NYC Environmental Protection

Carter H. Strickland, Jr.
Commissioner

John Rousakis
General Counsel
Bureau of Legal Affairs
JRousakis@dep.nyc.gov

May K. Chin
Assistant Counsel
Bureau of Legal Affairs
71 Smith Avenue
Kingston, NY 12401
mchin@dep.nyc.gov

T: (845) 340-7204
F: (845) 338-0765

December 5, 2012

Mr. David O. Wright, Esq.
2025 Crompond Road
Yorktown Heights, New York 10598

Re: Seven Hills Lake Dam

Dear Mr. Wright:

This letter is in response to your letter dated October 20, 2012. We agree with you that a meeting will be helpful to discuss the issues and reach a resolution.

At the outset, I wish to rectify a misunderstanding of our position reflected in your letter. You state that DEP understands that "we are each obligated to maintain our respective properties compliant with DEC dam safety regulations" but that DEP wants SHLPOA "to share the cost of the work [DEP] plan[s] to perform on [DEP's] portion." That is not our view. DEP's understanding of the dam safety regulations is that co-owners are jointly responsible for the entire dam's compliance with the regulations. However, the cost of any necessary work should be appropriately apportioned. We are open to various cost-sharing options, possibly including having each party pay for the work to be done on its property as you appear to propose, in the context of an agreement resolving responsibilities for the future maintenance of the dam. With that in mind, the other items in your letter are addressed below.

You indicated that SHLPOA has retained an engineer and is working with New York State DEC "to complete all required work on our portion of the dam." Please provide us with the engineer's scope of work and any assessment of the dam, plans or recommendations for required work. I note that SHLPOA told DEP representatives in summer 2011 that SHLPOA was hiring an engineer and would share plans and estimates for required work in the fall of 2011.

You ask for details of DEP's proposed work on DEP's "portion" of the dam.[1] DEP has no such details because, in the absence of an agreement with SHLPOA, DEP is not presently pursuing such work. Indeed, you previously informed DEP that SHLPOA did not want DEP to go ahead with any work that will be "claimed to be some form of benefit to the Association." The proposed work on DEP's portion of the dam is described generally in our engineering consultant's report from October 2011, which was previously provided to SHLPOA and which I am enclosing again with this letter for your reference.

With regard to data as to the classification of the dam, please identify the specific information you need. If it is available, we will certainly provide it. Please also inform us of the basis for SHLPOA's belief that the dam may be misclassified.

[1] Regarding this request, you cite correspondence which I do not have in my files. Please provide a copy of the correspondence quoted in the footnote to your letter.

Again, DEP remains willing to work with SHLPOA to reach a mutually acceptable solution that would ensure compliance with legal requirements and obviate any need for legal proceedings. As noted in my previous letter, DEP has actively sought such a resolution and proposed various options, all of which have been rejected by SHLPOA without a counterproposal. We look forward to the opportunity to have a constructive meeting at which concrete proposals for a resolution can be discussed. Please be in touch to provide the requested information and to schedule a meeting.

Sincerely,

May Chin

Attachment

C (letter only): Aaron Bloom, NYC Law Department
Robin Levine, DEP
Tina Johnstone, DEP
Mark Donecker, DEP
James Caggiano, DEP
Paul Costa, DEP

Mike Robilotta, SHL President
Robert W. Schunk, SHL

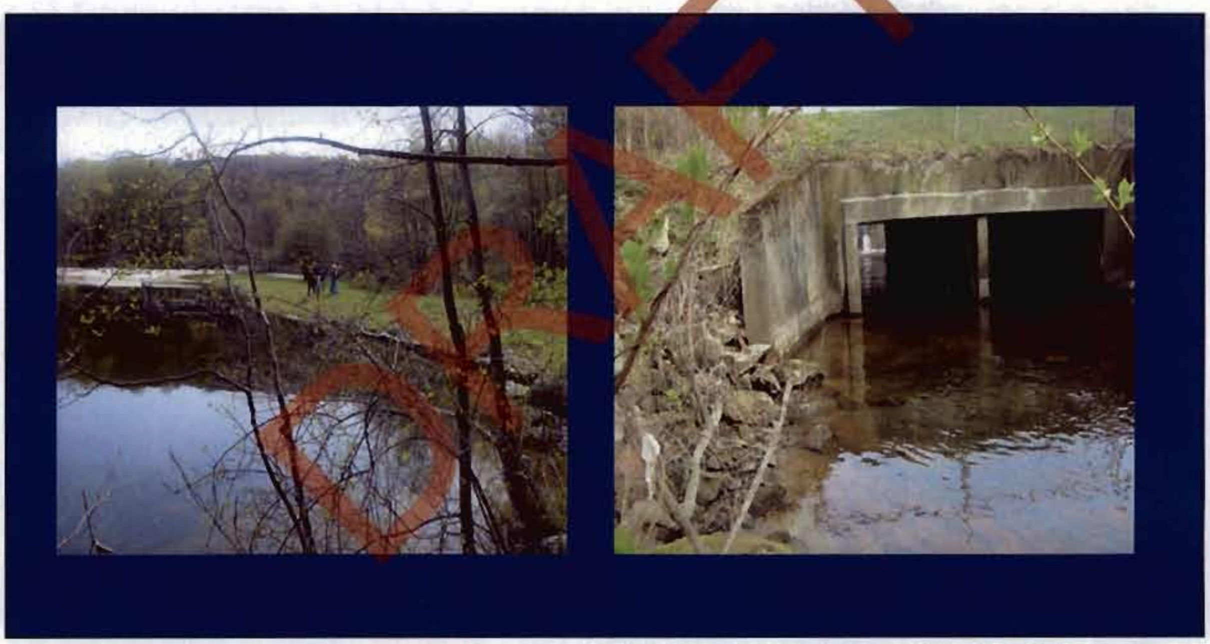
Seven Hills Lake Property Owners Association
P.O. Box 1087, Kent Lakes, New York 10512

Environmental Protection

CONTRACT EE-DSGN3
Small Dams Contract Development

Assessment Report for Seven Hills Lake Dam

Eastern Operations Division
NYSDEC ID# 213-2531



October 2011

AECOM

Contents

List of Tables

List of Figures

NO TEXT ON THIS PAGE

Summary

In March 2009 NYCDEP awarded a Task Order to AECOM under Task Order Contract EE-DSGN3, entitled "Small Dams Contract Development". Under this Task Order, DEP has requested AECOM to prepare an Assessment Report of the Seven Hills Lake Dam. The intent of this report is to make an initial structural and hydraulic assessment of the dam, and to establish its regulatory status for planning purposes.

To assist DEP in future planning activities, AECOM was required to define, at the conceptual level, any remedial works required to maintain the dam in a safe condition and in compliance with the NYSDEC regulatory requirements. In addition, the scope of work included an evaluation of the option to decommission the dam.

The hydrology and hydraulic studies presented in this report confirm the Hazard Classification assigned by NYSDEC to the dam; the Seven Hills Lake dam is an Intermediate Hazard dam (Hazard Class B). These studies also reveal that the present spillway has an adequate discharge capacity. The low level outlet has sufficient discharge capacity, but the controlling gates need to be replaced.

Some seepage was observed at the downstream toe of the dam, in the area to the right of the spillway discharge culvert; this area needs to be repaired. The stability analyses undertaken for this assessment show that the Seven Hills Lake Dam would be stable if the proposed modifications are implemented.

The report defines the measures necessary to bring the Seven Hills Lake dam into compliance with NYSDEC dam safety regulations, determines budget costs for these measures, and compares this remedial work option with the option to decommission the dam.

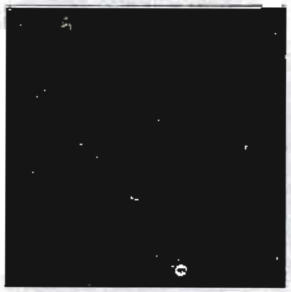
AECOM recommends that the remedial work option be followed for Seven Hills Lake Dam. The construction cost for this option is of the same order of magnitude as the cost of breaching the dam. Dam breaching is not considered to be a realistic option in this case because of the expected strong opposition of the Seven Hills Residents Association, who are majority joint owners of the project.

The recommended Remedial Work Plan is presented below.

NO TEXT ON THIS PAGE

Project Description

The Seven Hills Lake Dam is located in Kent Township, off Seven Hills Lake Road in Putnam County, New York. The dam is located on the Leetown Brook approximately one mile north of its confluence with the NYCDEP Boyd Corner Reservoir. At the dam location the Leetown Brook has a drainage area of 7 45 square miles.



Seven Hills Lake Dam is jointly owned by DEP and the Seven Hills Reservoir Association. DEP owns about 25% of the dam at the right abutment.

