse impacts to the water-based recreation facilities at Cowanesque Lake. Table 5-39 summarizes the elevations of the water-based recreation facilities at Cowanesque Lake and the impacts that drawdowns would have on these facilities. Based on this analysis, no impact modifications are recommended under Alternative M95.

5.6.6 Summary and Conclusion

Before the level of Cowanesque Lake was raised in 1990 to provide water supply storage, SRBC funded modifications to then-existing recreation facilities and addition of new recreation facilities. Those facilities were designed for the water supply operations of the Baseline Alternative. In the 1982 environmental impact statement, Appendix H, USACE concluded that release of water supply storage during low flow periods “would not be anticipated to have any affect upon the ability of the lake to attract visitors, except in extreme droughts such as 1964. Most drawdowns are anticipated to occur late in the recreation season and the lake is always expected to refill by the beginning of the following recreation season” (USACE, 1982).

Under all five alternatives considered in this report, drawdowns would occur during the recreation season but they would occur infrequently, and the lake level would remain at normal recreation elevation (1080 feet) for almost 80 percent of all recreation season days. There would be at most an 11 percent chance that the lake would be drawn down more than 1 foot, and there would be at most a 1 percent chance that the lake would be drawn down by more than 10 feet during the recreation season, which would affect the beaches and boat launches. Furthermore, the four optional trigger alternatives would likely result in similar drawdown frequencies, magnitude, and duration as the Baseline Alternative and the slight differences between them and the Baseline Alternative would not likely result in significant additional impacts to the recreation facilities. No impact modifications are proposed because similar short-term, minor, adverse impacts to water-based recreation facilities at Cowanesque Lake are expected under these four optional trigger alternatives and the Baseline Alternative.

5.7 IMPACT MODIFICATIONS

As summarized in the preceding sections of Chapter 5, impacts under the four optional trigger alternatives would be essentially the same as under the Baseline Alternative for all resource categories, i.e., water quality, vegetation (SAVs and wetlands), terrestrial resources, fish, and recreation. Therefore, no impact modifications are recommended for implementation of any of the four optional trigger alternatives.

6.0 SUMMARY AND CONCLUSIONS

6.1 SUMMARY OF DRAWDOWN DATA

Table 6-1 summarizes the difference in drawdown frequency, depth, duration, and seasonality among the five alternatives. In comparing the various results, it is important to recognize the key factor is the difference in impacts between the Baseline Alternative and each of the optional trigger alternatives. These differences represent potential changes to the current water supply operations at Cowanesque Lake. A description of the alternatives is contained in Section 3.2.

As shown in Table 6-1, Cowanesque Lake would remain at normal pool for approximately 80 percent of the time under all five alternatives. In years when drawdowns could occur, the percent of time Cowanesque Lake was drawn down greater than 1 foot differed by at most 4 percent in total days among all five alternatives. During the recreation season, Cowanesque Lake remains at normal pool for the same amount of time (82 percent) under all five alternatives. In years when drawdowns could occur during the recreation season, the percent of time that Cowanesque Lake was drawn down greater than 1 foot differed by at most 4 percent in total days among all five alternatives. Furthermore, the magnitude of drawdown in a median and extreme drawdown event differs by less than 1 foot between the four optional trigger alternatives and the Baseline Alternative. Similarly, the duration of drawdowns greater than 1 foot during a median and extreme drawdown event differs by at most 10 days. The duration of drawdowns greater than 3-feet during a median and extreme event differs by at most 14 days. Lastly, median and extreme drawdown events under all five alternatives occur during the same time of year, which generally runs from late summer/early fall into the fall and winter seasons.

6.2 SUMMARY OF RESOURCE IMPACTS

Figures 6-1 (all years) and 6-2 (recreation season May 20-Sept 14) depict the drawdown frequency that the Baseline and the four optional trigger alternatives reach key resource impact levels. Under all five alternatives, the majority of the period of record remains at normal pool. Between drawdowns of 0 and 10 feet, the four optional trigger alternatives exhibit minor incremental changes (1 to 2 percent) from the Baseline Alternative. At greater drawdown levels, however, the incremental differences between the four optional trigger alternatives and the Baseline Alternative decrease to less than 0.1 percent. The following sections summarize the resource impacts of the Baseline and the four optional trigger alternatives.

Water Quality

In the 1982 environmental impact statement for proposed water supply storage at Cowanesque Lake, USACE concluded that release of water supply storage during low flow periods would have no effect on water quality in the lake or in the Cowanesque River downstream of the lake (USACE, 1982). In 97 percent of years, it is expected that none of the alternatives would have a drawdown greater than 22 feet, which USACE established as a threshold for potential in-lake water quality effects from drawdown. The other 3 percent of years are severe drought events, where all or some of the alternatives may exceed the 22-foot threshold, but at a date in the fall during the normal destratification time of the lake, thereby minimizing any effects of drawdown.

Table 6-1 Summary of Impact Assessments

	Alternatives				
Lake Level Drawdown Factors	Baseline	WBH97	WBH95	M97	M95
1. Frequency of Drawdowns – Year Round(a)					
A. Years of drawdown > 1 ft and percent of total years.	28 years = 36%	28 years = 36%	34 years = 44%	32 years = 41%	40 years = 51%
B. Days of drawdown > 1 ft and percent of total days	2683 days = 9.4%	2838 days = 10.0%	3240 days = 11.4%	3089 days = 10.8%	3849 days = 13.5%
C. Percent time at drawdowns < 1 ft	91%	90%	89%	89%	86%
D. Percent time at normal pool	82%	82%	81%	81%	79%
2. Frequency of Drawdowns – During Recreation Season(a)					
A. Years of drawdown > 1 ft and percent of total years.	24 years = 31%	24 years = 31%	27 years = 35%	26 years = 33%	31 years = 40%
B. Days of drawdown > 1 ft and percent of total days	760 days = 8.3%	843 days = 9.2%	945 days = 10.3%	918 days = 10.0%	1144 days = 12.4%
C. Percent time at drawdowns < 1 ft	92%	91%	90%	90%	88%
D. Percent time at normal pool	82%	82%	82%	82%	82%
E. Days of drawdown > 3 ft and percent of total days	360 days = 4%	434 days = 5%	563 days = 6%	526 days = 6%	664 days = 7%
3. Depth of Drawdowns					
A. Median drawdown	5.6 feet	5.9 feet	5.2 feet	6.5 feet	5.5 feet
B. Maximum drawdown	44.7 feet	44.9 feet	44.8 feet	36.1 feet	44.8 feet
4. Duration of Drawdowns					
A. Duration of drawdown > 1 ft for median event	83 days	65 days	82 days	80.5 days	88.5 days
B. Duration of drawdown > 1 ft for extreme event	218 days	226 days	235 days	212 days	228 days
C. Duration of drawdown > 3 ft for median event	54.5 days	51 days	46 days	68 days	64.5 days
D. Duration of drawdowns > 3 ft for extreme event	204 days	207 days	214 days	190 days	212 days
5. Seasonality of Drawdowns					
A. Dates of drawdown >3 ft for median event	9/23/1932- 10/27/1932 9/8/2002- 11/20/2002	8/11/1959- 10/8/1959 9/4/1995- 10/16/1995	9/21/1932- 10/27/1932 10/5/1980- 11/28/1980	9/4/1995- 10/20/1995 8/4/1999- 10/31/1999	7/18/1934- 9/24/1934 8/5/1936- 11/2/1936
B. Dates of drawdown >7 ft for median event	None	None	None	None	None
C. Dates of drawdown >3 ft for extreme event	8/11/1964- 3/3/1965	8/7/1964- 3/2/1965	8/1/1964- 3/2/1965	8/20/1964- 2/25/1965	8/3/1964- 3/2/1965
D. Dates of drawdown >7 ft for extreme event	8/30/1964- 2/24/1965	8/24/1964- 2/24/1965	8/18/1964- 2/23/1965	9/4/1964- 2/17/1965	8/26/1964- 2/23/1965-

(a) Calculations based on 78 years of record = 28,489 days total year round and 9,204 total days during recreation season of May 20 to September 14. The symbols used: > (greater than) and < (less than).

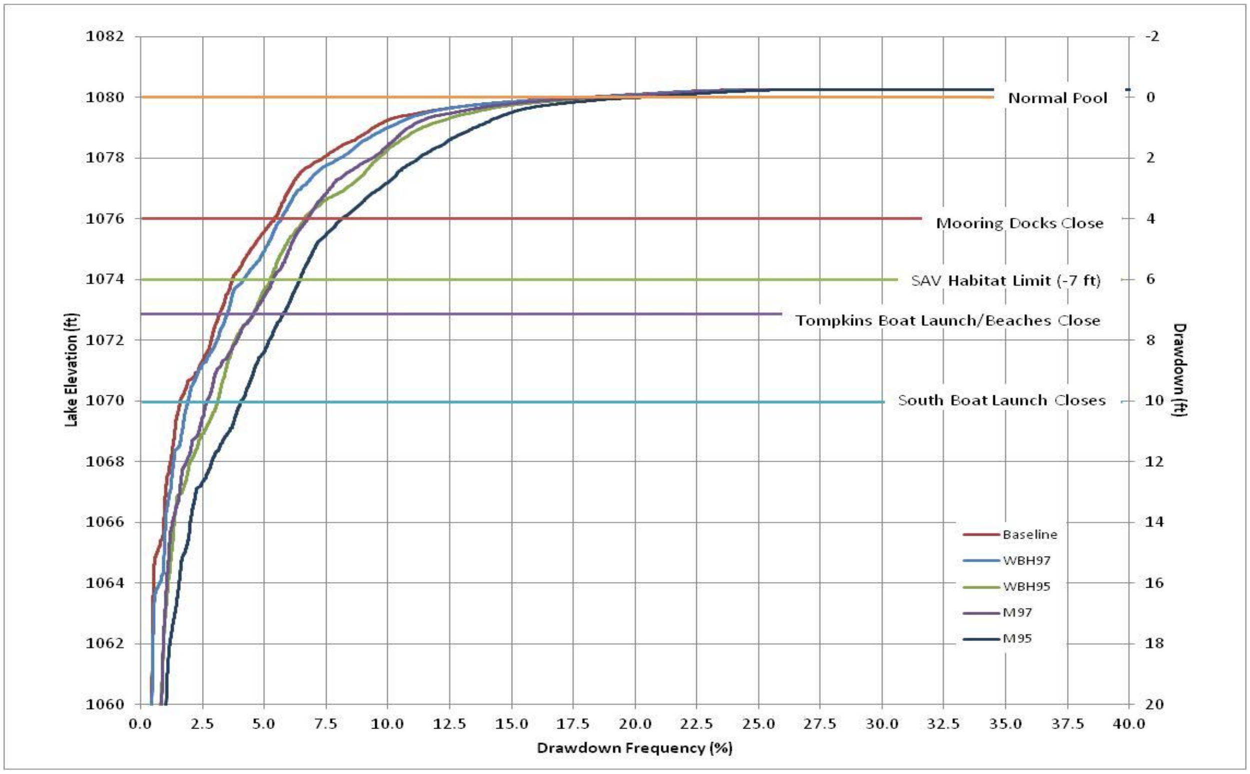

Figure 6-1 Simulated Drawdown Frequency Curve for Cowanesque Lake for the Entire Modeling Period with Key Resource Impact Levels

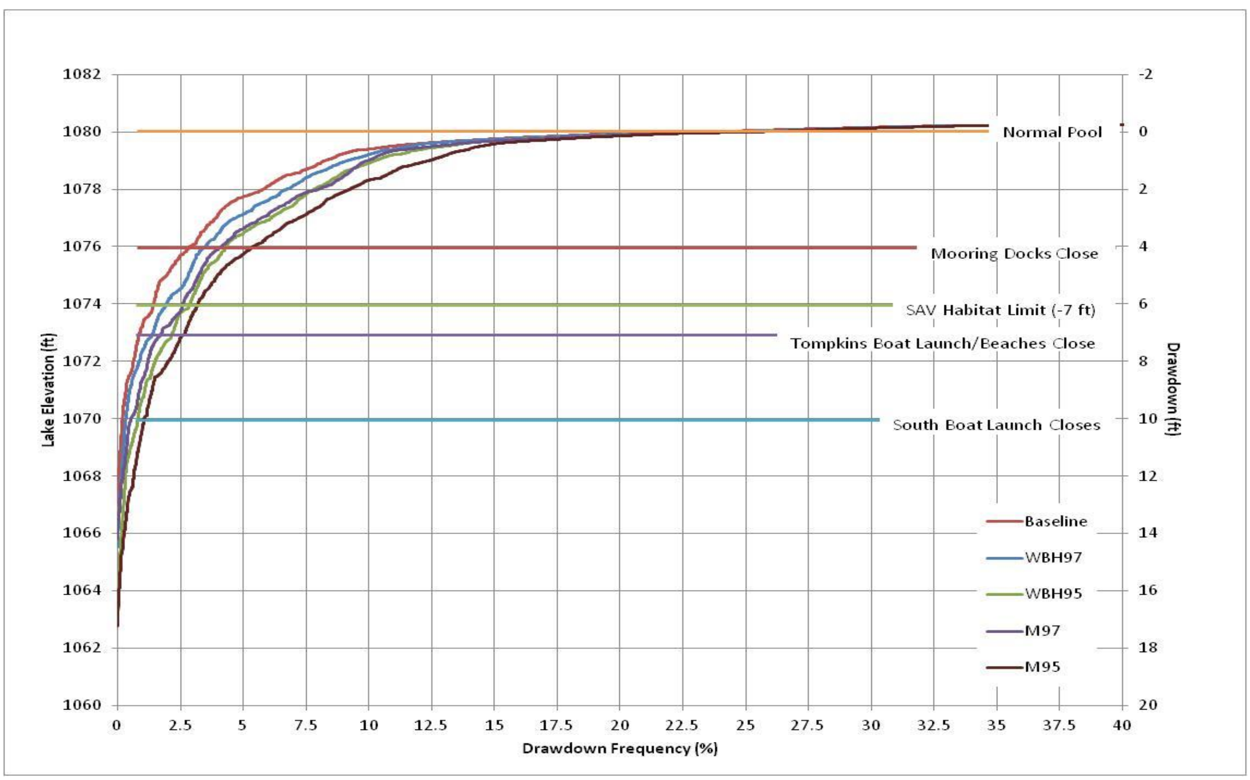

Figure 6-2 Simulated Drawdown Frequency Curve for the Recreation Season in the Modeling Period with Key Resource Impact Levels

Drawdown of the lake greater than 20 feet or so can affect USACE's ability to control the elevation from which releases are drawn, which in turn can affect its ability to meet optimum warmwater fishery temperatures downstream. Although the four optional trigger alternatives would have greater drawdown depth than the Baseline Alternative, they would have no incremental affect on downstream water temperature because the additional depth will still be above the second port or the additional drawdown would occur around the time the lake normally destratifies and temperature gradients are broken down.

Submerged Aquatic Vegetation

For 50 percent of years, lake drawdown is less than 1 foot under all alternatives, and there would be no impact to SAV. Under the four optional trigger alternatives, drawdown events would occur in fewer than 4 percent more days than under the Baseline Alternative, so there is not a large increase in drawdown under the four alternatives in the long term. In median event years, the drawdown event may begin 1 or 2 weeks earlier under the four alternatives than it would under the Baseline Alternative, which would cause earlier drying out of portions of the SAV area. However, there would be no difference in impact in the long term, because the SAV would recolonize in the following spring. During severe drought events, there may be moderate impacts to the SAV because the prolonged winter exposure may reduce SAV viability, but the SAV would be expected to recover over 1 or 2 years. This moderate impact would occur under all alternatives, so there is no increased impact from the four optional trigger alternatives compared to the Baseline Alternative. Impact modifications are not proposed for SAV because, in comparison to the Baseline Alternative, the four optional trigger alternatives are not expected to alter the level of impact—i.e., a minor effect changed to a moderate effect or a moderate effect changed to a major effect—to the SAV community.

Wetlands

In the 1982 environmental impact statement, USACE concluded that release of water supply storage during low flow periods "could cause an adverse but short-term effect" on wetlands because "water supply drawdowns would dewater these wetland areas occasionally" (USACE, 1982). However, "water supply drawdowns in combination with a normally stable pool would permit the growth of emergent wetlands due to the expected infrequent nature of the water supply drawdowns" (USACE, 1982). In comparison to the Baseline Alternative, the four optional trigger alternatives are not expected to alter the level of impact—i.e., a minor effect changed to a moderate effect or a moderate effect changed to a major effect—to the emergent wetland habitat. For 50 percent of years, lake drawdown is less than 1 foot under all alternatives, and there would be no impact to wetlands. For the event years, there is little variability for the duration and time of year between the Baseline Alternative and the four optional trigger alternatives. It is expected that the predicted drawdown duration and time of year at which drawdown occurs for all alternatives would result in moderate impacts on the emergent wetlands. The expected impacts for the four optional trigger alternatives is similar to the impact of the Baseline Alternative, so impact modifications are not proposed.

Terrestrial Resources

Terrestrial resources will not be affected by lake level drawdowns. No impact modifications for terrestrial resources are recommended.

Fish

In the 1982 environmental impact statement for proposed water supply storage at Cowanesque Lake, USACE concluded that release of water supply storage during low flow periods would have no effect on "the fishery [in the lake or in the Cowanesque River downstream of the lake] since the expected drawdown period (August-November) would not conflict with the spawning of the game fish (March to June). Furthermore, evidence from the Pennsylvania Fish [and Boat] Commission indicates that infrequent, moderate drawdowns can benefit a lake fishery by forcing small fish away from protective cover in the shallow reaches of a reservoir, making them more vulnerable to adult game fish predators" (USACE, 1982). The four optional trigger alternatives exhibit minor incremental differences compared to the Baseline Alternative. Under the four optional trigger alternatives, drawdown events occur in less than 4 percent more days in the period of record than the Baseline Alternative. Additionally, as the 1982 environmental impact statement explained, loss of established shallow water habitat caused by infrequent, moderate drawdowns can benefit the in-lake fishery. The four optional trigger alternatives could cause a slight increase in loss of established shallow water habitat; however, the incremental difference compared to the Baseline is minor. Lastly, increased water supply releases under the four optional trigger alternatives during low flow conditions are expected to improve habitat for aquatic communities downstream in the Cowanesque River. These releases would also improve the aquatic ecosystem in the Susquehanna River during drought periods and help meet the ecosystem flow recommendations from The Nature Conservancy study. No impact modifications for fisheries are recommended because the four optional trigger alternatives have similar impacts to the Baseline Alternative.

Recreational Resources

Before the level of Cowanesque Lake was raised in 1990 to provide water supply storage, SRBC funded modifications to then-existing recreation facilities and addition of new recreation facilities. Those facilities were designed for the water supply operations of the Baseline Alternative. In the 1982 environmental impact statement, Appendix H, USACE concluded that release of water supply storage during low flow periods "would not be anticipated to have any affect upon the ability of the lake to attract visitors, except in extreme droughts such as 1964. Most drawdowns are anticipated to occur late in the recreation season and the lake is always expected to refill by the beginning of the following recreation season" (USACE, 1982).

Under all five alternatives considered in this report, drawdowns would occur during the recreation season but they would occur infrequently, and the lake level would remain at normal recreation elevation (1080 feet) for about 80 percent of all recreation season days. Depending on the alternative considered, there would be an 8 to 12 percent chance that the lake would be drawn down more than 1 foot, and there would be at most a 1 percent chance that the lake would be drawn down by more than 10 feet during the recreation season, which would affect the beaches and boat launches. Furthermore, the four optional trigger alternatives would likely result in similar drawdown frequencies, magnitude, and duration as the Baseline Alternative and the slight differences between them and the Baseline Alternative would not likely result in significant additional impacts to the recreation facilities. No impact modifications are proposed because similar short-term, minor, adverse impacts to water-based recreation facilities at Cowanesque Lake are expected under these four optional trigger alternatives and the Baseline Alternative.

6.3 CONCLUSIONS

The four optional trigger alternatives would have similar or at most minimal incremental, impacts when compared to the Baseline Alternative. Natural resources would not be measurably more affected by the four optional trigger alternatives than they would be by the Baseline Alternative. In drought conditions, recreational resources may be affected under the four optional trigger alternatives more than they would under the Baseline Alternative, but the effects are minimal in the long-term. Impact modifications at the lake are not proposed because the four optional trigger alternatives would cause little increase in adverse impacts to natural or recreational resources.

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APPENDIX A

AGENCY CORRESPONDENCE

This appendix includes the letter sent by SRBC to several resource agencies and the responses received by letter, email, or phone.

Susquehanna River Basin Commission

a water management agency serving the Susquehanna River Watershed

August 4, 2011

Mr. David W. Garg
Regional Watershed Program Manager
Northcentral Region Office
PA Department of Environmental Protection
208 West Third Street, Suite 101
Williamsport, PA 17701

Re: Commission's Investigations to Optimize Use of Water Supply Storage at Cowanesque and Curwensville Lakes, Pennsylvania

Dear Mr. Garg:

I am writing to request your agency's initial input on investigations being conducted by the Susquehanna River Basin Commission (Commission). We are evaluating options to optimize the use of Commission-owned water supply storage at the U.S. Army Corps of Engineers' reservoirs, Cowanesque and Curwensville Lakes, located in Tioga County and Clearfield County, respectively, Pennsylvania.

The options for optimizing water use under consideration include various downstream trigger locations and flow levels at which compensatory flow releases from the lakes are required for mitigation of consumptive water use in the Susquehanna River Basin. The evaluation will focus on the engineering, environmental, and recreational effects of the alternative trigger flow levels, with a particular focus on the existing and planned features and facilities at the two lakes. It is recognized that alternatives to be considered could result in reduced lake levels during low flow conditions in late summer and fall. Alternative trigger levels will not increase current pool levels, nor will they impact flood control operations of the reservoirs.

The Commission also desires to further reduce the impact of human consumptive water use on the natural river flow regime and potentially improve and protect the downstream environment during significant low flow conditions.

Enclosed is a public notice for workshops the Commission held in June 2011. The notice contains additional information about the investigations. The Commission plans to hold additional workshops this fall to present the results of our investigations.

It would be extremely helpful if your agency would provide input to us regarding: (1) concerns or issues your agency has related to revised low flow operations at the two lakes;

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website: http://www.srbc.net e-mail: srbc@srbc.net

and (2) data and/or reports that may be useful to us during our investigation phase. Your input via e-mail or mail by August 19, 2011, would be greatly appreciated.

Thank you for your cooperation and attention to this matter. Questions should be directed by your staff to Matt Shank at (717) 238-0423, extension 113, or via e-mail at mshank@srbc.net. I can be contacted at extension 217 or via e-mail at jbalay@srbc.net.

Sincerely,

John W. Balay

John W. Balay, P.H.
Manager, Planning & Operations

Enclosure: Public Notice

cc: Nels J. Taber – PA Department of Environmental Protection, Northcentral Region Office

From: Detar, Jason [mailto:jdetar@pa.gov]
Sent: Monday, August 08, 2011 12:23 PM
To: Shank, Matthew
Cc: Hartle, Mark
Subject: RE: Curwensville Lake
Matt,
I am still interested in seeing more quantified information regarding potential reservoir drawdown scenarios, severity of drawdowns, length of drawdowns, etc. I believe you already have a copy of the summary report we pulled together from our 2009 Curwensville sampling, but can provide another copy if needed. The PFBC initiated a walleye stocking program at Curwensville in 2010. We will likely be evaluating the initial success of this program next Spring. Since the lake pool has been stabilized, vegetation has become established in some areas, enhancing habitat. Due to the steepsided nature of parts of this reservoir, it is unlikely that an overabundance of aquatic vegetation will occur. Additionally we've documented a substantial improvement in the resident gamefish populations. This likely due to stabilized pool and improved water quality. Any changes to reservoir pool level is likely to have negative impacts on resident fish populations and aquatic vegetation. This is likely to be exacerbated if reservoir levels fluctuate up and down during spring spawning period (March-May). Additionally changes to pool levels during summer months will impact thermocline and likely reduce the amount of coolwater habitat for species such as walleye. Impacts to recreational fishing and boating may also occur if drawdowns occur during summer months.
Thanks,
Jason

From: Shank, Matthew [mailto:mshank@srbc.net]
Sent: Friday, August 05, 2011 9:55 AM
To: Detar, Jason
Subject: Curwensville Lake

Jason,

Attached are 1) letter to PFBC requesting input regarding Curwensville/Cowanesque Lakes and 2) a copy of the June public workshop notice that also provides some information. We are currently asking for your general input and concerns regarding this project. If you have any comments or materials (data, reports, etc..) that you would like to share, please provide them by August 19.

Analysis regarding hydrologic studies, drawdown levels and frequencies, and potential impacts to environmental and recreational features is currently ongoing. We expect to present results at another public meeting this fall. I will keep you apprised.

Thanks,
Matt

Matthew K. Shank
Aquatic Biologist
Susquehanna River Basin Commission
1721 North Front Street
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Memo to the File
Subject: C2 Lakes Comments from Tom Randis, PADEP

In response to SRBC's letter of August 4, 2011, Tom Randis, Environmental Group Manager, PADEP, offered the following comments by phone on August 24, 2011.

- Tom's main concern was a decrease of Q7-10 flows during drought periods. Since DEP bases discharge permits on Q7-10 flows, any decrease from this level would result in inadequate dilution flows in receiving streams. I took this opportunity to explain that our analysis is investigating a range of options, including releasing higher quantities of water from the two reservoirs during low flow periods. The trigger level may change to seasonal, but it is likely that releases during low flows would increase due to the fact that in the past Q7-10 did not trigger releases during drought conditions. Tom said that any increase to baseflow during low flow periods would be a "win-win" as he sees it.

- A second concern is relative to potential impacts on a scale of individual withdrawals. Using Cowanesque Lake as an example, if SRBC allows withdrawals on the Tioga River upstream of the confluence with Cowanesque, the flow at the gage on the Tioga may be artificially increased because of the increased releases from Cowanesque Lake, while dilution flow on the Tioga River would not be adequate. Another example Tom used to explain this point: DEP has a discharge permit on Johnson Creek, which is a tributary to the Tioga River. If SRBC allows withdrawals upstream of the discharge on Johnson Ck, then dilution flows may not be adequate. But this change would not be detected because they rely on a Tioga River gage that is downstream of Cowanesque, and if releases are increased during low flows then their model may not detect impacts.

[Note by SRBC: Tom's second concern is at a very fine scale - on the scale of individual withdrawals and how they might complicate DEP's modeling efforts. The comment is not very applicable currently since the amount of augmented flow from either C2 Lake will not increase and only the frequency of releases will be slightly increased. PADEP should become more involved on this concern, as appropriate, when issuing future withdrawal approvals.]

Tom was very interested in hearing the results of our analysis. He wanted more specific information. SRBC will keep him informed.

From: Garg, David [mailto:dgarg@pa.gov]
Sent: Monday, August 29, 2011 11:42 AM
To: Shank, Matthew
Cc: Weaver, Susan K; Boos, Robert; Miller, Chad (DEP); Randis, Thomas
Subject: Cowanesque and Curewensville Lakes
Matt:

We have looked at the proposal to optimize use of water supply storage at the Cowanesque and Curewensville Lakes and have the following comments.

From the regional Water Quality folks:

There are no immediate downstream dischargers below the Cowanesque Lake. Downstream of the Curwensville Lake there are a number of municipal sewage treatment plant discharges and industrial dischargers that would be positively affected by increasing summer low flows (i.e., more dilution) assuming it's not all being withdrawn by gas companies. There are five upstream discharges above Cowanesque and one above Curwensville. It is unclear if lowering the lakes in the summer would adversely affect the impact from these discharges. The way we calculate water quality effluent limits is based on Q7-10 low flow, which would probably not be significantly affected upstream of the lakes. Lowering lake levels may improve phosphorus concentrations.

From our Water Use Planning folks:

Although the investigation will focus on the existing and planned features at the two lakes, my comment relates to the impact on downstream Public Water Supply Agencies (PWSAs). I would recommend to SRBC to include consideration of the following, if possible:

Determine (attempt to quantify) how the use of alternative trigger levels and the resulting revised release schedules will impact downstream PWSAs, specifically to assess the changes in stream flows and water quality at PWSA intakes when comparing the existing operations plans to any proposed plans.

I hope this helps you in your investigation.

Thanks,
Dave Garg

David Garg | Environmental Program Manager
Department of Environmental Protection
208 West Third Street, Suite 101, Williamsport, PA 17701
Phone: (570) 321-6581 | Fax: (570) 327-3565
www.depweb.state.pa.us

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Pennsylvania Field Office
315 South Allen Street, Suite 322
State College, Pennsylvania 16801-4850

August 30, 2011

Susquehanna River Basin Commission
ATTN: John W. Balay/Matthew Shank
1721 North Front St.
Harrisburg, PA 17102-2391

Dear Mr. Balay:

This responds to your letter of August 4, 2011, which solicits comments on revised low flow operations at Cowenesque and Curwensville Lakes, located in Tioga and Clearfield County. The Susquehanna River Basin Commission (SRBC) is proposing to optimize the use of SRBC-owned water supply storage at the afore-mentioned locations to more effectively address consumptive water use in the Susquehanna River Basin. The following comments are provided pursuant to the Endangered Species Act of 1973 (ESA, 87 Stat. 884, as amended; 16 U.S.C. 1531 *et seq.*) to ensure the protection of endangered and threatened species, and the Fish and Wildlife Coordination Act (FWCA, 48 Stat. 401, as amended; 16 U.S.C. 661 *et seq.*) to ensure the protection of other fish, wildlife, and habitats.

Federally Listed and Proposed Species

Except for occasional transient species, no federally listed or proposed threatened or endangered species under our jurisdiction are known to occur within the project impact area. Therefore, based on currently available information, no biological assessment or further consultation under the Endangered Species Act is required with the Fish and Wildlife Service. Should project plans change, or if additional information on listed or proposed species becomes available, this determination may be reconsidered.

Please note that a field survey may reveal previously undocumented populations of one or more species of concern within a project area. Refer to the enclosed list of *Federally Listed, Proposed, and Candidate Species in Pennsylvania* to determine which species may be found in your project area if suitable habitat is present. If surveys or further information reveals that a federally listed, proposed, or candidate species exists in your project area, contact the Fish and Wildlife Service immediately to discuss measures to avoid or minimize potential impacts to the species prior to initiating your project.

Bald Eagle

The bald eagle has been removed from the federal *List of Endangered and Threatened Wildlife*, and is therefore no longer protected under the Endangered Species Act. However, it continues to be protected under the Bald and Golden Eagle Protection Act (Eagle Act) and the Migratory Bird Treaty Act (MBTA). Both acts protect bald eagles by prohibiting killing, selling or otherwise harming eagles, their nests or eggs. The Eagle Act also protects eagles from disturbance. "Disturb" means to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available, 1) injury to an eagle; 2) a decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior; or 3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior.

On June 4, 2007, the Service released several important documents related to the protection of bald eagles under the Eagle Act, including 1) a final rule establishing a regulatory definition of "disturb"; 2) a final environmental assessment of the "disturb" regulation; and 3) *National Bald Eagle Management Guidelines*. On September 11, 2009, the Service released a final rule establishing a permit for the take of bald and golden eagles. The proposed rule establishes regulations for issuing permits to take bald and golden eagles where the take is associated with, and not the purpose of, otherwise lawful activities. A second permit type provides for take of bald and golden eagle nests for safety emergencies (of humans or eagles) or for when a nest renders a human-engineered structure inoperable. All of these documents can be found at http://www.fws.gov/migratorybirds/baldeagle.htm.

Three bald eagle nests are located in the vicinity of Cowanesque Lake and two nests are located in the vicinity of Curwensville Lake. Consequently, we recommend that you carefully evaluate the project type, size, location and layout in light of the *National Bald Eagle Management Guidelines* to determine whether or not bald eagles might be disturbed as a direct or indirect result of this project. If it appears that disturbance may occur, we recommend that you consider modifying your project consistent with the *Guidelines*. If you have questions about when and how to obtain a permit because you believe your proposed project will disturb bald eagles, and you are not able to implement measures to avoid disturbance, please contact the Service's Pennsylvania Field Office at 814-234-4090.

Additional Information

In addition, this project may have significant impacts on other fish, wildlife or habitats of federal concern. Therefore, the Service recommends the following measures:

- Follow guidance set forth in the most recent version of the Low Flow Protection Policy being developed.
- Maintain current ecological function to the best of your ability. Mimic seasonal fluctuations of water levels and maintain water temperature and quality such that aquatic species are less likely to be affected by the proposed changes.
- During periods of low flow, leave enough water to ensure flowing conditions for biota, including both resident and migratory fish.

- Avoid interbasin water transfers when possible. If transfers are necessary, minimize the ability for invasive species to enter the reservoirs. Develop a plan to eradicate the most likely invasive species in advance of performing water transfers.

Thank you for the opportunity to comment on this project. As specific methods for optimizing the use of water supply storage become available, the Service would appreciate the opportunity to comment at that time. If you have any questions or require further assistance, please contact Jennifer Siani of my staff at 814-234-4090.

Sincerely,

Clinton Riley
Field Office Supervisor

Enclosure

Federally Listed, Proposed, and Candidate Species in Pennsylvania

(revised January 20, 2011)

Common Name	Scientific Name	Status[1]	Distribution (Counties and/or Watersheds)
MAMMALS			
Indiana bat	*Myotis sodalis*	E	Hibernacula: Armstrong, Beaver, Blair, Centre, Fayette, Huntingdon, Lawrence, Luzerne, Mifflin and Somerset Co. Maternity sites: Adams, Armstrong, Bedford, Berks, Blair, Greene, Washington, and York Counties. Potential winter habitat state-wide in caves or abandoned mines. Potential summer habitat state-wide in forests or wooded areas.
BIRDS			
Piping plover	*Charadrius melodus*	E	Designated critical habitat on Presque Isle (Erie Co.). Migratory. No nesting in PA since 1950s, but recent colonization attempts at Presque Isle
REPTILES			
Bog turtle	*Clemmys (Glyptemys) muhlenbergii*	T	Adams, Berks, Bucks, Carbon, Chester, Cumberland, Delaware, Lancaster, Lebanon, Lehigh, Monroe, Montgomery, Northampton, Schuylkill and York Co. *Historically found in Crawford, Mercer and Philadelphia Co.*
Eastern massasauga rattlesnake	*Sistrurus catenatus catenatus*	C	Butler, Crawford, Mercer and Venango Co. *Historically found in Allegheny and Lawrence Co.*
MUSSELS			
Clubshell	*Pleurobema clava*	E	Allegheny River (Armstrong, Clarion, Forest, Venango, Warren); Conneaut Outlet (Crawford); Conneauttee Creek (Crawford); French Creek (Crawford, Erie, Mercer, Venango); LeBoeuf Creek (Erie); Muddy Creek (Crawford); Shenango River (Mercer) *Has not been found recently in 13 streams of historical occurrence in Butler, Beaver, Fayette, Greene, Indiana, Lawrence, and Westmoreland Co.*
Dwarf wedgemussel	*Alasmidonta heterodon*	E	Delaware River (Monroe, Pike, Wayne Co.). *Has not been found recently in streams of historical occurrence in the Delaware River watershed (Bucks, Carbon, Chester, Philadelphia) or Susquehanna River watershed (Lancaster)*
Northern riffleshell	*Epioblasma torulosa rangiana*	E	Allegheny River (Armstrong, Clarion, Forest, Venango, Warren); Conewango Creek (Warren); French Creek (Crawford, Erie, Mercer, Venango); LeBoeuf Creek (Erie); Muddy Creek (Crawford) *Has not been found recently in streams of historical occurrence, including Shenango River (Lawrence)*

APPENDIX B

TECHINAL DATA AND FIGURES

B1: FIGURES OF MODELED EVENTS AND ANNUAL LAKE ELEVATION MINIMUMS

B2: COMPLETE SUMMARY OF EXTREME AND MEDIAN DRAWDOWN EVENTS FOR EACH ALTERNATIVE

B3: FIGURES OF HISTORICAL ANNUAL LAKE ELEVATION MINIMUMS AND DAILY ELEVATION DATA

B4: DETAILED DATA PERTAINING TO 1962-1966 DROUGHT

APPENDIX B1

FIGURES OF MODELED EVENTS AND ANNUAL LAKE ELEVATION MINIMUMS

This appendix includes figures of the simulated daily lake elevation data for all drawdown event years, and figures of the minimum elevation in each year of the period of record for each of the alternatives.

