Cuddebackville Dam Removal
Hydrologic and Hydraulic Analysis
Cuddebackville, NY

Purpose:
The main goal of the Cuddebackville Dam Removal project is to restore access to upstream habitats to migratory fish along the Neversink River. A secondary goal is to maintain water in the historic Delaware and Hudson (D&H) canal.

Cuddebackville Dam is on the Neversink River approximately 1.1 miles upstream of the Route 209 bridge. The dam is made up of two sections, a southwest dam and a northeast dam, separated by a natural island. Upstream of the dams, there is another island that separates the total Neversink stream flow into two portions: one going to the southwest dam and the other going to the northeast dam. Between the two islands, there is a small channel that allows the mixing of the pools upstream of the southwest and northeast dams. A feeder canal for the D&H canal exits the Neversink River to the east just upstream of the northeast dam. Figure 1 shows the hydrologic and hydraulic points of interest. Removal of one or both of the dams could affect the water level upstream of the dam and therefore the amount of water that will enter the feeder canal and the D&H canal.

In order to quantify the affects of removal of one or both of the dams on the water level in the feeder and D&H canals, hydrologic and hydraulic analyses were performed. This narrative states the methods and assumptions used to determine the impacts of several removal scenarios and the recommendations that result from the analyses.

Discharge Frequencies:
Hydrologic analyses were carried out to establish the peak discharge frequency relationships. Because the purpose of this project is to determine whether the canal will flow without one or both of the dams, only flows less than the 10-year peak flow were analyzed. It is assumed that for flows higher than the 10-year flood, the canal will flow. The discharges used in the analysis were the 10-year peak flow, the 2-year peak flow, the annual mean flow, and the minimum average 7-day 2-year flow (a drought-type flow). The peak discharge for the 10-year flood was taken from the hydraulic analysis used in the Flood Insurance Study (FIS) for the Town of Deerpark, NY March 18, 1987. In the FIS, the peak discharge data at the dam site was interpolated from peak discharge calculations made at the Oakland Valley gage, having a drainage area of 223 square miles, and the Godeffroy gage, having a drainage area of 307 square miles. The drainage area upstream of the dam site is 235 square miles. The peak discharge for the 2-year flood was determined from extrapolating the FIS peak discharge data for the 10, 50, 100, and 500-year floods at the site. The annual mean discharge was determined from an interpolation of the annual mean discharges at the Oakland Valley gage and the Godeffroy gage. The minimum average 7-day 2-year flow was taken from a report entitled, "Low-Flow Frequency Analysis of Streams in New York", prepared by the U.S. Geological Survey, dated 1979, for the Oakland Valley gage. The discharges are shown in Table 1.

Table 1. Frequency flow data for the Neversink River at the Cuddebackville dams

10-year peak flow	2-year peak flow	Annual mean flow	Min. avg. 7-day 2-year flow
9,375 cfs	2,025 cfs	273 cfs	50 cfs

The total discharges along the Neversink River were split into a southwest discharge, the discharge going to the southwest dam, and a northeast discharge, the discharge going to the northeast dam. The amounts of the split discharges were based on channel geometry at the upstream end of the upstream island.

Hydraulic Analysis:
The HEC-RAS computer model was used to compute the elevations for the different dam removal scenarios. Existing conditions were modeled to assess the impact of the removal scenarios on existing water surface elevations. Existing topographic geometry was obtained from several sources: 1) Survey data obtained by Rettew Associates, Inc. in the summer of 2001 and referenced to NAVD 1988, 2) Survey data obtained by USGS in the summer of 1998 and referenced to a local datum, 3) Cross sections from the hydraulic model used in the 1987 FIS report and referenced to NGVD 1929. The USGS and FIS data were converted to NAVD 1988 for use in the HEC-RAS model. Stream roughness values were estimated based on site visits and pictures taken at the site. The starting water surface elevation was calculated using normal depth sufficiently downstream of the area of interest.

The resulting water-surface elevations from the existing conditions model for the annual mean flow compare favorably with actual water-surface elevations measured in the field in June 2001. Table 2 shows a comparison of computed water-surface elevations for the annual mean flow and actual elevations:

Table 2. Comparison of Computed and Actual Water-surface Elevations

	Computed elevation (feet – NAVD88)	Actual elevation (feet – NAVD88)	Difference (feet)
Downstream of the southwest dam	521.57	521.80	-0.23
Upstream of the southwest dam	525.82	525.56	0.26
Downstream of the northeast dam	519.76	519.29	0.47
Upstream of the northeast dam	526.57	526.44	0.13
Upstream of the upstream flow split location	531.40	531.70	-0.30

Dam Removal Scenarios:
Three alternatives were modeled:

1) Removal of both the southwest and northeast dams
2) Removal of the southwest dam without disturbing the northeast dam
3) Removal of the southwest dam and lowering the northeast dam to 526.5 feet NAVD

Figures 2 through 5 show comparison of the dam removal scenarios and existing conditions for each flow analyzed.