The Dam has been designated as a Class B dam by NYSDEC.

The Seven Hills Lake Dam is a 240-foot long earth embankment with a crest width that varies between 16 and 18 feet and a maximum height of about 15 feet.

The spillway is a drop inlet type located in the lake, approximately 160 feet from the left abutment. The drop shaft is connected to a 16-foot wide by 5-foot high box culvert crossing beneath the embankment dam at the deepest section. The low level outlet of the dam is combined with the drop inlet service spillway. There are two openings 24" diameter, with sluice gates located at the bottom of the upstream face of the concrete intake structure; these gates serve as the upstream intake of the low level outlet

Issues and Options

The main issues with Seven Hills Dam are;

- The spillway capacity is very inadequate. During the SDF event the reservoir level would rise about 3.7 feet over the top of the dam
- There is a major seepage area downstream of the right abutment of the dam
- The operating stem of one of the low level outlet gates is off vertical and it is probable that both sluice gates should be replaced
- The project is jointly owned

Several options were examined to address the major issue of inadequate spillway capacity. The most cost effective solution was determined to the addition of an auxiliary overflow spillway set along most of the dam crest, using articulated concrete block mats to protect the dam fill from erosion.

The dam breaching option, although competitive in price to the remedial works option, is not thought to be a realistic option because of the high amenity value of the reservoir to the local residents, who own about 75% of the dam.

Recommended Development Plan

The proposed remedial works comprise:

Addition of Auxiliary Spillway

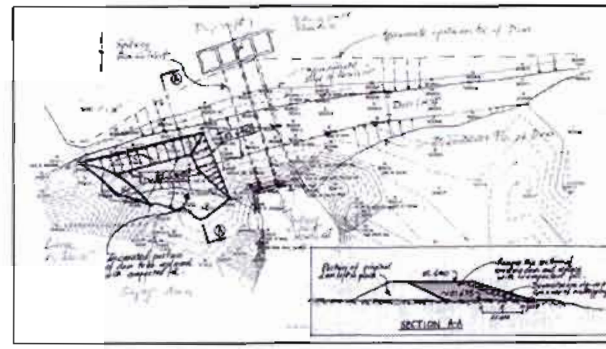
- Cover 190 feet of the dam with Articulated Concrete Block (ACB) Mat
- Excavate the downstream toe of the Articulated Concrete Mat and place rip-rap protection along the downstream toe
- Raise the remainder of the dam at the short abutment sections by about 5 feet

Repair Right Abutment of Dam

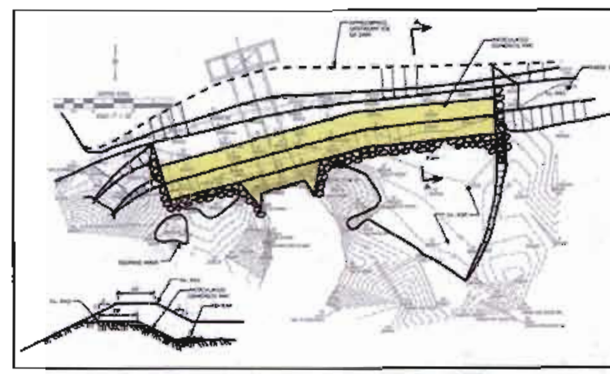
- Remove upstream portion of right abutment down to foundation level
- Reconstruct dam with compacted fill
- Add rip-rap slope protection at downstream slope to protect against minor overtopping
- Low Level Outlet
- Lower reservoir using existing sluice gates and pumps as necessary
- Remove existing sluice gates and frames at drop inlet structure
- Install new stainless steel sluice gates and frames

The construction costs for the development plan are estimated at $872,000, made up as follows;

- Phase 1 - $ 125,000: Repair of right abutment of dam
- Phase2 – $ 747,000: Increasing spillway capacity and replacing outlet gates.



Seven Hills Dam – Reconstruction of Right Abutment Portion of the Dam



Seven Hills Dam – Adding Auxiliary Overflow Spillway

SEVEN HILLS LAKE DAM
Remedial Work Plan

AECOM

NO TEXT THIS PAGE

1 Introduction

1.1 Background

Through their land acquisition program, DEP has obtained ownership of several small dams in the watersheds of both the Eastern and Western Operations divisions. In March 2009 DEP awarded a Task Order to AECOM under Task Order Contract EE-DSGN3, entitled "Small Dams Contract Development".

The intent of the Task Order was to make an initial structural and hydraulic assessment of the small dams, and to establish their regulatory status for planning purposes.

The present report presents the results of the assessments for Seven Hills Lake Dam.

1.2 Scope of Studies

The scope of work included the following tasks:

- Collection and Evaluation of Existing Information
- Site Inspection
- Data Evaluation and Visual Inspection Report
- Regulatory Status and Hazard Classification Assessment
- Regulatory Permitting and Review
- Hydrologic and Hydraulic Assessment Report
- Dam Stability Assessment
- Structural Assessment and Recommendations
- Dam Decommissioning
- Planning Report

To assist DEP in future planning activities AECOM was required, through the above tasks, to define at the conceptual level any remedial works required to maintain the dam in a safe condition and to evaluate costs and schedules for such remedial works. In addition the scope of work included an evaluation of the option for the decommissioning of the dam.

In addition to these tasks, DEP requested some additional inputs from AECOM with respect to submittals required by NYSDEC for a Hazard Class B dam, such as Seven Hills Lake Dam. These were:

- Preparation of the Annual Certificate
- Preparation of the Inspection and Maintenance Plan
- Preparation of the Emergency Action Plan

The deliverables from the above additional tasks are not part of this report.

1.3 Regulatory Framework

NYSDEC issued revised dam safety regulations in August 2009. These are set out in 6NYCRR Part 673: Dam Safety Regulations. The Regulations define a hazard classification for dams, and set out the obligation of dam owners with respect, *inter alia*, to inspections, operation and maintenance, development of emergency action plans (EAPs), engineering assessments, and documentation. The Regulations also set out actions that NYSDEC may undertake to ensure the safety of dams.

The Regulations define a time-table of actions and submittals required from dam owners, the most important of which are:

- Development of Inspection and Maintenance Plans by August 19, 2010
- Submittal of EAPs for High Hazard (Class C) dams by August 19, 2010
- Submittal of EAPs for Intermediate Hazard (Class B) dams by August 19, 2011

AECOM evaluated the applicability of the NYSDEC Dam Safety Regulations to the Seven Hills Lake Dam.

The recommendations developed by AECOM for the design of remedial measures have been governed principally by the NYSDEC publication "Guidelines for Design of Dams", revised January 1989. Procedures for dam inspections and the development of operation and maintenance recommendations were based on NYSDEC publication "an Owner's Manual for the Inspection and Maintenance of Dams in New York State", dated June 1987.

2 Project Description and Condition Assessment

The Seven Hills Lake Dam is located in Kent Township, off Seven Hills Lake Road in Putnam County, New York (Figure 2-1). The approximate coordinates of the dam are 41°28'52"N, 73°45'00"W. The Seven Hills Lake Dam is located on the Leetown Brook approximately one mile north of its confluence with the NYCDEP Boyd Corners Reservoir. At the dam location, the Leetown Brook has a drainage area of 7.45 square miles.

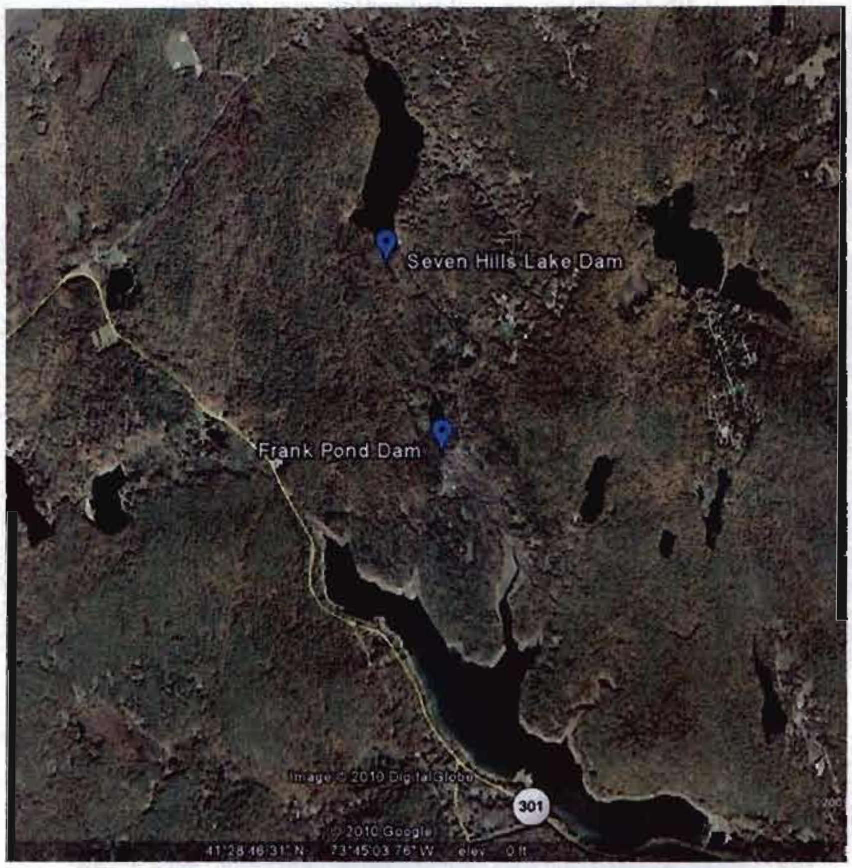


Figure 2-1: Seven Hills Dam – Location Map

The Seven Hills Lake Dam is listed on the New York State Inventory of Dams. Its identification number is 213-2531. Construction of the dam is reported by NYSDEC to have been completed in 1957. The most recent inspection was performed in 2008.