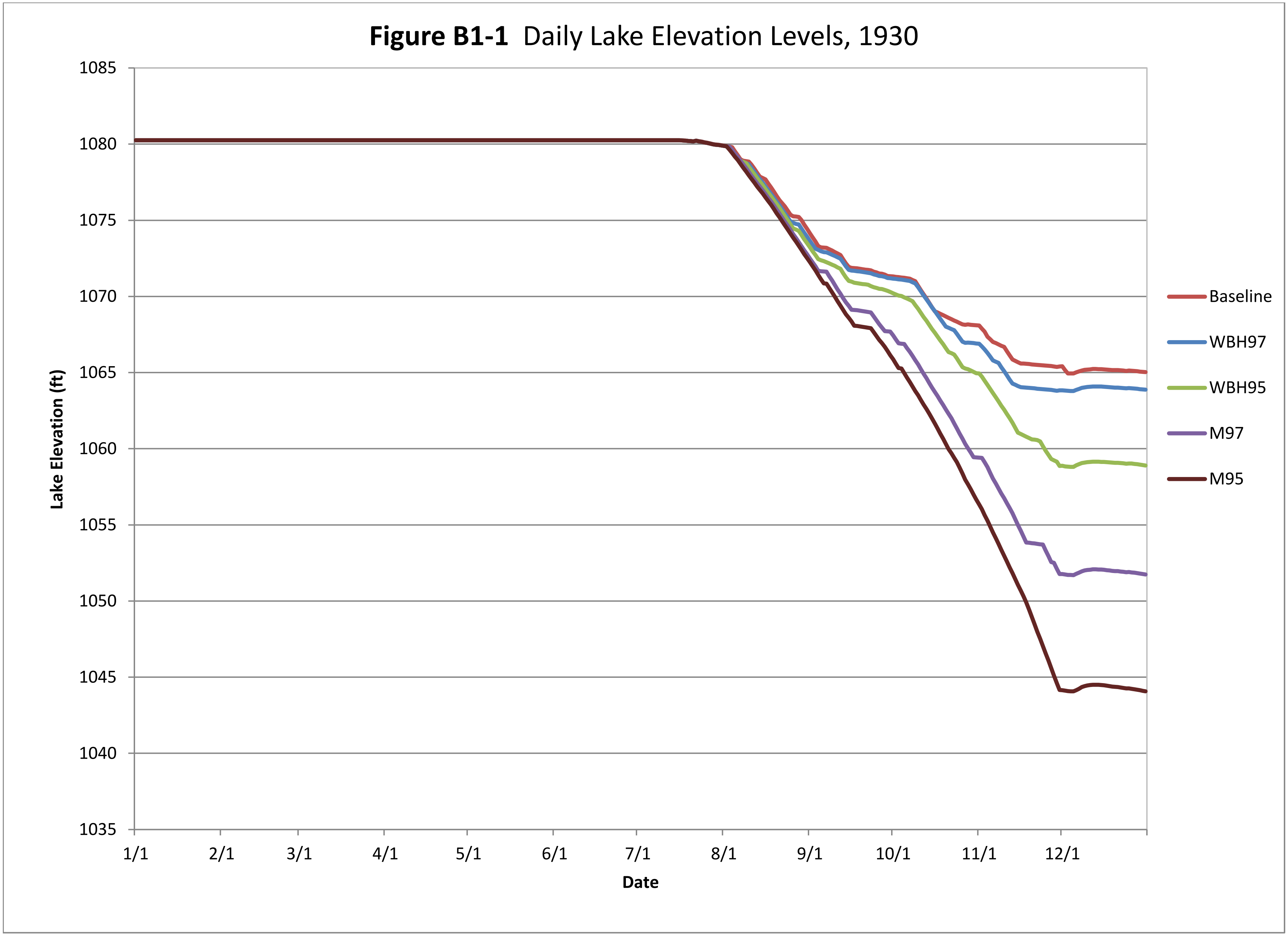
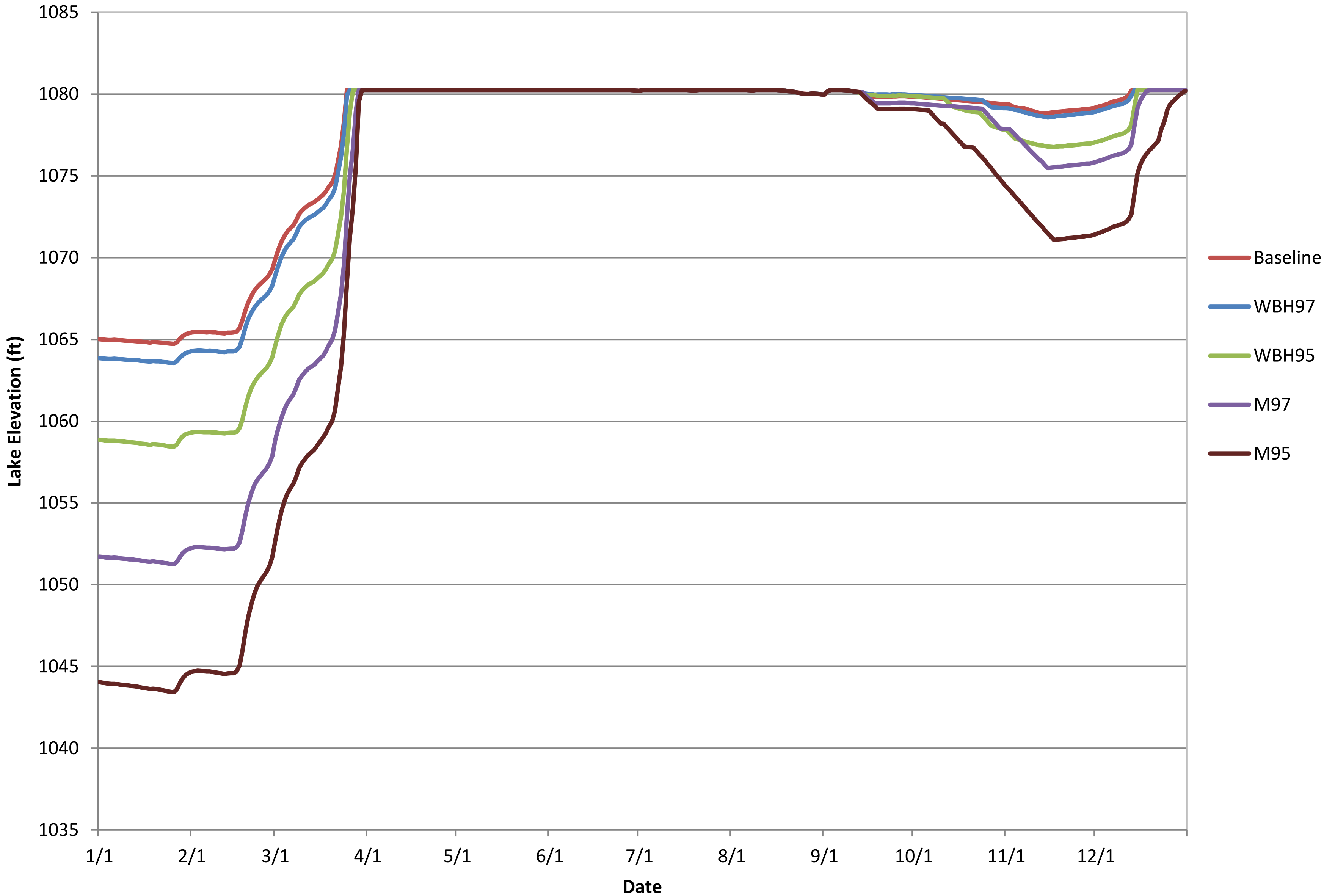


Figure B1-1 Daily Lake Elevation Levels, 1930
Lake Elevation (ft)
1085
1080
1075
1070
1065
1060
1055
1050
1045
1040
1035
1/1
2/1
3/1
4/1
5/1
6/1
7/1
8/1
9/1
10/1
11/1
12/1
Date
Baseline
WBH97
WBH95
M97
M95

Figure B1-2 Daily Lake Elevation Levels, 1931



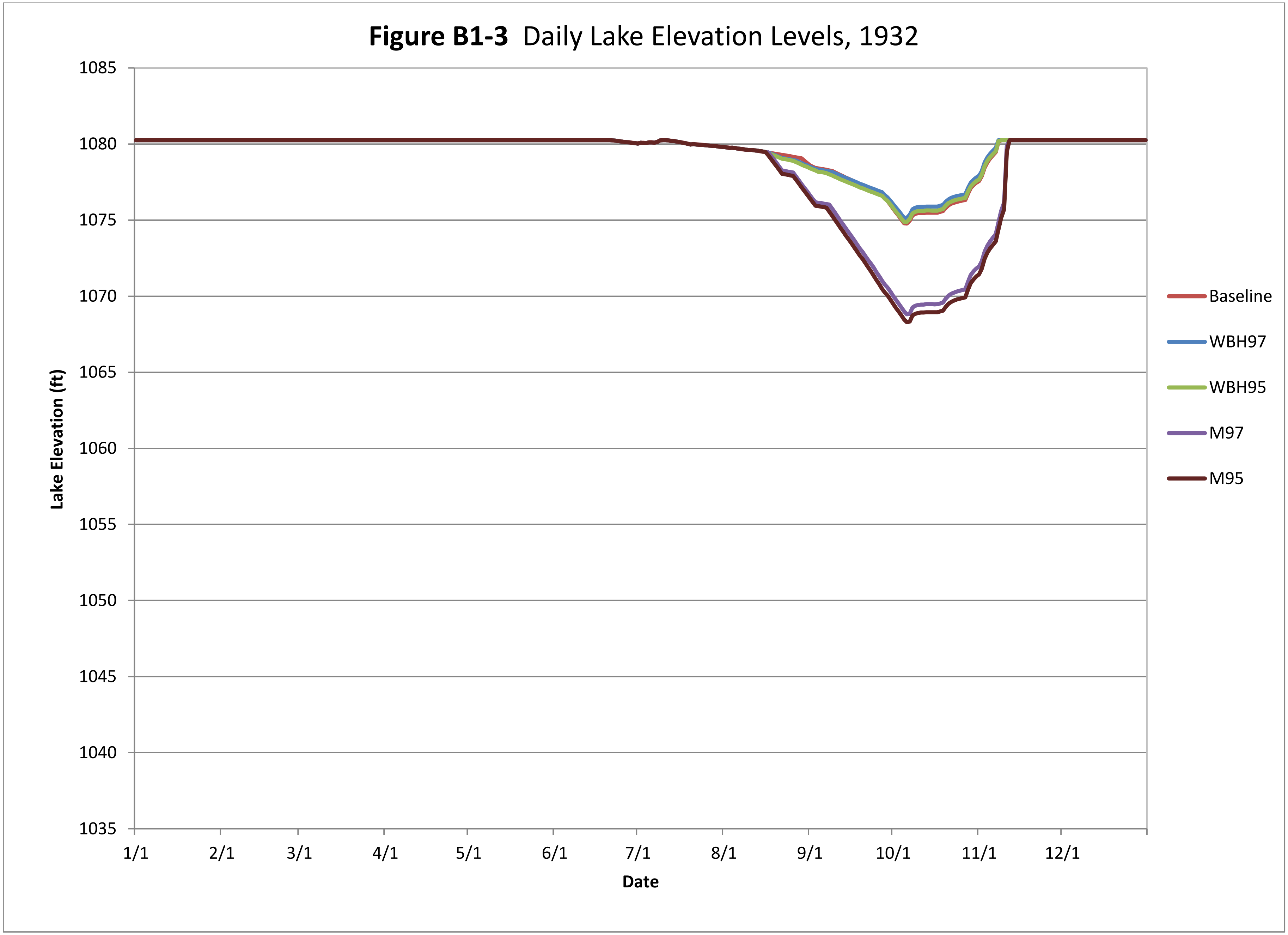


Figure B1-3 Daily Lake Elevation Levels, 1932
1085
1080
1075
1070
1065
1060
1055
1050
1045
1040
1035
Lake Elevation (ft)
1/1
2/1
3/1
4/1
5/1
6/1
7/1
8/1
9/1
10/1
11/1
12/1
Date
Baseline
WBH97
WBH95
M97
M95

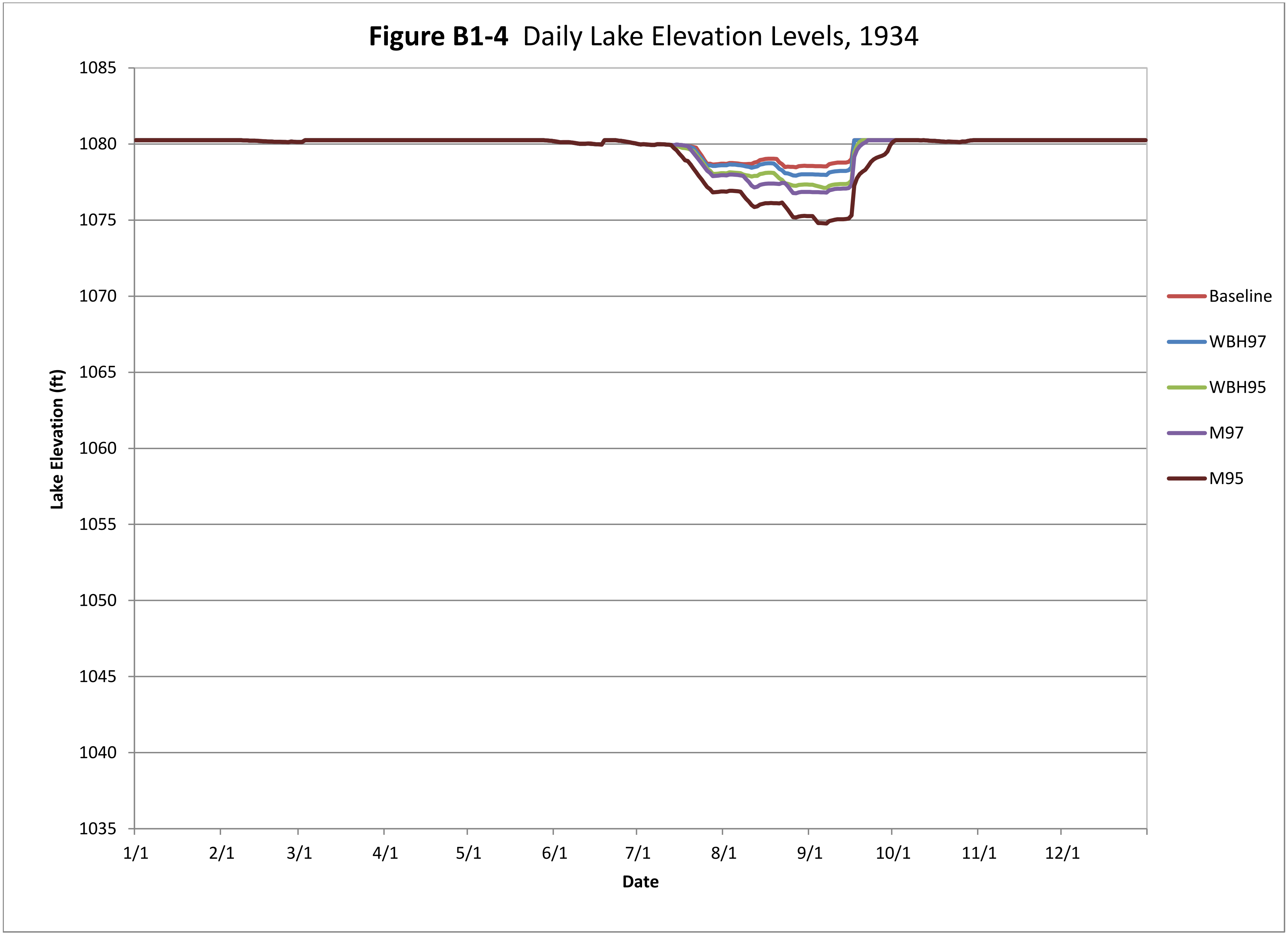


Figure B1-4 Daily Lake Elevation Levels, 1934
1085
1080
1075
1070
1065
1060
1055
1050
1045
1040
1035
Lake Elevation (ft)
1/1
2/1
3/1
4/1
5/1
6/1
7/1
8/1
9/1
10/1
11/1
12/1
Date
Baseline
WBH97
WBH95
M97
M95

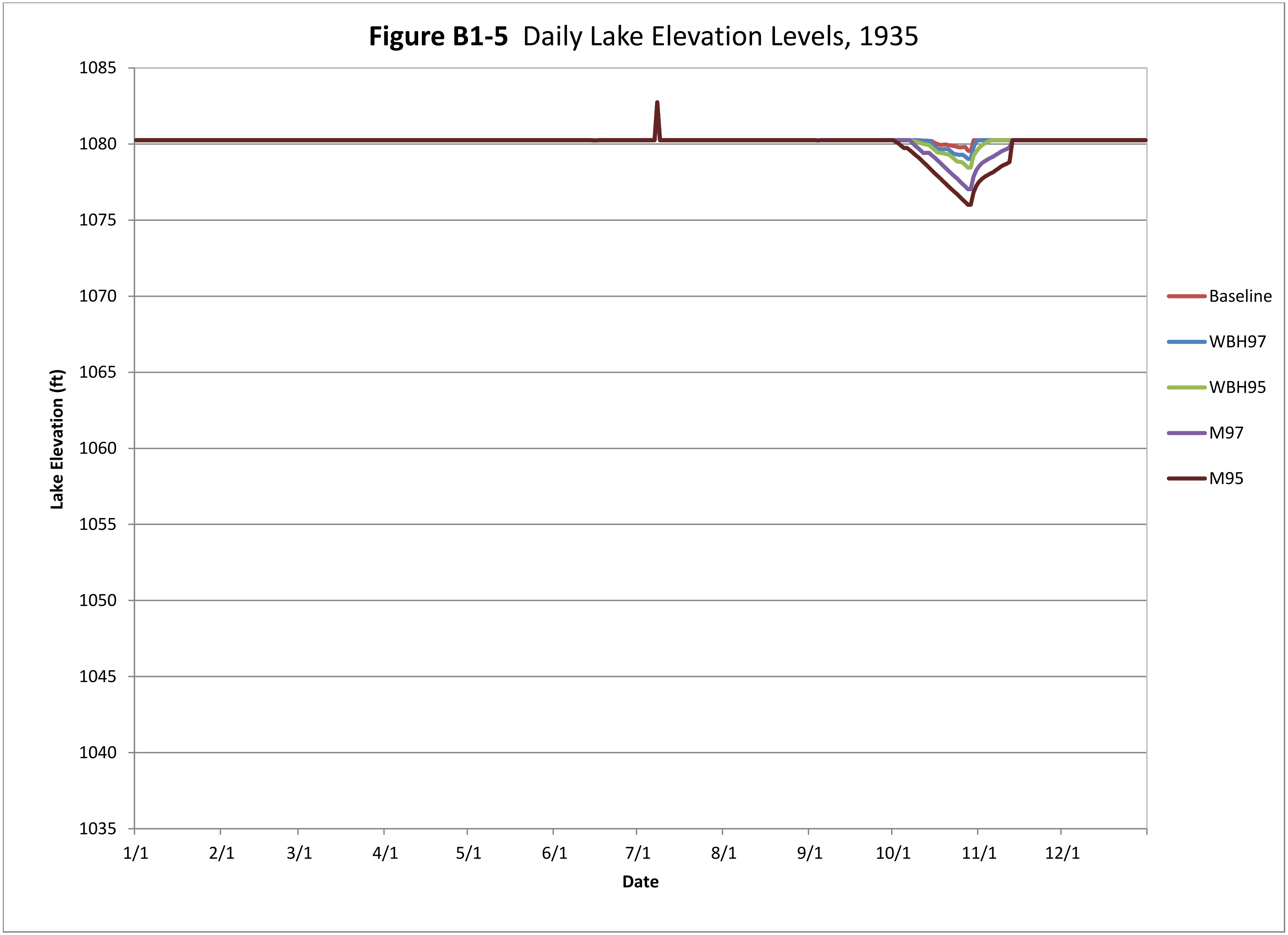


Figure B1-5 Daily Lake Elevation Levels, 1935
1085
1080
1075
1070
1065
1060
1055
1050
1045
1040
1035
Lake Elevation (ft)
1/1
2/1
3/1
4/1
5/1
6/1
7/1
8/1
9/1
10/1
11/1
12/1
Date
Baseline
WBH97
WBH95
M97
M95

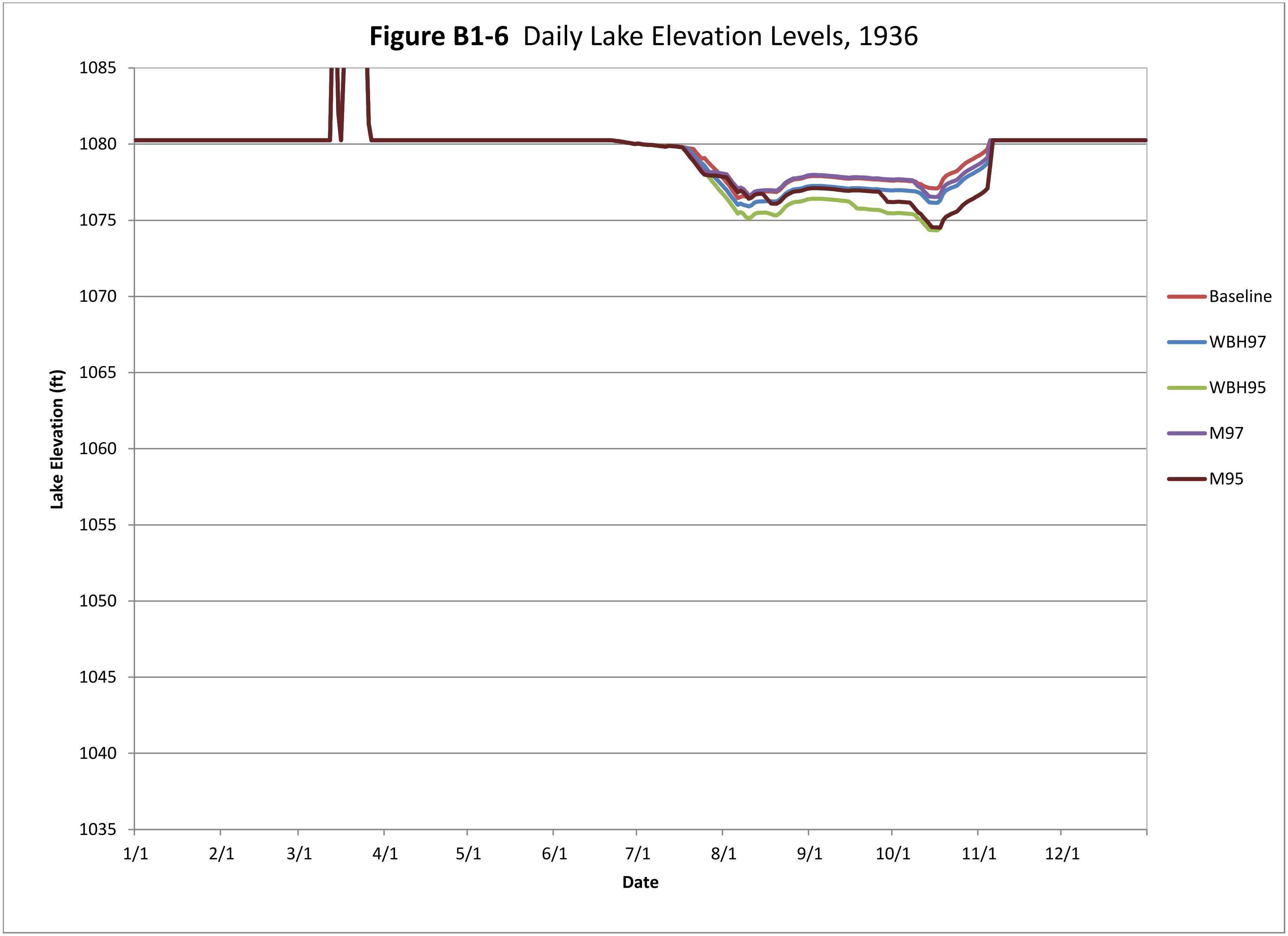


Figure B1-6 Daily Lake Elevation Levels, 1936
Lake Elevation (ft)
1085
1080
1075
1070
1065
1060
1055
1050
1045
1040
1035
1/1
2/1
3/1
4/1
5/1
6/1
7/1
8/1
9/1
10/1
11/1
12/1
Date
Baseline
WBH97
WBH95
M97
M95

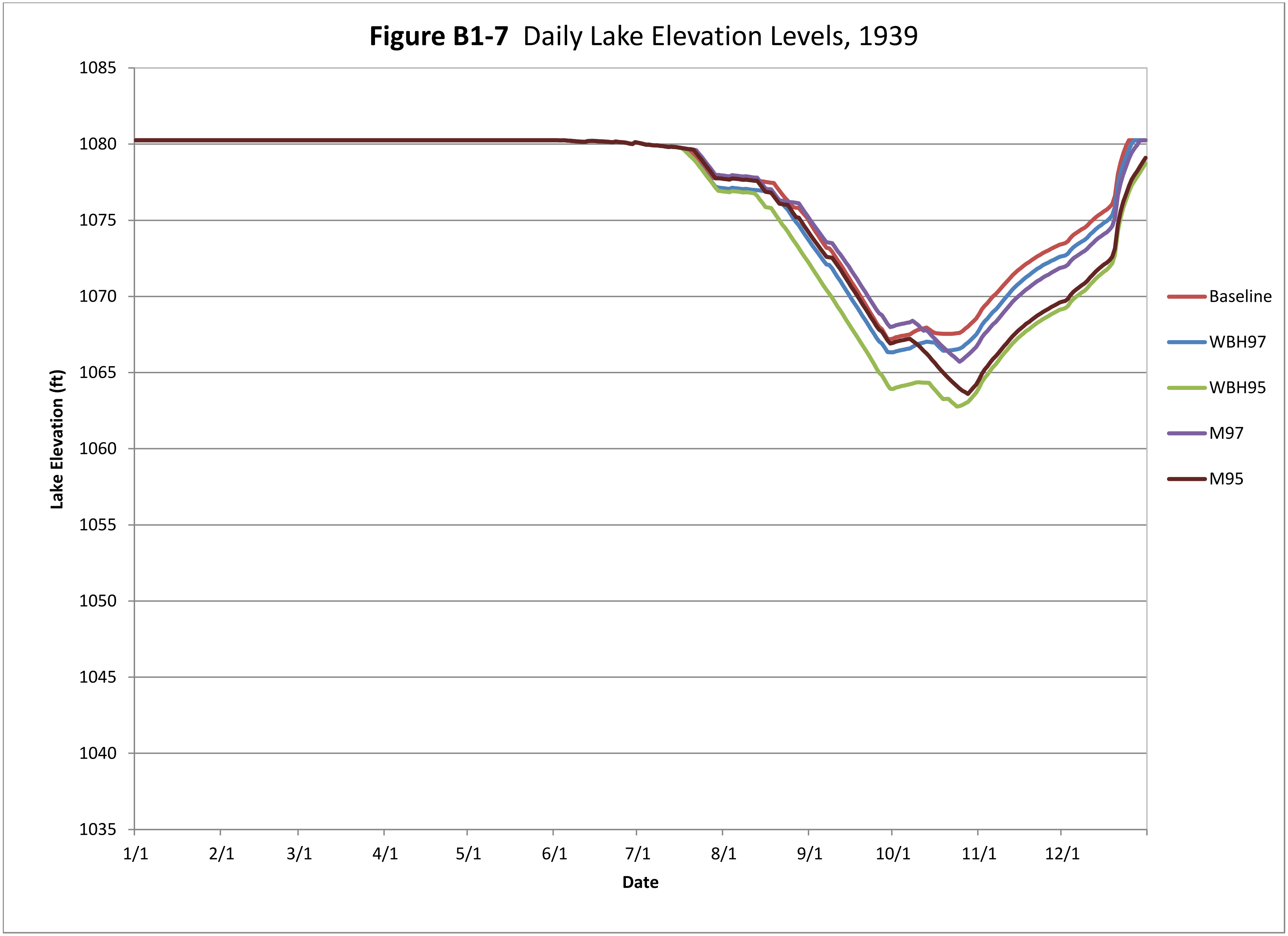


Figure B1-7 Daily Lake Elevation Levels, 1939
Lake Elevation (ft)
1085
1080
1075
1070
1065
1060
1055
1050
1045
1040
1035
1/1
2/1
3/1
4/1
5/1
6/1
7/1
8/1
9/1
10/1
11/1
12/1
Date
Baseline
WBH97
WBH95
M97
M95

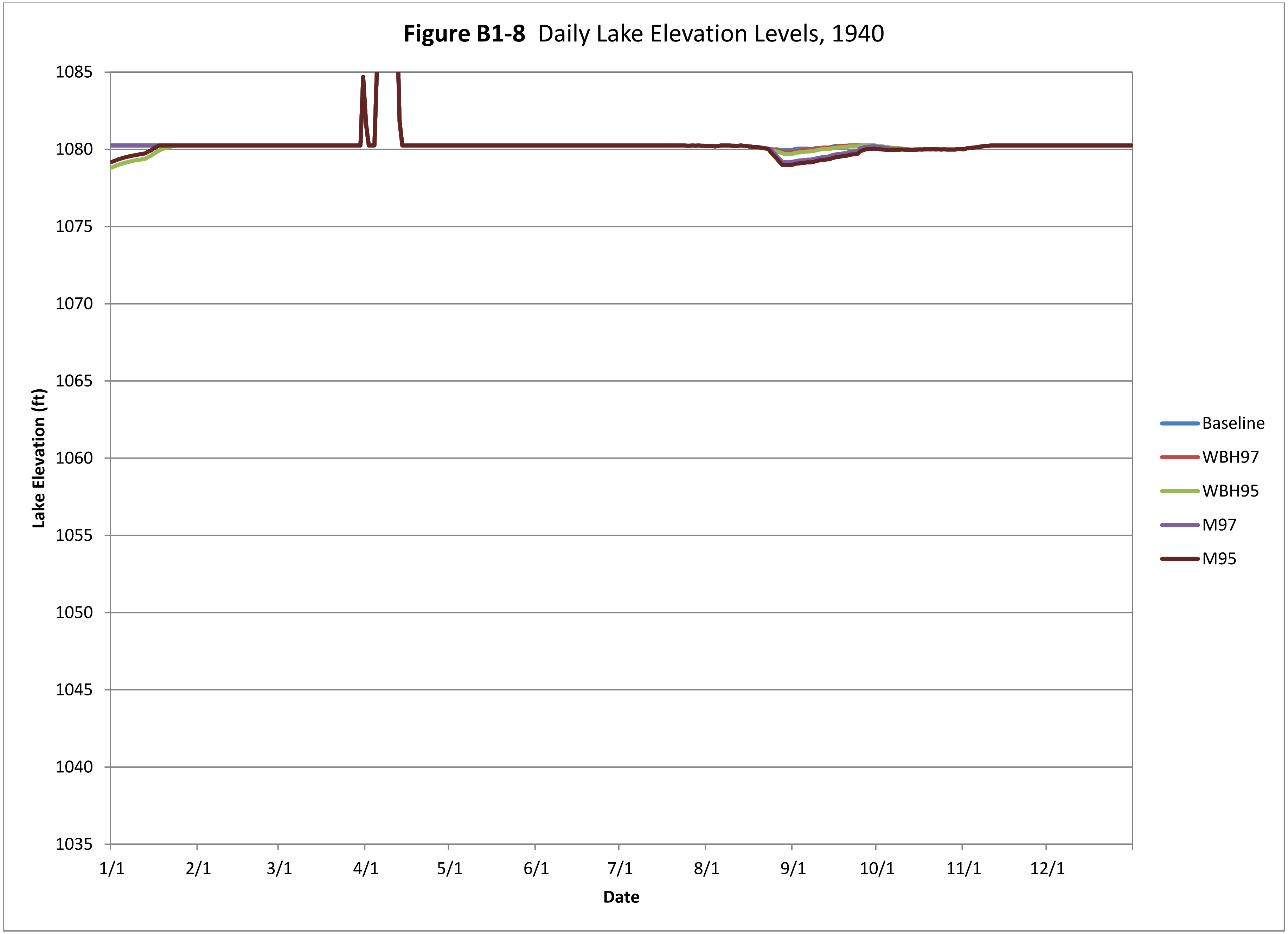


Figure B1-8 Daily Lake Elevation Levels, 1940
1085
1080
1075
1070
1065
1060
1055
1050
1045
1040
1035
Lake Elevation (ft)
1/1
2/1
3/1
4/1
5/1
6/1
7/1
8/1
9/1
10/1
11/1
12/1
Date
Baseline
WBH97
WBH95
M97
M95

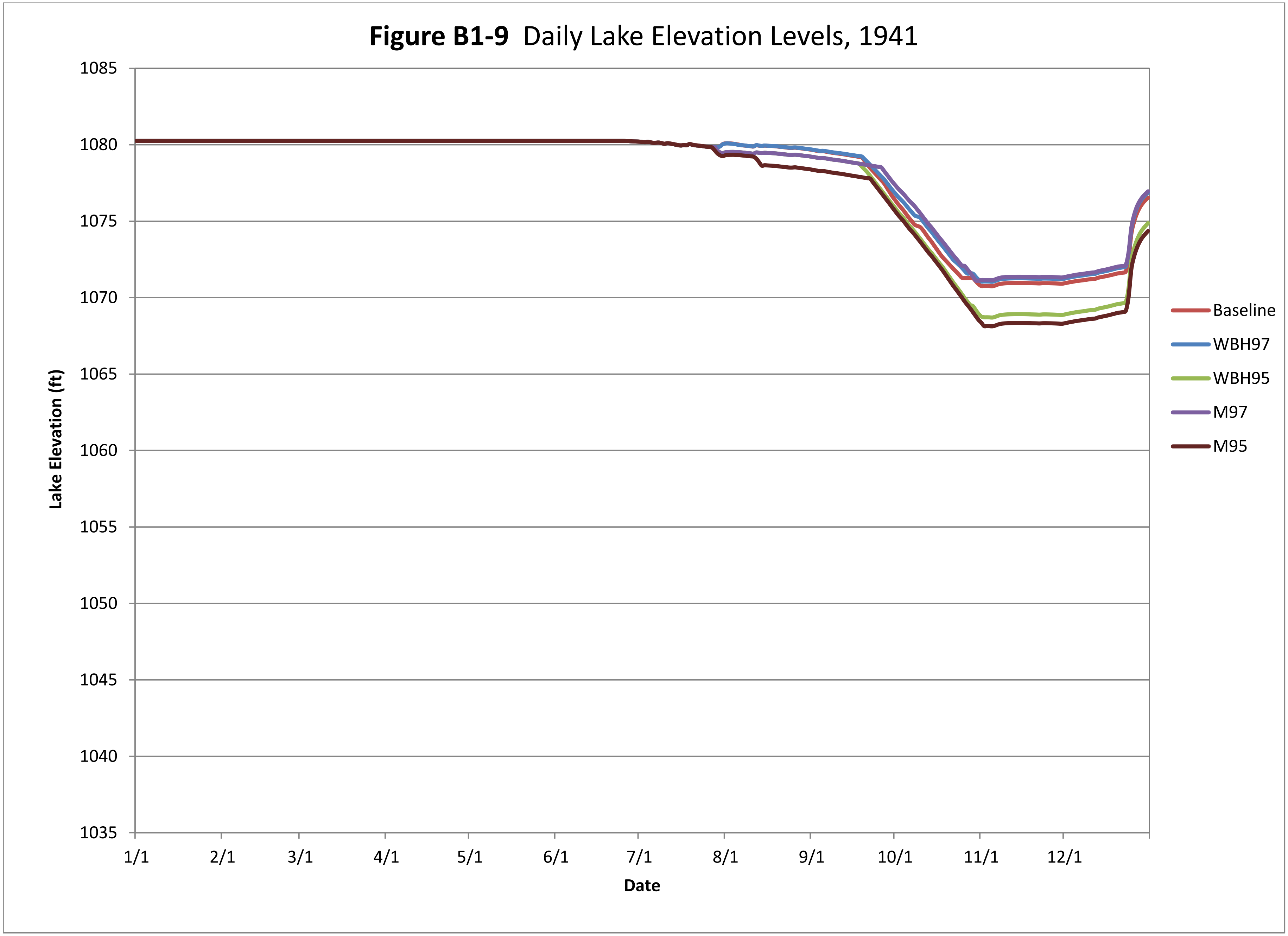


Figure B1-9 Daily Lake Elevation Levels, 1941
1085
1080
1075
1070
1065
1060
1055
1050
1045
1040
1035
Lake Elevation (ft)
1/1
2/1
3/1
4/1
5/1
6/1
7/1
8/1
9/1
10/1
11/1
12/1
Date
Baseline
WBH97
WBH95
M97
M95

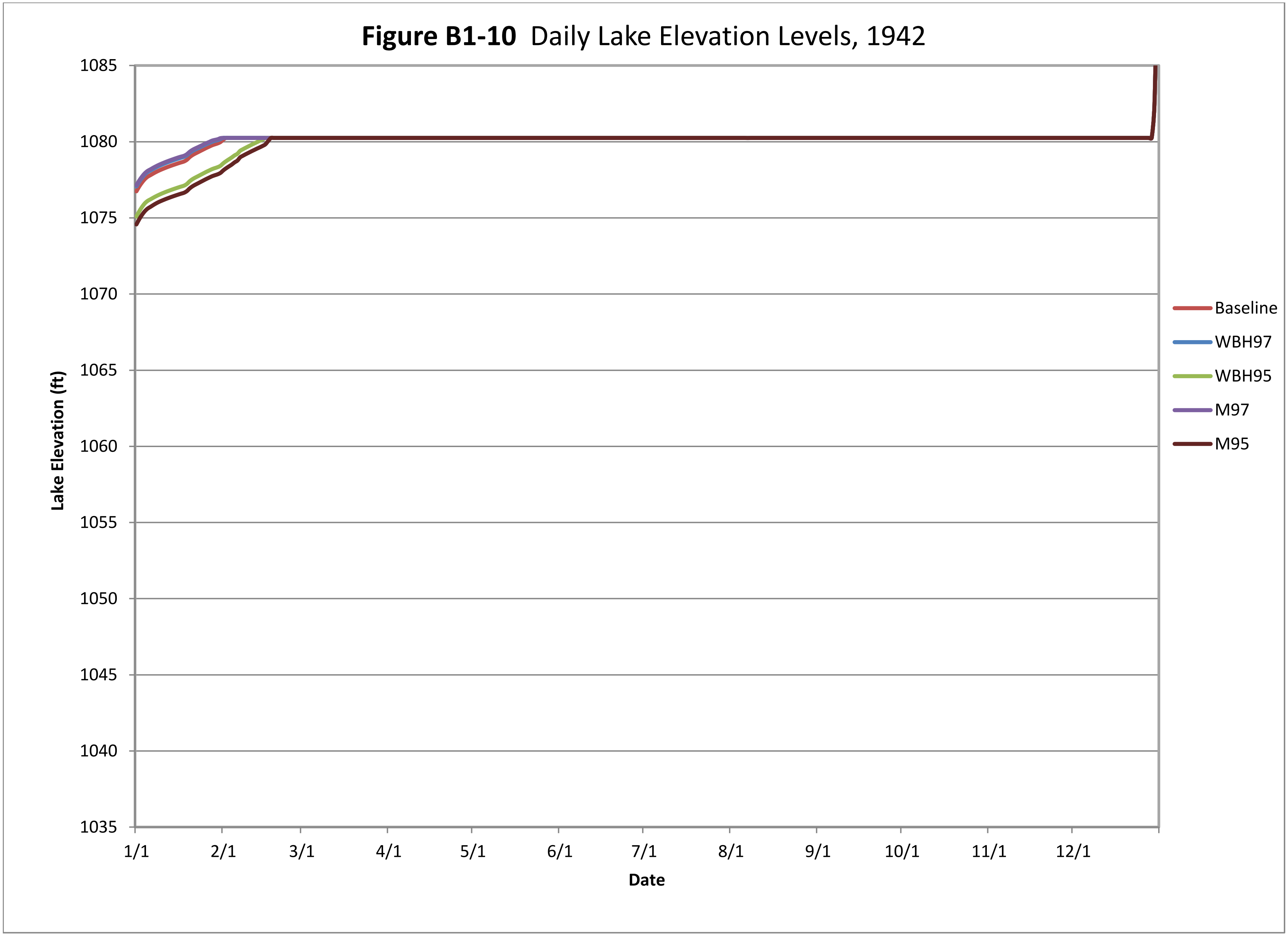


Figure B1-10 Daily Lake Elevation Levels, 1942
1085
1080
1075
1070
1065
1060
1055
1050
1045
1040
1035
Lake Elevation (ft)
1/1
2/1
3/1
4/1
5/1
6/1
7/1
8/1
9/1
10/1
11/1
12/1
Date
Baseline
WBH97
WBH95
M97
M95

