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**Channel Capacity:** Maximum flow through a river or man made channel without reaching damaging stages. Often expressed as 'cfs' (cubic feet per second).

**Storage Capacity:** Volume of water a lake or reservoir holds at a certain elevation.

**Normal Pool Elevation:** Typical water elevation of a lake or reservoir. This value might change seasonally.

**Winter Drawdown:** Difference between the summer normal pool elevation and the winter normal pool elevation.

**Spillway:** A structure used to provide for the release of flood flows from a dam into a river. Spillways pass flood flows so water does not overtop and damage or destroy a dam.

**Stoplog:** A hydraulic engineering control element used in floodgates to adjust the water level and/or flow rate in a river, canal, or reservoir. Stoplogs are typically long, rectangular timber beams or boards that are placed on top of each other and dropped into premade slots inside a dam weir (the "stoplog bay"). Placing more stoplogs in a stoplog bay increases the pool elevation of the lake or reservoir and decreases the releases.

**Flashboards:** Bulkheads placed on the crest or top of a channel wall or control structure. Flashboards are designed to break and wash away under high flow conditions ("to operate") and thus to provide additional storage while permitting large flows to pass a dam at lower elevations. In contrast, stoplogs are intended to be reused.

**Obermeyer Gate:** The OBERMEYER Spillway Gate system is most simply described as a row of steel gate panels supported on their downstream side by inflatable air bladders. By controlling the pressure in the bladders, the pond elevation maintained by the gates can be adjusted within the system control range (full inflation to full deflation) and accurately maintained at user-selected set-points. [from http://www.obermeyerhydro.com/info.htm ].

**Upstream Flooding:** Flooding occurring upstream of a dam site due to high reservoir or lake pool elevation.

**Downstream Flooding:** Flooding occurring downstream of a dam site. Releases from the dam in certain cases can contribute to downstream flooding.

**Sub-basin:** Area draining into a lake or river above a certain point.

**Precipitation:** Rainfall or snowfall onto an area, typical expressed as depth of water over an area.

**Excess Precipitation:** Precipitation not infiltrating into the ground.

**Mean Areal Precipitation (MAP):** Assumed mean precipitation over an area, typically a river sub-basin. It is typically estimated from observation at climate sites in the area.

**Mean Areal Temperature (MAT):** Assumed mean temperature over an area, typically a river sub-basin. It is typically estimated from observation at climate sites in the area.

**Snow Water Equivalent:** Volume of water (expressed as depth of water over an area) that is stored in snow.

**Runoff:** Flow of water on or just below the ground caused by excess precipitation.

**Snow Model:** A computer model simulating the accumulation and melting of snow over an area. The most important inputs to a snow model are typically MAT and MAP.

**Rainfall-Runoff Model:** A computer model simulating the effects of rainfall (or snowmelt) onto an area and estimates the resulting runoff into a river or lake.

# B-1.0 INTRODUCTION

This section describes the lakes and reservoirs that were investigated as part of this study in the Piscataquog, Salmon Falls, and Suncook river basins. It introduces the observed data available for the May 2006 and April 2007 flood events, presents the results of computer model simulations of these events, and explains the dam operations as provided by Hampshire's Department of Environmental Services New Hampshire Department of Environmental Service (NHDES) Dam Bureau staff. Subsequently, the effects of alternative dam operations are assessed.

## B-1.1 Available Data

The climate data used in this study are temperature and precipitation, available primarily from the Unites States Geological Survey (USGS), the United States Army Corps of Engineers (USACE), the National Weather Service (NWS), and a network of climate sites operated by the NHDES. These data are typically recorded every 15 minutes or every hour at climate sites in the region, and provide a good representation of the weather development during the May 2006 and April 2007 flood events.

Additional precipitation data were estimated through radar observations and provided by the NWS.

Observations of streamflow data were obtained primarily from the USGS, but also from the USACE and the NHDES data collection network. Observations of lake elevations ("pool elevation") were supplied by the USACE, the NHDES, and operators of private dams. For most NHDES dams, pool elevations are read manually when a NHDES dam operator is on site. This is typically performed once a week, but might occur several times a day during flood conditions. These pool observations are usually recorded by day, and do not indicate the exact hour of the observation. In this study, it assumed these observations occurred at noon, if not noted otherwise.

The NHDES keeps a log of the activities of its dam operators at its dams and thus provides a history of performed operations. The NHDES dam operation logs typically note the current pool elevation, and changes to gates (opening or closing) and stoplogs (adding or removing), recorded by date. The dam operators often note special conditions at the dam site, such as debris or ice on the lake. The NHDES provided these dam operation logs for use in this study. Operations at private dams were provided by the owners and vary from detailed observations (every 5 minutes) to qualitative descriptions only.

## B-1.2 Model Simulations

The initial model simulations presented in this section aim at reproducing the dam operations and the resulting pool elevations as they actually happened during the May 2006 and April 2007 flood events. As such, the simulated pool elevations, reservoir releases, and streamflow try to match observations where available.

In doing so, the simulations provide an estimate of inflows into the lakes and rivers investigated. These inflows can be used to simulate effects of alternative dam operations.

This study employs two different types of models for the simulations. Computer models employed in NHDES' forecast system were used to simulate the conditions on the Salmon Falls River, the Suncook River, and the Piscataquog River. The Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS) was used to simulate the conditions in the Souhegan basin, where no NHDES model exists. This appendix presents results for those dams modeled with the NHDES system. Appendix C presents results for the dams in the Souhegan basin.

The models in the NHDES forecast system are similar to those used by the NWS to predict river flows at the NWS River Forecast Centers (RFCs). Mean areal temperature and precipitation are used as input to

the “SNOW-17” snow model, which simulates the accumulation and the melt of snow in the area. The output from this model consists of snow melt (when snow on the ground is melting) and rainfall (when no snow is present), expressed as depth of water in inches over the simulated area. This output is fed into the Sacramento Soil Moisture Accounting Model (SAC-SMA), which transforms the snowmelt and rainfall into runoff into a lake or river reach. The estimated runoff depends on the amount of snowmelt and rainfall and the moisture content of the soil (e.g., a wetter soil has higher moisture content and produces more runoff than dry soil). The NHDES forecast system also includes reservoir simulation models, which estimate lake elevations based on inflow to the lake and releases from the lake. The releases are determined using reported opening heights of gates at the dam, number of stoplogs in the bays, the existence of flashboards, and releases through turbines for hydropower generation.

As part of the initial model simulations, mean areal temperature and precipitation were estimated from climate observations in the area. In general, there were only few climate sites reporting in the area and the estimated mean areal temperature and precipitation are at times questionable. These data sets were therefore adjusted as needed to provide adequate and correctly timed snowmelt and rainfall volumes to compute realistic inflows into the reservoir models.

Once the computer models were configured to simulate the actual dam operations and observed pool elevations sufficiently, alternative dam operations were modeled to assess their impact. These ‘scenarios’ also will be described in this Appendix.

## B-2.0 SALMON FALLS RIVER

The return period of the April 2007 flood event on the Salmon Falls River was about 75 years, according to observations at Milton Three Ponds. The flows downstream of Milton Three Ponds for the May 2006 and April 2007 event are shown in Figure 2-1. The figure includes the FEMA 10, 50, 100, and 500 year flood flows.

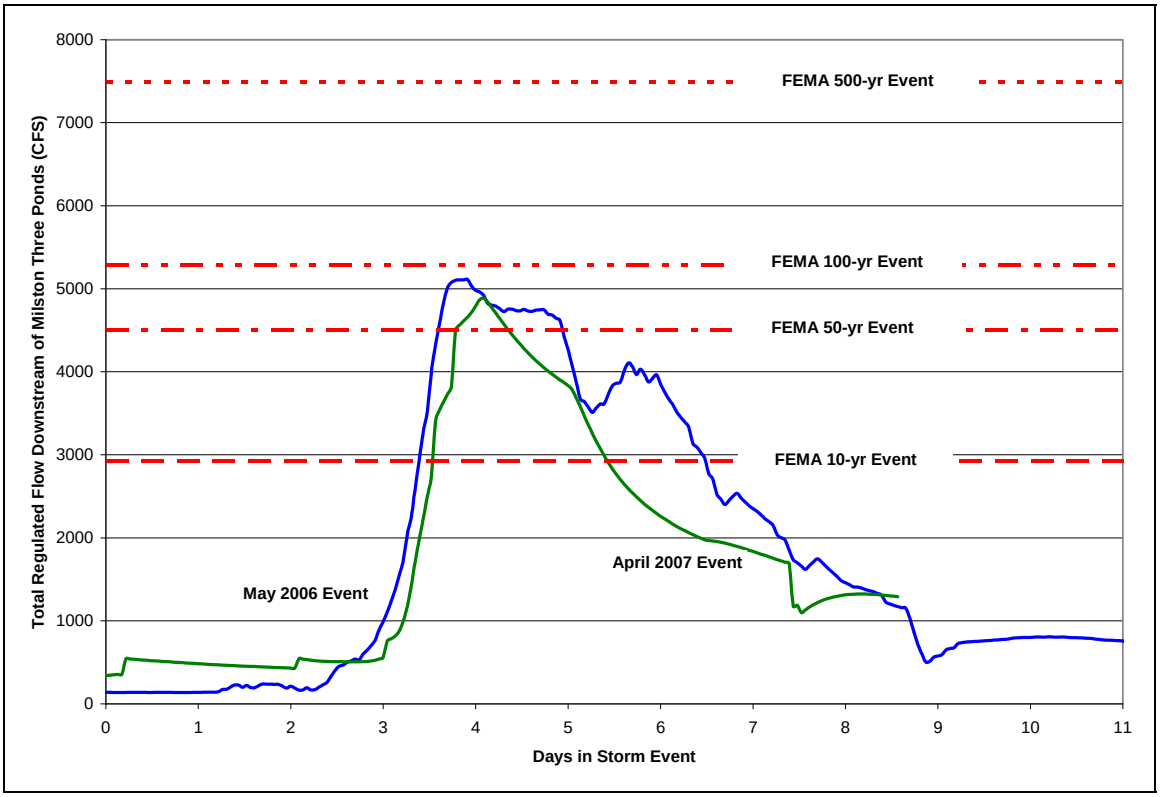


**Figure 2-1: Salmon Falls - Comparison of May 2006 and April 2007 Events and FEMA Flood Levels**

Figure 2-2 depicts the dams investigated in the Salmon Falls River basin.

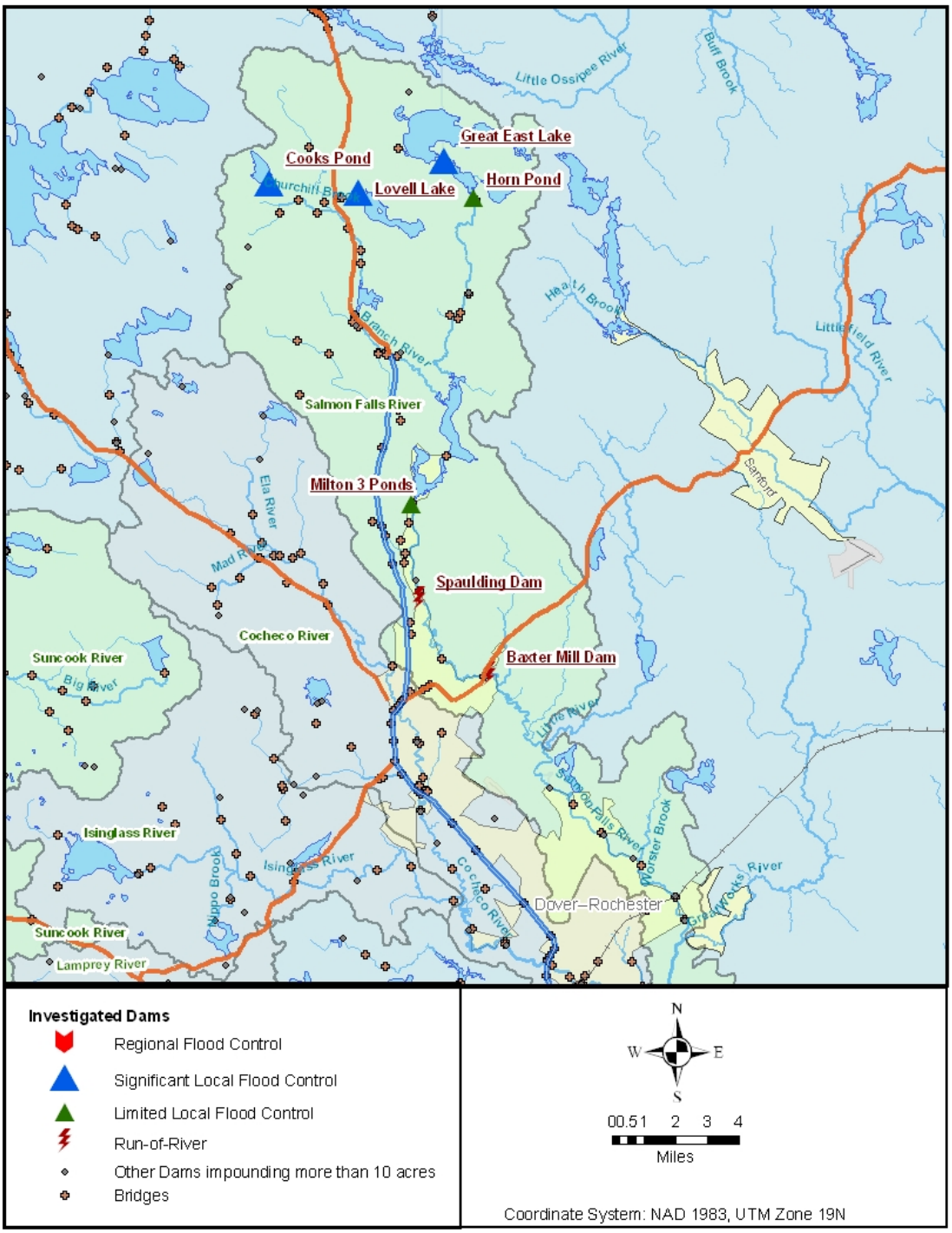


**Figure 2-2: Dams Investigated in the Salmon Falls River Basin**

## B-2.1 Great East Lake (NHDES# 241.14)

### B-2.1.1 General Description

Great East Lake is located in the headwaters of the Salmon Falls River, to the east of the town of Wakefield at the New Hampshire-Maine border. Most of the lakeshore is developed. The lake has a storage capacity of about 19,600 acre-feet at normal levels, and up to 27,700 acre-feet at its maximum elevation. Between those levels, Great East Lake can store about 9.7 inches of runoff into the lake, providing significant storage capacity and local flood control capabilities.

The pool elevation can be controlled by NHDES staff at a small dam structure at the southeastern edge of the lake near Canal Road. This is typically done by manual operation of a gate, or, during the winter months, by using stoplogs located just upstream of the gate.

The typical summer lake elevation is 574.25 feet, which corresponds to the elevation of the spillway. The lake is usually drawn down by 3 feet starting in October. Refill occurs in general during the spring with a goal of reaching the summer lake elevation once ice is melted. It requires approximately 6.1 inches of runoff to refill the lake from the lower winter pool to the normal summer pool.

A plan view of Great East Lake Dam is shown in Figure 2-3.

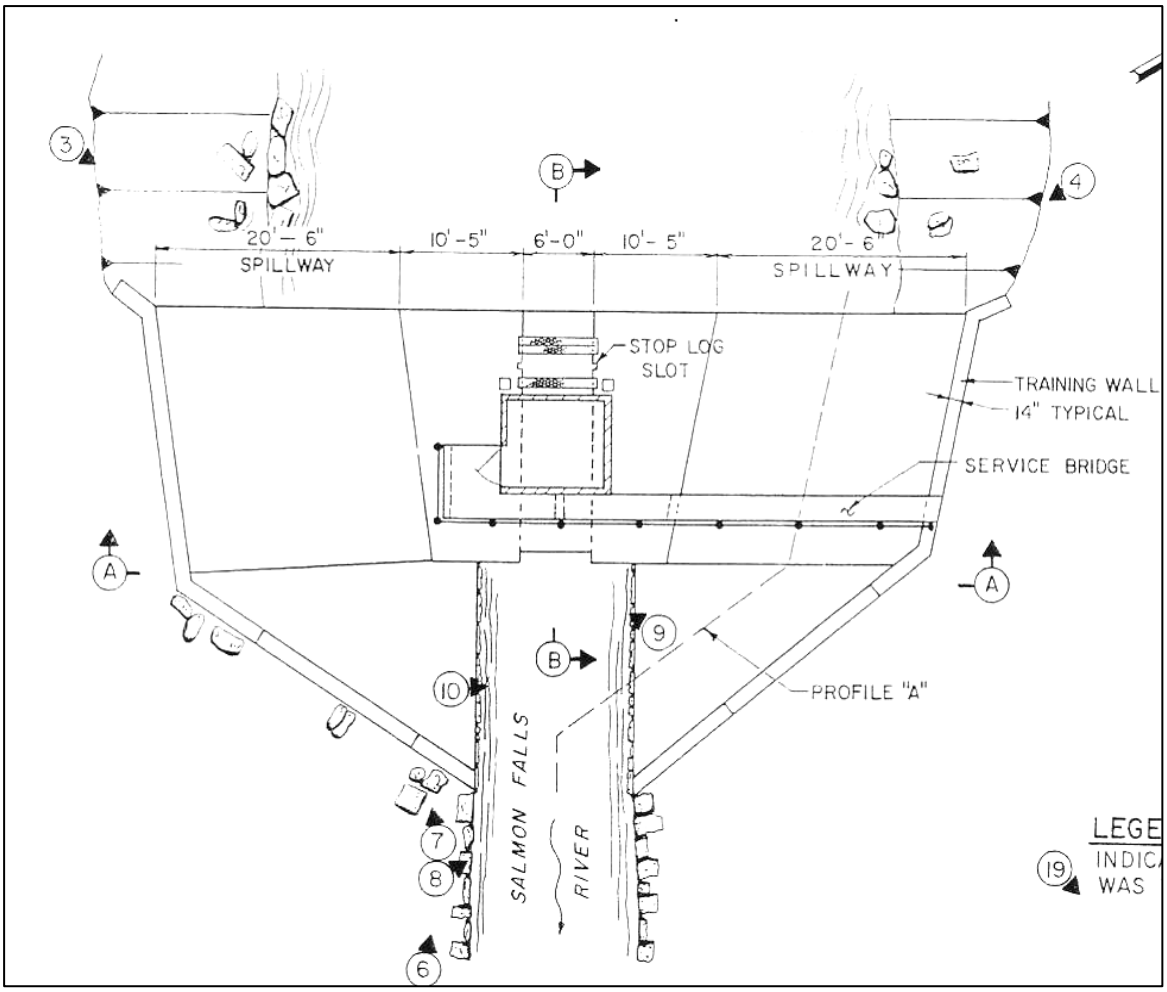


**Figure 2-3: Plan View of Great East Lake**

### B-2.1.2 Actual Operations

All observed data for the May 2006 and April 2007 flood events were provided by the NHDES. They consist of observations of the pool elevations as well as stoplog and gate settings as noted by dam operators during visits to the site. The pool elevation is recorded relative to the summer lake elevation of 574.25 feet. Table 2-1 and Table 2-2 list the pool elevation and the dam operations performed by the NHDES at Great East Lake.

**Table 2-1: Great East Lake Pool Elevation and Dam Operations during the May 2006 Flood**

| DATE | POOL ELEVATION | LOG BAY | GATE | COMMENTS | DAM OPERATOR |
|---|---|---|---|---|---|
| 5/4/2006 | -0.80 | 15 LOGS IN | 30" OPEN | MINUS ONE FOOT ON LOGS IN | CT |
| 5/13/2006 | -0.5 | 14 LOGS IN | 30" OPEN | PULLED ONE LOG | CT |
| 5/14/2006 | 0.6 | 10 LOGS IN | 30" OPEN | PULLED FOUR LOGS | CT/CL |
| 5/15/2006 | 0.85 | 10 LOGS IN | 30" OPEN | | CL |
| 5/16/2006 | 0.9 | 10 LOGS IN | 30" OPEN | | CL |
| 5/17/2006 | 1 | 10 LOGS IN | 30" OPEN | | CL |
| 5/22/2006 | 0.7 | 10 LOGS IN | 36" OPEN | OPENED GATE TO 36" | CT/BH |

**Table 2-2: Great East Lake Pool Elevation and Dam Operations during the April 2007 Flood**

| DATE | POOL ELEVATION | LOG BAY | GATE | COMMENTS | DAM OPERATOR |
|---|---|---|---|---|---|
| 4/3/2007 | -1.35 | 17 LOGS IN | 48" OPEN | SET ONE LOG/ICE STILL ON LAKE | AS |
| 4/10/2007 | -0.9 | 17 LOGS IN | 48" OPEN | LET RUN AS IS/ICE SOLID ON LAKE | CT |
| 4/12/2007 | -0.8 | 16 LOGS IN | 48" OPEN | PULL ONE LOG .18 FLOW | CT |
| 4/16/2007 | 0.2 | 16 LOGS IN | 48" OPEN | LET RUN AS IS | CT |
| 4/17/2007 | 1 | 16 LOGS IN | 48" OPEN | LET RUN AS IS | CT |
| 4/19/2007 | 1.1 | 13 LOGS IN | 48" OPEN | PULLED THREE LOGS | CT |
| 4/23/2007 | 0.7 | 13 LOGS IN | 48" OPEN | LET RUN AS IS | PA |

Ten days before the May 2006 storm, on May 4, the pool elevation was 0.8 foot below the spillway crest. At the onset of the storm, on May 13, the pool was 0.5 foot below the spillway crest. One stoplog was removed, increasing releases and slowing the rise in pool elevation during the event. The pool elevation overtopped the spillway crest by 0.6 foot on May 14, 2006, and remained high despite the removal of 4 additional stoplogs. The maximum recorded depth over the spillway was 1.0 foot on May 17, which corresponds to 2.0 feet below the top of the dam.

The lake was still refilling from the winter drawdown at the beginning of April 2007. The pool was 1.35 feet below the spillway on April 4, and 0.9 foot below on April 10. Snowmelt induced by the high temperatures and the rain event on April 12 filled the lake, which crested the spillway by 0.2 foot on April 16. The pool rose rapidly in response to the April 16 event, reaching a maximum of 1.1 feet over the spillway crest on April 19, at which time three stoplogs were removed to increase the releases and lower the pool elevation.

The simulation for April 2007 is depicted in Figure 2-4 and tracks the observed pool elevations reasonably well. This is shown by the red line for simulated pool elevations and the gray dots for observations.

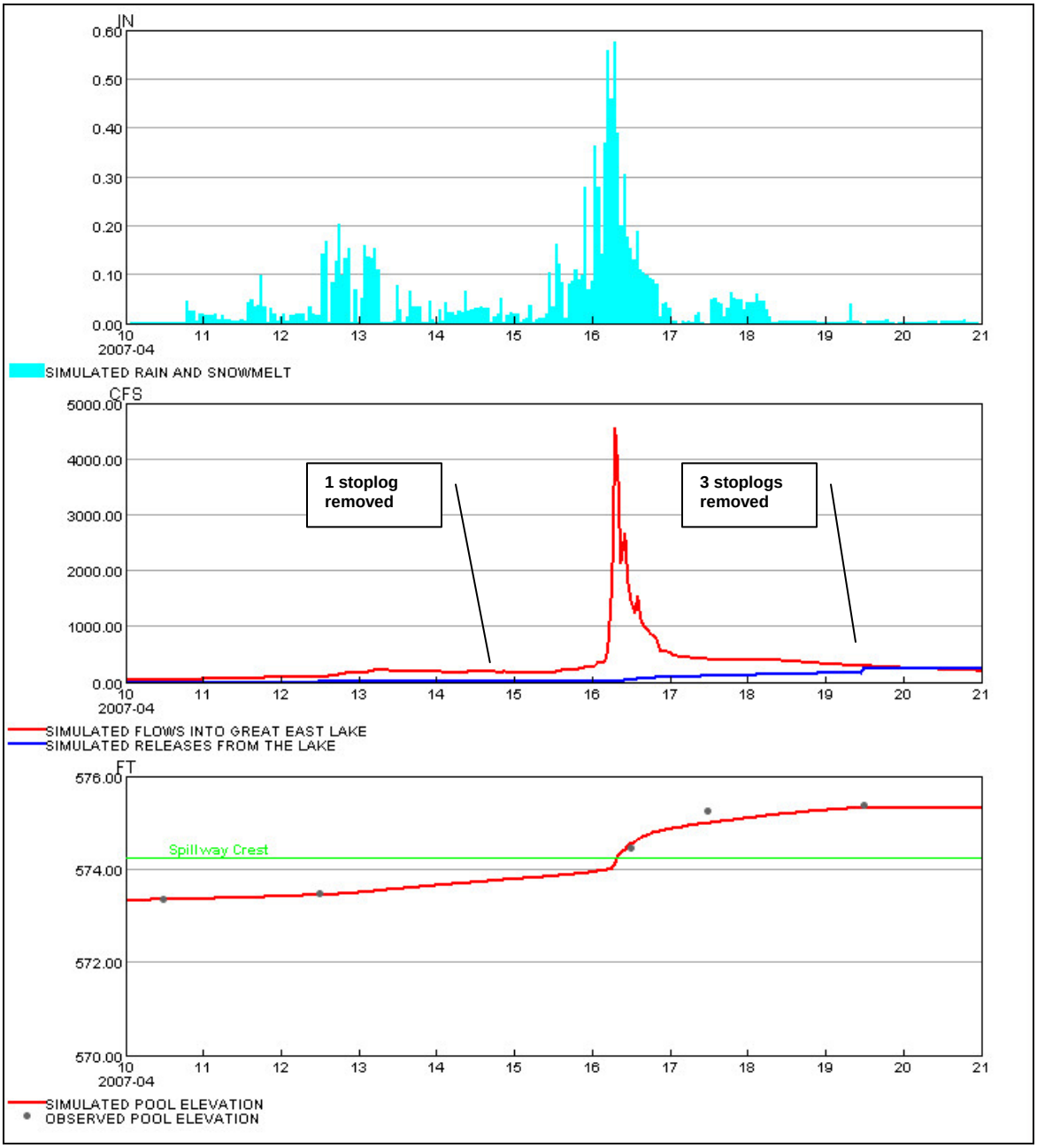


**Figure 2-4: Great East Lake Simulation Results for the April 2007 Flood Event**

Great East Lake has a large storage capacity beyond its full pool elevation and stored most of the runoff from the 2006 and 2007 events. As a result, the releases from the lake were significantly smaller in magnitude than the inflows, providing considerable downstream flood control.

In 2007, the increase of releases on April 19 was primarily aimed at preventing a further rise of lake levels and possible upstream flooding. At the same time, the releases were modulated as not to exceed the limited capacity of the downstream channel.

Even though the lake filled significantly above the normal pool elevation in April 2007, no complaints regarding upstream flooding were received by the NHDES.

### B-2.1.3 Alternative Operations

A simulation of Great East Lake with the pool elevation at the winter drawdown level on April 14 was tested and is shown in Figure 2-5. All other operations were assumed to be unchanged. Holding the winter pool elevation into April would have caused more water to be captured during the event, allowing Great East Lake to release lower flows (less than 100 versus more than 300 cfs of peak flow).

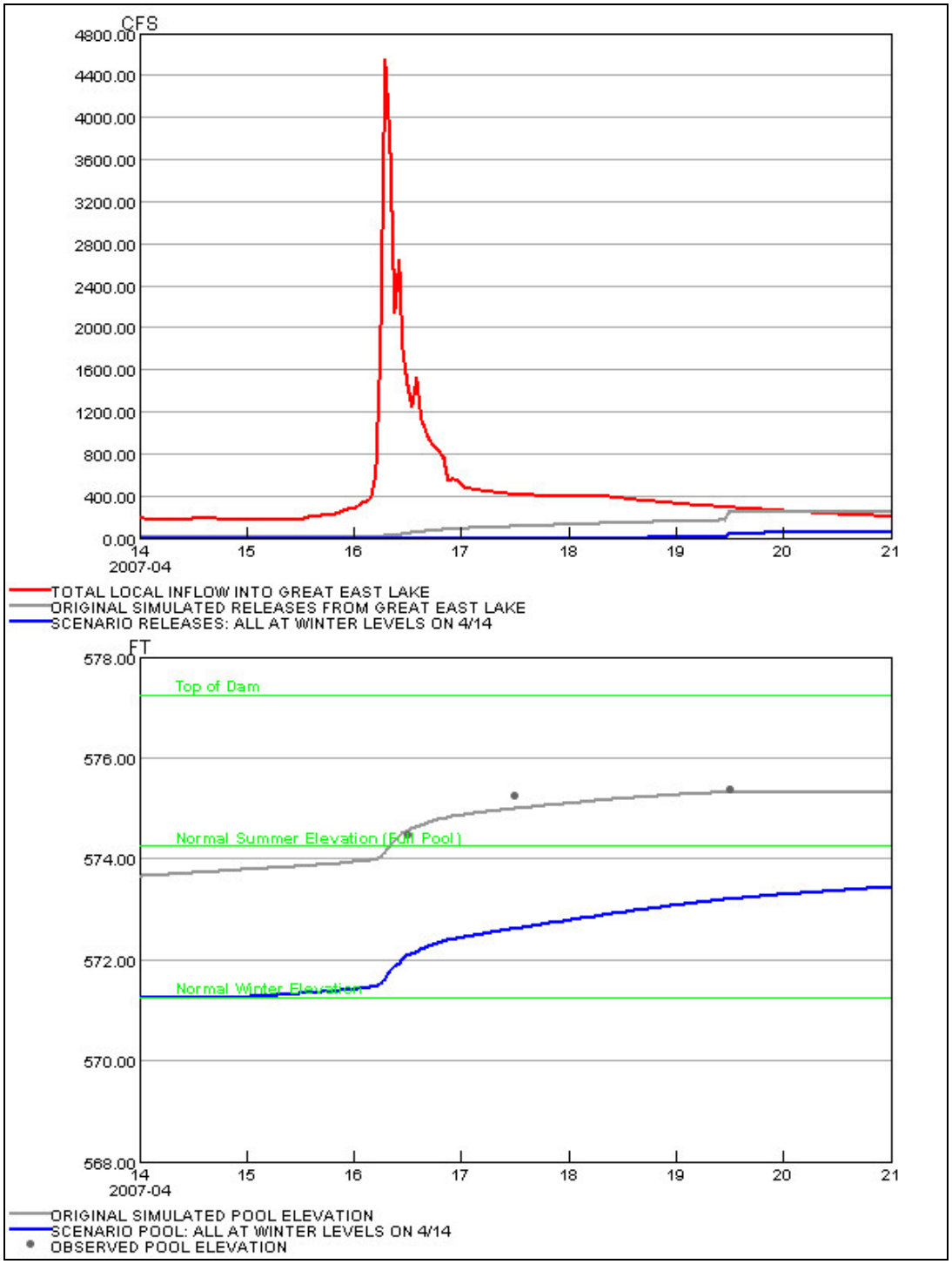


**Figure 2-5: Great East Lake Alternative Operations - Starting at Minimum Pool on April 14th**

## B-2.2 Horn Pond (NHDES# 241.15)

### B-2.2.1 General Description

Horn Pond is located on the Salmon Falls River just downstream of Great East Lake. Development seems concentrated along Camp Road and New Bridge Road on the eastern and western shore.

Inflows into Horn Pond are greatly affected by the upstream operations at Great East Lake Dam. Horn Pond is significantly smaller than Great East Lake, with a storage capacity of about 2,750 acre-feet at normal levels, and up to 3,300 acre-feet at its maximum elevation. Between those levels, Horn Pond can store about 0.5 inch of runoff into the lake, providing by itself little storage capacity and limited flood control capabilities.

Pool elevation at Horn Pond can be controlled by NHDES staff at a dam structure at the southern end of the lake near Route 109 / Lovell Lake Road. This is typically done by adding or removing stoplogs from 11 bays. The dam has no spillway.

The typical summer lake elevation is 554.32 feet, which corresponds to the elevation of the topmost stoplogs. The lake is usually drawn down by 1.5 feet after Columbus Day. Refill occurs in general during the spring after all ice is melted. It requires only 0.25 inch of runoff to refill the lake from the lower winter pool to the normal summer pool.

A plan view of Horn Pond Dam is shown in Figure 2-6.

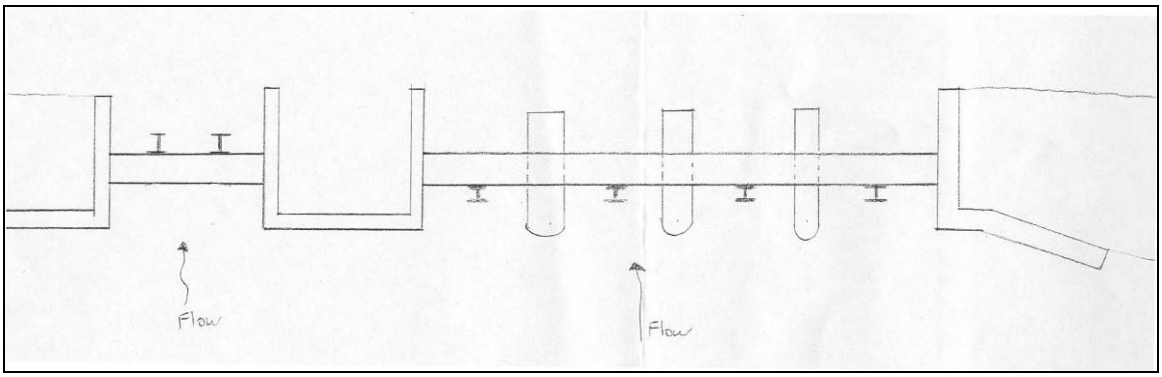


**Figure 2-6: Plan View of Horn Pond Dam**

### B-2.2.2 Actual Operations

All observed data for the May 2006 and April 2007 flood events were provided by the NHDES. They consist of observations of the lake pool as well as stoplog settings as noted by dam operators during visits to the site. The pool elevation is recorded relative to the ‘normal’ summer lake elevation of 554.32 feet, the elevation of the topmost stoplog when all stoplogs are in place. Table 2-3 and Table 2-4 list the pool elevation and the dam operations performed by the NHDES at Horn Pond. Stoplog bays not listed are filled with logs and no operation occurred during the event.

**Table 2-3: Horn Pond Pool Elevation and Dam Operations during the May 2006 Flood**

| DATE | POOL ELEVATION | LOG BAY 1 | LOG BAY 2 | LOG BAY 3 | LOG BAY 4 | LOG BAY 7 | LOG BAY 8 | COMMENTS | INT |
|---|---|---|---|---|---|---|---|---|---|
| 5/4/2006 | -0.60 | | | 2 OUT | 1 OUT | | | NOT MUCH RAIN | CT |
| 5/13/2006 | 0 | 1 OUT | 1OUT | 3 OUT | 3 OUT | 2 OUT | 1 OUT | PULLED 8 LOGS | CT |
| 5/14/2006 | 0.45 | 1 OUT | 4 OUT | 3 OUT | 3 OUT | 2 OUT | 1 OUT | PULLED 3 LOGS | CT/CL |
| 5/15/2006 | 0.6 | 1 OUT | 4 OUT | 3 OUT | 3 OUT | 2 OUT | 1 OUT | | CL |
| 5/16/2006 | 0.8 | 1 OUT | 4 OUT | 3 OUT | 3 OUT | 2 OUT | 1 OUT | | CL |
| 5/17/2006 | 0.7 | 4 OUT | 4 OUT | 3 OUT | 3 OUT | 2 OUT | 1 OUT | 11 LOGS OUT ME. SIDE | CL |
| 5/22/2006 | 0.5 | 4 OUT | 4 OUT | 3 OUT | 3 OUT | 2 OUT | 1 OUT | LET RUN AS IS | CT/BH |

**Table 2-4: Horn Pond Pool Elevation and Dam Operations during the April 2007 Flood**

| DATE | POOL ELEVATION | LOG BAY 1 | LOG BAY 2 | LOG BAY 3 | LOG BAY 4 | LOG BAY 5 | COMMENTS | INT |
|---|---|---|---|---|---|---|---|---|
| 4/3/2007 | -1.1 | 2 OUT | 3 OUT | 2 OUT | 3 OUT | 2 OUT | LET RUN/ICE STILL ON POND | AS |
| 4/10/2007 | -1 | 2 OUT | 2 OUT | 2 OUT | 3 OUT | 2 OUT | SET ONE LOG ME. SIDE | CT |
| 4/12/2007 | -1 | 2 OUT | 2 OUT | 2 OUT | 3 OUT | 2 OUT | NO CHANGE | CT |
| 4/16/2007 | 0.05 | 2 OUT | 2 OUT | 2 OUT | 3 OUT | 2 OUT | LET RUN | CT |
| 4/17/2007 | 0.3 | 2 OUT | 2 OUT | 2 OUT | 3 OUT | 2 OUT | LET RUN | CT |
| 4/18/2007 | 0.62 | 2 OUT | 2 OUT | 2 OUT | 3 OUT | 2 OUT | LET RUN | CT |
| 4/19/2007 | 0.7 | 4 OUT | 4 OUT | 4 OUT | 5 OUT | 3 OUT | PULLED 9 LOGS | CT |
| 4/23/2007 | -0.05 | 4 OUT | 4 OUT | 4 OUT | 5 OUT | 3 OUT | LET RUN | PA |

The pool was 0.6 foot below the normal pool elevation on May 4, 2006 rising to the normal pool elevation at the onset of the storm event on May 13. At this time, 11 stoplogs were removed. Releases increased, but the pool elevation continued to rise and overtopped all stoplogs on May 14. The maximum recorded depth over the stoplogs was 0.8 foot on May 16, which was 1.7 feet below the top of the dam. Three additional stoplogs were removed on May 17, and the pool elevation dropped.

The pool was 1.1 feet below the normal pool elevation on April 3, 2007, refilling from the winter drawdown level. Despite setting one stoplog in place, the pool remained steady and was 1.0 foot below normal pool elevation on April 12, just before the storm. The April 16 event rapidly raised the pool elevation, which increased the release and therefore prevented a significant rise above the normal pool elevation. The maximum of 0.7 foot over the normal pool elevation was reached on April 19, which was 1.8 feet below the top of the dam. At this time, nine stoplogs were removed and the pool began to fall.

The simulation for April 2007 is depicted in Figure 2-7 and tracks the observed pool elevations very well as shown by the red line for simulated pool elevations and the gray dots for observations.

In May 2006, the dam was operated to increase discharges by removing stoplogs just as the event started. The lake was still able to store large amounts of flood waters, but did neither overtop nor cause (reported) upstream flooding.

Even though Horn Pond has only limited storage capacity, it was operated successfully to store most of the inflow on April 15 and the early hours of April 16, 2007. This eased the potential for downstream flooding. The stored waters were released after the flood event on April 19, when 9 stoplogs were removed. During the event, the lake filled to 0.7 foot above the normal pool elevation—however, no upstream flooding was reported to the NHDES.

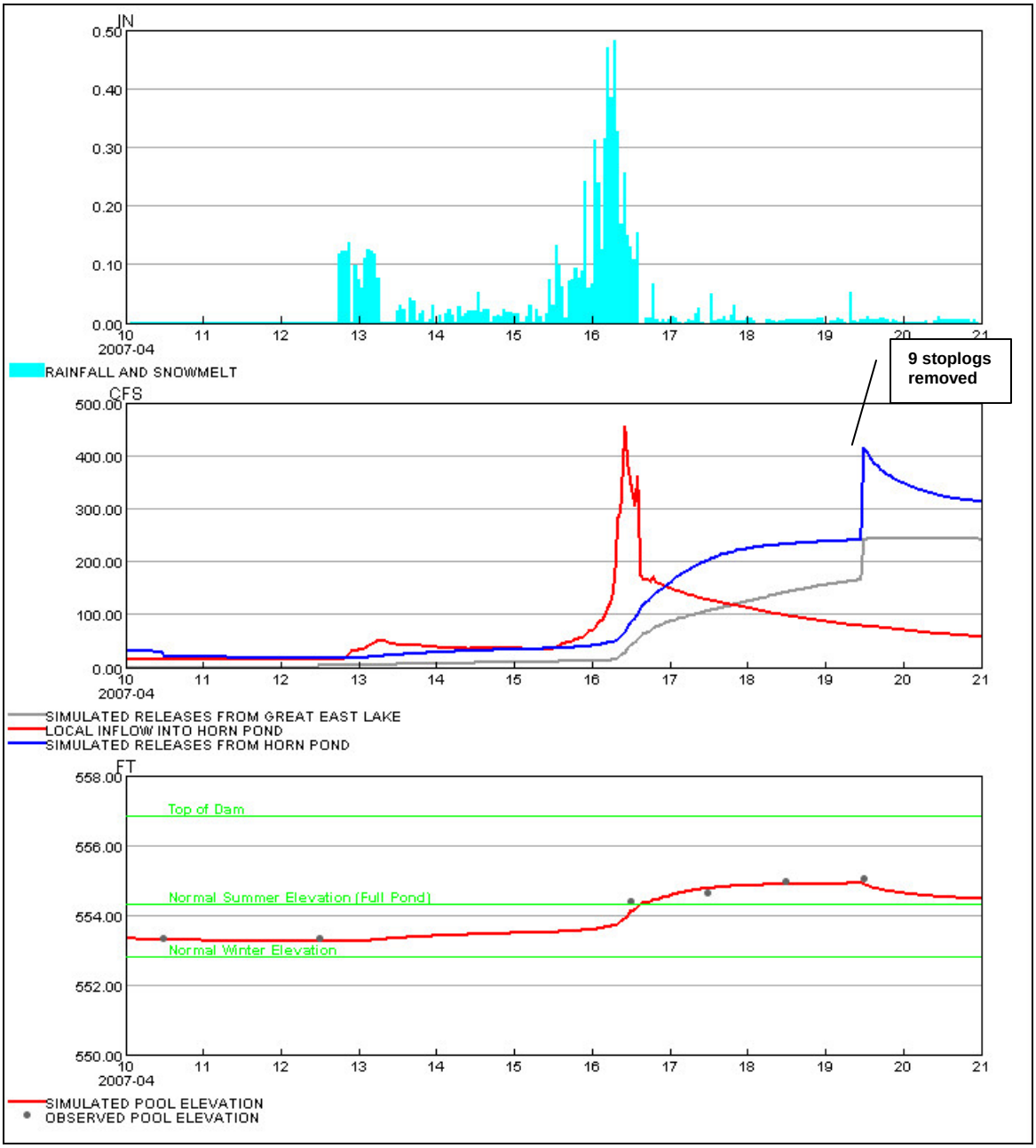


**Figure 2-7: Horn Pond Simulation Results for the April 2007 Flood Event**

## B-2.2.3 Alternative Operations

A simulation of Horn Pond with the pool elevation at the winter drawdown level on April 14 was tested and is shown in Figure 2-8. All other operations were assumed to be unchanged. This scenario was designed assuming that the pool elevation at Great East Lake was also at the winter drawdown level on April 14.

Similarly to Great East Lake, holding the winter pool elevation into April would have caused more water to be captured during the event. With the initial pool at the winter level on April 14, the water level in the

pond did not rise above the normal summer elevation during the flood event. Peak releases on April 16 were reduced from 160 cfs to 80 cfs.

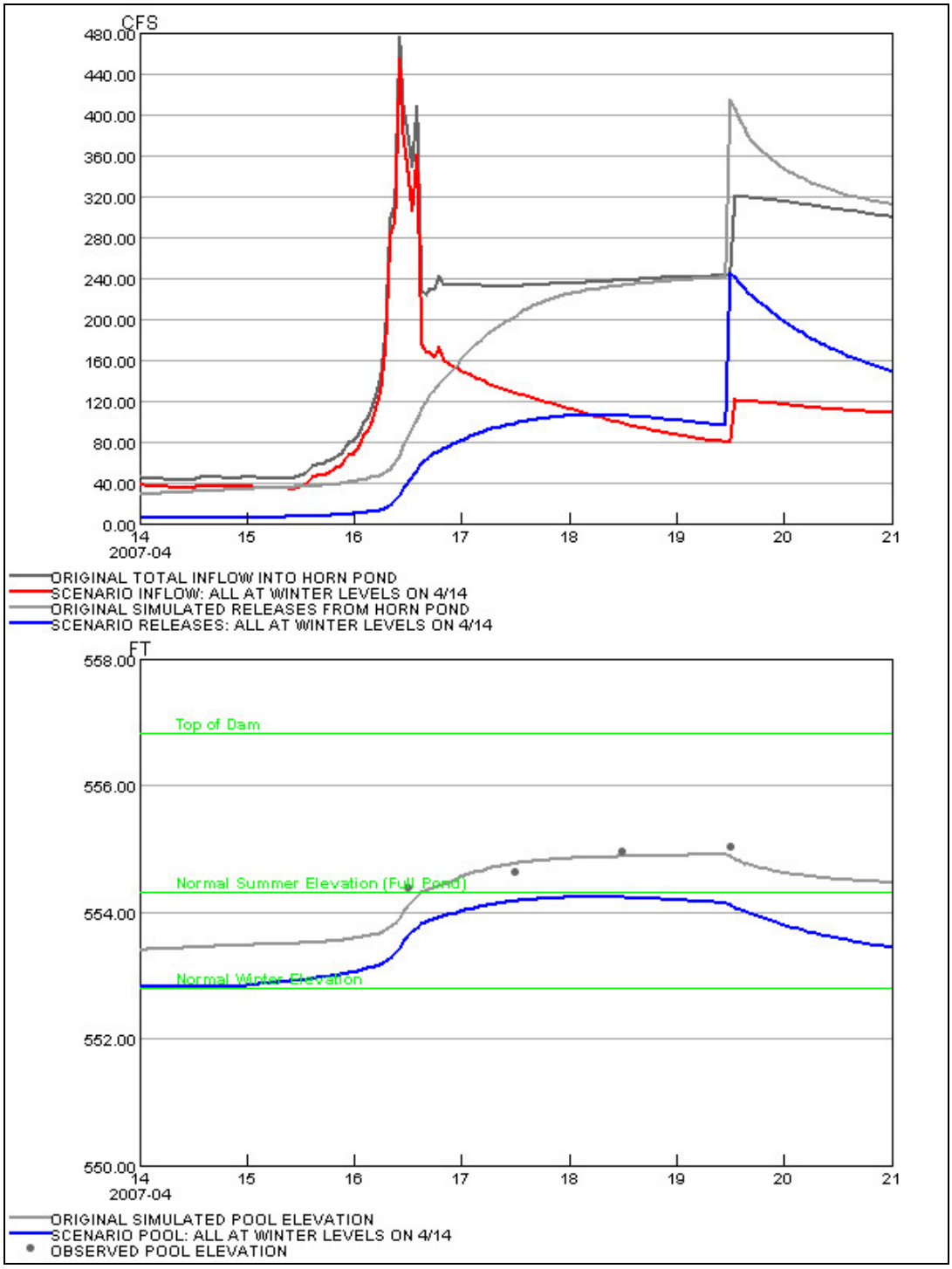


**Figure 2-8: Horn Pond Alternative Operations - Starting at Minimum Pool on April 14th**

## B-2.3 Cooks Pond (AKA Kingswood Lake, NHDES# 032.02)

### B-2.3.1 General Description

Cooks Pond, also called Kingswood Lake, is located off of the Salmon Falls River on Churchill Brook. Development is concentrated along the north-east shore off of Gov John Wentworth Highway. There is also some development on the opposite shore.

Cooks Pond has a relatively small amount of storage, with a capacity of about 594 acre-feet at its normal elevation, and 1,260 acre-feet at its maximum elevation. Between those levels, Cooks Pond can store approximately 7.2 inches of runoff into the lake. Although the storage is small, Cooks Pond can provide significant local flood control due to a small contributing area.

Pool elevations at Cooks Pond are controlled by NHDES staff at a dam structure at the southern end with three stoplog bays with ten stoplogs in each bay. The dam has no spillway.

The typical summer lake elevation is 654.0 feet, which corresponds to the elevation of the topmost stoplogs. The drawdown for the lake begins around Columbus Day. Stoplogs are slowly removed from the dam to try and achieve a four foot drawdown. In most years the full four foot drawdown is not met. Three to three and a half feet drawdown is the usual target level. Most of the stoplogs are replaced at the beginning of the year. The lake will slowly refill over the remaining winter months to reach full pond. It requires approximately 8.5 inches of runoff to refill the lake from the lower winter pool to the normal summer pool.

A plan view of Cooks Pond Dam is shown in Figure 2-9.

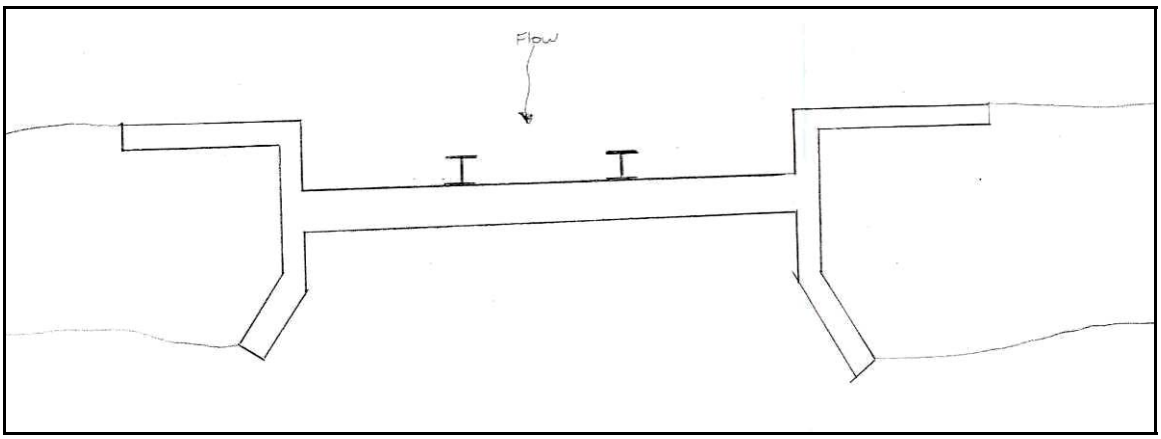


**Figure 2-9: Plan View of Cooks Pond Dam**

### B-2.3.2 Actual Operations

All observed data for the May 2006 and April 2007 flood events were provided by the NHDES. The pool elevation is recorded relative to the summer lake elevation of 654.0 feet. Table 2-5 and Table 2-6 list the pool elevation and the dam operations performed by the NHDES at Cooks Pond.