The Seven Hills Lake Dam is an earth embankment approximately 240 feet. The dam height is approximately 15 feet. The dam has a drop inlet service spillway. The drop intake has a rectangular opening approximately 33 feet long by 10 foot wide. The reservoir created by the Seven Hills Lake Dam is approximately 3,200 feet long by 750 feet wide and has an approximate surface area of 55 acres. The impoundment capacity is estimated to be approximately 295 acre-feet or 96 million gallons.

Dam and Appurtenant Works

The Seven Hills Lake Dam is a 240-foot long earth embankment with a crest width that varies between 16 and 18 feet (See Figure 2-2). The embankment is in generally good condition, except for about 30 feet of the downstream embankment slope near the right abutment, which is in poor condition. The upper reaches of the upstream slope are grassed and the remainder of the slope to lake level and below is protected with dumped stone riprap. The downstream embankment slope on the left side of the service spillway is covered with grass and is in good condition. There is moderate erosion along the lower area of the slope abutting the downstream left spillway training wall.

Figure 2-2: View of Seven Hills Dam

The downstream slope on the right side of the service spillway is not well maintained and is overgrown with trees, bushes, saplings, cattails, and grass. There is moderate erosion along the lower area of the slope abutting the downstream right spillway training wall.

About 30 feet of the downstream slope surface near the right abutment consists of dumped large size boulders and rock fill; additionally, this area is overgrown with grass and bushes. There is significant seepage along the downstream toe of the rock fill.

The spillway is a drop inlet type located in the lake approximately 160 feet from the left abutment (see Figure 2-3). The drop inlet crest structure is a rectangular concrete box structure, which is protected at the top by a chain link fence, which serves as trash rack. The overall dimensions of the opening are approximately 37 feet long by 12 feet wide, with a total net weir length of 85 feet. The drop shaft is connected to a 16-foot wide by 5-foot high box culvert crossing the embankment dam at right angles; the culvert is centrally divided by a concrete vertical wall approximately 8 inch thick.

The spillway outlet concrete structure located at the downstream slope of the embankment is in good condition, except for minor erosion at the bottom surfaces of both downstream training walls. The discharge from the downstream outlet structure flows into a natural channel.

The low level outlet of the dam is combined with the drop inlet service spillway. There are two openings 24" diameter, with sluice gates located at the bottom of the upstream face of the concrete intake structure; these gates serve as the upstream intake of the low level outlet. The operating gate stems of both sluice gates are located at the top of the structure. The operating stem of the right low level outlet sluice gate is out of alignment by about 10 degrees from the vertical.

Figure 2-3: Seven Hills Dam - Drop Inlet Spillway

Conditions Downstream of the Dam

Within 100 feet from the spillway outlet, there are remnants of the abutment walls of an old bridge crossing the Leetown Brook; the abutments have been washed away, the deck is missing and the abutment walls are in poor structural conditions.

Further downstream, the floodplain is a wooded area, approximately 200 to 300 feet wide, for approximately 2,700 feet until it reaches the reservoir impounded by Frank Pond dam, which is located downstream on Leetown Brook. There is a residence located on the right abutment of the Frank Pond Dam that would be affected by the potential failure of the Seven Hills Lake Dam. Approximately 300 feet downstream of the Frank Pond Dam spillway the Leetown Brook crosses Nimham Road under a bridge with a 12-foot wide opening. It also crosses East Boyd Road under a similar bridge approximately 100 feet further downstream. These are the only structures in the Leetown Brook valley located between Frank Pond Dam and the Boyd Corners Reservoir, a distance of approximately 2,300 feet.

3 Regulatory Status

3.1 NYSDEC Dam Safety Regulations Regulatory

AECOM evaluated the applicability of the NYSDEC Dam Safety Regulations to the Seven Hills Lake Dam, and in compliance with those regulations assigned a recommended Hazard Classification to the dam. The regulations in question are set out in 6NYCRR Part 673: Dam Safety Regulation.

3.2 Hazard Classification System

Under Section 673.5, NYSDEC may assign a Hazard Classification for a dam, irrespective of the dam height and reservoir storage, according to the impact of dam failure. The Hazard Classifications are based on several potential damage factors, the most relevant to this study being;

- Threat to people
- Threat to homes and buildings
- Threat to roads
- Threat of economic and environmental damage

Four classifications may be assigned depending on the extent and degree of the above threats, as follows;

- Class A: Low Hazard Dam
- Class B: Intermediate Hazard Dam
- Class C: High Hazard Dam
- Class D: Negligible or No Hazard Dam

The system of hazard classification is summarized in Table 3-1.

Table 3-1: Dam Hazard Classification System

Threat Category	Hazard Classification			
	Class A	**Class B**	**Class C**	**Class D**
Threat to people	- Personal injury unlikely	- Personal injury likely, - Loss of life not expected	- Loss of life likely	- No threat to people
Threat to Homes and Buildings	- Damage to isolated or unoccupied buildings	- Damage to isolated homes	- Widespread or serious damage to homes. - Damage to industrial or commercial buildings	- No threat to homes or buildings
Threat to Roads	- Damage to minor roads	- Damage to main highways	- Damage to main highways	- No threat to roads
Threat of Economic or Environmental damage	- Substantial environmental and economic damage unlikely	- Substantial environmental and economic damage likely	- Widespread economic and environmental damage likely	- No economic or environmental threat

The Seven Hills Lake Dam is listed as the Seven Hills Realty Co Inc. Dam in the New York State Inventory of Dams and is classified by NYSDEC as a Hazard Class B.

3.3 Dam Break Studies to Confirm Hazard Classification

3.3.1 Approach

Two dam break analyses were undertaken for the dam as follows;

- **Sunny Day break,** in which it was assumed that the dam could fail for some non-flood reason, such as slope failure caused by piping.
- **Break during the Spillway Design Flood,** in which it is implied that dam failure is caused mainly by overtopping during an extreme flood event.

The dam break analyses in this study were performed using the HEC-HMS and HEC-RAS programs.

HEC-HMS is a program developed by the US Army Core of Engineers to simulate the precipitation-runoff processes of watershed systems. HEC-HMS was used to develop the floods for each dam and to evaluate the adequacy of spillway capacity. Additionally, HEC-HMS has a dam break feature which can simulate a dam break caused by overtopping or piping, using alternative breach triggers, and can produce an outflow hydrograph for the dam break.

HEC-RAS is a US Army Core of Engineers program used to perform hydraulic calculations for natural and constructed channels. HEC-RAS, can be used to route the flood hydrograph produced by a dam break through the channel downstream of the dam and in this way to develop downstream water surface profiles. The dam break hydrograph itself may be developed using HEC-RAS.

In these studies HEC-HMS was used to develop the dam break hydrograph, and HEC-RAS was subsequently used to develop the downstream water surface profiles.

Both the HEC-HMS and HEC-RAS programs require the user to input a number of key dam break parameters in order to simulate the breach. The critical parameters required for dam break analysis include the following:

- Average width of breach
- Slide slope of breach
- Time to breach

The parameters used in these studies were based on FERC Engineering Guidelines for the Evaluation of Hydropower Projects. Table 3-3 presents the dam breach parameters that were entered into the HEC-HMS model to simulate the breach at the Seven Hills Lake Dam.