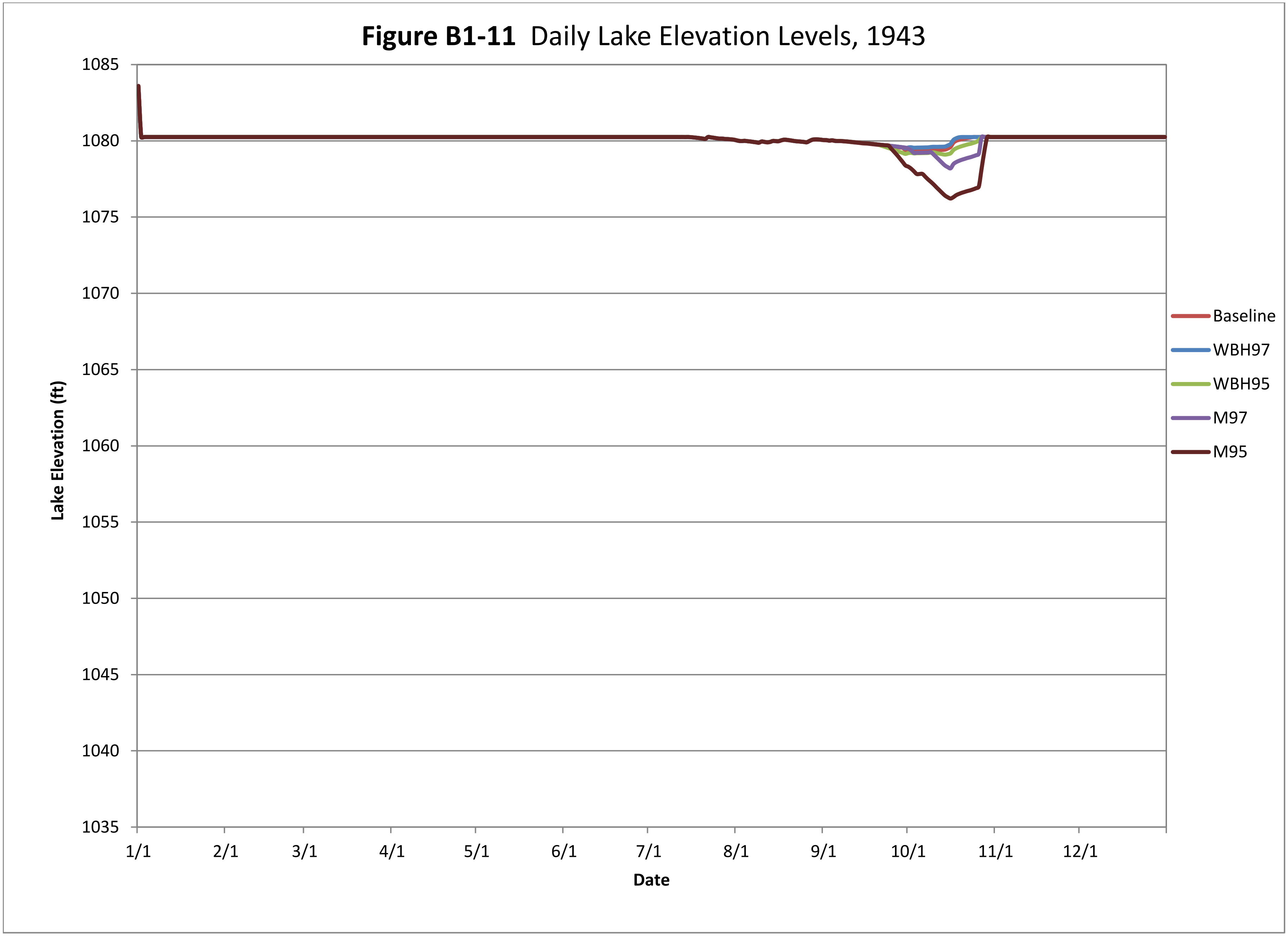


Figure B1-11 Daily Lake Elevation Levels, 1943
1085
1080
1075
1070
1065
1060
1055
1050
1045
1040
1035
Lake Elevation (ft)
1/1
2/1
3/1
4/1
5/1
6/1
7/1
8/1
9/1
10/1
11/1
12/1
Date
Baseline
WBH97
WBH95
M97
M95

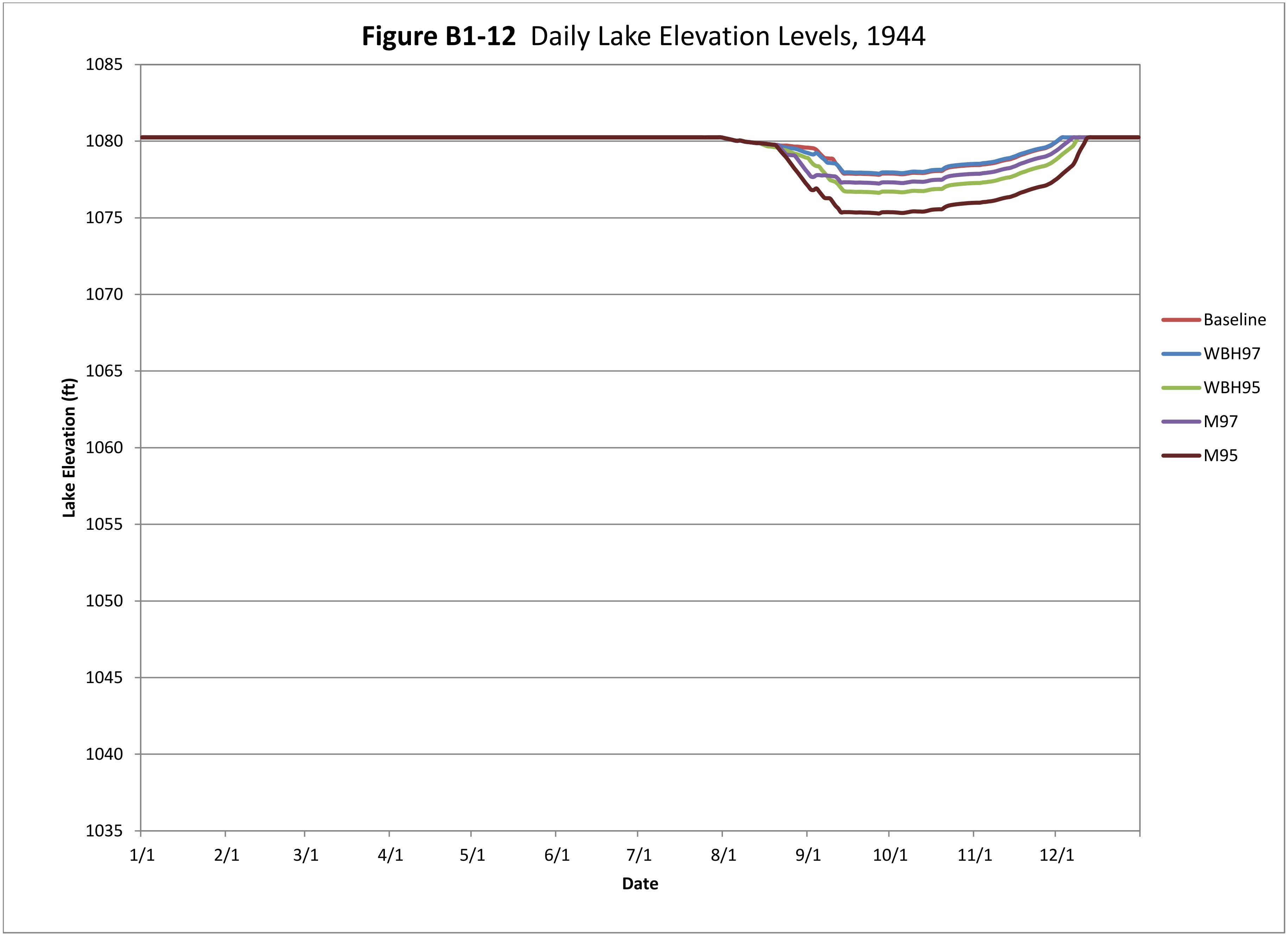


Figure B1-12 Daily Lake Elevation Levels, 1944
Lake Elevation (ft)
1085
1080
1075
1070
1065
1060
1055
1050
1045
1040
1035
1/1
2/1
3/1
4/1
5/1
6/1
7/1
8/1
9/1
10/1
11/1
12/1
Date
Baseline
WBH97
WBH95
M97
M95

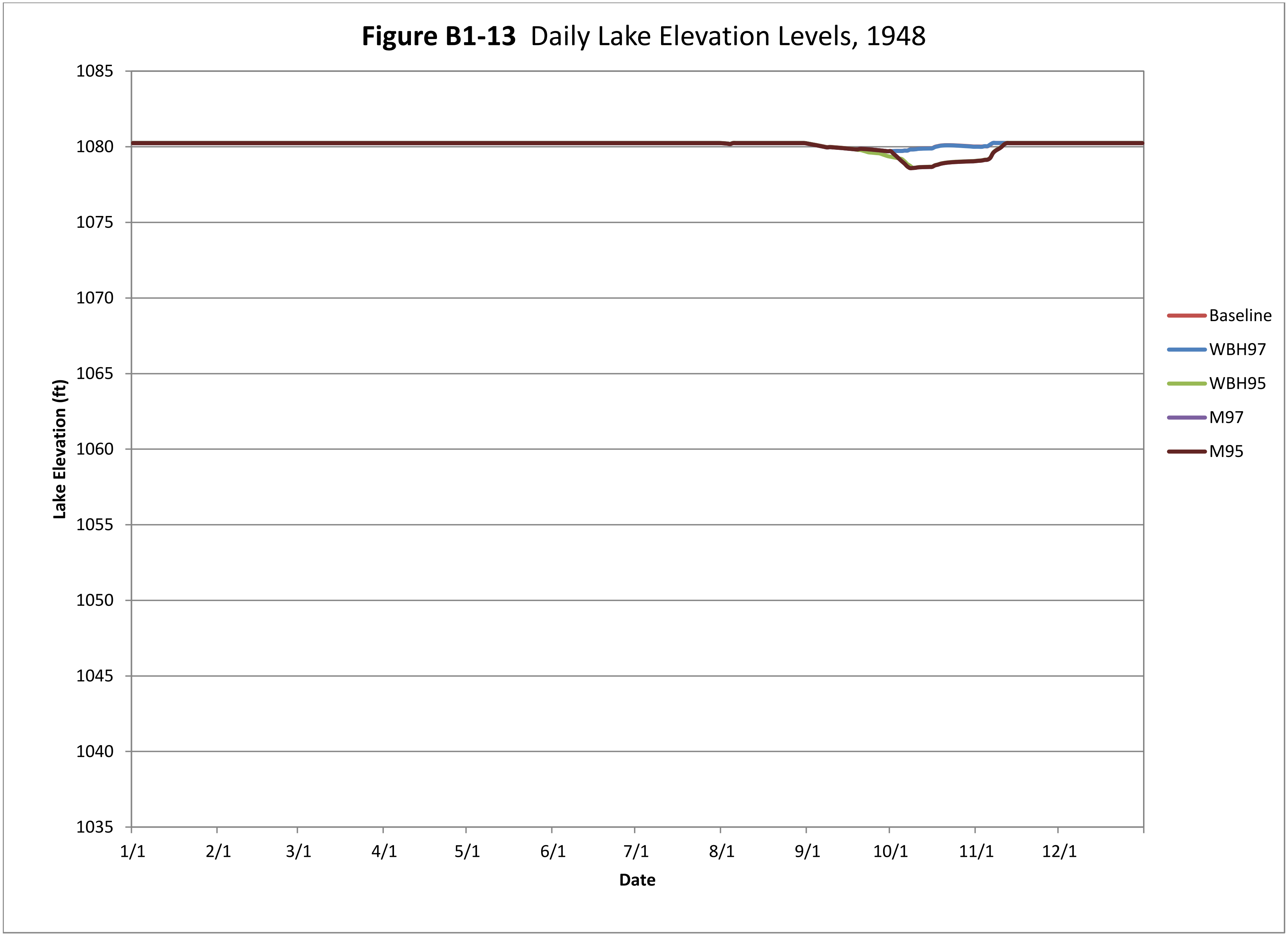


Figure B1-13 Daily Lake Elevation Levels, 1948
1085
1080
1075
1070
1065
1060
1055
1050
1045
1040
1035
Lake Elevation (ft)
1/1
2/1
3/1
4/1
5/1
6/1
7/1
8/1
9/1
10/1
11/1
12/1
Date
Baseline
WBH97
WBH95
M97
M95

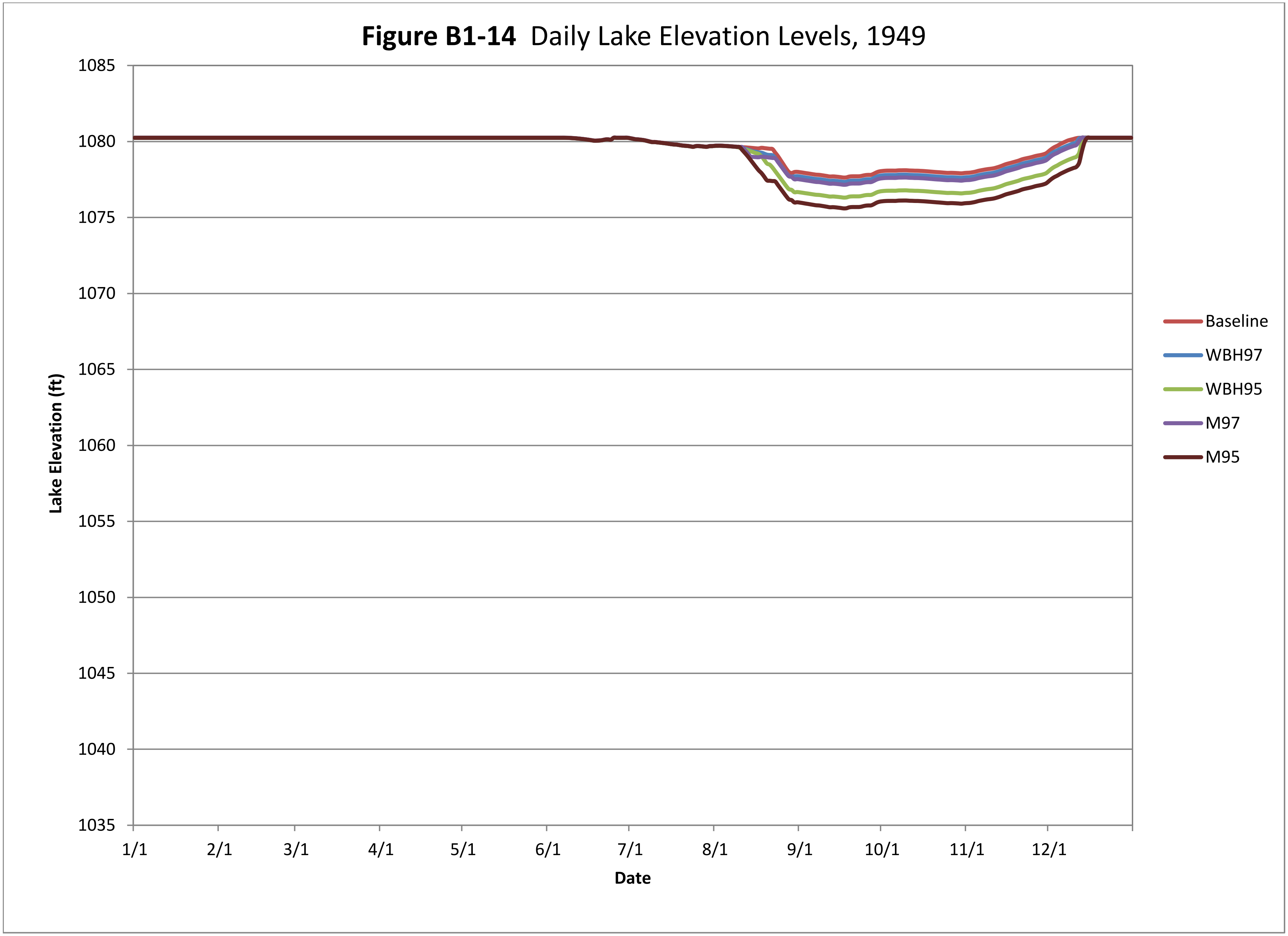


Figure B1-14 Daily Lake Elevation Levels, 1949
Lake Elevation (ft)
1085
1080
1075
1070
1065
1060
1055
1050
1045
1040
1035
1/1
2/1
3/1
4/1
5/1
6/1
7/1
8/1
9/1
10/1
11/1
12/1
Date
Baseline
WBH97
WBH95
M97
M95

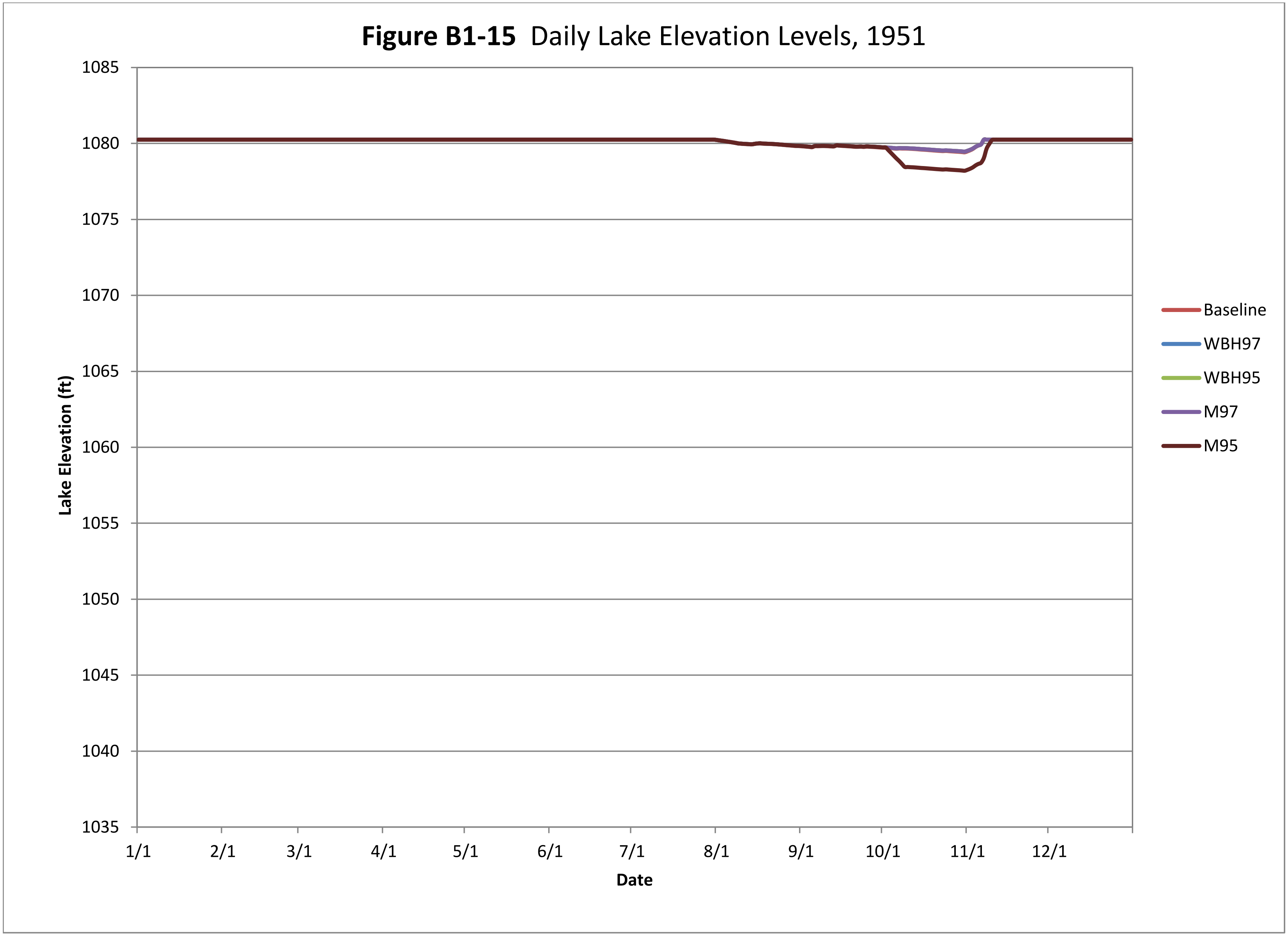


Figure B1-15 Daily Lake Elevation Levels, 1951
1085
1080
1075
1070
1065
1060
1055
1050
1045
1040
1035
Lake Elevation (ft)
1/1
2/1
3/1
4/1
5/1
6/1
7/1
8/1
9/1
10/1
11/1
12/1
Date
Baseline
WBH97
WBH95
M97
M95

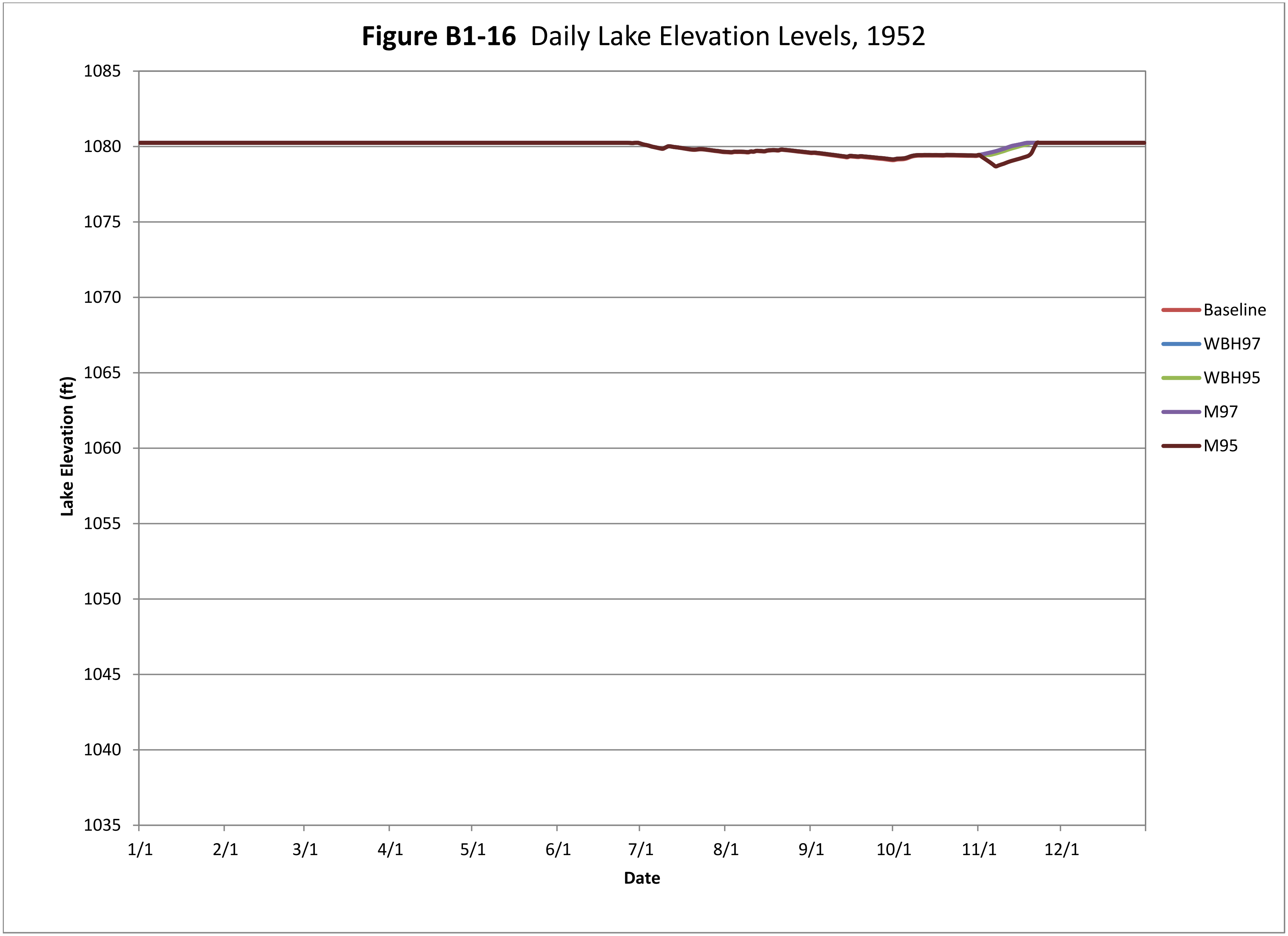


Figure B1-16 Daily Lake Elevation Levels, 1952
1085
1080
1075
1070
1065
1060
1055
1050
1045
1040
1035
Lake Elevation (ft)
1/1
2/1
3/1
4/1
5/1
6/1
7/1
8/1
9/1
10/1
11/1
12/1
Date
Baseline
WBH97
WBH95
M97
M95

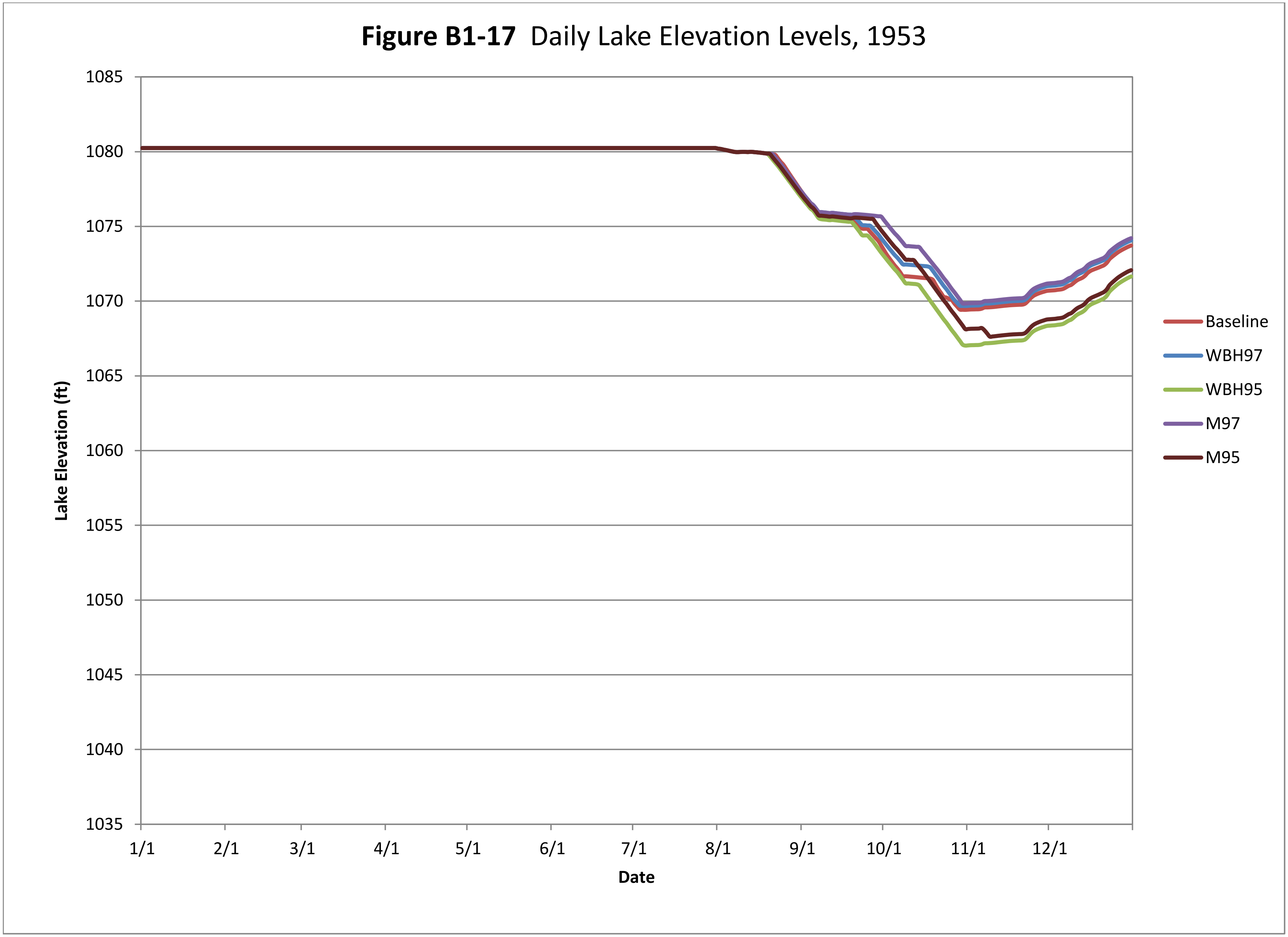


Figure B1-17 Daily Lake Elevation Levels, 1953
Lake Elevation (ft)
1085
1080
1075
1070
1065
1060
1055
1050
1045
1040
1035
1/1
2/1
3/1
4/1
5/1
6/1
7/1
8/1
9/1
10/1
11/1
12/1
Date
Baseline
WBH97
WBH95
M97
M95

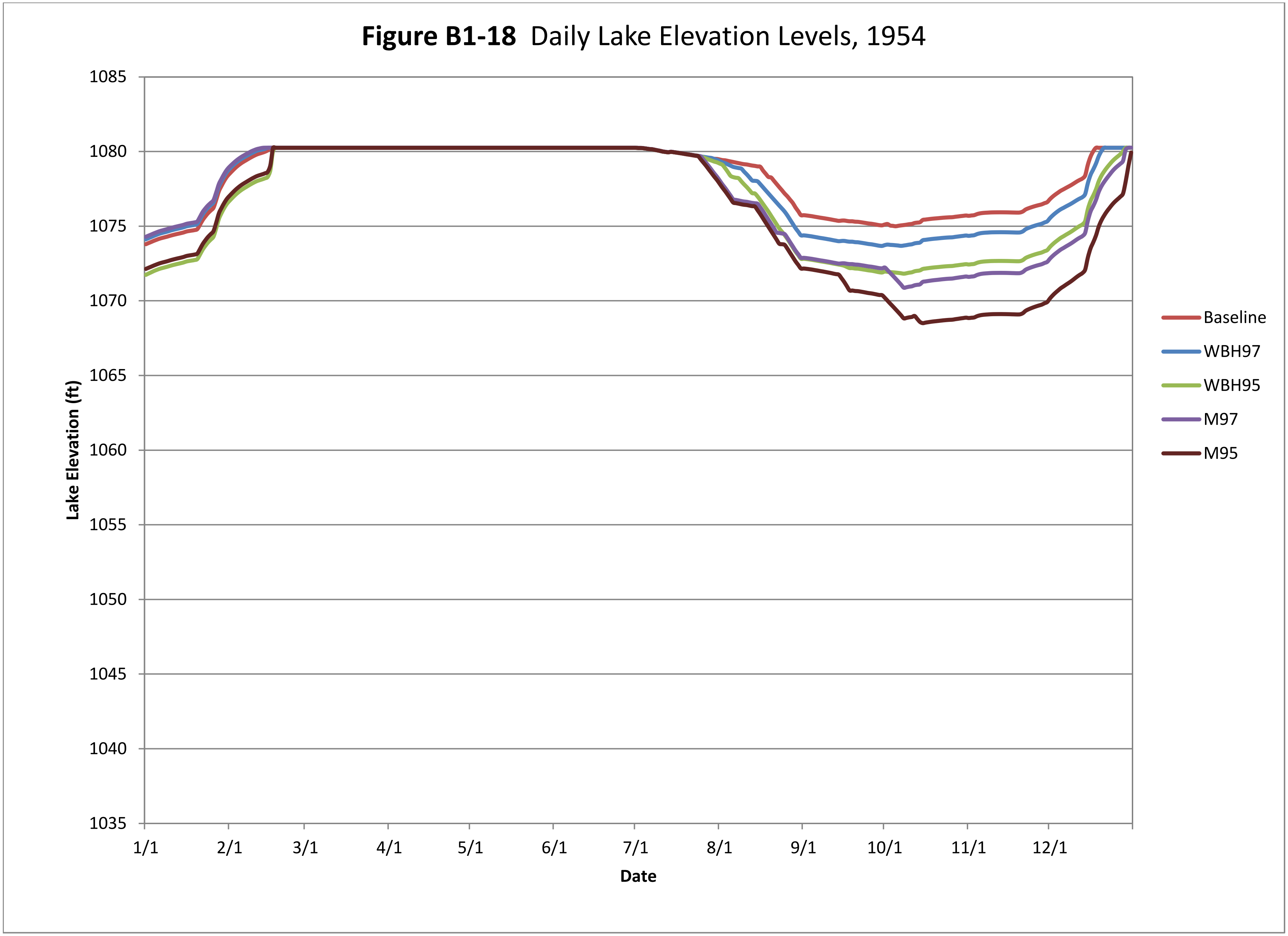
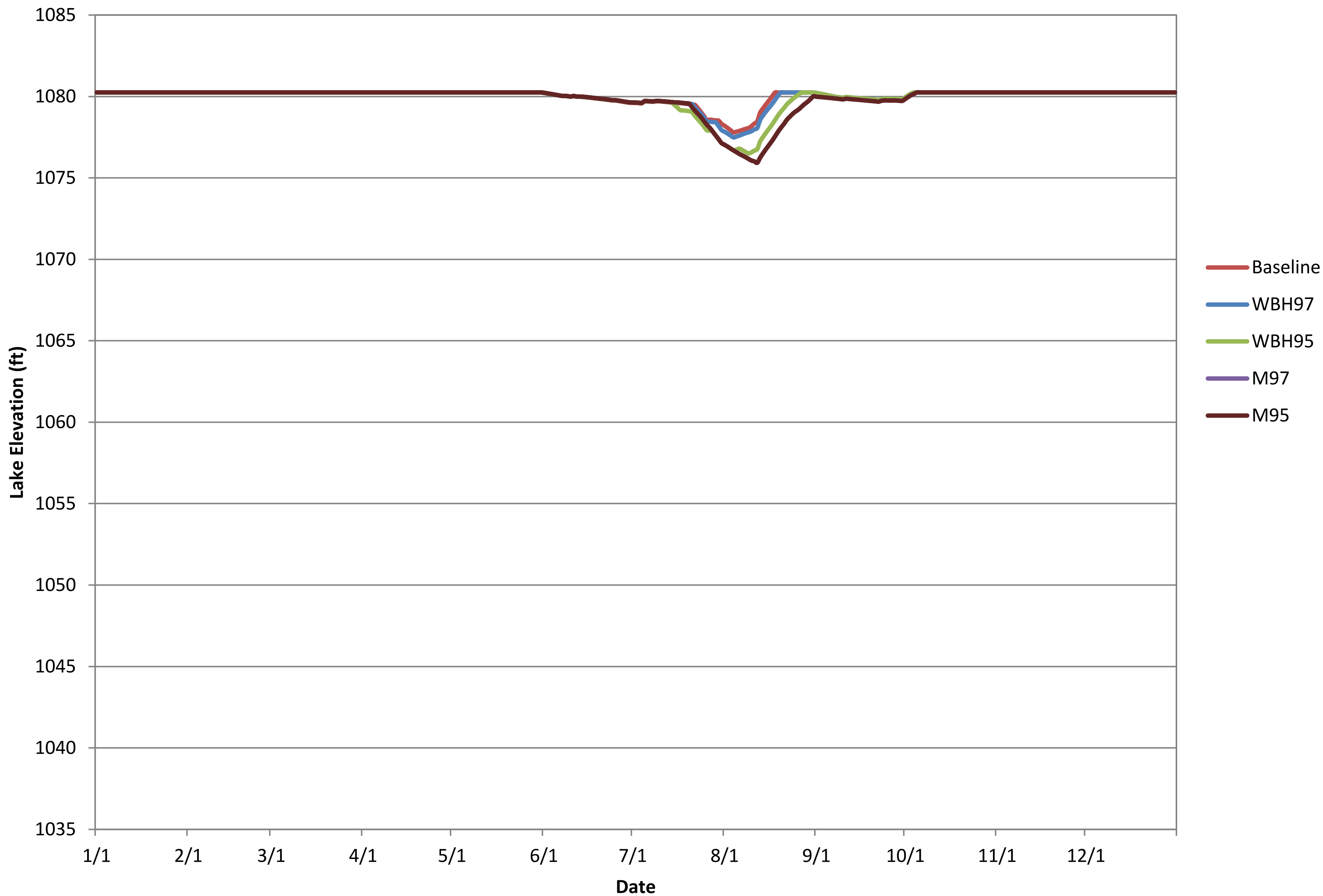


Figure B1-18 Daily Lake Elevation Levels, 1954
1085
1080
1075
1070
1065
1060
1055
1050
1045
1040
1035
Lake Elevation (ft)
1/1
2/1
3/1
4/1
5/1
6/1
7/1
8/1
9/1
10/1
11/1
12/1
Date
Baseline
WBH97
WBH95
M97
M95

Figure B1-19 Daily Lake Elevation Levels, 1955



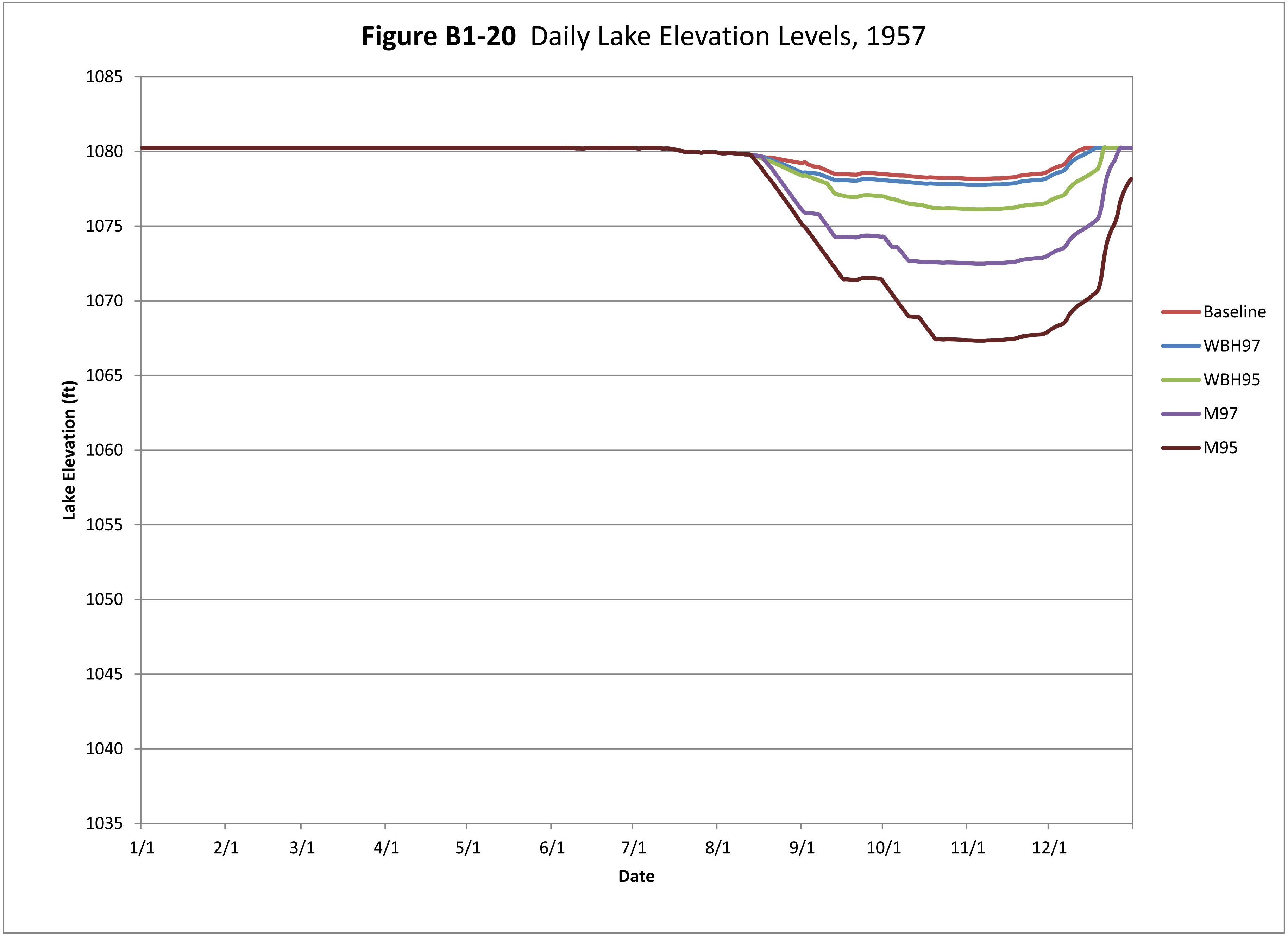


Figure B1-20 Daily Lake Elevation Levels, 1957
1085
1080
1075
1070
1065
1060
1055
1050
1045
1040
1035
Lake Elevation (ft)
1/1
2/1
3/1
4/1
5/1
6/1
7/1
8/1
9/1
10/1
11/1
12/1
Date
Baseline
WBH97
WBH95
M97
M95