**Table 2-5: Cooks Pond Pool Elevation and Dam Operations during the May 2006 Flood**

| DATE | POOL ELEVATION | LOG BAY 1 | LOG BAY 2 | LOG BAY 3 | COMMENTS | INT |
|---|---|---|---|---|---|---|
| 5/4/2006 | 0.15 | 0 OUT | 0 OUT | 0 OUT | | CT |
| 5/13/2006 | 0.45 | 1 OUT | 1 OUT | 0 OUT | PULLED 2 LOGS/FULL CULVERT | CT |
| 5/14/2006 | 1.5 | 1 OUT | 1 OUT | 0 OUT | ROAD FLOODED D/S | CT/CL |
| 5/15/2006 | 1.25 | 1 OUT | 1 OUT | 0 OUT | | CL |
| 5/22/2006 | 0.45 | 1 OUT | 1 OUT | 1 OUT | PULLED ONE LOG | CT/BH |

**Table 2-6: Cooks Pond Pool Elevation and Dam Operations during the April 2007 Flood**

| DATE | POOL ELEVATION | LOG BAY 1 | LOG BAY 2 | LOG BAY 3 | COMMENTS | INT |
|---|---|---|---|---|---|---|
| 4/3/2007 | -0.55 | 0 OUT | 0 OUT | 0 OUT | ALL LOGS IN/ICE TURNING BLACK | AS |
| 4/10/2007 | -0.25 | 0 OUT | 0 OUT | 0 OUT | | CT |
| 4/12/2007 | 1 | 1 OUT | 1 OUT | 0 OUT | PULLED 2 LOGS /CULVERT OK | CT |
| 4/30/2007 | 0.1 | 0 OUT | 0 OUT | 0 OUT | SOMEONE PUT ALL LOGS BACK IN | AS |

Ten days before the May 2006 event, all the stoplogs were in place and the pool was 0.15 foot above the top of the stoplogs. On May 13, as inflows increased, the pool elevation was 0.45 foot above the top of stoplog elevation and two stoplogs were removed. The maximum recorded pool elevation was 1.5 feet above the stoplog elevation and occurred on May 14. This was 1.25 feet below the top of the dam. One additional stoplog was removed on May 22. The pool was 0.45 foot below the top of stoplog elevation at this time.

As evident in Table 2-6, the NHDES did not operate this dam during the April 2007 flood event. All stoplogs were in place and the lake was 0.55 foot below the top of the stoplogs on April 3, and 0.25 below on April 10. The lake was slowly filling at the time and the pool elevation reached 1.0 over the top of stoplogs by April 17. This was the maximum recorded pool elevation, 1.75 feet below the top of the dam. Two stoplogs were pulled at this time. The next observed pool elevation was 0.1 foot above the top of stoplog elevation on April 30.

According to the NHDES, downstream flooding at a camp site and a private road is a concern during large rainfall events—therefore, no more stoplogs were removed during the April event. No upstream flooding was reported to the NHDES and the lake provided significant local flood control during both events.

Note that the dam operators noticed on April 30, 2007, that someone had replaced some stoplogs to keep the lake from draining faster. According to the NHDES local residents have in the past added or removed stoplogs themselves. The NHDES plans to lock down the stoplogs in the future.

The simulation for April 2007 is depicted in Figure 2-10 and tracks the observed pool elevations very well.

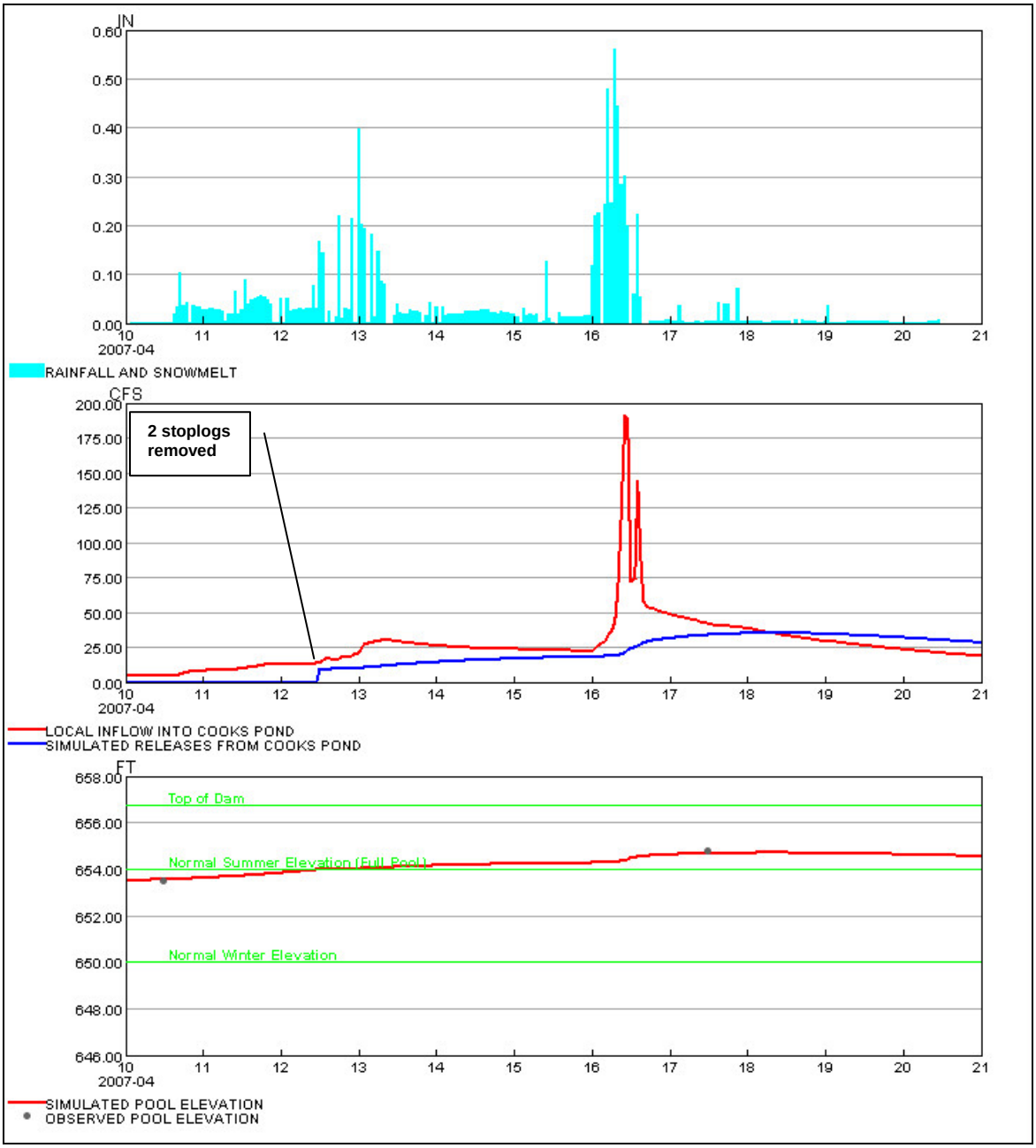


**Figure 2-10: Cooks Pond Simulation Results for the April 2007 Flood Event**

## B-2.3.3 Alternative Operations

A simulation of Cooks Pond with the pool elevation at the winter drawdown level on April 14 was tested and is shown in Figure 2-11. All other operations were assumed to be unchanged. As in many of the headwater reservoirs with smaller catchment areas, Cooks Pond provided flood storage during the April 2007 event. Maintaining the winter drawdown longer would increase the flood control storage capability, allowing Cooks Pond to reduce the releases from a maximum of 30 cfs on April 16 to almost zero.

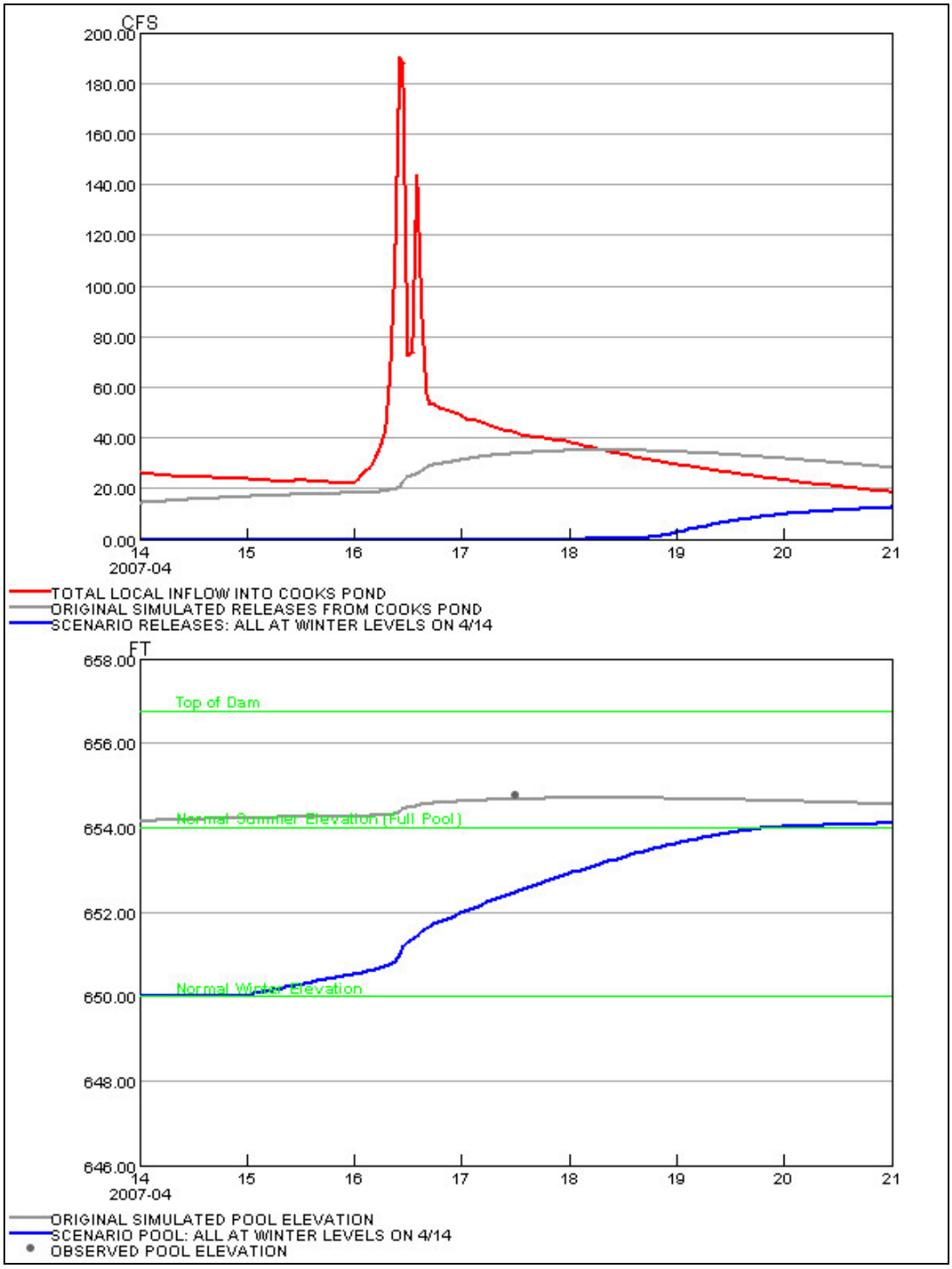


**Figure 2-11: Cooks Pond Alternative Operations - Starting at Minimum Pool on April 14th**

## B-2.4 Lovell Lake (NHDES# 241.06)

### B-2.4.1 General Description

Lovell Lake is a headwater located off of the Churchill Brook, a tributary to Salmon Falls River. Sanbornville is located off of the North-West corner of the lake. Development along the lake is concentrated near the town.

Lovell Lake has a capacity of 1750 acre-feet at its normal elevation, and 2400 acre-feet at its maximum elevation. Between those levels, Lovell Lake can store approximately 2.55 inches of runoff.

Pool elevations on Lovell Lake are controlled by NHDES staff at a dam structure at the North-West end of the lake. Water levels can be controlled through eight stoplog bays with six stoplogs in each bay, except for one deep bay which contains eleven stoplogs. A culvert under a road, located just downstream of the stoplog bays, can potentially restrict releases from the lake.

The typical summer lake elevation is 572.39 feet, which corresponds to the elevation of the topmost stoplogs and the normal elevation. Water level is drawn down three feet below full pool starting after Columbus Day. Every 4th year, the drawdown is increased to four feet (2003, 2007, 2011, 2015, etc.). It requires approximately 7.8 inches of runoff to refill the lake from the lower winter pool to the normal summer pool, providing for significant local flood control.

A plan view of Lovell Lake Dam is shown in Figure 2-12.

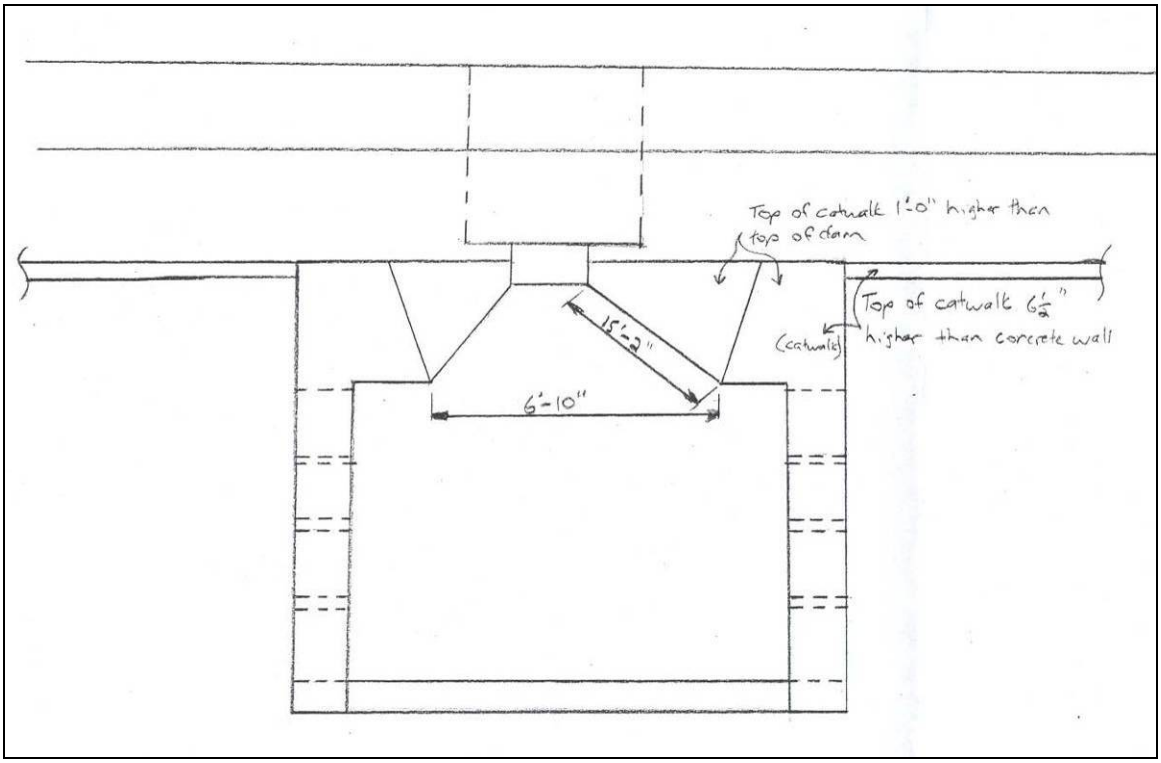


**Figure 2-12: Plan View of Lovell Lake Dam**

## B-2.4.2 Actual Operations

All observed data for the May 2006 and April 2007 flood events were provided by the NHDES. The pool elevation is recorded relative to the summer lake elevation of 572.39 feet. Table 2-7 and Table 2-8 list the pool elevation and the dam operations performed by the NHDES at Lovell Lake.

**Table 2-7: Lovell Lake Pool Elevation and Dam Operations during the May 2006 Flood**

| | POOL | | LEFT SIDE | | | | RIGHT SIDE | | DEEP BAY | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DATE | ELEVATION | LOG BAY 1 | LOG BAY 2 | LOG BAY 3 | LOG BAY 4 | LOG BAY 1 | LOG BAY 2 | LOG BAY 3 | LOG BAY 4 | COMMENTS | INT |
| 5/4/2006 | -0.60 | 0 OUT | 0 OUT | 0 OUT | 0 OUT | 0 OUT | 0 OUT | 0 OUT | 0 OUT | ALL IN | CT |
| 5/13/2006 | 0.1 | 0 OUT | 0 OUT | 1 OUT | 1 OUT | 0 OUT | 0 OUT | 0 OUT | 0 OUT | PULLED 2 LOGS | CT |
| 5/14/2006 | 1 | 0 OUT | 0 OUT | 1 OUT | 4 OUT | 0 OUT | 0 OUT | 0 OUT | 3 OUT | PULLED 3 LEFT/3 RIGHT | CT/CL |
| 5/15/2006 | 0.3 | 0 OUT | 0 OUT | 1 OUT | 4 OUT | 0 OUT | 0 OUT | 0 OUT | 3 OUT | | CL |
| 5/16/2006 | 0.4 | 0 OUT | 0 OUT | 1 OUT | 4 OUT | 0 OUT | 0 OUT | 0 OUT | 3 OUT | | CL |
| 5/17/2006 | 0 | 0 OUT | 0 OUT | 0 OUT | 2 OUT | 0 OUT | 0 OUT | 0 OUT | 2 OUT | SET SOME LOGS | CL |

**Table 2-8: Lovell Lake Pool Elevation and Dam Operations during the April 2007 Flood**

| | POOL | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| DATE | ELEVATION | LOG BAY 1 | LOG BAY 2 | LOG BAY 3 | LOG BAY 4 | LOG BAY 1 | LOG BAY 2 | LOG BAY 3 | LOG BAY 4 | COMMENTS | INT |
| 4/3/2007 | -1.1 | 1 OUT | 1 OUT | 1 OUT | 2 OUT | 1 OUT | 1 OUT | 1 OUT | 2 OUT | LET RUN /ICE STILL ON POND | AS |
| 4/10/2007 | -1.1 | 1 OUT | 1 OUT | 1 OUT | 2 OUT | 1 OUT | 1 OUT | 1 OUT | 2 OUT | LET RUN /SOLID ICE STILL ON POND | CT |
| 4/12/2007 | -0.9 | 1 OUT | 1 OUT | 1 OUT | 3 OUT | 1 OUT | 1 OUT | 1 OUT | 2 OUT | PULLED ONE LOG | CT |
| 4/16/2007 | 0.2 | 1 OUT | 1 OUT | 1 OUT | 3 OUT | 1 OUT | 1 OUT | 1 OUT | 2 OUT | LET RUN | CT |
| 4/18/2007 | 0.25 | 1 OUT | 1 OUT | 1 OUT | 3 OUT | 1 OUT | 1 OUT | 1 OUT | 2 OUT | LET RUN | CT |
| 4/23/2007 | -0.65 | 1 OUT | 1 OUT | 1 OUT | 2 OUT | 1 OUT | 1 OUT | 1 OUT | 1 OUT | SET LOGS | PA |

All stoplogs were in place on May 4, 2006 and the pool was 0.60 foot below the spillway crest. Inflows to the lake began to increase on May 13 and two stoplogs were removed. Pool elevation overtopped the spillway crest by 0.1 foot on May 13. The pool continued to rise, and reached the maximum recorded height of 1.0 foot over the spillway on May 14. This was 0.8 foot below the top of the dam. Six more stoplogs were removed on May 14, effectively lowering the pool. The pool elevation gradually decreased over the next three days, and dropped below the spillway crest on May 17.

Lovell Lake was filling when the April 2007 event occurred, and was 1.1 feet below the spillway crest on April 3. Ice was still on the pond and the pool elevation changed slowly until April 12, when it rose 0.2 foot in response to rain and snow melt. One stoplog was removed on April 12, but no other operations were performed during the storm. The spillway was overtopped by 0.2 foot on April 16. The pool reached a maximum recorded height on April 18, 0.25 ft over the spillway crest, corresponding to 1.6 feet below the top of the dam. One stoplog was set on April 23 and the pool had dropped to 0.65 foot below the spillway.

According the NHDES, action is taken when the pool elevation reaches 0.5 ft over full pond (spillway crest) to prevent upstream flooding. Also, the lake typically spills to the left side of the control structure at one foot above the spillway. Stoplogs were therefore removed on May 14, 2006. Pool elevations were lower April 2007 and no action was required during this event. No reports of upstream flooding were reported by the NHDES.

The simulation for April 2007 is depicted in Figure 2-13 and tracks the observed pool elevations well.

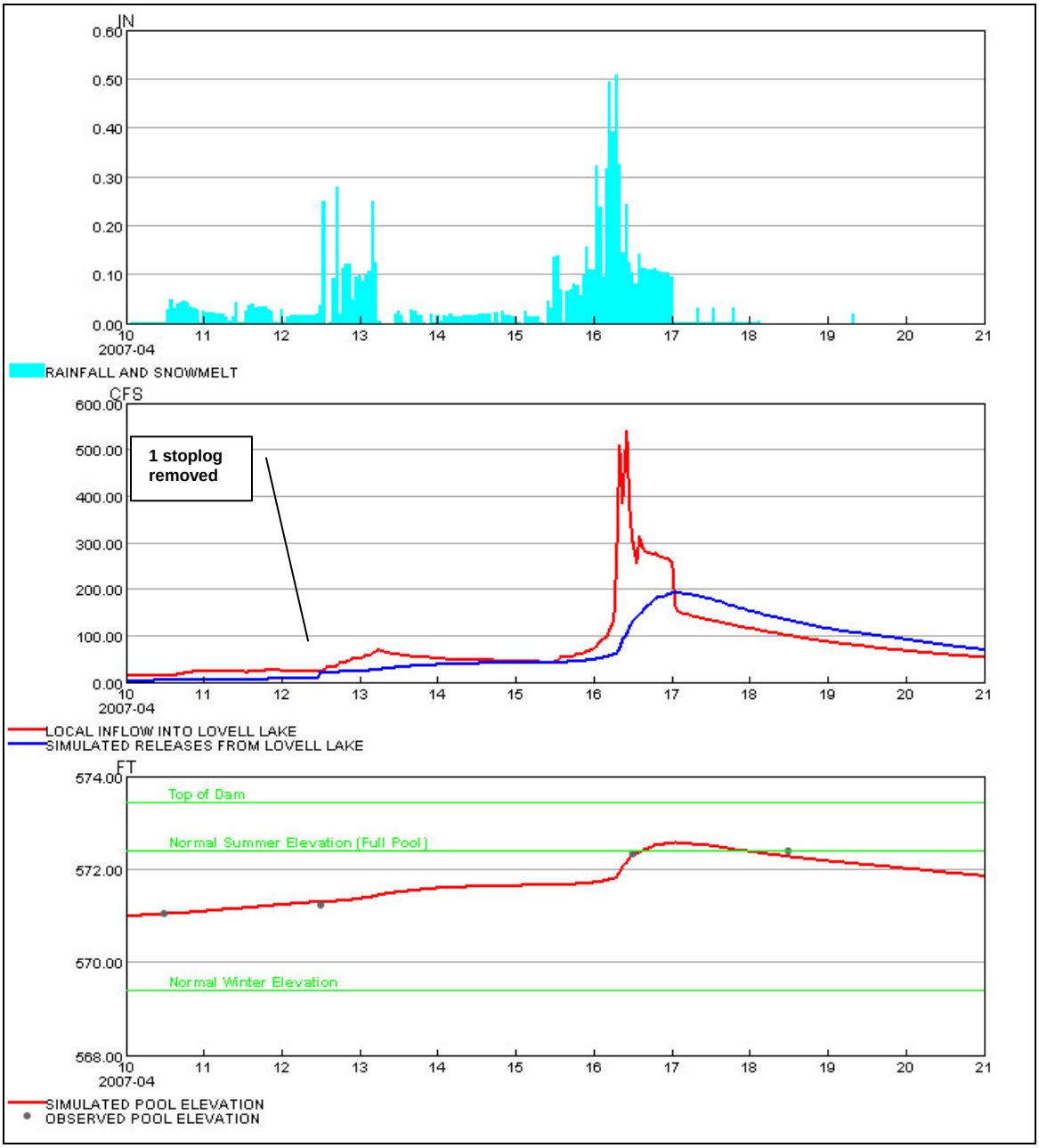


**Figure 2-13: Lovell Lake Simulation Results for the April 2007 Flood Event**

## B-2.4.3 Alternative Operations

A simulation of Lovell Lake with the pool elevation at the winter drawdown level on April 14 was tested and is shown in Figure 2-14. All other operations were assumed to be unchanged. With a fairly small catchment area, Lovell Lake was able to significantly reduce the peak of the April 2007 event.

Maintaining the winter drawdown level into April would further increase the flood control storage capabilities of Lovell Lake. Lovell Lake was approximately three-quarters of the way to its normal summer elevation on April 14. If the lake where maintained at the normal winter elevation in April then it would not have filled to the summer pool elevation during this storm event. The maximum releases on April 16 could have been reduced from approximately 200 cfs to approximately 70 cfs.

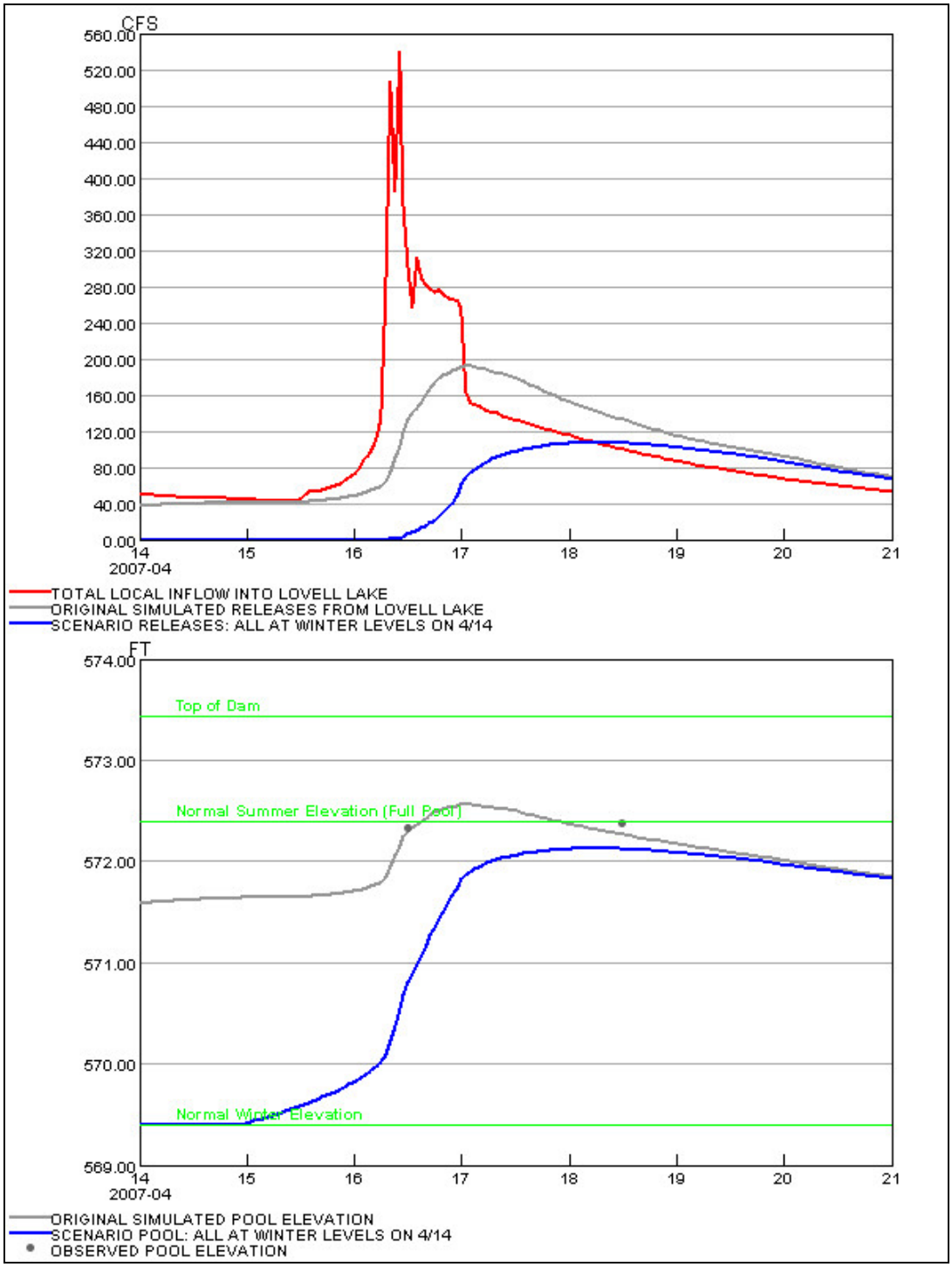


**Figure 2-14: Lovell Lake Alternative Operations - Starting at Minimum Pool on April 14th**

## B-2.5 Milton Three Ponds (NHDES# 161.06)

### B-2.5.1 General Description

Milton Three Ponds Dam is located on the Salmon Falls River downstream of where Churchill Brook/Branch River enters the Salmon Falls River. Milton Pond consists of several connected ponds, which is where it gets its name. Housing developments are present along the majority of the shoreline around the ponds.

The Milton Ponds are larger then all the upstream ponds but Great East Lake. The ponds have a storage capacity of about 12,500 acre-feet at normal levels, and 15,000 acre-feet at its maximum elevation. This allows for the storage of 0.42 inch of runoff (assuming no other regulation upstream).

Pool elevations at Milton Ponds are controlled by the NHDES at a dam structure at the southern end of the lakes. This is typically done by adding or removing stoplogs from twenty bays and by controlling one automated Obermeyer gate and two deep gates (referred to as the 'New Hampshire- NH' gate and the 'Maine-ME' gate). The dam itself has no spillway—at high pool water flows over the stoplog bays.

The typical summer lake elevation is 414.67 feet, expected to be reached by June 1. The pond level slowly decreases over the summer months, leaving the level six to twelve inches below full by Columbus Day. After Columbus Day, the lake level is slowly lowered to a target of 3.25 feet below the June 1 target. This allows for shorefront maintenance and prepares for spring runoff. This information was obtained from the NHDES Dam Bureau website. Other information sent by NHDES shows an annual drawdown of three feet. It requires 0.69 inch of runoff to refill the lake from the lower winter pool to the normal summer pool.

A plan view and photograph of Milton Three Ponds Dam are shown in Figure 2-15 and Figure 2-16.

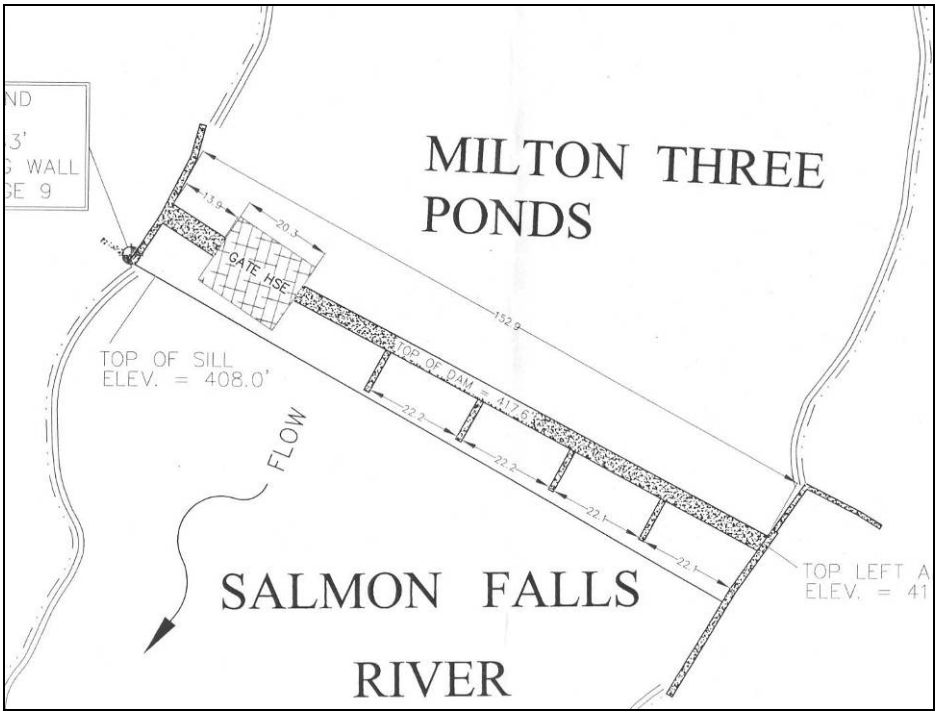


**Figure 2-15: Plan View of Milton Three Ponds Dam**

**Figure 2-16: Photograph of Milton Three Ponds Dam**

## B-2.5.2 Actual Operations

All observed data for the May 2006 and April 2007 flood events were provided by the NHDES. The pool elevation is recorded relative to the summer lake elevation of 414.67 feet. Table 2-9 and Table 2-10 list the pool elevation and the dam operations

**Table 2-9: Milton Ponds Pool Elevation and Dam Operations during the May 2006 Flood**

| DATE | POOL ELEVATION | NH GATE | ME GATE | OBIE PANEL | LOG BAYS | COMMENTS | INT |
|---|---|---|---|---|---|---|---|
| 5/12/2006 | -1.13 | OPEN 6" | OPEN 25" | OPEN 14" | 2 OUT | | SND |
| 5/13/2006 | -1.14 | OPEN 48" | CLOSED | OPEN 11" | 2 OUT | | SND |
| 5/14/2006 | 0.95 | OPEN 48" | CLOSED | OPEN 11" | 3 OUT | 1 LOG BAY STRING PULLED | SND |
| 5/16/2006 | 0.45 | OPEN 48" | CLOSED | OPEN 11" | 5 OUT | 23 LOGS OUT TOTAL | SND |
| 5/18/2006 | -1.10 | OPEN 48" | OPEN 48" | OPEN 15" | 5 OUT | | SND |
| 5/19/2006 | -1.45 | OPEN 40" | OPEN 28" | OPEN 14.6" | 3 OUT | | SND |
| 5/20/2006 | -0.96 | OPEN 40" | OPEN 48" | OPEN 14.6" | 3 OUT | | SND |
| 5/21/2006 | -0.92 | OPEN 40" | OPEN 48" | OPEN 14.6" | 3 OUT | | SND |
| 5/22/2006 | -1.05 | OPEN 40" | OPEN 48" | OPEN 14.6" | 3 OUT | | SND |
| 5/23/2006 | -1.13 | OPEN 40" | OPEN 48" | OPEN 14.6" | 3 OUT | | SND |
| 5/24/2006 | -1.30 | OPEN 40" | OPEN 48" | OPEN 14.6" | 3 OUT | | SND |
| 5/25/2006 | -1.51 | OPEN 40" | OPEN 1" | OPEN 14" | 3 OUT | | SND |
| 5/26/2006 | -1.37 | OPEN 40" | OPEN 13" | OPEN 12" | 2 OUT | | SND |

**Table 2-10: Milton Ponds Pool Elevation and Dam Operations during the April 2007 Flood**

| DATE | POOL ELEVATION | NH GATE | ME GATE | OBIE PANEL | LOG BAYS | COMMENTS | INT |
|---|---|---|---|---|---|---|---|
| 4/1/2006 | -1.78 | OPEN 36" | OPEN 1" | OPEN 14.1" | logs @ 14.0' | | SND |
| 4/2/2006 | -1.77 | OPEN 36" | OPEN 1" | OPEN 14.1" | logs @ 14.0' | | SND |
| 4/3/2006 | -1.64 | OPEN 36" | OPEN 1" | OPEN 14.1" | logs @ 14.0' | | SND |
| 4/4/2006 | -1.59 | OPEN 36" | OPEN 1" | OPEN 14.1" | logs @ 14.0' | | SND |
| 4/5/2006 | -1.58 | OPEN 36" | OPEN 1" | OPEN 14.1" | logs @ 14.0' | | SND |
| 4/6/2006 | -1.67 | OPEN 12" | OPEN 4" | OPEN 14.1" | logs @ 14.0' | | SND |
| 4/7/2006 | -1.61 | OPEN 12" | OPEN 4" | OPEN 14.1" | logs @ 14.0' | | SND |
| 4/8/2006 | -1.63 | OPEN 12" | OPEN 4" | OPEN 14.1" | logs @ 14.0' | | SND |
| 4/9/2006 | -1.63 | OPEN 12" | OPEN 4" | OPEN 14.1" | logs @ 14.0' | | SND |
| 4/10/2006 | -1.66 | OPEN 12" | OPEN 4" | OPEN 14.1" | logs @ 14.0' | | SND |
| 4/11/2006 | -1.68 | OPEN 12" | OPEN 4" | OPEN 14.1" | logs @ 14.0' | | SND |
| 4/12/2006 | -1.69 | CLOSED | CLOSED | OPEN 14.5" | logs @ 13.4' | | SND |
| 4/13/2006 | -1.72 | CLOSED | OPEN 36" | OPEN 14.5" | logs @ 13.4' | | SND |
| 4/14/2006 | -1.91 | CLOSED | OPEN 36" | OPEN 14.5" | logs @ 13.4' | | SND |
| 4/15/2006 | -2.00 | OPEN 12" | OPEN 48" | OPEN 9.8" | logs @ 13.4' | | SND |
| 4/16/2006 | -1.71 | OPEN 12" | OPEN 48" | OPEN 9.8" | Between the morning of the 16th and the morning of the 20th the NH gate was opened to "full" and two adiitional rows of stroplogs were removed. At the time I was at the state's EOC in full statewide response mode. You may be able approximate the timing of some of these ops from the rating curve. | | SND |
| 4/17/2006 | 1.09 | OPEN 12" | OPEN 48" | OPEN 9.8" | | | SND |
| 4/18/2006 | 0.09 | OPEN 12" | OPEN 48" | OPEN 9.8" | | | SND |
| 4/19/2006 | -1.04 | OPEN 12" | OPEN 48" | OPEN 9.8" | | | SND |
| 4/20/2006 | -1.79 | OPEN 48" | CLOSED | OPEN 9.8" | logs @ 12.2' | | SND |
| 4/21/2006 | -1.59 | OPEN 22" | OPEN 48" | OPEN 14.5" | logs - 7@13.5' & 13@12.9' | | SND |
| 4/22/2006 | -1.84 | OPEN 22" | OPEN 48" | OPEN 14.5" | logs - 7@13.5' & 13@12.9' | | SND |
| 4/23/2006 | -2.07 | CLOSED | OPEN 48" | OPEN 14.5" | logs @ 14.0' | | SND |
| 4/24/2006 | -1.61 | CLOSED | OPEN 48" | OPEN 14.5" | logs @ 14.0' | | SND |
| 4/25/2006 | -1.49 | CLOSED | OPEN 48" | OPEN 14.5" | logs @ 14.0' | | SND |
| 4/26/2006 | -1.52 | CLOSED | OPEN 48" | OPEN 14.5" | logs @ 14.0' | | SND |
| 4/27/2006 | -1.60 | CLOSED | OPEN 48" | OPEN 14.5" | logs @ 14.0' | | SND |
| 4/28/2006 | -1.61 | CLOSED | OPEN 48" | OPEN 14.5" | logs @ 14.0' | | SND |
| 4/29/2006 | -1.63 | CLOSED | OPEN 48" | OPEN 14.5" | logs @ 14.0' | | SND |
| 4/30/2006 | -1.63 | CLOSED | OPEN 48" | OPEN 14.5" | logs @ 14.0' | | SND |

On May 12 2006, the Milton Dam pool was 1.13 feet below full pool elevation. At this time the NH gate was open 6”, the ME gate was open 25”, the top of the Obermeyer panel set to 14”, and two log were out from all bays. When inflows to Milton Dam peaked on May 14, the NH gate was opened 48”, the ME gate was closed, the Obermeyer panels were lowered to 11”, and 3 log were out from all bays. At this time the pool elevation topped out at 0.95 foot above full pool elevation, about 2 feet below the top of the dam.

The Milton Dam was actively operated before and during the April 2007 event. On April 3, the pool was 1.64 feet below the spillway as the reservoir was refilling from winter drawdown. Until the 16th, the pool was dropped slightly by removing stoplogs, opening gates, and lowering the Obermeyer panels as the inflows increased. Some of the inflows were stored during the event by not opening the NH gate all the way, and by not lowering the Obermeyer gate completely. This provided relief for the downstream Milton Hydro project, which incurred damage early in the event and was in danger of failing. On the other hand, it caused the water level at Milton Three Ponds to rise and, according to accounts from residents, contributed to considerable upstream flood damages. Some stoplogs were removed during the event; removing stoplogs when water is overtopping them is, however, dangerous and often impossible, as water pressure keeps them lodged in the bay. The maximum recorded pool elevation was 1.09 feet above the spillway on April 17. This was 1.87 feet below the top of the dam, slightly higher than in 2006.

Pool elevation and release data are automatically collected at Milton Dam and are available at an hourly time interval. This allows for an in-depth calibration of the simulation models. As seen in Figure 2-17, it was possible to simulate the observed pool elevations well. Observed releases are not matched as well, indicating a possible inaccuracy in the elevation-storage relationship for the three ponds.

During the April 2007 flood event, the inflows at Milton Dam were at least one magnitude larger than releases at the dams studied upstream. The peak inflow at Milton Dam was more than 6000 cfs, compared

to peak releases of 200 cfs each from Lovell Lake and Horn Pond and 40 cfs from Cooks Pond. This illustrates that most of the inflows were generated downstream of those dams. The operations at Milton Dam demonstrate how competing objectives regarding the prevention of upstream and downstream damages complicates the operation of a dam during a serious flood event. Another small dam, Union Meadows Dam, is located between Cooks Pond, Lovell Lake, and Milton Three Ponds, but the flood control potential of that dam is minor as well. Union Meadows Dam is not modeled in this study.

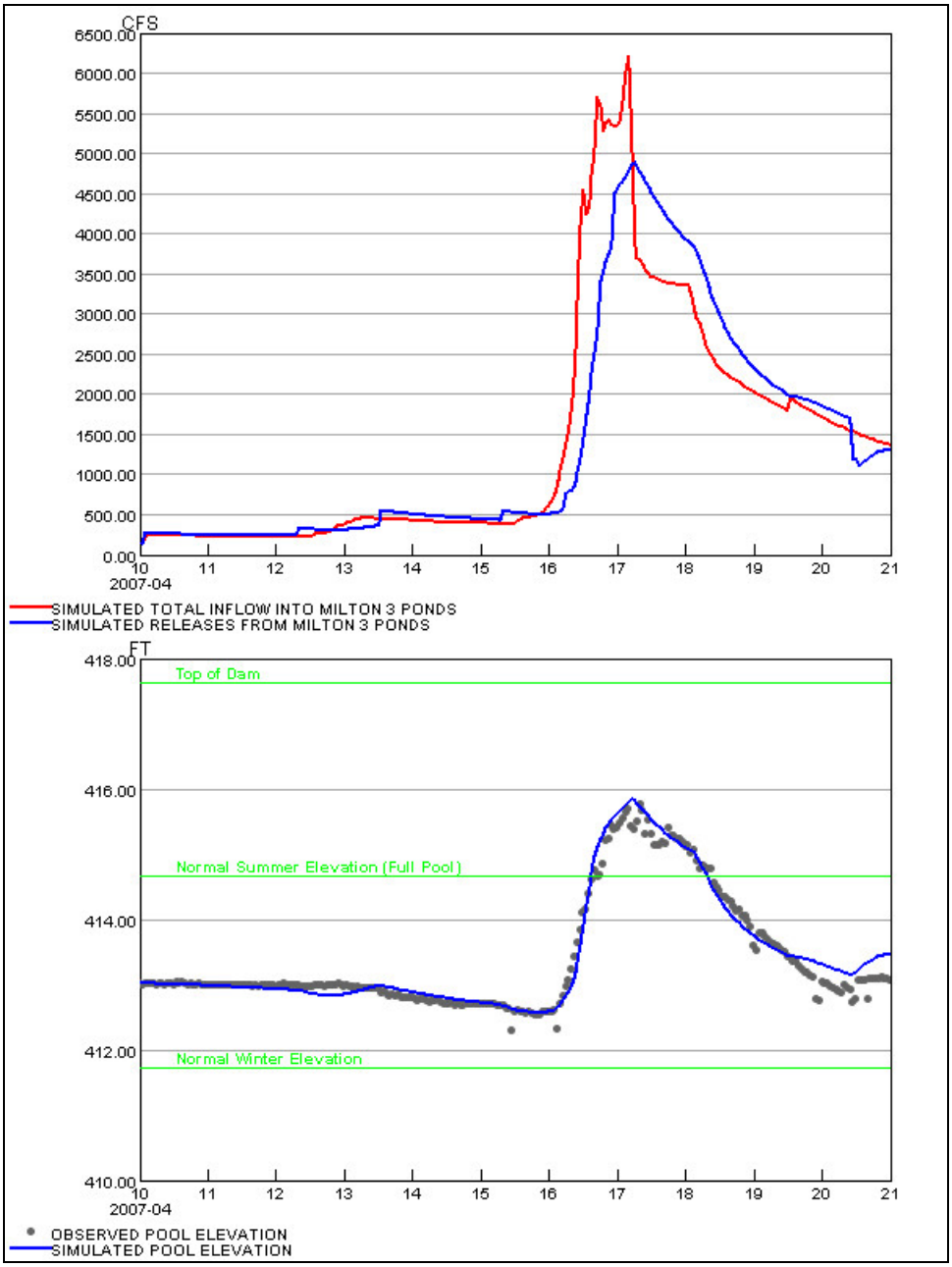


**Figure 2-17: Milton Three Ponds Simulation Results for the April 2007 Flood Event**

### B-2.5.3 Alternative Operations

Several different scenarios were tested for Milton Three Ponds, considering it is a point where upstream flooding occurred. Figure 2-18 and Figure 2-19 show the three different scenarios in terms of the releases and pool elevations respectively. The scenarios tested include the following operations for Milton Three Ponds: all gates are open and stoplogs removed on April 10; winter drawdown maintained until April 10; and all gates fully open on April 10. Maintaining the winter drawdown until April 10 and holding all other operations had very little effect on the maximum pool elevation and no effect on the maximum releases during the event.

Opening all the gates and removing the stoplogs or only opening all the gates several days before the event drew down the pool elevation very far below the normal winter elevation and significantly affected the maximum pool elevation and releases. These operations provide the maximum possible flood control benefits given the current infrastructure at the site.

A possible improvement at the Milton Three Ponds dam site is to replace the four stoplog bays next to the gate house with an Obermeyer panel. These panels can be lowered much faster than stoplogs can be removed. They can therefore be used to lower pool elevations in anticipation of an event and pass larger flows at lower pool elevations during an event. Figure 2-20 illustrates the effect of lowering this new Obermeyer gate in addition to the existing gates on April 15, 2007 at noon, the time when the NWS predicted likely flooding in the area: Significant water volumes can be released in a short time, lowering the maximum pool elevation reached by about half a foot for the April 2007 event. The effect on peak releases would be insignificant.