Table 3-2 Seven Hills Lake Dam Break Parameters

Parameter	Value
Final Breach Bottom Width	28 ft
Breach Side Slope	1V:1H
Breach Weir Coefficient	2.6
Breach Formation Time	0.5 hour
Failure Trigger	Time of peak flow

The downstream area between Seven Hills Lake Dam and Frank Pond Dam was modeled using the HEC-RAS Software and was represented as a series of sections. The contour maps produced for the inspection reports were used to develop these sections. Typically, a cross section was taken every 50 feet (see Figure 3-1).

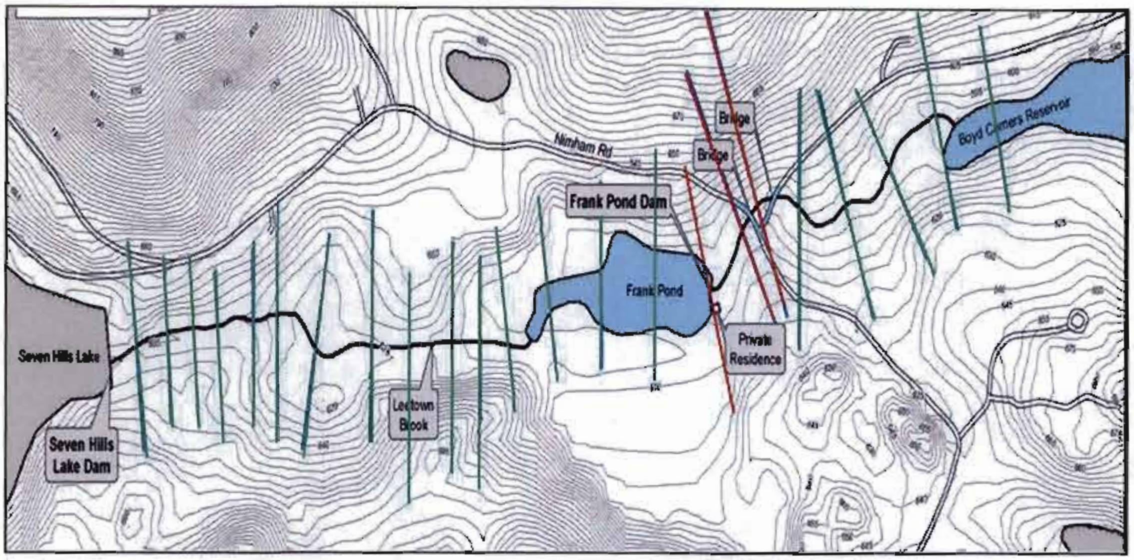


Figure 3-1: Seven Hills Lake Dam – HEC-RAS Downstream Cross Sections

The dam break hydrograph produced in HEC-HMS was entered at the beginning of the reach and routed downstream to Frank Pond. The Frank Pond Dam was modeled as an inline structure in the HEC-RAS model. Additionally, there are two road bridges located downstream of Frank Pond; both were modeled in HEC-RAS.

3.3.2 Sunny Day Break

Figures 3-2 and 3-3 present the flow and reservoir stage hydrographs at Seven Hills Lake Dam and Frank Pond Dam, respectively, during a Sunny Day Dam Break at Seven Hills. Figure 3-3 shows that during the Sunny Day Dam break at Seven Hills Lake Dam, the water level at Frank Pond Dam just barely rises to the elevation of the house.

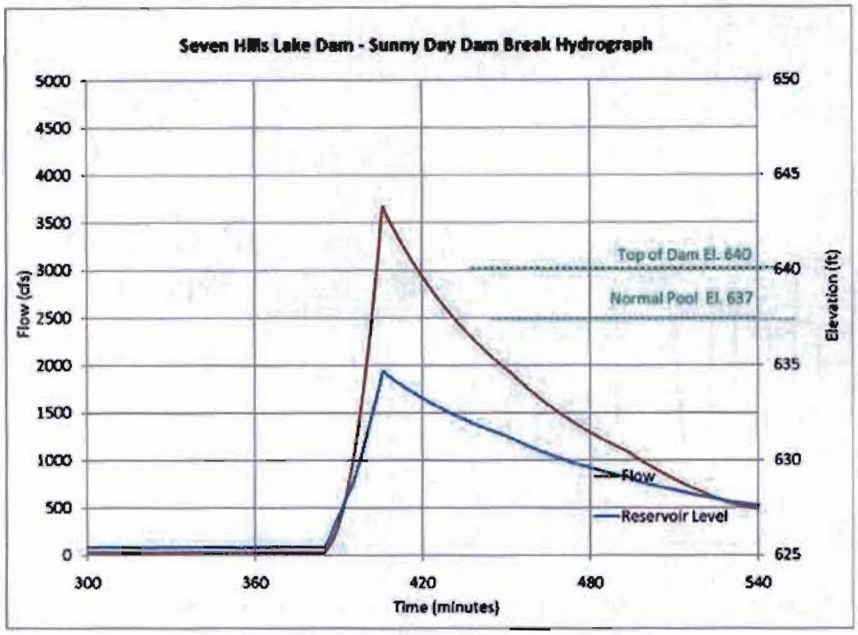


Figure 3-2: Seven Hills Lake Dam – Sunny Day Dam Break Hydrograph

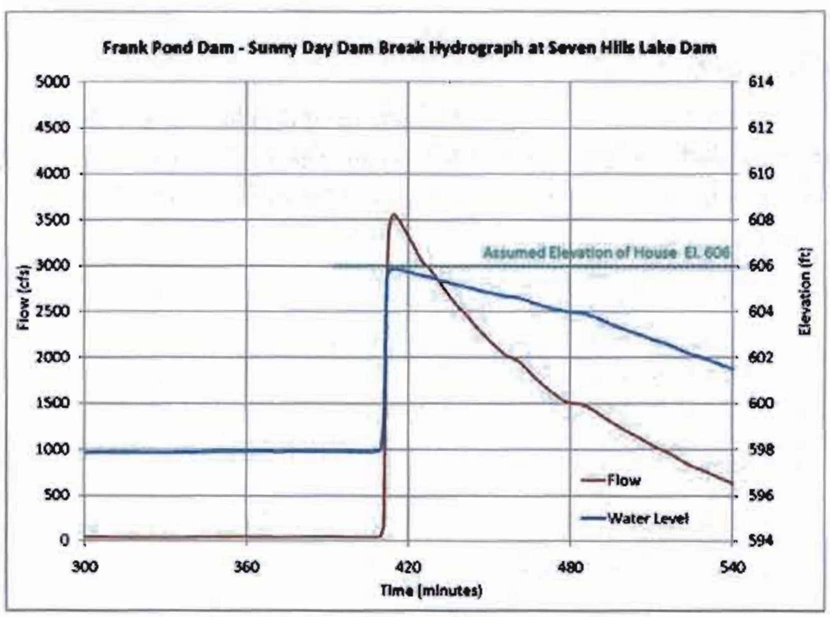


Figure 3-3: Sunny Day Break at Seven Hills – Flood Levels at Frank Pond Dam

Figure 3-4 shows the downstream flow profile as a result of a Sunny Day Dam Break at the Seven Hills Lake Dam.

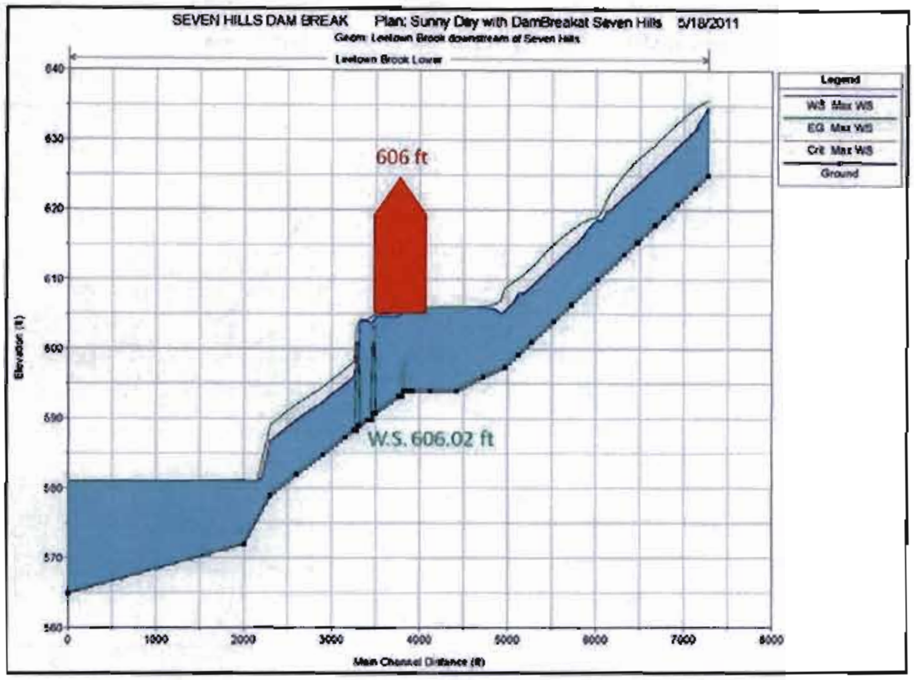


Figure 3-4: Downstream Profile during Sunny Day Breach at Seven Hills Lake Dam

It should be noted that there is no significant flooding at the house located near Frank Pond.