1) Removal of both the southwest and northeast dams:
Figures 2-5 show a comparison of the profiles for existing conditions and the removal of both dams for the 10-year flow, the 2-year flow, the annual mean flow, and the minimum average 7-day 2-year flow. As expected, the water-surface elevations upstream of the southwest and northeast dams for all flows are reduced by several feet after removal of the dams. The water-surface elevation upstream of the northeast dam for flows less than or equal to the 2-year flow is lower than the lowest elevation of the feeder canal opening, 526.4 feet NAVD. This means that if both dams are removed, no water will enter the feeder canal until the flow is greater than that of a 2-year event.

2) Removal of the southwest dam without disturbing the northeast dam:
Figures 2-5 show a comparison of the profiles for existing conditions and removal of the southwest dam for the 10-year flow, the 2-year flow, the annual mean flow, and the minimum average 7-day 2-

year flow. The water-surface elevations upstream of the southwest dam decrease by several feet as a result of its removal. The water-surface elevations upstream of the northeast dam show no significant change from existing conditions.

3) Removal of the southwest dam and lowering the northeast dam to 526.5 feet NAVD:
Elevation 526.5 feet NAVD is slightly higher than the lowest elevation of the feeder canal entrance opening. The southwest dam is removed so the water-surface elevations are the same as in the previous two scenarios upstream of the southwest dam. The water-surface elevations upstream of the northeast dam fall between the results of the existing conditions and the complete dam removal for the 10-year and 2-year flows. For the annual mean flow and the minimum average 7-day 2-year flow, the water-surface elevations upstream of the northeast dam for existing conditions and lowering the dam are the same. (see Figures 2-5)

Conclusions and Recommendations:
The results of the dam removal scenarios show that the removal of the southwest dam will not affect water-surface elevations upstream of the northeast dam for low flows. This result is not surprising since the existing conditions hydraulic analysis shows that the area where the total Neversink River flow splits is not controlled by backwater effects from the southwest dam for low flows. Since backwater effects do not control the flow split location, the same amount of water flows to the northeast dam, whether or not the southwest dam exists. Therefore, the water-surface elevations upstream of the northeast dam are the same whether or not the southwest dam exists.

Data collected in June 2001 indicate that the water-surface elevations in the feeder canal and the D&H canal are approximately the same as the water-surface elevation upstream of the northeast dam. If removing the southwest dam will not affect water-surfaces upstream of the northeast dam, then the feeder and D&H canals will also not be affected. The southwest dam can be removed to provide increased habitat for aquatic biota and will not reduce water flow in the D&H canal.

Because the water elevations upstream of the northeast dam and in the feeder canal are the same, the removal scenarios for the northeast dam have significant impacts on maintaining water levels in the D&H canal. A complete removal of the northeast dam results in drying out the feeder canal for stream flows equal and below the 2-year flow. A lowering of the northeast dam to 526.5 feet NAVD would maintain water in the canal for everyday flows but the canal water levels would be lower. This may be a sufficient scenario with respect to the canal however there are not many benefits to lowering the dam to that elevation. Most of the dam would still be in place and fish passage would not be possible. The recommendation for the northeast dam is to leave it in place and to make no changes to the entrance to the canal.

The existing conditions water-surface elevations for the minimum average 7-day 2-year flow show that the northeast dam pool elevation is lower than the elevation of the entrance to the feeder canal. As shown above, for the minimum average 7-day 2-year flow, removing the southwest dam does not change the northeast dam pool elevation, but removing the northeast dam lowers the northeast dam pool elevation significantly. So, in drought-type conditions, water will not enter the feeder canal for any of the scenarios, including the existing conditions.

With both dams in place, the small channel allows mixing of their upstream pools for pool elevations higher than 525.8 feet NAVD, the maximum elevation of the small channel bottom. The flow direction through the small channel depends on which pool elevation is greater. With the southwest dam removed, the northeast pool elevation will be higher than the elevation on the southwest side of the small channel for average flows. Water could move through the small channel from the northeast pool to the southwest channel. Water leaving the northeast pool would lower the water-surface elevations upstream of the northeast dam and in the canals. It is recommended that the maximum

elevation of the small channel bottom be raised to the elevation of the feeder canal entrance to ensure that water will enter the canal before it is able to move through the small channel. Only a localized area of the small channel would need to be raised and the small channel will still contain water for most flows.