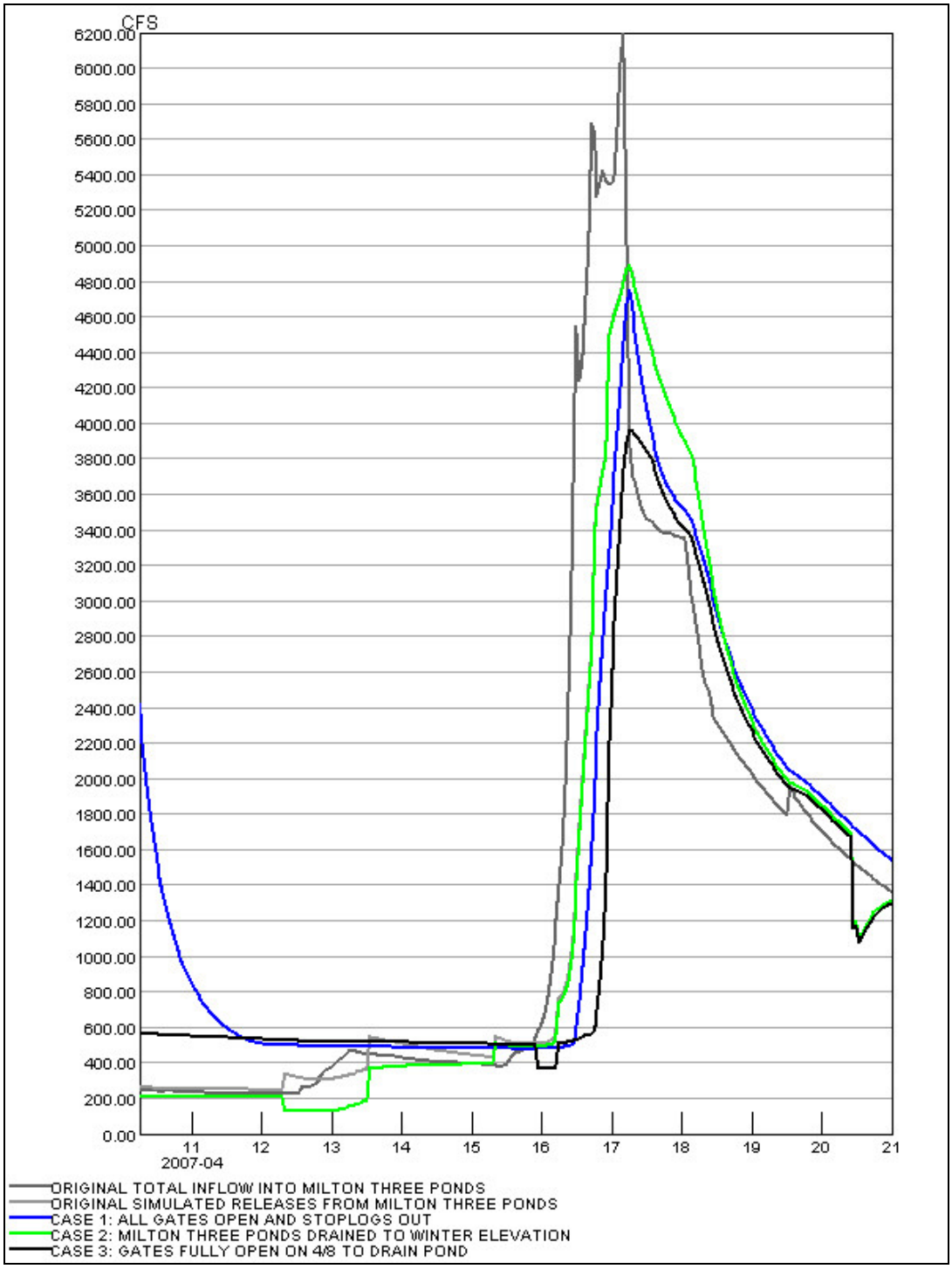


**Figure 2-18: Milton Three Ponds Alternative Operations - Various Scenarios (Flow)**

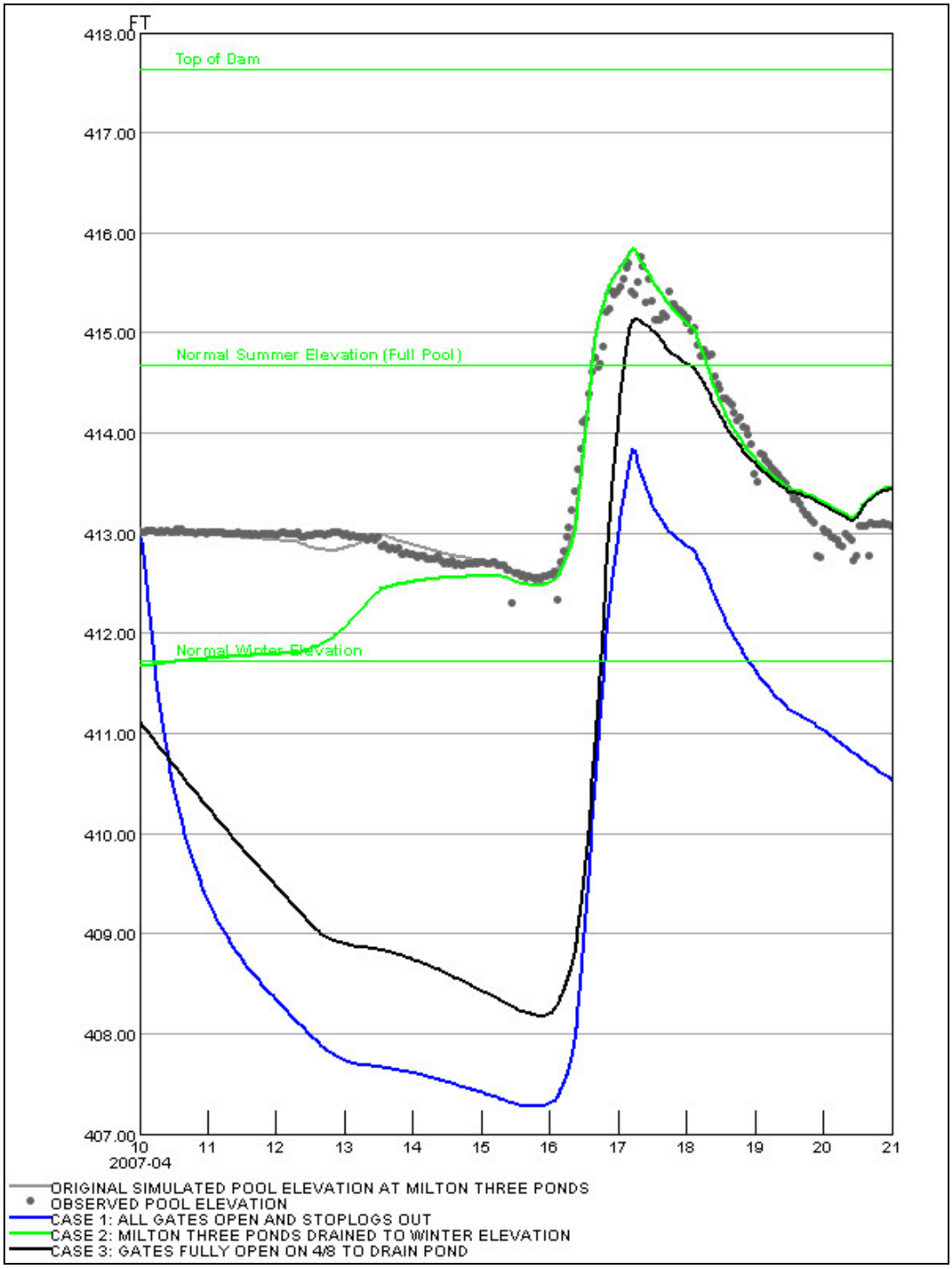


**Figure 2-19: Milton Three Ponds Alternative Operations - Various Scenarios (Pool)**

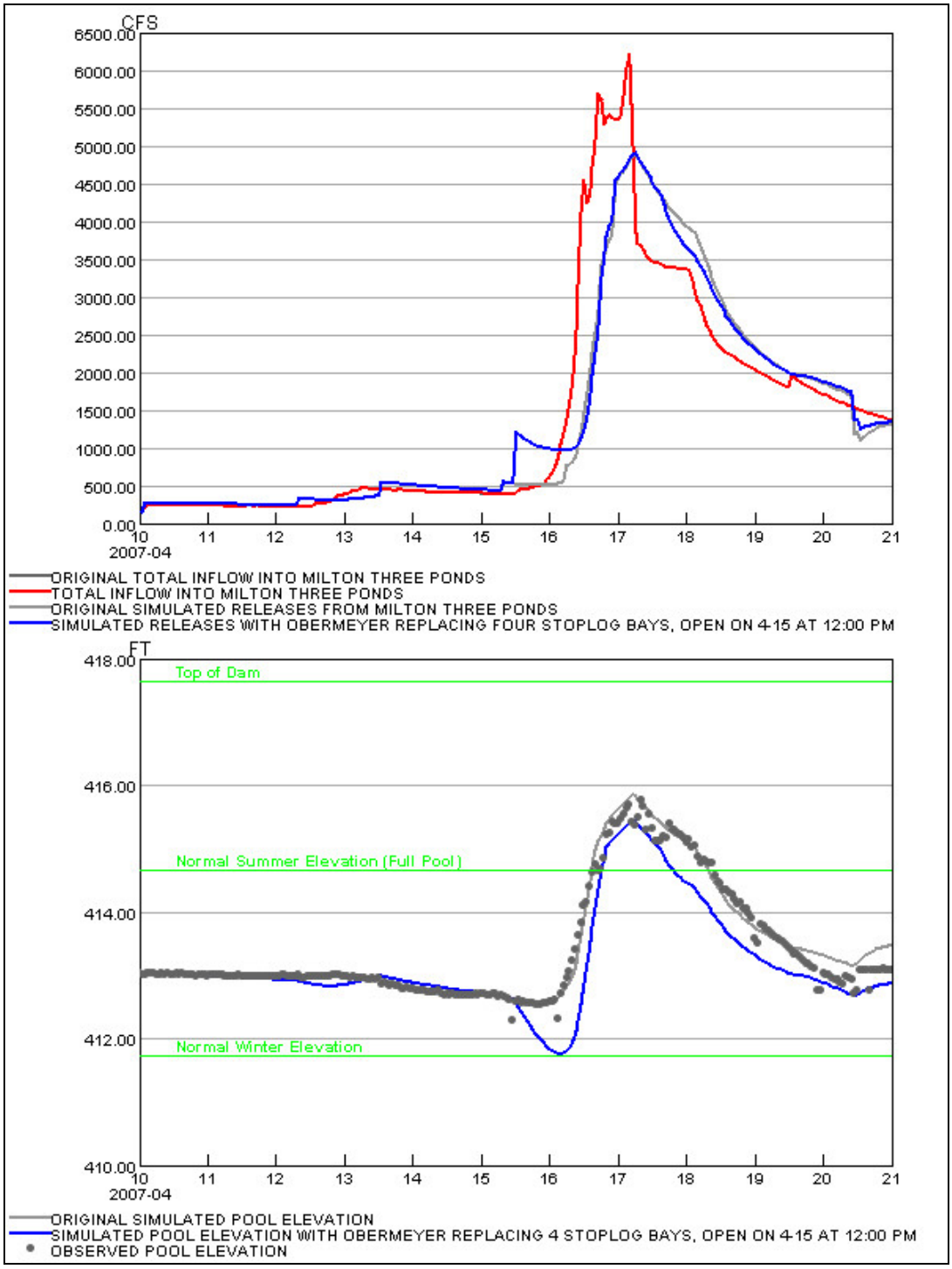


**Figure 2-20: Milton Three Ponds Alternative Operations – Open New Gate on April 15th**

## B-2.6 Spaulding Pond (NHDES# 204.08)

### B-2.6.1 General Description

The run-of-river Spaulding Dam is owned by the Spaulding Ave Industrial Complex, LLC and serves as a hydro power project. It is located downstream of Milton Ponds. Housing and other developments are located around the pond. Spaulding Pond is very small, with a capacity of approximately 325 acre-feet at normal pool elevation, and 700 acre-feet at its maximum elevation. This provides for a storage capacity of only 0.06 inch between these pool elevations.

The normal elevation of the pond is 247.0 feet. The water levels at Spaulding Pond are controlled by nine stoplog bays, three gates at the dam, and three gates at a mill where the powerhouse is located.

A plan view and photograph of Spaulding Pond Dam are shown in Figure 2-21 and Figure 2-22 respectively.

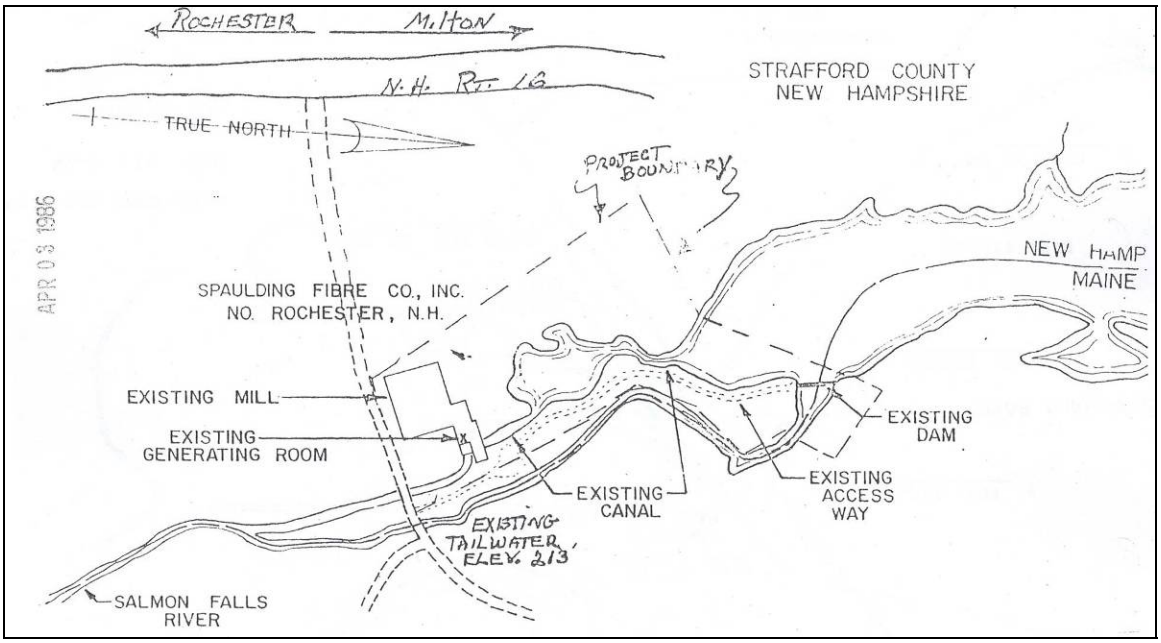


**Figure 2-21: Plan View of Spaulding Pond Dam**

### B-2.6.2 Actual Operations

On May 12, 2006 the pool was 3” above normal pool, and as a precaution one gate was set to a half open position. The pool rose rapidly in response to the storm and by the evening of May 13 the pool had reached 20” above full pond. At this time all three operational gates were fully opened, effectively dropping the pool elevation at a rate of 1” per hour. However, five hours later, early in the morning on May 14, the pool had risen to 30” above full pond. Accumulating debris was removed and 12 stoplogs were pulled, which maintained the pool at 12” below the top of the dam.

Spaulding Pond Dam was not overtopped during the April 2007 storm. The dam was monitored hourly while the pool was rising and every 2 to 3 hours while declining. The maximum pond elevation at the dam was 26 inches over the spillway boards at ‘2:00 p.m. on 4-17-07’. The dam was operated during the

storm, but the specifics are not known. No portion of the dam structure was damaged and the plant manager was not aware of any downstream damages.

As evident in Figure 2-23, it is hard to thoroughly simulate and evaluate this project for the April 2007 event, given the limited availability of observed data. It was therefore assumed that the pool was kept roughly constant until the onset of the event, and that the gates were fully opened in the morning of April 16 to prevent possible overtopping. These operations cause the pool elevation to rise close to the single observed elevation.

Note that opening the gates does dramatically drop the pool for a short period of time and cause a small spike in releases in the morning hours of the 16th. However, the large inflows and the small storage capacity of the lake cause the Spaulding Pond to rise quickly again. Inflows then pass through the pond almost unchanged, demonstrating that the project has no appreciable flood control effect.

**Figure 2-22: Photograph of Spaulding Pond Dam**

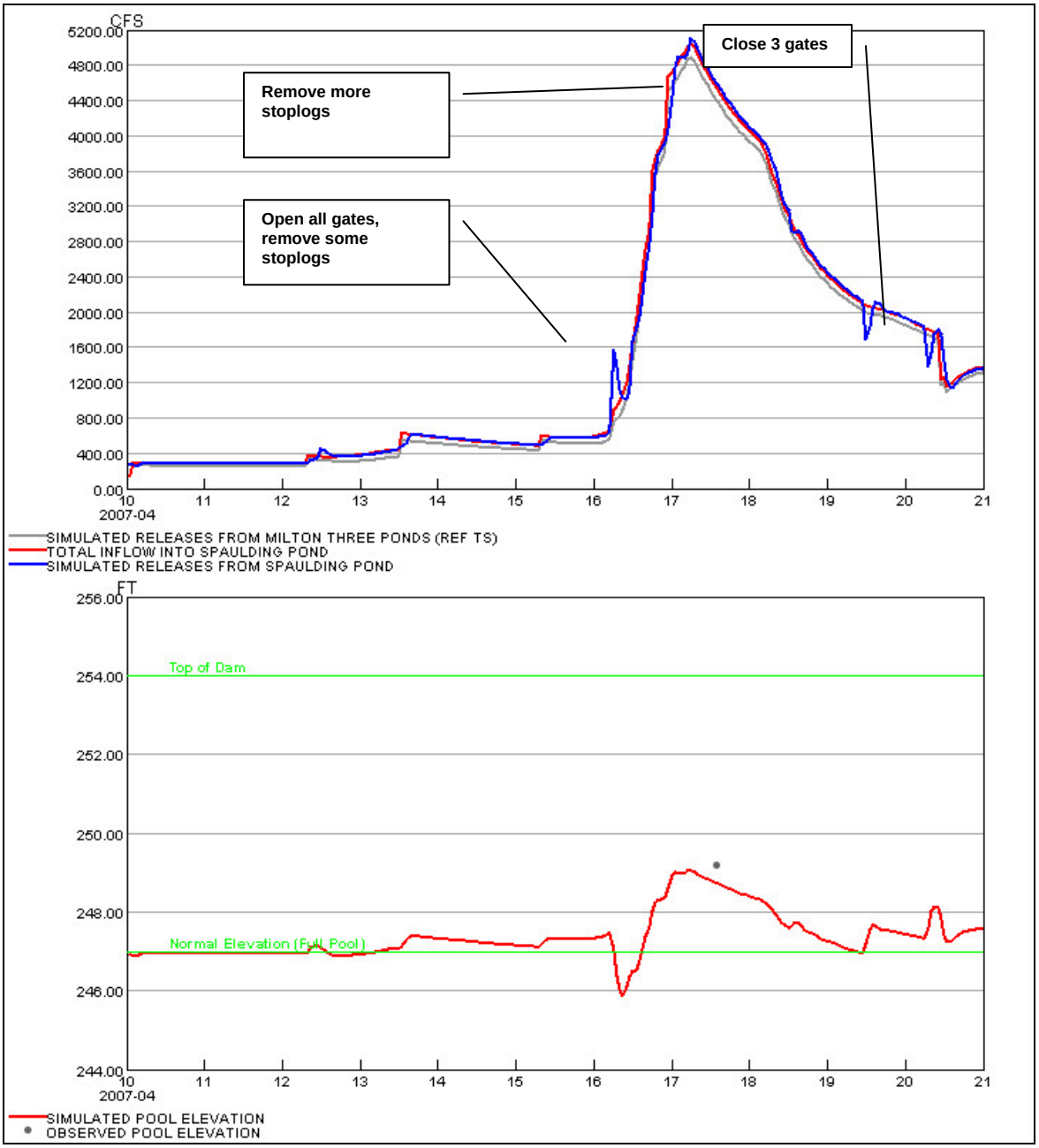


**Figure 2-23: Spaulding Pond Simulation Results for the April 2007 Flood Event**

## B-2.6.3 Alternative Operations

Two scenarios were tested for Spaulding Pond. The first (Figure 2-24), shows the pool elevation at the winter level on April 14. All other operations were assumed to be unchanged. This scenario assumes that all upstream reservoirs were also drawdown to the winter level. The second scenario (Figure 2-25) shows the simulation results if all the gates were open and stoplogs removed on April 10. Because Spaulding Pond has very little storage, maintaining the pool elevation at its winter level in April would have had little effect on the flows or pool elevations. However, if Spaulding Pond had opened all its gates and removed all its stoplogs, the pool elevation could have been maintained below the summer elevation.

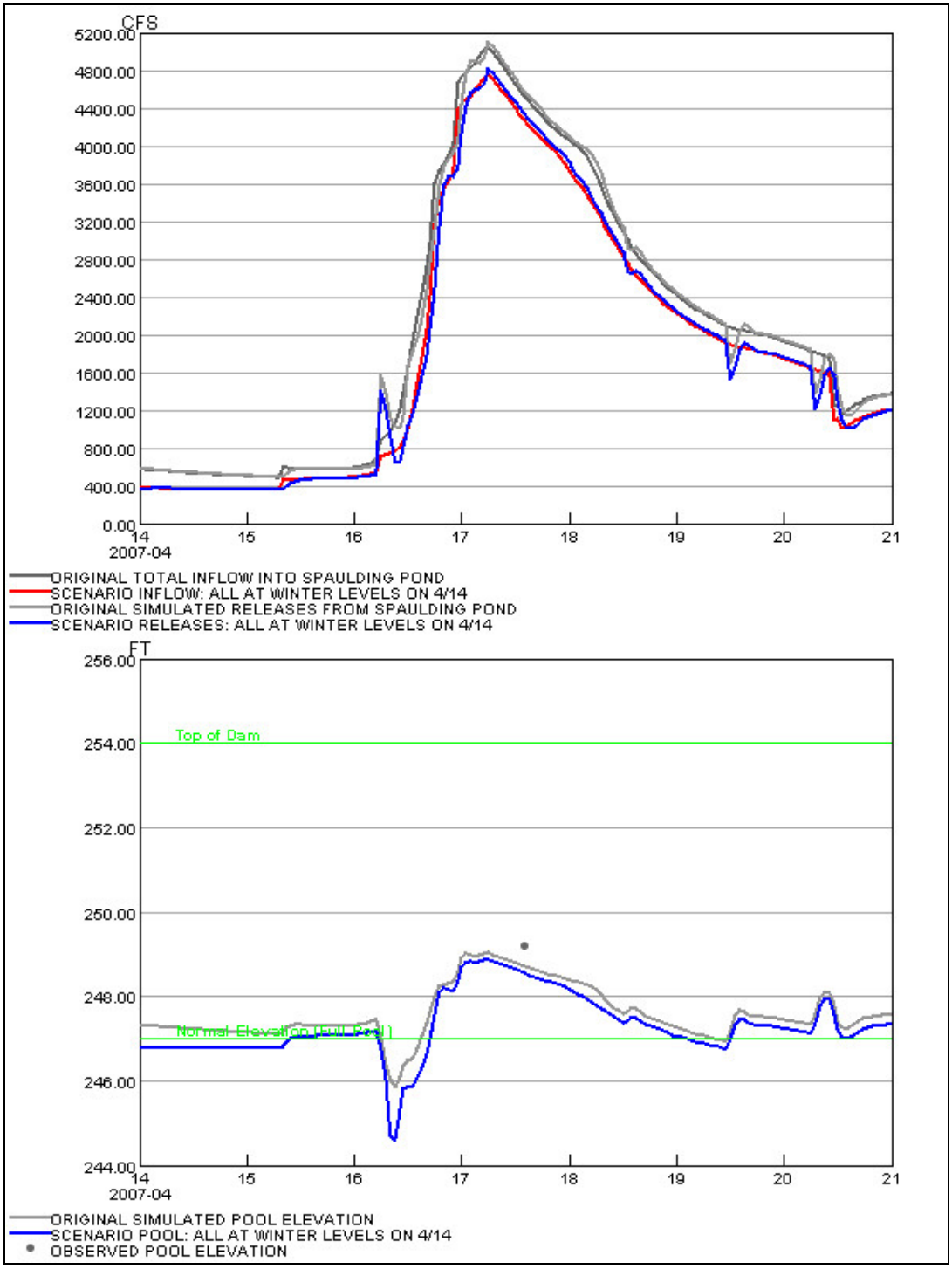


**Figure 2-24: Spaulding Pond Alternative Operations - Starting at Minimum Pool on April 14th**

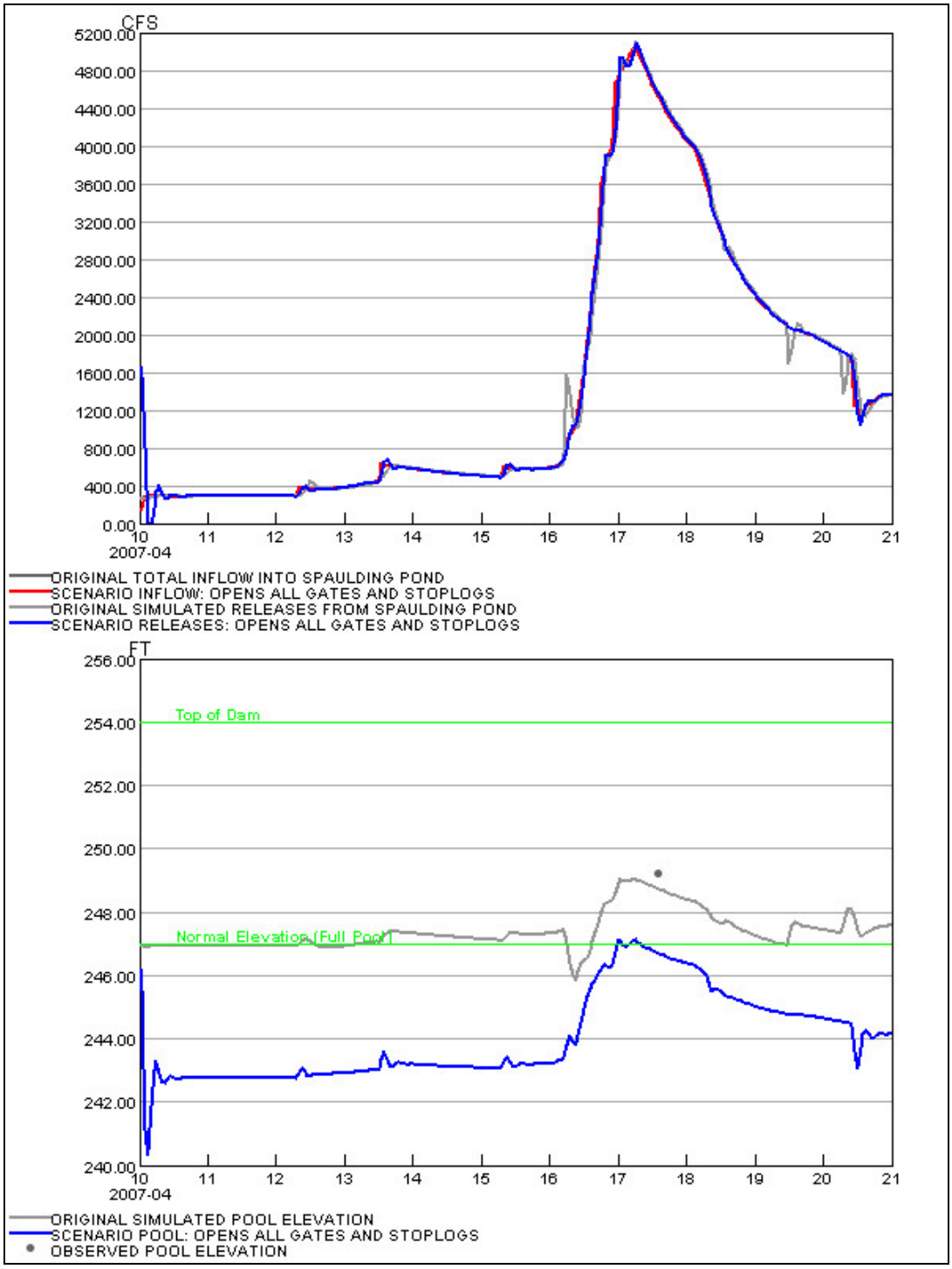


**Figure 2-25: Spaulding Pond Alternative Operations - All Gates Open and Stoplogs Removed on 4-10**

## B-2.7 Baxter Mill Dam (NHDES #204.06)

### B-2.7.1 General Description

Baxter Mill Dam is a run-of-river structure located downstream of Spaulding Pond. The pond behind Baxter Mill Dam is very small and is surrounded by developments on almost all sides. It has a capacity of about 230 acre-feet at normal its elevation, and 350 acre-feet at its maximum elevation. Baxter Mill Dam originally consisted of an uncontrolled wooden spillway with a height of 9.8 feet. According to the NHDES, a drainpipe next to this spillway is inoperable. The weir was damaged during the May 2006 event when approximately 37 ft of the 103 feet wide section failed. An additional nine feet of the spillway was lost during the April 2007 flood. Since then, the structure was rebuilt to a height of approximately 5 feet, as shown in the photograph in Figure 2-26.

**Figure 2-26: Photograph of Baxter Mill Dam**

A plan view of Baxter Mill Dam is shown in Figure 2-27.

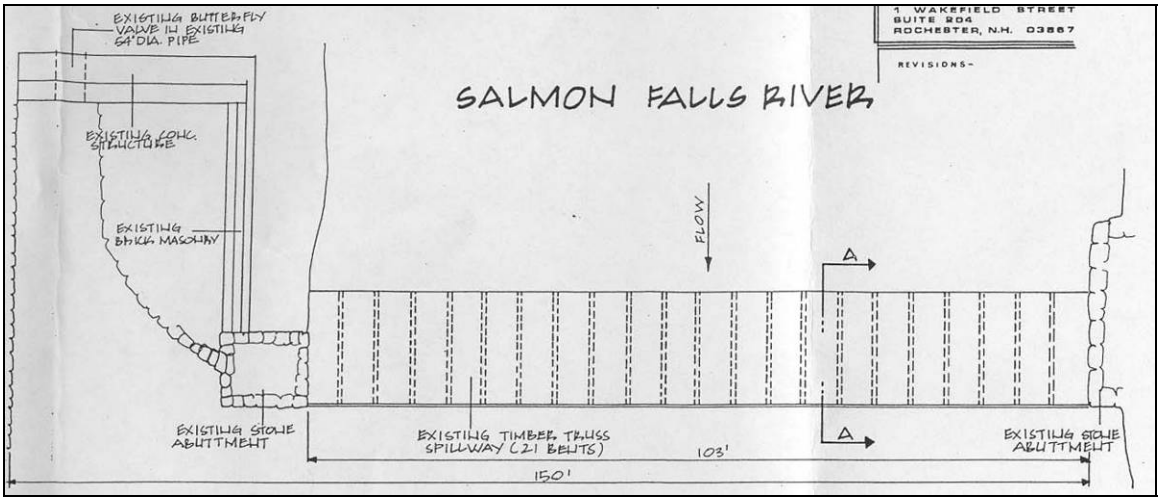


**Figure 2-27: Plan View of Baxter Mill Dam**

## B-2.7.2 Actual Operations

No observed pool elevation data are available for either the May 2006 or the April 2007 events. No operations can be performed at the site.

The model for Baxter Mill Dam was set up to simulate the failure of part of the spillway during the April 2007 event. The exact time of the failure is unknown. For simulation purposes it was assumed that the failure happened at 2 p.m. on April 16, shortly after a small flow peak caused by the opening of gates at Spaulding Dam passed. The failure of the spillway caused only a temporary drop in pool elevation and an almost unnoticeable increase in releases, as shown in Figure 2-28.

## B-2.7.3 Alternative Operations

Several scenarios were run for Baxter Mill Dam, including: winter drawdown held until 4-10 (Figure 2-29); failure of spillway at the peak flow, before the event, and no failure (Figure 2-30 and Figure 2-31); and simulation of the new spillway (Figure 2-32). When holding the winter drawdown for all reservoirs until April 10, the flow and pool elevation for Baxter Mill Dam are reduced slightly. This cannot be attributed to increases in storage capacity of Baxter Mill Dam, but due to the combined effect of all the upstream reservoirs. Different failures of the Baxter Mill spillway changed the shape of the hydrograph slightly, but had little effect on the peak flow or pool elevation. Finally, the new and lower spillway at Baxter Mill Dam would have maintained the pool elevation significantly lower (thus preventing overtopping), but would have had little effect on the peak flow.

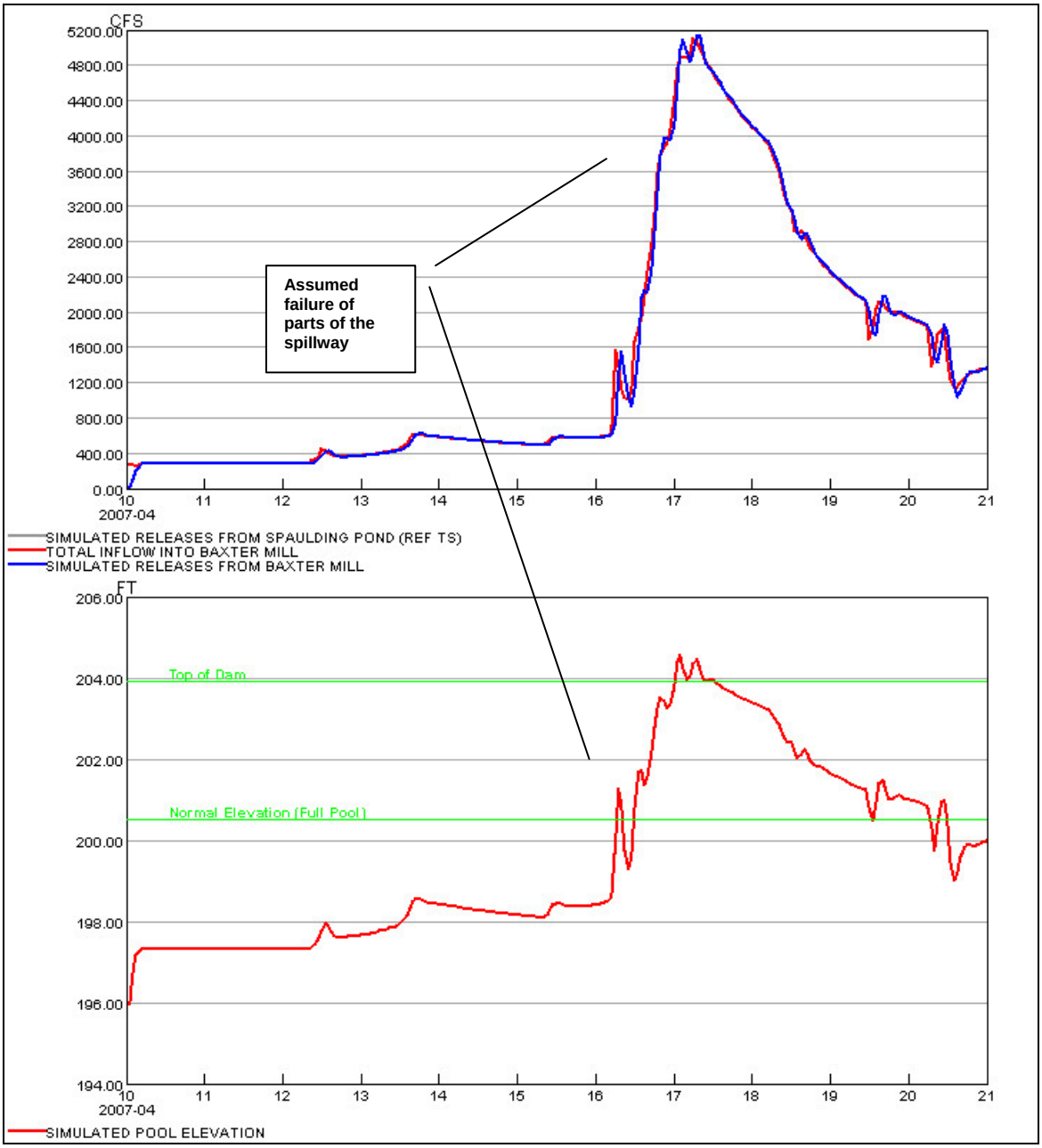


**Figure 2-28: Baxter Mill Dam Simulation Results for the April 2007 Flood Event**

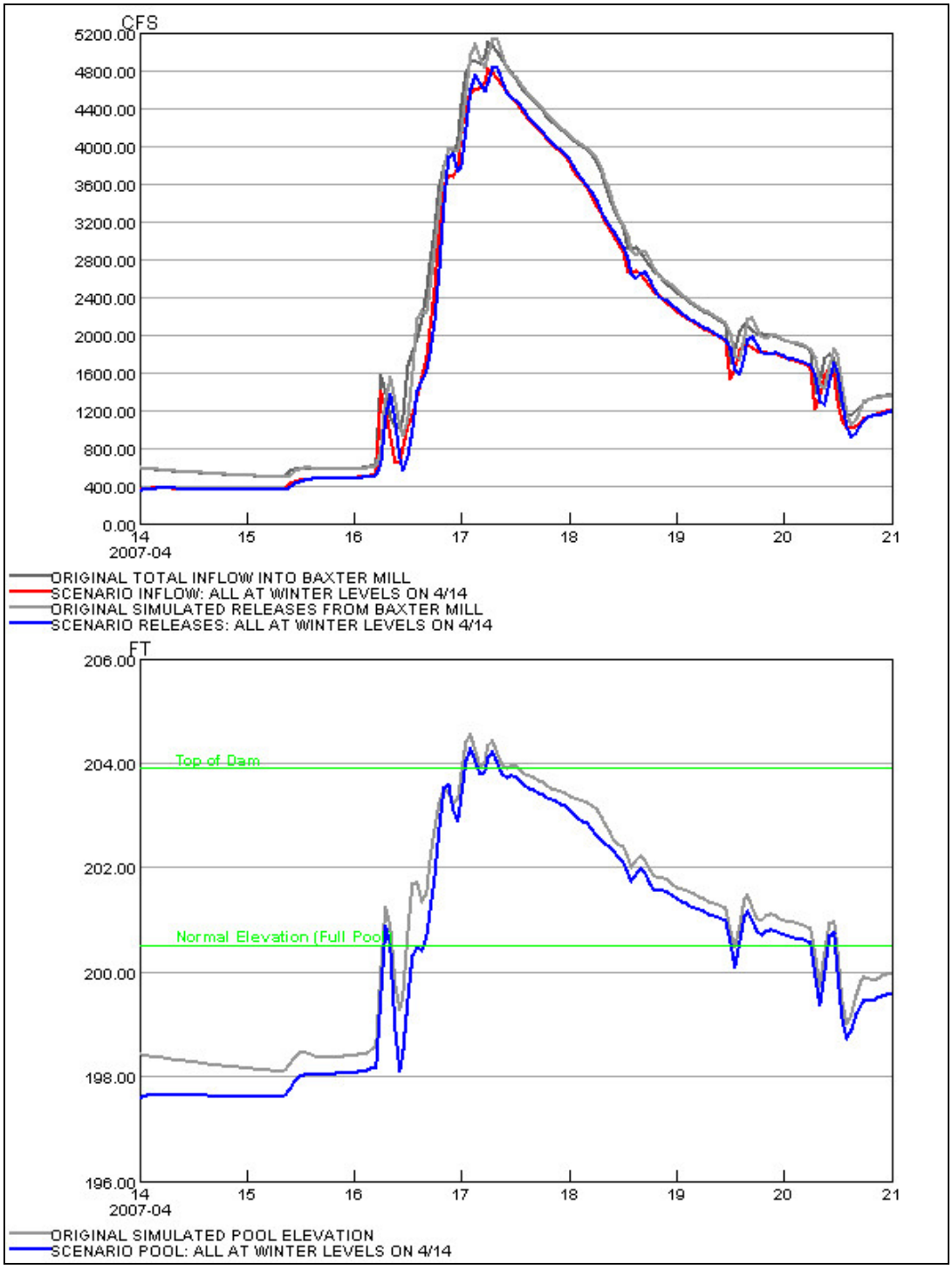


**Figure 2-29: Baxter Mill Dam Alternative Operations - Starting at Minimum Pool on April 14**

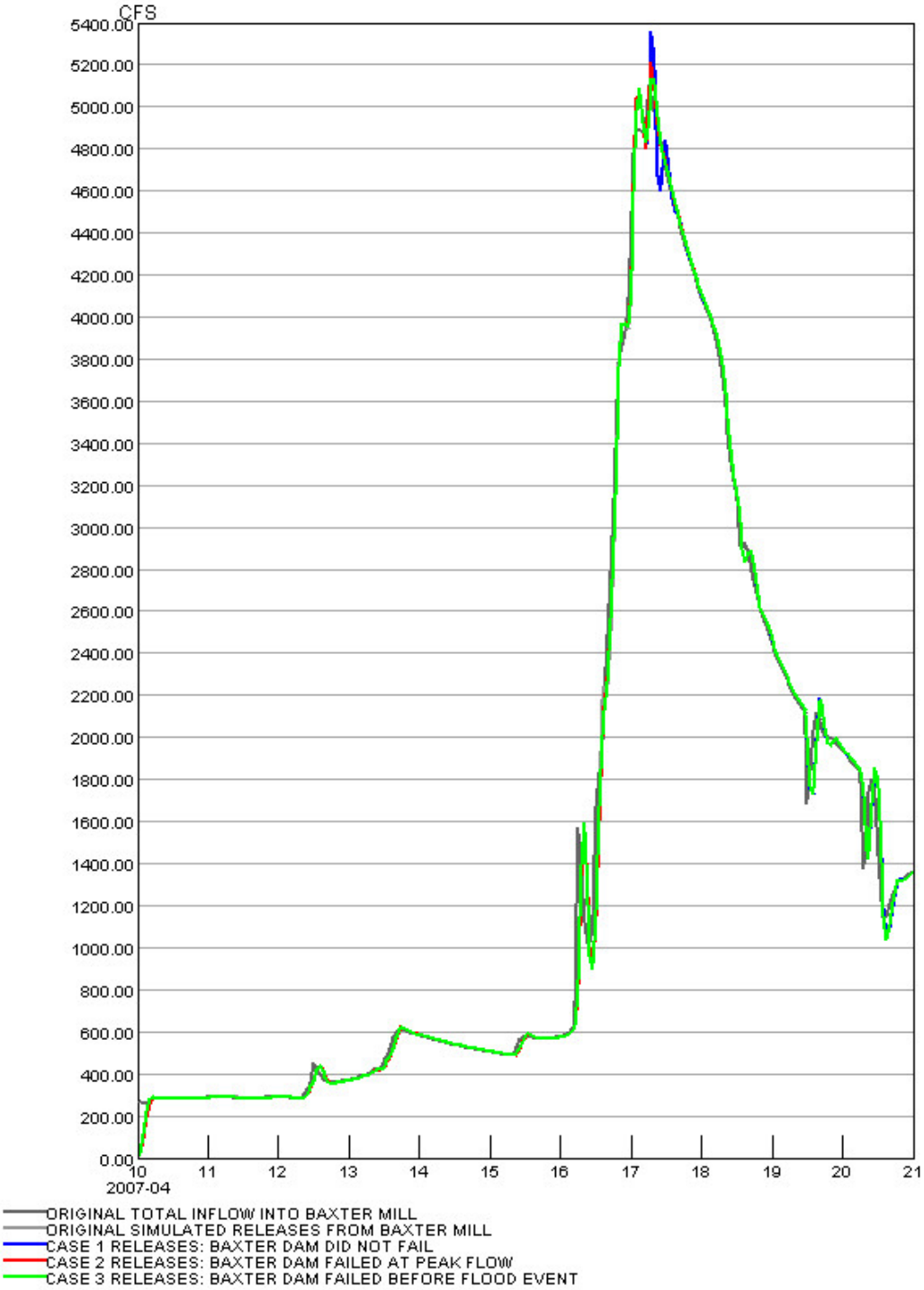


**Figure 2-30: Baxter Mill Dam Alternative Operations - Spillway Failure (Flow)**

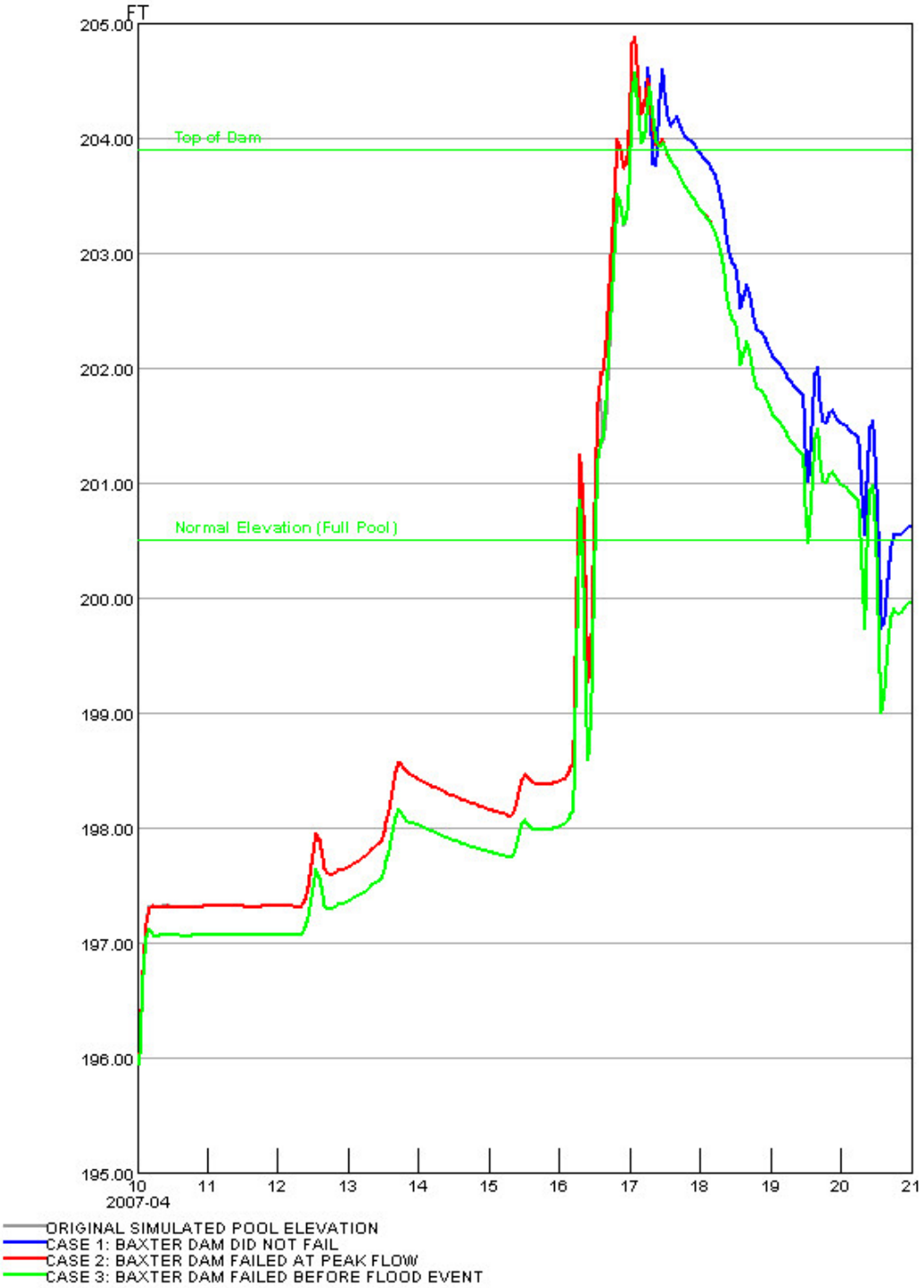


**Figure 2-31: Baxter Mill Dam Alternative Operations - Spillway Failure (Pool)**

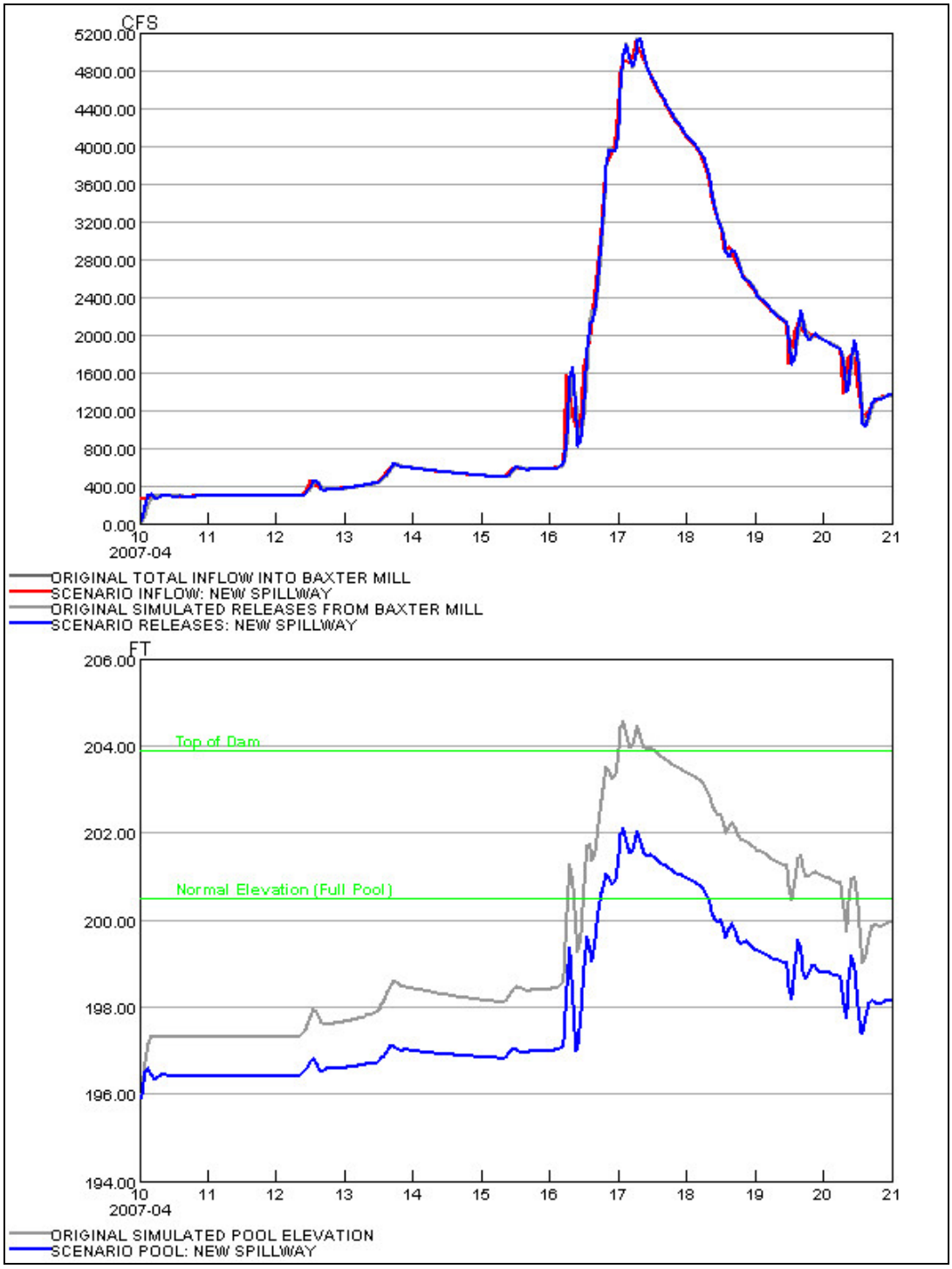


**Figure 2-32: Baxter Mill Dam Alternative Operations - New Spillway**

## B-3.0 SUNCOOK RIVER

The return period of the April 2007 flood event on the Suncook River was close to 50 years, according flow observations near North Chichester. These are shown for the May 2006 and April 2007 events in Figure 3-1, including the FEMA 10, 50, 100, and 500 year flood flows.