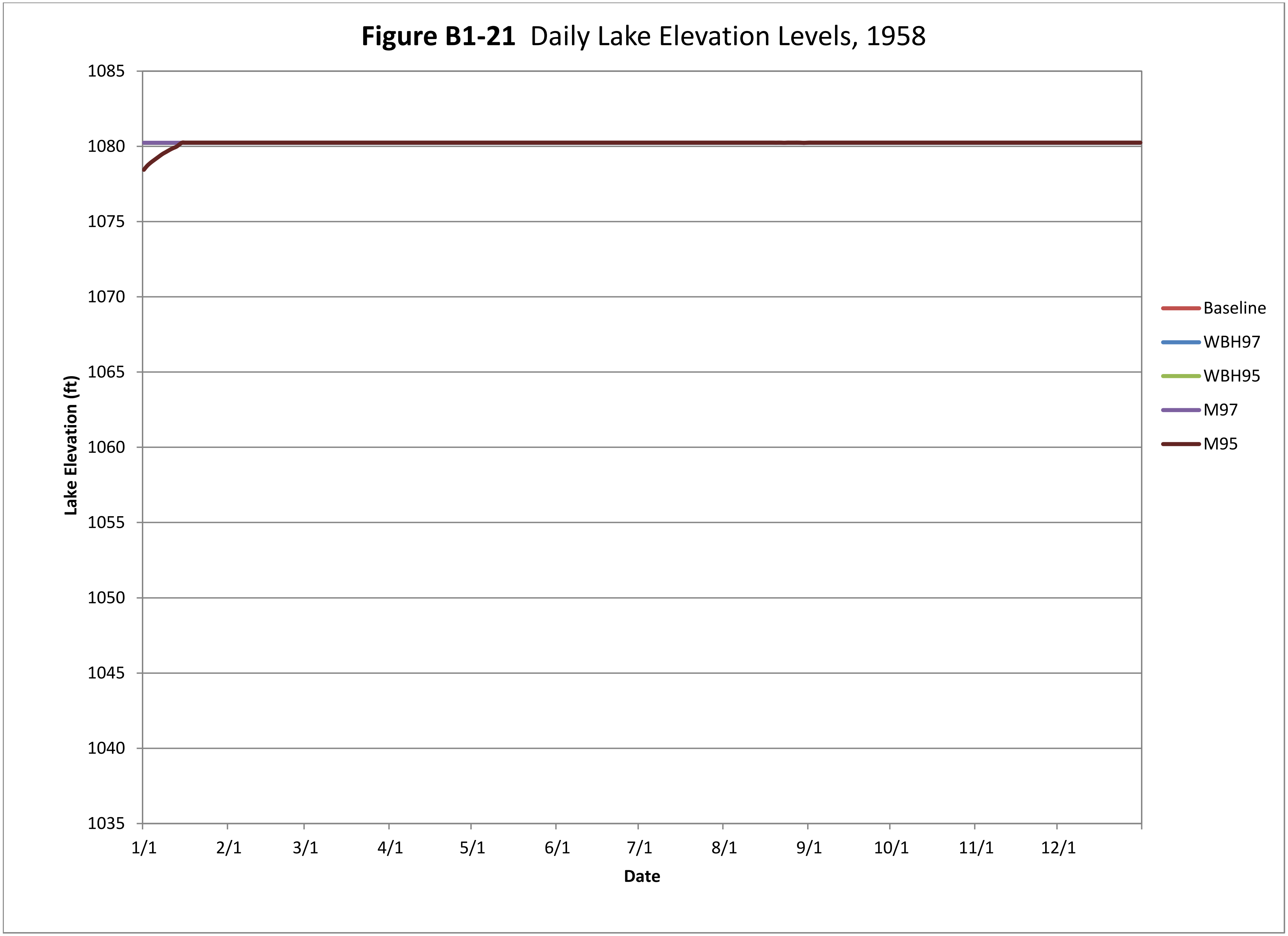


Figure B1-21 Daily Lake Elevation Levels, 1958
Lake Elevation (ft)
1085
1080
1075
1070
1065
1060
1055
1050
1045
1040
1035
1/1
2/1
3/1
4/1
5/1
6/1
7/1
8/1
9/1
10/1
11/1
12/1
Date
Baseline
WBH97
WBH95
M97
M95

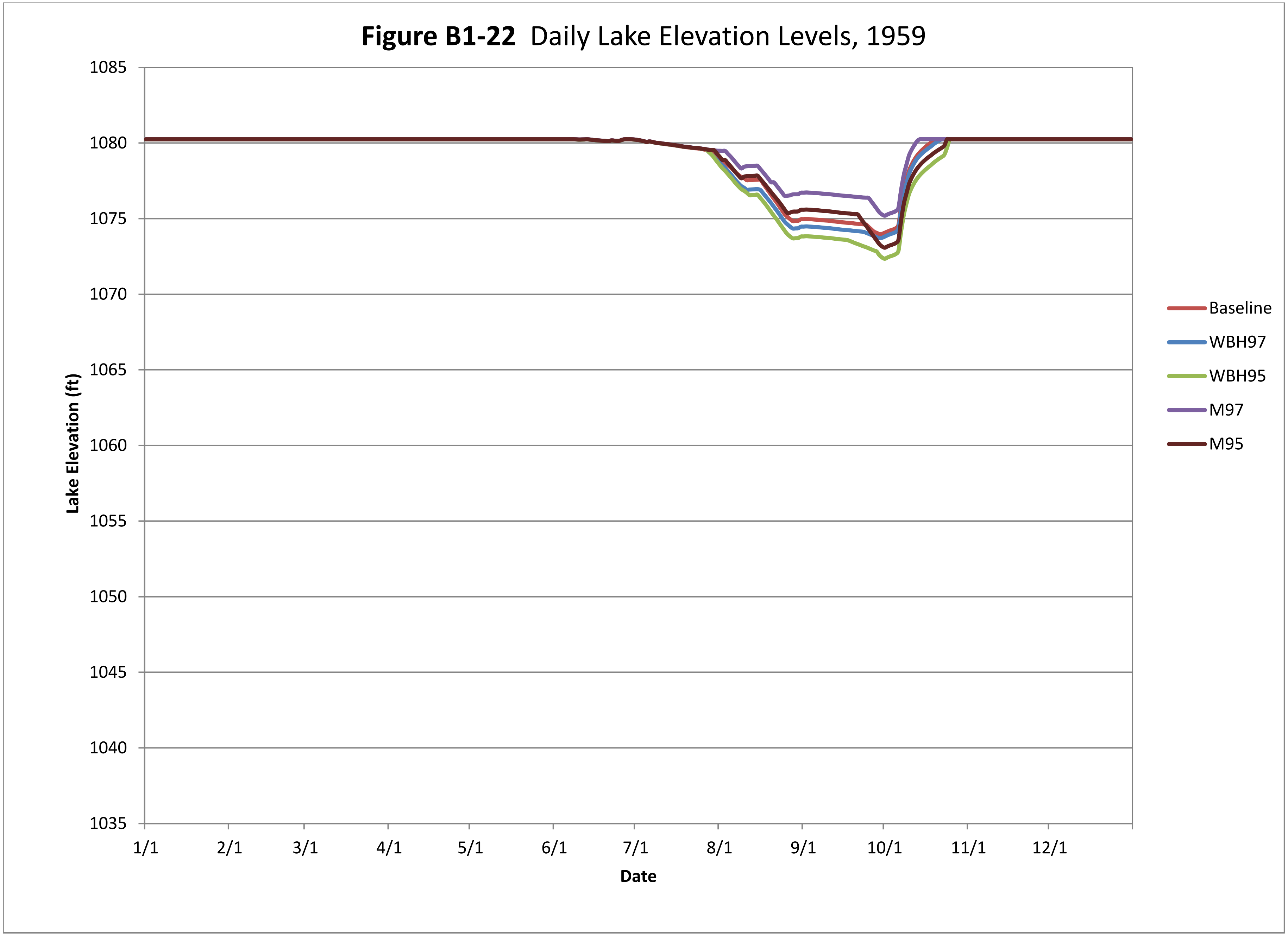
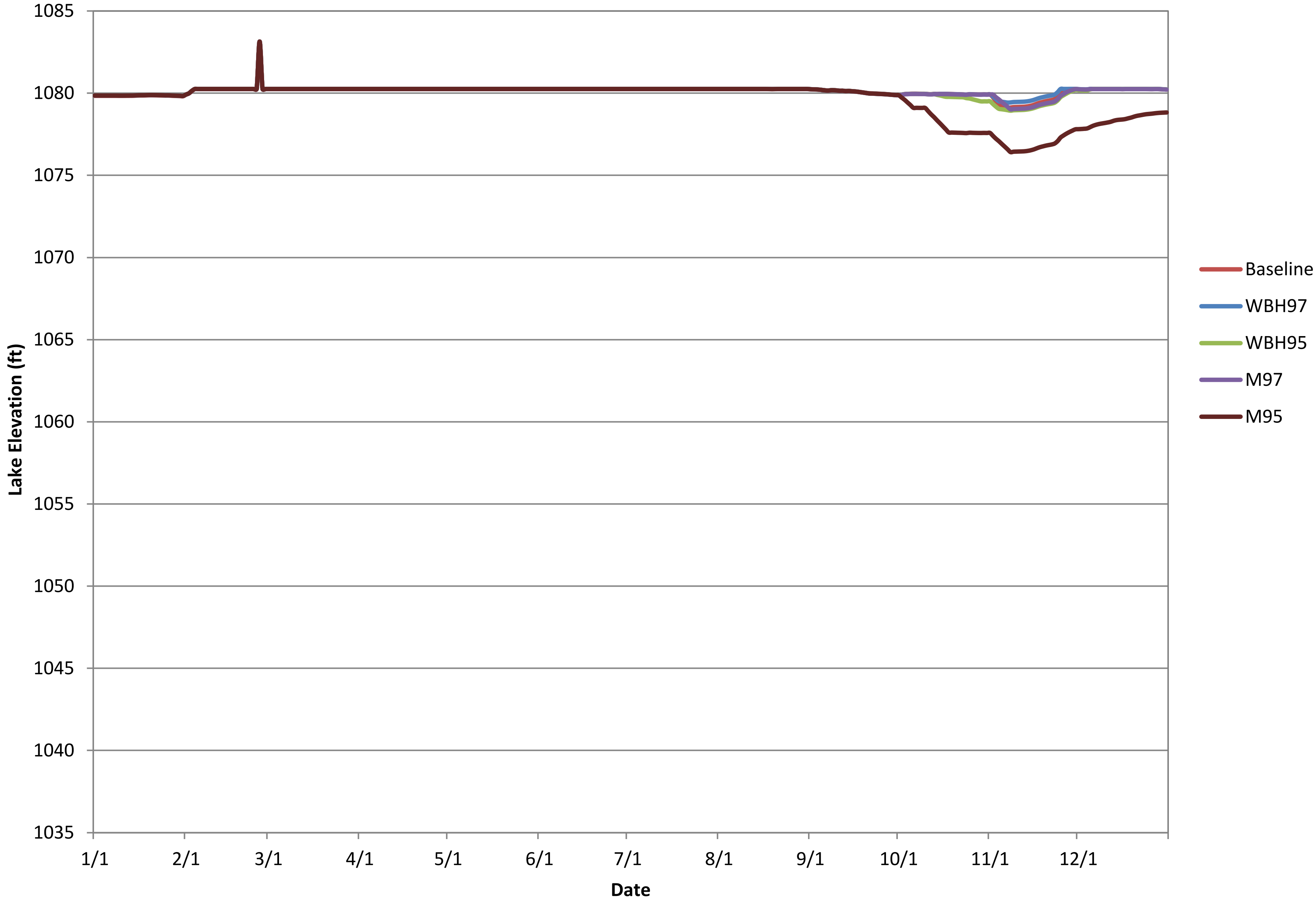


Figure B1-22 Daily Lake Elevation Levels, 1959
1085
1080
1075
1070
1065
1060
1055
1050
1045
1040
1035
Lake Elevation (ft)
1/1
2/1
3/1
4/1
5/1
6/1
7/1
8/1
9/1
10/1
11/1
12/1
Date
Baseline
WBH97
WBH95
M97
M95

Figure B1-23 Daily Lake Elevation Levels, 1961



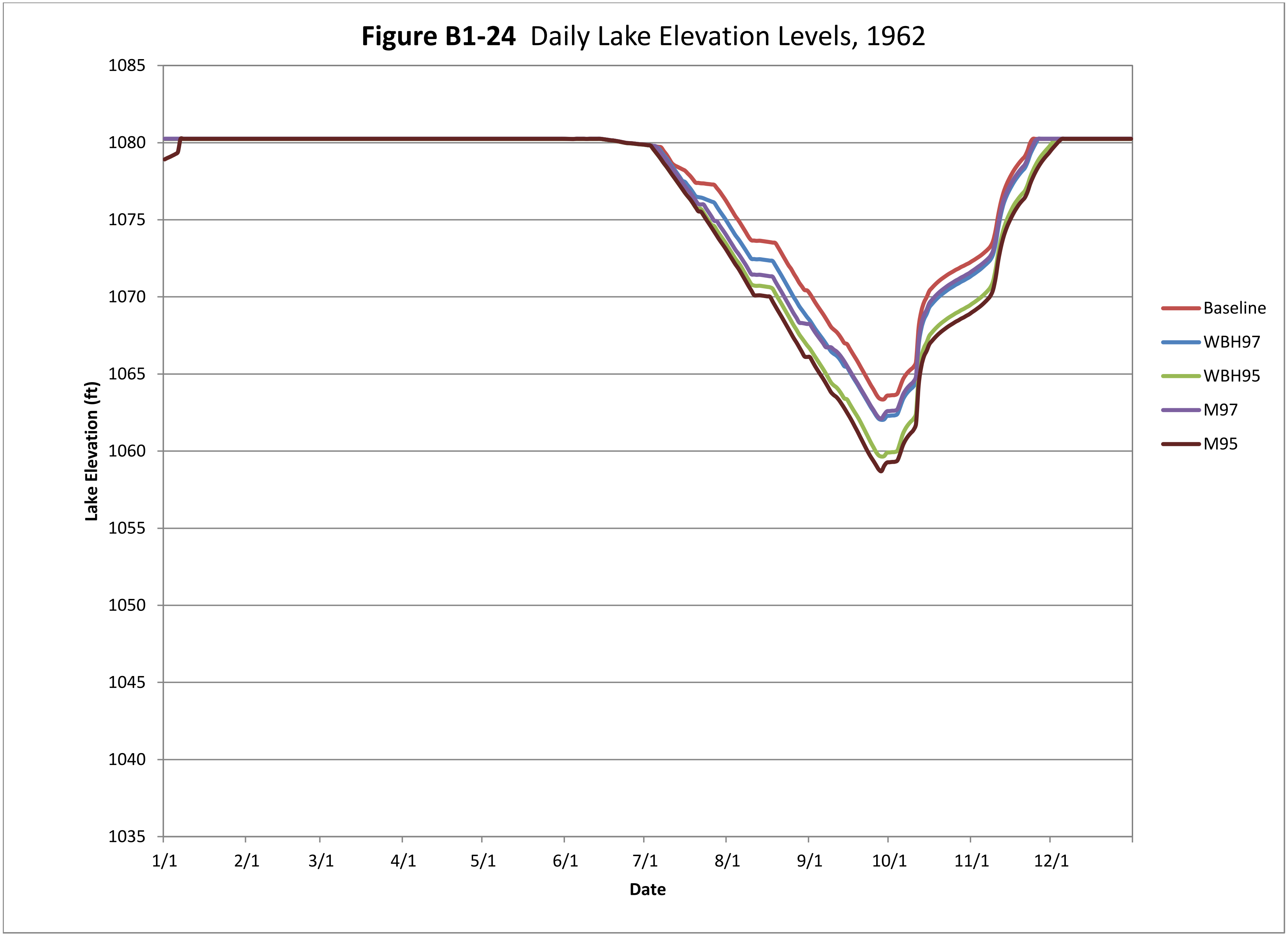


Figure B1-24 Daily Lake Elevation Levels, 1962
Lake Elevation (ft)
1085
1080
1075
1070
1065
1060
1055
1050
1045
1040
1035
1/1
2/1
3/1
4/1
5/1
6/1
7/1
8/1
9/1
10/1
11/1
12/1
Date
Baseline
WBH97
WBH95
M97
M95

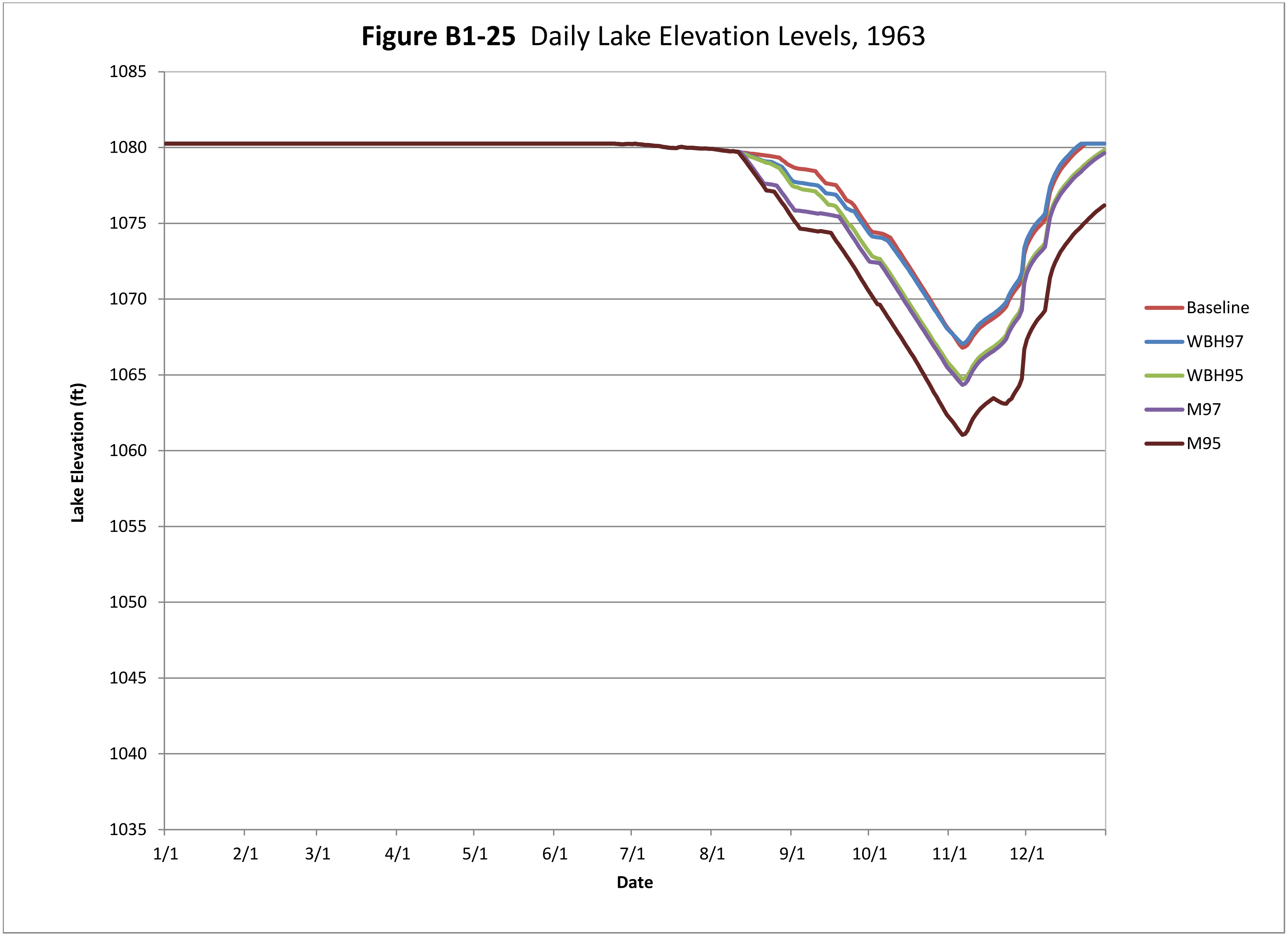


Figure B1-25 Daily Lake Elevation Levels, 1963
Lake Elevation (ft)
1085
1080
1075
1070
1065
1060
1055
1050
1045
1040
1035
1/1
2/1
3/1
4/1
5/1
6/1
7/1
8/1
9/1
10/1
11/1
12/1
Date
Baseline
WBH97
WBH95
M97
M95

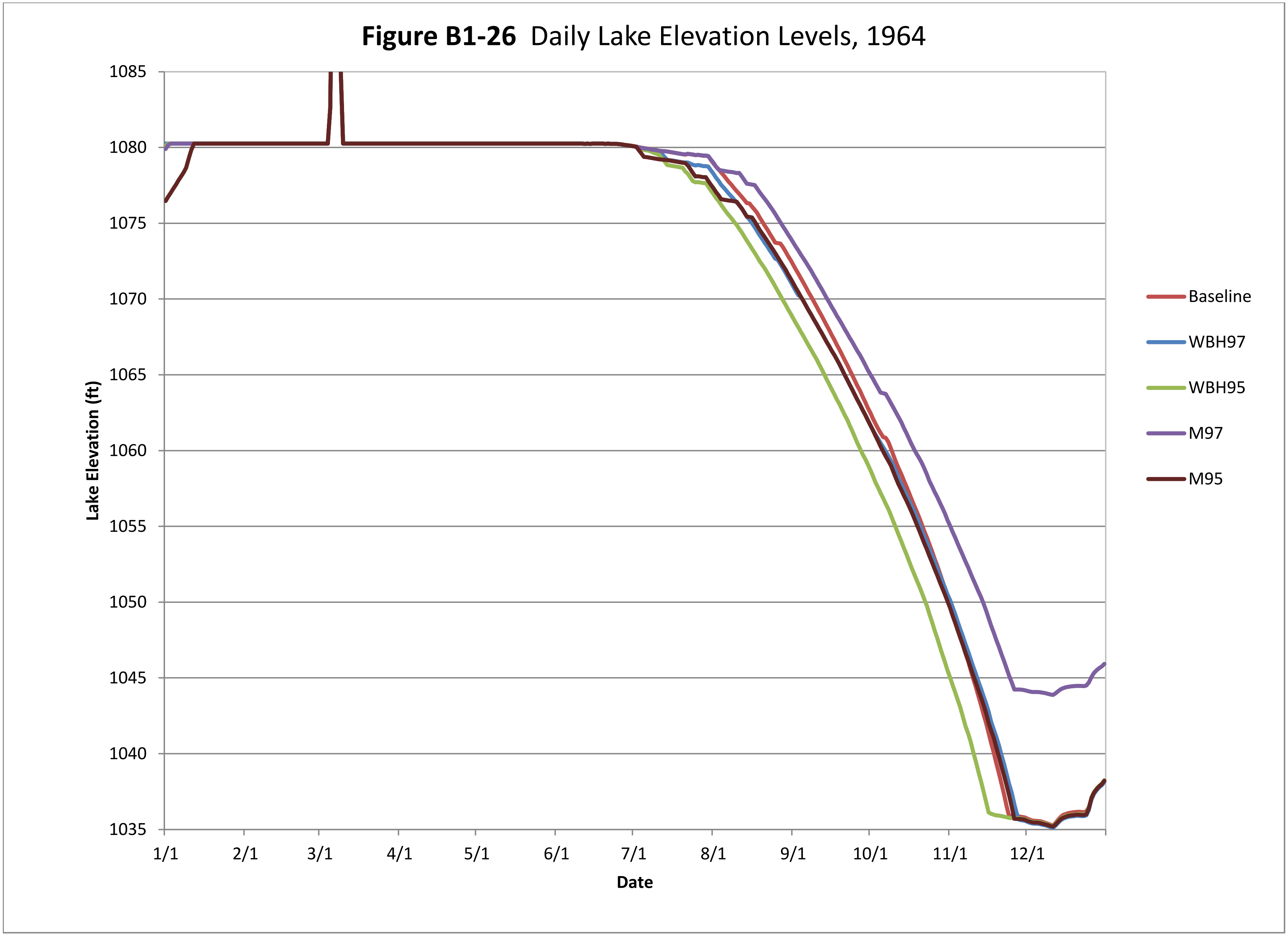


Figure B1-26 Daily Lake Elevation Levels, 1964
Lake Elevation (ft)
1085
1080
1075
1070
1065
1060
1055
1050
1045
1040
1035
1/1
2/1
3/1
4/1
5/1
6/1
7/1
8/1
9/1
10/1
11/1
12/1
Date
Baseline
WBH97
WBH95
M97
M95

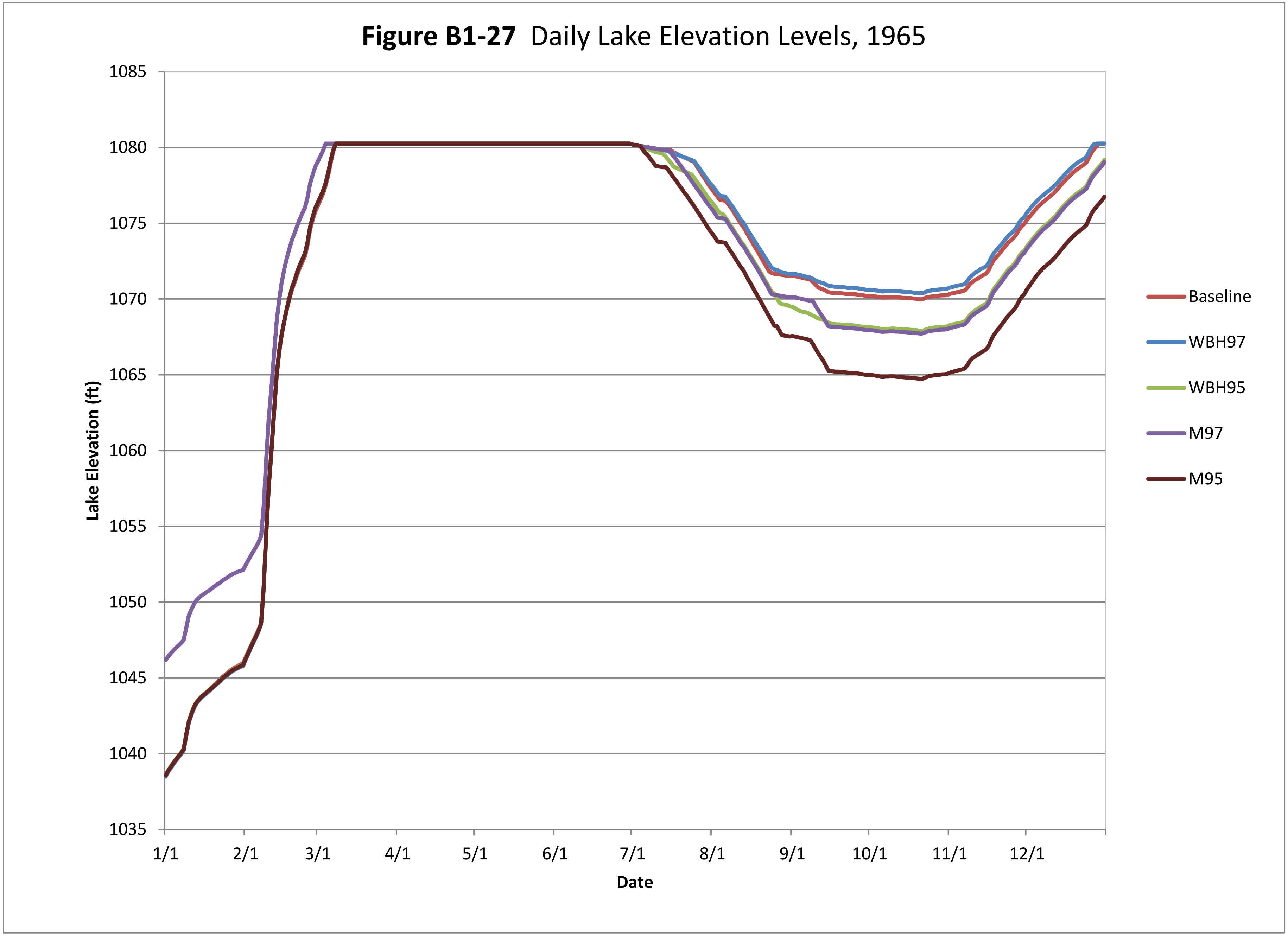


Figure B1-27 Daily Lake Elevation Levels, 1965
1085
1080
1075
1070
1065
1060
1055
1050
1045
1040
1035
Lake Elevation (ft)
1/1
2/1
3/1
4/1
5/1
6/1
7/1
8/1
9/1
10/1
11/1
12/1
Date
Baseline
WBH97
WBH95
M97
M95

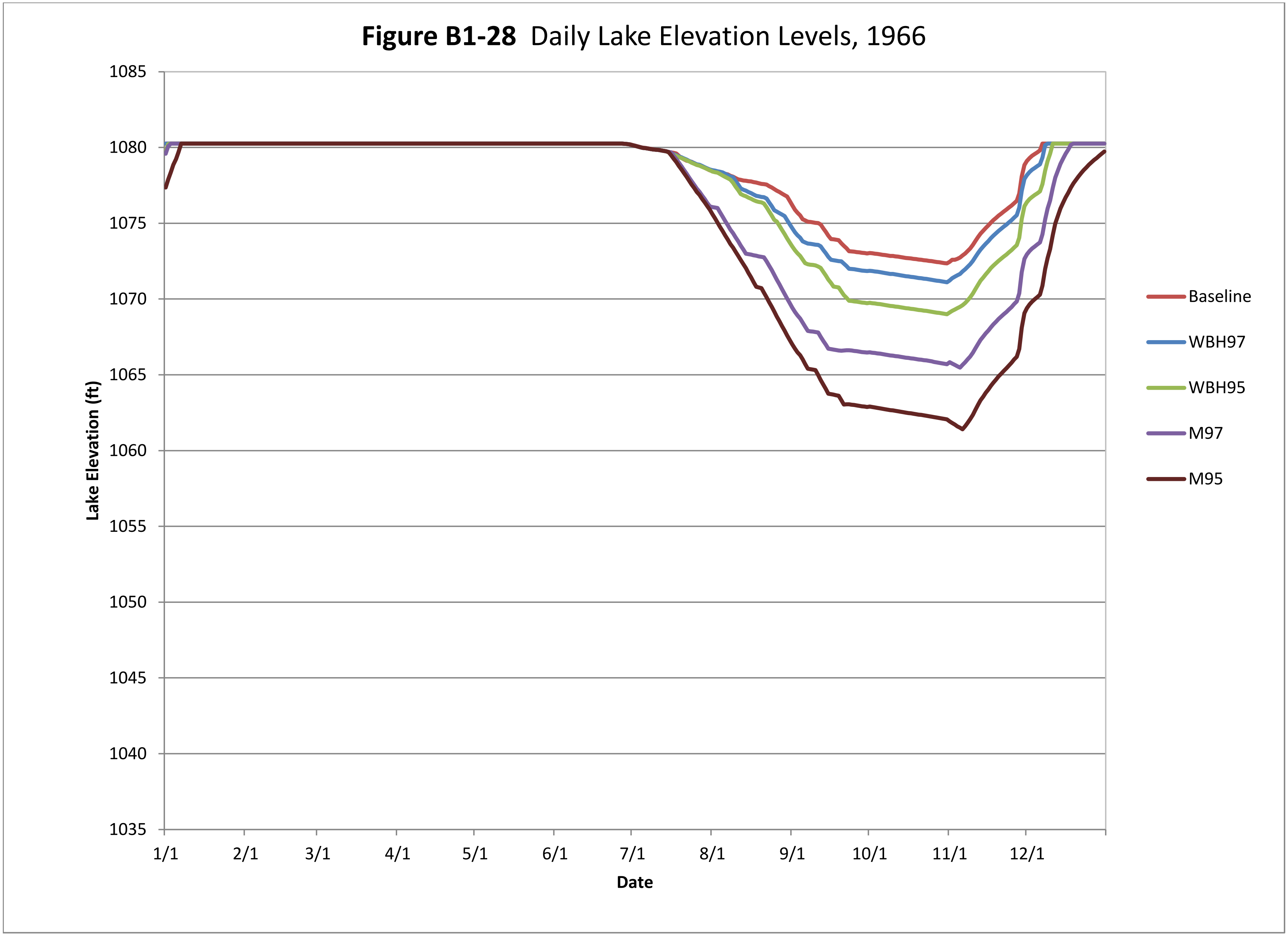


Figure B1-28 Daily Lake Elevation Levels, 1966
Lake Elevation (ft)
1085
1080
1075
1070
1065
1060
1055
1050
1045
1040
1035
1/1
2/1
3/1
4/1
5/1
6/1
7/1
8/1
9/1
10/1
11/1
12/1
Date
Baseline
WBH97
WBH95
M97
M95

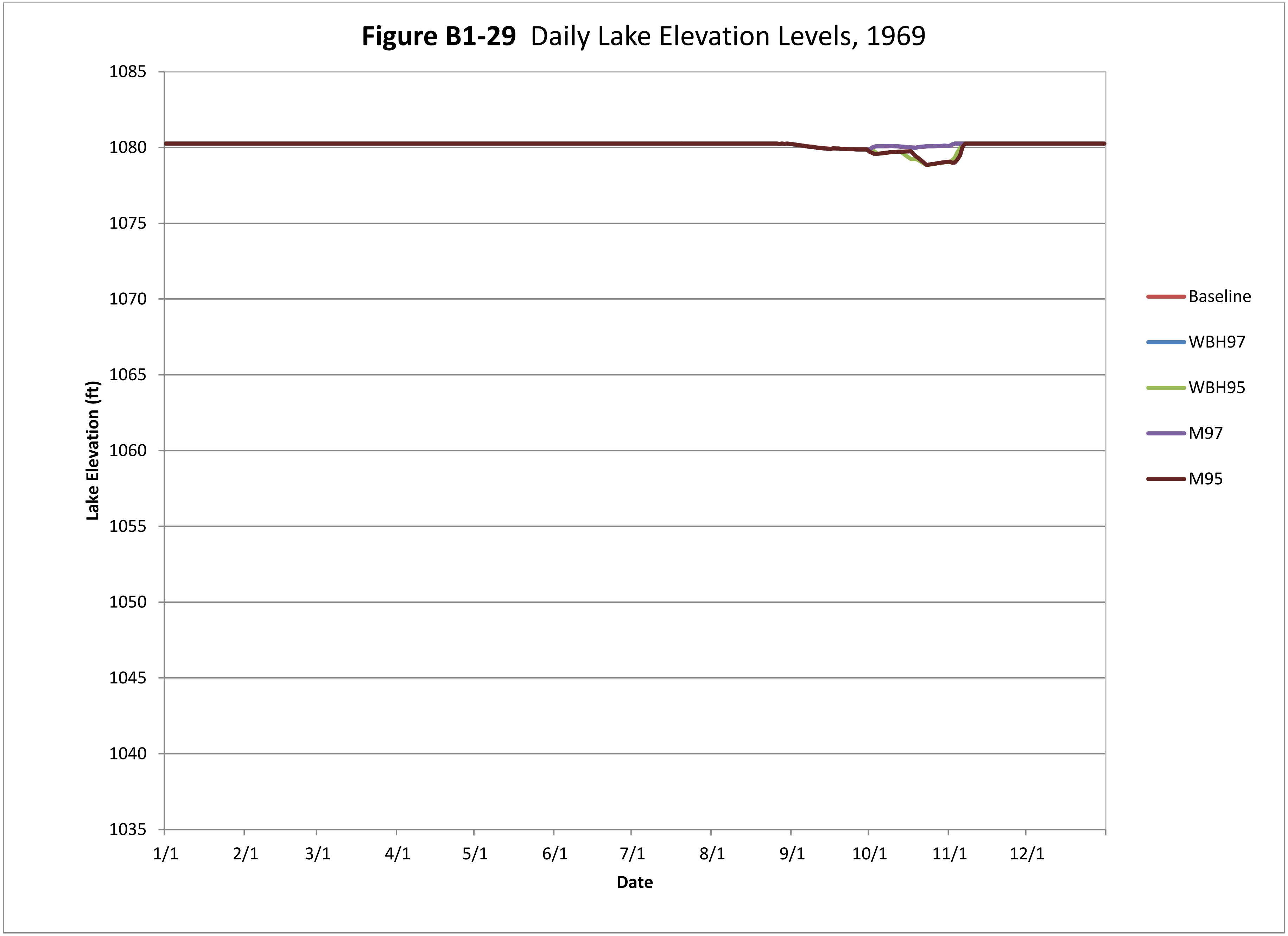


Figure B1-29 Daily Lake Elevation Levels, 1969
1085
1080
1075
1070
1065
1060
1055
1050
1045
1040
1035
Lake Elevation (ft)
1/1
2/1
3/1
4/1
5/1
6/1
7/1
8/1
9/1
10/1
11/1
12/1
Date
Baseline
WBH97
WBH95
M97
M95