3.3.3 Dam Break during Design Flood

Figures 3-5 and 3-6 present the flow and reservoir stage hydrographs at Seven Hills Lake Dam and Frank Pond Dam, respectively, during the SDF Dam Break at Seven Hills. Figure 3-6 shows that during the SDF Dam break at Seven Hills Lake Dam, the water level at Frank Pond Dam rises approximately 4 feet over the ground floor level of the house. Therefore, a SDF Dam Break at Seven Hills Lake Dam would cause significant flooding at Frank Pond and the nearby residence.

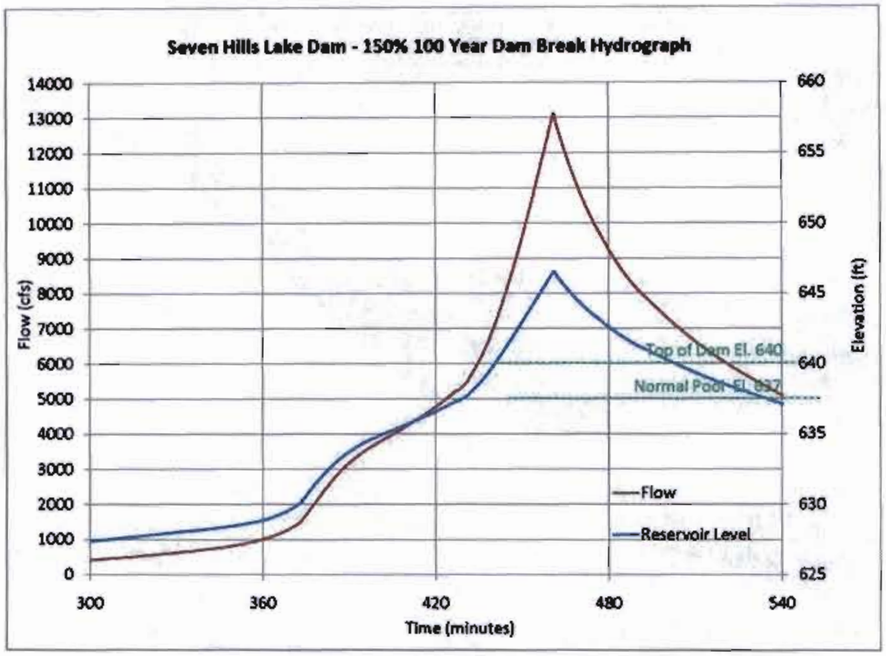


Figure 3-5: Seven Hills Lake Dam – 150% of the 100-Year Dam Break Hydrograph

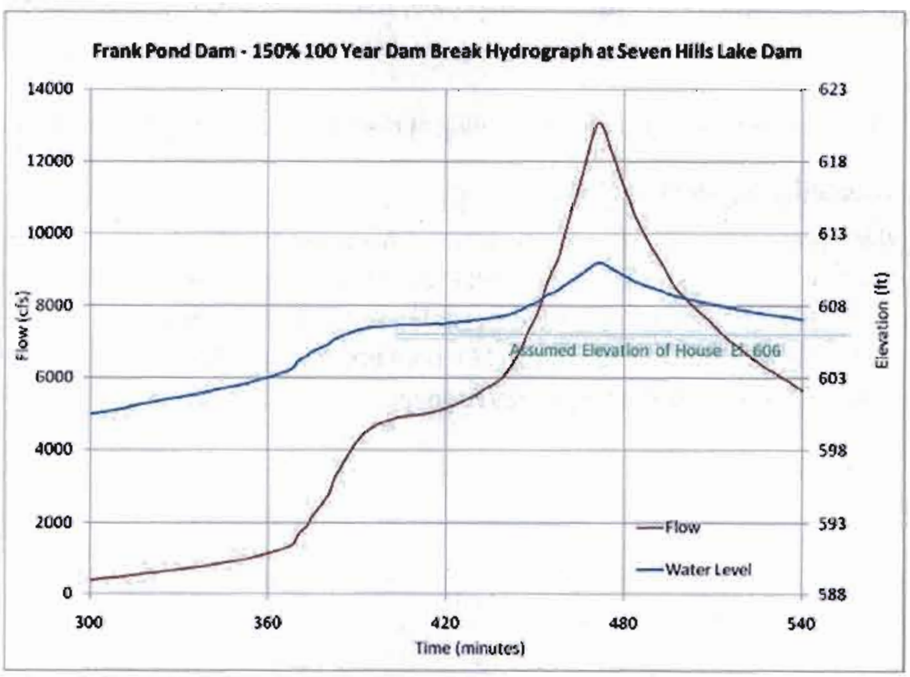


Figure 3-6: Frank Pond Dam – 150% of the 100-Year Dam Break at Seven Hills

Figure 3-27 shows the downstream flow profile as a result of a Sunny Day Dam Break at the Seven Hills Lake Dam.

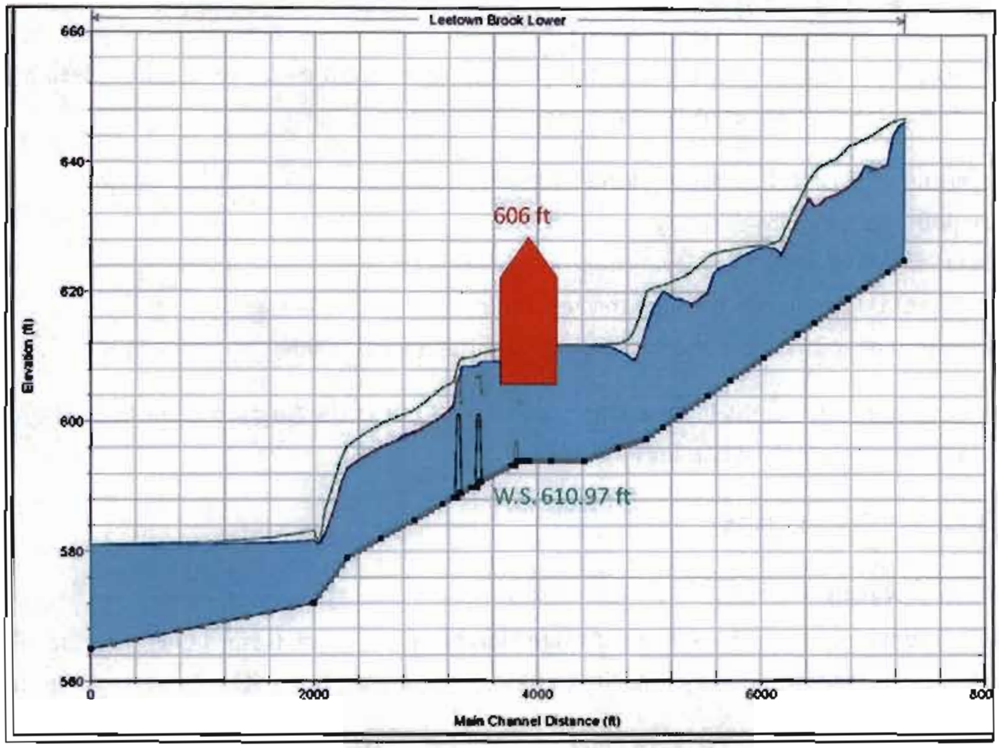


Figure 3-7: Downstream Profile during SDF Dam Break at Seven Hills Lake Dam

It should be noted from Figure 3-7 that the SDF Dam Break at Seven Hills Lake Dam would cause significant flooding at the Frank Pond residence, as well as significant flooding at the downstream bridges.

3.3.4 Conclusions

Based on the present study, the house located at Frank Pond Dam would experience significant flooding in the event of a dam break during the Spillway Design Flood at Seven Hills Lake Dam. It is therefore confirmed that the Seven Hills Dam should remain as Hazard Class B.

4 Adequacy of Spillway Capacity

4.1 Objectives and Scope

As part of the safety assessment, the capability of the spillway to pass the required design flood was evaluated. The evaluation covered the following:

- Determination of inflow design flood hydrographs
- Development of spillway rating curve
- Development of reservoir elevation/storage curve
- Routing of design floods through the reservoir
- Evaluation of spillway capability to safely pass the design flood

Hydraulic requirements for dams in New York State are set out in the Guidelines for the Design of Dams which was last revised by NYSDEC in January 1989.