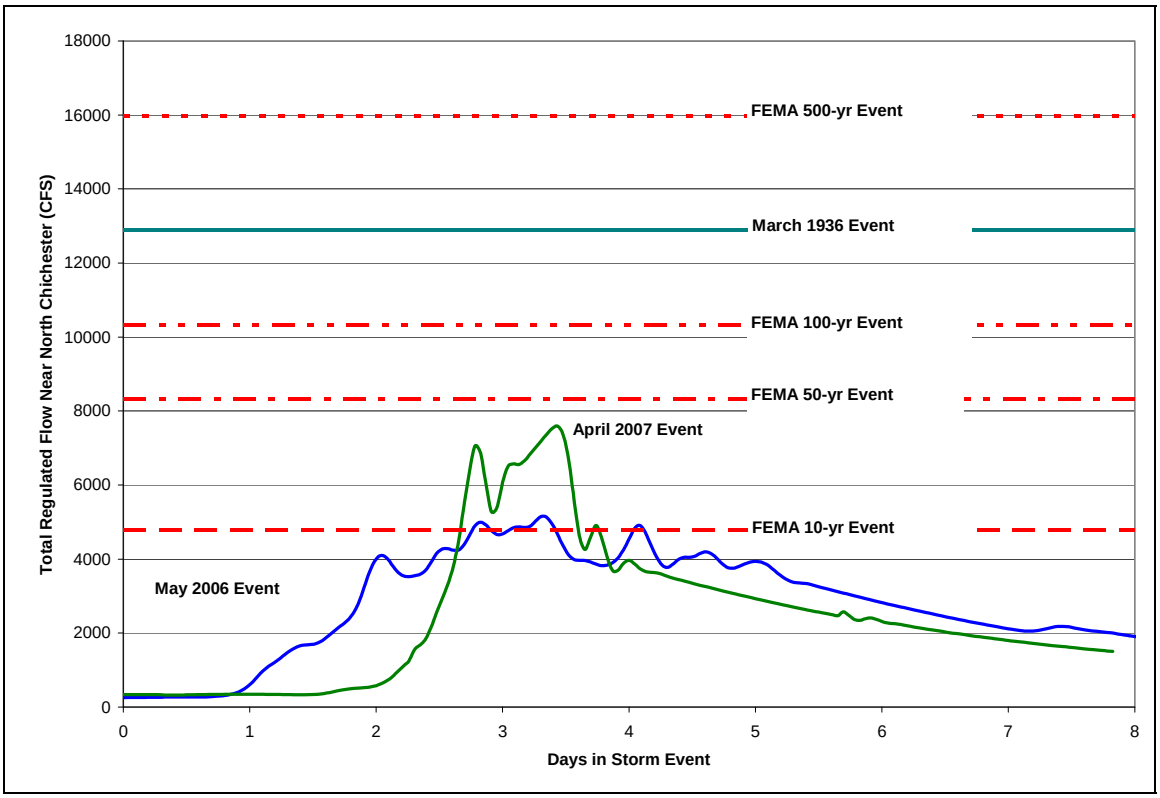


**Figure 3-1: Suncook River - Comparison of May 2006 and April 2007 Events and FEMA Flood Levels**

Figure 3-2 depicts the dams investigated in the Suncook River basin.

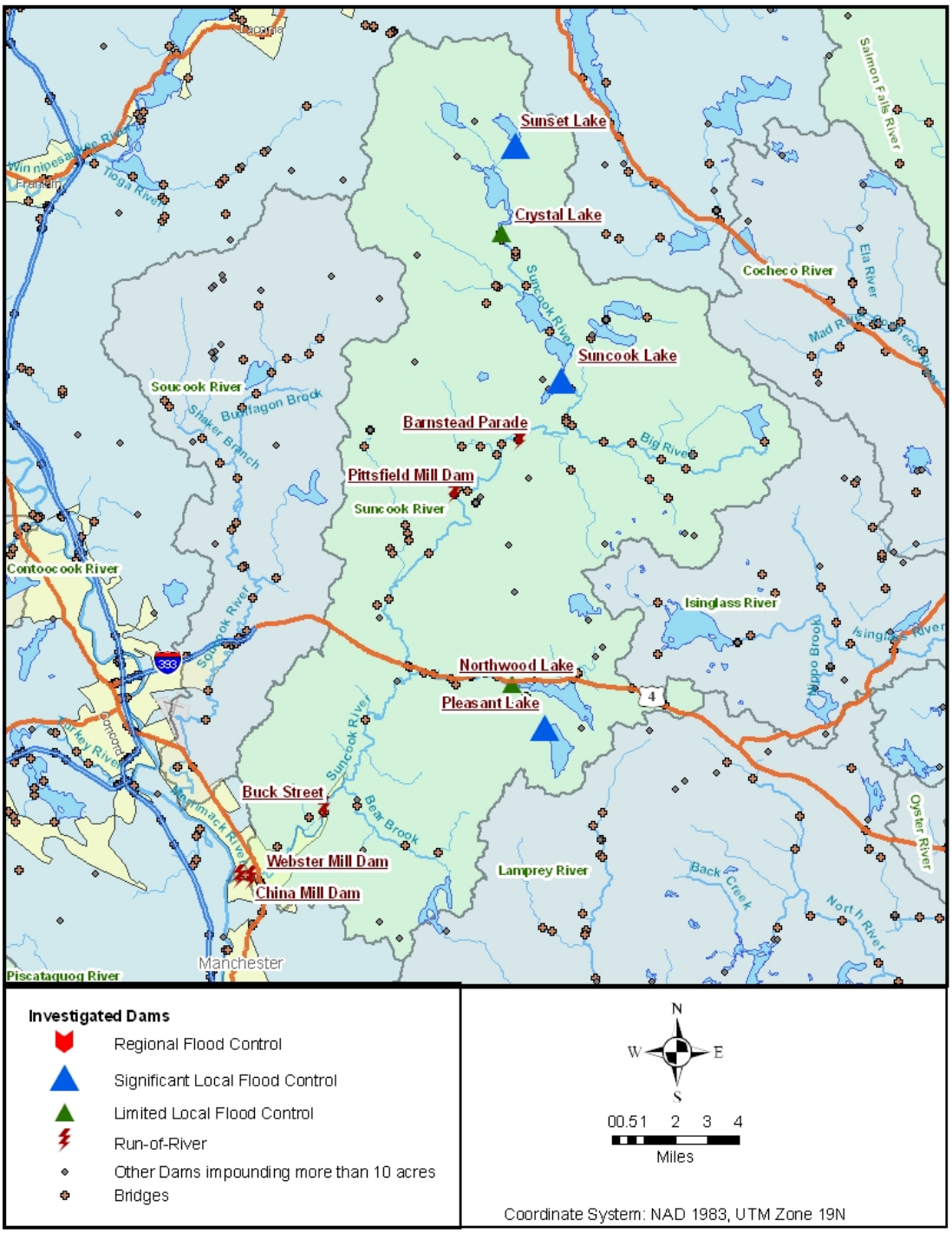


**Figure 3-2: Dams Investigated in the Suncook River Basin**

## B-3.1 Sunset Lake (NHDES# 006.01)

### B-3.1.1 General Description

Sunset Lake is located in the headwaters of the Suncook River. The lake shoreline is mostly undeveloped; the only major housing development is off the northeast shore of the lake.

Sunset Lake has a capacity of about 1,400 acre-feet at its normal elevation, and 1,860 acre-feet at its maximum elevation. Between those levels, Sunset Lake can store approximately 1.21 inches of runoff into the lake.

Pool elevations at Sunset Lake are controlled by NHDES staff at a dam structure at the southern end. Water levels can be controlled through two winter stoplog bays and two gates (made from stoplogs bolted together).

The typical summer lake elevation is 807.0 feet, which corresponds to the top of the spillway. After Columbus Day, the lake is drawn down seven feet from the full level. It requires approximately 4.9 inches of runoff to refill the lake from the lower winter pool to the normal summer pool. Given this, Sunset Lake can provide significant local flood control.

A plan view of Sunset Lake Dam is shown in Figure 3-3.

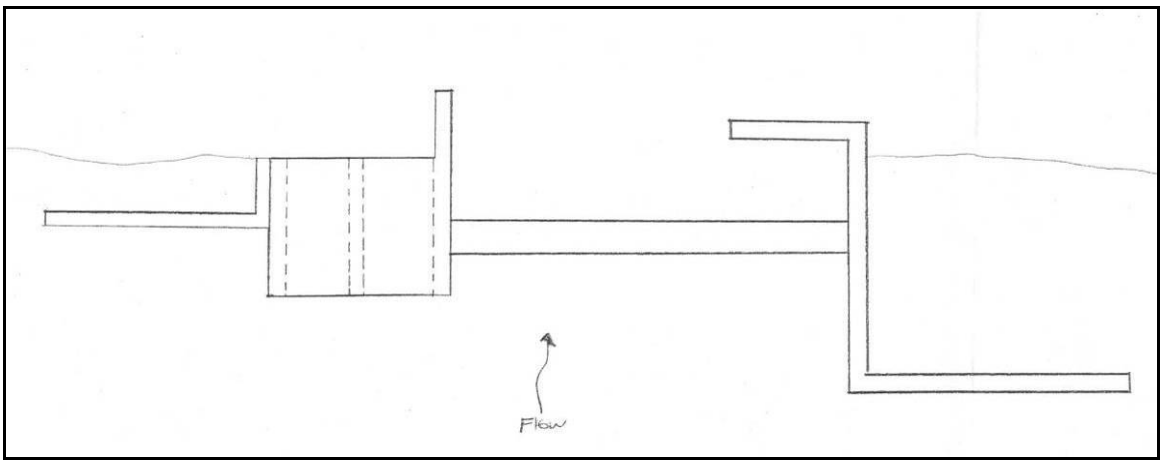


**Figure 3-3: Plan View of Sunset Lake Dam**

### B-3.1.2 Actual Operations

All observed data for the May 2006 and April 2007 flood events were provided by the NHDES. The pool elevation is recorded relative to the summer lake elevation of 807.0 feet. Table 3-1 and Table 3-2 list the pool elevation and the dam operations performed by the NHDES at Sunset Lake.

**Table 3-1: Sunset Lake Pool Elevation and Dam Operations during the May 2006 Flood**

| DATE | POOL ELEVATION | LEFT GATE | RIGHT GATE | COMMENTS | INT |
|---|---|---|---|---|---|
| 5/1/2006 | -2.10 | CLOSED | CLOSED | | PA |
| 5/14/2006 | 1.75 | CLOSED | CLOSED | LET RUN AS IS PER JG | PA |
| 5/15/2006 | 1.9 | CLOSED | CLOSED | LET RUN AS IS | PA |
| 5/16/2006 | 1.6 | CLOSED | CLOSED | LET RUN AS IS | PA |
| 5/17/2006 | 0.85 | CLOSED | CLOSED | WATER LEVEL COMING DOWN GOOD | PA |

**Table 3-2: Sunset Lake Pool Elevation and Dam Operations during the April 2007 Flood**

| DATE | POOL ELEVATION | LEFT GATE | RIGHT GATE | COMMENTS | INT |
|---|---|---|---|---|---|
| 4/3/2007 | -2.85 | CLOSED | CLOSED | | PA |
| 4/13/2007 | -1.15 | OPEN 5" | CLOSED | ICE LOCKED BACK ONTO SHORELINE | PA |
| 4/16/2007 | 1.2 | OPEN 5" | CLOSED | RAIN EVENT/DAM CLEAR OF DEBRIS | PA |
| 4/19/2007 | 0.75 | OPEN 5" | CLOSED | WATER LEVEL COMING DOWN/ICE ON LAKE | PA |
| 4/24/2007 | 0.4 | OPEN 5" | CLOSED | ICE OUT | PA |

For the duration of the May 2006 storm event, both gates remained closed. On May 1, the pool was 2.1 feet below the spillway crest. Inflows increased rapidly in response to the storm, and the spillway crest was overtopped by 1.75 feet on May 14. The maximum recorded height over the spillway was 1.9 feet, and occurred on May 15. This corresponds to 2.0 feet below the top of the dam. Upstream flooding was reported at this pool elevation. The pool was still 0.85 foot over the spillway on May 17.

Given the data available, opening the gates at the onset of the event might have helped minimizing upstream flooding; however, it might have worsened downstream flooding.

Sunset Lake was filling at the beginning of April 2007. Both gates were closed and the pool was 2.85 feet below the spillway on April 3. By April 13 the pool had risen to 1.15 feet below the spillway and the left gate was opened to 5 inches to release flows in anticipation of the event. The gates were not operated further during the event in order to provide downstream flood control for seriously endangered areas. This caused the pool to rise to a maximum recorded depth of 1.2 feet above the normal pool, which, according to the NHDES, does not cause upstream flooding problems. This elevation was 2.7 feet below the top of the dam. The pool elevation remained above the spillway crest, and was 0.4 foot over on April 24. The lake was not ice free until April 24.

The simulation for April 2007 is depicted in Figure 3-4 and tracks the observed pool elevations very well.

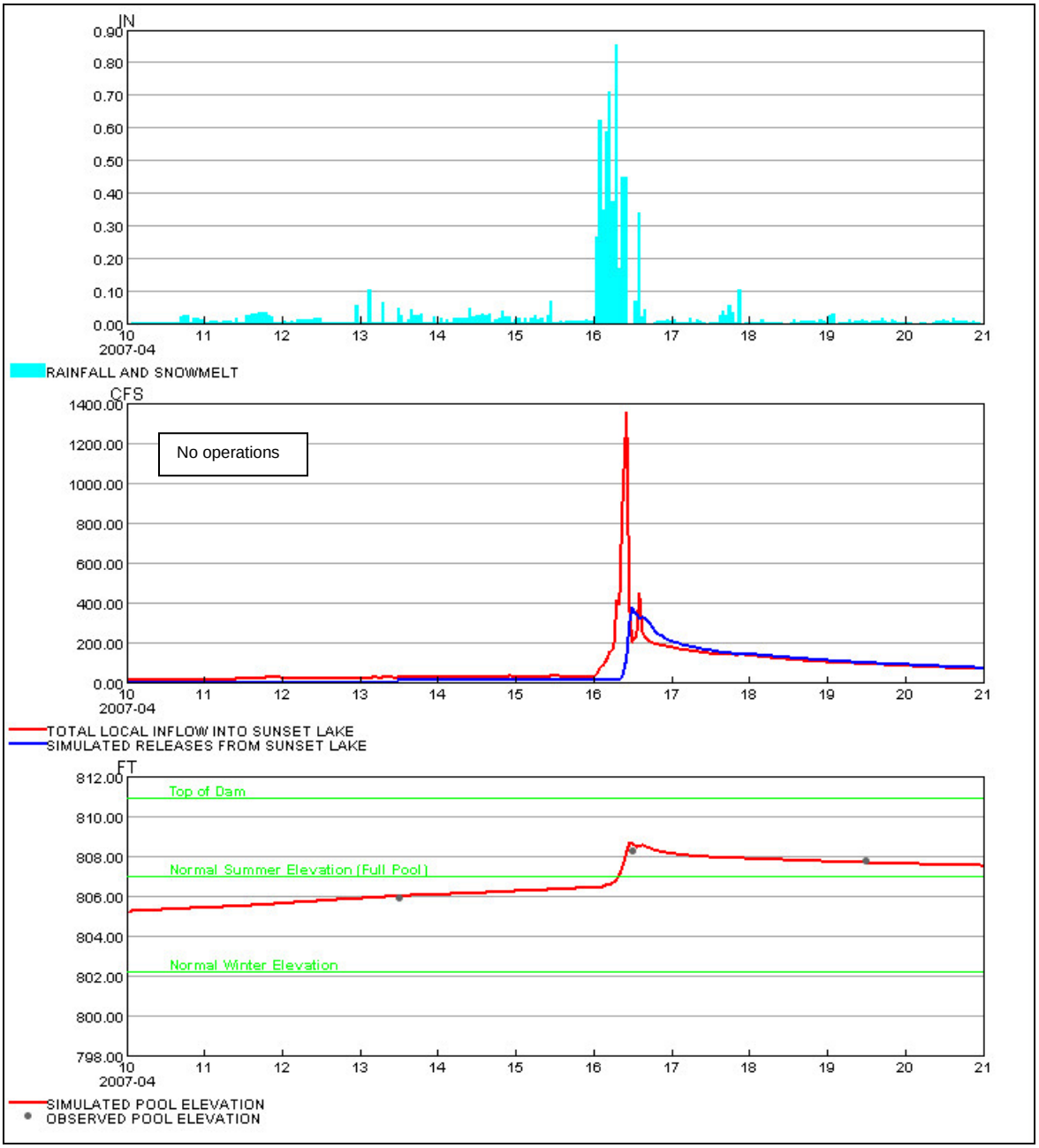


**Figure 3-4: Sunset Lake Simulation Results for the April 2007 Flood Event**

### B-3.1.3 Alternative Operations

A simulation of Sunset Lake with the pool elevation at the winter drawdown level on April 14 was run and is shown in Figure 3-5. All other operations were assumed to be unchanged. Given these alternative operations, Sunset Lake would have been able to significantly reduce the April 16, 2007, peak release from approximately 370 cfs to 20 cfs.

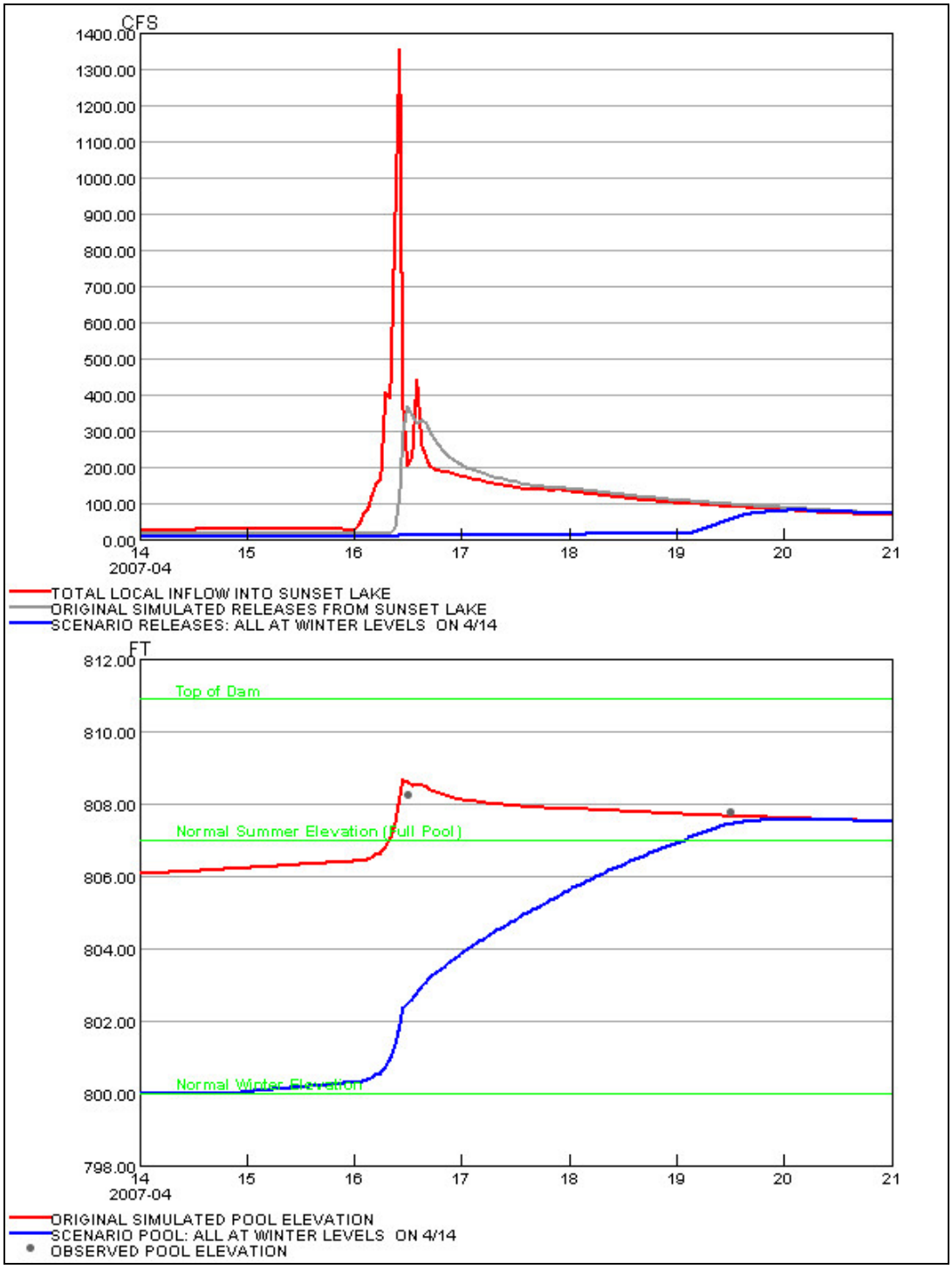


**Figure 3-5: Sunset Lake Alternative Operations - Starting at Minimum Pool on April 14**

## B-3.2 Crystal Lake (NHDES# 091.11)

### B-3.2.1 General Description

Crystal Lake is located on the Suncook River, downstream of Sunset Lake, to the west of Alton. There are well-spaced housing developments around the majority of the lake.

Crystal Lake has a capacity of about 1,400 acre-feet at its normal elevation, and 3,500 acre-feet at its maximum elevation. Between the normal and maximum levels, Crystal Lake can store approximately 1.44 inches of runoff. Pool elevations at Crystal Lake are controlled by NHDES staff using one stoplog bay at the dam structure.

The typical summer lake elevation is 623.19 feet, which corresponds to the top of the spillway. After Columbus Day, the lake is drawn down towards a target of three feet; however, this target is not met in most years. It requires approximately 2.24 inches of runoff to refill the lake from the lower winter pool to the normal summer pool. Given this, Crystal Lake can provide limited local flood control.

A plan view and photograph of Crystal Lake Dam are shown in Figure 3-6 and Figure 3-7.

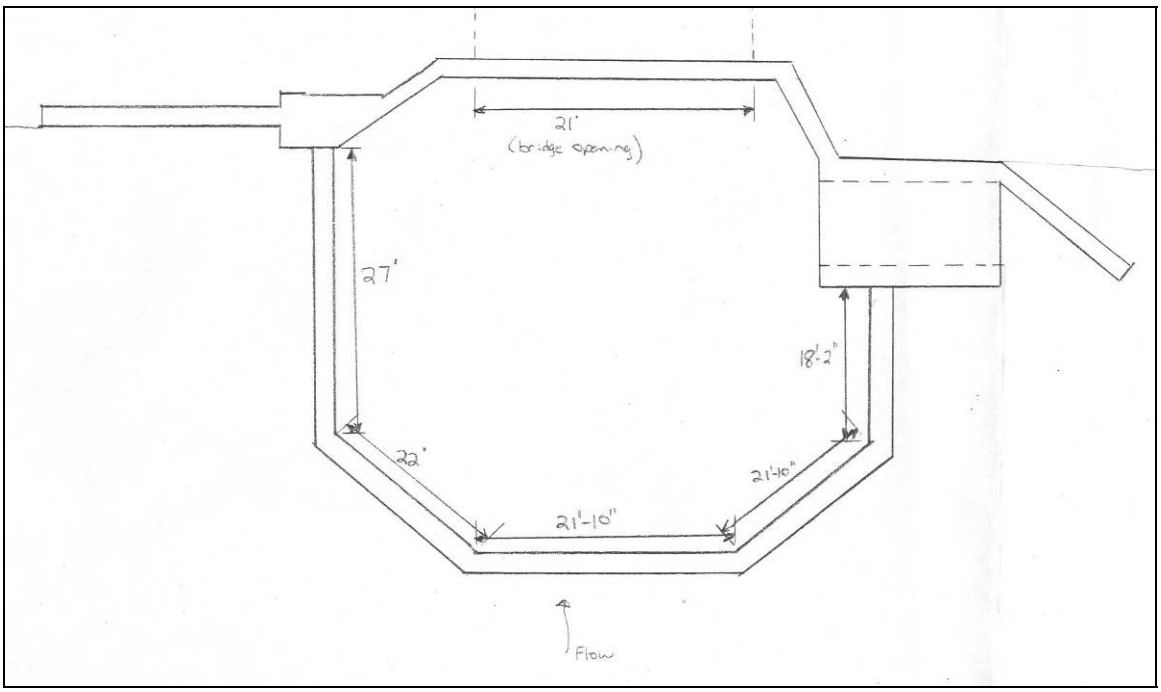


**Figure 3-6: Plan View of Crystal Lake Dam**

### B-3.2.2 Actual Operations

All observed data for the May 2006 and April 2007 flood events were provided by the NHDES. The pool elevation is recorded relative to the summer lake elevation of 623.19 feet. Table 3-3 and Table 3-4 list the pool elevation and the dam operations performed by the NHDES at Crystal Lake.

All stoplogs were in place on May 1, 2006 and the pool was 0.10 foot below the spillway crest. On May 12, two days before peak runoff occurred, the pool was 0.12 foot below the spillway and two stoplogs were removed. During peak runoff on May 14 a total of three stoplogs were out. At this time the pool

elevation reached its maximum recorded height of 3.0 feet over the spillway crest, 1.7 feet below the top of the dam. At this time the flows over the stoplogs inhibited any additional operations. As the storm abated the pool elevation dropped 1.0 foot and on May 16 three more stoplogs could be removed. Pool elevation continued to drop and on May 20 four stoplogs were set in place with the pool elevation 0.4 foot above the spillway crest.

**Figure 3-7: Photograph of the Crystal Lake Dam Spillway**

**Table 3-3: Crystal Lake Pool Elevation and Dam Operations during the May 2006 Flood**

| DATE | POOL ELEVATION | LOG BAY | COMMENTS | INT |
|---|---|---|---|---|
| 5/1/2006 | 0.10 | ALL IN | CLEAR | PA |
| 5/12/2006 | 0.12 | 2 OUT | PULLED 2 LOGS/CLEAR | PA |
| 5/14/2006 | 3 | 3 OUT | RAIN EVENT/PULLED ONE LOG | PA |
| 5/15/2006 | 2.5 | 3 OUT | CLEAR | PA |
| 5/16/2006 | 2 | 3 OUT | WATER LEVEL DROPPED .50 OVER NIGHT | PA |
| 5/17/2006 | 1.1 | 6 OUT | PULLED 3 MORE LOGS | PA |
| 5/20/2006 | 0.4 | 2 OUT | SET 4 LOGS | PA |

**Table 3-4: Crystal Lake Pool Elevation and Dam Operations during the April 2007 Flood**

| DATE | POOL ELEVATION | LOG BAY | COMMENTS | INT |
|---|---|---|---|---|
| 4/3/2007 | -1 | 5 OUT | LET RUN FOR NOW/KEEP EYE ON LEVEL | PA |
| 4/13/2007 | -1.15 | 6 OUT | PULLED ONE LOG/ICE STILL TIGHT | PA |
| 4/16/2007 | 2.6 | 6 OUT | RAIN EVENT/DAM CLEAR | PA |
| 4/19/2007 | 0.9 | 6 OUT | CLEAR/ICE STILL ON LAKE | PA |

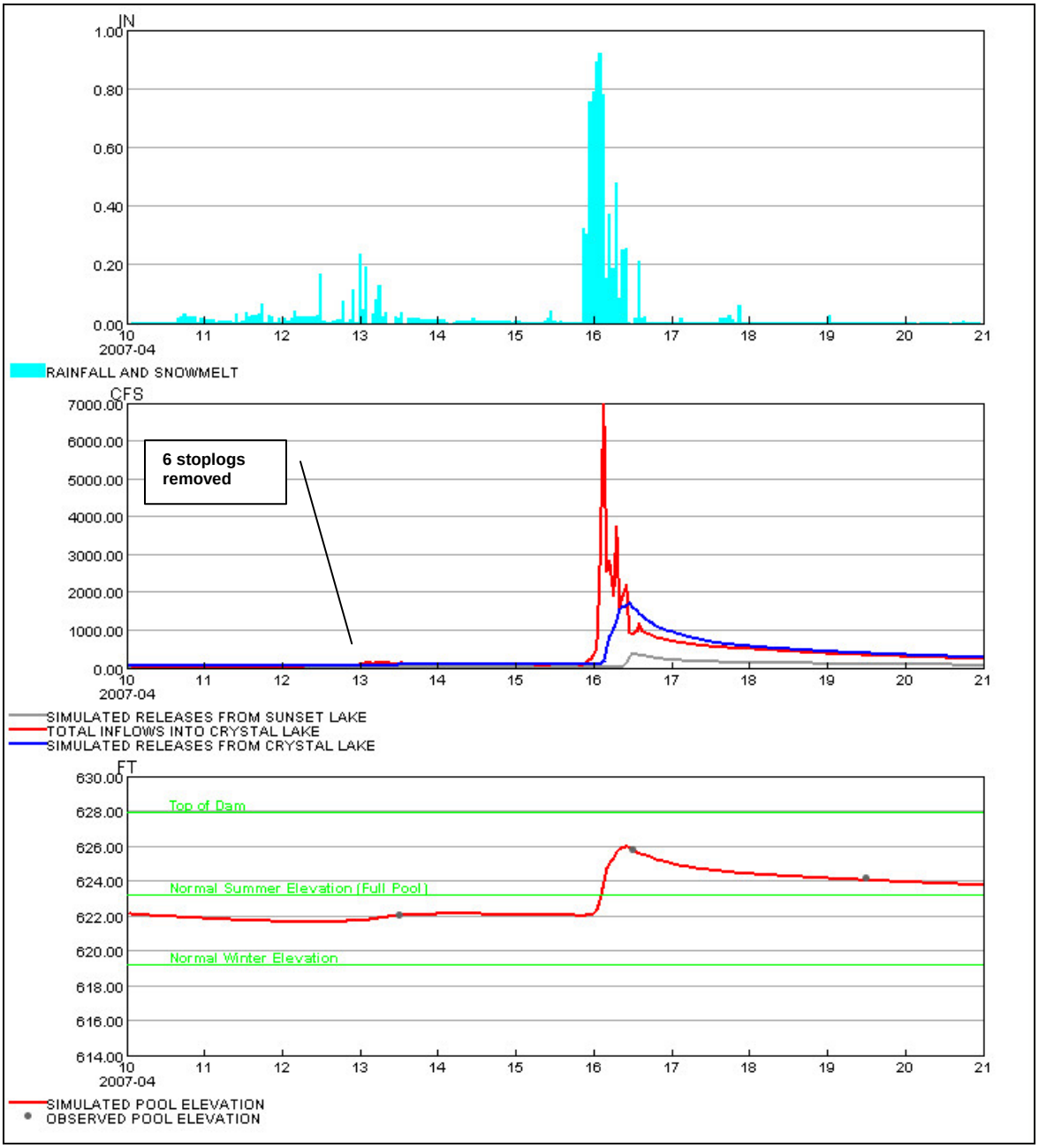


**Figure 3-8: Crystal Lake Simulation Results for the April 2007 Flood Event**

Prior to the April 2007 event, the NHDES tried to keep the pool of Crystal Lake constant to prevent the ice on the lake to cause damage to the shores. On April 3 the pool was 1.0 foot below the spillway crest, and on April 13 the pool was 1.15 feet below. NHDES operators were able to remove six of ten stoplogs on April 13 in anticipation of the event. This kept the pool elevation constant until April 16, when heavy precipitation and snowmelt quickly filled the lake to its maximum recorded height of 2.6 feet above the spillway. This was 2.10 feet below the top of the dam. At this time, however, no more operations were possible, as the remaining stoplogs were submerged by about 6 feet of water. This caused flooding at an upstream road and residences. However, Crystal Lake provided appreciable downstream flood control as the peak of the inflows (most of which were generated below Sunset Lake) was stored.

The simulation for April 2007 is depicted in Figure 3-8 and tracks the observed pool elevations very well.

### B-3.2.3 Alternative Operations

A simulation of Crystal Lake with the pool elevation at the winter drawdown level on April 14 was tested and is shown in Figure 3-9. All other operations were assumed to be unchanged. All upstream reservoirs were also maintained at the winter level until April 14 for this simulation. Starting at the minimum pool on April 14, another 2.3 feet below the original starting pool, would have reduced the maximum pool elevation reached by approximately 0.25 ft. The maximum releases on April 16 could have been reduced by almost 25 percent (from an actual 1700 cfs to 1300 cfs).

An alternative scenario investigated assumed that the existing stoplogs were replaced with a gate of similar dimensions. The simulation included dam operations that opened the gate at 1 p.m. on April 12 2007, just when a regional flood outlook implying possible flooding within the next five days was issued by the NWS. Figure 3-10 demonstrates that this would have significantly lowered the pool elevation by the start of the event and would have lowered the peak pool elevation reached by more than half a foot. Peak releases on April 16 would have been reduced from approximately 1700 cfs to approximately 1400 cfs.

Since upstream flooding is a concern at this site, a small reduction in the pool elevation could have an impact on the local residences.

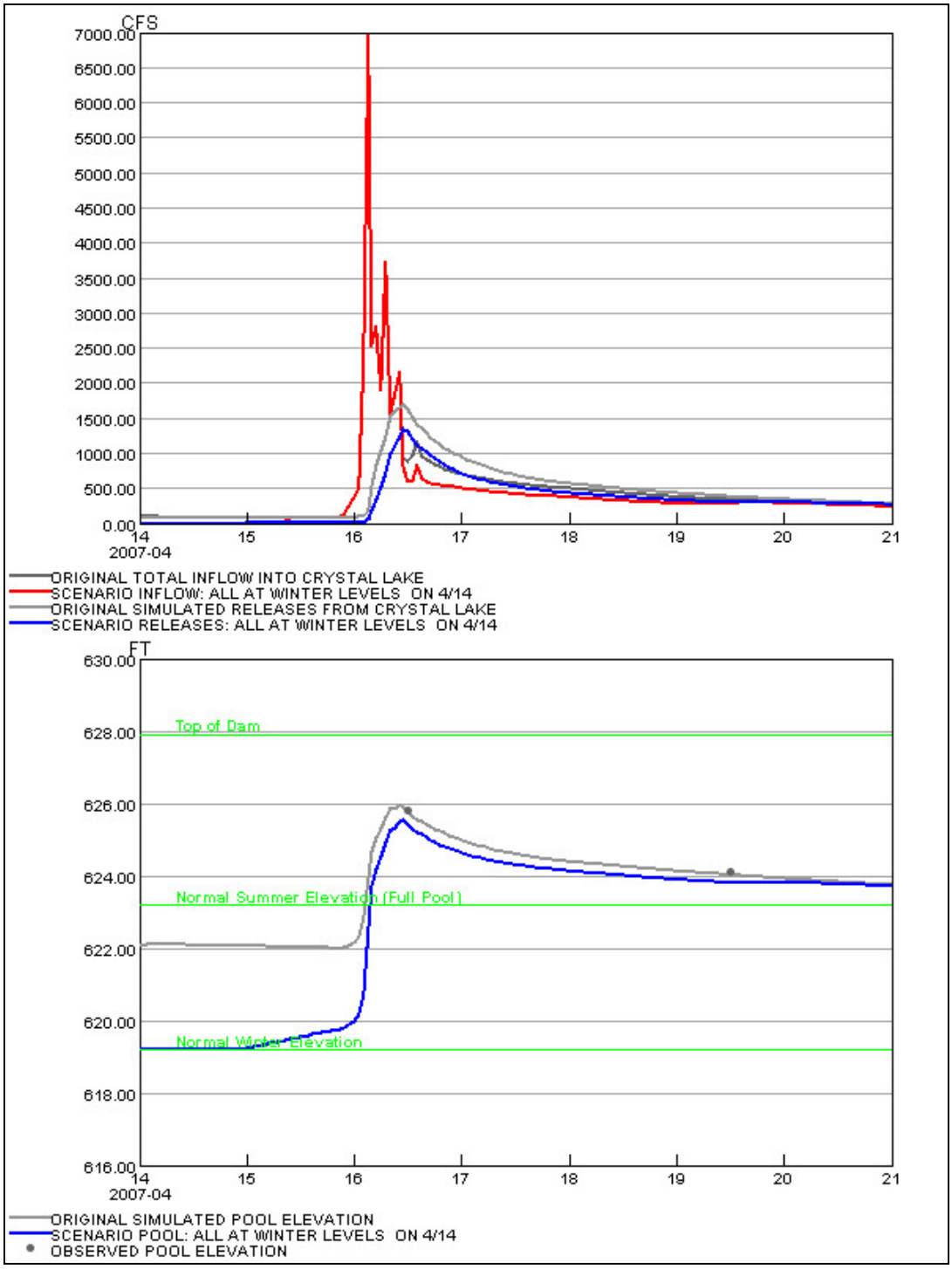


**Figure 3-9: Crystal Lake Alternative Operations - Starting at Minimum Pool on April 14, 2007**

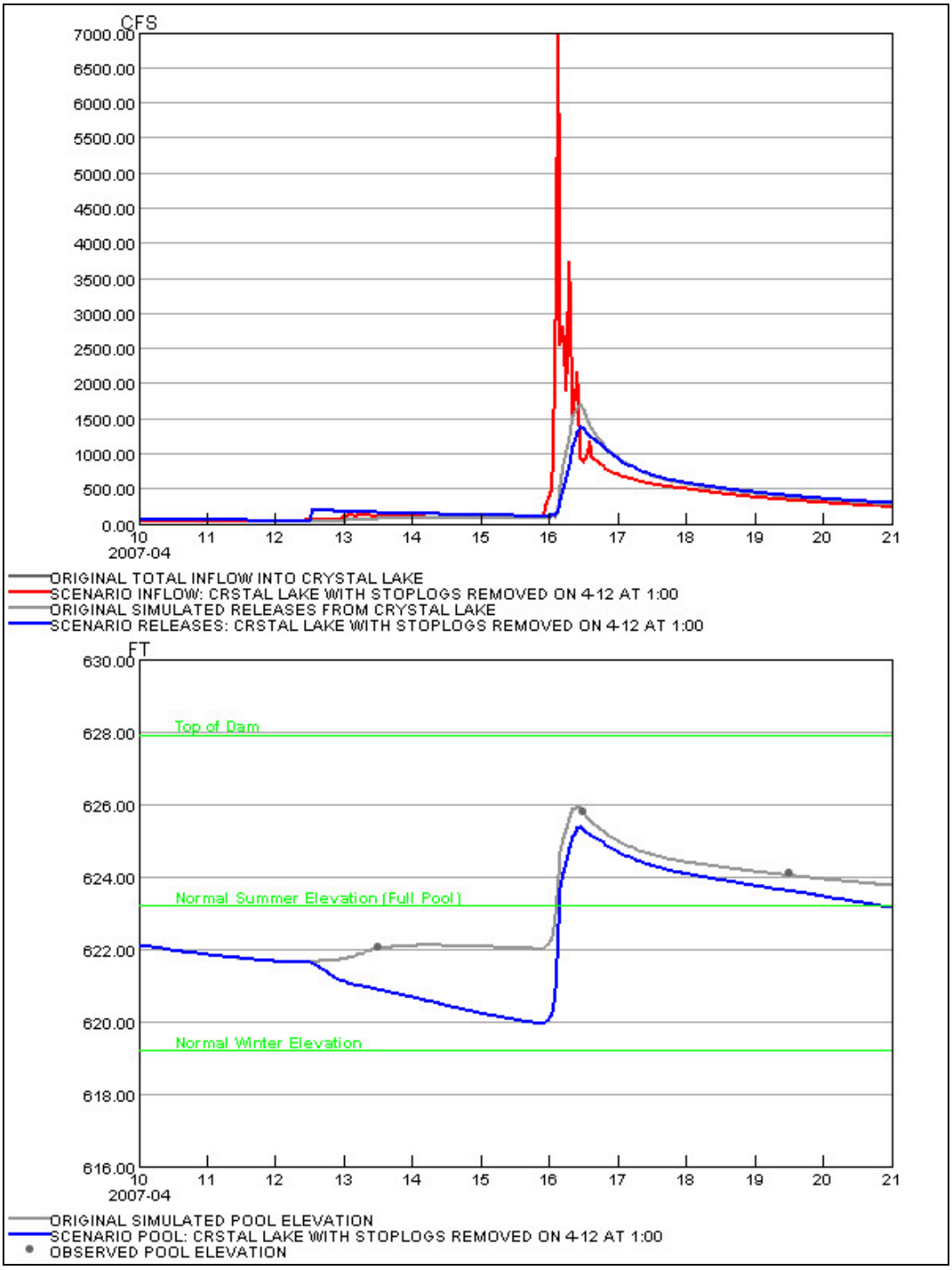


**Figure 3-10: Crystal Lake Alternative Operations - New Gate (in place of stoplogs) opened April 12, 2007**

## B-3.3 Suncook Lake (NHDES# 014.03)

### B-3.3.1 General Description

Suncook Lake is split into an upper and lower portion. Most of the shoreline is developed on the lower lake, and about half on the upper lake. The lake has a storage capacity of about 1,617 acre-feet at normal levels, and up to 7,917 acre-feet at its maximum elevation. Between those levels, Suncook Lake can store about 2.15 inches of runoff.

The pool elevation can be controlled by NHDES staff at a small dam structure at the southeastern edge of the lower lake in Gilmanton. The water level is controlled by opening the gates at the dam.

Typically, the lake level is maintained full (its 'normal level'), during the summer months. This elevation is 550.75 feet. Drawdown for Suncook Lake generally begins around October 1. The full drawdown of five feet is reached by Columbus Day in most years.

A narrow canal and a bridge divide the upper and lower portions of Suncook Lake. This can cause lake elevations to differ in the upper and lower parts. The water level in the lower portion of the lake is therefore two to three feet lower then the lake level in the upper portion during winter operations. It requires 1.09 inches of runoff to refill the lake from the lower winter pool to the normal summer pool.

A plan view of Suncook Lake Dam is shown in Figure 3-11.

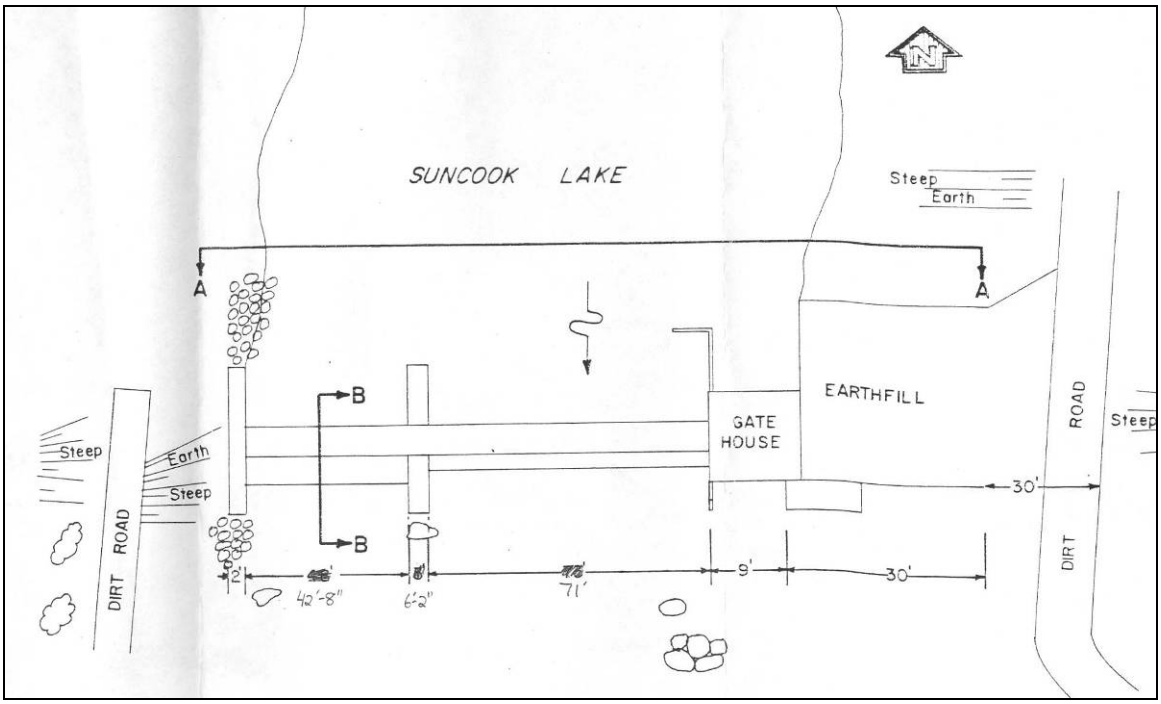


**Figure 3-11: Plan View of Suncook Lake Dam**

## B-3.3.2 Actual Operations

All observed data for the May 2006 and April 2007 flood events were provided by the NHDES. The pool elevations are recorded relative to the summer lake elevation of 550.75 feet. Table 3-5 and Table 3-6 list the pool elevation and the dam operations performed by the NHDES at Suncook Lake.

**Table 3-5: Suncook Lake Pool Elevation and Dam Operations during the May 2006 Flood**

| DATE | TIME | DAM POOL ELEVATION | LAKE POOL ELEVATION | LEFT GATE | RIGHT GATE | COMMENTS | INT |
|---|---|---|---|---|---|---|---|
| 5/1/2006 | | 0.08 | -0.10 | CLOSED | CLOSED | | PA |
| 5/8/2006 | | 0.25 | | CLOSED | CLOSED | | AS |
| 5/12/2006 | | | -0.15 | CLOSED | CLOSED | | PA |
| 5/14/2006 | | 2.1 | HIGH | FULL OPEN | FULL OPEN | RAIN EVENT/DAM CLEAR | PA |
| 5/15/2006 | | 2.35 | | FULL OPEN | FULL OPEN | FREE BOARD ON LEFT SIDE= 1.80 | PA |
| 5/16/2006 | AM | 2 | 1.8 | FULL OPEN | FULL OPEN | DAM CLEAR/COMING DOWN SLOW | PA |
| 5/16/2006 | PM | 1.9 | | FULL OPEN | FULL OPEN | MINUS 19"OFF OF CONCRETE | CL |
| 5/17/2006 | | 1.7 | 1.5 | FULL OPEN | FULL OPEN | DROPPING GOOD | PA |
| 5/20/2006 | | 0.5 | 0.8 | 2 FEET OPEN | 2 FEET OPEN | CLOSED BOTH GATES TO 2 FEET OPEN | PA |
| 5/22/2006 | | 0.4 | | 2 FEET OPEN | 2 FEET OPEN | LET RUN | PA |

**Table 3-6: Suncook Lake Pool Elevation and Dam Operations during the April 2007 Flood**

| DATE | TIME | DAM POOL ELEVATION | LAKE POOL ELEVATION | LEFT GATE | RIGHT GATE | COMMENTS | INT |
|---|---|---|---|---|---|---|---|
| 3/27/2007 | | -5.5 | -2.85 | 2 FEET OPEN | OPEN FULL | CLOSED ONE GATE TO 2 FEET OPEN<br>ICE STILL ON UPPER AND LOWER PONDS TURNING GRAY IN COLOR | AS |
| 4/3/2007 | | -3.25 | -2.4 | 2 FEET OPEN | OPEN FULL | LET RUN/ICE PULLING AWAY FROM SHORE | PA |
| 4/13/2007 | | -4.6 | -3.2 | 2 FEET OPEN | OPEN FULL | CHOPPY/WINDY | PA |
| 4/16/2007 | 6PM | 0.3 | 0 | 2 FEET OPEN | OPEN FULL | RAIN EVENT | PA |
| 4/16/2007 | 9PM | 2 | | 2 FEET OPEN | OPEN FULL | | PA |
| 4/17/2007 | | 1.9 | | 2 FEET OPEN | OPEN FULL | COMING DOWN | PA |
| 4/19/2007 | | 1.3 | 2 | OPEN FULL | OPEN FULL | SOME DEBRIS IN GATES/CLEAR OUT WHEN WATER LEVEL IS DOWN | PA |

Both the left and right gates were closed on May 1, 2006 and the pool was 0.08 foot above the spillway. Pool elevation had risen to 0.25 foot above the spillway on May 8. Lake inflows peaked on May 14, at which time both gates were fully opened. The pool elevation reached a maximum of 2.35 feet over the spillway crest on May 15. This was 0.82 foot below the top of the dam. The gates remained fully open until May 20, when the openings were reduced to 2 feet. At this time the pool was 0.5 foot over the spillway crest. Some damage was reported at an upstream campground during the storm event.