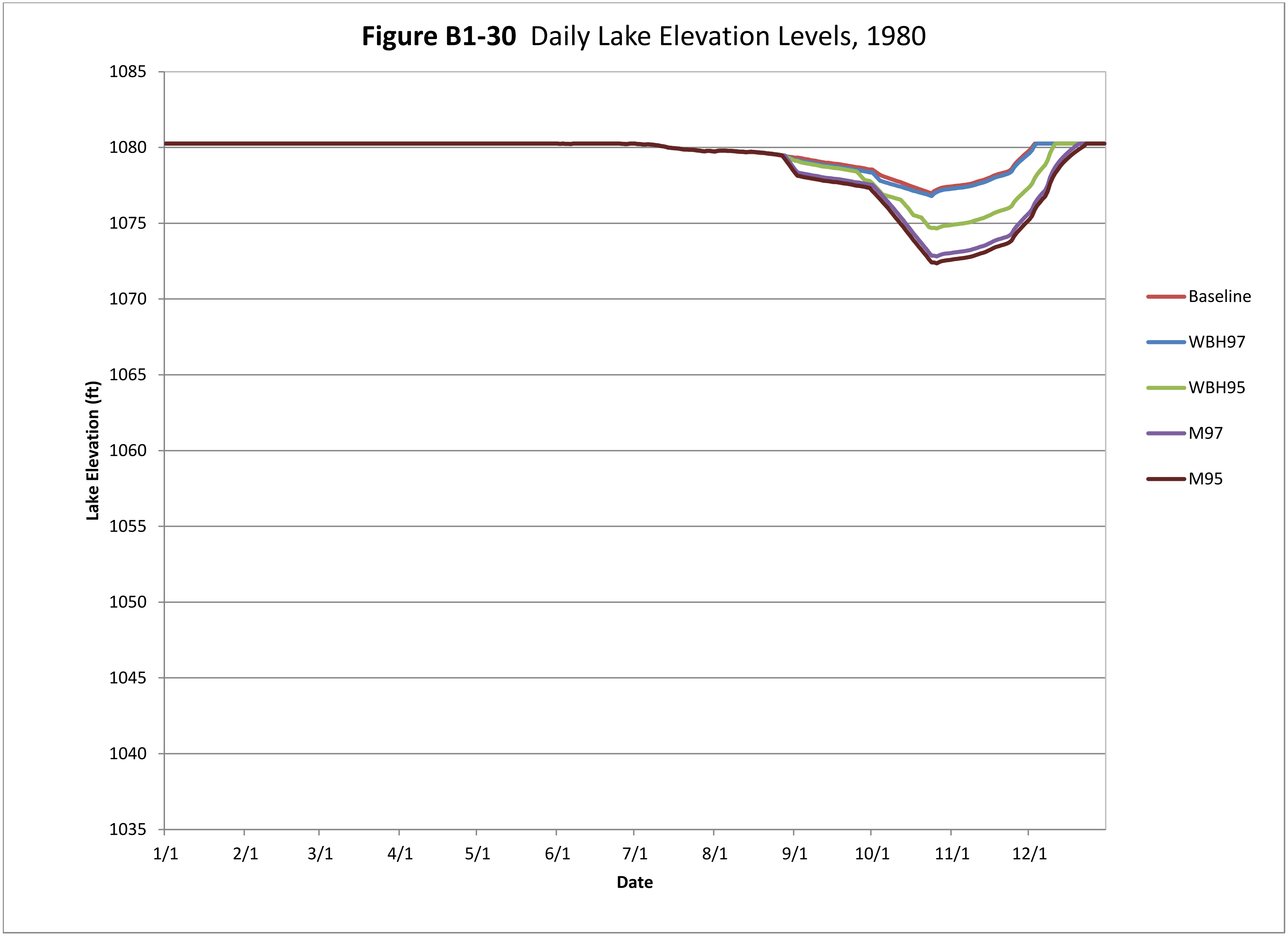


Figure B1-30 Daily Lake Elevation Levels, 1980
1085
1080
1075
1070
1065
1060
1055
1050
1045
1040
1035
Lake Elevation (ft)
1/1
2/1
3/1
4/1
5/1
6/1
7/1
8/1
9/1
10/1
11/1
12/1
Date
Baseline
WBH97
WBH95
M97
M95

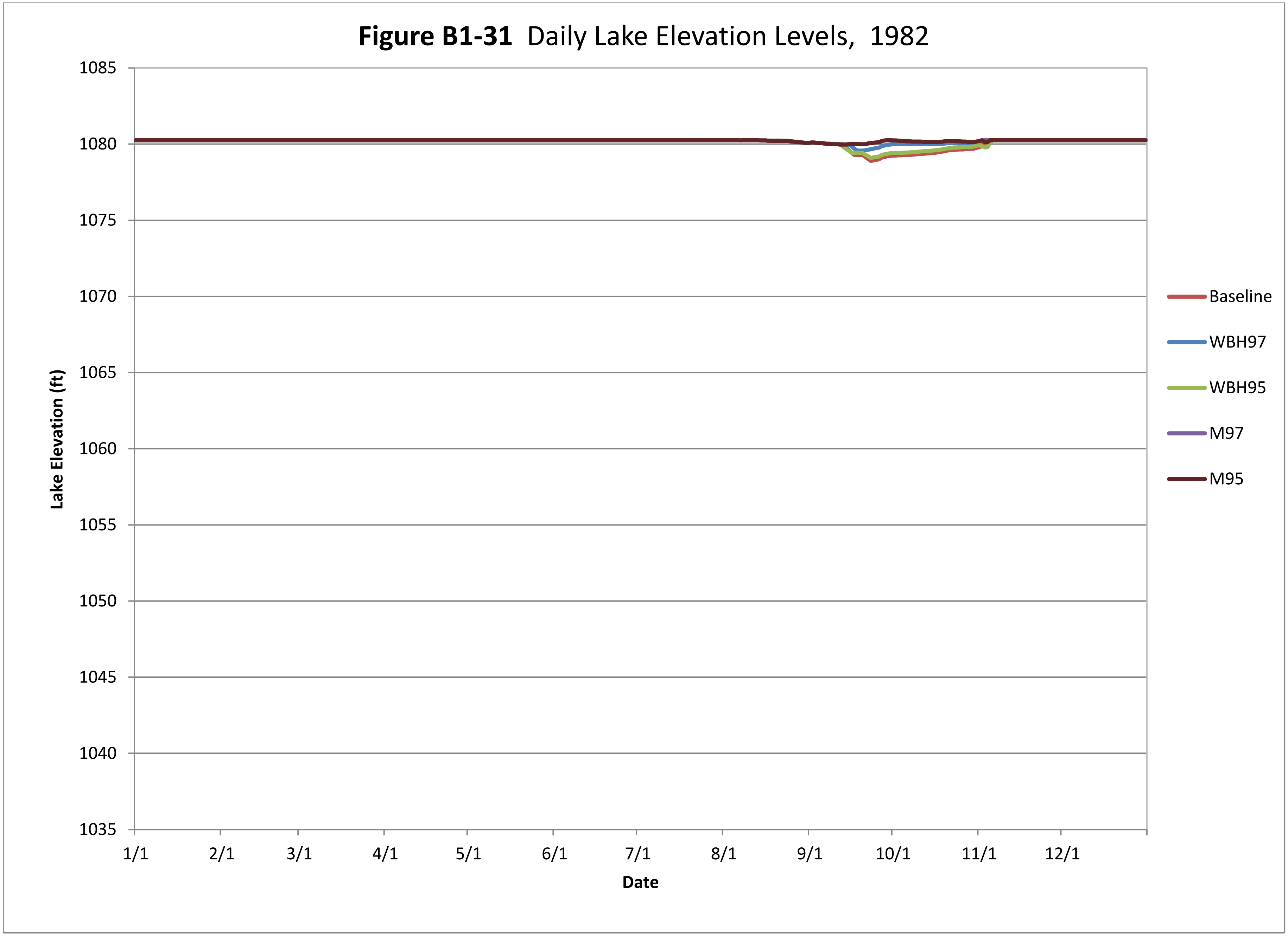


Figure B1-31 Daily Lake Elevation Levels, 1982
1085
1080
1075
1070
1065
1060
1055
1050
1045
1040
1035
Lake Elevation (ft)
1/1
2/1
3/1
4/1
5/1
6/1
7/1
8/1
9/1
10/1
11/1
12/1
Date
Baseline
WBH97
WBH95
M97
M95

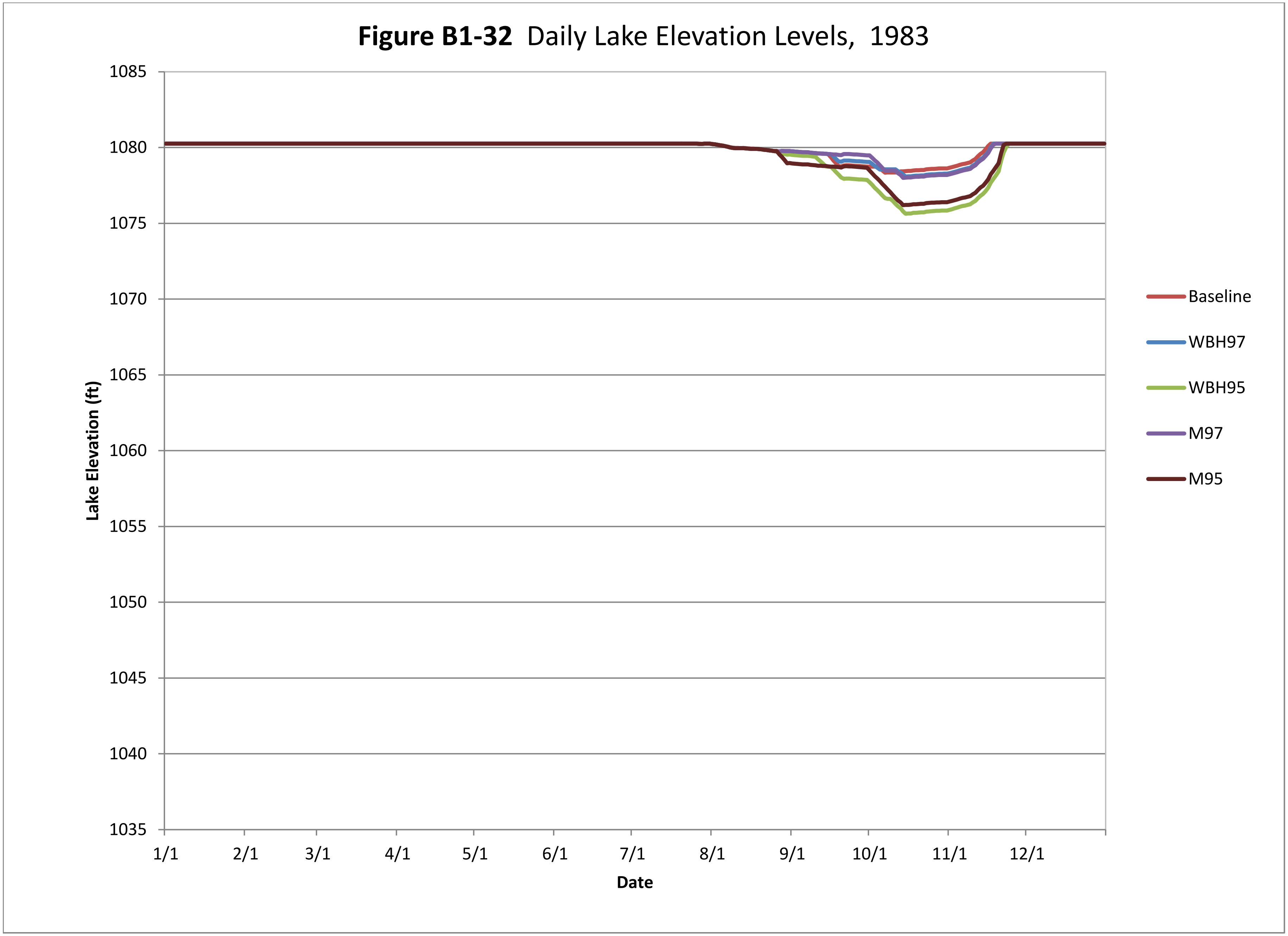


Figure B1-32 Daily Lake Elevation Levels, 1983
Lake Elevation (ft)
1085
1080
1075
1070
1065
1060
1055
1050
1045
1040
1035
1/1
2/1
3/1
4/1
5/1
6/1
7/1
8/1
9/1
10/1
11/1
12/1
Date
Baseline
WBH97
WBH95
M97
M95

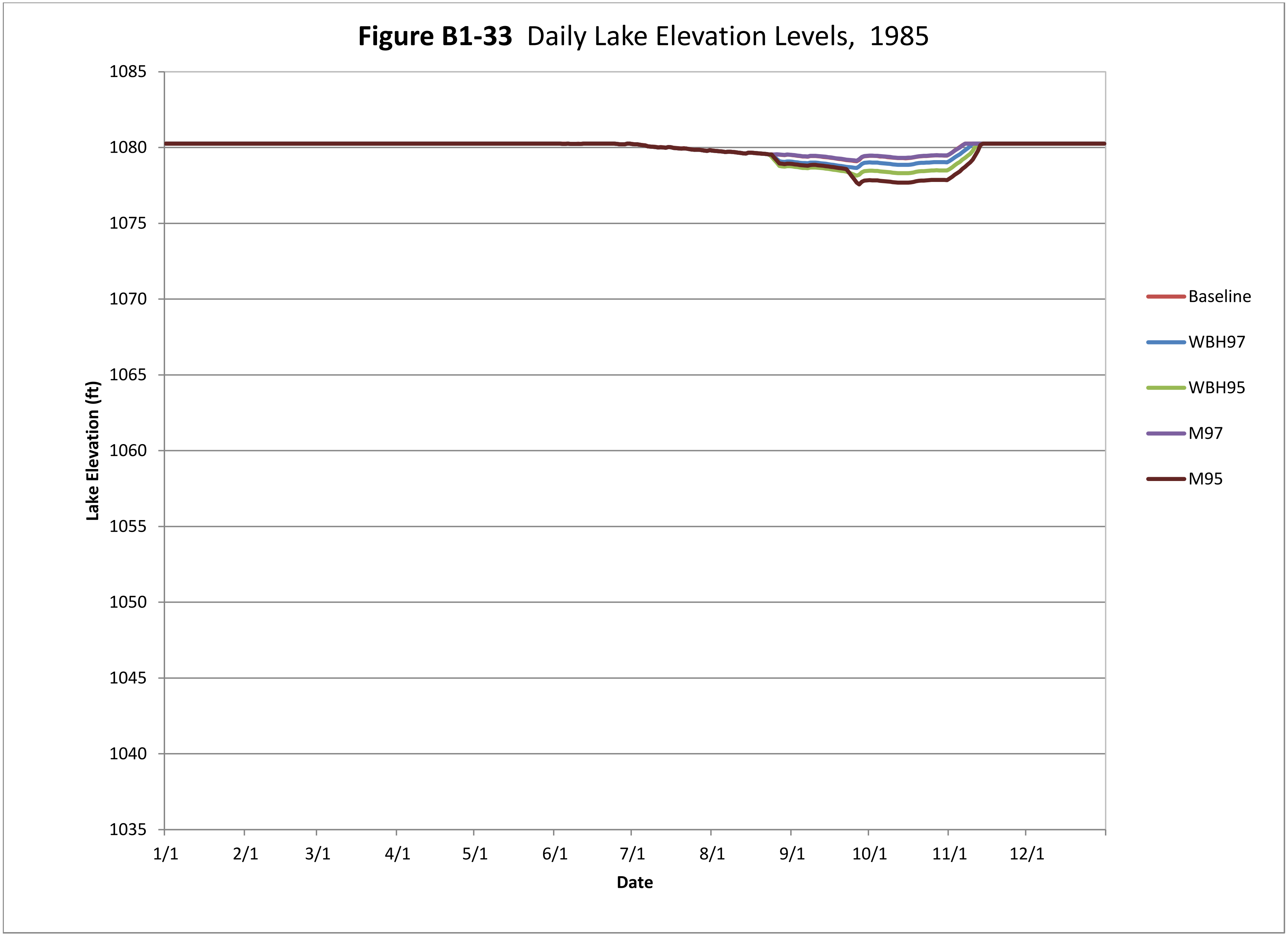


Figure B1-33 Daily Lake Elevation Levels, 1985
1085
1080
1075
1070
1065
1060
1055
1050
1045
1040
1035
Lake Elevation (ft)
1/1
2/1
3/1
4/1
5/1
6/1
7/1
8/1
9/1
10/1
11/1
12/1
Date
Baseline
WBH97
WBH95
M97
M95

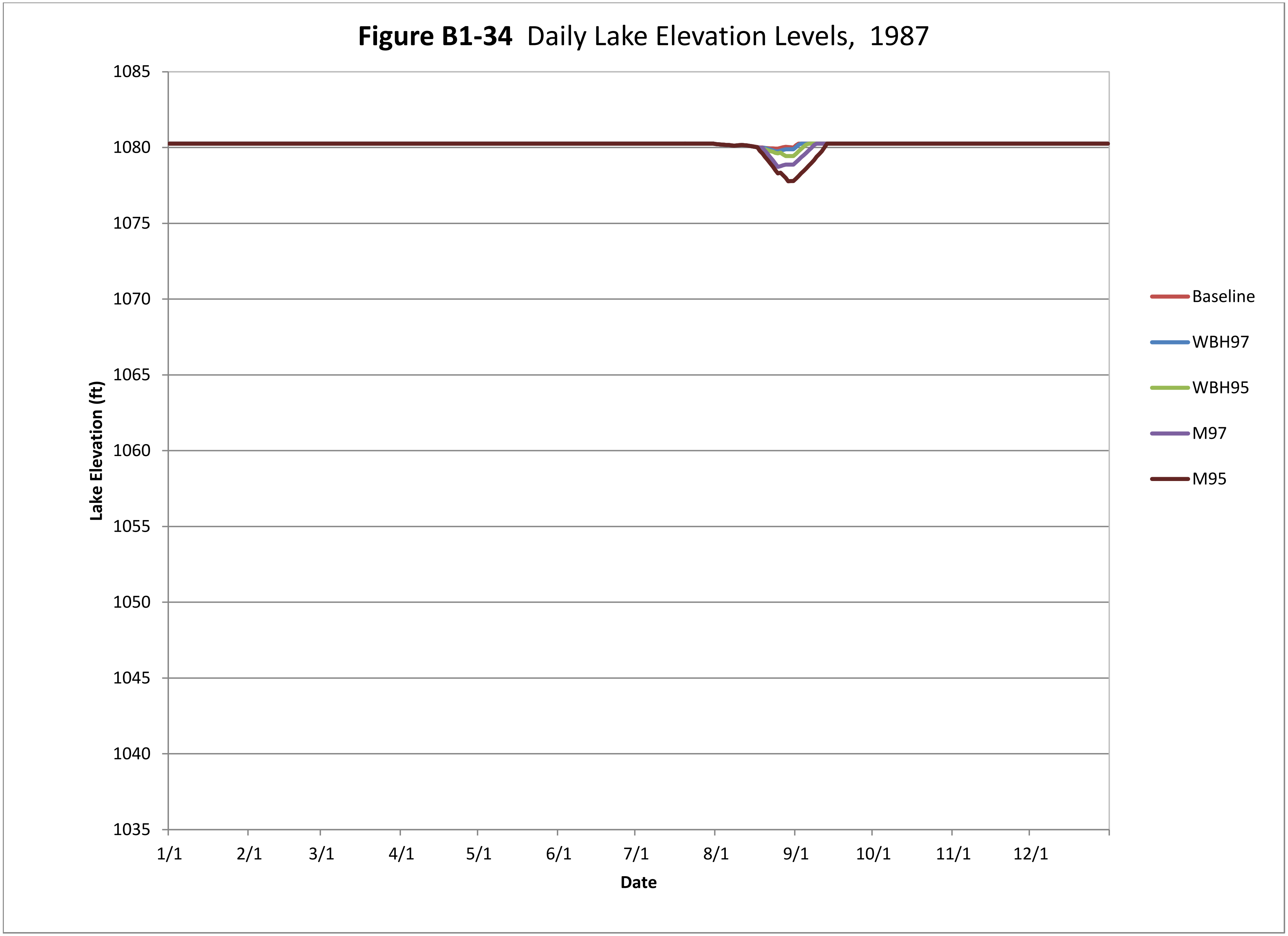


Figure B1-34 Daily Lake Elevation Levels, 1987
1085
1080
1075
1070
1065
1060
1055
1050
1045
1040
1035
Lake Elevation (ft)
1/1
2/1
3/1
4/1
5/1
6/1
7/1
8/1
9/1
10/1
11/1
12/1
Date
Baseline
WBH97
WBH95
M97
M95

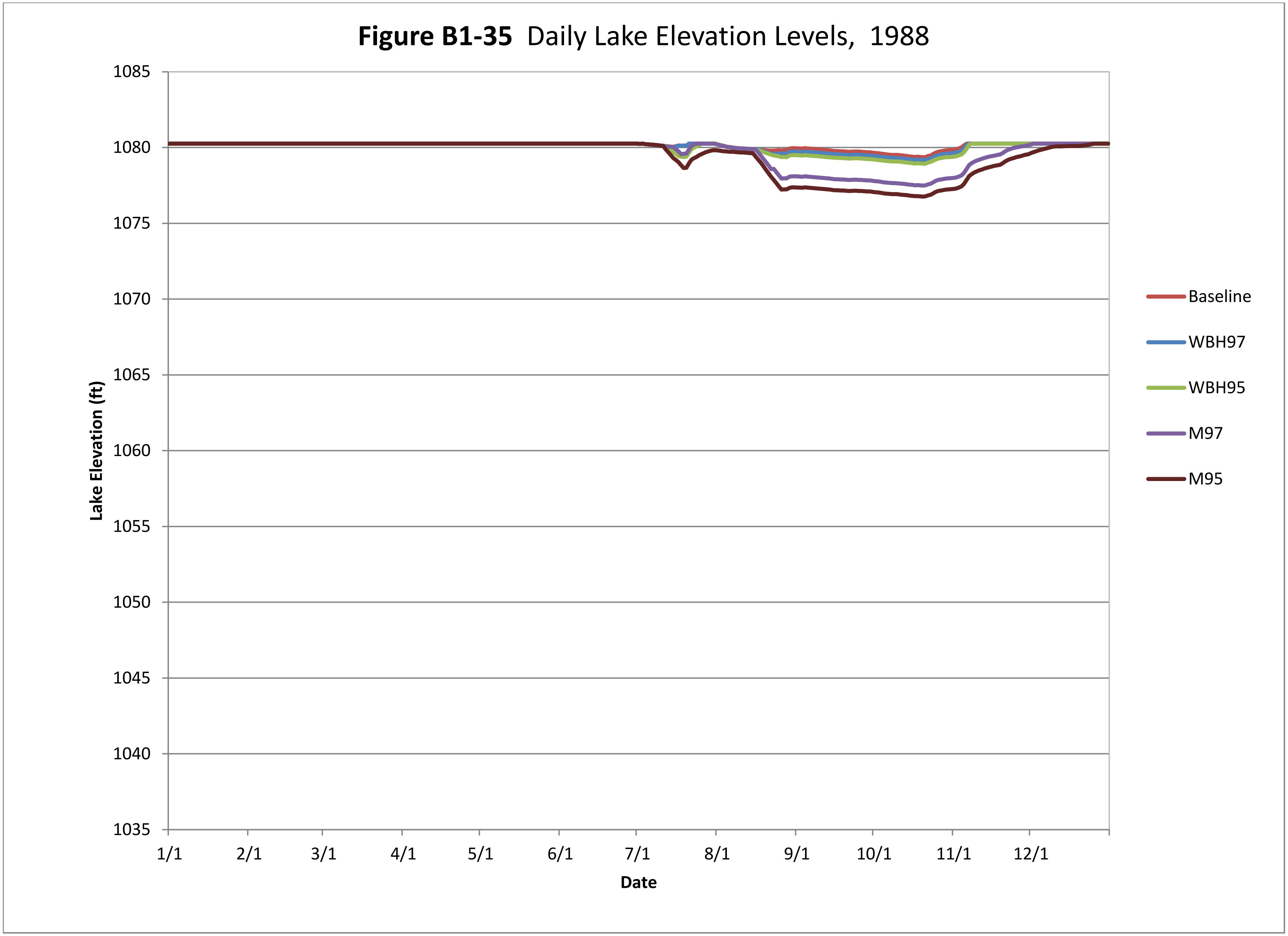


Figure B1-35 Daily Lake Elevation Levels, 1988
1085
1080
1075
1070
1065
1060
1055
1050
1045
1040
1035
Lake Elevation (ft)
1/1
2/1
3/1
4/1
5/1
6/1
7/1
8/1
9/1
10/1
11/1
12/1
Date
Baseline
WBH97
WBH95
M97
M95

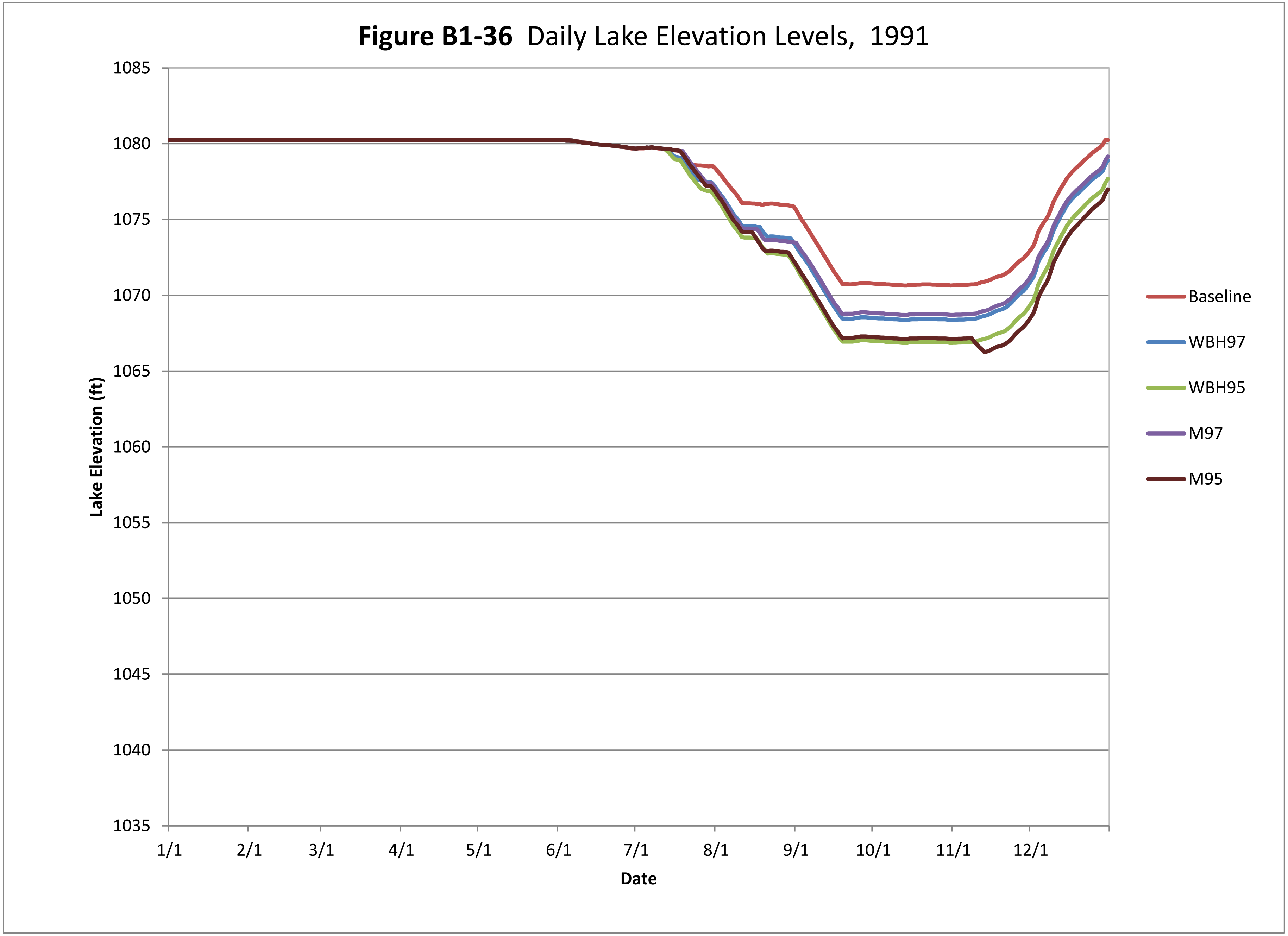


Figure B1-36 Daily Lake Elevation Levels, 1991
1085
1080
1075
1070
1065
1060
1055
1050
1045
1040
1035
Lake Elevation (ft)
1/1
2/1
3/1
4/1
5/1
6/1
7/1
8/1
9/1
10/1
11/1
12/1
Date
Baseline
WBH97
WBH95
M97
M95

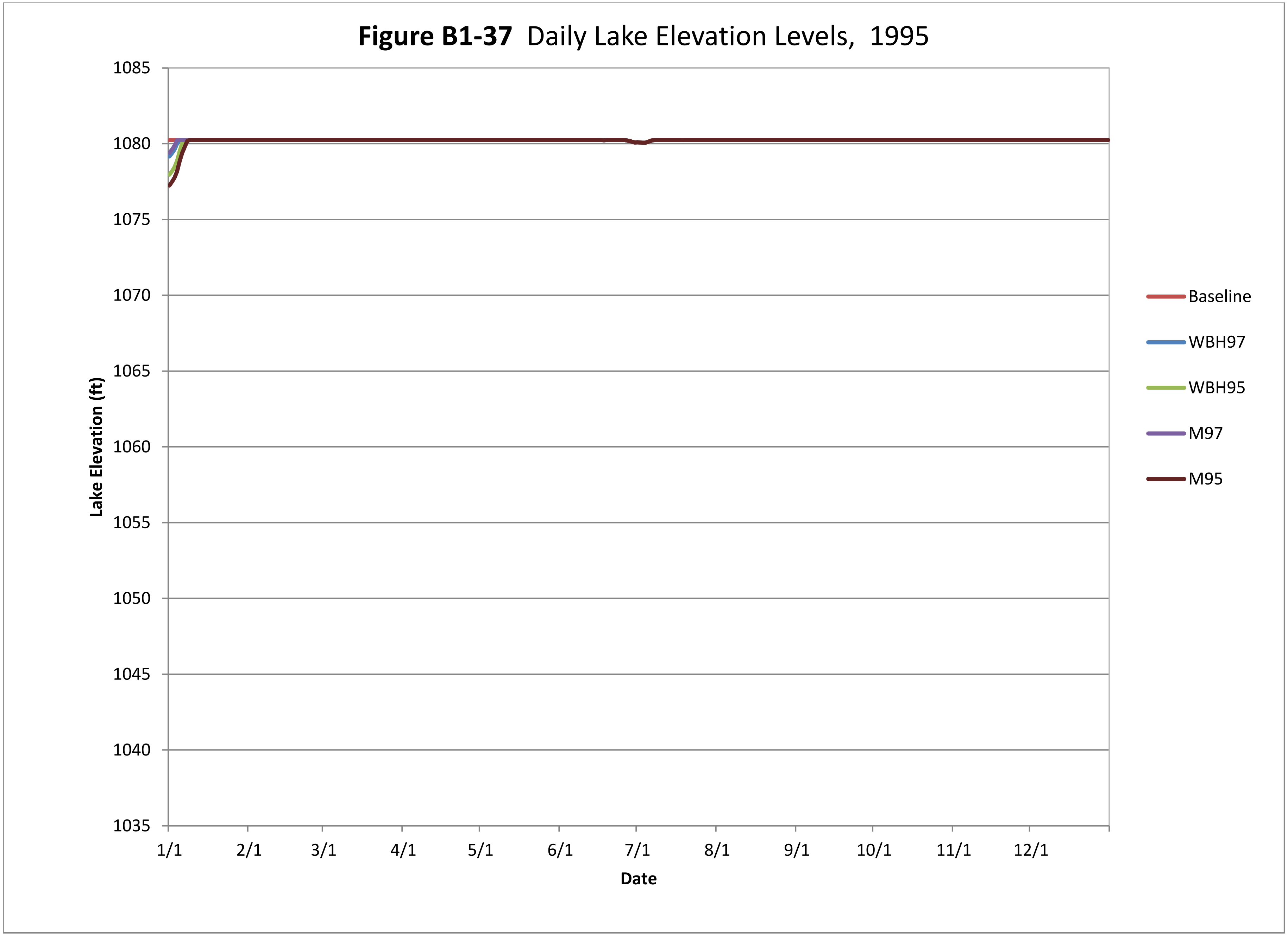


Figure B1-37 Daily Lake Elevation Levels, 1995
Lake Elevation (ft)
1085
1080
1075
1070
1065
1060
1055
1050
1045
1040
1035
1/1
2/1
3/1
4/1
5/1
6/1
7/1
8/1
9/1
10/1
11/1
12/1
Date
Baseline
WBH97
WBH95
M97
M95

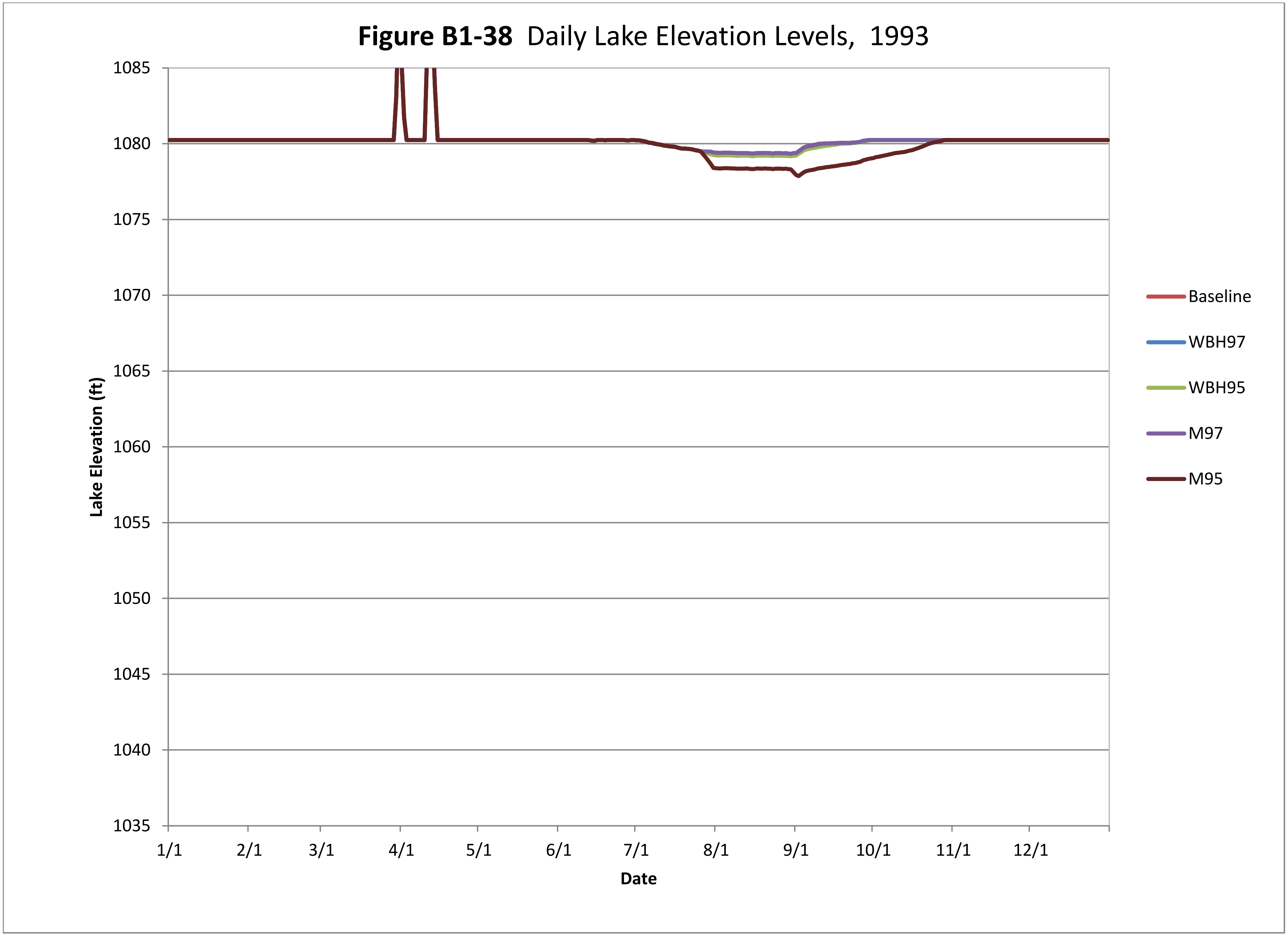


Figure B1-38 Daily Lake Elevation Levels, 1993
1085
1080
1075
1070
1065
1060
1055
1050
1045
1040
1035
Lake Elevation (ft)
1/1
2/1
3/1
4/1
5/1
6/1
7/1
8/1
9/1
10/1
11/1
12/1
Date
Baseline
WBH97
WBH95
M97
M95

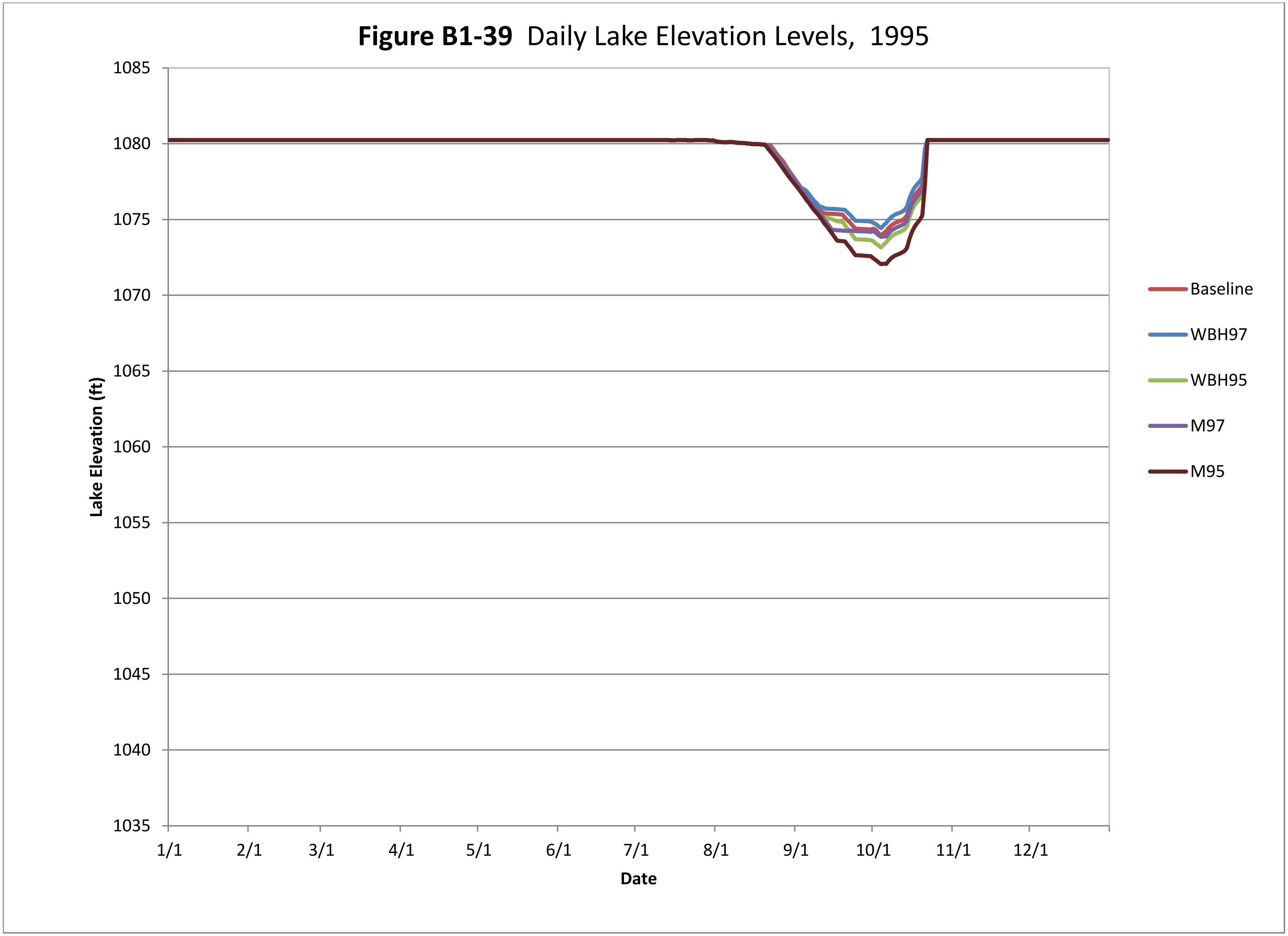


Figure B1-39 Daily Lake Elevation Levels, 1995
Lake Elevation (ft)
1085
1080
1075
1070
1065
1060
1055
1050
1045
1040
1035
1/1
2/1
3/1
4/1
5/1
6/1
7/1
8/1
9/1
10/1
11/1
12/1
Date
Baseline
WBH97
WBH95
M97
M95