4.2 Inflow Hydrographs

4.2.1 NYSDEC Requirements

The NYSDEC Guidelines define the Spillway Design Flood (SDF) for each Hazard Classification. Existing dams should have adequate spillway capacity to pass the following SDF without overtopping the dam:

Hazard Class	SDF
A	100-yr Flood
B	150% 100-yr Flood
C	50% PMF

If an auxiliary spillway is provided in addition to the service spillway, the service spillway design flood (SSDF) for small dams (less than 40 feet high and storage at normal water surface of less than 1,000 ac-ft) should be as follows:

Hazard Class	SSDF
A	5-yr Flood
B	25-yr Flood
C	25-yr Flood

An auxiliary spillway should not be placed on fill, and the velocities in the auxiliary spillway should not exceed the non-erodible velocities of the spillway materials. AECOM interprets this requirement of the NYSDEC Guidelines to be that direct spillway flow must not pass over erodible fill, but that spillways may be incorporated in or over dam fill material provided that secure non-erodible flow surfaces are provided.

For the Seven Hills Dam 150% of the 100-year flow hydrograph was used as the inflow to the reservoir. Additionally, the 5-year and 25-year floods have been determined for reference purposes.

4.2.2 Flood Simulation

The HEC-HMS model, version 3.4 (August 2009), developed by the US Army Corps of Engineers was used to simulate the rainfall-runoff process and the reservoir-spillway behavior. The program includes a large set of methods to predict flows, stages, and timing in the watersheds, streams and reservoirs.

For the purpose of this study, 24-hour frequency-based hypothetical storm events were simulated. The runoff volumes were calculated using the SCS Curve Number (CN), and the SCS unit hydrograph method was used to transform rainfall to runoff. The lag times were estimated by taking 60% of the time of concentrations of the watersheds. The time of concentration of each watershed was calculated using the methodology presented in the Technical Release 55 (TR-55) to calculate the travel times for sheet flow, shallow concentrated flow, and channel flow. TR-55 is a publication from the US Department of Agriculture, Natural Resources Conservation Service.

4.2.3 Storm Event Precipitation

Per NYSDEC request, rainfall data for the catchment area was collected from the web site "Extreme Precipitation in New York and New England" (http://www.precip.net/). The project is a joint collaboration between the Northeast Regional Climate Center (NRCC) and the Natural Resource Conservation Service state offices in New York, Connecticut, Rhode Island, Massachusetts, Vermont, New Hampshire and Maine to produce extreme rainfall statistics for these seven states.

This new extreme rainfall study includes rainfall events through the end of 2008, providing an updated set of statistics to be used for engineering design instead of the older Technical Paper 40 dated from 1961.

The precipitation depths used in this assessment were;

- 5-yr, 24-hour storm: 4.21 in.
- 25-yr, 24-hour storm: 6.32 in.
- 100-yr, 24hour storm: 8.86 in.

4.2.4 Hydrologic Characteristics of the Basin

For the development of the inflow hydrographs, the watershed was subdivided into 10 sub-basins as shown on Figure 4-1. These represent the natural drainage sub-divisions of the Seven Hills watershed. For example Sub-basins 1 and 2 represent the watersheds of two dams in the upper reaches of Leetown Brook, namely Upper and Lower Chia Lin dams.

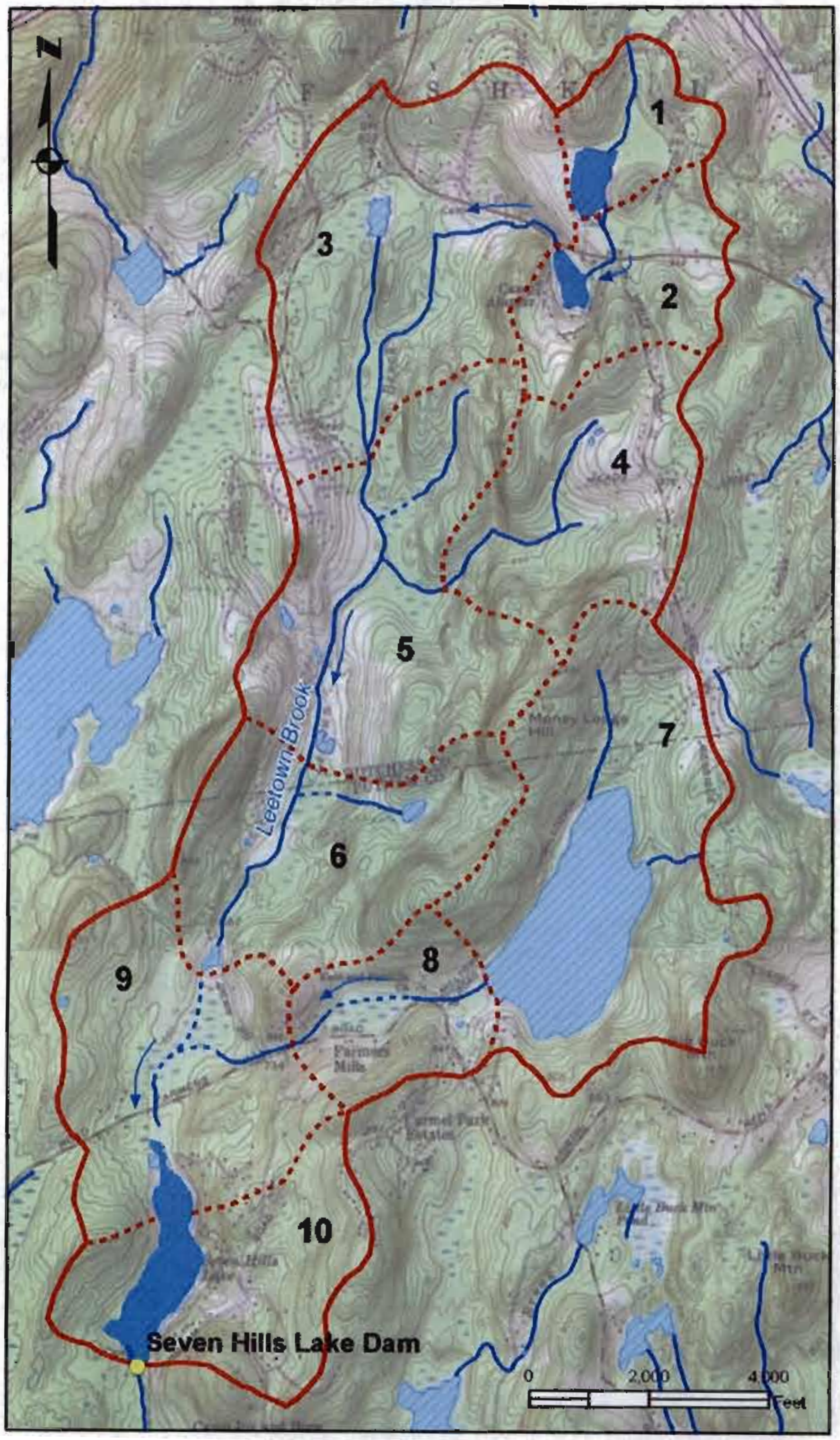


Figure 4-1: Seven Hills Lake Dam - Catchment Area Map

EE-DSGN3: Seven Hills Lake Dam
Assessment Report
Adequacy of Spillway Capacity

The three main hydrologic characteristics of each of the sub-basins making up the total watershed are the type of ground cover, the type of soil, and the slope of the terrain and streams.

The first two components are simulated in the SCS method by the use of the Curve Number (CN) which is estimated based on the type of ground cover (pavement, lawn, forest, etc.), and on the infiltration ability of the soil. The TR-55 publication provides CN values for different ground cover and soil combinations.

The type of ground cover was estimated based on the observations made during the site inspections. The watershed for the Seven Hills Dam consists mainly of wooded areas with significant uncontrolled brush. Soil characteristics were collected from the Natural Resource Conservation Service on their Web Soil Survey site (http://websoilsurvey.nrcs.usda.gov/). The site specific soils were mapped on the drainage area. Each of the soils is then categorized in one of four Hydrologic Groups A to D, from the most pervious to most impervious, as defined in the TR-55 publication.

The third component, which characterizes how rapidly the rainfall is transformed into stream discharge, is simulated by the time of concentration (T_c), which is the time it takes for the water to travel from the hydraulically most distant point of the watershed to the basin outlet. The T_c of each basin or sub-basin was calculated by adding the travel time for sheet flow, shallow concentrated flow, and channel flow. Estimates of the parameters used for the sheet flow, shallow concentrated flow and channel flow were based on the review of the detailed topography, field observations, and photographs taken during the dam inspections.