The Lower Suncook Lake was close to its maximum winter drawdown during the first half of April 2007. The pool was 3.25 feet below the spillway on April 3. The pool had dropped to 4.6 feet below the spillway on April 13. The dam was not operated until April 19 to provide some flood control downstream while not causing upstream flooding at the same time. Not fully opening all the gates caused Sunset Lake to rise to about 2 feet above normal pool on April 16, which was 1.17 feet below the top of the dam. Some upstream flooding occurred according to verbal complaints received by the NHDES. However, large portions of the inflows were stored and thus Sunset Lake provided significant downstream flood control.

The constriction between the upper and the lower lake often minimizes the impact of operations at the dam (at the lower portion) on the upper lake. Thus, flooding might occur along the shore of the upper lake even though the dam is discharging at its maximum capacity.

This complicates modeling the Suncook Lakes. The observed pool elevations could not be exactly reproduced—however, the general trend is captured as shown in Figure 3-12.

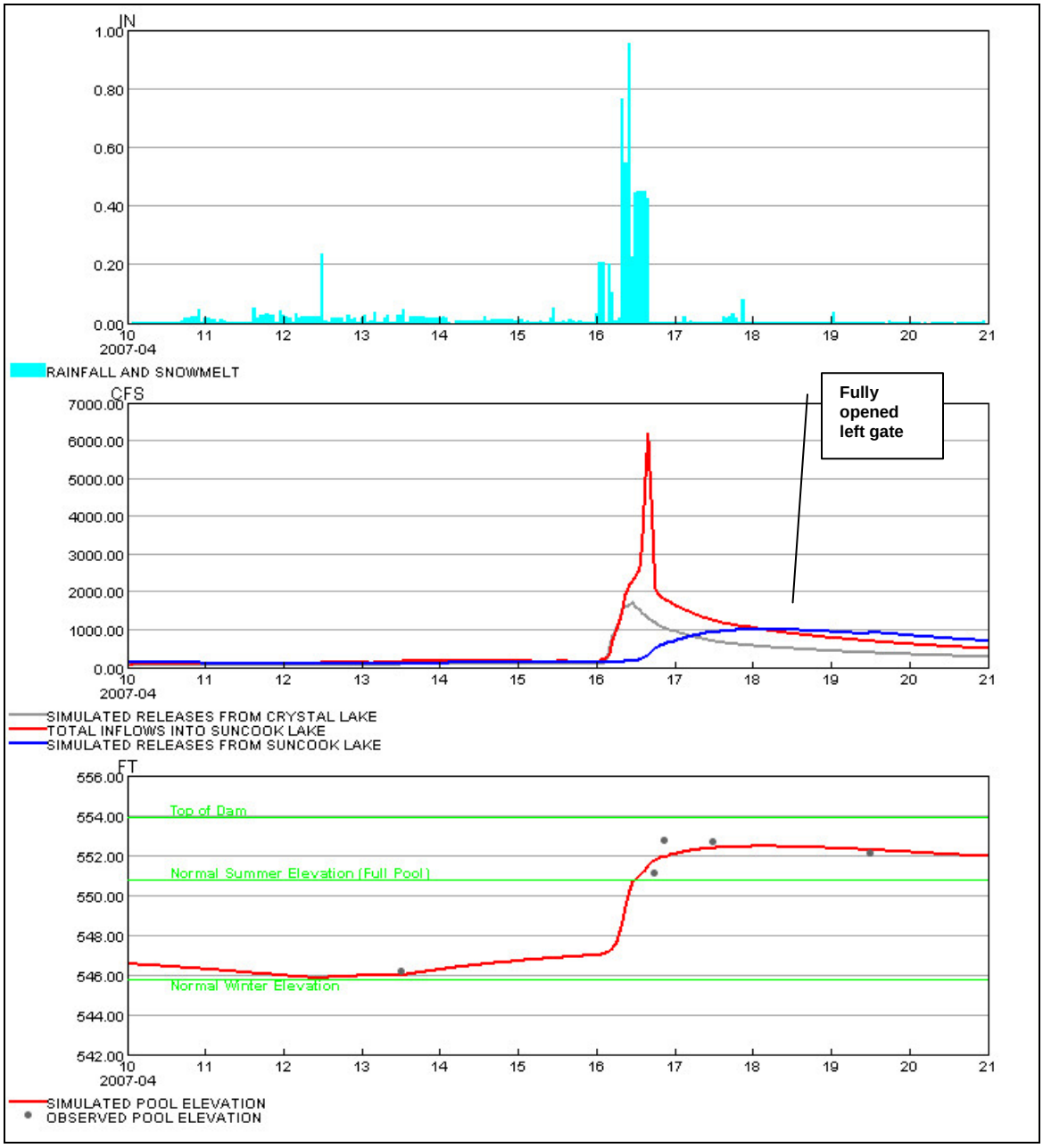


**Figure 3-12: Suncook Lake Simulation Results for the April 2007 Flood Event**

## B-3.3.3 Alternative Operations

A simulation of Suncook Lake with the pool elevation at the winter drawdown level on April 14 was tested and is shown in Figure 3-13. All other operations were assumed to be unchanged. All upstream reservoirs were also maintained at the winter level until April 14 for this simulation.

Before the April 2007 event, Suncook Lake was already near the winter drawdown. Therefore little additional flood control was gained by maintaining the winter drawdown longer. The maximum pool elevation would have been slightly reduced by starting at the winter pool elevation. Similarly, the maximum releases between April 16 and April 17 would have been reduced from approximately 1000 cfs

to approximately 750 cfs. Considering that upstream flooding was a problem, this small reduction could be significant.

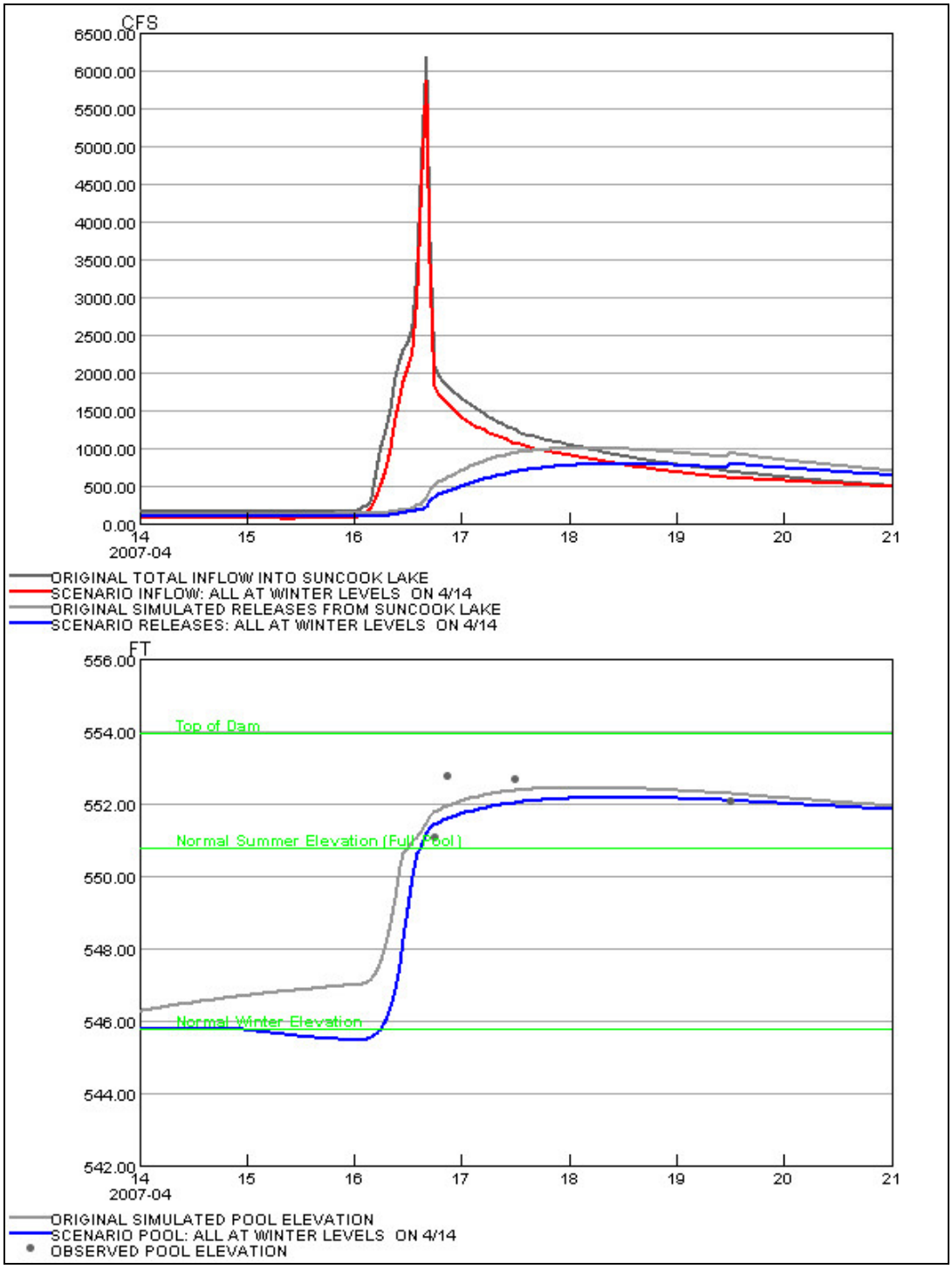


**Figure 3-13: Suncook Lake Alternative Operations - Starting at Minimum Pool on April 14**

## B-3.4 Barnstead Parade (NHDES# 014.08)

### B-3.4.1 General Description

Barnstead Parade is a run-of-river project located directly upstream of the town of Barnstead. The lakeshore on the northern side, along Parade Hill Road, is mostly developed. The impounded area is a small pond, located directly on the Suncook River. It has a storage capacity of 550 acre-feet at normal levels, and up to 1,000 acre-feet at its maximum elevation. Between those levels, Barnstead Parade can store about 0.08 inch of runoff.

The pool elevations are controlled by NHDES staff at a dam structure located in the town of Barnstead. This is typically done by manual operation of a gate, a stoplog bay, and flashboards. The normal lake elevation is 494.36 feet, which corresponds to the top of the flashboards at the dam. After Columbus Day, drawdown begins and the lake level is lowered by 1.5 feet.

A plan view and photograph of Barnstead Parade Dam are shown in Figure 3-14 and Figure 3-15, respectively.

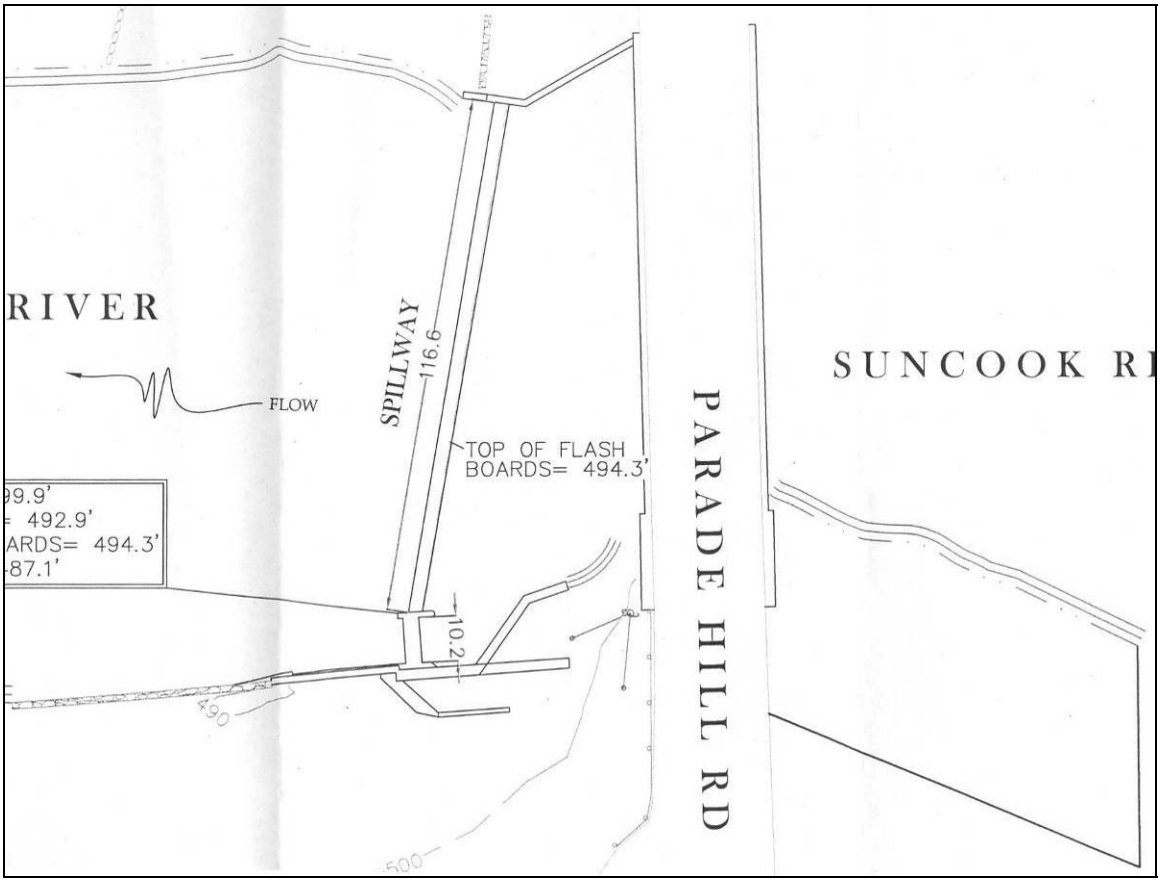


**Figure 3-14: Plan View of Barnstead Parade Dam**

**Figure 3-15: Photograph of Barnstead Parade Dam**

## B-3.4.2 Actual Operations

All observed data for the May 2006 and April 2007 flood events were provided by the NHDES. The pool elevation is recorded relative to the summer lake elevation of 494.36 feet. Table 3-7 and Table 3-8 list the pool elevation and the dam operations performed by the NHDES at Barnstead Parade.

**Table 3-7: Barnstead Parade Pool Elevation and Dam Operations during the May 2006 Flood**

| DATE | POOL ELEVATION | GATE | LOG BAY | SPILLWAY/FLASHBOARD CONDITION | COMMENTS | INT |
|---|---|---|---|---|---|---|
| 5/1/2006 | 0.38 | GATE CLOSED | ALL IN | FLASH BOARDS UP | | PA |
| 5/8/2006 | 0.45 | GATE CLOSED | ALL IN | | | AS |
| 5/12/2006 | 0.45 | | 3 OUT | | PULLED 3 LOGS/CLEARED DEBRIS | PA |
| 5/14/2006 | 3 | GATE FULL OPEN | 3 OUT | FLASH BOARDS OPERATED IN | | |
| | | | | MIDDLE SECTION APROX. 40 FEET | RAIN EVENT | PA |
| 5/15/2006 | 3 | GATE FULL OPEN | 3 OUT | | RIGHT WALL=2.00' OF FREEBOARD | PA |
| 5/16/2006 | 3.25 | GATE FULL OPEN | 3 OUT | | COMING DOWN | PA |
| 5/17/2006 | 2.75 | GATE FULL OPEN | 3 OUT | ALL OF F/B'S OPERATED OVERNIGHT | COMING DOWN | PA |
| 5/20/2006 | 1.75 | GATE FULL OPEN | 3 OUT | | CLEAR/LET RUN | PA |
| 5/22/2006 | -1.2 | GATE FULL OPEN | 3 OUT | | LET RUN | PA |

**Table 3-8: Barnstead Parade Pool Elevation and Dam Operations during the April 2007 Flood**

| DATE | TIME | POOL ELEVATION | GATE | LOG BAY | SPILLWAY/FLASHBOARD CONDITION | COMMENTS | INT |
|---|---|---|---|---|---|---|---|
| 4/3/2007 | | -0.3 | GATE CLOSED | 4 OUT | FLASH BOARDS NOT ON SPILLWAY | CLEAR | PA |
| 4/13/2007 | | -0.6 | GATE CLOSED | 4 OUT | | LET RUN/CLEAR | PA |
| 4/16/2007 | | 4.5 | GATE CLOSED | 4 OUT | | RAIN EVENT | PA |
| 4/17/2007 | AM | 3.75 | GATE CLOSED | 4 OUT | | CLEAR | PA |
| 4/17/2007 | 5:30 PM | 2.3 | GATE CLOSED | 4 OUT | | CLEAR | PA |
| 4/19/2007 | | 1.25 | GATE CLOSED | 4 OUT | | | PA |

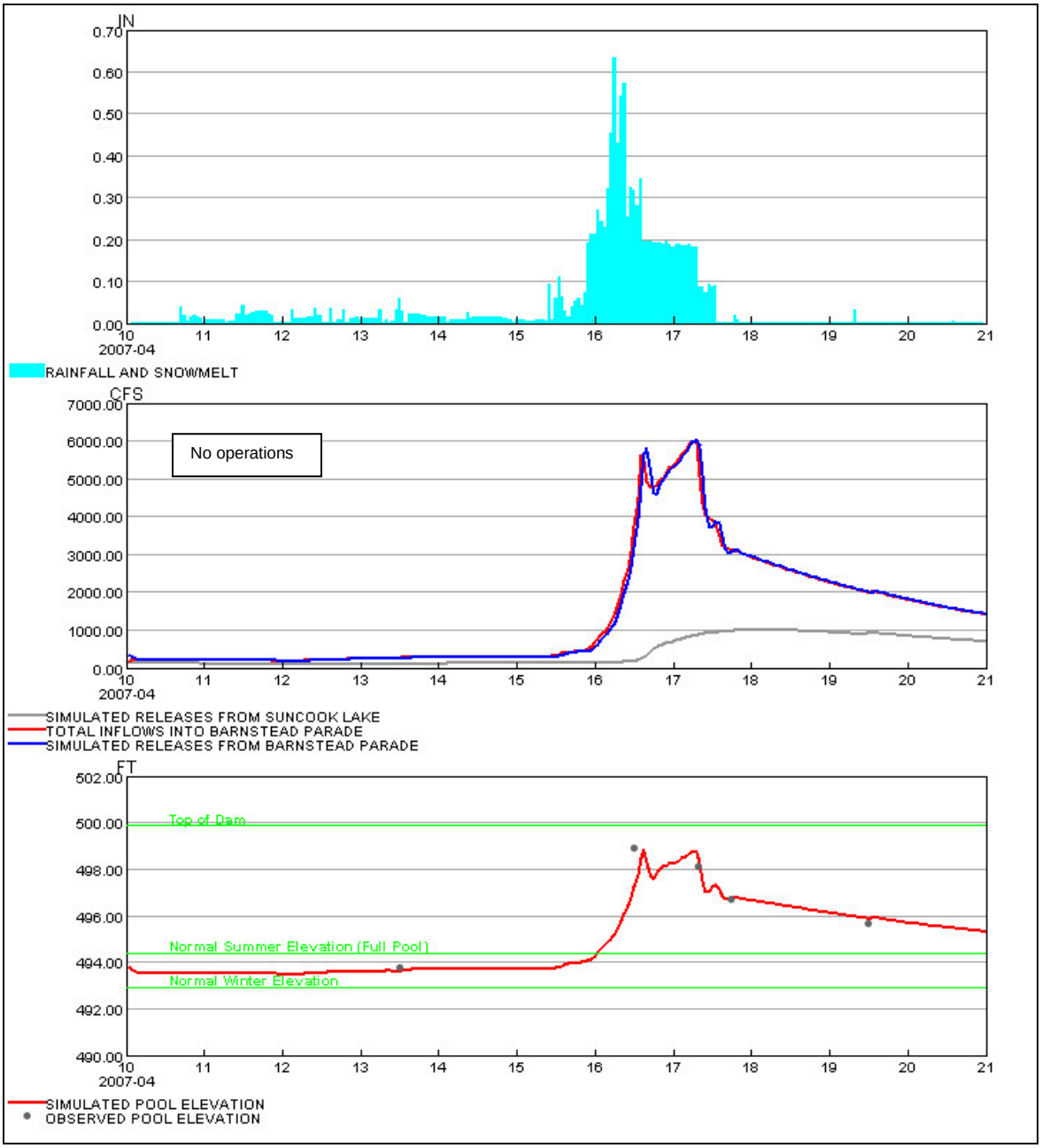


**Figure 3-16: Barnstead Parade Simulation Results for the April 2007 Flood Event**

At the beginning of May 2006, the gate at the dam was closed, all stoplogs were in place, and the flash boards were installed. The pool was 0.38 foot above the flashboards on May 1, and rose to 0.45 foot over on May 8. The pool was still 0.45 foot over on May 12. Three stoplogs were removed at this time in anticipation of the storm event. Inflows started to increase on May 13, raising the pool to 3 feet above the flashboards on May 14. On this day the gate was fully opened, in addition 40 feet of flashboards operated. On May 16 the pool elevation reached its maximum recorded height of 3.25 feet above the flashboards. This was 3.75 feet below the top of the dam. During the following night the remaining flashboards operated and the pool elevation started to drop. On May 22, with all flashboards out, the gates still fully open and three stoplogs out, the pool elevation had dropped to 0.3 foot above the spillway crest.

For the April 2007 event, the observed pool elevations at Barnstead parade suggest that most of its inflows originated in the area downstream of Suncook Lake. According to the NHDES, high pool at Barnstead Parade does typically not cause upstream damage. Flashboards were not installed at the time of the April 2007 event and the dam itself was not operated during the event. The pool was 1.20 feet above the spillway on April 3, and had dropped to 0.9 foot above the spillway on April 13. Without intervention, Barnstead Parade rose to a maximum recorded height of 6.0 feet above the spillway on April 16. This was 1.0 feet below the top of the dam. No flood damage was reported to the NHDES. The pool dropped after the storm event and was 2.75 feet above the spillway crest on April 19. Downstream flooding is a concern at this location, but the simulation results suggest that the releases very closely mirror the inflows into Barnstead Parade and that the project does not provide any appreciable flood control.

The area contributing runoff to Barnstead Parade includes the Big River and is about twice the size of the area contributing to Suncook Lake. Most of the inflows into Barnstead Parade during the April 2007 event (peaking at approximately 6000 cfs) were therefore generated below Suncook Lake, which released a maximum of approximately 1800 cfs on April 16. The simulation for April 2007 is depicted in Figure 3-16 and tracks the observed pool elevations reasonably well.

### B-3.4.3 Alternative Operations

Figure 3-17 shows a simulation of Barnstead Parade with the pool elevation at the winter drawdown level on April 14. The upstream reservoirs were also simulated to be at the winter drawdown level on April 14. All other operations were unchanged. Barnstead Parade is a very small reservoir and the alternative operations would not have significantly reduced the maximum pool elevation. The peak flows at the site would have been reduced by approximately 250 cfs (from a total of 6000 cfs) on April 17, caused by lower releases from Suncook Lake.

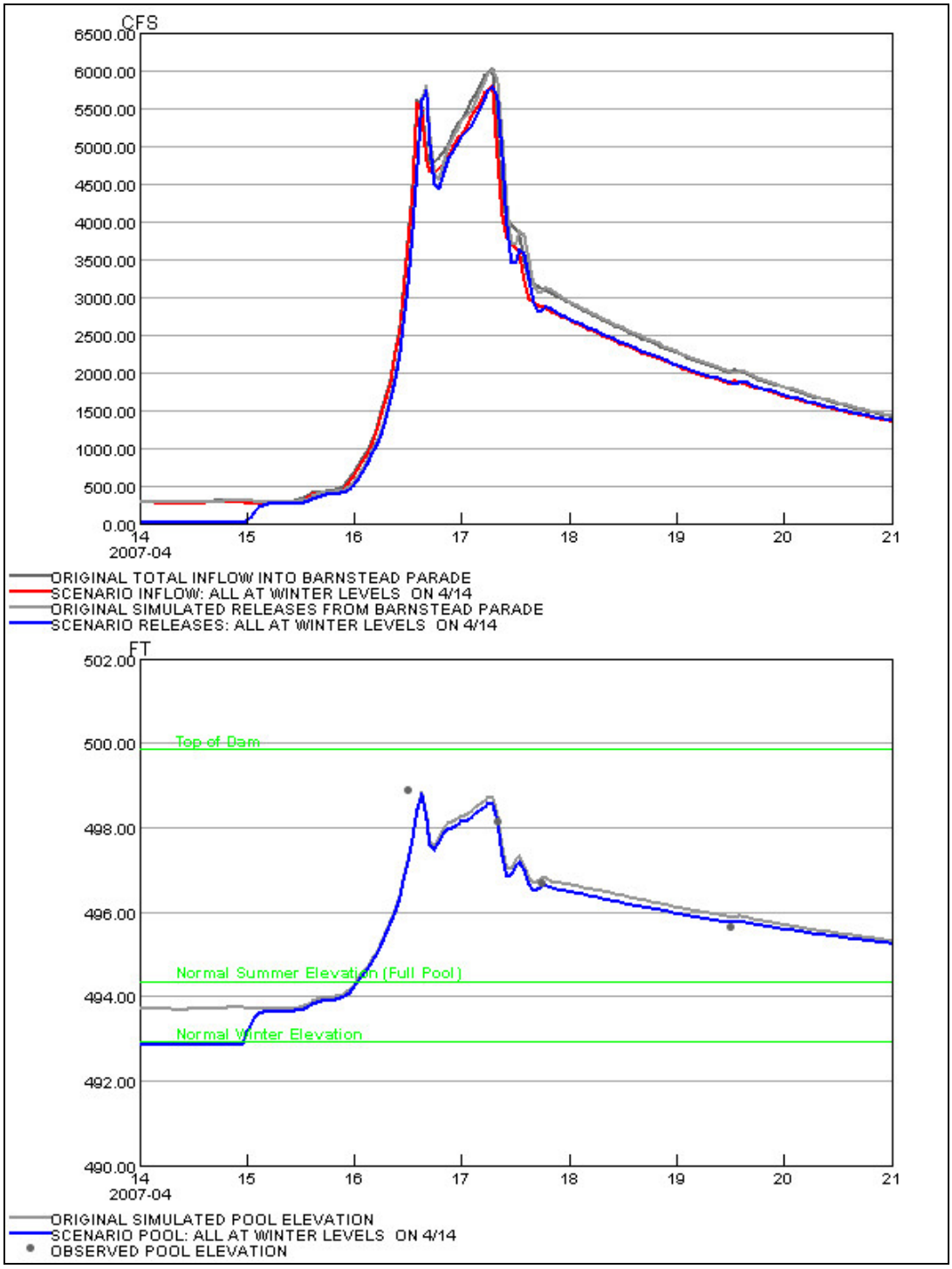


**Figure 3-17: Barnstead Parade Alternative Operations - Starting at Minimum Pool on April 14**

## B-3.5 Pittsfield Mill Dam (NHDES# 195.11)

### B-3.5.1 General Description

Pittsfield Mill Dam is run-of-river project located below Barnstead Parade in the town of Pittsfield. As the pond is located in the town, most of the shoreline is developed. The pond has a very small storage capacity of about 112 acre-feet at normal levels, and up to 212 acre-feet at its maximum elevation. 0.01 inch of runoff can be stored between those elevations.

The pool elevation can be controlled at a small dam structure at the western edge of the pond. This is typically done by manual operation of two gates and two log bays.

A photograph of Pittsfield Mill Dam is shown in Figure 3-18.

**Figure 3-18: Photograph of Pittsfield Mill Dam**

### B-3.5.2 Actual Operations

All observed data for the May 2006 and April 2007 flood events were provided by the NHDES. The pool elevation is recorded relative to the summer lake elevation of 474.6 feet. Table 3-9 and Table 3-10 list the pool elevation and the dam operations.

**Table 3-9: Pittsfield Mill Dam Pool Elevation and Dam Operations during the May 2006 Flood**

| DATE | TIME | POOL ELEVATION | LEFT GATE | RIGHT GATE | LOG BAY | LOG BAY | SPILLWAY/FLASHBOARD CONDITION | COMMENTS | INT |
|---|---|---|---|---|---|---|---|---|---|
| 5/3/2006 | | 0.80 | CLOSED | CLOSED | ALL IN | ALL IN | | | AS |
| 5/12/2006 | | 0.35 | CLOSED | CLOSED | 3 OUT | 3 OUT | | PULLED 3,3 | PA |
| 5/14/2006 | | 3 | 1.50 OPEN | 7" OPEN | 3 OUT | 3 OUT | SANDBAGGED RIGHT AND LEFT SIDE | RAIN EVENT/TEETH ON GATE | PA/BH/MC |
| | | | | | | | | MECH. BROKE/ FIRE DEPT. SANDBAGGING | |
| 5/15/2006 | 8:30AM | 4.1 | 1.50 OPEN | 7" OPEN | 3 OUT | 3 OUT | | CUT CABLE/HOLDING DEBRIS/.10 OVER GATE SIDE | PA |
| 5/15/2006 | 12:00PM | 4.1 | 1.50 OPEN | 7" OPEN | 3 OUT | 3 OUT | | | PA |
| 5/15/2006 | 2:30PM | 4.15 | 1.50 OPEN | 7" OPEN | 3 OUT | 3 OUT | | | PA |
| 5/16/2006 | | 3.35 | 1.50 OPEN | 7" OPEN | 3 OUT | 3 OUT | | MINUS 0.65 FROM TOP OF CONCRETE/GATE SIDE | PA |
| 5/16/2006 | PM | 3 | 1.50 OPEN | 7" OPEN | 3 OUT | 3 OUT | | MINUS 12" OFF CONCRETE/GATE SIDE | CL |
| 5/17/2006 | | 2.85 | 1.50 OPEN | 7" OPEN | 3 OUT | 3 OUT | | MINUS 1.15 FROM TOP DECK/GATE SIDE | PA |
| 5/20/2006 | | 1.2 | 1.50 OPEN | 7" OPEN | 3 OUT | 3 OUT | | CLEAR/LET RUN | PA |

**Table 3-10: Pittsfield Mill Dam Pool Elevation and Dam Operations during the April 2007 Flood**

| DATE | TIME | POOL ELEVATION | LEFT GATE | RIGHT GATE | LOG BAY | LOG BAY | COMMENTS | INT |
|---|---|---|---|---|---|---|---|---|
| 4/3/2007 | | 1 | CLOSED | CLOSED | ALL IN | ALL IN | CLEAR | PA |
| 4/13/2007 | | 0.75 | CLOSED | CLOSED | ALL IN | ALL IN | CLEANED OUT LOG BAYS | PA |
| 4/16/2007 | | 3.5 ALSO SEE COMMENTS | CLOSED | OPEN 6 FEET | ALL IN | ALL IN | AM= 6" OF FREEBOARD/FIRE DEPT. SAND BAGGING/ AT 1:00 PM PLUS .50 OVER CONCRETE, BOTH SIDES SANDBAGGED/ START OPENING GATE TO 15" AT 3:00PM AND WATER IS PLUS 1.0' OVER TOP/GOT GATE OPEN TO 6.0'/ 10:00PM POND STARTING TO COME DOWN | PA |
| 4/17/2007 | PM | -1.5 | CLOSED | OPEN 6 FEET | ALL IN | ALL IN | MINUS 5.5 OF FREEBOARD/GATE= 6.0' | PA |
| 4/19/2007 | | 1.6 | OPEN | OPEN | ALL IN | ALL IN | CREW WORKING D/S | PA |
| 4/23/2007 | | 0.6 | 1 FOOT OPEN | 1 FOOT OPEN | ALL IN | ALL IN | CLOSED BOTH GATES TO 1 FOOT EACH | PA/CL |

On May 3, 2006 the pool elevation was 0.80 foot above the spillway crest. Six stoplogs were removed on May 12, effectively dropping the pool elevation to 0.35 foot over the spillway. At this time both the right and left sides of the spillway were sandbagged. Inflows to the dam started to increase on May 13. On May 14 the left gate was opened 1.5 feet and the right gate was opened 0.6 foot. No more operations were performed. The maximum recorded pool elevation was 4.15 feet over the spillway crest on May 15, exceeding the top of dam elevation by 0.15 foot.

Pittsfield Mill Pond was 1.0 foot over the spillway crest on April 3, 2007. Ten days later, on April 13, the pool had dropped slightly to 0.75 foot over the spillway. On April 16, one gate was opened amidst rising pool elevations. A second gate could initially not be operated and was only opened 6 feet in the afternoon of the 16th. By this time the water levels at Pittsfield Mill Pond had risen above the top of the dam, which was sandbagged to prevent overtopping and associated damage. At that time it was already impossible to remove stoplogs. The maximum recorded height was 2.5 feet over the spillway on April 16, exceeding the dam height by 0.5 foot.

The simulation model (see Figure 3-19) implements some documented operations at the gates in the afternoon of April 17, 2007, however, it seems impossible to recreate the sudden drop in pool suggested by a pool observation at 7 p.m. that day.

The vast majority of inflows into Pittsfield Mill Pond are releases from Barnstead Parade, which itself cannot provide significant flood control. Note that the operations at Pittsfield Mill Dam had only minor impact on the releases from this dam, which greatly resemble the inflows. This demonstrates the limited flood control capacity of the Pittsfield Mill project.

The USGS estimated peak flow at a gage downstream of Pittsfield Mill, “Suncook River at North Chichester,” to be 10, 600 cfs. This is very close to the 10,554 cfs estimated by the simulation for the gage at 7 a.m. on April 17.

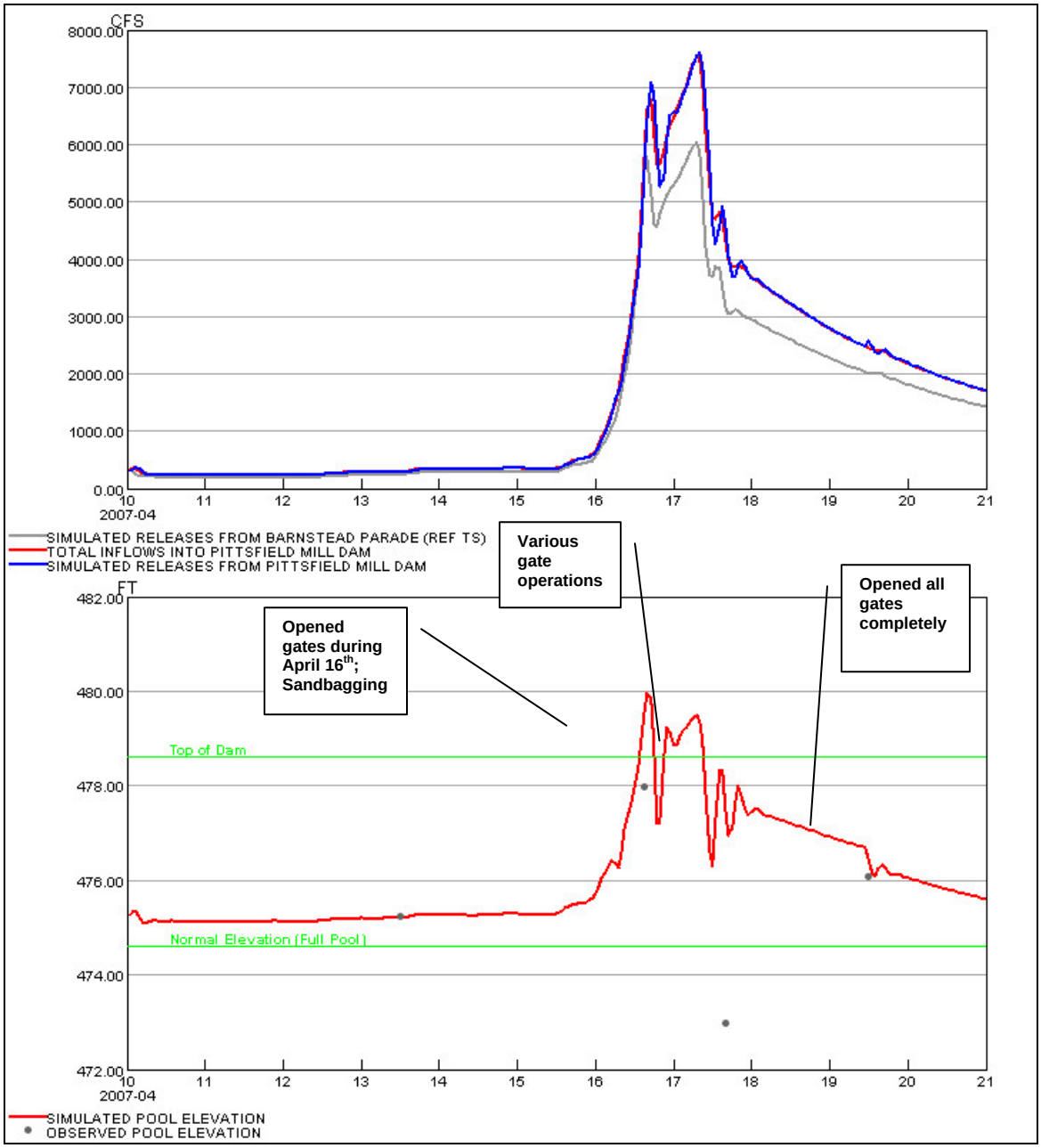


**Figure 3-19: Pittsfield Mill Dam Simulation Results for the April 2007 Flood Event**

## B-3.5.3 Alternative Operations

Figure 3-20 shows a simulation of Pittsfield Mill Dam with the pool elevation at the winter drawdown level on April 14. The upstream reservoirs were also at the winter drawdown for this simulation. All other operations were unchanged. The results of additional alternative operations are shown in Figure 3-21, addressing concerns regarding the effects of the inoperable gate at the dam. The investigated scenarios include: (1) approaching the event with a completely drained reservoir ('minimum pool') on April 14; (2) starting at minimum pool, with all gates open and all stoplogs removed, thus providing maximum discharge capacity, (3) starting at minimum pool with all gates closed and all stoplogs in, thus storing the

maximum flood volume in the reservoir. These scenarios employ very extreme operations, but illustrate the maximum achievable flood control benefits.

Neither scenario resulted in significant drops in peak pool elevation, indicating that Pittsfield Mill Dam can provide no appreciable flood control through the storage of flood waters.

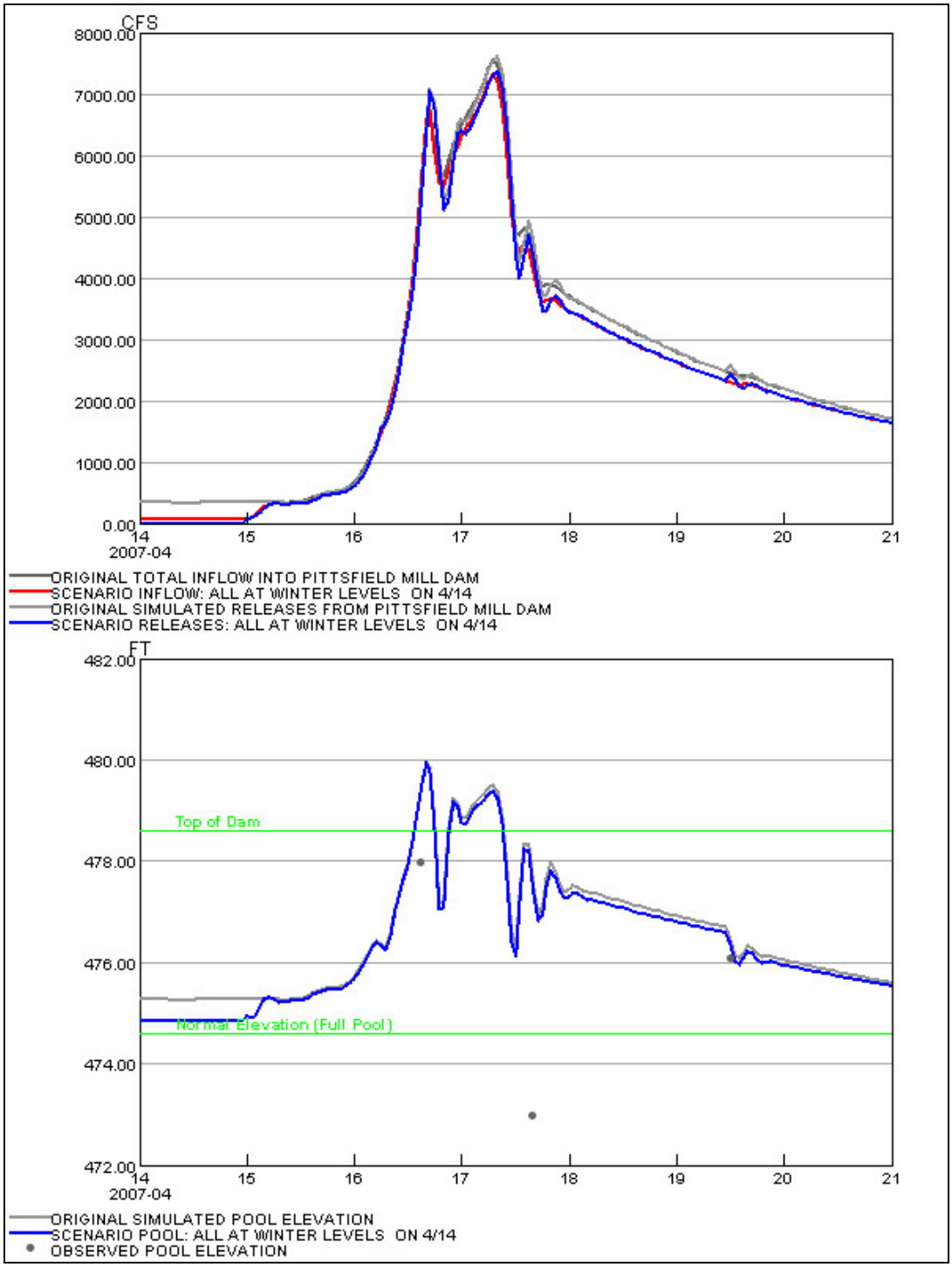


**Figure 3-20: Pittsfield Mill Dam Alternative Operations - Starting at Winter Pool on April 14**

**Figure 3-21: Pittsfield Mill Dam Alternative Operations - Various Scenarios**

## B-3.6 Pleasant Lake (NHDES# 061.01)

### B-3.6.1 General Description

Pleasant Lake is located on the Little Suncook River, upstream of Northwood Lake. The majority of the shoreline is developed. The lake has a storage capacity of 552 acre-feet and 1,200 acre-feet at its normal and maximum elevations respectively. Between those levels, Pleasant Lake can store about 3.45 inches of runoff, providing significant local flood control. The normal pool elevation is 578.7 feet. Operations at Pleasant Lake are limited to setting or removing stoplogs in front of the culvert at the dam site.

A plan view of Pleasant Lake Dam is shown in Figure 3-22.

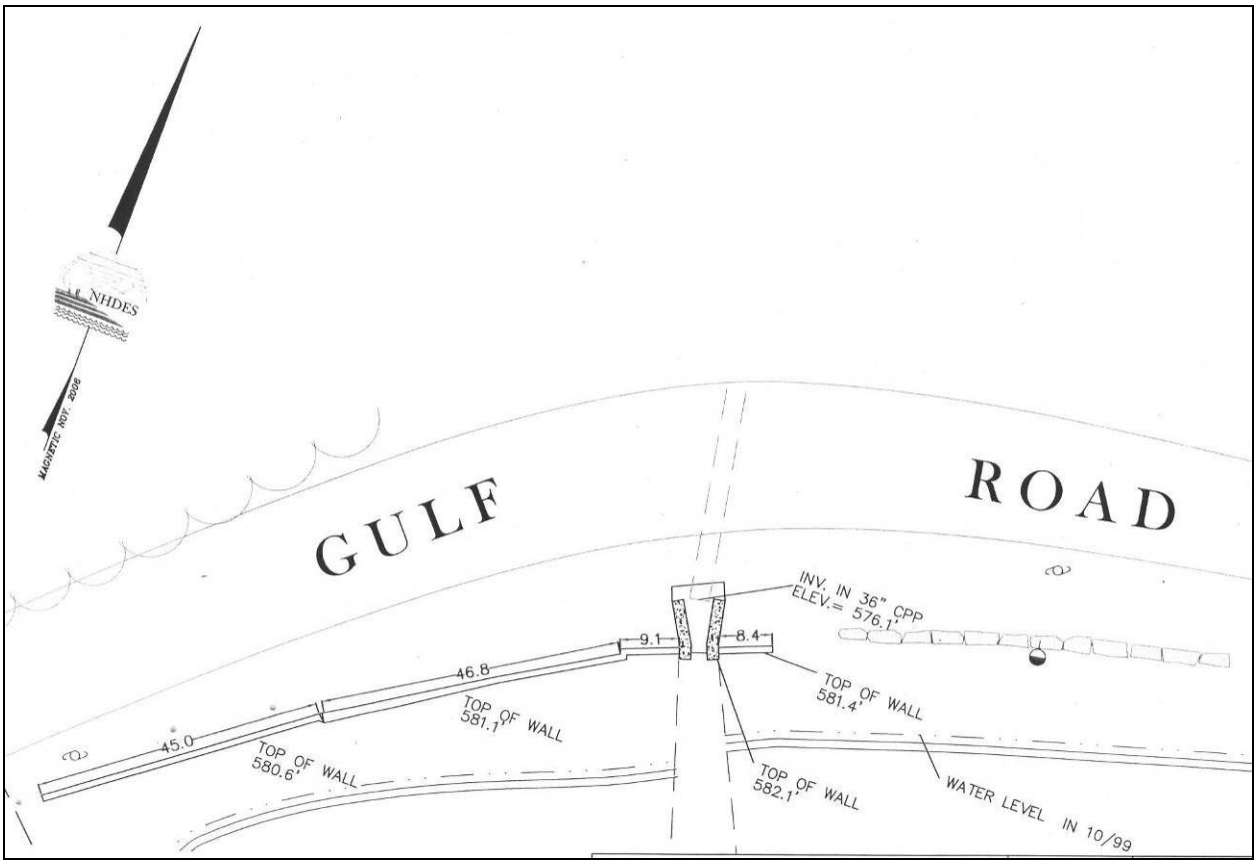


**Figure 3-22: Plan View of Pleasant Lake Dam**

### B-3.6.2 Actual Operations

All observed data for the May 2006 and April 2007 flood events were provided by the NHDES. The pool elevation is recorded relative to the normal lake elevation of 578.7 feet minus 6.30 feet. Table 3-11 and Table 3-12 list the pool elevation and the dam operations.

**Table 3-11: Pleasant Lake Pool Elevation and Dam Operations during the May 2006 Flood**

| DATE | TIME | POOL ELEVATION | LOG BAY | COMMENTS | INT |
|---|---|---|---|---|---|
| 5/5/2006 | | 6.10 | 1HALF LOG OUT | OK/F/F | CT |
| 5/8/2006 | | 6.12 | | WINDY | CT |
| 5/11/2006 | | 6.1 | | NO CHANGE | CT |
| 5/13/2006 | 6:30 AM | 6.26 | 1 FULL/1 HALF LOG OUT | PULLED ONE LOG | CT |
| 5/13/2006 | 5:00PM | 6.4 | 2 FULL/1HALF LOG OUT | PULLED ONE LOG | CT |
| 5/15/2006 | | 9.6 | 2 FULL/1HALF LOG OUT | MINUS 1 FOOT@CORE WALL/OVER ROAD WATER OVER ROAD/BOIL ON D/S SIDE | CT |
| 5/17/2006 | | 9.6 | 2 FULL/1HALF LOG OUT | MINUS 1 FOOT@CORE WALL/OVER ROAD | CT |
| 5/18/2006 | | 9.5 | 2 FULL/1HALF LOG OUT | OK | CT |
| 5/20/2006 | | 9.45 | 3 FULL/1 HALF LOG OUT | PULLED ONE LOG | CT |
| 5/21/2006 | | 9.05 | ONE LOG IN | PULLED ONE LOG/ALL OUT EXCEPT BASE LOG | CT |

**Table 3-12: Pleasant Lake Pool Elevation and Dam Operations during the April 2007 Flood**

| DATE | TIME | POOL ELEVATION | LOG BAY | COMMENTS | INT |
|---|---|---|---|---|---|
| 4/10/2007 | | 5.5 | ALL OUT | CLEAR/STILL ICE ON LAKE | PA |
| 4/19/2007 | | 7.5 | ALL OUT | 0.8 OVER TOP OF LAKE GAGE | AS |
| 4/23/2007 | | 7.1 | ALL OUT | OK/LET RUN | CT |

One half stoplog was out at the beginning of May 2006, with a pool elevation of 0.2 foot below normal lake elevation. Lake inflows began to rise on May 13, and two stoplogs were removed. The pool elevation continued to rise, spilling over the road and reaching the maximum recorded height of 3.3 feet above normal lake elevation on May 15. Additional stoplogs were pulled on both May 20 and May 21, resulting in a 0.5 foot drop in the pool elevation.

In April 2007, no stoplogs were present and no operations were performed at the dam. On April 10, the pool was 0.8 foot below normal lake elevation. After the storm on April 19 the pool had risen to its maximum recorded height of 1.2 feet over normal lake elevation. Given this, the simulations suggest that the pond quickly rose above normal pool elevation and started spilling over the road next to the highest portion of the dam.

The NHDES states that flooding is a problem both upstream and downstream of the dam—and while the lake did hold back significant flow volumes, the configuration of the dam and the limited possibilities for operation seem to have hindered additional flood prevention measures at the site.