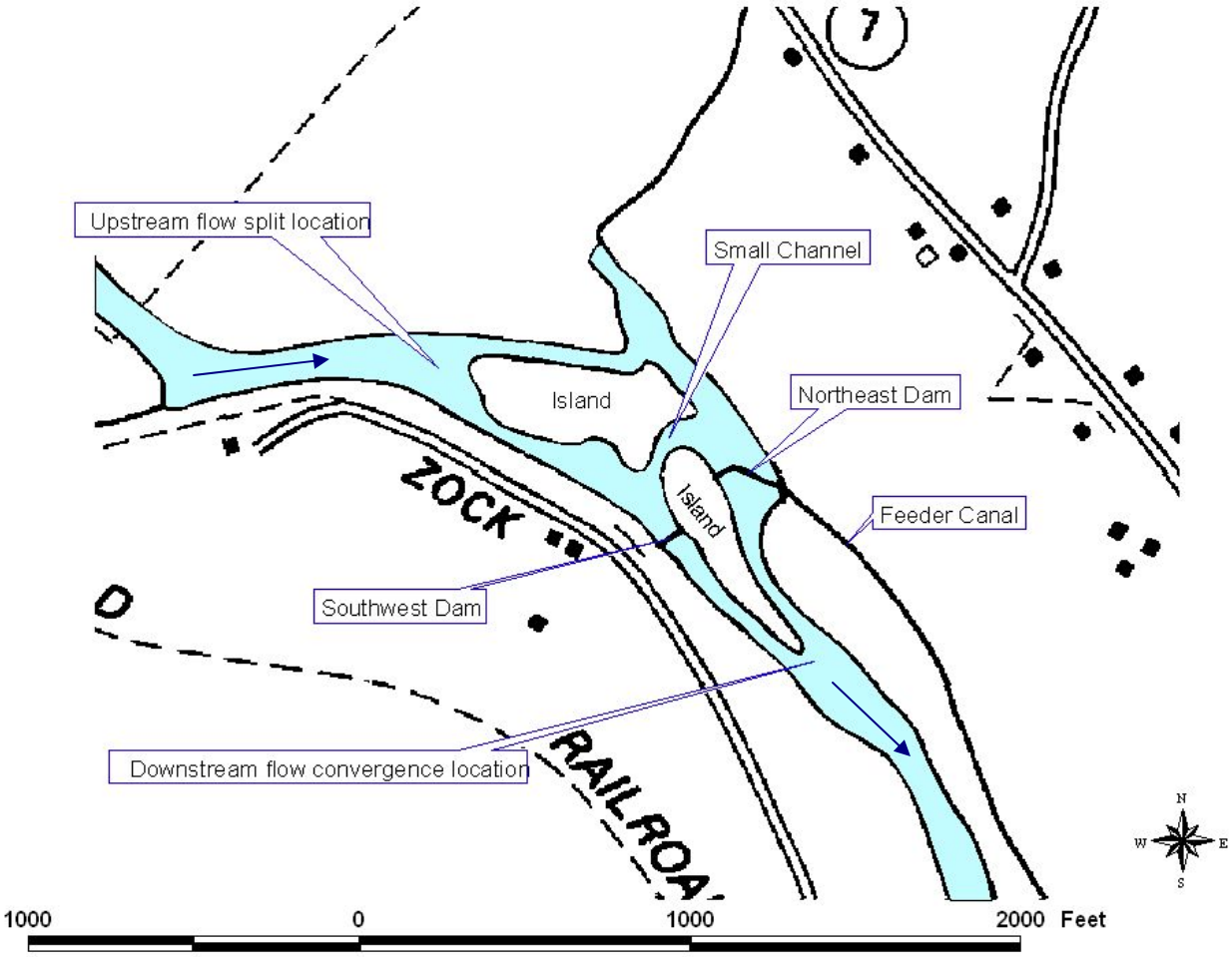