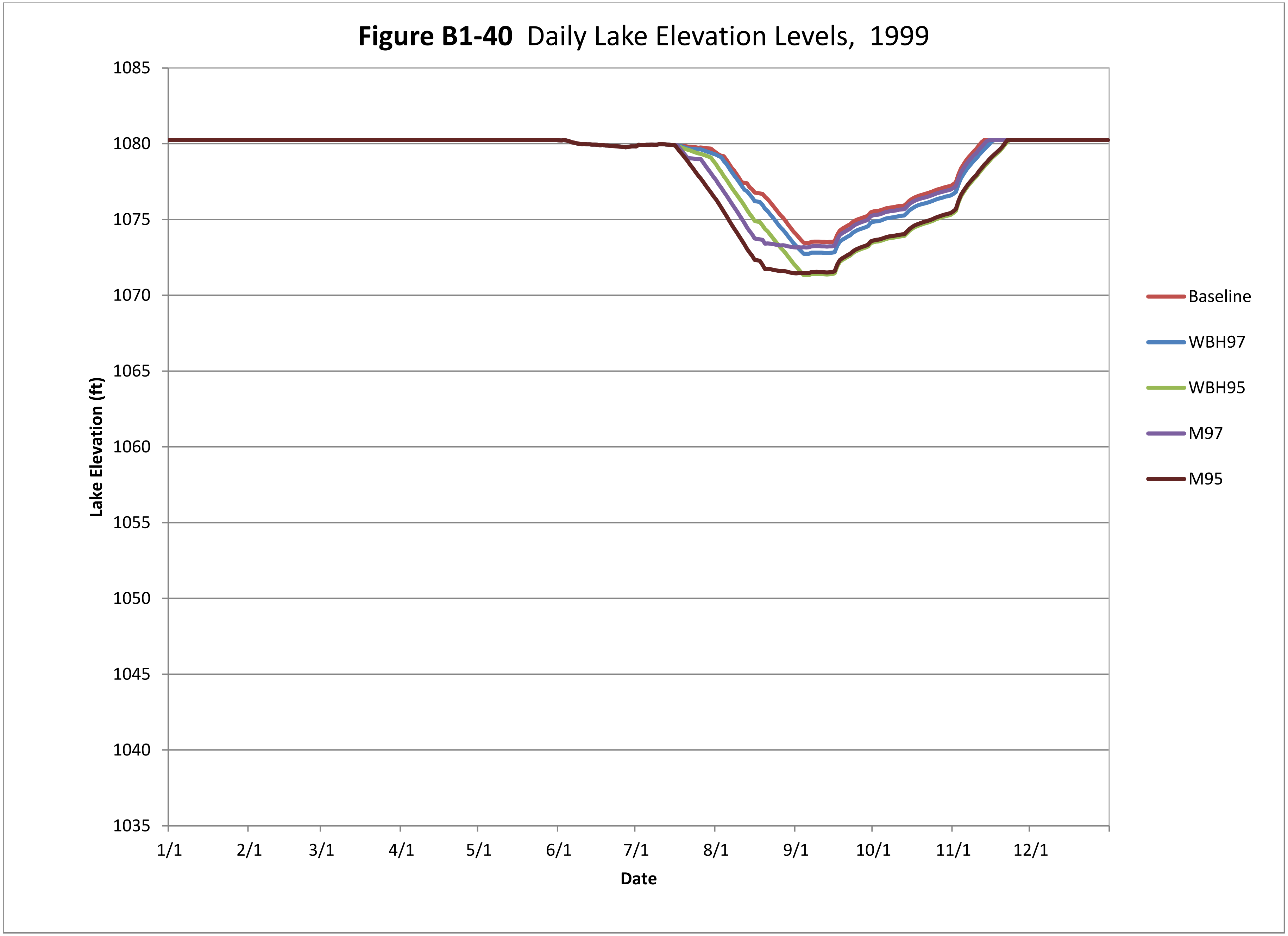


Figure B1-40 Daily Lake Elevation Levels, 1999
1085
1080
1075
1070
1065
1060
1055
1050
1045
1040
1035
Lake Elevation (ft)
1/1
2/1
3/1
4/1
5/1
6/1
7/1
8/1
9/1
10/1
11/1
12/1
Date
Baseline
WBH97
WBH95
M97
M95

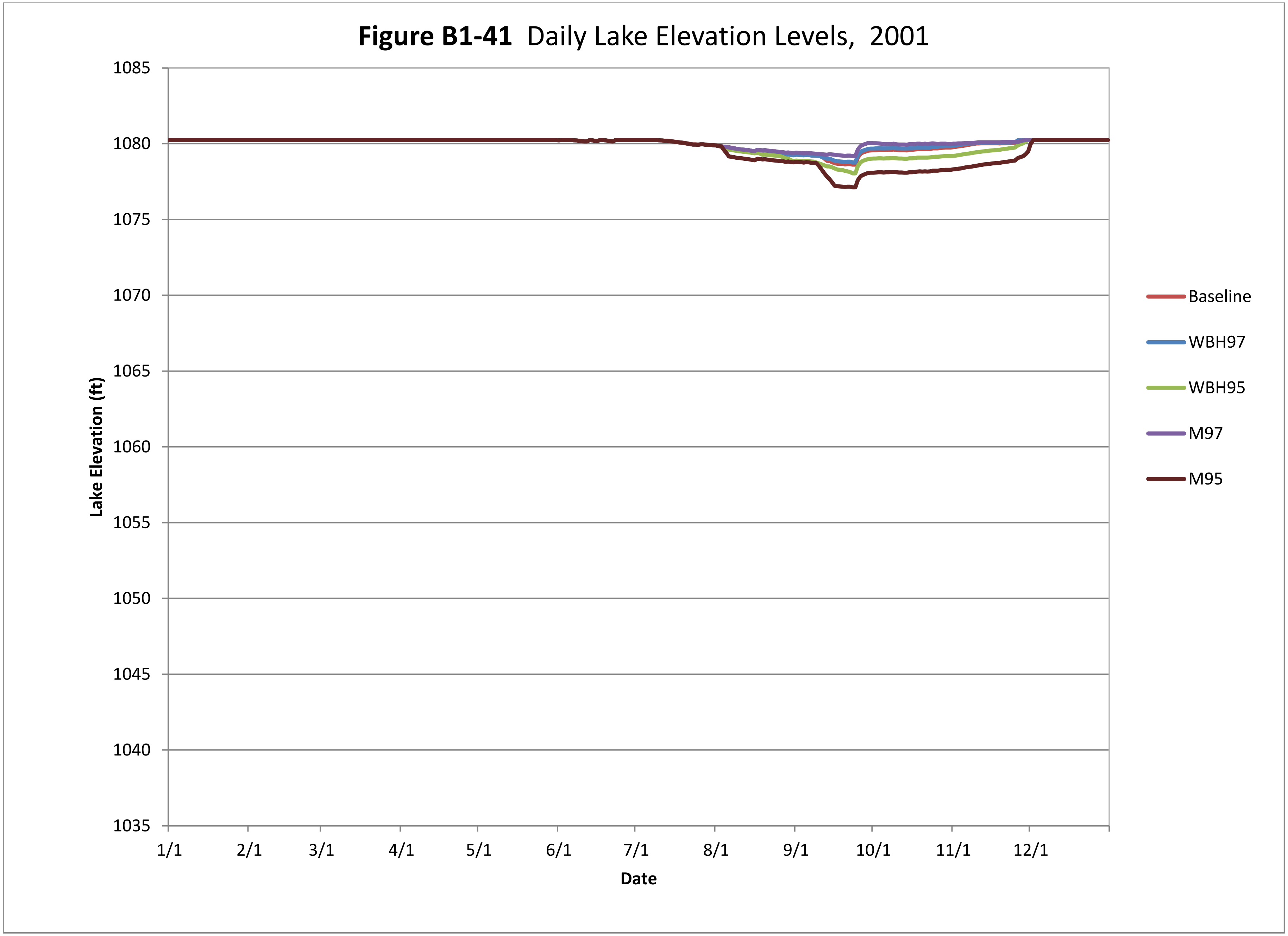


Figure B1-41 Daily Lake Elevation Levels, 2001
Lake Elevation (ft)
1085
1080
1075
1070
1065
1060
1055
1050
1045
1040
1035
1/1
2/1
3/1
4/1
5/1
6/1
7/1
8/1
9/1
10/1
11/1
12/1
Date
Baseline
WBH97
WBH95
M97
M95

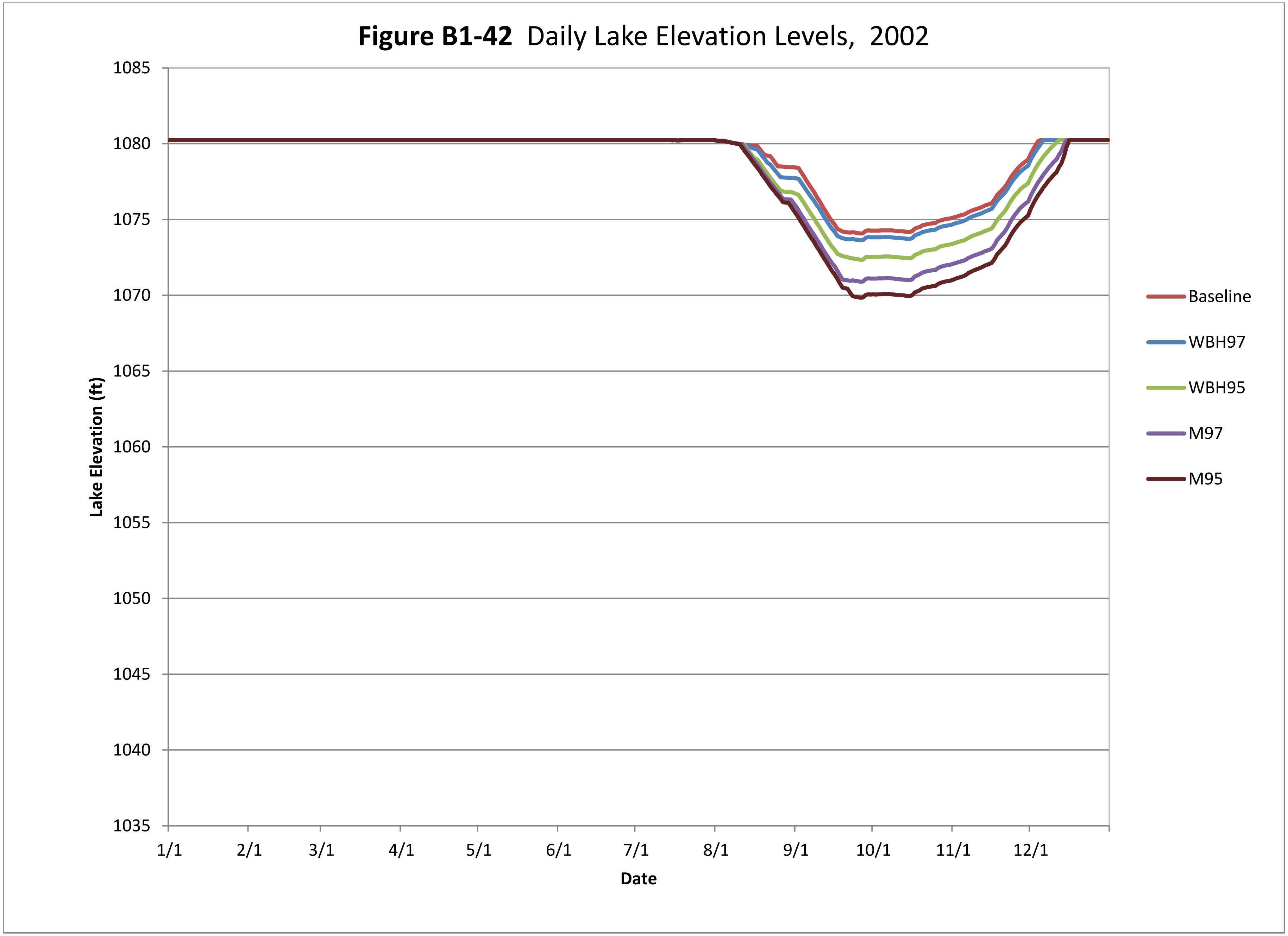


Figure B1-42 Daily Lake Elevation Levels, 2002
Lake Elevation (ft)
1085
1080
1075
1070
1065
1060
1055
1050
1045
1040
1035
1/1
2/1
3/1
4/1
5/1
6/1
7/1
8/1
9/1
10/1
11/1
12/1
Date
Baseline
WBH97
WBH95
M97
M95

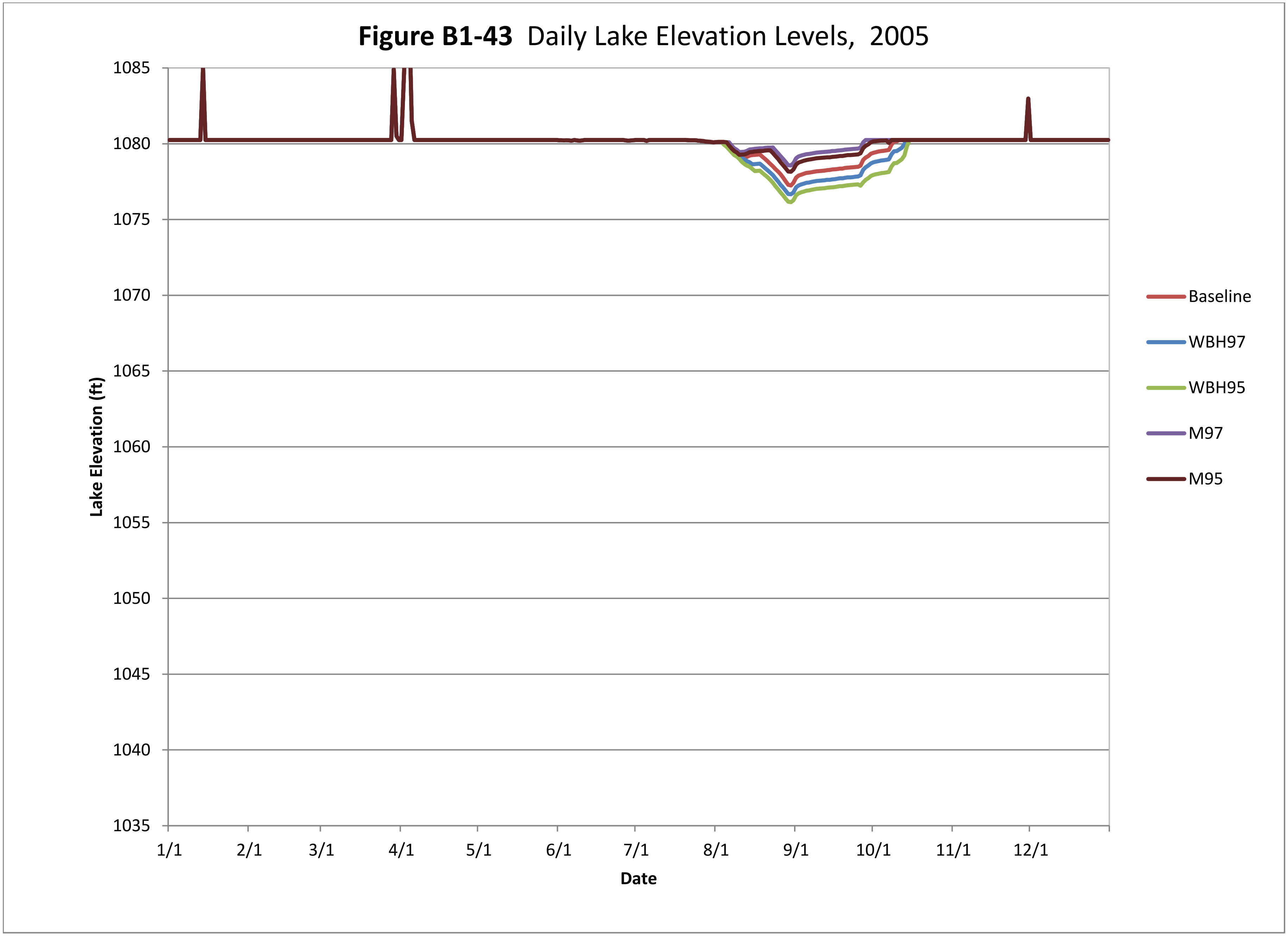


Figure B1-43 Daily Lake Elevation Levels, 2005
Lake Elevation (ft)
1085
1080
1075
1070
1065
1060
1055
1050
1045
1040
1035
1/1
2/1
3/1
4/1
5/1
6/1
7/1
8/1
9/1
10/1
11/1
12/1
Date
Baseline
WBH97
WBH95
M97
M95

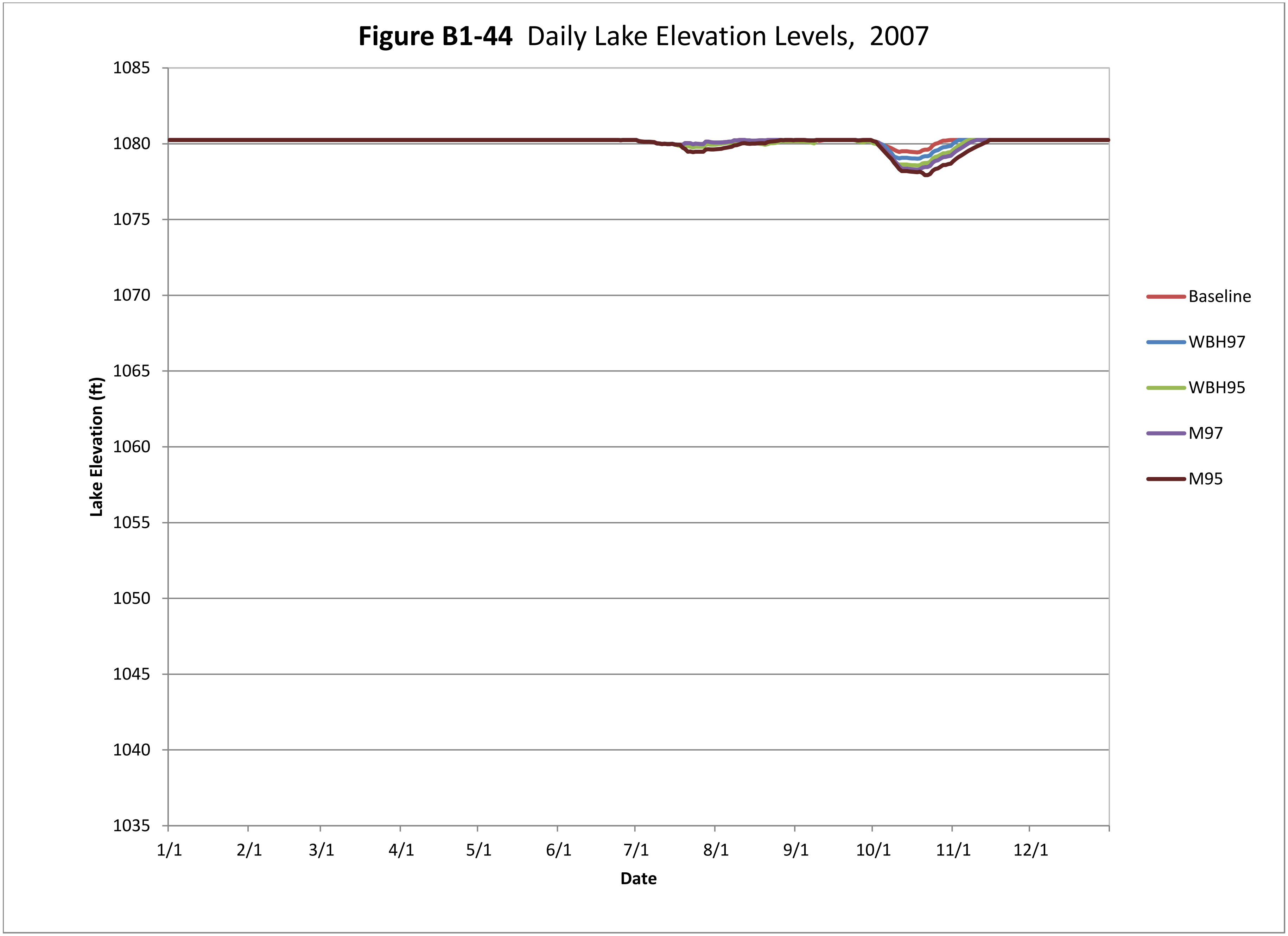


Figure B1-44 Daily Lake Elevation Levels, 2007
Lake Elevation (ft)
1085
1080
1075
1070
1065
1060
1055
1050
1045
1040
1035
1/1
2/1
3/1
4/1
5/1
6/1
7/1
8/1
9/1
10/1
11/1
12/1
Date
Baseline
WBH97
WBH95
M97
M95

Figure B1-45 Baseline Modeled Annual Minimum Elevations for Cowanesque Lake, 1930 - 2007

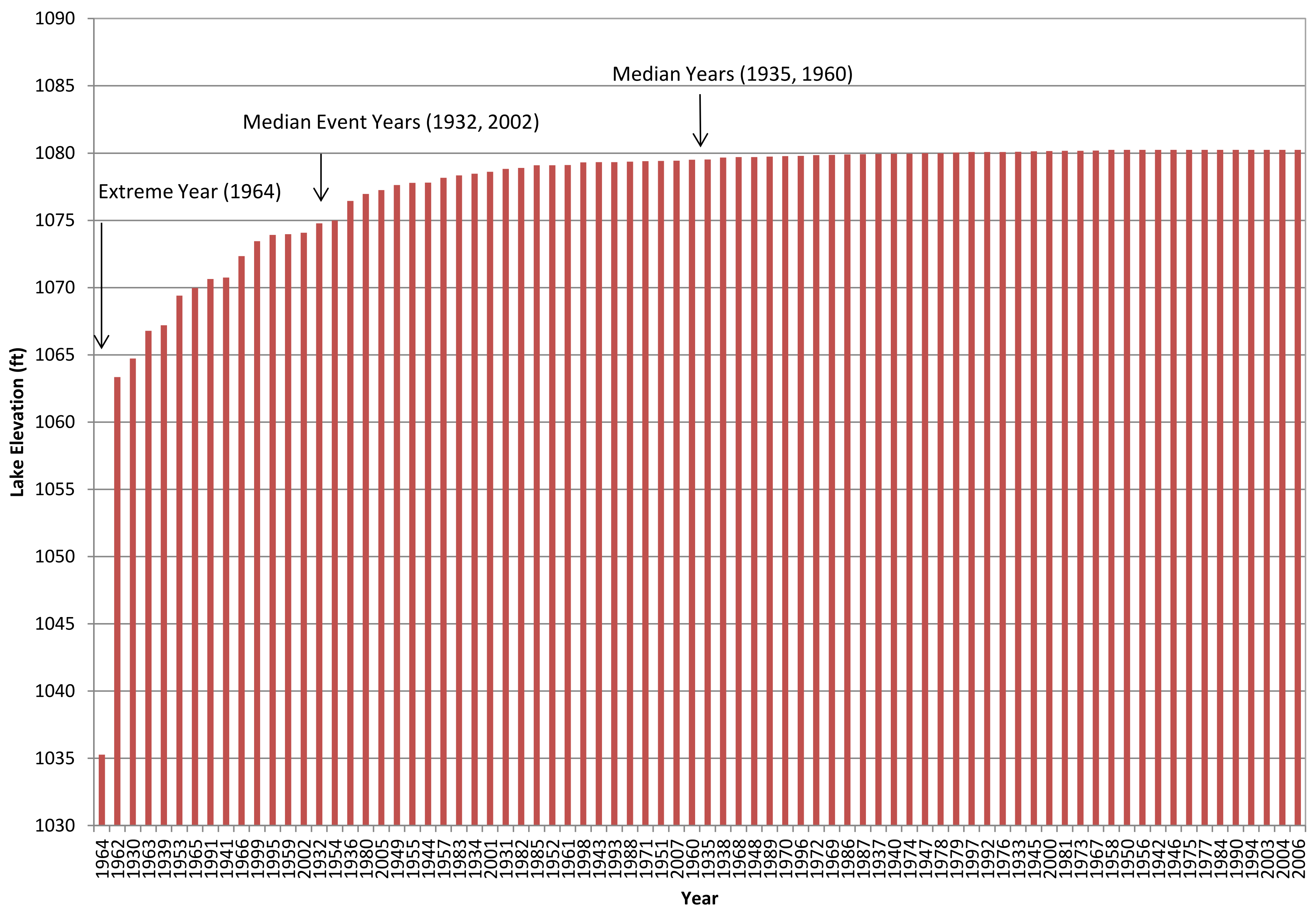
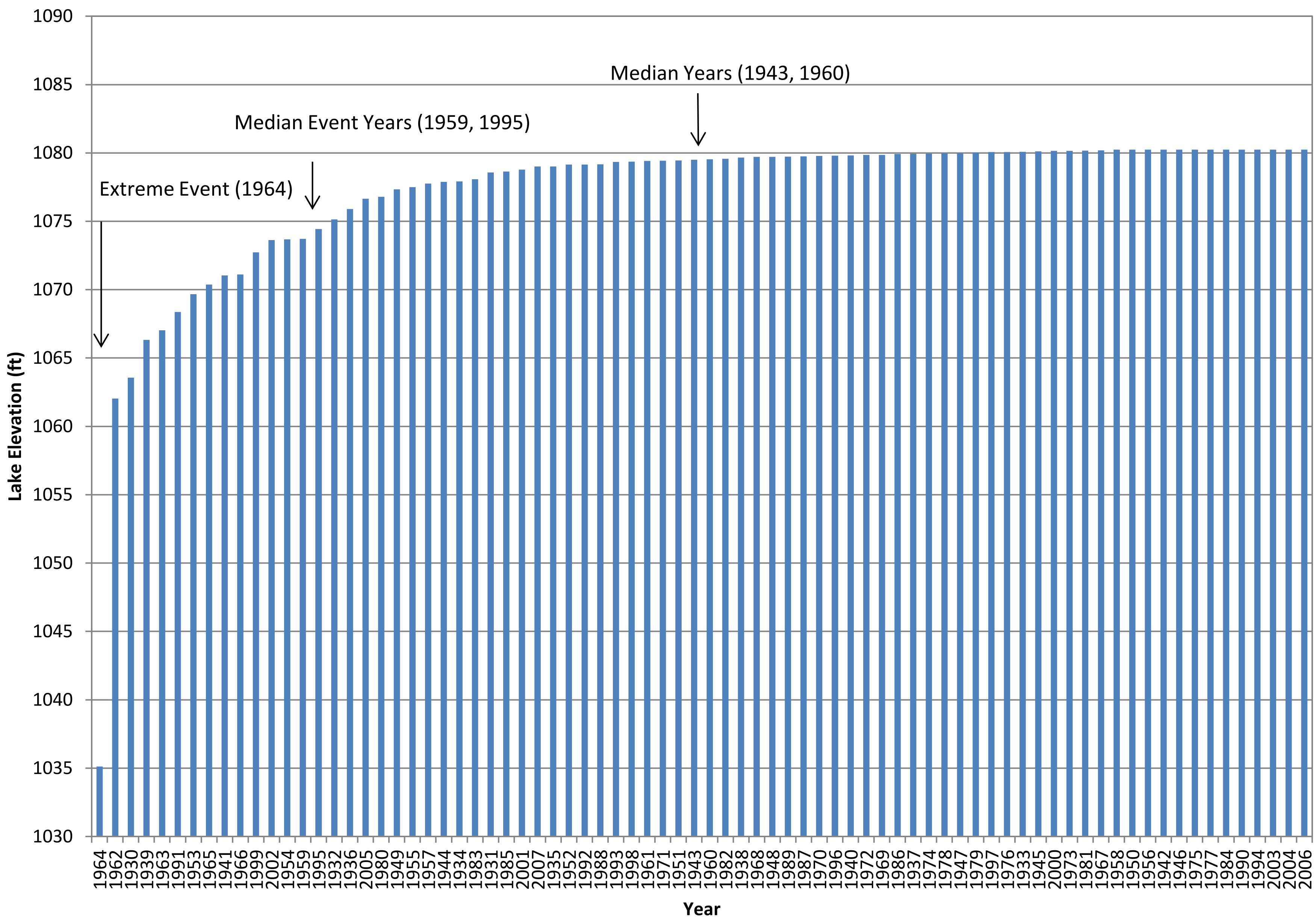


Figure B1-46 WBH97 Modeled Annual Minimum Elevations for Cowanesque Lake, 1930- 2007



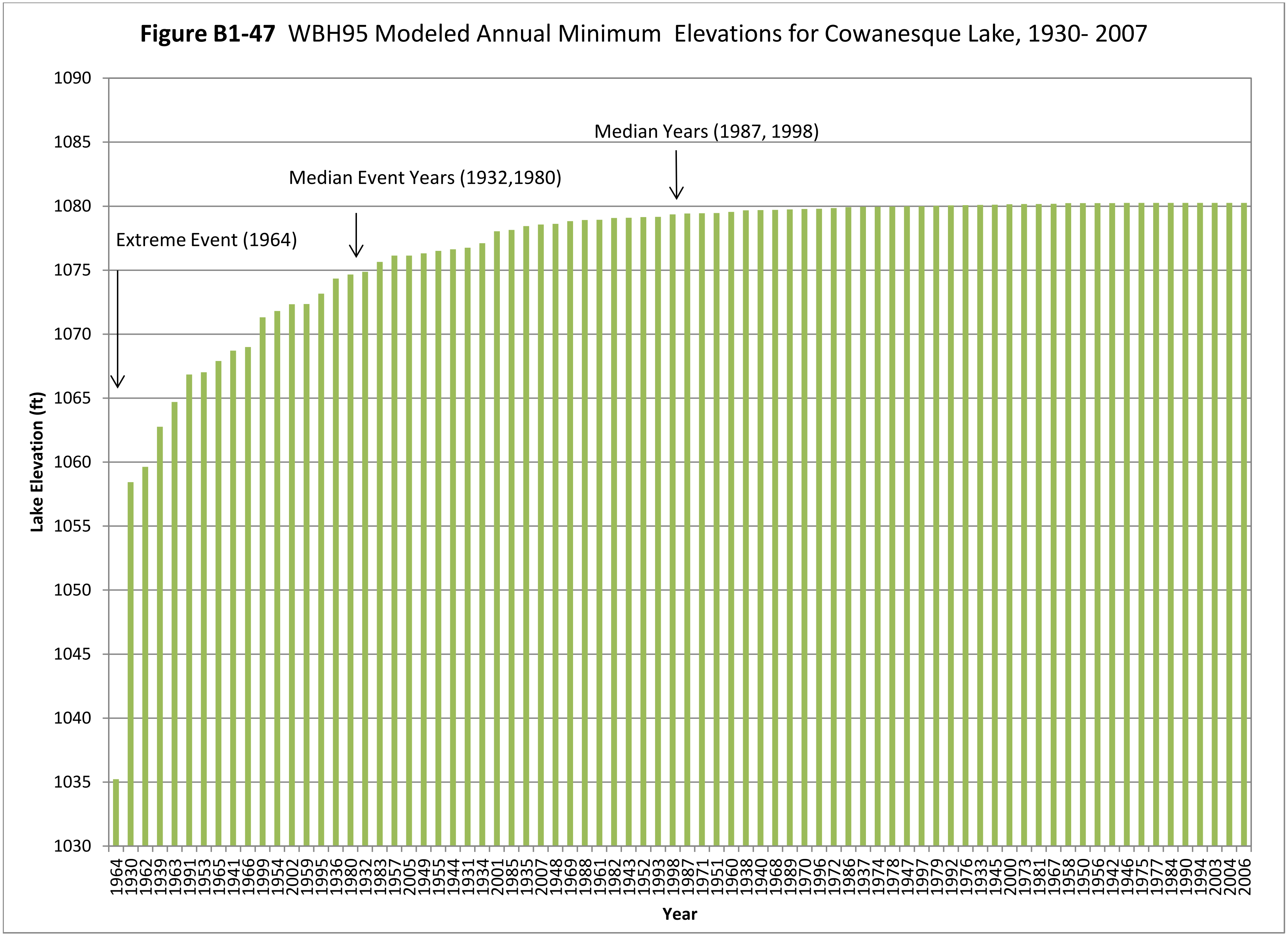


Figure B1-47 WBH95 Modeled Annual Minimum Elevations for Cowanesque Lake, 1930- 2007
Median Years (1987, 1998)
Median Event Years (1932,1980)
Extreme Event (1964)
Lake Elevation (ft)
Year
1090
1085
1080
1075
1070
1065
1060
1055
1050
1045
1040
1035
1030

Figure B1-48 M97 Modeled Annual Average Elevations for Cowanesque Lake, 1930 - 2007

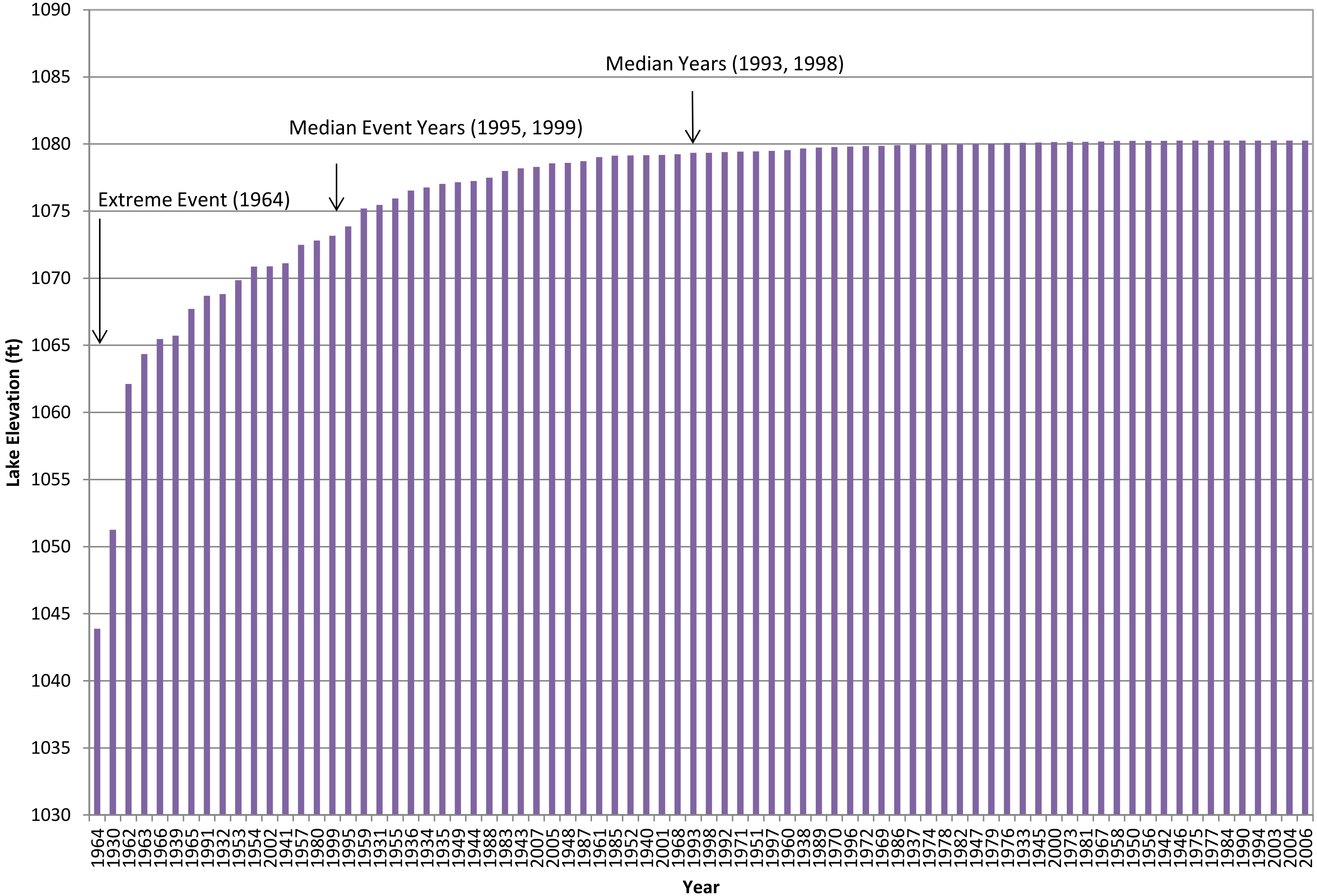
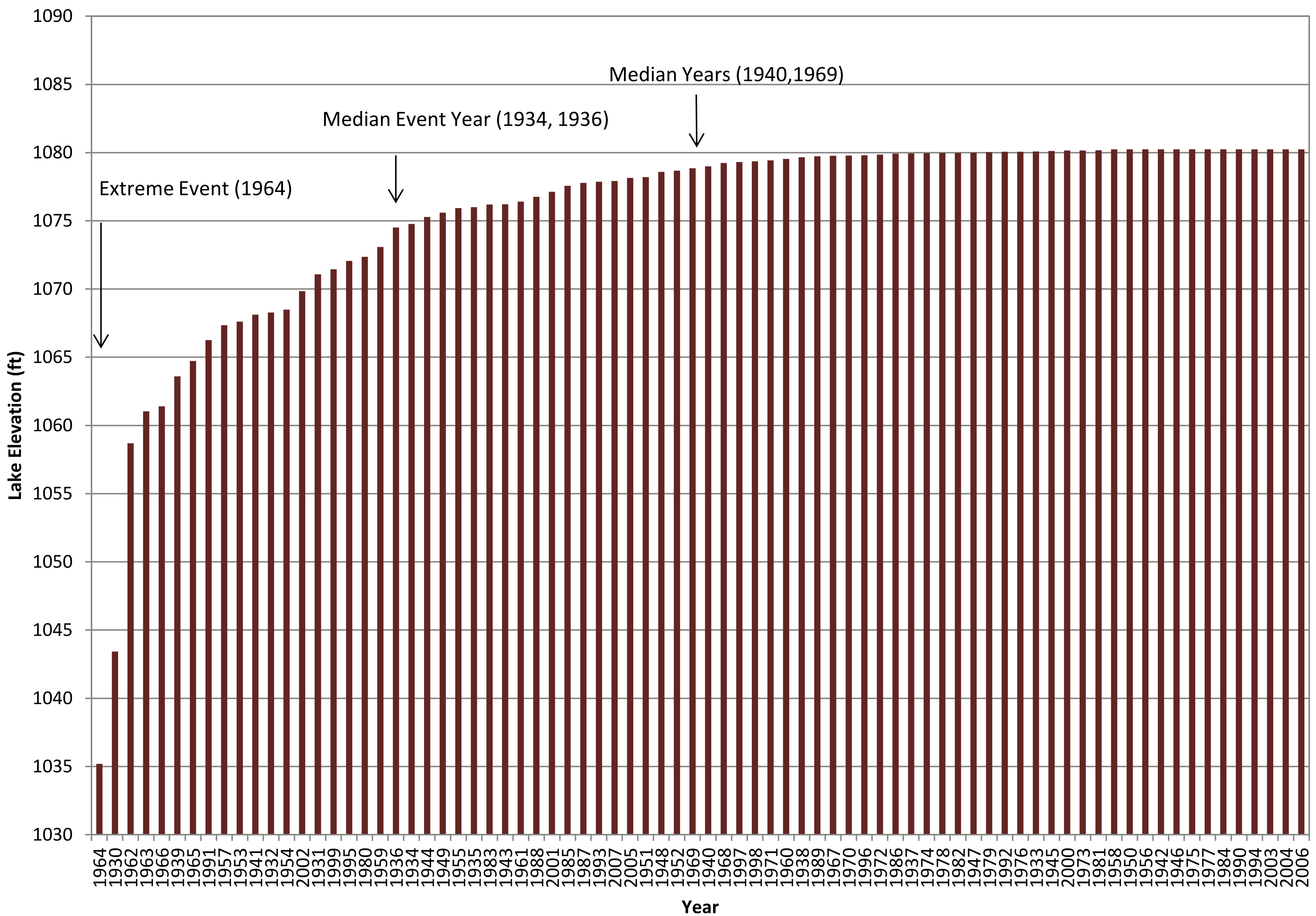