### B-3.6.3 Alternative Operations

A simulation of Pleasant Lake with a lower pool elevation on April 14, 2007, was tested and is shown in Figure 3-23 and Figure 3-24. All other operations were assumed to be unchanged. These alternative operations would have dropped the maximum pool elevation reached during the event by approximately half a foot. The maximum releases during the event would not have changed because they would have been restricted by the capacity of the culvert at the outlet.

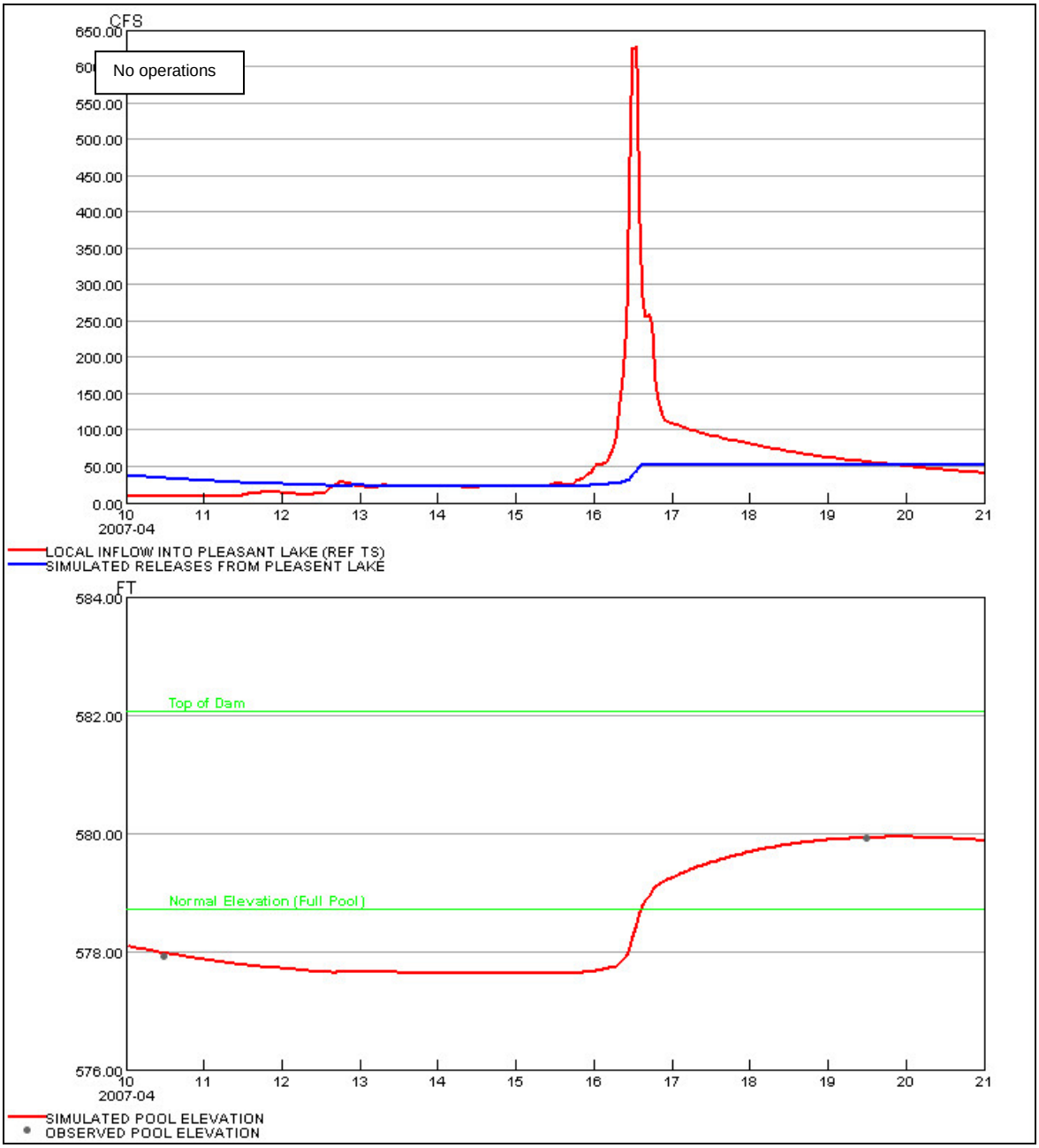


**Figure 3-23: Pleasant Lake Simulation Results for the April 2007 Flood Event**

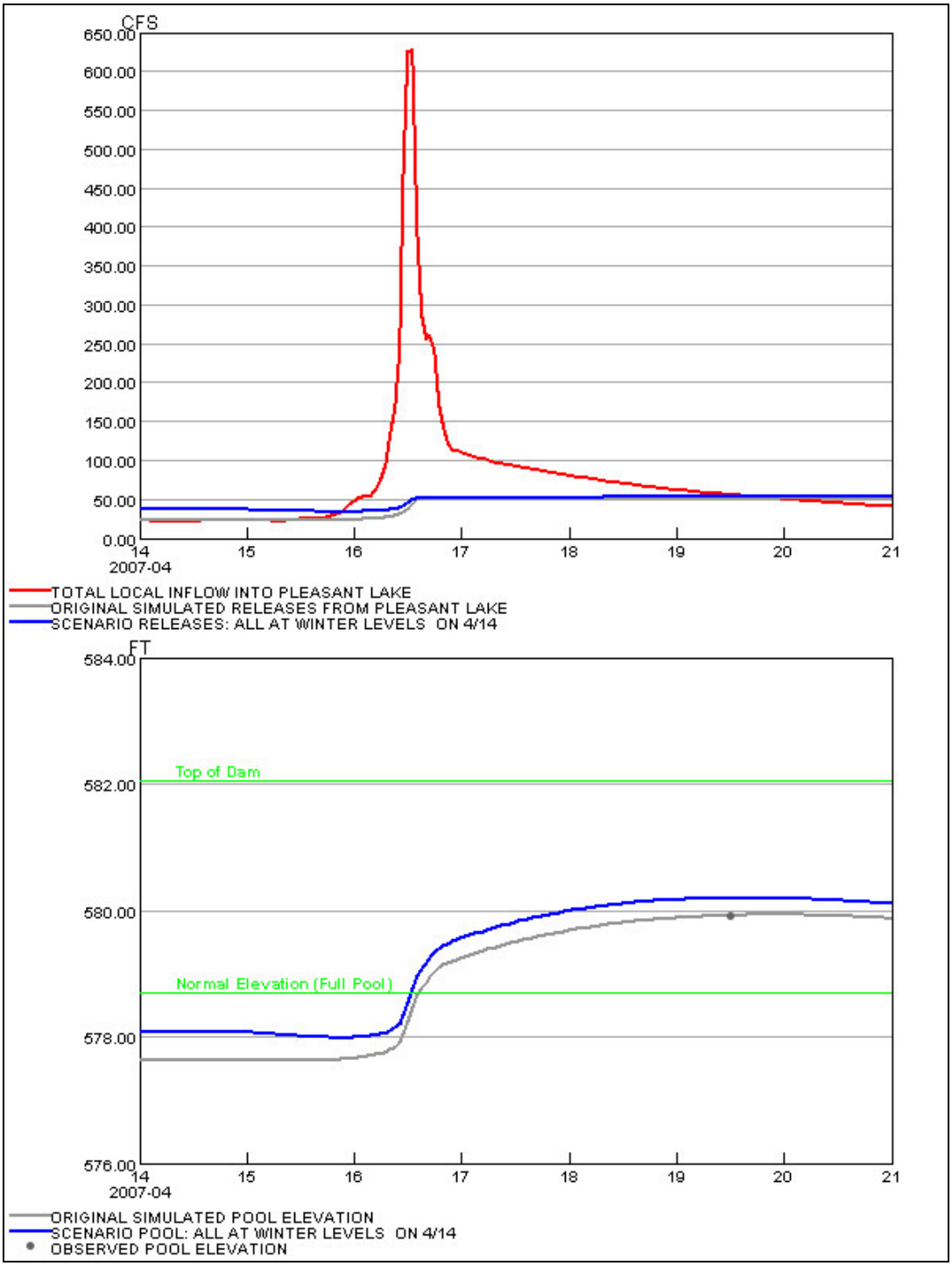


**Figure 3-24: Pleasant Lake Alternative Operations - Starting at Minimum Pool on April 14**

# B-3.7 Northwood Lake (NHDES# 079.01)

## B-3.7.1 General Description

Northwood Lake is located on the Little Suncook River, along Dover Road or Highway 4. The lake has a storage capacity of 2,400 acre-feet at normal levels, and 3,200 acre-feet at its maximum elevation. Between those levels, Northwood Lake can store about 0.75 inch of runoff.

The water levels are regulated through a dam structure located at the west end of the lake in Epsom. This is typically done by manual operation of a gate and four stoplog bays.

The full pond elevation, which is maintained in the summer, corresponds to an elevation of 516.94. As with most lakes in the area, drawdown begins after Columbus Day. The lake has a target six feet below full pond, although it usually only reaches five to five and a half feet. This information was obtained from the NHDES Dam Bureau website. Other information received by NHDES indicates an annual drawdown of four feet.

The lake is filled just after ice out or by May 1. The filling rate is controlled through the stoplog bays. It requires about 2.24 inches of runoff to refill the lake from the lower winter pool to the normal summer pool. Given this, the lake can provide limited flood control in winter and spring.

## B-3.7.2 Actual Operations

All observed data for the May 2006 and April 2007 flood events were provided by the NHDES. The pool elevation is recorded relative to the summer lake elevation of 516.94 feet. Table 3-13 and Table 3-14 list the pool elevation and the dam operations performed by the NHDES at Northwood Lake.

**Table 3-13: Northwood Lake Pool Elevation and Dam Operations during the May 2006 Flood**

| DATE | TIME | POOL ELEVATION | LOG BAY 1 | LOG BAY 2 | LOG BAY 3 | LOG BAY 4 | GATE | COMMENTS | INT |
|---|---|---|---|---|---|---|---|---|---|
| 5/1/2006 | | -0.15 | ALL IN | ALL IN | ALL IN | ALL IN | CLOSED | LET RUN/CLEAR | PA |
| 5/5/2006 | | 0.3 | ALL IN | ALL IN | ALL IN | ALL IN | CLOSED | ALL LOGS IN | CT |
| 5/8/2006 | | 0.3 | ALL IN | ONE OUT | ALL IN | ALL IN | CLOSED | PULLED ONE LOG/RAIN COMING | CT |
| 5/9/2006 | | 0.3 | ALL IN | 2 OUT | ALL IN | ALL IN | CLOSED | PULLED ONE MORE LOG/OK | AS/CT |
| 5/11/2006 | | 0.2 | ALL IN | 5 OUT | ALL IN | ALL IN | CLOSED | PULLED 3 LOGS/TOTAL 5 OUT ONE BAY | CT |
| 5/13/2006 | 6:00AM | 0.2 | 3 OUT | 5 OUT | ALL IN | ALL IN | CLOSED | RISING/PULLED MORE LOGS | CT |
| 5/13/2006 | 5:30PM | 0.4 | 4 OUT | 6 OUT | 1 OUT | 1 OUT | CLOSED | PULLED ONE STRING/SANDBAGGED LOWER LEFT CORE WALL | CT |
| 5/14/2006 | | 1.5 | 4 OUT | 6 OUT | 1 OUT | 1 OUT | CLOSED | NOTHING | MHC |
| 5/15/2006 | | 1.6 | 4 OUT | 6 OUT | 1 OUT | 1 OUT | 2.60 OPEN | | CT |
| 5/15/2006 | 6:00PM | 1.4 | 4 OUT | 6 OUT | 1 OUT | 1 OUT | 2.60 OPEN | | CT |
| 5/16/2006 | | 1 | 4 OUT | 6 OUT | 1 OUT | 1 OUT | 2.60 OPEN | NO CHANGES | CT |
| 5/17/2006 | | 0.85 | 4 OUT | 6 OUT | 1 OUT | 1 OUT | 2.60 OPEN | GATE @ 2' 6" OPEN | CT |
| 5/18/2006 | | 0.6 | 4 OUT | 6 OUT | 1 OUT | 1 OUT | 2.60 OPEN | LET RUN | CT |
| 5/19/2006 | | -0.3 | 1 OUT | 1 OUT | 1 OUT | ALL IN | CLOSED | SET LOGS | CT |
| 5/20/2006 | | 0.25 | 2 OUT | 2 OUT | 2 OUT | 1 OUT | CLOSED | PULLED LOGS | CT |
| 5/21/2006 | | 0.3 | 2 OUT | 3 OUT | 3 OUT | 2 OUT | CLOSED | PULLED LOGS | CT |

**Table 3-14: Northwood Lake Pool Elevation and Dam Operations during the April 2007 Flood**

| DATE | POOL ELEVATION | LOG BAY 1 | LOG BAY 2 | LOG BAY 3 | LOG BAY 4 | GATE | COMMENTS | INT |
|---|---|---|---|---|---|---|---|---|
| 4/4/2007 | -2.85 | 6 OUT | 6 OUT | 6 OUT | 6 OUT | CLOSED | SET ONE STRING/ICE BLACK/CHECKED AREA | CT |
| 4/6/2007 | -2.6 | 5 OUT | 6 OUT | 6OUT | 5 OUT | CLOSED | SET 2 LOGS/1,0,0,1 | PA/AS |
| 4/10/2007 | -2.45 | 5 OUT | 6 OUT | 6OUT | 5 OUT | CLOSED | LET RUN/CLEAR/ICE IS OUT | PA |
| 4/16/2007 | 0.65 | 5 OUT | 6 OUT | 6OUT | 5 OUT | CLOSED | SANBAGGED LEFT LOWER SIDE | GL |
| 4/17/2007 | 1.2 | 5 OUT | 6 OUT | 6OUT | 5 OUT | CLOSED | RAIN EVENT/7" OF FREEBOARD | PA |
| 4/19/2007 | 0.45 | 5 OUT | 6 OUT | 6OUT | 5 OUT | CLOSED | OK/LET RUN | AS |

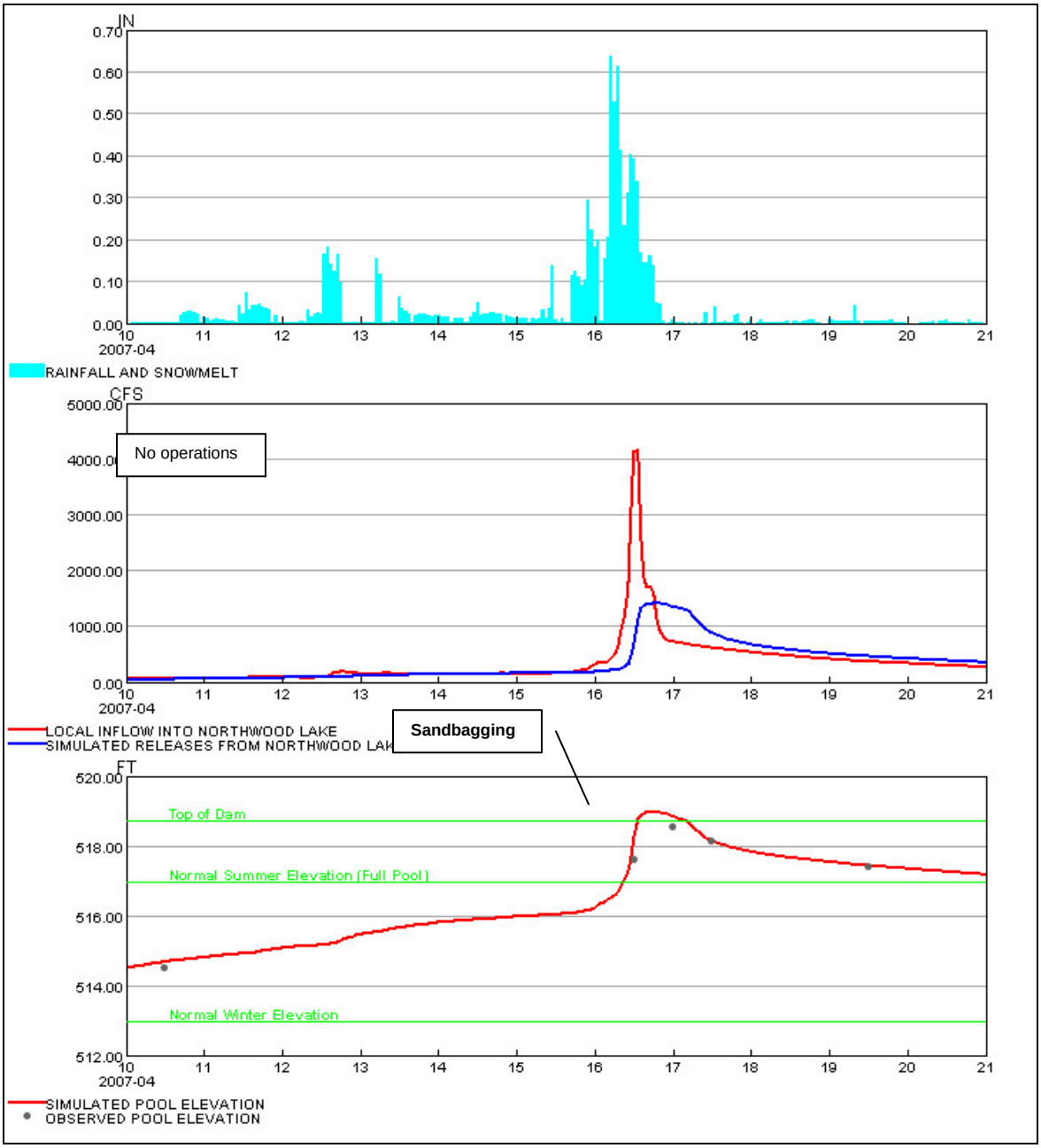


**Figure 3-25: Northwood Lake Simulation Results for the April 2007 Flood Event**

The pool elevation was 0.15 foot below the spillway crest on May 1, 2006. At this time all stoplogs were in place and the gate was closed. On May 5 the pool elevation had risen to 0.3 foot above the spillway crest. In anticipation of rain, one stoplog was removed on May 8, one on May 9, and three on May 11. This prevented the pool elevation from rising further. In response to the rain event, inflows to the lake started to rise on May 13. Seven more stoplogs were removed and the lower left core wall was sandbagged. The pool continued to rise, and the maximum recorded pool elevation reached 1.6 feet above the spillway on May 15, 0.16 foot below the top of the dam. At this time the gate was opened 2.6 feet and the pool elevation began to drop. No more action was taken until nine stoplogs were set and the gate was closed on May 19. The pool elevation dropped below the spillway crest at this time. However, the next day the pool began to rise again, overtopping the spillway by 0.25 foot. Four stoplogs were removed on May 20 and three more on May 21, with the pool elevation 0.3 foot above the spillway.

Northwood Lake was refilling during the first weeks in April 2007. On April 4 the pool was 2.85 feet below the spillway crest, rising slightly to 2.45 feet below the spillway by on April 10. The pool rose quickly in response to the storm and overtopped the spillway by 0.65 foot on April 16. No operations were performed and the pool reached a maximum recorded height of 1.2 feet above the spillway on April 17. This was 0.56 foot below the top of the dam. During the event the lake provided significant local downstream flood control (see the differences in inflows and releases in Figure 3-25) and filling it prevented possible damage along Route 4 downstream. For that reason, no operations were performed during the April 2007 event; instead, the dam was sandbagged to prevent overtopping. Nevertheless, the downstream side of the dam developed some sinkholes.

The area contributing runoff to Northwood Lake downstream of Pleasant Lake is about 5 times as large as the area controlled by Pleasant Lake. Inflows into Northwood Lake during the April 2007 event (peaking at approximately 4100 cfs on April 16) were therefore significantly larger than the releases from Pleasant Lake (peaking at 25 cfs).

### B-3.7.3 Alternative Operations

Figure 3-26 shows a simulation of Northwood Lake with the winter drawdown held until April 14. All other operations were unchanged. These operations would have reduced the peak water level to only minimally overtop the dam. Maximum releases would have been reduced from approximately 1400 cfs to approximately 1350 cfs.

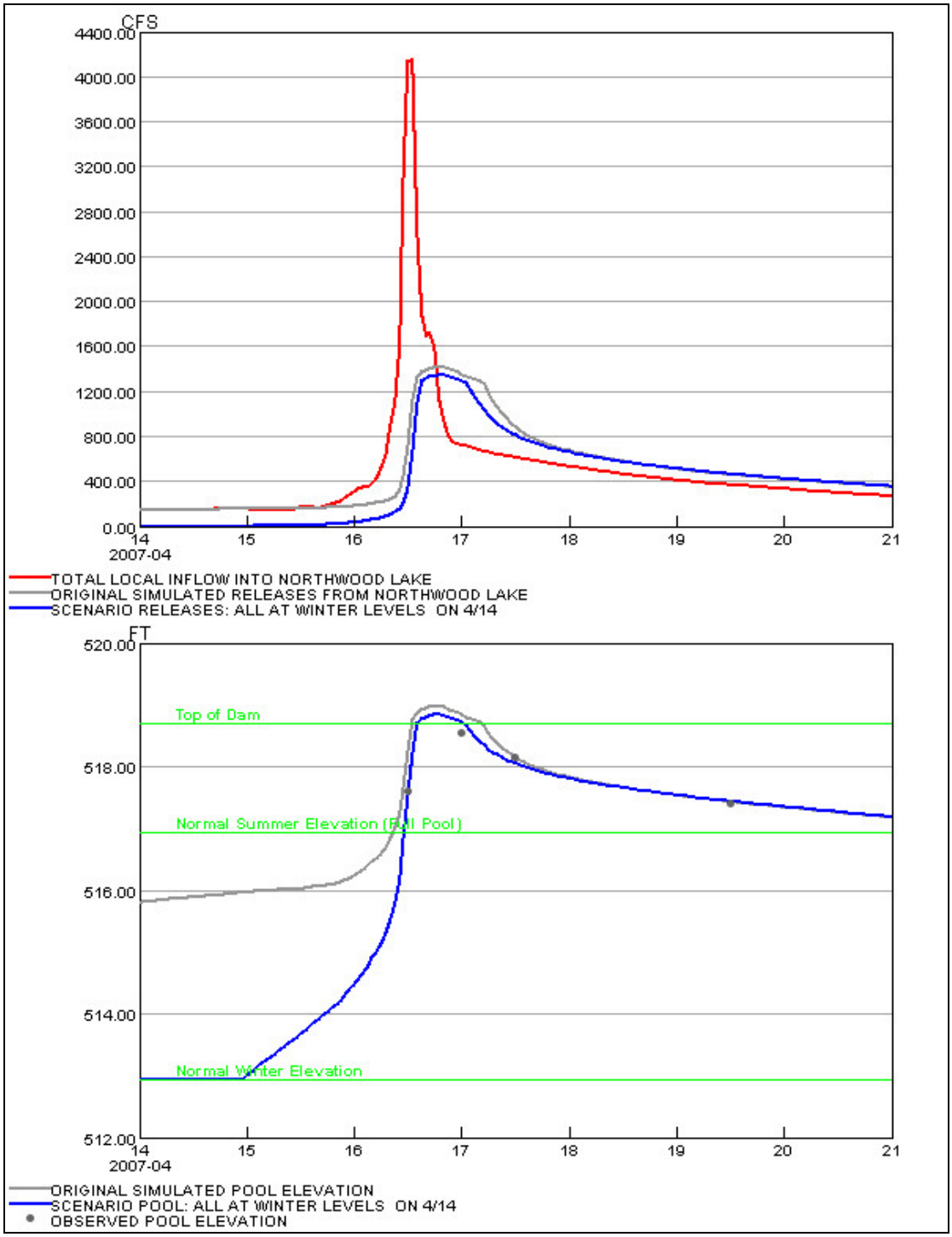


**Figure 3-26: Northwood Lake Alternative Operations - Starting at Minimum Pool on April 14**

## B-3.8 Buck Street Dams (NHDES# 004.16 and 190.05)

### B-3.8.1 General Description

The two Buck Street Dams are located on the Suncook River, where Route 28 meets Buck Street. Being a run-of-river project, the pond has virtually no storage—83 acre-feet at normal levels and up to 413 acre-feet at its maximum elevation. The pool elevation is controlled by NHDES staff at the east and west dams. The east dam operates with two conventional gates; the west dam is operated through three stoplog bays.

The typical summer lake elevation is 291.59 feet, which corresponds to the elevation of the spillway on the east dam. The lake is usually drawn down five feet after Columbus Day through manual operation of the gates and stoplogs bays. It takes only 0.02 inch of rainfall to refill the lake.

A plan view and a photograph of East Buck Street Dam are shown in Figure 3-27 and Figure 3-29 respectively and West Buck Street Dam in Figure 3-28 and Figure 3-30.

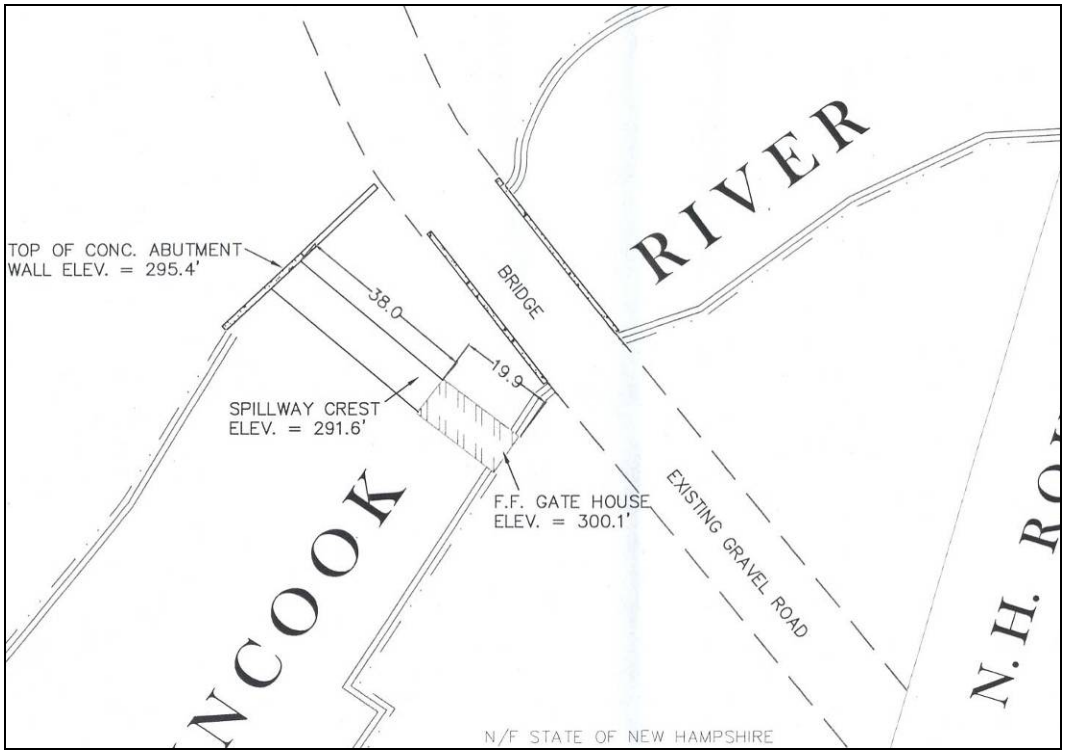


**Figure 3-27: Plan View of East Buck Street Dam**

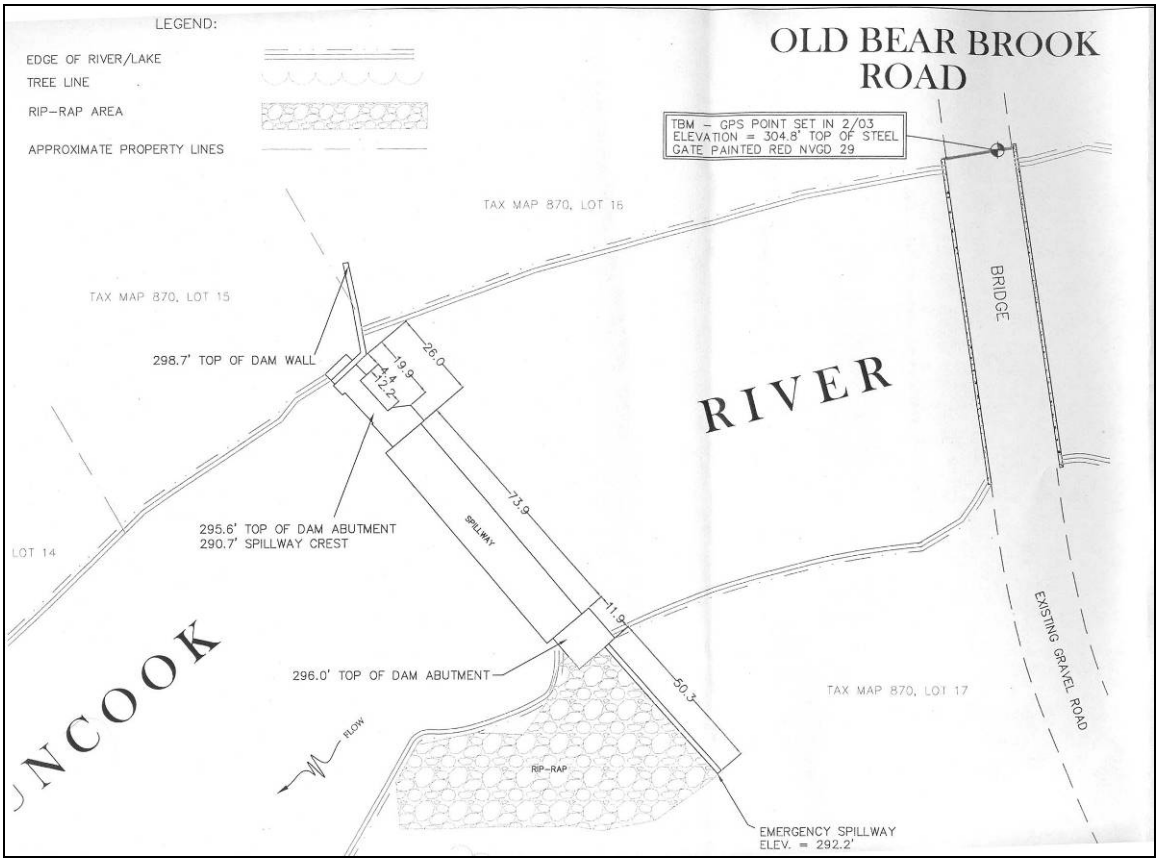


**Figure 3-28: Plan View of West Buck Street Dam**

**Figure 3-29: Photograph of East Buck Street Dam**

**Figure 3-30: Photograph of West Buck Street Dam**

## B-3.8.2 Actual Operations

All observed data for the May 2006 and April 2007 flood events were provided by the NHDES. The pool elevation is recorded relative to the summer lake elevation of 291.59 feet. Table 3-15 and Table 3-16 list the pool elevation and the dam operations performed by the NHDES at East Buck Street Dam. Table 3-17 and Table 3-18 list the pool elevation and the dam operations performed by the NHDES at West Buck Street Dam.

**Table 3-15: Buck Street East Pool Elevation and Dam Operations during the May 2006 Flood**

| DATE | POOL ELEVATION | LEFT GATE | RIGHT GATE | COMMENTS | INT |
|---|---|---|---|---|---|
| 5/3/2006 | 1.40 | GATES CLOSED | GATES CLOSED | | AS |
| 5/14/2006 | 5 | FULL OPEN | FULL OPEN | OPENED GATES FULL | WPH |
| 5/15/2006 | 6 | FULL OPEN | FULL OPEN | BASED ON 5/14 AND 5/16 DATA FROM WEST SIDE | AS |
| 5/16/2006 | 3 | FULL OPEN | FULL OPEN | DROPPED APPOX. 1.50 OVERNIGHT | PA |

**Table 3-16: Buck Street East Lake Pool Elevation and Dam Operations during the April 2007 Flood**

| DATE | POOL ELEVATION | LEFT GATE | RIGHT GATE | COMMENTS | INT |
|---|---|---|---|---|---|
| 3/28/2007 | 0.8 | FULL OPEN | FULL OPEN | ALL CLEAR | CT |
| 4/16/2007 | 5 | FULL OPEN | FULL OPEN | GATES FULL OF DEBRIS | PA |
| 4/17/2007 | 7.75 | FULL OPEN | FULL OPEN | MINUS 2 FOOT 4 INCHES/BRIDGE ON RIGHT | GL |
| 4/19/2007 | 3 | FULL OPEN | FULL OPEN | DEBRIS/SINKHOLES/WASHOUTS | PA |

**Table 3-17: Buck Street West Pool Elevation and Dam Operations during the May 2006 Flood**

| DATE | POOL ELEVATION | LOG BAY 1 | LOG BAY 2 | LOG BAY 3 | COMMENTS | INT |
|---|---|---|---|---|---|---|
| 5/3/2006 | 1.40 | 4 OUT | 5OUT | 4OUT | W/ SOME LOGS OUT OK | AS |
| 5/14/2006 | 5 | 4 OUT | 5OUT | 4OUT | WATER AT SLAB | WPH |
| 5/15/2006 | 6 | 4 OUT | 5OUT | 4OUT | WATER 1 FOOT OVER SLAB | WPH |
| 5/16/2006 | 3 | 4 OUT | 5OUT | 4OUT | WATER OFF DECK/DAM CLEAR | PA |

**Table 3-18: Buck Street West Lake Pool Elevation and Dam Operations during the April 2007 Flood**

| DATE | POOL ELEVATION | LOG BAY 1 | LOG BAY 2 | LOG BAY 3 | COMMENTS | INT |
|---|---|---|---|---|---|---|
| 3/28/2007 | 0.8 | 7 LOGS OUT | 7 LOGS OUT | 7 LOGS OUT | ALL CLEAR | CT |
| 4/16/2007 | 5.6 | 7 LOGS OUT | 7 LOGS OUT | 7 LOGS OUT | OVER EMERG. SPILL/OVER TOP OF LOG AREA BY .60 | PA |
| 4/17/2007 | 7.75 | 7 LOGS OUT | 7 LOGS OUT | 7 LOGS OUT | SIX INCHES BELOW RIGHT CUT OFF WALL | GL |
| 4/19/2007 | 3 | 7 LOGS OUT | 7 LOGS OUT | 7 LOGS OUT | WASHOUT RIGHT SIDE | PA |

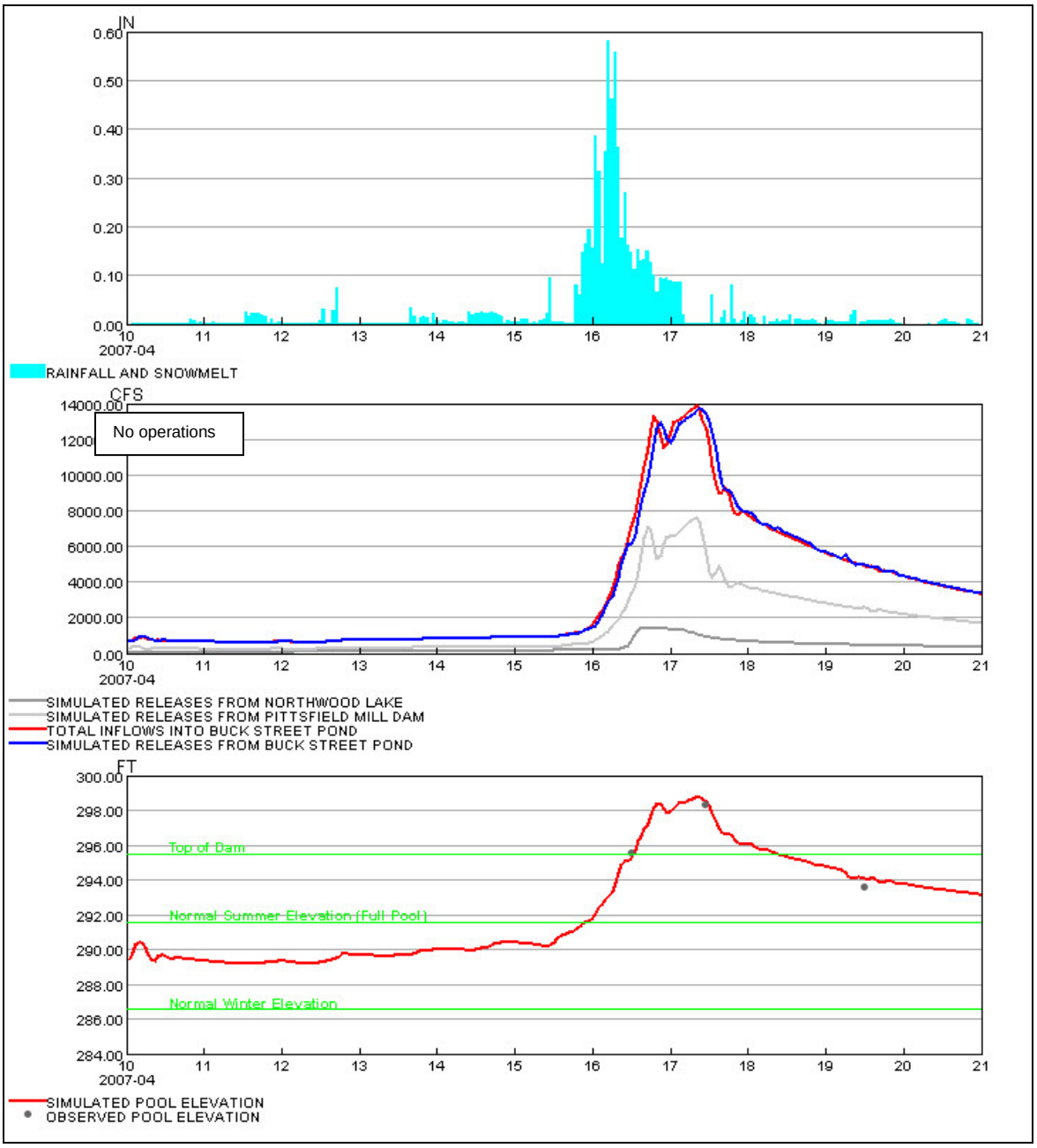


**Figure 3-31: Buck Street Dams Simulation Results for the April 2007 Flood Event**

On May 3, 2006 both gates were closed on the East Dam, and 13 stoplogs were out on the West Dam. The pool elevation was 1.4 feet over the East spillway crest and 1.3 feet over the West spillway crest, but still 2.5 feet below the top of the dam. Pool elevation rose rapidly and reached the top of dam on May 14.

At this time the East Dam gates were fully opened but no additional stoplogs were removed from the West Dam. The pool elevation continued to rise and reached the maximum recorded elevation of 2.1 feet over the dam on May 15. No action was taken that day, given that the stoplogs were submerged considerably. Still, the pool dropped and was 0.9 foot below the top of dam on May 16.

At the beginning of the April 16 event, all gates at the Buck Street Dams were open and seven of ten stoplogs were removed. Nevertheless the pool rose far beyond the top of the dam during the event, in part caused by debris that was clogging the gate bays. The simulation can reproduce this fairly well. Given the flat terrain upstream of the dams, the simulation assumes a significant increase in storage capacity behind the dam once they overtop. This causes a brief delay in the rise of the releases once the dam overtop.

The simulation (see Figure 3-31) demonstrates that the project had no flood control potential, but caused, according to the NHDES, significant upstream flooding on a side road of Route 28.

### B-3.8.3 Alternative Operations

Figure 3-32 is simulation of the Buck Street Dams with the pool elevation held at its winter drawdown until April 14. Upstream reservoirs were also held at their winter pool. All other operations were unchanged. Maintaining the winter drawdown had little effect on the maximum pool elevation, due to the very limited storage capacity behind the Buck Street Dams. The flows at the dams would have been virtually unaffected by operations at the site itself. The reduction in peak release of approximately 500 cfs (from an actual 13,700 cfs) on April 17 would have been caused by alternative operations at the upstream dams.

On the other hand, opening all the gates and stoplogs (Figure 3-33) would have resulted in some reduction in the peak water level while not affecting the releases.

An additional scenario assessed the effects of lower spillways on the maximum pool elevations reached. Figure 3-34 demonstrates that lowering both spillways by 2 feet each would have resulted in a drop of the maximum pool elevation by approximately 1.5 feet without affecting the releases.

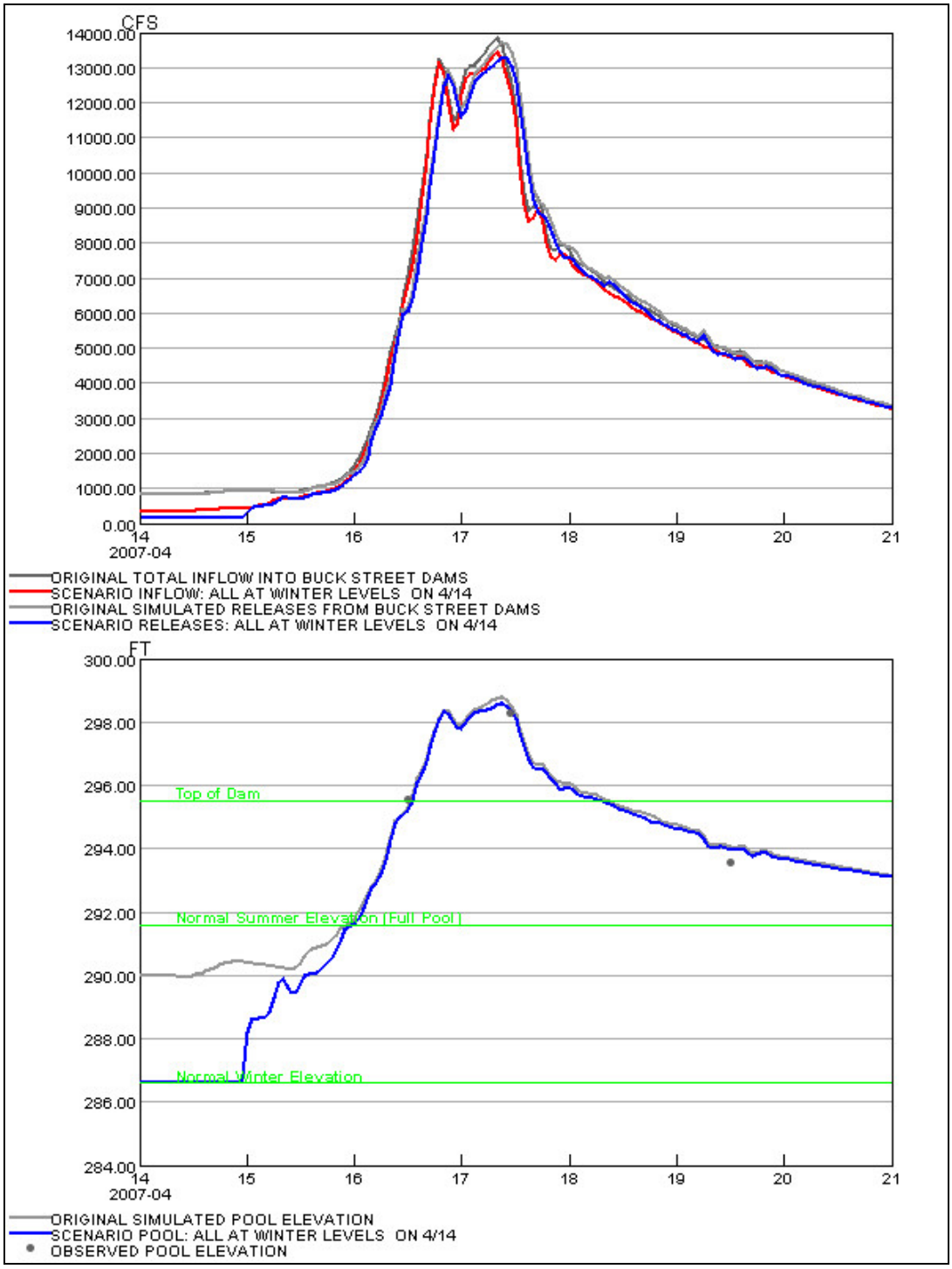


**Figure 3-32: Buck Street Dams Alternative Operations - Starting at Minimum Pool on April 14**

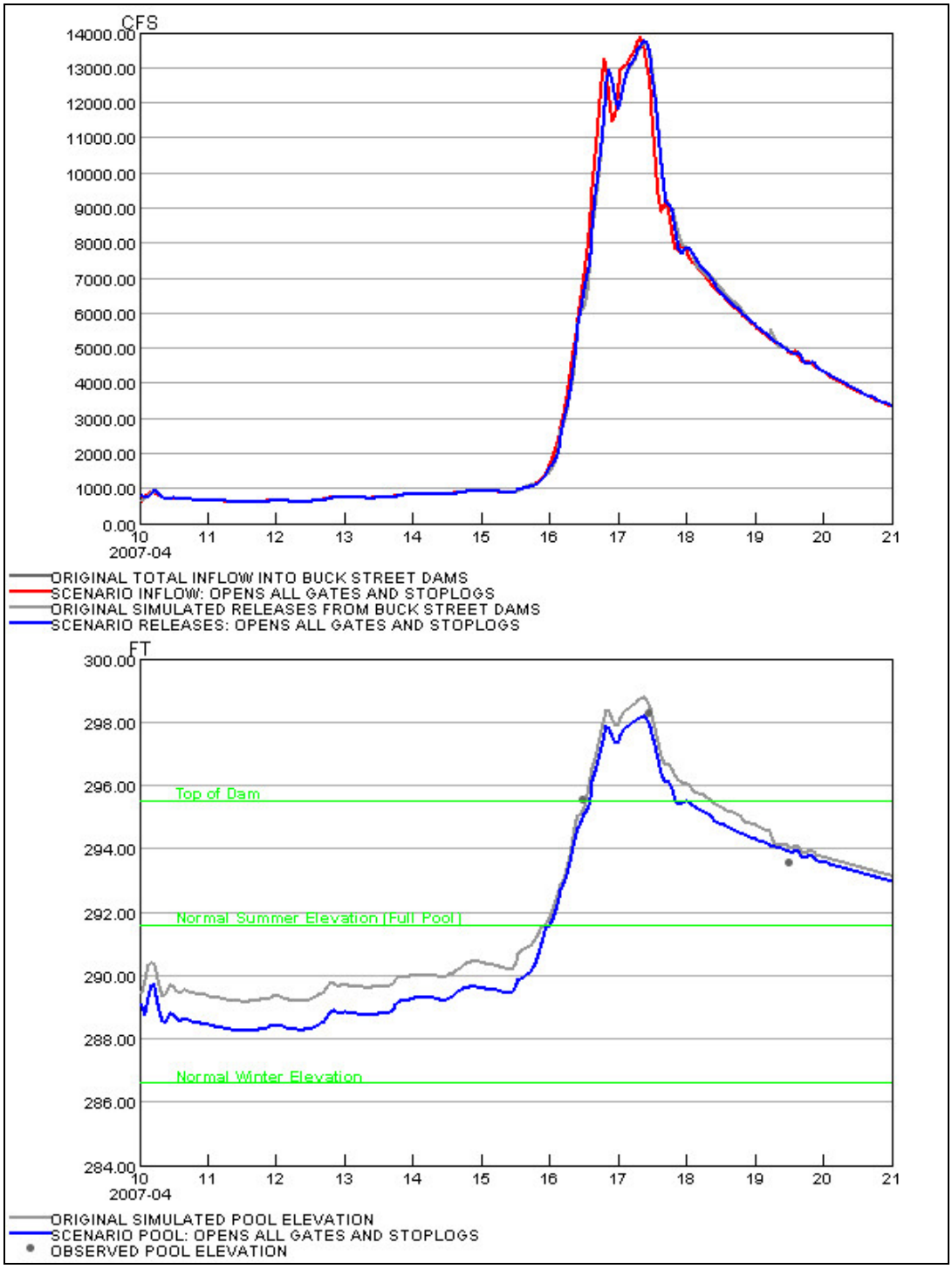


**Figure 3-33: Buck Street Dams Alternative Operations - Opens all Gates and Removes Stoplogs**

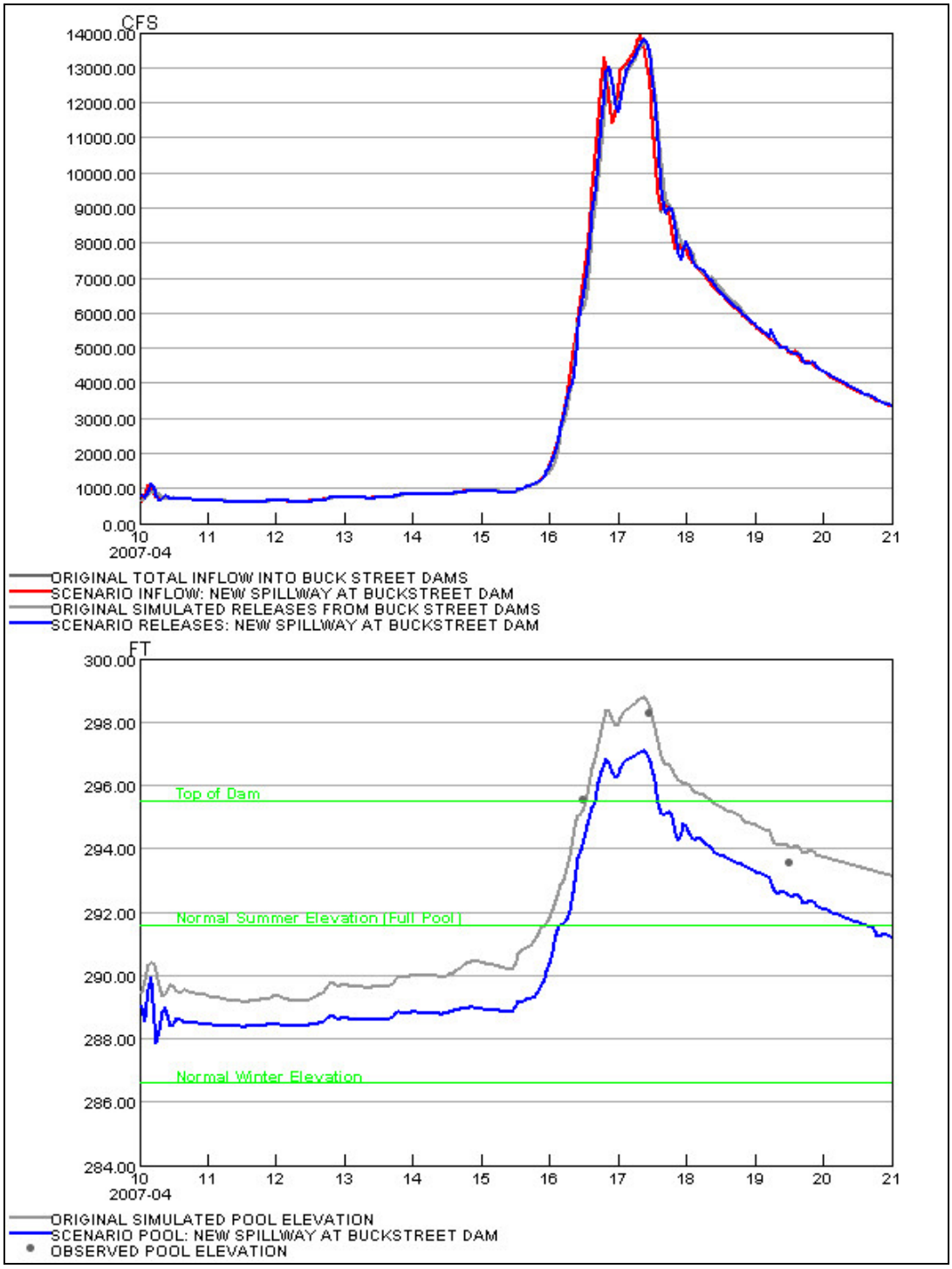


**Figure 3-34: Buck Street Dams Alternative Operations - Spillways lowered by two feet**

## B-3.9 Webster Mill Dam / Pembroke Generating Station (NHDES# 190.03)

### B-3.9.1 General Description

Webster Mill Dam is located on the Suncook River in the town of Suncook. It is a small run-of-river hydropower project, with a normal storage capacity of 60 acre-feet and a maximum capacity of 165 acre-feet. The dam is privately owned and operated through a sluice gate, two stoplog bays, and an Obermeyer panel. The typical summer lake elevation is 276.8 feet, which corresponds to the elevation of the Obermeyer panel raised by 3.8 feet over the spillway.