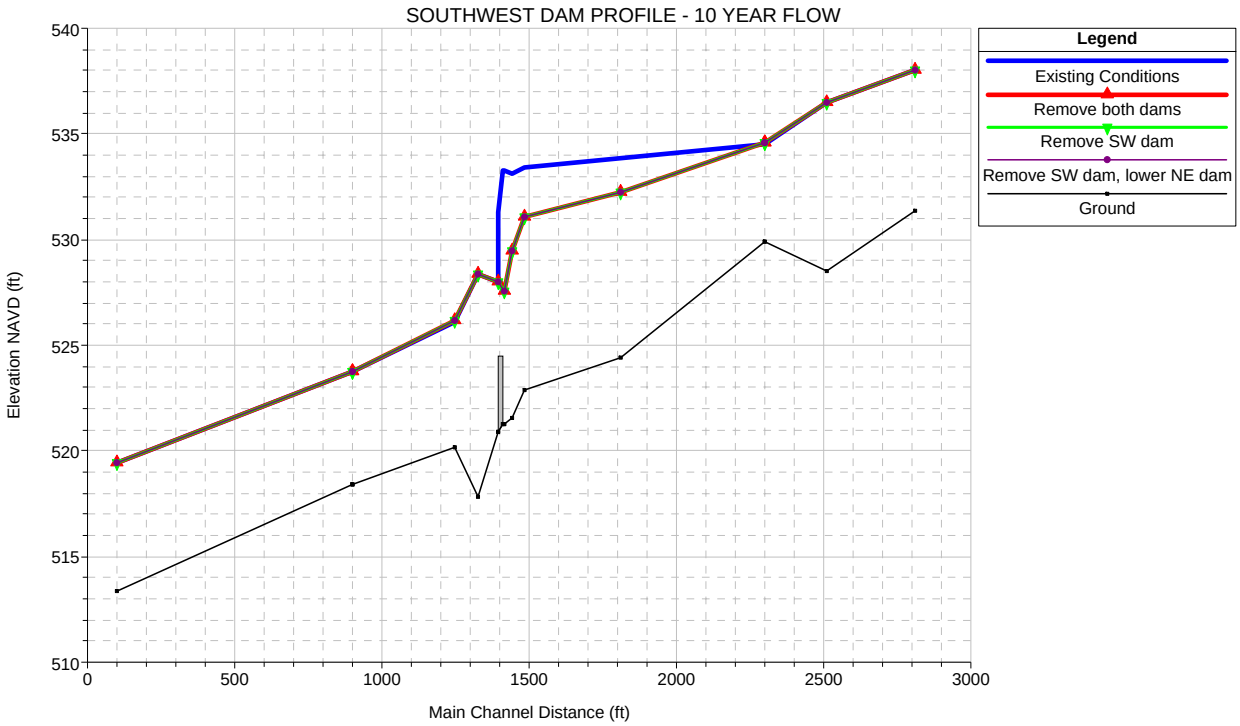