The hydrological characteristics of the watershed as evaluated in these studies may be summarized as follows;

- Catchment Area: 7.45 sq. miles
- Predominant Ground Cover: Brush, Wood-Grass Mixture (poor condition)
- Runoff Curve Number (CN): 74

	Sub-basin Name	Drainage Area (sq. mi.)	Predominant Soil Group	CN	T_c (hr)
1	Upper Chia Lin	0.28	C (78%)/D (12%)	79	0.55
2	Lower Chia Lin	0.43	B (45%)/C (38%)	74	0.80
3	Leetown Brook Sub-Basin 01	0.97	B (68%)/C (19%)	76	1.26
4	Mead Lane Sub-Basin	0.66	B (37%)/C (63%)	73	0.81
5	Leetown Brook Sub-Basin 02	1.05	B (52%)/C (42%)	72	0.95
6	Leetown Brook Sub-Basin 03	0.81	B (60%)/C (28%)	71	0.79
7	White Pond Sub-Basin	1.22	B (58%)/C (22%)	77	0.43
8	Farmer Hill Sub-Basin	0.37	B (68%)/C (16%)	71	0.55
9	Leetown Brook Sub-Basin 04	0.91	B (66%)/C (20%)	72	0.45
10	Seven Hills Lake Sub-Basin	0.75	B (54%)/C (36%)	74	0.51

Applying the selected precipitation depths to the sub-basins resulted in the following reservoir inflow flood events;

Reservoir Flood Inflow Events

- 5-yr, 24-hour storm:
  - Peak Flow: 1,406 cfs
  - Runoff Volume: 537 ac-ft
- 25-yr, 24-hour storm:
  - Peak Flow: 3,113 cfs
  - Runoff Volume: 1,094 ac-ft
- 100-yr, 24-hour storm:
  - Peak Flow: 5,419 cfs
  - Runoff Volume: 1,827 ac-ft
- 150% of 100-yr, 24-hour storm:
  - Peak Flow: 8,129 cfs
  - Runoff Volume: 2,741 ac-ft

4.3 Spillway Rating Curve

The spillway is a drop inlet type located in the lake, approximately 160 feet from the left abutment. The drop inlet structure is a rectangular concrete box structure. The overall dimensions of the opening are approximately 37 feet long by 12 feet wide, resulting in a total net weir length of 85 feet. The inspection of the structure was performed using a boat. The drop shaft is connected to a 16 foot wide by 5 foot high box culvert crossing the embankment dam at right angles; the culvert is centrally divided by a concrete vertical wall approximately 8 inches thick.

Spillway Characteristics

- Top of Dam Elevation: 640 ft
- Spillway Crest Elevation: 637 ft
- Spillway Type: Single; Drop Inlet
- Spillway Crest Length: 85 ft

The spillway rating curve based on these characteristics is shown on Figure 4-2

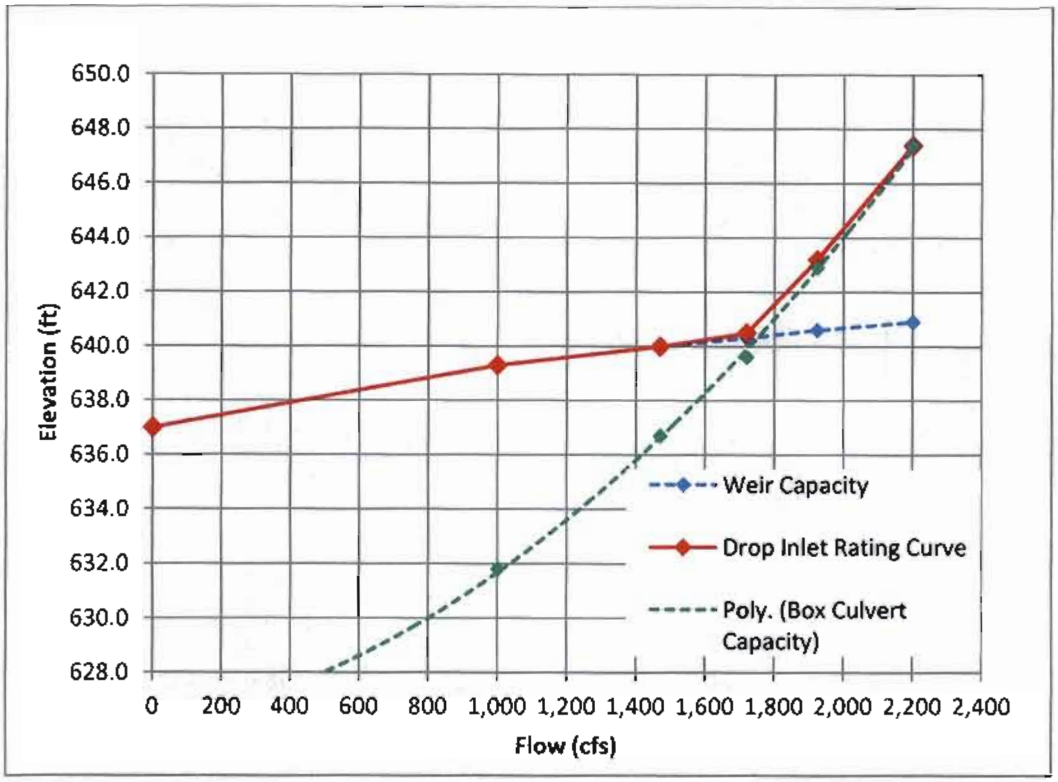


Figure 4-2: Seven Hills Lake Dam - Spillway Rating Curve

The spillway capacity with the reservoir at the top of the dam at El 640 (i.e. with no freeboard) is approximately 1,500 cfs.

4.4 Reservoir Elevation/Storage Characteristics

The reservoir elevation- storage characteristics were determined by measuring the reservoir area at several elevations from available maps. The principle data used in this process were;

- Top of Dam Elevation: 640 ft
- Spillway Crest Elevation: 637 ft
- Reservoir Area at Spillway Crest Elev.: 55.3 acres
- Reservoir Area at Top of Dam Elev.: 64.4 acres

The resulting elevation-area curve is shown on Figure 4-3.

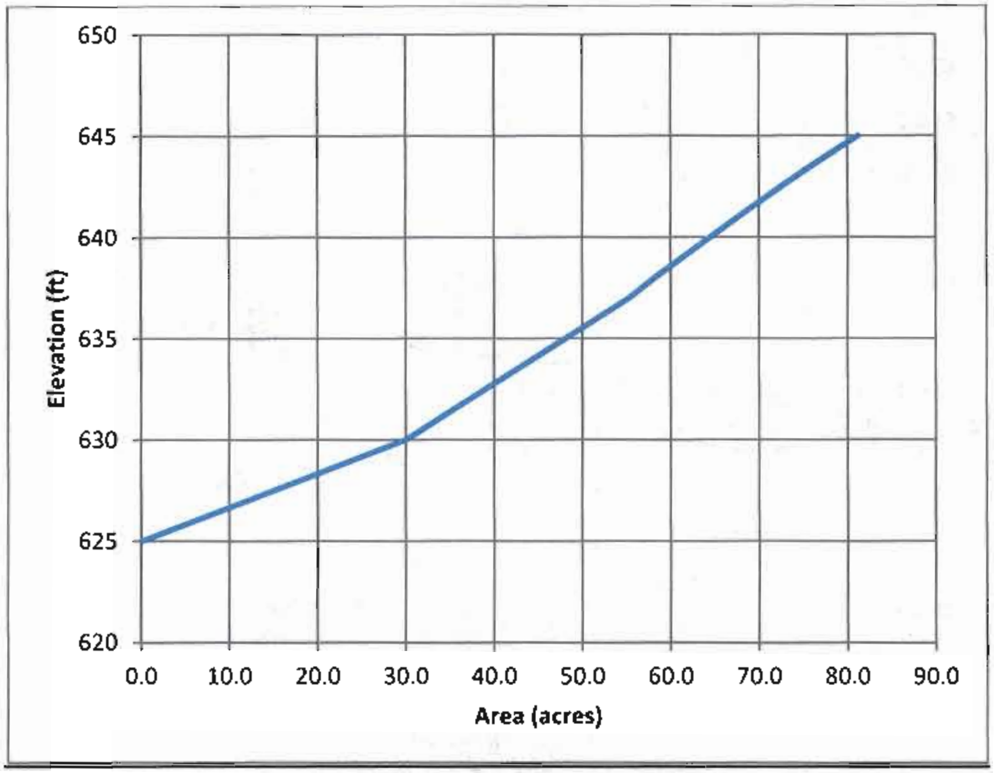


Figure 4-3: Seven Hills Lake Dam - Reservoir Area Curve

The reservoir volume at normal pool level (El 637) is estimated to be 369 acre-feet. Maximum impoundment volume, assuming the reservoir is at the top of the dam (El 640), is estimated at 548 acre-feet.