A plan view of Webster Mill Dam / Pembroke Generating Station is presented in Figure 3-35. A photograph of Webster Mill Dam is shown in Figure 3-36.

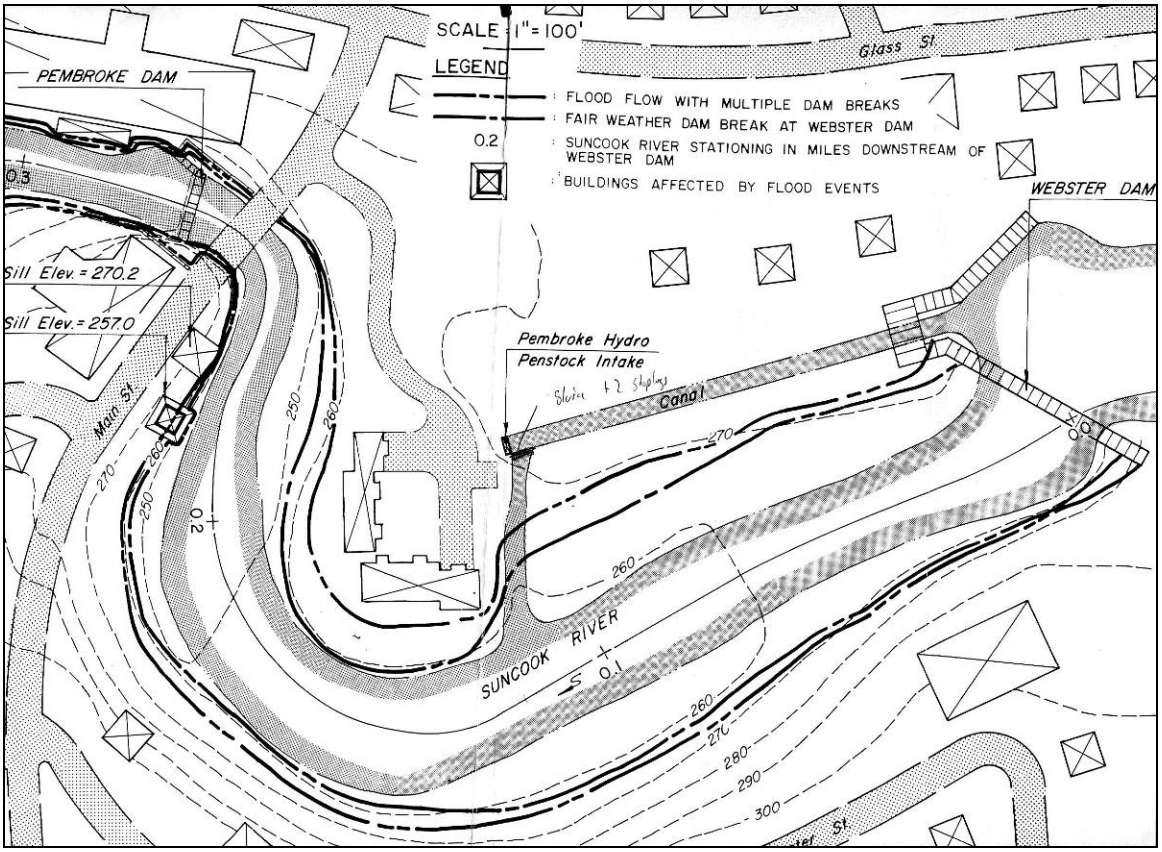


**Figure 3-35: Plan View of Photograph of Webster Mill Dam / Pembroke Generating Station**

**Figure 3-36: Photograph of Webster Mill Dam**

## B-3.9.2 Actual Operations

Observed data for the 2006 and 2007 flood events consisted of daily values for pool, releases, and power generation provided by the dam operators. Important operations are listed in Table 3-19 and Table 3-20.

**Table 3-19: Webster Dam Operations during the April 2007 Flood**

| DATE | TIME | POOL ELEVATION | OBERMEYER | STOPLOGS | SLUICE GATE | TURBINES |
|---|---|---|---|---|---|---|
| 5/13/2006 | | | Deflating | | | Generating |
| 5/14/2006 | | | Fully deflated | All removed | Open | Generating |
| 5/18/2006 | | | At 3.8 ft | | | Generating |

**Table 3-20: Webster Dam Operations during the April 2007 Flood**

| DATE | TIME | POOL ELEVATION | OBERMEYER | STOPLOGS | SLUICE GATE | TURBINES |
|---|---|---|---|---|---|---|
| 4/16/2007 | 10:30 AM | | Fully deflated | | | Generating |
| 4/16/2007 | 12 noon | | | All removed | Open | Generating |
| 4/19/2007 | | | At 3.8 ft | All In | Closed | Generating |

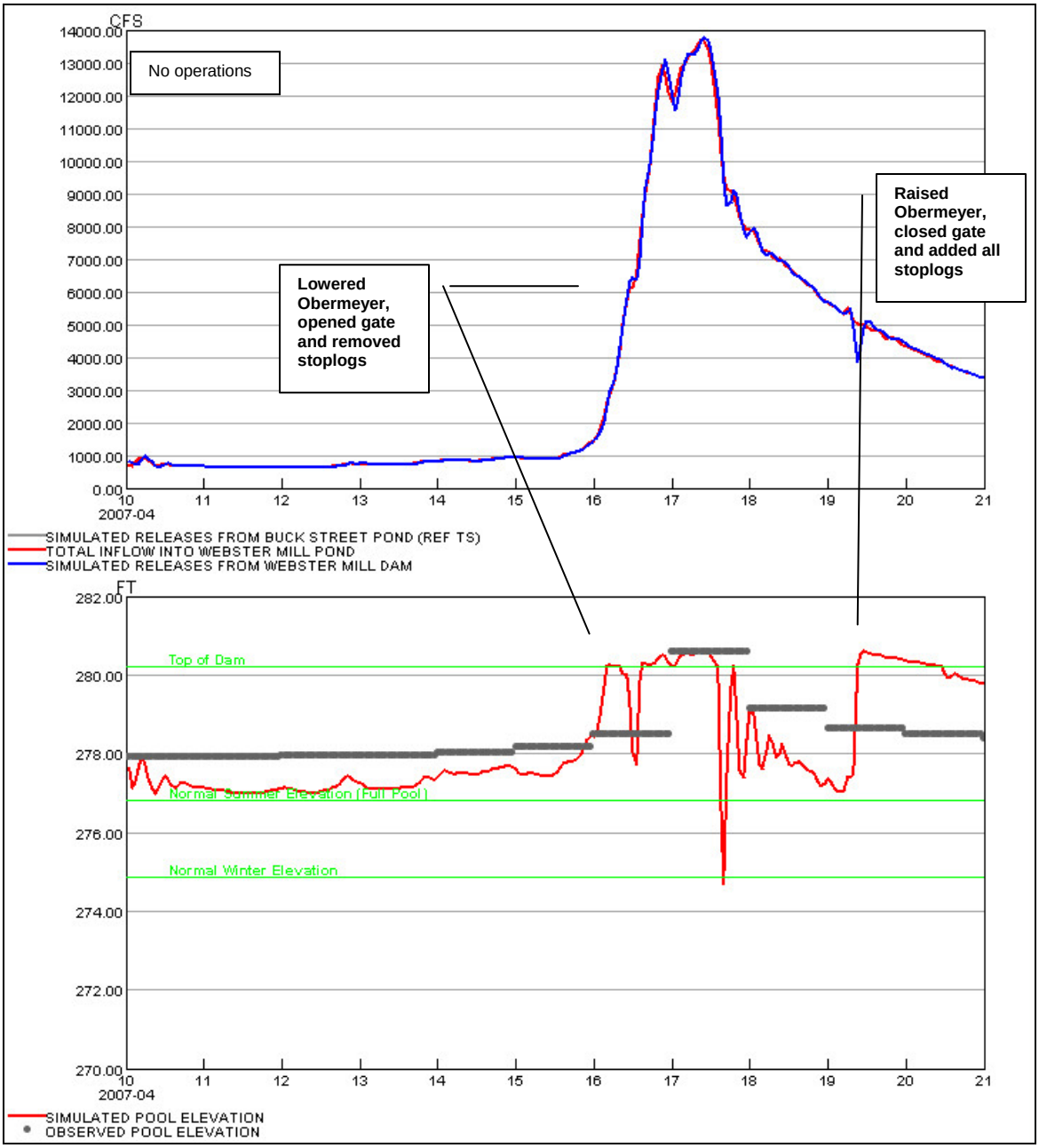


**Figure 3-37: Webster Mill Dam Simulation Results for the April 2007 Flood Event**

The pool elevation at the site was 1.26 feet above full pond on May 3, 2006 and rose slightly to 1.3 feet above by May 13. In response, the Obermeyer was lowered on May 14 and all stoplogs were removed and the sluice gate was opened. Despite these operations the pool elevation continued to rise, and by May 16 had reached a maximum of 2.88 feet over the normal pool elevation. At this time the pool was 0.52 foot below the top of the dam. The water began to drop on May 17, and the Obermeyer was raised by 3.8 feet on May 18. The pool continued to drop and no further actions were taken.

The pool at Webster Mill was 1.35 feet above full pond on April 3, 2007. Ten days later, on April 13, the pool had dropped to 1.15 feet above full pond. On April 16 the Obermeyer gate was fully lowered, all stoplogs were removed, and the sluice gate was opened in response to rising water levels. By then the pool was 1.70 feet over full pond. It continued to rise to a maximum height of 3.80 feet over full pond on

April 17, reaching almost the top of the dam. On April 19 the pool had dropped 1.07 feet below the top of the dam, 2.33 feet over full pond. At this time the Obermeyer gate was raised to 3.8 feet, all stoplogs were set in place and the sluice gate was closed.

Simulating pool elevation and releases at Webster Mill Dam proved challenging, because the very little storage in the project causes extreme changes in the simulated pool elevation when the inflows differ from the estimated outflows. Estimating exact releases on a one-hour time step was impossible, because only daily observations regarding the operations were available. As a result, the pool elevation oscillates significantly.

One would expect the pool to react very quickly to changes in operation, as evident on April 16, 2007, when the Obermeyer gate was lowered by 3.8 feet, or on the April 19, 2007, when it was raised again.

Operations at the site seem to have had very little impact on the passed flows, as depicted in Figure 3-37. The pool elevation rose almost to the top of the dam during both events, even with all gates and stoplogs open and the Obermeyer panel dropped. Upstream flooding was not reported.

### B-3.9.3 Alternative Operations

Figure 3-38 shows a simulation of Webster Mill Dam with the pool elevation held at the winter drawdown until April 14. Upstream reservoirs were also held at the winter pool until this date. All other operations were unchanged. Maintaining the winter drawdown would have had no appreciable affect on the maximum pool elevation, due to the limited storage capacity behind Webster Mill Dam. The reduction in peak releases on April 17 would have been entirely caused by alternative operations at upstream dams.

Another scenario was run, where the Obermeyer gate at Webster Mill Dam was lowered on the 15th of April (Figure 3-39) instead of the 16th. This would have resulted in a very little change of the peak water level without affecting the releases.

The scenario simulations indicate that Webster Mill Dam cannot provide any appreciable flood control storage.

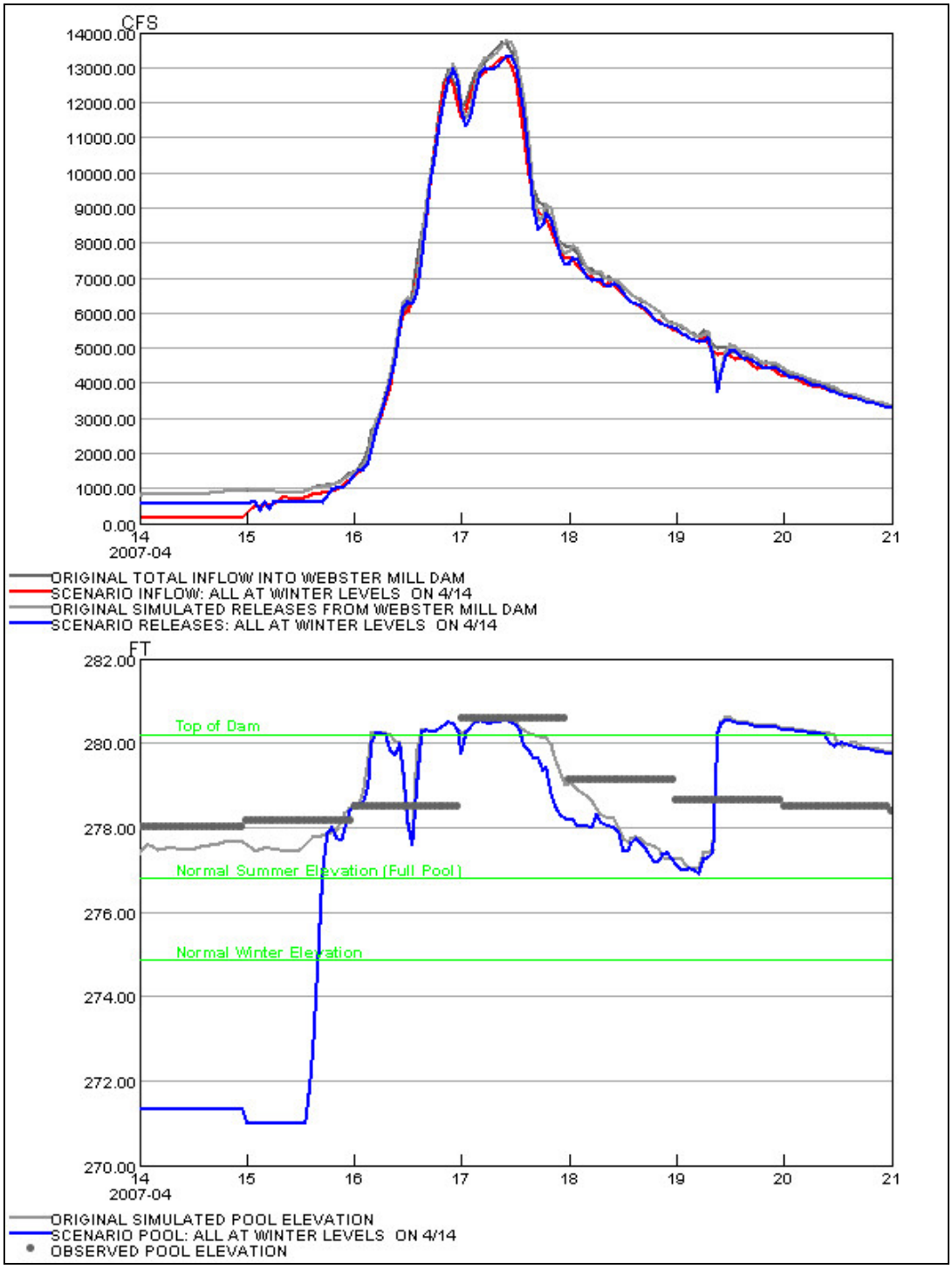


**Figure 3-38: Webster Mill Dam Alternative Operations - Starting at Minimum Pool on April 14**

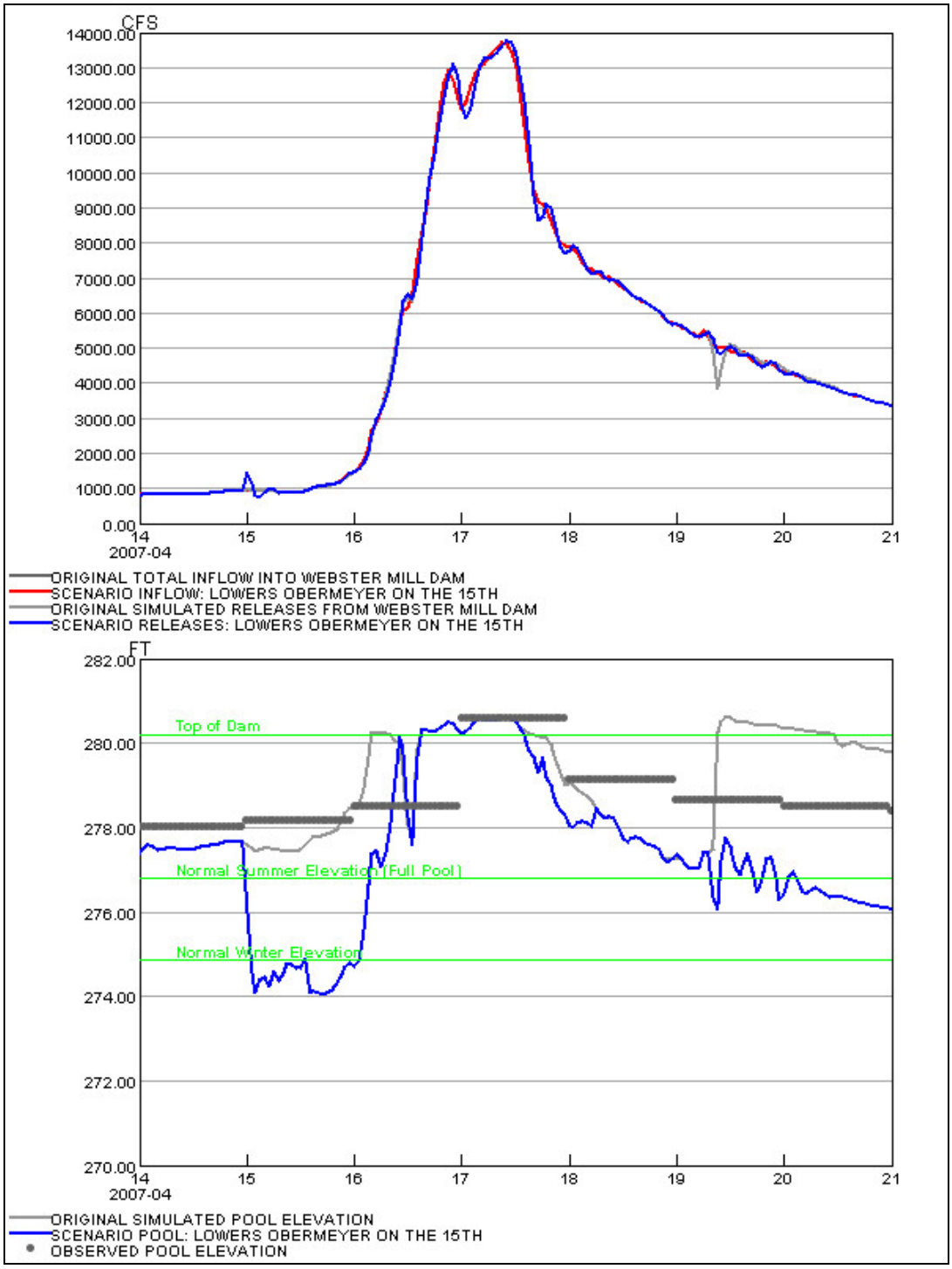


**Figure 3-39: Webster Mill Dam Alternative Operations - Lowers Obermeyer on April 15**

## B-3.10 China Mill Dam (NHDES# 190.01)

### B-3.10.1 General Description

China Mill Dam is located close to the mouth of the Suncook River, below Webster Mill Dam. This run-of-river project has a normal storage capacity if 6 acre-feet and a maximum capacity of 14 acre-feet. The dam is privately owned and operated for hydropower generation using four gates that control flow to power turbines as well as a smaller waste gate at the dam. The typical lake elevation is 226.4 feet, which corresponds to the elevation of the spillway.

A plan view and photograph of China Mill Dam are shown in Figure 3-40 and Figure 3-41 respectively.

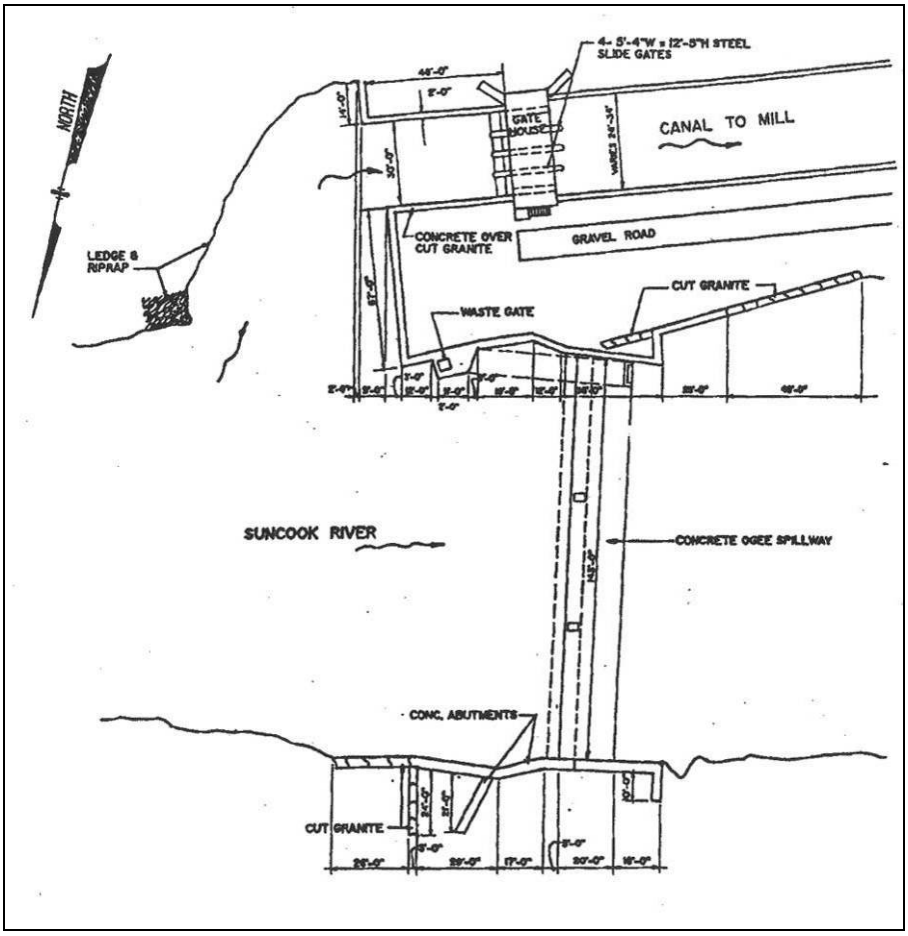


**Figure 3-40: Plan View of China Mill Dam**

**Figure 3-41: Photograph of China Mill Dam**

## B-3.10.2 Actual Operations

The dam operators provided hourly flow through the turbines, pool elevation, and the status of the waste gate for both the May 2006 and the April 2007 floods. These data were sufficient for modeling.

**Figure 3-42: China Mill Dam Simulation Results for the April 2007 Flood Event**

At the beginning of May 2006, the pool elevation was about equal to the spillway crest. The pool elevation started to rise on May 13, in response to the storm event and the dam waste gate was opened. At 10:00 p.m. on May 14, a high trash differential was noted. The turbines were not operated from 11:00 p.m. on May 14 through 11:00am on May 16 due to insufficient net head. The pool elevation reached a maximum height of 6.45 feet over the spillway on May 15, but remained 0.85 foot below the top of the dam. On May 16, the pool began a steady decline.

On April 3, 2007, the pool was about 1 foot over the spillway crest. The pool was rising and reached 1.4 feet over the spillway by April 13. During the April 2007 event, the waste gate in the dam was fully open, but flow through powerhouse was prevented due to damaged equipment. The uncontrolled spillway

therefore provided the majority of the release capacity. The pool reached a maximum elevation of 6.74 feet over the spillway on April 16, but remained 0.56 foot below the top of the dam.

The simulation of the China Mill project (see Figure 3-42) is plagued by the same issues as the one for Webster Mill Dam: The very small storage causes oscillation in the pool when inflows are not matched exactly by releases. The simulated pool elevations are therefore not usable.

The very small size of the impoundment behind China Mill Dam prevents any flood control, and releases are typically very similar to the inflows. During both events, the waste gate in the dam was fully open, but no flows were passed through the turbines. The uncontrolled spillway therefore provided the majority of the release capacity. Observations at the dam suggest that the dam was not overtopped. Upstream flooding was not reported.

## B-4.0 PISCATAQUOG RIVER

The return period of the April 2007 flood event on the Piscataquog River was approximately 75 years, according to observations near Goffstown. These are shown in Figure 4-1 for the May 2006 and April 2007 events. The figure includes the FEMA 10-, 50-, 100-, and 500-year flood flows.

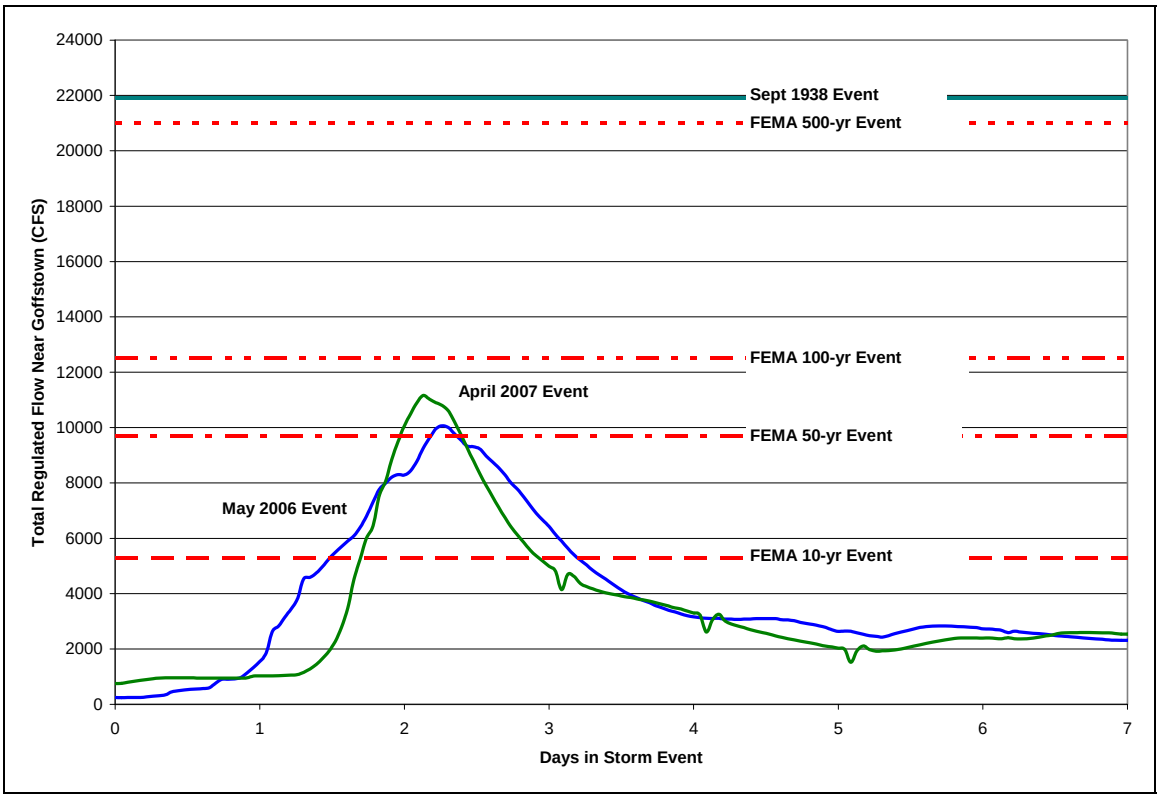


**Figure 4-1: Piscataquog River - Comparison of May 2006 and April 2007 Events and FEMA Flood Levels**

Figure 4-2 depicts the dams investigated in the Piscataquog River basin.

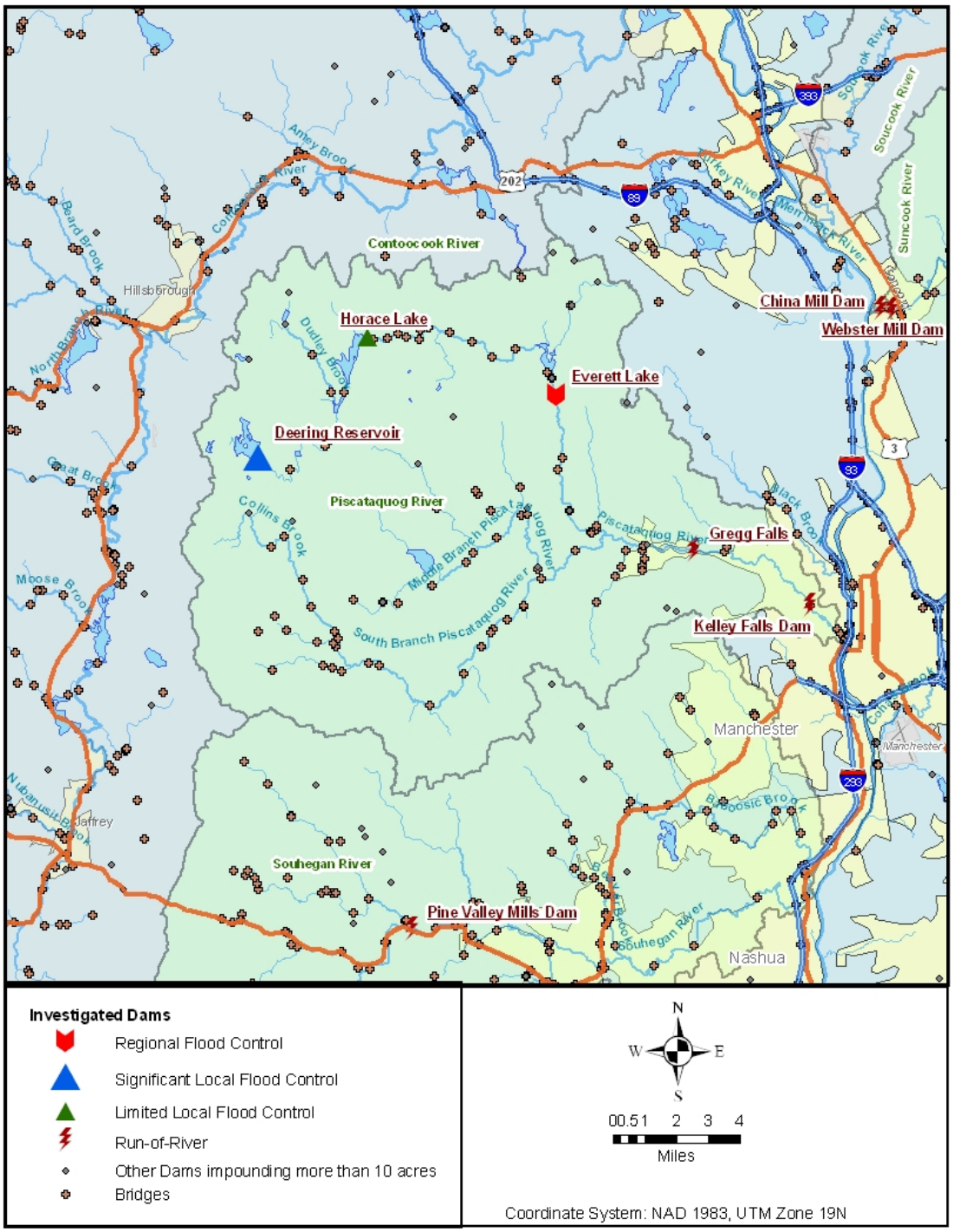


**Figure 4-2: Dams Investigated in the Piscataquog River Basin**

## B-4.1 Deering Reservoir (NHDES # 062.05)

### B-4.1.1 General Description

Deering Reservoir is located in the headwaters of the Piscataquog River, to the south of the town of Deering. Most of the lakeshore is undeveloped. At normal and maximum levels the lake can store approximately 3,400 and 4,980 acre-feet respectively. Deering Reservoir can store 7.1 inches of runoff into the lake, providing significant local flood control capacity.

Deering Reservoir is controlled and operated through one stoplog bay. The spillway used to be equipped with flashboards until 2006, when they were permanently removed during a rebuilt of the spillway. During the summer months, the lake elevation is maintained at 919.1 feet, which corresponds to the elevation of the top of the former flashboards (now the elevation of the new spillway). After Columbus Day the lake level is lowered to one foot below full pool by November 1. After this initial target is reached, the pool is lowered another three feet. In the spring, the stoplogs are replaced to catch the spring runoff. It requires about 5.64 inches of runoff to refill the lake from the lower winter pool to the normal summer pool.

A plan view of Deering Dam is shown in Figure 4-3.

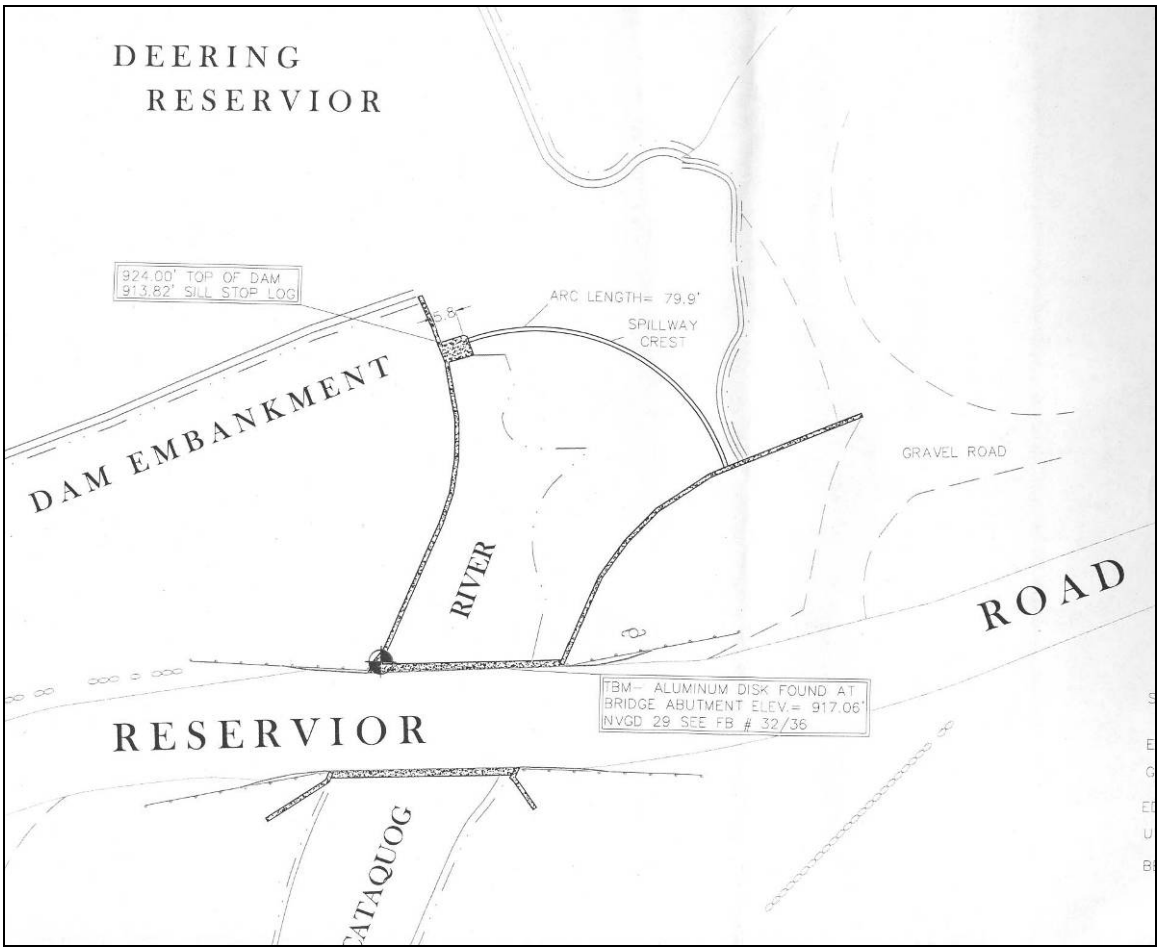


**Figure 4-3: Plan View of Deering Dam**

### B-4.1.2 Actual Operations

All observed data for the May 2006 and April 2007 flood events were provided by the NHDES. The pool elevation is recorded relative to the summer lake elevation of 919.1 feet. Table 4-1 and Table 4-2 list the pool elevation and the dam operations performed by the NHDES at Deering Reservoir.

**Table 4-1: Deering Reservoir Pool Elevation and Dam Operations during the May 2006 Flood**

| DATE | TIME | POOL ELEVATION | LOG BAY | SPILLWAY/FLASHBOARD CONDITION | COMMENTS | INT |
|---|---|---|---|---|---|---|
| 5/1/2006 | | -1.20 | 1 OUT | FLASH BOARDS UP | | CT |
| 5/5/2006 | | -1 | 1 OUT | | NO CHANGES MADE | PA |
| 5/14/2006 | | 0.5 | 3 OUT | | PULLED TWO LOGS | AS |
| 5/15/2006 | | 0.45 | 3 OUT | | LET RUN W/ THREE LOGS OUT | AS |
| 5/17/2006 | | 0.18 | ALL IN | | SET THREE LOGS | AS/MC |
| 5/22/2006 | | 0.25 | ALL IN | | | PA |

**Table 4-2: Deering Reservoir Pool Elevation and Dam Operations during the April 2007 Flood**

| DATE | TIME | POOL ELEVATION | LOG BAY | SPILLWAY/FLASHBOARD CONDITION | COMMENTS | INT |
|---|---|---|---|---|---|---|
| 4/2/2007 | | -2.5 | 3 OUT | NEW CONCRETE SPILLWAY | ICE STILL ON LAKE/CREW ON SITE | AS |
| 4/3/2007 | | -2.25 | 2 OUT | AT FULL POND ELEVATION | PUT ONE LOG IN LOG BAY | CL |
| 4/13/2007 | | -1.5 | 5 OUT | NO MORE FLASHBOARDS | PULLED THREE LOGS FROM LOG BAY | CREW |
| 4/16/2007 | AM | -0.5 | 5 OUT | | | WPH |
| 4/16/2007 | 3:00 PM | -0.1 | 5 OUT | | LET RUN | WPH |

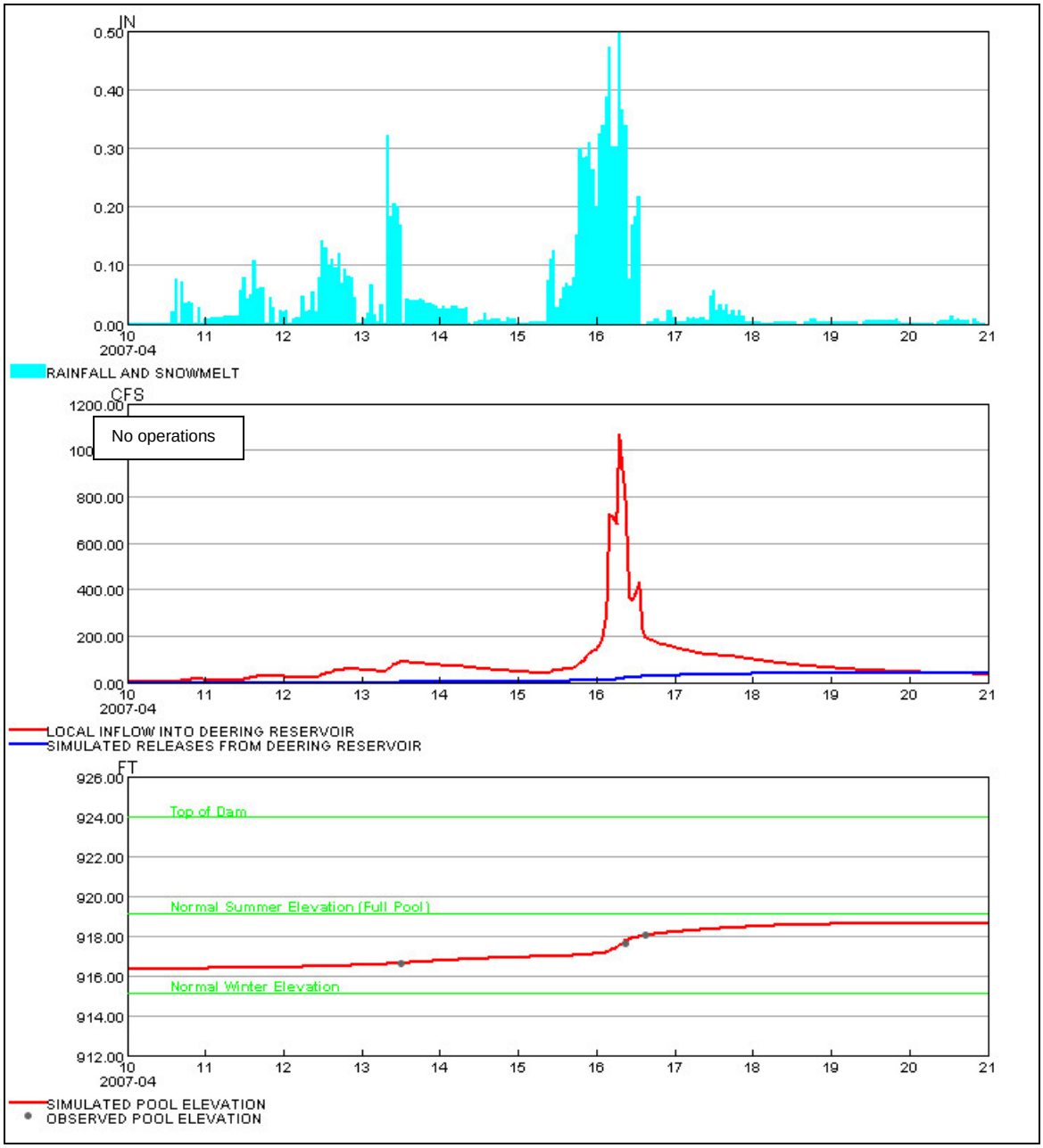


**Figure 4-4: Deering Reservoir Simulation Results for the April 2007 Flood Event**

At the beginning of May 2006, the flashboards were up, one stoplog was out, and the pool elevation was 1.2 feet below the flashboards. The pool began to rise in response to the storm event and reached a maximum of 0.5 foot above the flashboard elevation on May 14. This was 4.9 feet below the top of the dam. At this time two additional stoplogs were removed. No further action was taken and the pool began to drop but remained above the flashboards. All stoplogs were replaced on May 17. The pool began to rise again and was 0.25 foot above the flashboards on May 22.

Deering Reservoir was refilling from the winter drawdown in April 2007, and was 1.2 feet below the spillway crest on April 3. No flashboards were in place as they had been permanently removed. On April 13, 2007, the pool was 0.45 foot below the spillway and NHDES dam operators removed three stoplogs

in anticipation of the flood event. On April 16, the pool reached a maximum recorded height of 0.95 foot over the spillway, but was still 5 feet below the top of the dam. The dam was then not operated any further as it did not rise to the full lake elevation during the event. Given this, the lake provided excellent flood control for the areas immediately downstream.

The simulation for April 2007 is depicted in Figure 4-4 and tracks the observed pool elevations very well.

### B-4.1.3 Alternative Operations

A simulation of Deering Reservoir with the pool elevation held at the winter level until April 14 was tested and is shown in Figure 4-5. All other operations were assumed to be unchanged. Given these alterative operations, Deering Lake would have been able to catch the entire April 2007 upstream flood flows. Releases from the dam could have been reduced from an actual 30 cfs to almost zero.

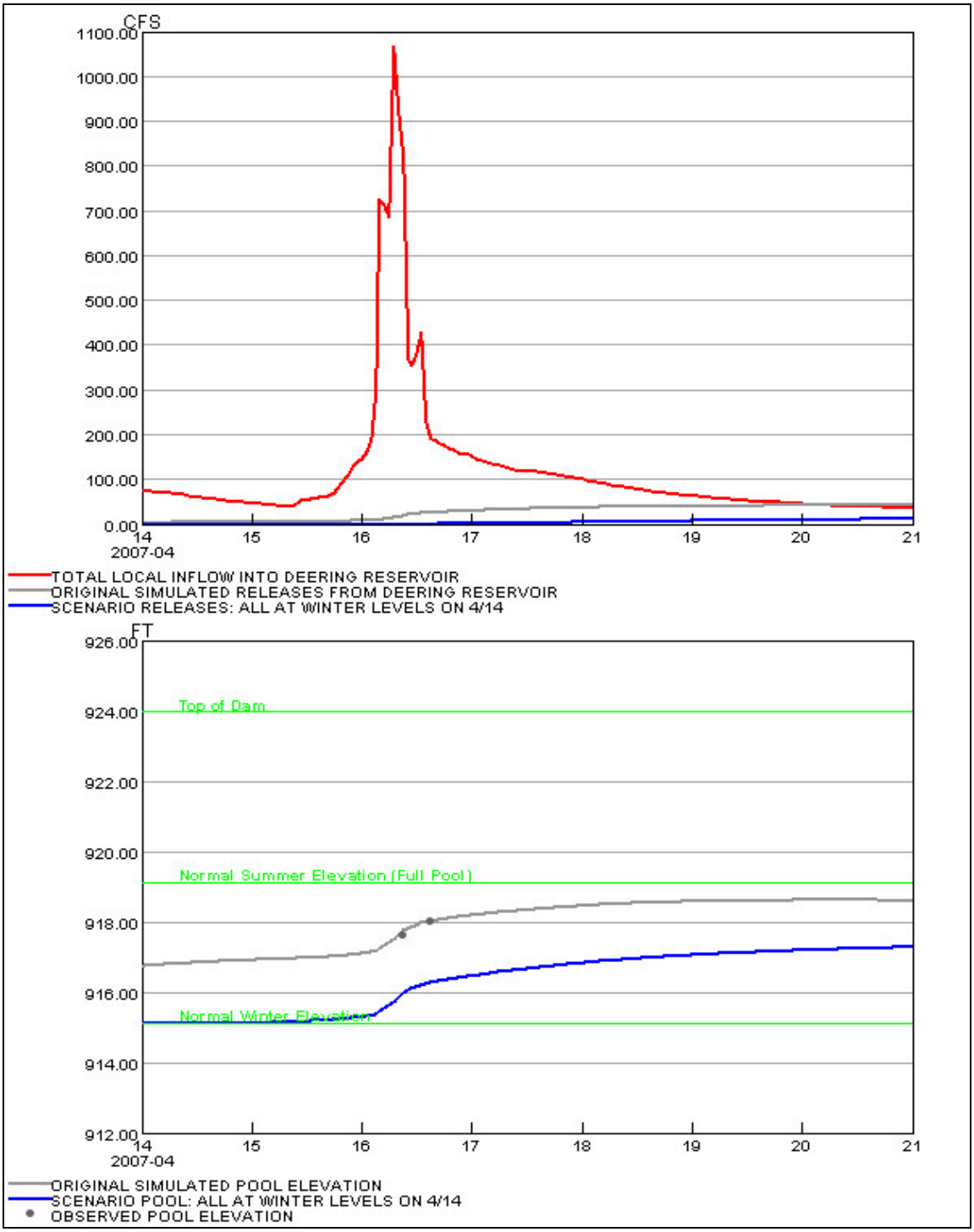


**Figure 4-5: Deering Reservoir Alternative Operations - Starting at Minimum Pool on April 14**

## B-4.2 Horace Lake (AKA Weare Reservoir, NHDES# 247.01)

### B-4.2.1 General Description

Horace Lake is a reservoir located on the Piscataquog River, downstream of Deering Reservoir. Horace Lake has sparse housing developments around most of the shoreline. The lake has a storage capacity of about 6,300 acre-feet at normal levels, and up to 8,600 acre-feet at its maximum elevation. Between those levels, Horace Lake can store about 1.49 inches of runoff into the lake, providing limited local flood control.