Figure 1. Site map



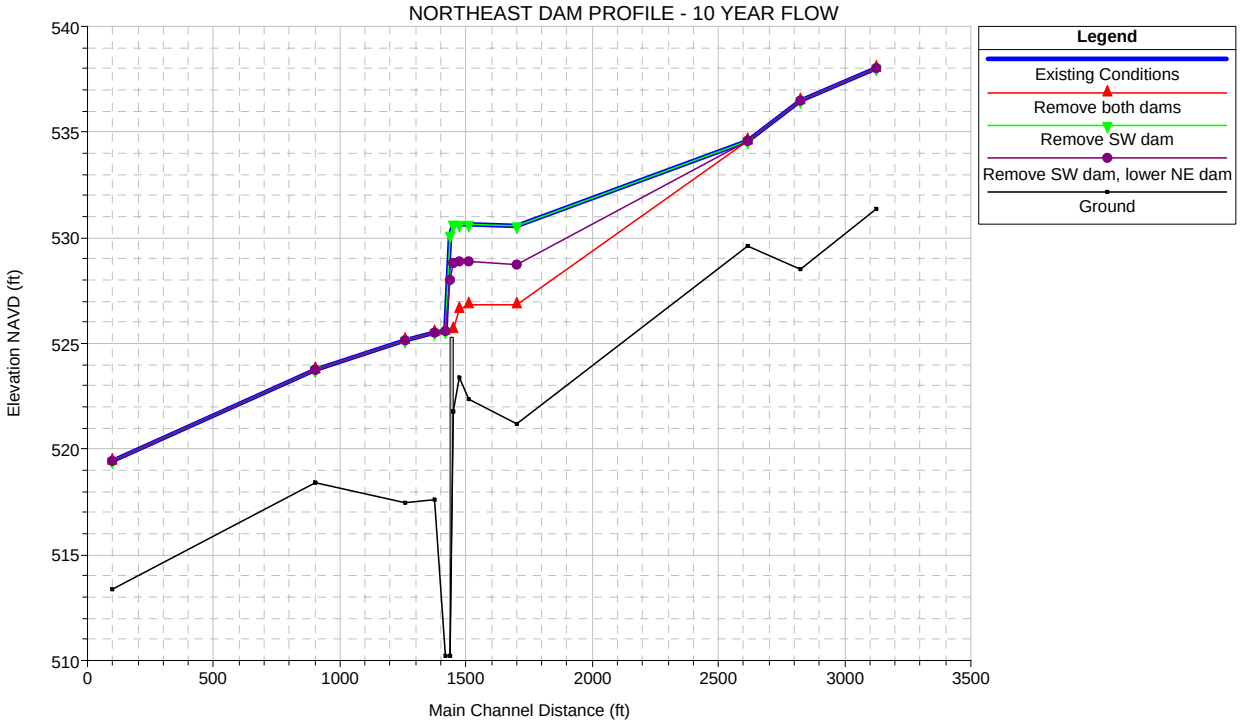
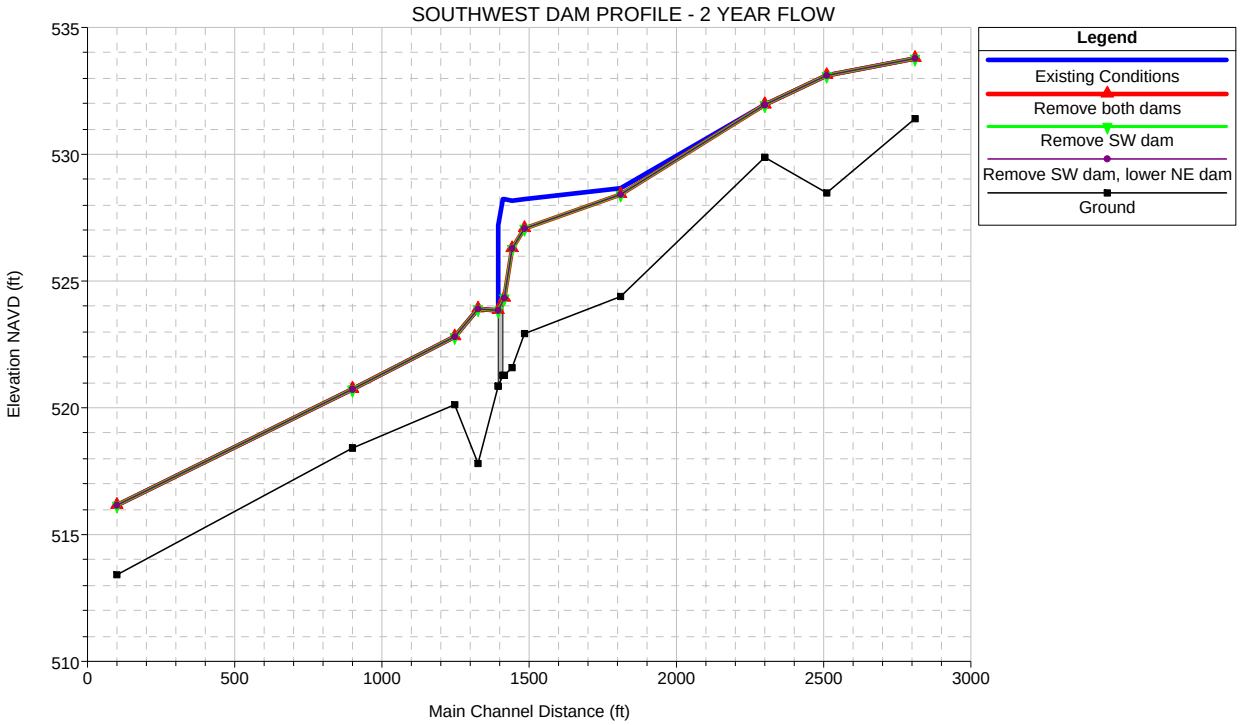


Figure 2. Dam profiles for existing conditions and removal scenarios for the 10-year flow