Figure B1-49 M95 Modeled Annual Minimum Elevations for Cowanesque Lake, 1930- 2007



APPENDIX B2

COMPLETE SUMMARY OF EXTREME AND MEDIAN DRAWDOWN EVENTS FOR EACH ALTERNATIVE

Each table includes: the drawdown event years for each of the four optional trigger alternatives ranked by minimum lake elevation (i.e. one being the lowest elevation), the minimum elevation for that drawdown year, the minimum elevation simulated by the Baseline Alternative for the corresponding drawdown year, the difference between the minimum elevations under the Baseline and the optional trigger alternative, and a comment describing the type of year (extreme, median of drawdown years), and median for 78 year period of record

Table B2-1 Comparison of Modeled Annual Minimum Elevation Data between Alternative WBH97 and the Baseline Alternative for all Event Years for Alternative WBH97

	Year	Minimum Lake Elevation Under Alternative WBH97 (feet)	Minimum Lake Elevation Under Baseline Alternative (feet)	Difference Between Baseline Alternative and Alternative WBH97 (feet)	Comments
1	1964	1035.1	1035.3	-0.1	Extreme event
2	1962	1062.0	1063.4	-1.3	
3	1930	1063.8	1064.9	-1.1	
4	1939	1066.3	1067.2	-0.9	
5	1963	1067.0	1066.8	0.2	
6	1991	1068.4	1070.6	-2.3	
7	1953	1069.7	1069.4	0.3	
8	1965	1070.4	1070.0	0.4	
9	1941	1071.0	1070.7	0.3	
10	1966	1071.1	1072.3	-1.2	
11	1999	1072.7	1073.5	-0.7	
12	2002	1073.6	1074.1	-0.5	
13	1954	1073.7	1075.0	-1.3	
14	1959	1073.7	1074.0	-0.3	Median events when drawdown > 1 ft
15	1995	1074.4	1073.9	0.5	
16	1932	1075.1	1074.8	0.4	
17	1936	1075.9	1076.4	-0.5	
18	2005	1076.7	1077.2	-0.6	
19	1980	1076.8	1077.0	-0.2	
20	1949	1077.3	1077.6	-0.3	
21	1955	1077.5	1077.8	-0.3	
22	1957	1077.8	1078.2	-0.4	
23	1944	1077.9	1077.8	0.1	
24	1934	1077.9	1078.5	-0.6	
25	1983	1078.1	1078.3	-0.3	
26	1931	1078.6	1078.8	-0.2	
27	1985	1078.6	1079.1	-0.4	
28	2001	1078.8	1078.6	0.2	
39	1943	1079.5	1079.3	0.2	Median events for 78-year period
40	1960	1079.5	1079.5	0.03	

Table B2-2 Comparison of Modeled Annual Minimum Elevation Data between Alternative WBH95 and the Baseline Alternative for all Event Years for Alternative WBH95

	Year	Minimum Lake Elevation Under Alternative WBH95 (feet)	Minimum Lake Elevation Under Baseline Alternative (feet)	Difference Between Baseline Alternative and Alternative WBH95 (feet)	Comments
1	1964	1035.2	1035.3	-0.04	Extreme event
2	1930	1058.8	1064.9	-6.1	
3	1962	1059.6	1063.4	-3.7	
4	1939	1062.8	1067.2	-4.4	
5	1963	1064.7	1066.8	-2.1	
6	1991	1066.9	1070.6	-3.8	
7	1953	1067.0	1069.4	-2.4	
8	1965	1067.9	1070.0	-2.1	
9	1941	1068.7	1070.7	-2.0	
10	1966	1069.0	1072.3	-3.3	
11	1999	1071.3	1073.5	-2.1	
12	1954	1071.8	1075.0	-3.2	
13	2002	1072.3	1074.1	-1.7	
14	1959	1072.4	1074.0	-1.6	
15	1995	1073.2	1073.9	-0.8	
16	1936	1074.3	1076.4	-2.1	
17	1980	1074.7	1077.0	-2.3	Median events when drawdown > 1 ft
18	1932	1074.9	1074.8	0.1	
19	1983	1075.6	1078.3	-2.7	
20	1957	1076.1	1078.2	-2.0	
21	2005	1076.1	1077.2	-1.1	
22	1949	1076.3	1077.6	-1.3	
23	1955	1076.5	1077.8	-1.3	
24	1944	1076.6	1077.8	-1.2	
25	1931	1076.8	1078.8	-2.1	
26	1934	1077.1	1078.5	-1.4	
27	2001	1078.0	1078.6	-0.6	
28	1985	1078.1	1079.1	-1.0	
29	1935	1078.4	1079.5	-1.1	
30	2007	1078.6	1079.4	-0.9	
31	1948	1078.6	1079.7	-1.1	
32	1969	1078.8	1079.9	-1.0	
33	1988	1078.9	1079.4	-0.4	
34	1961	1078.9	1079.1	-0.2	
39	1998	1079.4	1079.3	0.04	Median events for 78-year period
40	1987	1079.4	1079.9	-0.5	

Table B2-3 Comparison of Modeled Annual Minimum Elevation Data between Alternative M97 and the Baseline Alternative for all Event Years for Alternative M97

	Year	Minimum Lake Elevation Under Alternative M97 (feet)	Minimum Lake Elevation Under Baseline Alternative (feet)	Difference Between Baseline Alternative and Alternative M97 (feet)	Comments
1	1964	1043.9	1035.3	8.61	Extreme event
2	1930	1051.7	1064.9	-13.2	
3	1962	1062.1	1063.4	-1.2	
4	1963	1064.3	1066.8	-2.4	
5	1966	1065.5	1072.3	-6.9	
6	1939	1065.7	1067.2	-1.5	
7	1965	1067.7	1070.0	-2.3	
8	1991	1068.7	1070.6	-1.9	
9	1932	1068.8	1074.8	-6.0	
10	1953	1069.9	1069.4	0.4	
11	1954	1070.9	1075.0	-4.1	
12	2002	1070.9	1074.1	-3.2	
13	1941	1071.1	1070.7	0.4	
14	1957	1072.5	1078.2	-5.7	
15	1980	1072.8	1077.0	-4.2	
16	1999	1073.2	1073.5	-0.3	Median events when drawdown > 1 ft
17	1995	1073.9	1073.9	-0.1	
18	1959	1075.2	1074.0	1.2	
19	1931	1075.5	1078.8	-3.3	
20	1955	1075.9	1077.8	-1.9	
21	1936	1076.5	1076.4	0.1	
22	1934	1076.8	1078.5	-1.7	
23	1935	1077.0	1079.5	-2.5	
24	1949	1077.2	1077.6	-0.5	
25	1944	1077.2	1077.8	-0.6	
26	1988	1077.5	1079.4	-1.9	
27	1983	1078.0	1078.3	-0.3	
28	1943	1078.2	1079.3	-1.1	
29	2007	1078.3	1079.4	-1.1	
30	2005	1078.6	1077.2	1.3	
31	1948	1078.6	1079.7	-1.1	
32	1987	1078.7	1079.9	-1.2	
39	1993	1079.3	1079.3	0.01	Median events for 78-year period
40	1998	1079.4	1079.3	0.04	

Table B2-4 Comparison of Modeled Annual Minimum Elevation Data between Alternative M95 and the Baseline Alternative for all Event Years for Alternative M95

	Year	Minimum Lake Elevation Under Alternative M95 (feet)	Minimum Lake Elevation Under Baseline Alternative (feet)	Difference Between Baseline Alternative and Alternative M95 (feet)	Comments
1	1964	1035.2	1035.3	-0.1	Extreme event
2	1930	1044.1	1064.9	-20.9	
3	1962	1058.7	1063.4	-4.7	
4	1963	1061.0	1066.8	-5.8	
5	1966	1061.4	1072.3	-10.9	
6	1939	1063.6	1067.2	-3.6	
7	1965	1064.7	1070.0	-5.3	
8	1991	1066.3	1070.6	-4.4	
9	1957	1067.3	1078.2	-10.8	
10	1953	1067.6	1069.4	-1.8	
11	1941	1068.1	1070.7	-2.6	
12	1932	1068.3	1074.8	-6.5	
13	1954	1068.5	1075.0	-6.5	
14	2002	1069.8	1074.1	-4.2	
15	1931	1071.1	1078.8	-7.7	
16	1999	1071.5	1073.5	-2.0	
17	1995	1072.1	1073.9	-1.9	
18	1980	1072.4	1077.0	-4.6	
19	1959	1073.1	1074.0	-0.9	
20	1936	1074.5	1076.4	-1.9	Median event when drawdown > 1 ft
21	1934	1074.8	1078.5	-3.7	
22	1944	1075.3	1077.8	-2.5	
23	1949	1075.6	1077.6	-2.0	
24	1955	1075.9	1077.8	-1.9	
25	1935	1076.0	1079.5	-3.5	
26	1983	1076.2	1078.3	-2.1	
27	1943	1076.2	1079.3	-3.1	
28	1961	1076.4	1079.1	-2.7	
29	1988	1076.8	1079.4	-2.6	
30	2001	1077.1	1078.6	-1.5	
31	1985	1077.6	1079.1	-1.5	
32	1987	1077.8	1079.9	-2.1	
33	1993	1077.9	1079.3	-1.5	
34	2007	1077.9	1079.4	-1.5	
35	2005	1078.2	1077.2	0.9	
36	1951	1078.2	1079.4	-1.2	
37	1948	1078.6	1079.7	-1.1	
38	1952	1078.7	1079.1	-0.4	
39	1969	1078.8	1079.9	-1.0	Median events for 78-year period
40	1940	1079.0	1079.9	-1.0	

APPENDIX B3

FIGURES OF HISTORICAL ANNUAL LAKE ELEVATION MINIMUMS AND DAILY ELEVATION DATA

This appendix includes figures of the historical daily lake elevation data for all historical drawdown event years, and a figure of the minimum elevation in each year of the period of record.

Figure B3-1 Historical Annual Minimum Elevations for Cowanesque Lake, 1930 - 2007

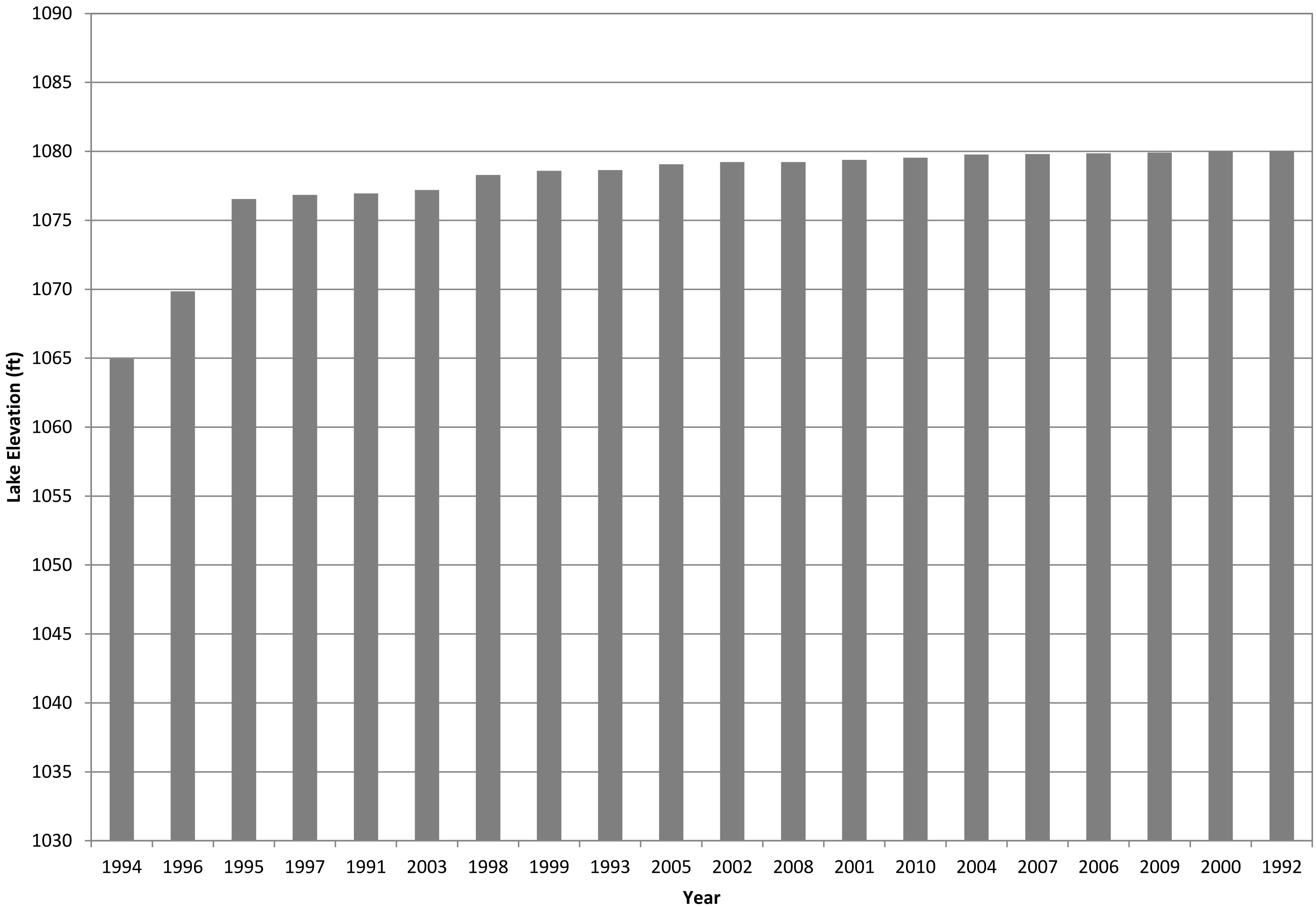
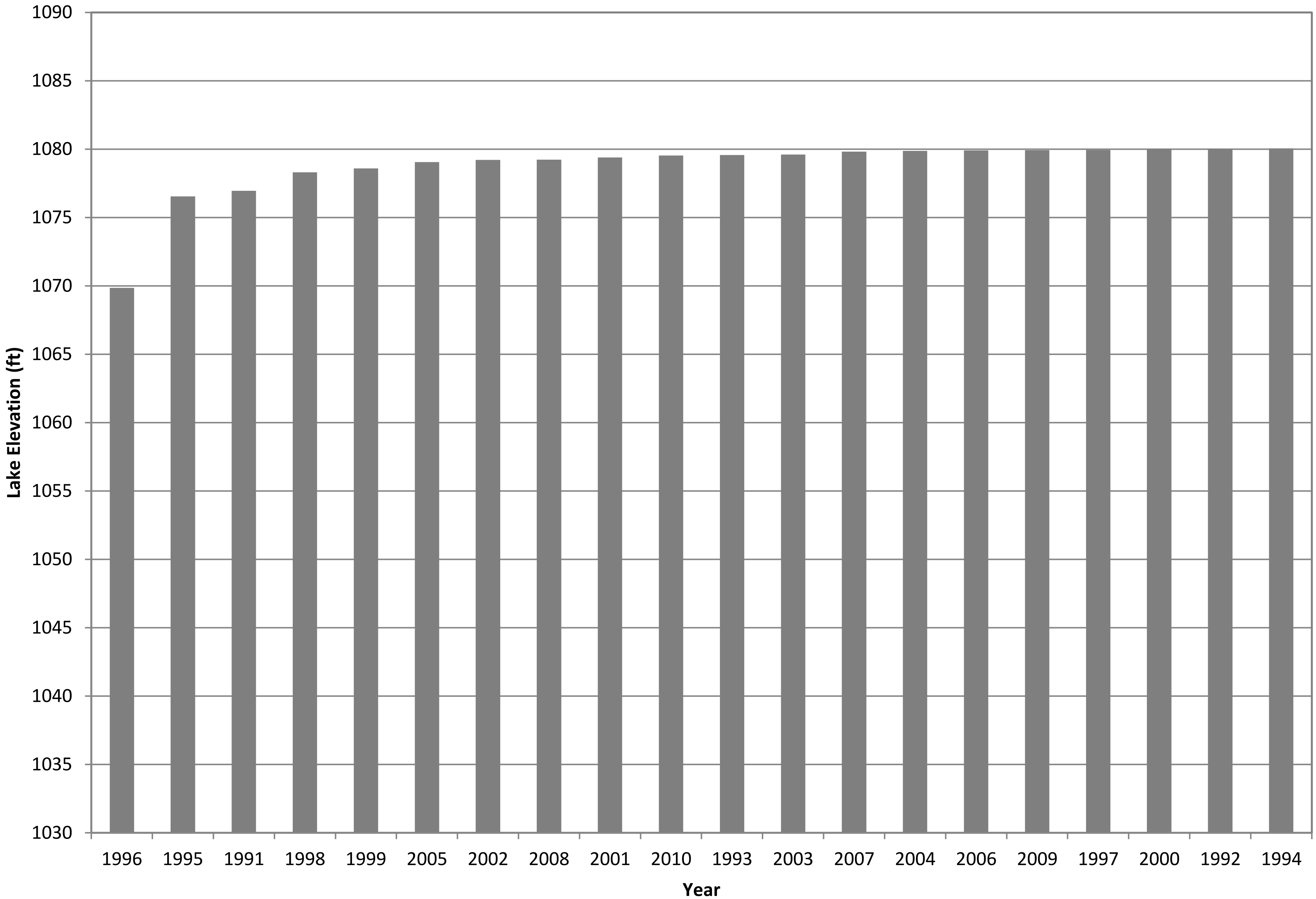


Figure B3-2 Historical Annual Minimum Elevations for Cowanesque Lake during the Recreation Season, 1991 – 2010



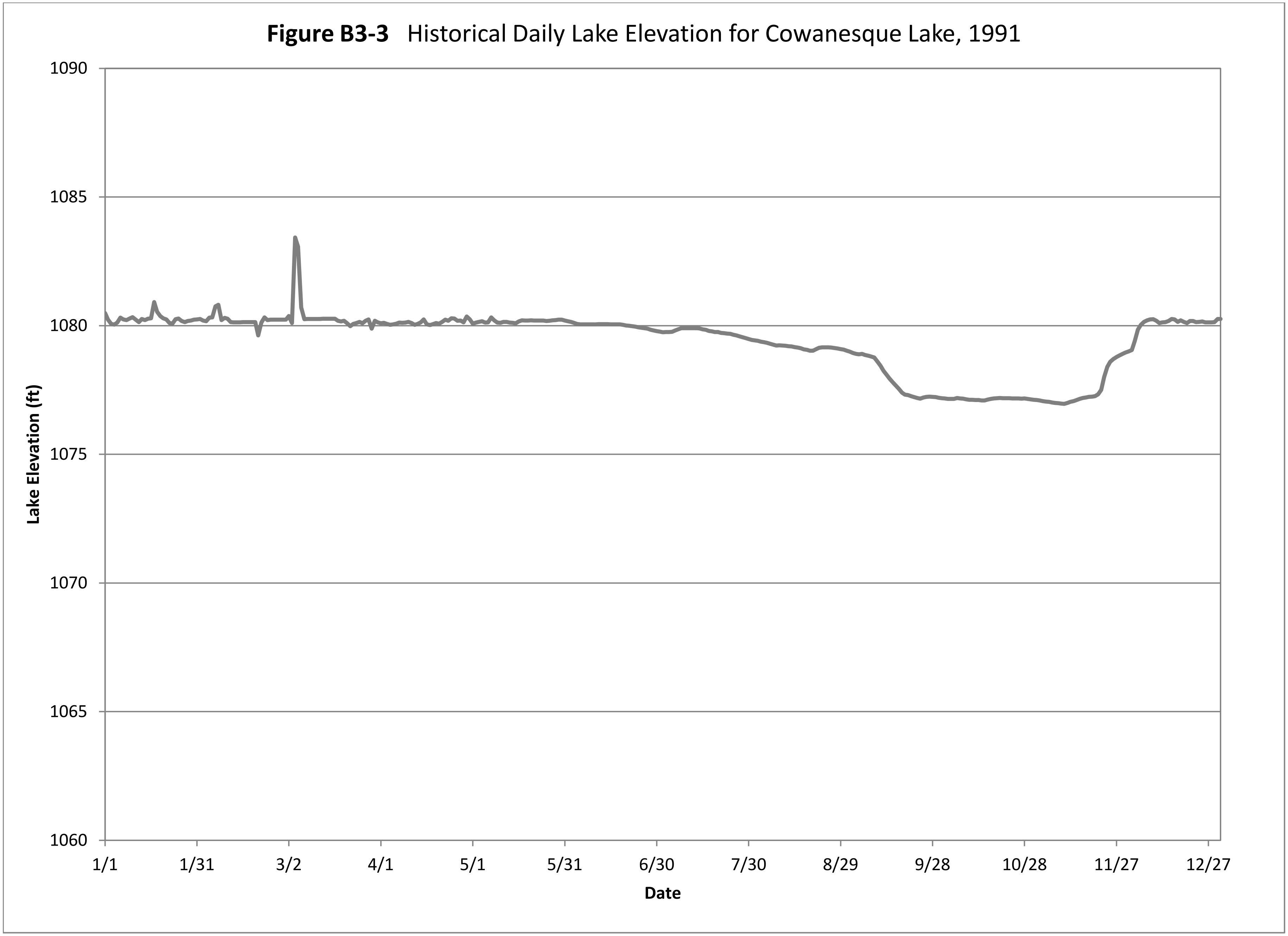


Figure B3-3 Historical Daily Lake Elevation for Cowanesque Lake, 1991
1090
1085
1080
1075
1070
1065
1060
Lake Elevation (ft)
1/1
1/31
3/2
4/1
5/1
5/31
6/30
7/30
8/29
9/28
10/28
11/27
12/27
Date

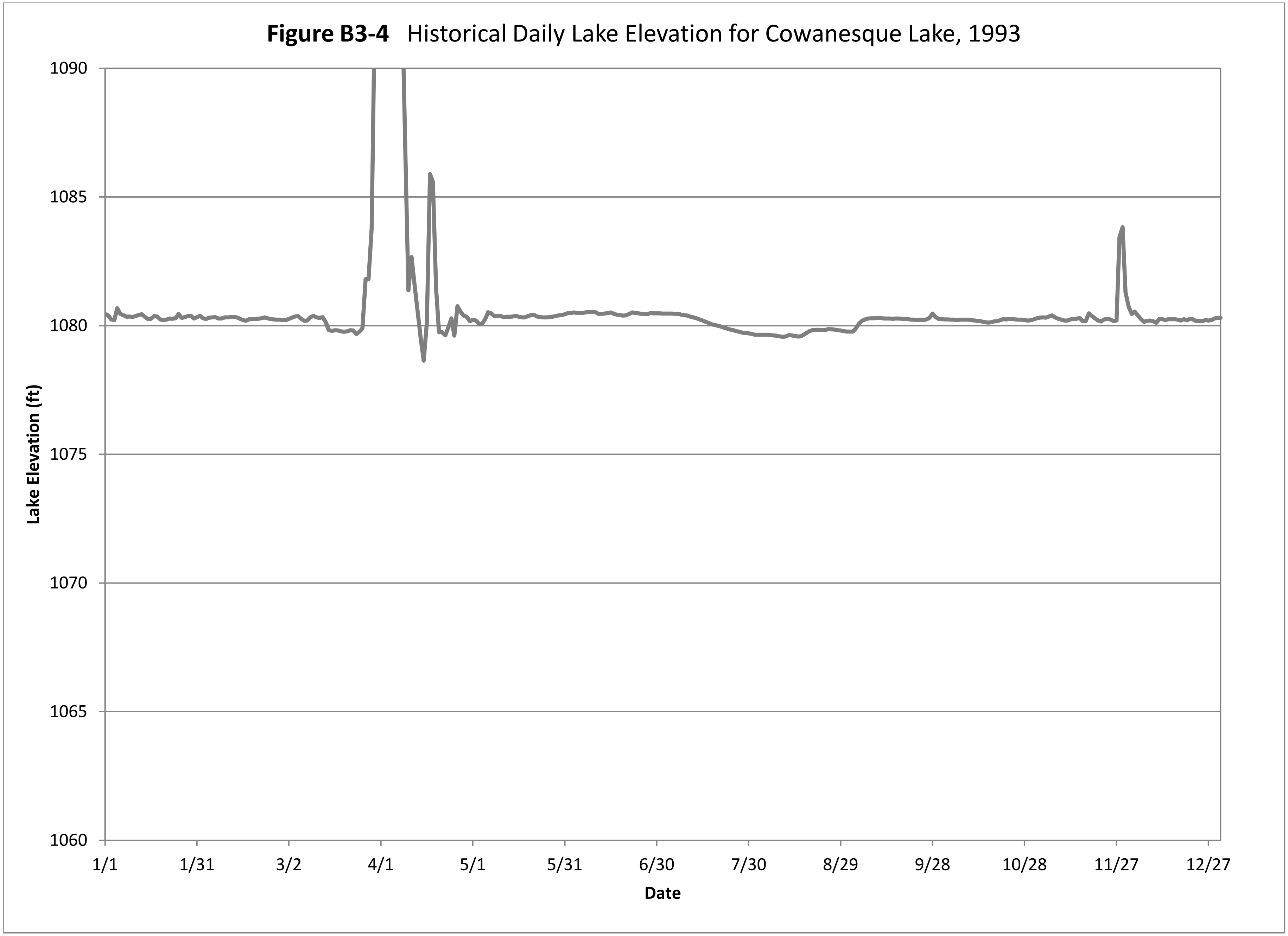
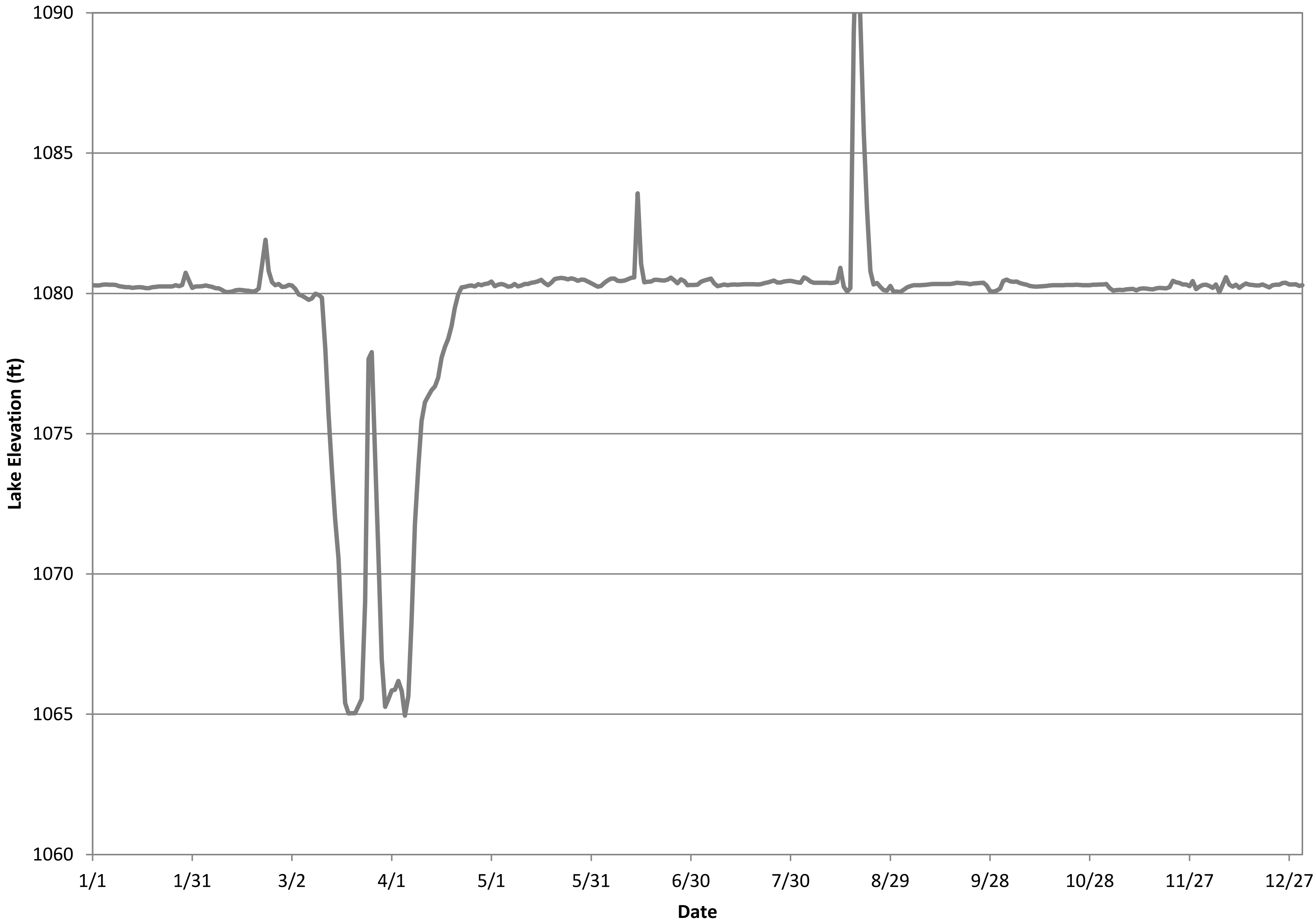


Figure B3-4 Historical Daily Lake Elevation for Cowanesque Lake, 1993
1090
1085
1080
1075
1070
1065
1060
Lake Elevation (ft)
1/1
1/31
3/2
4/1
5/1
5/31
6/30
7/30
8/29
9/28
10/28
11/27
12/27
Date

Figure B3-5 Historical Daily Lake Elevation for Cowanesque Lake, 1994



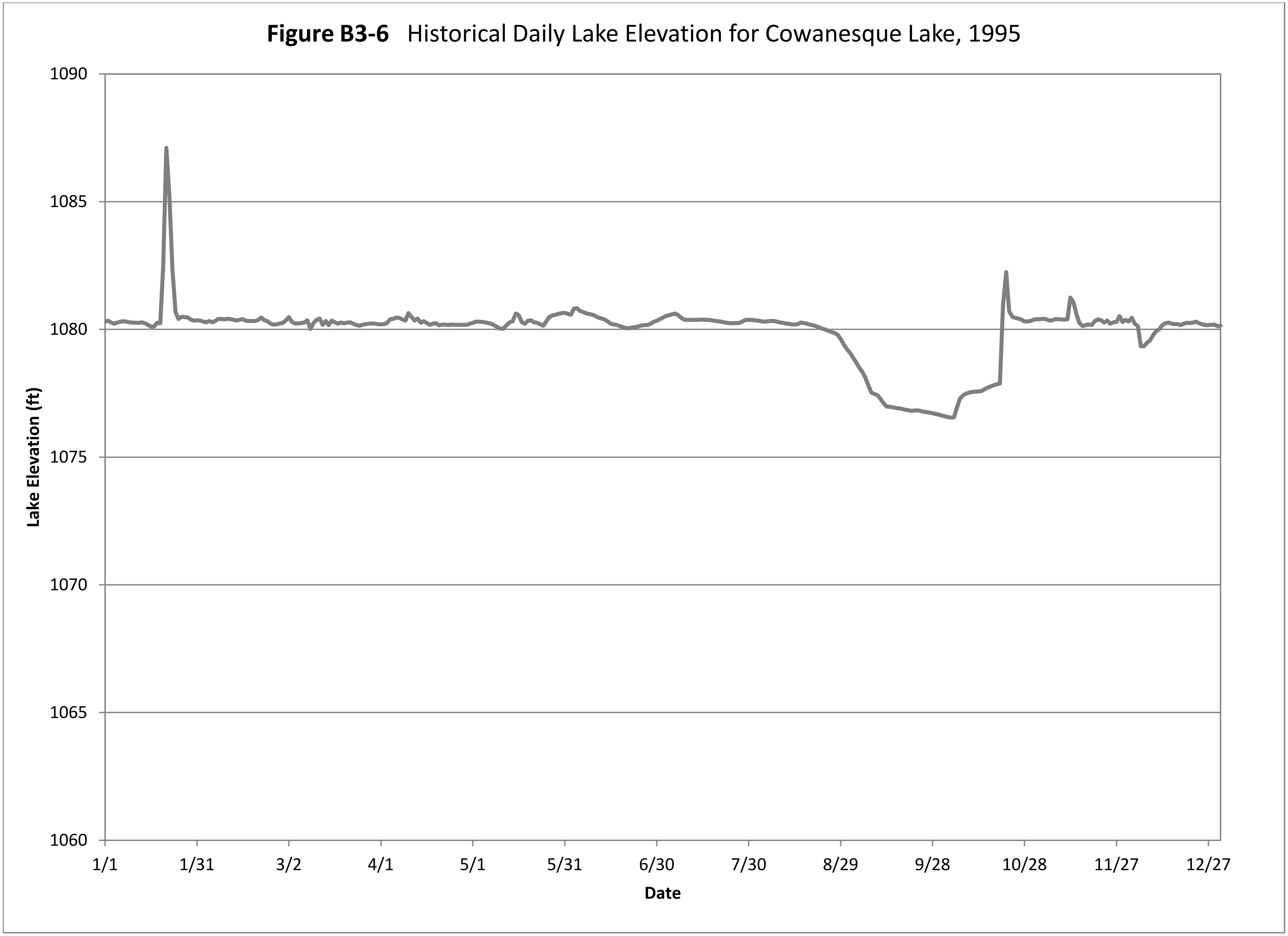


Figure B3-6 Historical Daily Lake Elevation for Cowanesque Lake, 1995
1090
1085
1080
1075
1070
1065
1060
Lake Elevation (ft)
1/1
1/31
3/2
4/1
5/1
5/31
6/30
7/30
8/29
9/28
10/28
11/27
12/27
Date