The pool elevation can be controlled at a dam structure at the southeastern edge of the lake. This is typically done by manual operation of five stoplog bays and a gate.

The normal or summer elevation of the lake is 655.49 feet, which corresponds to the elevation of the spillway crest. The lake is usually drawn down by five feet after Columbus Day. It requires about 1.05 inches of runoff to refill the lake from the lower winter pool to the normal summer pool.

### B-4.2.2 Actual Operations

All observed data for the May 2006 and April 2007 flood events were provided by the NHDES. The pool elevation is recorded relative to the summer lake elevation of 655.49 feet. Table 4-3 and Table 4-4 list the pool elevation and the dam operations performed at Horace Lake by NHDES.

**Table 4-3: Horace Lake Pool Elevation and Dam Operations during the May 2006 Flood**

| DATE | POOL ELEVATION | LOG BAY 1 | LOG BAY 2 | LOG BAY 3 | LOG BAY 4 | LOG BAY 5 | GATE | COMMENTS | INT |
|---|---|---|---|---|---|---|---|---|---|
| 5/1/2006 | -3.15 | 2 OUT | 2 OUT | 5 OUT | 2 OUT | 2 OUT | OPEN 2" | | CT |
| 5/5/2006 | -2 | 2 OUT | 2 OUT | 3 OUT | 2 OUT | 2 OUT | OPEN 2" | SET TWO LOGS CENTER BAY | PA |
| 5/9/2006 | -1.45 | 1 OUT | 1 OUT | 1 OUT | 1 OUT | 1 OUT | OPEN 3" | SET SIX LOGS OPENED GATE TO 3" | AS |
| 5/12/2006 | -0.9 | 1 OUT | 1 OUT | 1 OUT | 1 OUT | 1 OUT | OPEN 3" | LET RUN AS IS | AS |
| 5/14/2006 | 1.6 | 1 OUT | 1 OUT | 1 OUT | 1 OUT | 1 OUT | OPEN 3" | LET RUN AS IS | AS |
| 5/16/2006 | 1.05 | 1 OUT | 1 OUT | 1 OUT | 1 OUT | 1 OUT | OPEN 3" | LET RUN AS IS | AS |
| 5/19/2006 | 0.4 | 1 OUT | 1 OUT | 1 OUT | 1 OUT | 1 OUT | OPEN 3" | LET RUN AS IS | PA |
| 5/22/2006 | 0.4 | 1 OUT | 1 OUT | 1 OUT | 1 OUT | 1 OUT | OPEN 3" | LET RUN AS IS | PA |

**Table 4-4: Horace Lake Pool Elevation and Dam Operations during the April 2007 Flood**

| DATE | POOL ELEVATION | LOG BAY 1 | LOG BAY 2 | LOG BAY 3 | LOG BAY 4 | LOG BAY 5 | GATE | COMMENTS | INT |
|---|---|---|---|---|---|---|---|---|---|
| 4/2/2007 | -3.25 | ALL OUT (8) | ALL OUT (8) | ALL OUT (8) | ALL OUT (8) | ALL OUT (8) | CLOSED | LET RUN AS IS/ ICE STILL ON POND | AS |
| 4/16/2007 | 0.5 | ALL OUT (8) | ALL OUT (8) | ALL OUT (8) | ALL OUT (8) | ALL OUT (8) | CLOSED | LET RUN AS IS | WPH |
| 4/18/2007 | 0.4 | ALL OUT (8) | ALL OUT (8) | ALL OUT (8) | ALL OUT (8) | ALL OUT (8) | CLOSED | LET RUN AS IS | WPH |

On May 1, 2006 a total of 13 stoplogs were out and the gate was 2” open. The pool elevation was 3.15 feet below the spillway crest. Two logs were put back in place on May 5. Six additional logs were set and the gate was opened to 3” on May 9. At this time the pool elevation had risen to 0.9 foot below the spillway. No further actions were taken and the pool rose to 1.6 feet above the spillway on May 14. This was the maximum recorded pool elevation and corresponds to 5.40 feet below the top of the dam. The pool started to drop on May 16 and was 0.4 foot above the spillway on May 22.

Horace Lake was 3.25 feet below the spillway crest on April 3, 2007, nearing the halfway point in refilling from the winter drawdown level to the summer pool elevation when the April 16 event occurred. At that time all stoplogs were removed from the bays and the single gate was closed. The NHDES did not operate the dam during the event and the reservoir filled to about 0.5 foot above the spillway crest on April 16. This was the maximum recorded pool elevation, and corresponds to 6.5 feet below the top of the dam. The NHDES did not open the gate during the event to prevent downstream flooding, assuming that no upstream flooding was likely. Horace Lake was able to delay and mute the highest inflows during the April event, thus providing some flood control immediately downstream.

The simulation for April 2007 is depicted in Figure 4-6 and tracks the observed pool elevations reasonably well.

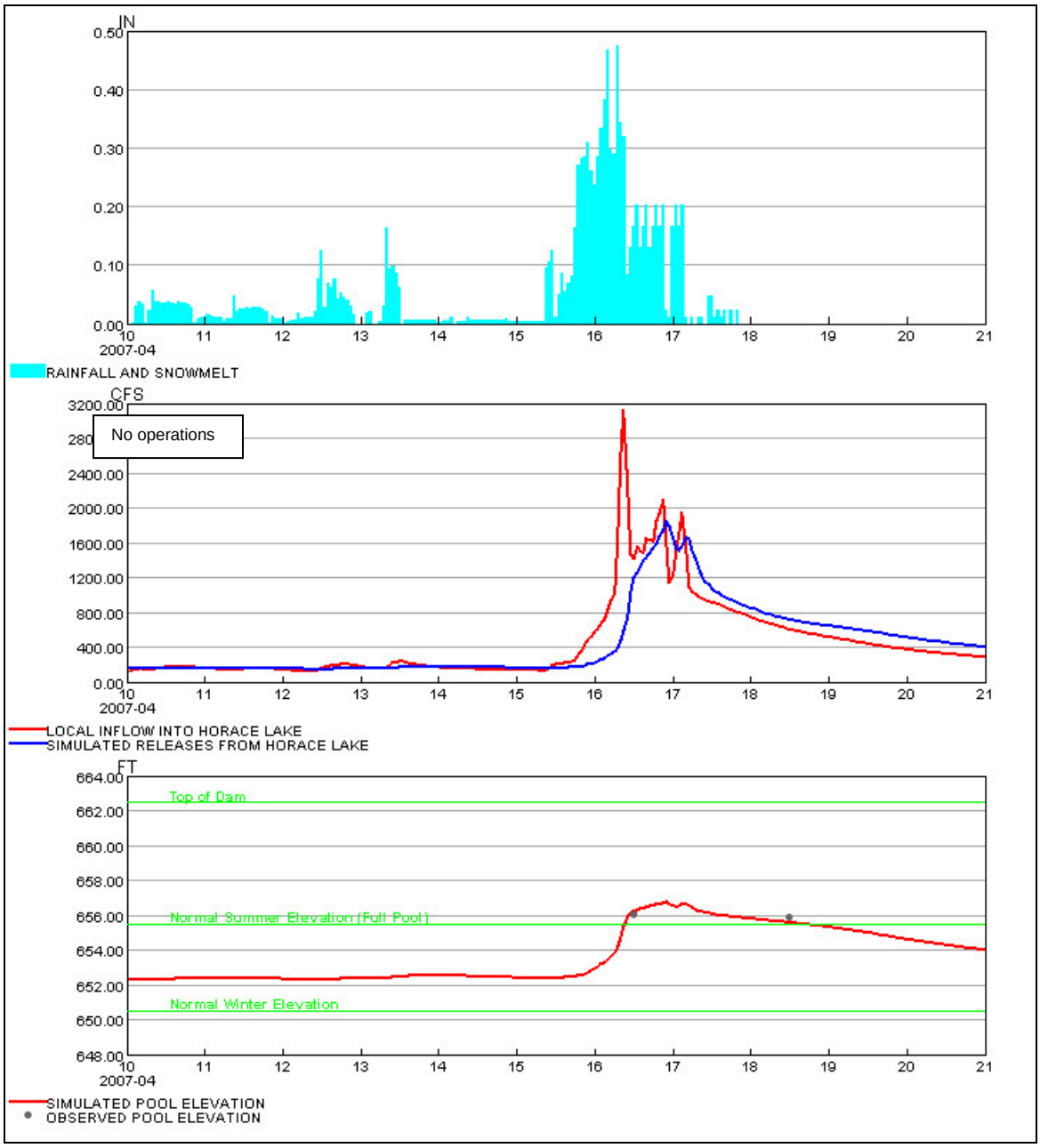


**Figure 4-6: Horace Lake Simulation Results for the April 2007 Flood Event**

## B-4.2.3 Alternative Operations

A simulation of Horace Lake with the pool elevation at the winter drawdown level on April 14 was tested and is shown in Figure 4-7. All other operations were unchanged.

Lowering the pool elevation more did not provide any appreciable reduction in the peak water level or flow.

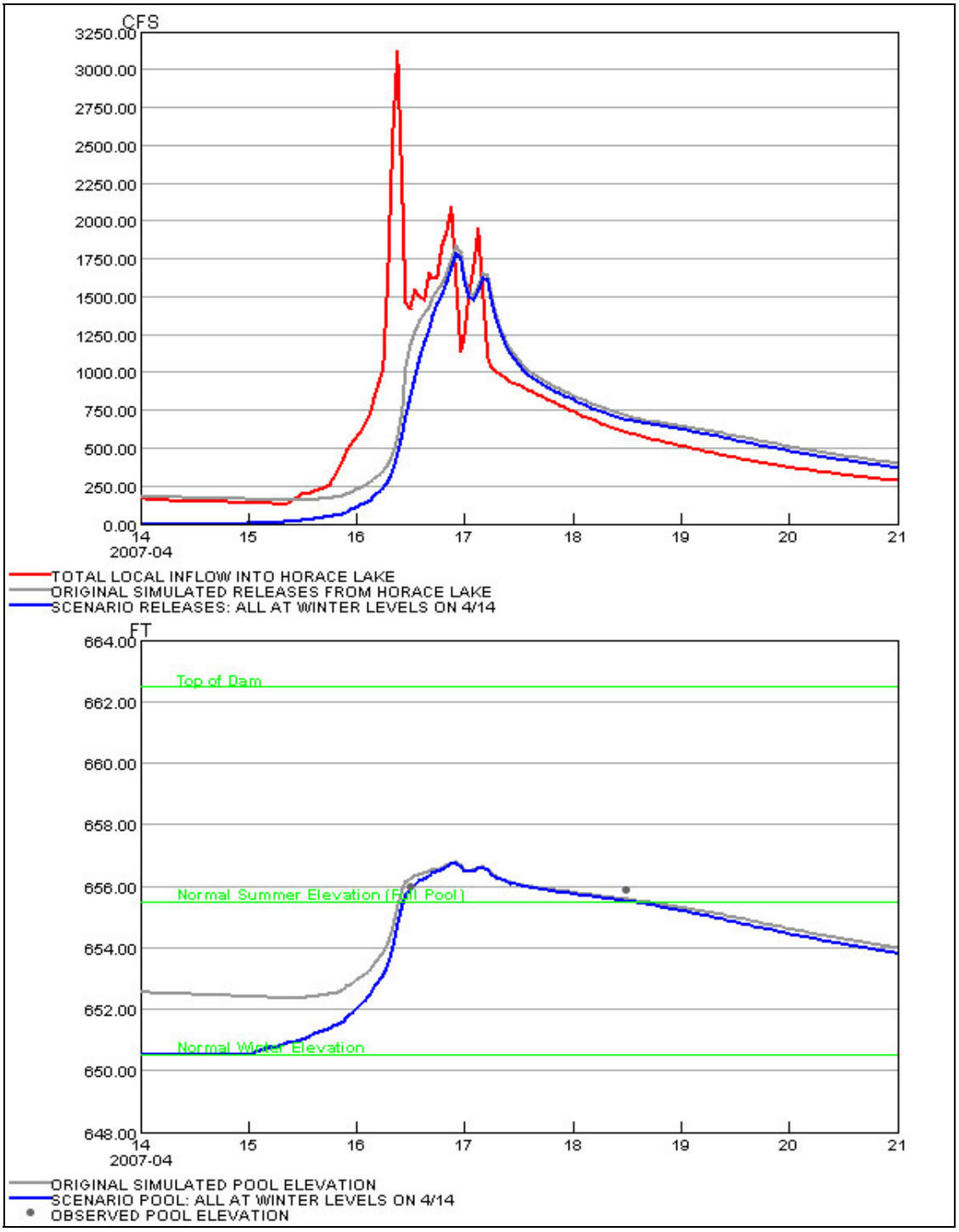


**Figure 4-7: Horace Lake Alternative Operations - Starting at Minimum Pool on April 14**

## B-4.3 Everett Dam (NHDES# 247.14)

### B-4.3.1 General Description

Everett Dam is located on the Piscataquog River, downstream of Horace Lake. Most of the lakeshore is developed, except for a park on the east side of the reservoir. The Lake has a storage capacity of about 1,000 acre-feet at normal pool elevation of 340 feet, and up to 132,800 acre-feet at its maximum elevation of 430 feet. Between those levels, Everett Dam can store 25.76 inches of runoff into the lake, providing significant regional flood control. With this amount of storage, the lake has never filled to capacity. The closest it came was in 1987 at 95 percent.

Everett Dam is designed to hold back floods in the upper reaches of the Piscataquog River as well as flood waters from the Contoocook River, which is connected to Everett Lake via a canal originating at Hopkinton Lake. Once Hopkinton Lake reaches a pool elevation of 400.75 feet, water can flow through the canal into Everett Dam if the pool elevation there is lower. Conversely, water from Everett Dam can flow into Hopkinton Lake at high pool elevations.

The pool elevations at Everett Dam are controlled by the US Army Corps of Engineers (USACE) New England District at the dam structure, located at the northeast end of the impoundment. The dam structure uses three hydraulic gates and one 8 feet circular conduit to control releases. Operating instructions for Everett Lake can be found at the USACE website:
www.reservoircontrol.com.

A photograph of Everett Dam is shown in Figure 4-8.

**Figure 4-8: Photograph of Everett Dam**

### B-4.3.2 Actual Operations

Pool elevations, releases, gate settings, and computed inflows for Everett Dam were downloaded at an hourly time step from the USACE website www.reservoircontrol.com. Reports on the benefits of the USACE flood control dams during flood events can be found on the same website.

Table 4-5 and Table 4-6 list important operation changes and events during the 2006 and 2007 floods.

**Table 4-5: Everett Dam Pool Elevation and Dam Operations during the May 2006 Flood**

| DATE | TIME | POOL ELEVATION | RELEASE | GATE 1 | GATE 2 | GATE 3 | COMMENTS |
|---|---|---|---|---|---|---|---|
| before 5/13/06 | | | | 0 | 3 ft open | 0 | Normal gate setting |
| 5/13/2006 | 17:15 | 342.75 | 46 cfs | 0 | 0.5 ft open | 0 | |
| 5/14/2006 | 8:45 AM | 342.75 | 33 cfs | 0 | 0.3 ft open | 0 | |
| 5/15/2007 | 2:00 AM | | | | | | Flows from Hopkinton Lake start entering |
| 5/17/2006 | 12 noon | 398.04 | 1002 cfs | 1.9 ft open | 1.9 ft open | 1.9 ft open | |
| 5/17/2006 | 2:00 PM | 398.7 | 987 cfs | 2 ft open | 2.9 ft open | 2 ft open | |
| 5/18/2006 | 9:00 PM | | | | | | Flows return to Hopkinton Lake |
| 5/26/2006 | 1:45 PM | 399.49 | 1265 cfs | 2.3 ft open | 2.9 ft open | 2.3 ft open | |

**Table 4-6: Everett Dam Pool Elevation and Dam Operations during the April 2007 Flood**

| DATE | TIME | POOL ELEVATION | RELEASE | GATE 1 | GATE 2 | GATE 3 | COMMENTS |
|---|---|---|---|---|---|---|---|
| before 4/15/07 | | | | 0 | 3 ft open | 0 | Normal gate setting |
| 4/15/2007 | 15:45 | 342.93 | 48 cfs | 0 | 0.5 ft open | 0 | |
| 4/16/2007 | 7:30 AM | 347.82 | 20 cfs | 0 | 0.1 ft open | 0 | |
| 4/17/2007 | 7:00 AM | | | | | | Flows from Hopkinton Lake start entering |
| 4/19/2007 | 3:15 PM | 395.55 | 1025 cfs | 2 ft open | 2 ft open | 2 ft open | |
| 4/20/2007 | 11:15 AM | 399.87 | 1418 cfs | 2.7 ft open | 2.8 ft open | 2.7 ft open | |
| 4/25/2007 | 8:00 PM | | | | | | Flows from Hopkinton Lake stop entering |

In the beginning of May 2006, Everett Dam gates were set at the normal setting. Two of the gates were closed, and one gate was open 3 feet. The pool elevation at this time was 2.75 feet above the normal pond elevation, but still 73 feet below the spillway crest. As the storm began on May 13 the opening at Gate 2 was reduced to 0.5 foot, and releases were set to 46 cfs. On May 14, the opening at Gate 2 was further reduced to 0.3 foot and releases were cut back to 33 cfs. These operations held back almost all of the upstream contribution, releasing only the required minimum flows. Water from Hopkinton Lake started entering Everett Lake the following day, on the 15. No further operations were performed until May 17 when two gates were opened 2.0 ft, one gate opened 2.9 ft, and releases were increased to about 1,000 cfs. The next day, on the 18th, flows began returning back to Hopkinton Lake. On May 26 two gates were opened to 2.3 feet, and the third was left at 2.9 ft. Releases were increased to 1,265 cfs. On this day the pool reached the maximum recorded elevation, 16.5 feet below the spillway crest. This was 30.5 feet below the top of the dam. All operations at the dam conformed to the published flood operation rules.

Everett Lake was almost empty at the beginning of the April 2007 flood event. The pool was 73 feet below the spillway on April 15. The USACE started to close the single open gate in the afternoon of April 15, even before the inflows increased significantly. This reduced the releases from the project to about 48 cfs, which is close to the minimum releases of 32 cfs required by the outflow guidance for the project during a flood event. Releases were kept at very low levels until after the event, which filled the lake significantly. In the afternoon of April 17, flood water from Hopkinton Lake started entering Everett Lake, eventually raising its pool to 51 percent of the flood control storage capacity. Note in Figure 4-9 that the flows from Hopkinton Lake vastly exceeded the flows entering Everett Lake through the Piscataquog River after April 18. The USACE started releasing significant flows only after the event on April 19, evacuating the lake with releases close to the maximum allowed rate of 1,500 cfs. The pool reached the maximum recorded height on April 20 and was 16 feet below the spillway, 30 feet below the top of the dam.

During both events, Everett Dam provided significant regional flood control benefits, reducing any contributions form the upper reaches of the Piscataquog River to the minimum allowed flows.

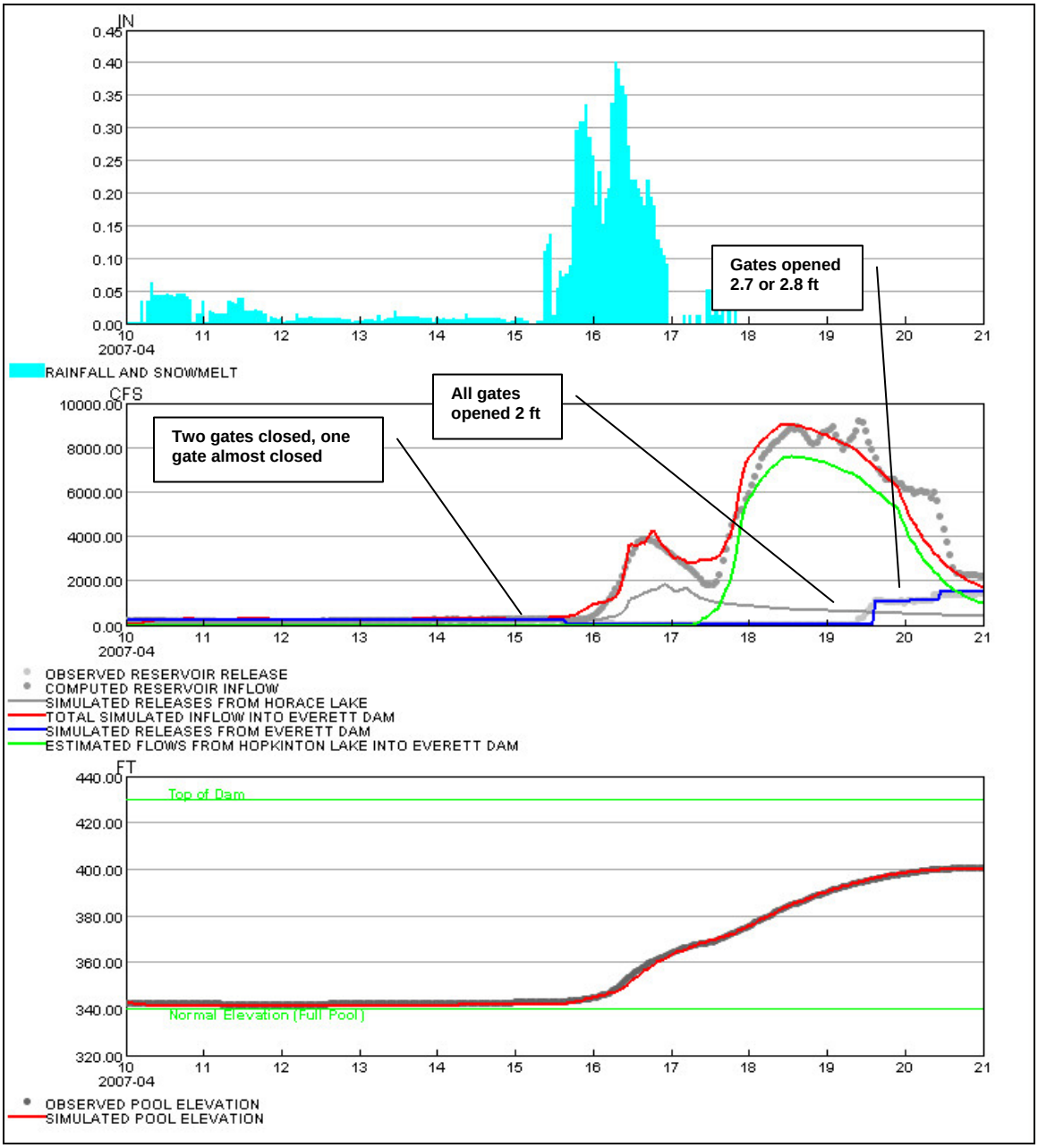


**Figure 4-9: Everett Dam Simulation Results for the April 2007 Flood Event**

## B-4.4 Gregg Falls Dam (NHDES# 093.01)

### B-4.4.1 General Description

Gregg Falls Dam is located downstream of Everett Dam, below the confluence of the main stem Piscataquog River with the unregulated South Branch of the Piscataquog River. Gregg Falls is located directly downstream of Goffstown and most of the shoreline is developed. Gregg Falls Lake has a storage capacity of about 1,800 acre-feet at normal levels, and up to 4,700 acre-feet at its maximum elevation, providing 0.27 inch of flood control storage. It is considered a run-of-river hydropower project.

The water levels in Gregg Falls Lake are controlled by Algonquin Power Systems, which leases the dam from the NHDES, through a spillway with flashboards, two gates, and turbines. The site also includes a fish bypass with a maximum discharge capacity of 21 cfs.

A photograph of Gregg Falls Dam is shown in Figure 4-10.

**Figure 4-10: Photograph of Gregg Falls Dam**

### B-4.4.2 Actual Operations

Algonquin Power Systems provided detailed operations as well as pool elevation, discharges through the gates, over the spillway and power generation in 5–minute intervals.

On May 6, 2006 the pool was 0.2 foot below the flashboards and rose to about the height of the flashboards on May 13. During the May 2006 event, all gates and the fish bypass were fully open. Flashboards were in place, but about half of them had been destroyed by ice before the event. Releases

from the project were controlled by the two installed turbines. Additional uncontrolled discharge occurred over the spillway. The maximum pool elevation was 3.3 feet over the flashboards and occurred on May 14. This was 2.7 feet below the top of the dam. No upstream flooding was reported.

As depicted in Figure 4-11, most of the inflows into Gregg Falls during the April 2007 event originated in the unregulated South Branch of the Piscataquog River-Everett Dam held back almost the entire contribution from the upper reaches of the Piscataquog River itself. Gregg Falls has no winter drawdown, and the water elevation is typically close to the top of the spillway or flashboards. On April 10, 2007 the pool was 1.5 feet below the elevation at the top of the flashboards, which were not erected at this time. The pool dropped slightly by April 13 to 1.65 feet below the flashboards. During the April 2007 event, all gates and the fish bypass were fully open. Releases from the project were controlled by the two installed turbines. Additional uncontrolled discharge occurred over the spillway. The maximum pool elevation of 2.1 feet over the flashboards (3.9 feet below the top of the dam) was reached in the evening of April 16th. No upstream flooding was reported. However, significant flooding occurred downstream of the project.

Given the data provided by the operator, the simulation captures the peak pool elevation and the peak release very well—however, it is short on volume. The simulation also follows the observed hydrograph at the downstream Goffstown gage, capturing the magnitude and timing of the peak.

### B-4.4.3 Alternative Operations

This study investigated whether alternative seasonal or flood control operations could have prevented the flooding downstream. Figure 4-12 shows the results if Gregg Falls had been completely drained before the event on April 14. While unreasonable, this scenario illustrates the maximum flood control benefit that the project could possibly provide. However, even with Gregg Falls completely drained before the event there would have been no appreciable reduction in the peak releases and peak water level because the small reservoir would have filled up rapidly at the beginning of the event.

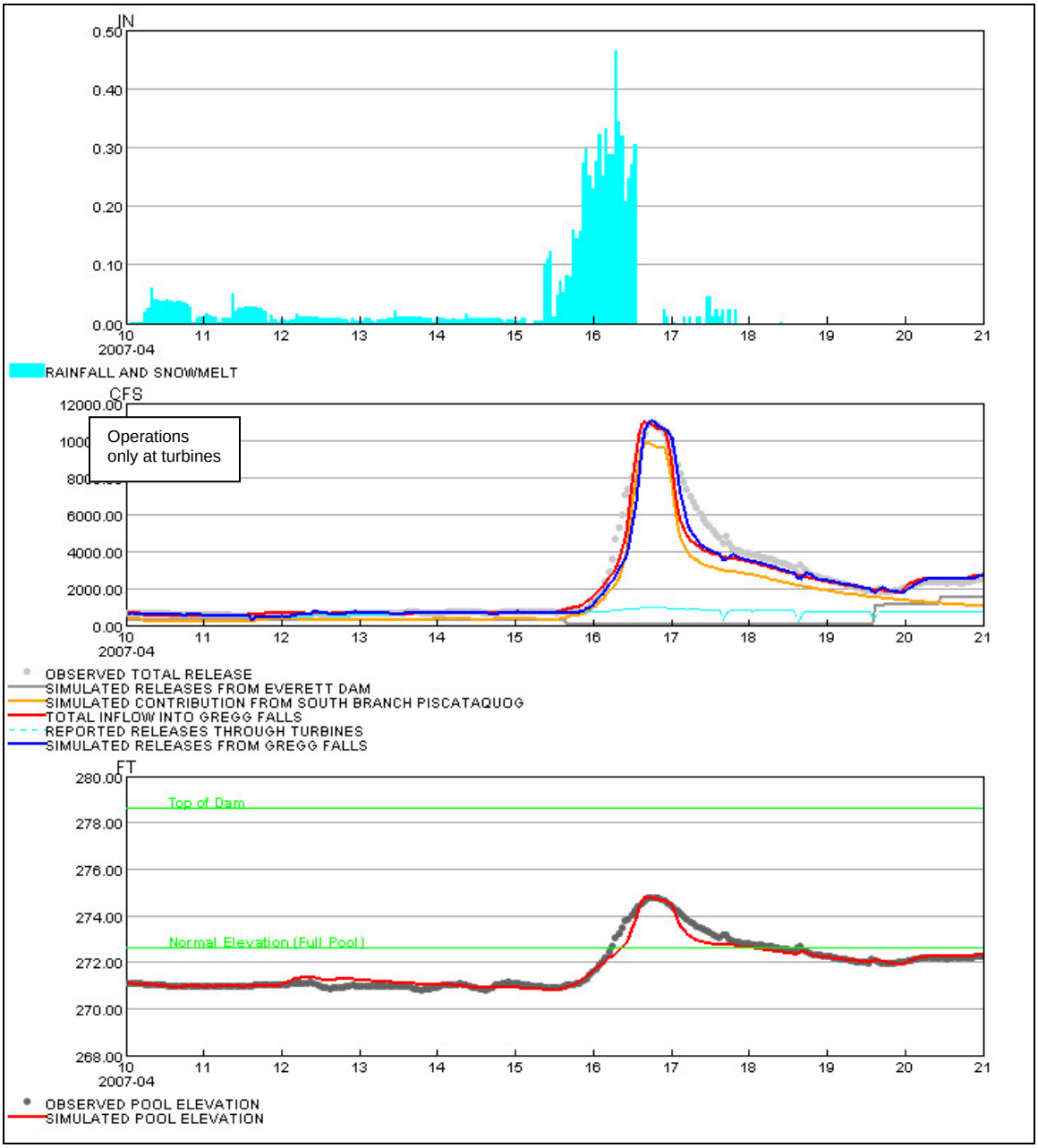


**Figure 4-11: Gregg Falls Dam Simulation Results for the April 2007 Flood Event**

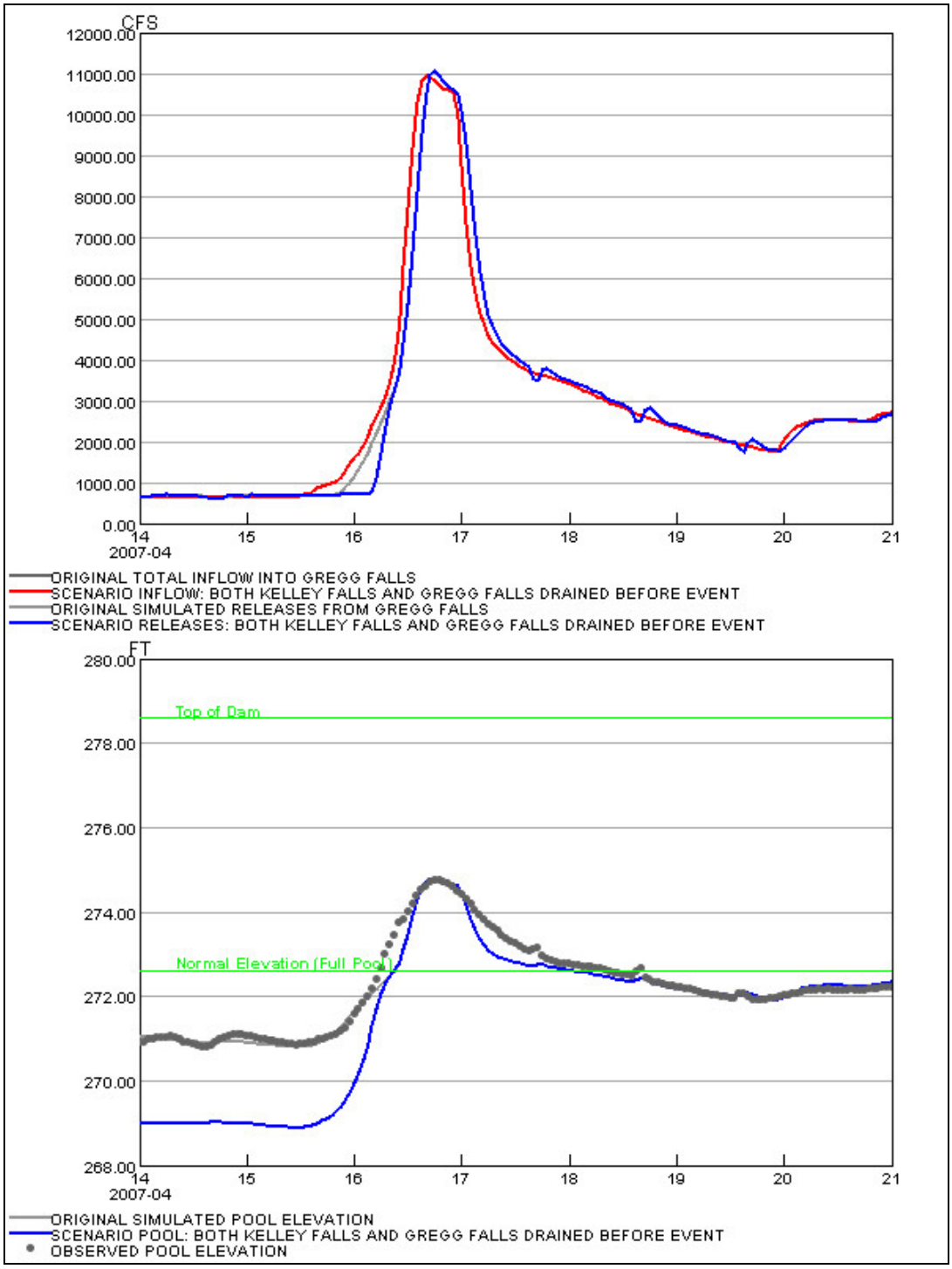


**Figure 4-12: Gregg Falls Alternative Operations - Drained before Event**

## B-4.5 Kelley Falls Dam (NHDES# 150.02)

### B-4.5.1 General Description

The run-of-river Kelley Falls hydropower project is located on the Piscataquog River in Manchester. Most of the shoreline is developed. The lake has a storage capacity of about 1,000 acre-feet at normal levels, and up to 2,290 acre-feet at its maximum elevation, providing a flood control storage of only about 0.11 inch. The water levels are controlled through a spillway with flashboards, a waste gate, and a relief gate. The typical summer lake elevation is 160.7 feet, which corresponds to the elevation of the flashboards.

A plan view and photograph of Kelley Falls Dam are shown in Figure 4-13 and Figure 4-14 respectively.

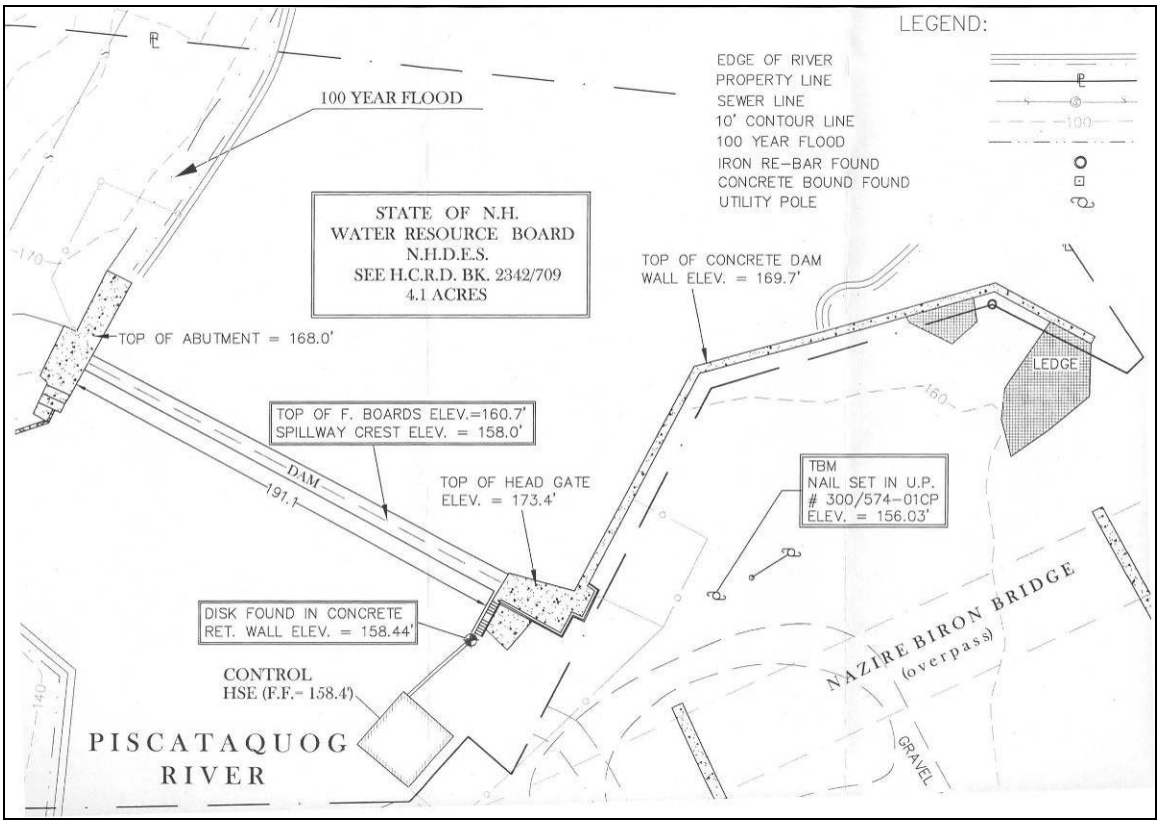


**Figure 4-13: Plan View of Kelley Falls Dam**

**Figure 4-14: Photograph of Kelley Falls Dam**

## B-4.5.2 Actual Operations

A presentation describing the operations during the April 2007 event was provided by the dam operator Enel North America, Inc. (see Figure 4-15). No information regarding pool elevations or operations at the dam is available for 2006.

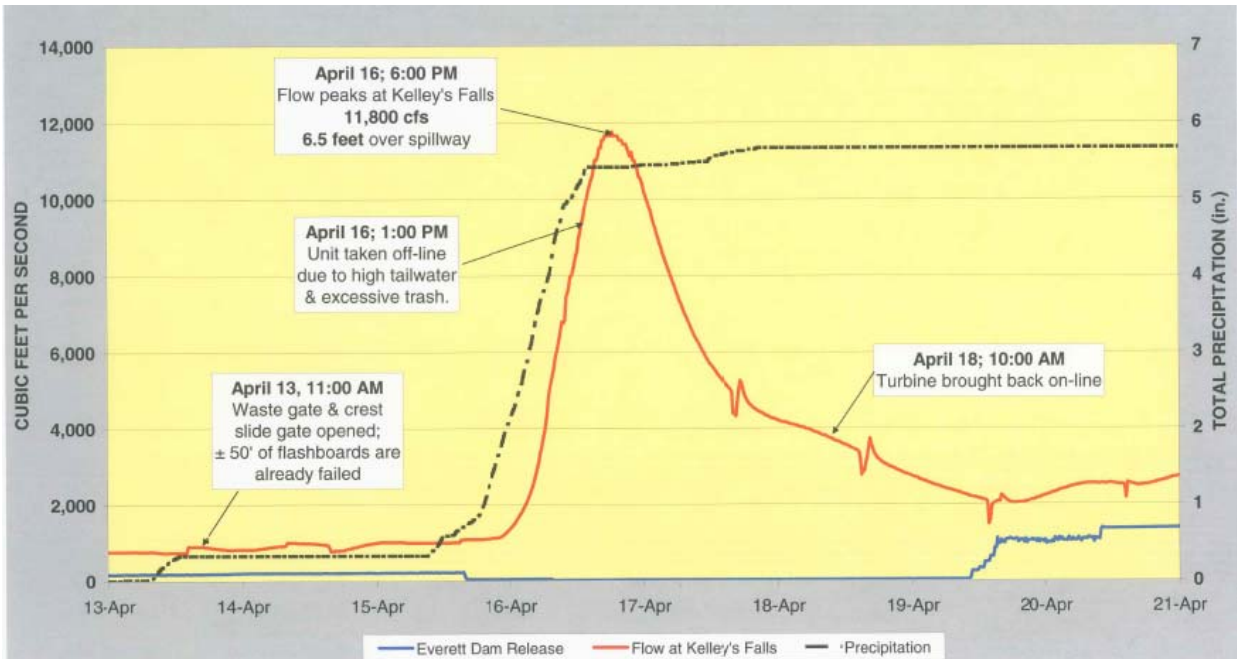


**Figure 4-15: Operations at Kelley Falls Dam in April 2007**

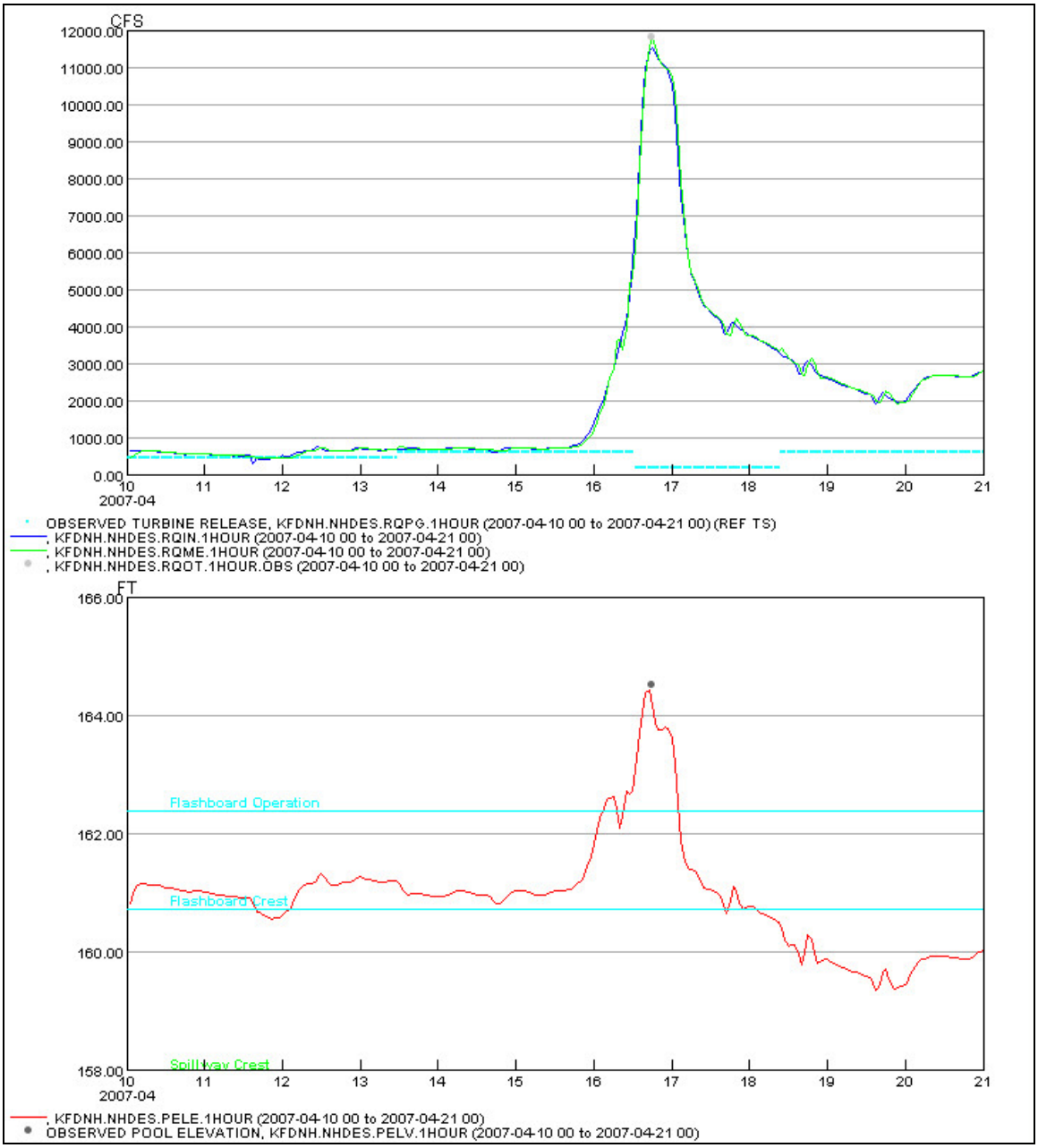


**Figure 4-16: Kelley Falls Dam Simulation Results for the April 2007 Flood Event**

At the beginning of the April 2007 event, the dam was operated to be close to the elevation of the flashboard crest. On April 13, about 50 feet of flashboards had failed. At 11 a.m. this day the fish bypass and a relieve valve were opened and increased flows through the project. The turbine was taken offline at 1:00 p.m. on April 16 due to high tailwater and excessive debris. Maximum pool height was reached at 6:00 p.m. when it was 6.5 feet over the spillway, but remained 3.8 feet below the top of the dam. It appears from photographs that the entire flashboard section failed at some point during the event—it is assumed that that happened at the peak of the event.

Significant flooding was reported upstream of the project. This was caused by high peak pool elevations behind Kelley Falls Dam and likely aggravated by trash that accumulated at an abandoned trestle bridge upstream of the dam.

The simulation of pool elevations at Kelley Falls Dam worked well, as sown in Figure 4-16. The results indicate that Kelley Falls Dam had only very minor effects on modulating the inflows.

### B-4.5.3 Alternative Operations

Given that operations at the project during the April 2007 event had provided for almost the maximum discharge capacity, the assessment of alternative operations focused on the pool elevation before the event. An extreme case was to enter the event completely drained. Figure 4-17 shows the results of this scenario. However, even with the pond drained before the event there would have been no appreciable reduction in the peak flow or water level. This indicates that only structural improvements can minimize upstream flooding during events the magnitude of April 2007.

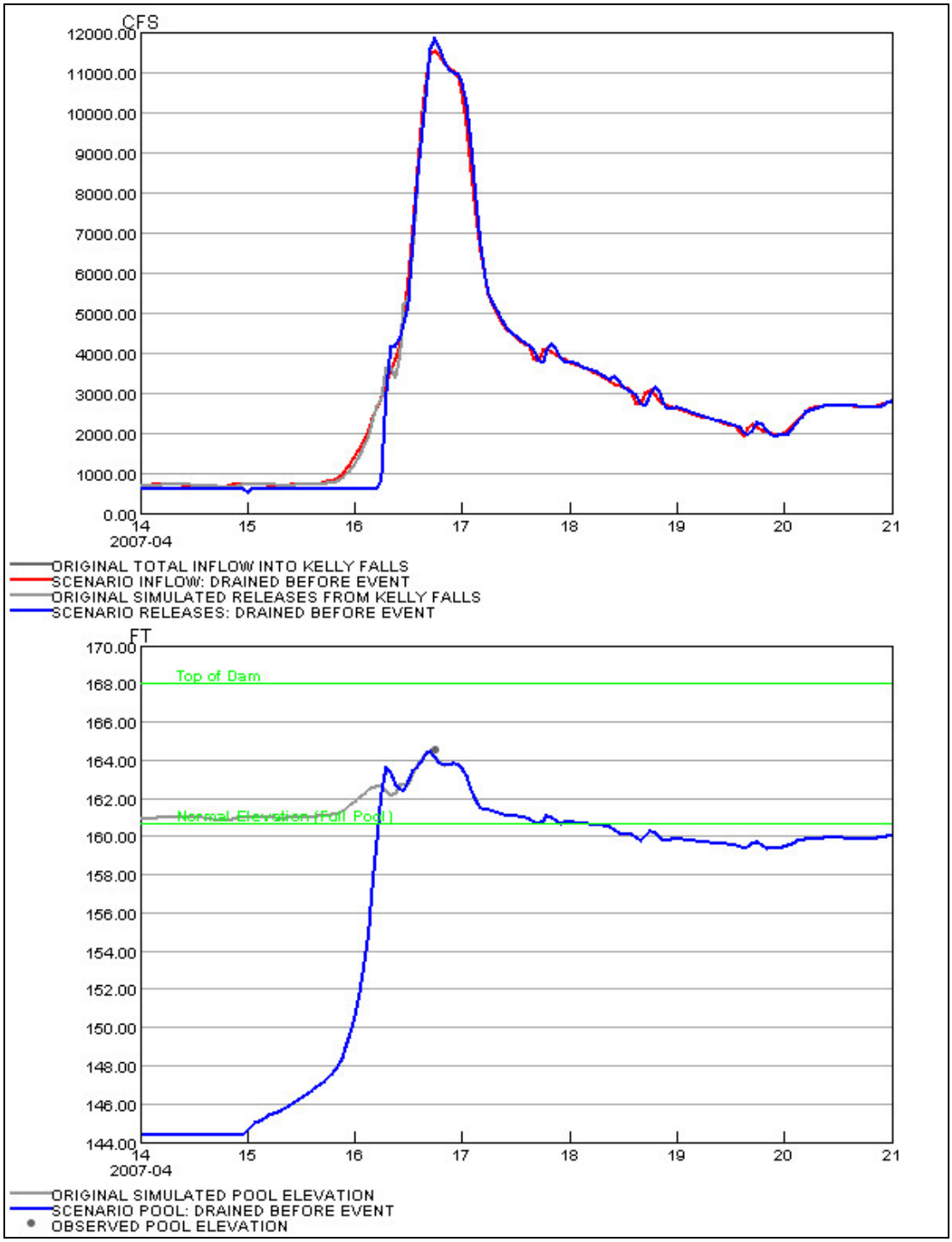


**Figure 4-17: Kelley Alternative Operations - Drained before Event**