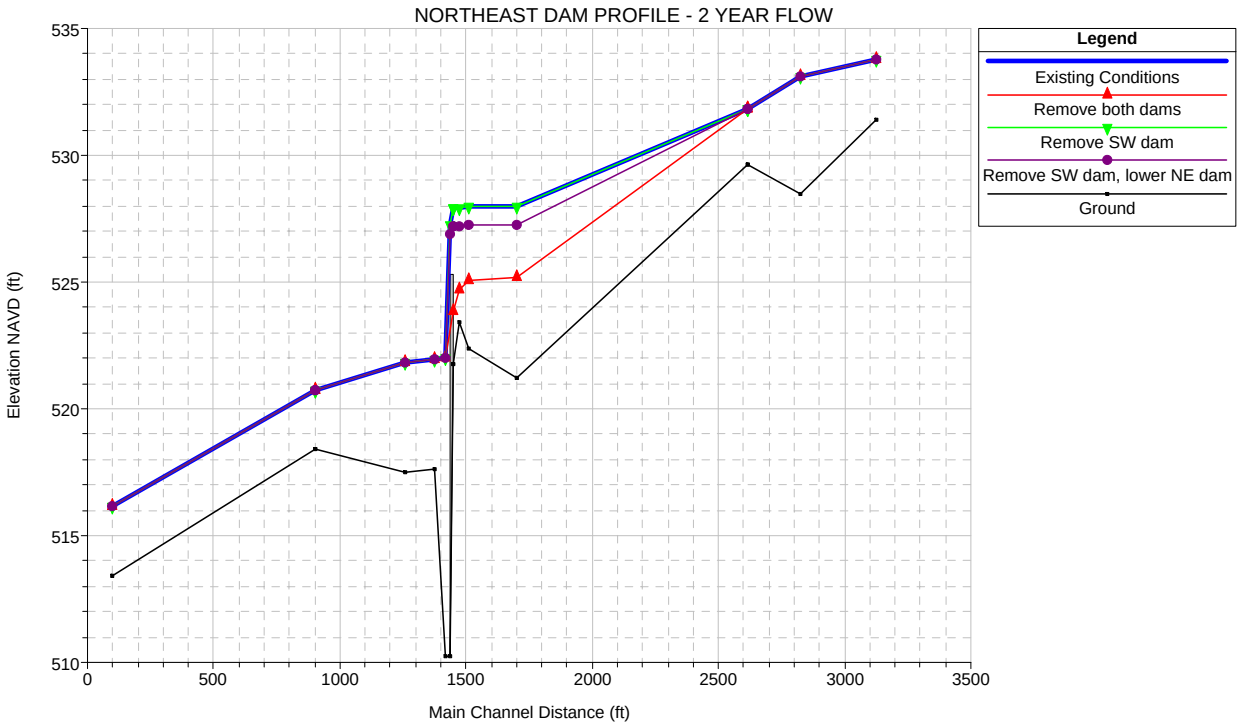
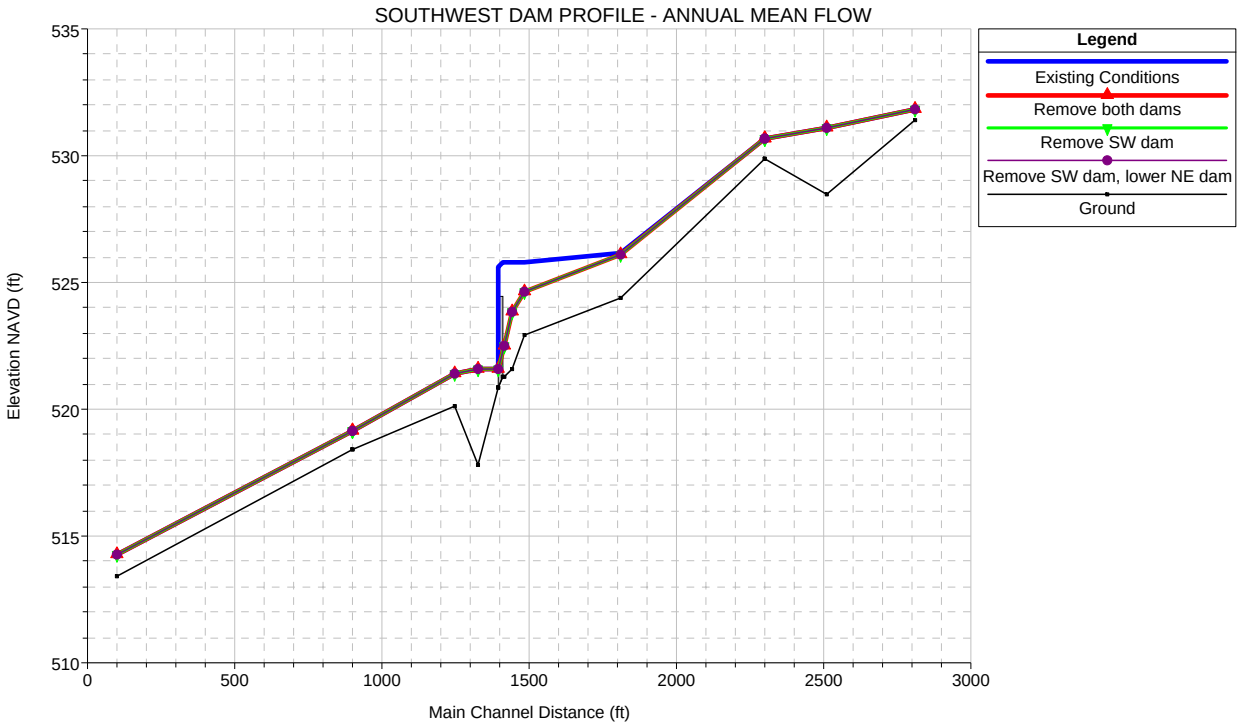