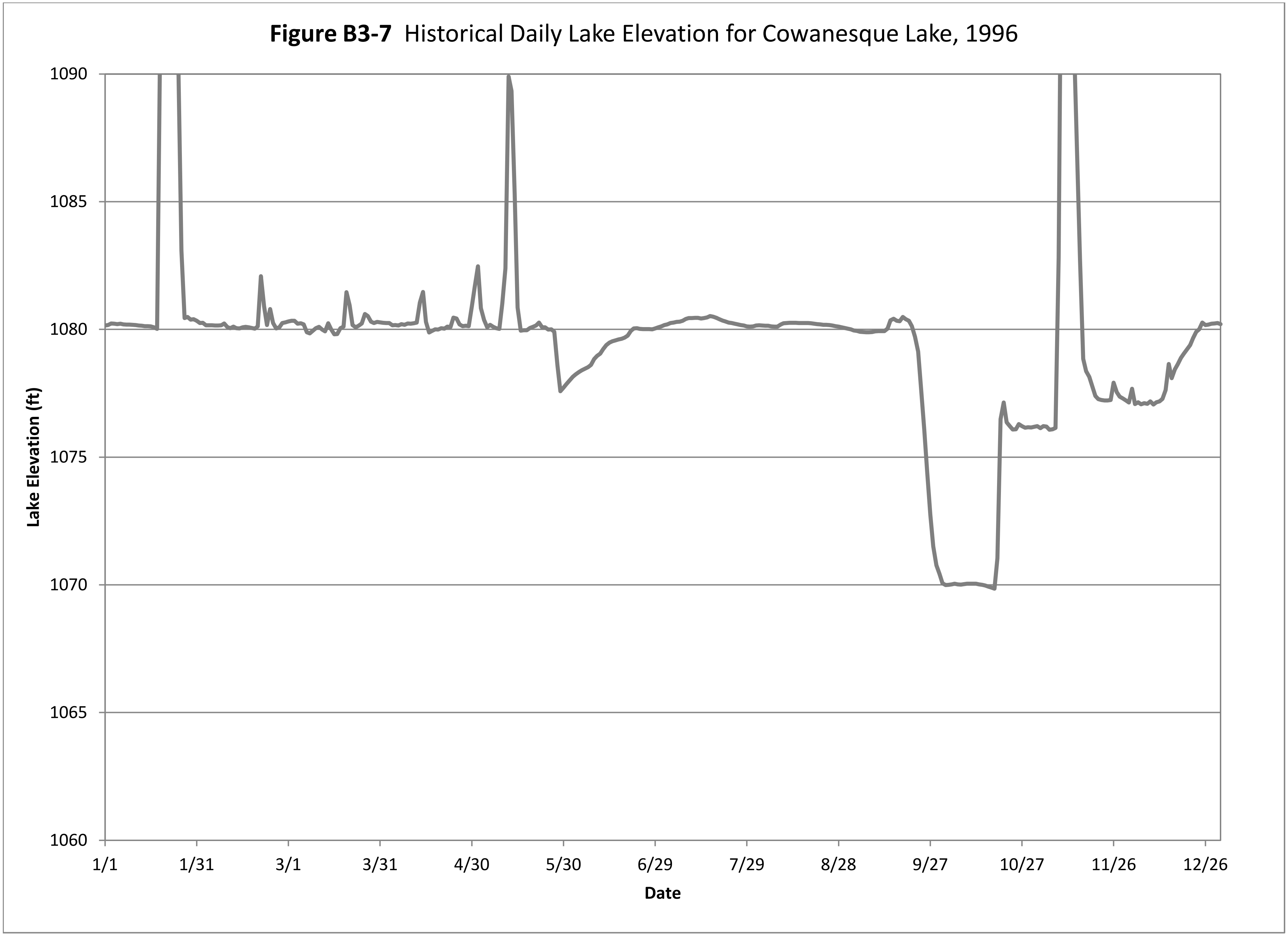
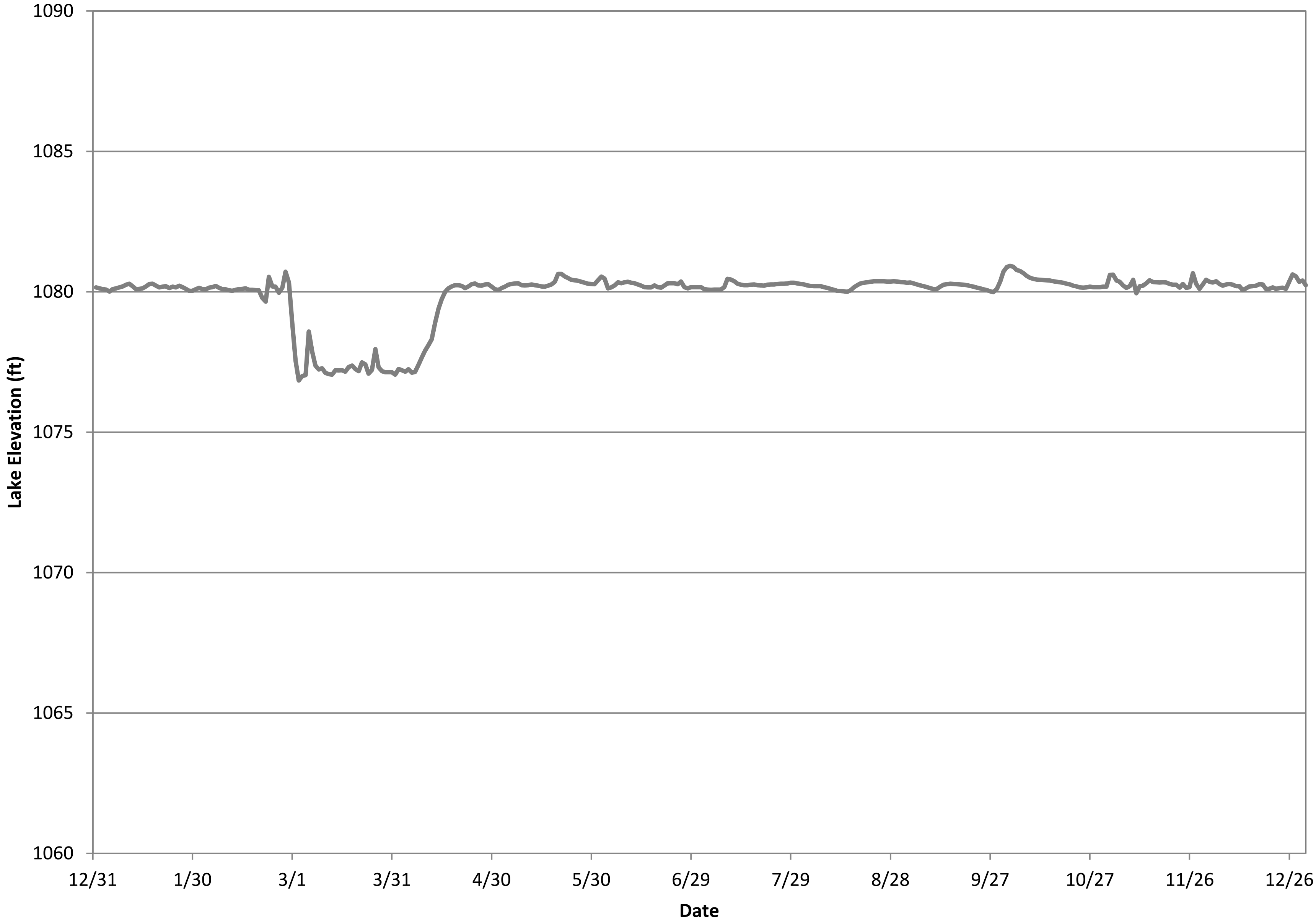


Figure B3-7 Historical Daily Lake Elevation for Cowanesque Lake, 1996
1090
1085
1080
1075
1070
1065
1060
Lake Elevation (ft)
1/1
1/31
3/1
3/31
4/30
5/30
6/29
7/29
8/28
9/27
10/27
11/26
12/26
Date

Figure B3-8 Historical Daily Lake Elevation for Cowanesque Lake, 1997



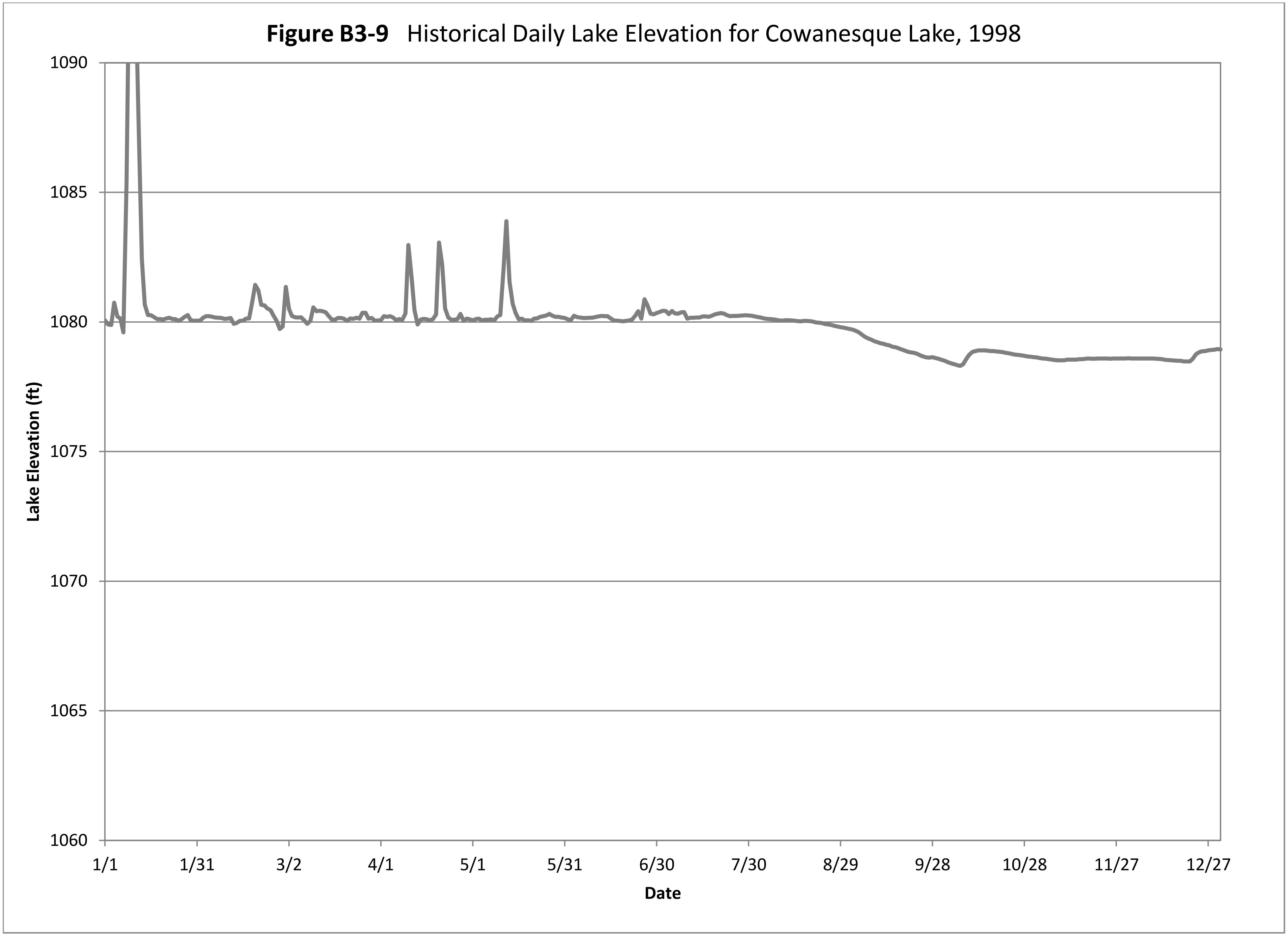


Figure B3-9 Historical Daily Lake Elevation for Cowanesque Lake, 1998
Lake Elevation (ft)
1090
1085
1080
1075
1070
1065
1060
1/1
1/31
3/2
4/1
5/1
5/31
6/30
7/30
8/29
9/28
10/28
11/27
12/27
Date

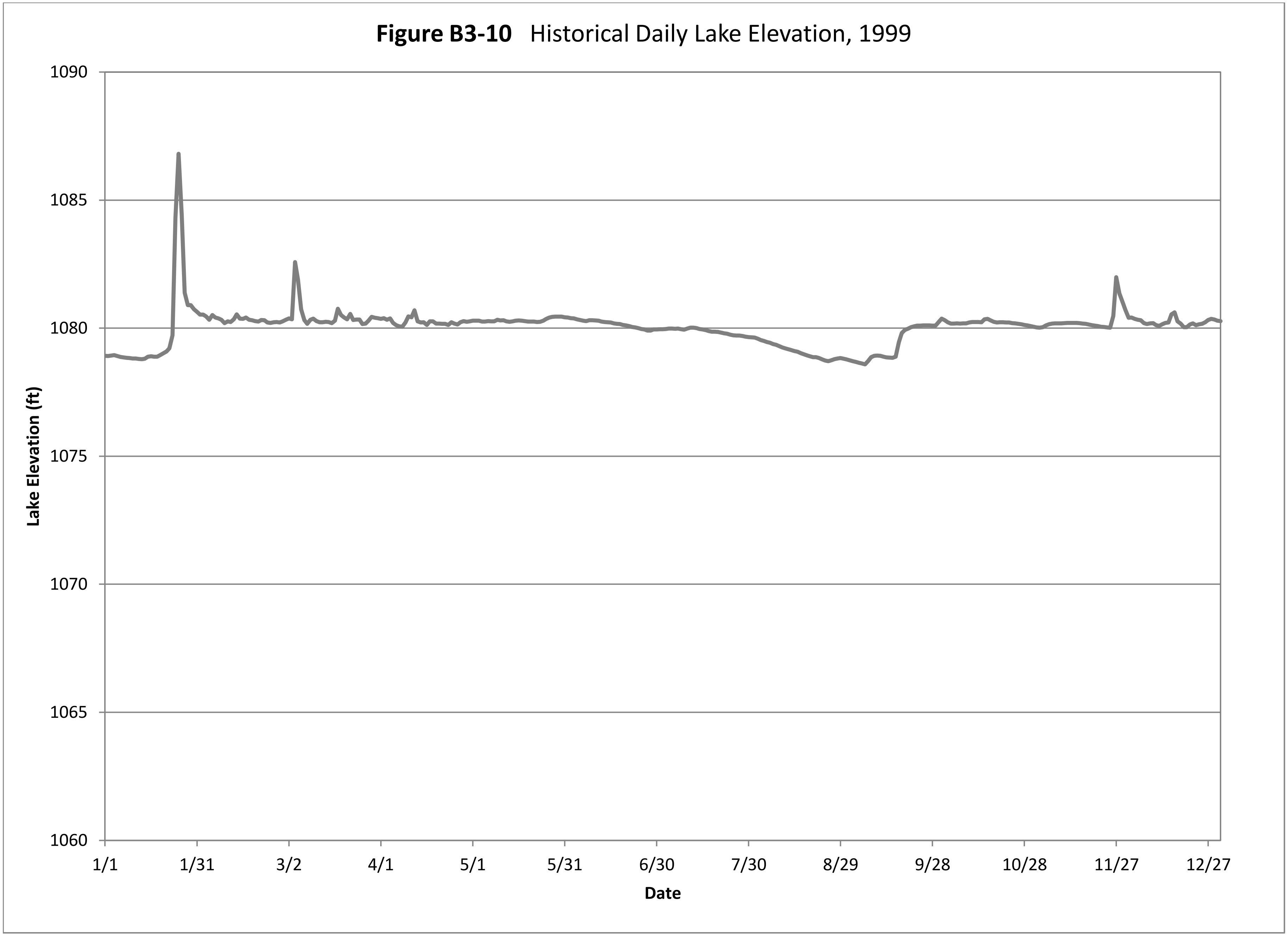


Figure B3-10 Historical Daily Lake Elevation, 1999
1090
1085
1080
1075
1070
1065
1060
Lake Elevation (ft)
1/1
1/31
3/2
4/1
5/1
5/31
6/30
7/30
8/29
9/28
10/28
11/27
12/27
Date

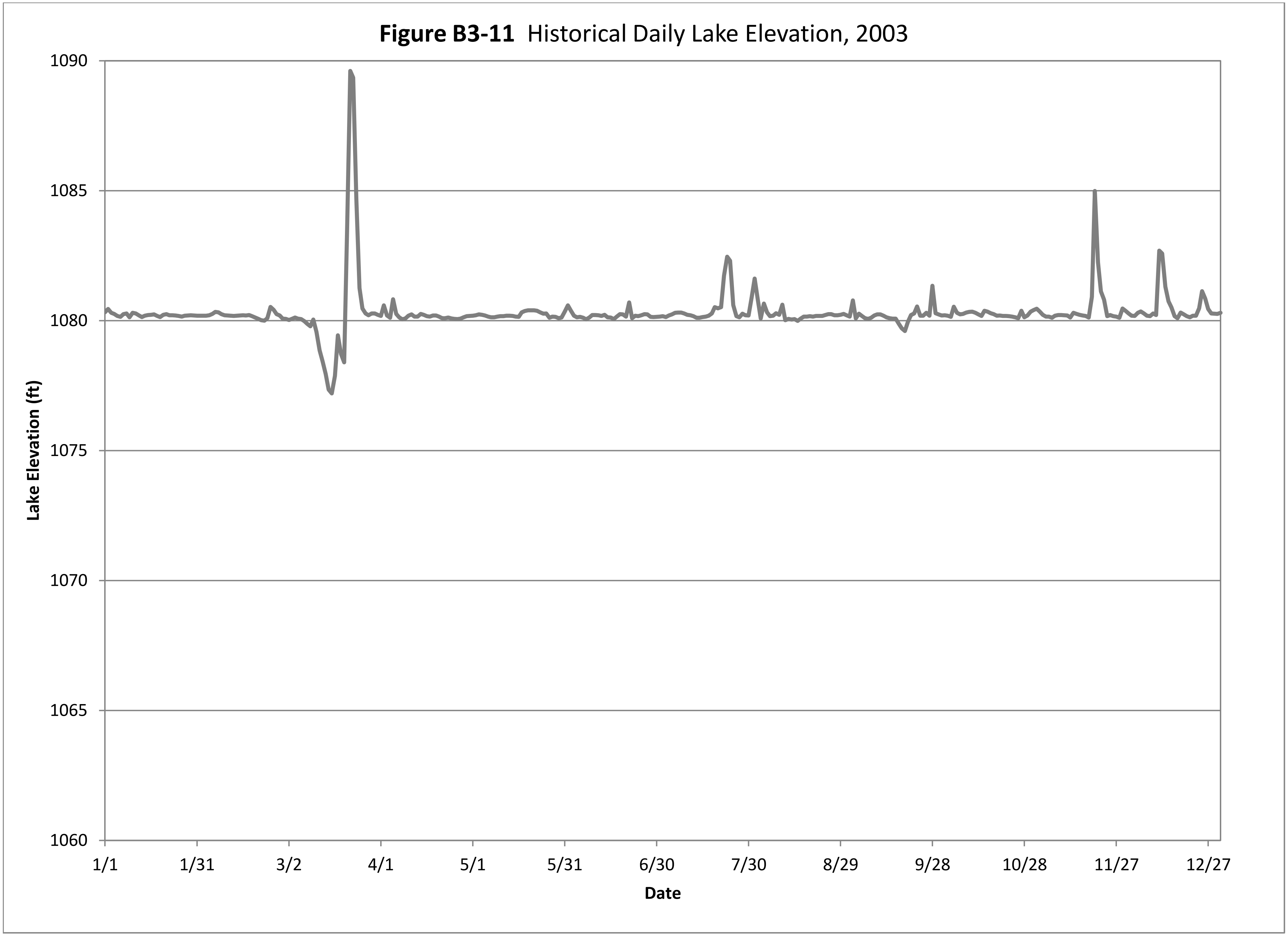


Figure B3-11 Historical Daily Lake Elevation, 2003
1090
1085
1080
1075
1070
1065
1060
Lake Elevation (ft)
1/1
1/31
3/2
4/1
5/1
5/31
6/30
7/30
8/29
9/28
10/28
11/27
12/27
Date

APPENDIX B4

DETAILED DATA PERTAINING TO 1962-1966 DROUGHT

This appendix includes more detailed data of the number of days under the Baseline and four optional trigger alternatives that drawdowns are within a given range for each year of the 1962-1966 drought.

Table B4-1 Number of Days Drawdown is within a Given Drawdown Range for the 1962 Event

Drawdown Range (ft)	Alternative				
	Baseline	WBH97	WBH95	M97	M95
1 < Drawdown ≤ 3	26	17	13	16	14
3 < Drawdown ≤ 5	10	17	17	13	17
5 < Drawdown ≤ 7	20	9	12	11	11
7 < Drawdown ≤ 10	34	39	24	41	21
10 < Drawdown ≤ 15	28	30	42	31	44
15 < Drawdown ≤ 20	16	25	27	25	25
20 < Drawdown ≤ 25	0	0	8	0	13
25 < Drawdown	0	0	0	0	0
Total	134	137	143	137	145

Table B4-2 Number of Days Drawdown is within a Given Drawdown Range for the 1963 Event

Drawdown Range (ft)	Alternative				
	Baseline	WBH97	WBH95	M97	M95
1 < Drawdown ≤ 3	29	25	31	24	11
3 < Drawdown ≤ 5	12	20	16	28	16
5 < Drawdown ≤ 7	20	18	14	12	29
7 < Drawdown ≤ 10	17	18	19	22	16
10 < Drawdown ≤ 15	31	31	41	39	29
15 < Drawdown ≤ 20	0	0	4	7	38
20 < Drawdown	0	0	0	0	0
Total	109	112	125	132	139

Table B4-3 Number of Days Drawdown is within a Given Drawdown Range for the 1964 Event

Drawdown Range (ft)	Alternative				
	Baseline	WBH97	WBH95	M97	M95
1< Drawdown ≤ 3	13	18	21	22	23
3 < Drawdown ≤ 5	15	14	13	12	21
5 < Drawdown ≤ 7	11	9	11	11	11
7 < Drawdown ≤ 10	17	19	16	14	16
10 < Drawdown ≤ 15	19	21	22	20	21
15 < Drawdown ≤ 20	19	17	16	19	17
20 < Drawdown ≤ 25	13	16	14	16	15
25 < Drawdown ≤ 30	12	14	14	38	14
30 < Drawdown ≤ 35	25	25	26	29	25
35 < Drawdown ≤ 40	24	25	25	31	26
40 < Drawdown ≤ 45	50	48	57	0	48
45 < Drawdown	0	0	0	0	0
Total	218	226	235	212	237

Table B4-4 Number of Days Drawdown is within a Given Drawdown Range for the 1965 Event

Drawdown Range (ft)	Alternative				
	Baseline	WBH97	WBH95	M97	M95
1 < Drawdown ≤ 3	19	20	24	18	12
3 < Drawdown ≤ 5	21	22	20	22	15
5 < Drawdown ≤ 7	18	16	19	18	21
7 < Drawdown ≤ 10	91	90	23	34	26
10 < Drawdown ≤ 15	2	0	82	73	73
15 < Drawdown ≤ 20	0	0	0	0	28
20 < Drawdown	0	0	0	0	0
Total	151	148	168	165	175

Table B4-5 Number of Days Drawdown is within a Given Drawdown Range for the 1966 Event

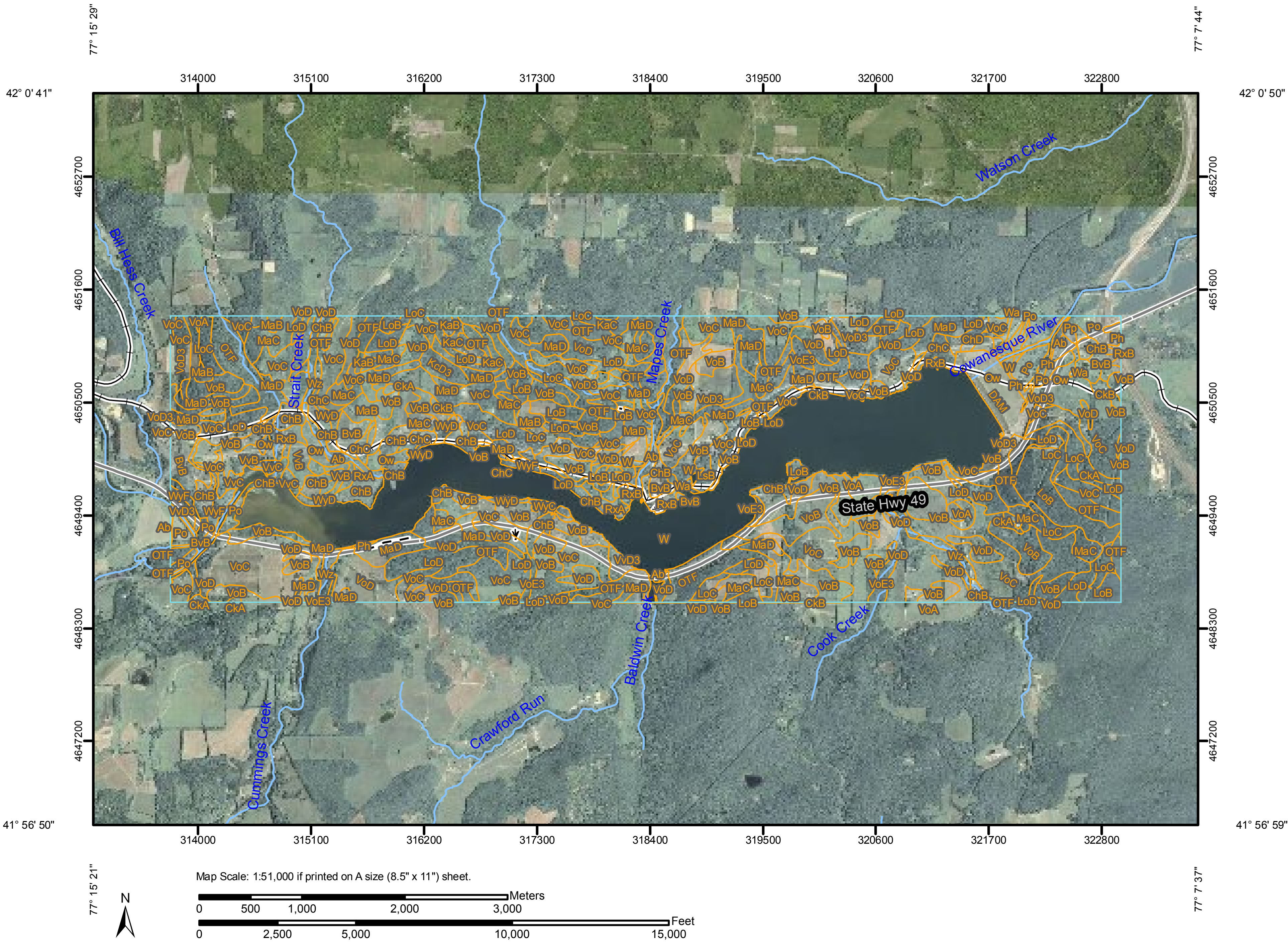
Drawdown Range (ft)	Alternative				
	Baseline	WBH97	WBH95	M97	M95
1 < Drawdown ≤ 3	36	30	21	12	21
3 < Drawdown ≤ 5	27	20	22	13	12
5 < Drawdown ≤ 7	31	27	13	13	10
7 < Drawdown ≤ 10	35	58	34	21	17
10 < Drawdown ≤ 15	0	0	47	89	33
15 < Drawdown ≤ 20	0	0	0	0	71
20 < Drawdown	0	0	0	0	0
Total	129	135	137	148	164

APPENDIX C

SOIL MAP

This appendix includes a map of the soils adjacent to the lake.

Soil Map—Tioga County, Pennsylvania
(Cowanesque Lake Soils)



MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Units

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other

Special Line Features
- Gully
- Short Steep Slope
- Other

Political Features
- Cities

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads

MAP INFORMATION

Map Scale: 1:51,000 if printed on A size (8.5" × 11") sheet.

The soil surveys that comprise your AOI were mapped at 1:20,000.

Please rely on the bar scale on each map sheet for accurate map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 18N NAD83

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Tioga County, Pennsylvania
Survey Area Data: Version 5, Jun 18, 2009

Date(s) aerial images were photographed: Data not available.

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Tioga County, Pennsylvania (PA117)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
Ab	Alluvial land	45.7	0.7%
BvB	Braceville gravelly loam, 3 to 8 percent slopes	91.6	1.4%
ChB	Chenango gravelly loam, 2 to 12 percent slopes	183.6	2.9%
ChC	Chenango gravelly loam, 12 to 20 percent slopes	48.6	0.8%
ChD	Chenango gravelly loam, 20 to 30 percent slopes	15.2	0.2%
CkA	Chippewa silt loam, 0 to 3 percent slopes	26.7	0.4%
CkB	Chippewa silt loam, 3 to 8 percent slopes	15.1	0.2%
DAM	Dams and impoundment structures	78.3	1.2%
KaB	Kanona silt loam, 3 to 8 percent slopes	14.9	0.2%
KaC	Kanona silt loam, 8 to 15 percent slopes	38.7	0.6%
KcD3	Kanona silty clay loam, 15 to 25 percent slopes, eroded	26.1	0.4%
LoB	Lordstown channery loam, 3 to 12 percent slopes	170.5	2.7%
LoC	Lordstown channery loam, 12 to 20 percent slopes	109.9	1.7%
LoD	Lordstown channery loam, 20 to 30 percent slopes	336.6	5.3%
LsB	Lordstown very stony loam, 3 to 12 percent slopes	13.0	0.2%
MaB	Mardin channery silt loam, 3 to 8 percent slopes	50.3	0.8%
MaC	Mardin channery silt loam, 8 to 15 percent slopes	159.3	2.5%
MaD	Mardin channery silt loam, 15 to 25 percent slopes	329.1	5.2%
OTF	Oquaga and Lordstown soils, very steep	425.2	6.7%
Ow	Orrville silt loam	47.8	0.7%
Ph	Philo silt loam	25.2	0.4%
Po	Pope soils	98.8	1.5%
Pp	Pope fine sandy loam, high bottom	4.1	0.1%
RxA	Rexford silt loam, 0 to 3 percent slopes	8.8	0.1%
RxB	Rexford silt loam, 3 to 10 percent slopes	48.2	0.8%
VoA	Volusia channery silt loam, 0 to 3 percent slopes	36.0	0.6%
VoB	Volusia channery silt loam, 3 to 8 percent slopes	605.8	9.5%

Tioga County, Pennsylvania (PA117)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
VoC	Volusia channery silt loam, 8 to 15 percent slopes	1,377.6	21.6%
VoD	Volusia channery silt loam, 15 to 25 percent slopes	462.7	7.2%
VoD3	Volusia channery silt loam, 15 to 25 percent slopes, eroded	100.6	1.6%
VoE3	Volusia channery silt loam, 25 to 35 percent slopes, eroded	52.1	0.8%
VvB	Volusia channery silt loam, silty substratum, 3 to 8 percent slopes	44.2	0.7%
VvC	Volusia channery silt loam, silty substratum, 8 to 15 percent slopes	17.5	0.3%
VvD3	Volusia channery silt loam, silty substratum, 15 to 25 percent slopes, eroded	22.4	0.4%
W	Water	1,097.7	17.2%
Wa	Wayland silty clay loam	27.3	0.4%
WyC	Wyoming gravelly sandy loam, 12 to 20 percent slopes	6.2	0.1%
WyD	Wyoming gravelly sandy loam, 20 to 30 percent slopes	37.0	0.6%
WyF	Wyoming gravelly sandy loam, 30 to 50 percent slopes	30.9	0.5%
Wz	Wyoming gravelly loam, flooded	55.3	0.9%
Totals for Area of Interest		**6,384.5**	**100.0%**

APPENDIX D

WETLAND SURVEYS

D1 : WETLANDS MAP FROM AUGUST 17-19 SURVEY

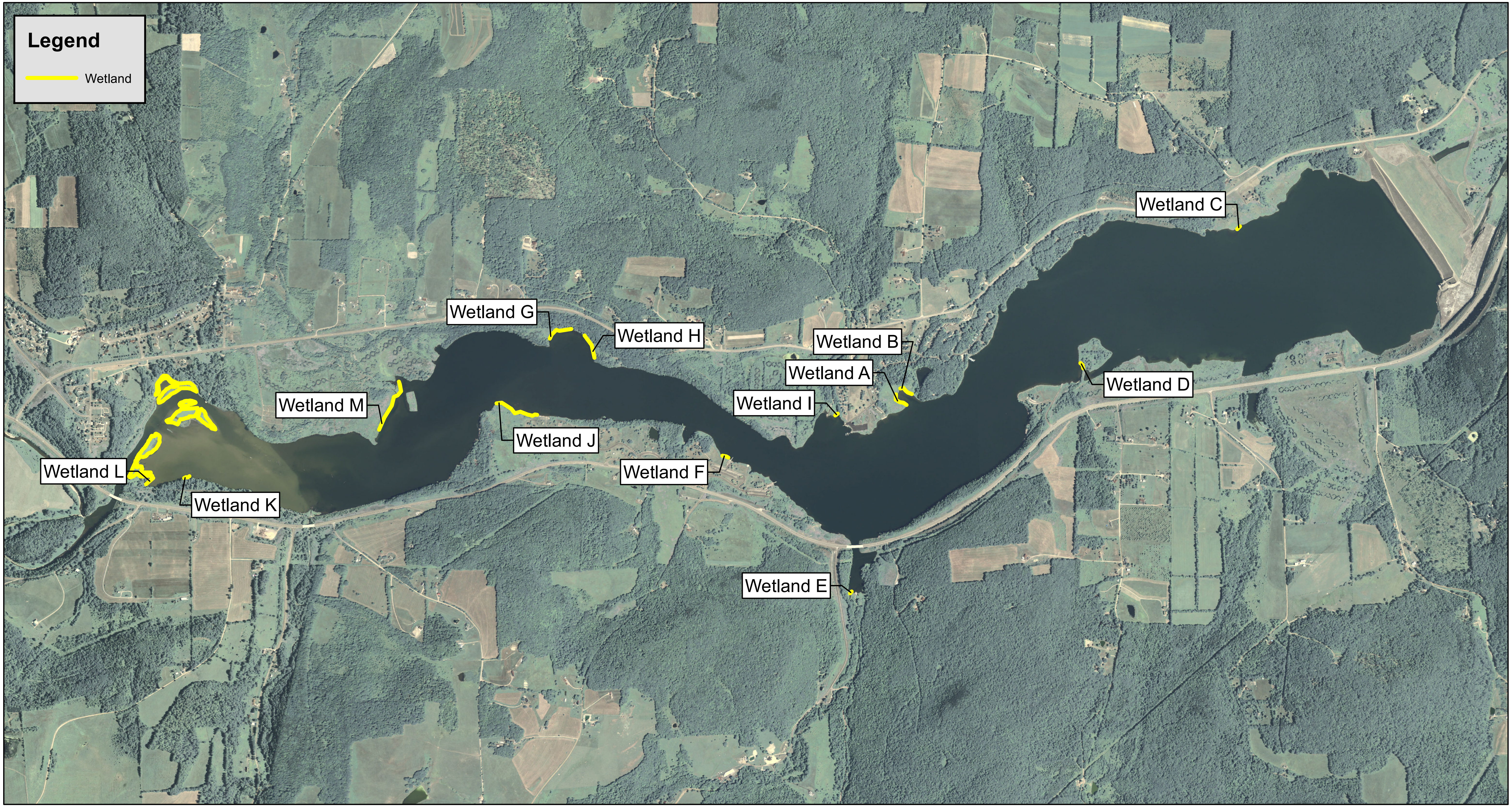
This appendix includes a map of the wetlands surveyed on August 17-19, 2011.

D2: SPECIES LISTS AND PHOTOGRAPHS FROM WETLAND SURVEY, AUGUST 17-19, 2011

This appendix contains the species lists and photographs taken during the wetland surveys conducted on August 17-19, 2011.

APPENDIX D1

WETLANDS MAP FROM AUGUST 17 – 19, 2011, SURVEY



Cowanesque Lake, Wetlands Map

0 0.25 0.5 Miles

N W E S

Aerial Imagery:
USDA Service Center Agencies, 2010

APPENDIX D2

SPECIES LISTS AND PHOTOGRAPHS FROM WETLAND SURVEY, AUGUST 17-19, 2011

Table D-1 Wetland A,B Plant Species

Scientific name	Common name	Status
Scirpus validus	Soft stem bulrush	OBL
Viburnum recognitum	Northern arrowwood	FACW
Scirpus cyperinus	Woolbrush	OBL
Mimulus alatus	Winged monkey flower	OBL
Cyperus esculentus	Yellow nutsedge	FACW
Carex lurida	Shallow sedge	OBL
Juncus effusus	Soft rush	FACW
Carex Scoparia	Broom sedge	FACW
Boehmeria cylindrica	Small spike false nettle	FACW
Ludwigia palustrus	Marsh seedbox	OBL
Bidens connata	Purplestem beggarticks	FACW
Hypericum mutilum	Dwarf St. Johns Wart	FACW
Calystegia sepium	Hedge bindweed	FAC
Eleocharis ovata obtusa	Blunt spike rush	OBL
Asclepias incarnata	Swamp milkweed	OBL
Leersia oryzoides	Rice cut grass	OBL
Eupatorium perfoliatum	Common boneset	FACW
Verbena hastata	Blue verbena	FACW
Onoclea sensibilis	Sensitive fern	FACW
Carex vulpinoidea	Fox sedge	OBL
Pilea pumila	Clearweed	FACW
Lysimachia nummularia	Moneywort	FACW
Typha latifolia	Broadleaf cattail	OBL
Galium palustre	Marsh bedstraw	OBL
Polygonum hydropiper	Marsh water pepper	OBL
Phalaris arundinacea	Reed canary grass	FACW
Euthamia tenuifolia	Flat top fragrant goldenrod	FACU

Table D-2 Wetland D Plant Species

Scientific name	Common name	Status
Bidens connata	Purplestem beggarticks	FACW
Viburnum recognitum	Northern arrowwood	FACW
Salix nigra	Black willow	FACW
Verbena hastata	Blue vervain	FACW
Cornus amomum	Silky dogwood	FACW

Table D-3 Wetland E Plant Species

Scientific name	Common name	Status
Sparganium eurycarpum	Giant burreed	OBL
Viburnum recognitum	North arrowwood	FACW
Biddens connata	Purplestem beggarticks	FACW
Eupatorium purpureum	Joe pyeweed	FACW
Phalaris arundinacea	Reed canary grass	FACW
Typha latifolia	Broadleaf cattail	OBL
Eupatorium perfoliatum	Common boneset	FACW
Juncus effusus	Soft rush	FACW

Table D-4 Wetland G,H Plant Species

Scientific name	Common name	Status
Lobelia siphilitica	Great blue lobelia	FACW
Mentha spicata	Spearmint	FACW

Table D-5 Wetland I Plant Species

Scientific name	Common name	Status
Alnus serrulata	Smooth alder	OBL
Scirpus atrovirens	Green bulrush	OBL
Populus deltiodes	Cottonwood saplings	FAC
Scirpus cyperinus	Woolgrass	FACW
Scirpus validus	Soft stem bullrush	OBL
Carex vulpinoidea	Fox sedge	OBL
Eupatorium purpureum	Joe pyeweed	FACW
Typha latifolia	Broadleaf cattail	OBL
Eupatorium perfoliatum	Common boneset	FACW
Viburnum recognitum	Northern arrowwood	FACW
Lythrum salicaria	Purple loosestrife	FACW
Bacopa monnieri	Moneywort	OBL
Lycopus uniflorus	Northern bugleweed	OBL
Euthamia tenuifolia	Flat top fragrant goldenrod	FACU

Table D-6 Wetland J,K Plant Species

Scientific name	Common name	Status
Scirpus validus	Soft stem bullrush	OBL
Bidens connata	Purplestem beggarticks	FACW
Verbena hastata	Blue verbena	FACW
Onoclea sensibilis	Sensitive fern	FACW
Phalaris arundinacea	Reed canary grass	FACW
Salix nigra	Black willow	FACW
Mentha spicata	Spearmint	FACW
Cornus amomum	Silky dogwood	FACW
Cicuta bulbifera	Bulblet bearing water hemlock	OBL
Eupatorium purpureum	Joe pyeweed	FACW
Xanthium strumarium	Clotbur	FAC

Table D-7 Wetland L,M Plant Species

Scientific name	**Common name**	Status
Scirpus validus	Soft stem bullrush	OBL
Bidens connata	Purplestem beggarticks	FACW
Verbena hastata	Blue verbena	FACW
Onoclea sensibilis	Sensitive fern	FACW
Phalaris arundinacea	Reed canary grass	FACW
Salix nigra	Black willow	FACW
Mentha spicata	Spearmint	FACW
Cornus amomum	Silky dogwood	FACW
Cicuta bulbifera	Bulblet bearing water hemlock	OBL
Eupatorium purpureum	Joe pyeweed	FACW
Xanthium strumarium	Clotbur	FAC
Teucrium canadense	American germander	FACW

Wetland A

Wetland B

Wetland C

Wetland D

Wetland E

Wetland E

Wetland E

Wetland F

Wetland G

Wetland H

Wetland I

Wetland J

Wetland K

Wetland L

Wetland M

Wetland M

Wetland M

Wetland M

Wetland M