Figure 3. Dam profiles for existing conditions and removal scenarios for the 2-year flow



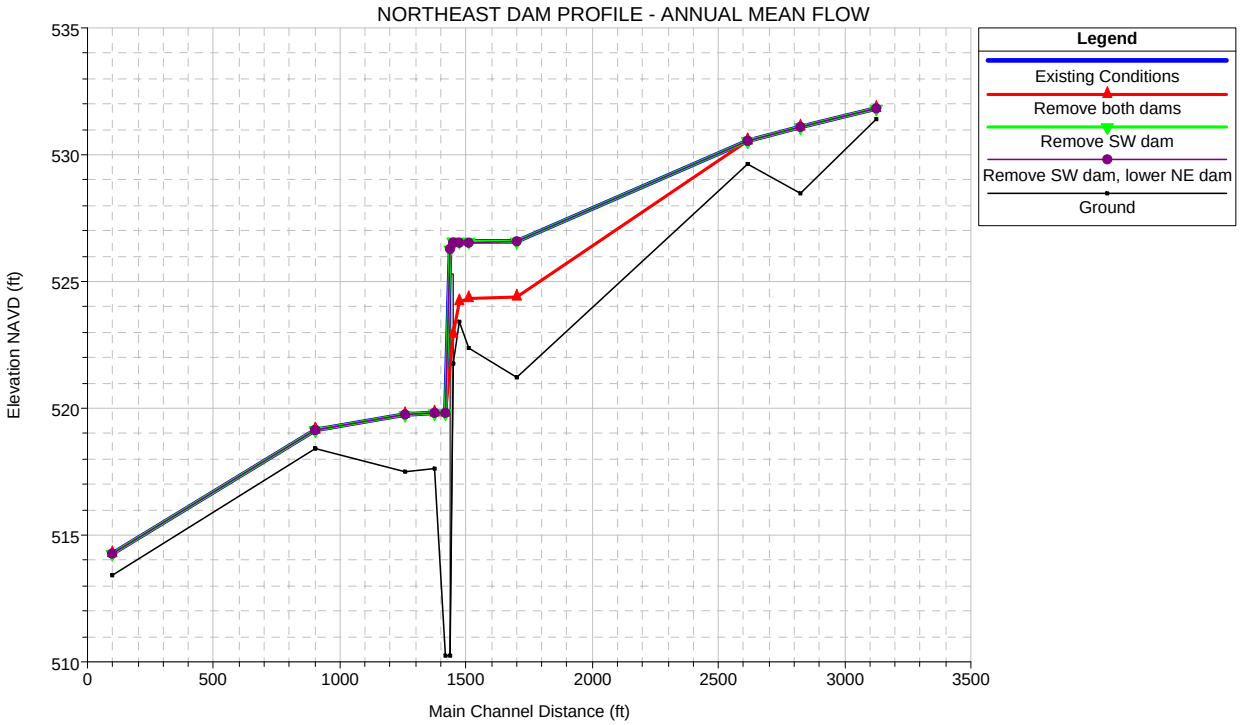
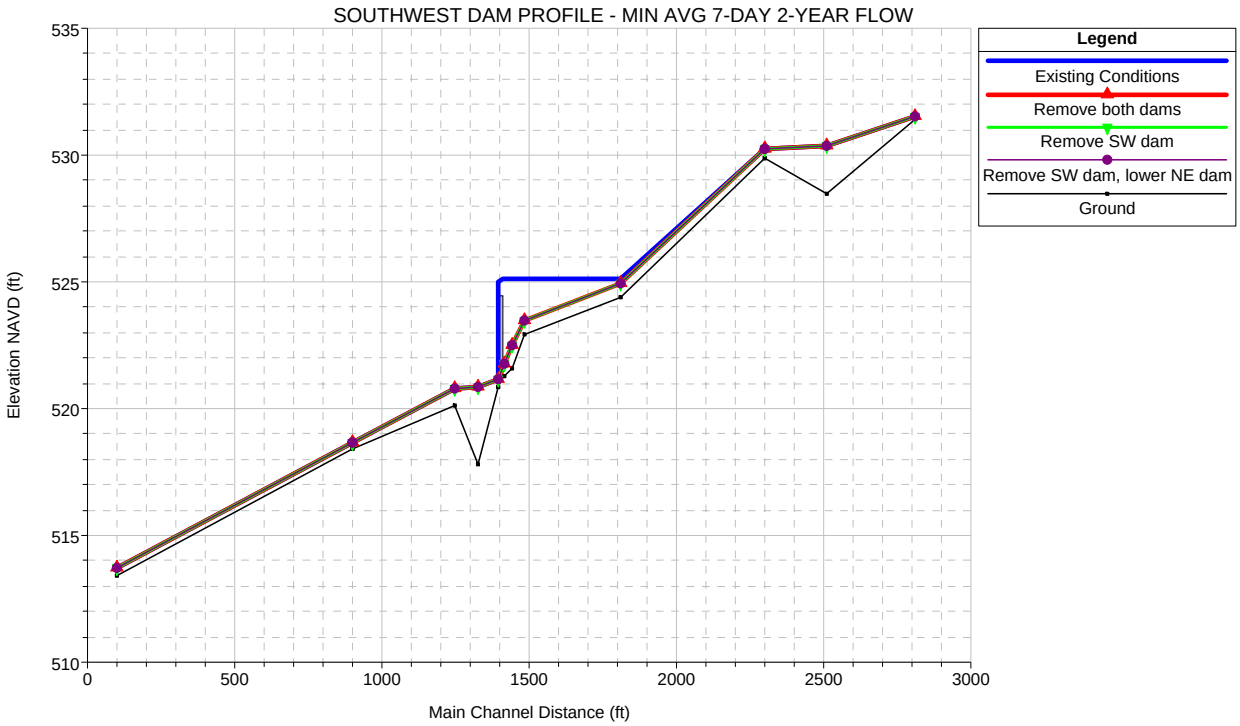


Figure 4. Dam profiles for existing conditions and removal scenarios for the annual mean flow



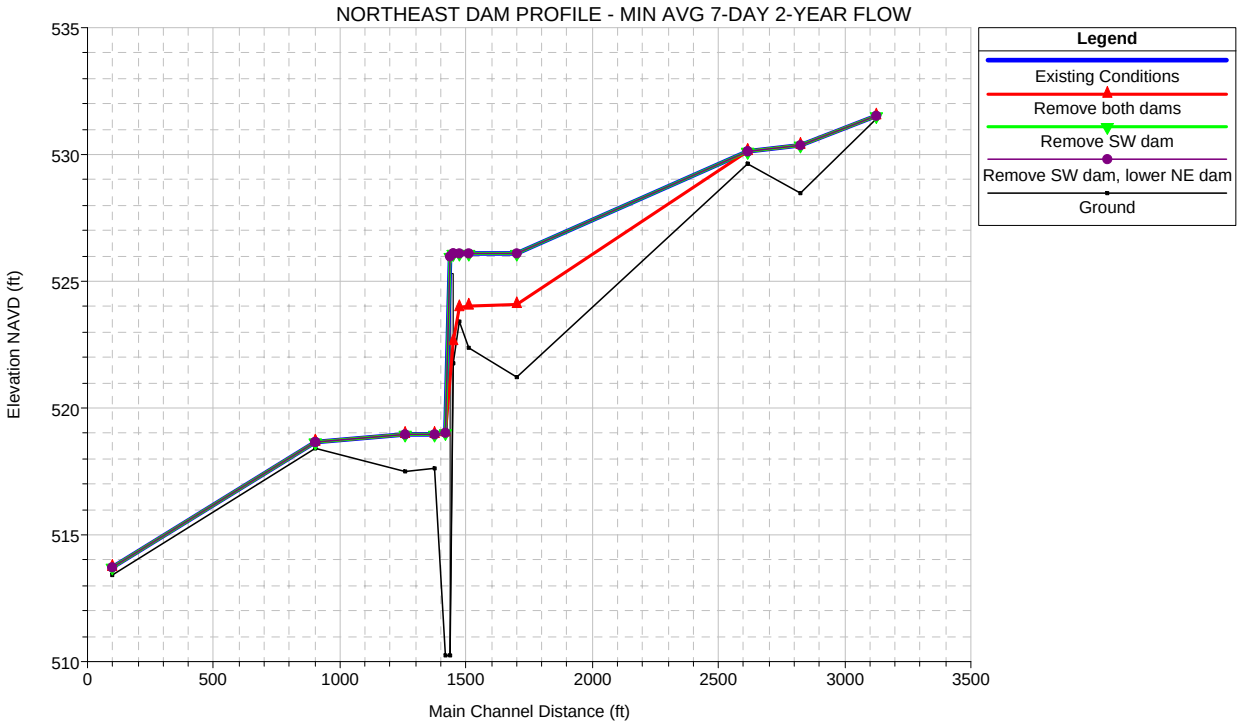


Figure 5. Dam profiles for existing conditions and removal scenarios for the minimum average 7-day 2-year flow