4.5 Routing of Spillway Design Flood through Seven hills Reservoir

The inflow and outflow hydrographs for the routing of the spillway design flood through the reservoir is shown on Figure 4-4. The variation in reservoir level during the routing is shown on Figure 4-5. Similar routings were done for the 5-year and 25-year floods. The results of the routings are summarized below.

- 5-yr, 24-hour storm:
  - Peak Outflow: 989 cfs
  - Maximum Water Surface Elev.: 639.3 ft
- 25-yr, 24-hour storm:
  - Peak Outflow: 2,269 cfs
  - Maximum Water Surface Elev.: 640.9 ft
- 100-yr, 24hour storm:
  - Peak Outflow: 4,302 cfs
  - Maximum Water Surface Elev.: 642.5 ft

- 150% of 100-yr, 24hour storm:
    - Peak Outflow: 6,820cfs
    - Maximum Water Surface Elev.: 643.7 ft

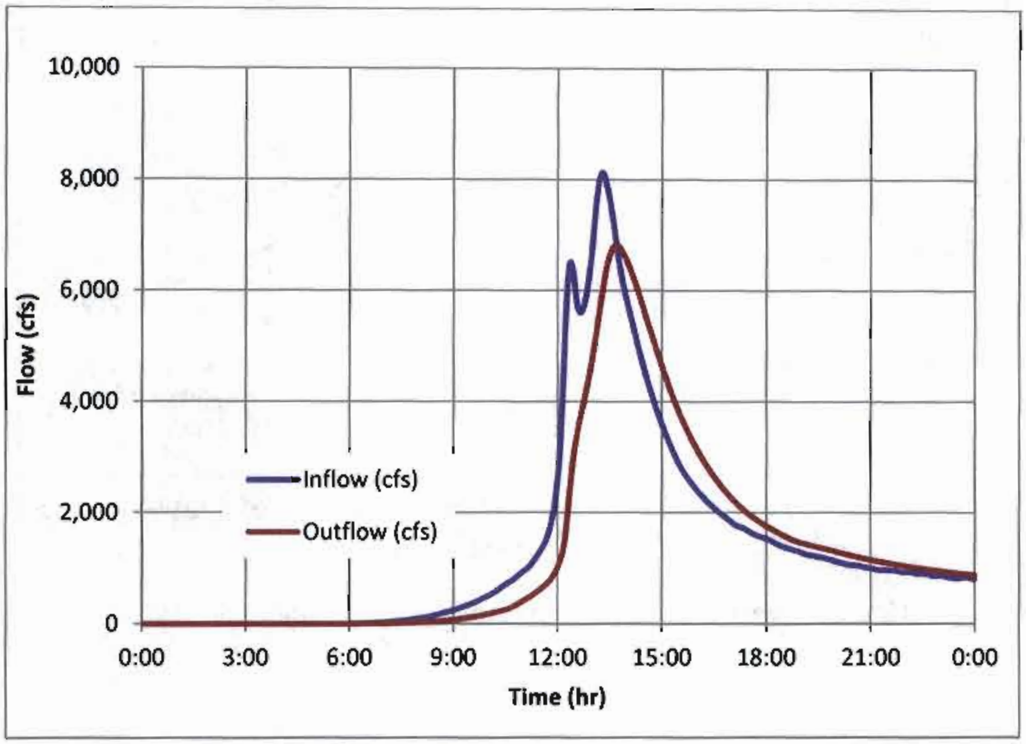


Figure 4-2: Seven Hills Lake Dam - Spillway Design Flood Routing

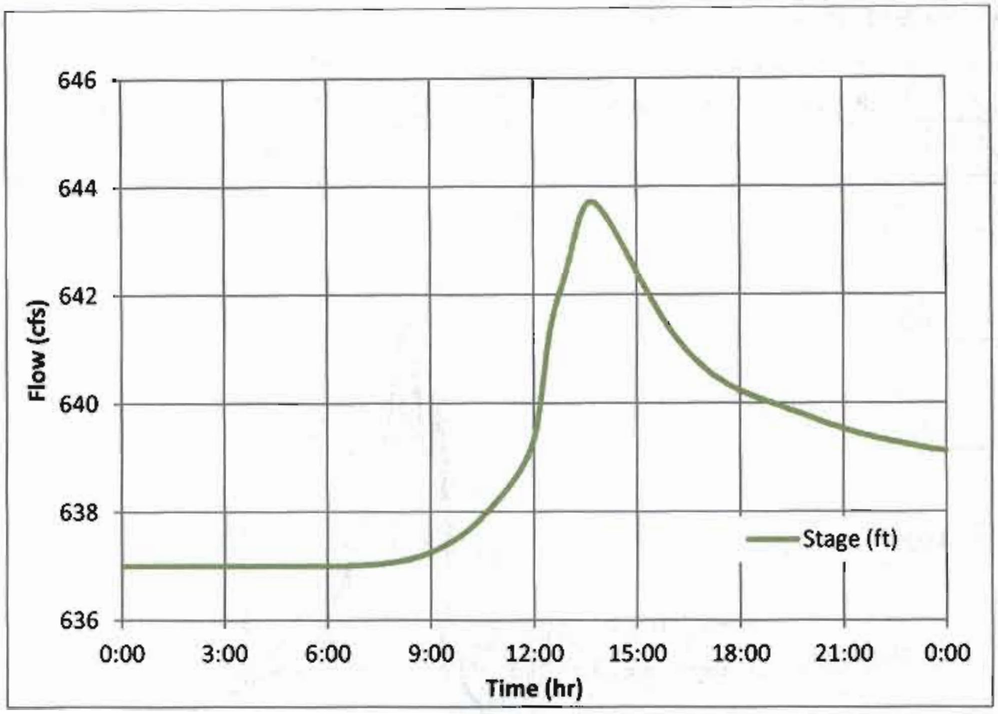


Figure 4-3: Seven Hills Lake Dam – Reservoir Stage during SDF Event

4.6 Adequacy of Spillway Capacity

During the 100-year flood event, the reservoir rises 5.5 feet above the normal pool elevation and 2.5 feet above the top of dam; the maximum discharge reaches 4,302 cfs, including approximately 2,370 cfs over the top of dam.

The Seven Hills Lake Dam has been classified by NYSDEC as a Hazard Class B dam. The Spillway Design Flood for this dam is 150% of the 100-year flood. During the Spillway Design Flood (SDF) event, the reservoir is estimated to reach a peak stage 3.7 feet above the top of dam, and the total outflow is estimated at 6,820 cfs. Only about 1,950 cfs of this total would be passed by the drop inlet spillway, with a flow of about 4,870 cfs passing over the crest of the dam. This indicates clearly that the capacity of the existing spillway is significantly inadequate.

5 Adequacy of Low Level Outlet Capacity

5.1 Objectives and Scope

As part of the safety assessment of the dam, the capability of the low level outlet work to draw down the reservoir was evaluated. The evaluation covered the following:

- Development of the low level outlet rating curve
- Development of the reservoir elevation/storage curve
- Evaluation of reservoir draw down time

5.2 NYSDEC Criteria for Low Level Outlet Capacity

Hydraulic requirements for dams in New York State are set out in the Guidelines for the Design of Dams which was last revised by NYSDEC in January 1989. Under the Guidelines, the low level outlet is required to have sufficient capacity to discharge 90% of the reservoir storage below spillway crest level within 14 days, assuming no inflow.

5.3 Assessment of Low Level Outlet Capacity

The low level outlet of the Seven Hills Lake dam consists of two openings located on the northern wall of the drop inlet spillway controlled by two 24-in square slide gates. The low level outlet discharges into the 16-foot wide by 5-foot high box culvert crossing the embankment dam (see Figure 5-1).

The low level outlet has an estimated discharge capacity of 120 cfs with the reservoir at normal pool level (spillway crest elevation), and is capable of releasing 90% of the reservoir volume in 1.9 days.

Figure 5-1: Reservoir Outlet

The low level outlet capacity is thus adequate to meet NYSDEC reservoir draw-down criteria.

NO TEXT ON THIS PAGE

6 Remedial Work Options

6.1 Objectives and Scope

One of the important objectives of the study is to define the measures necessary to bring the Seven Hills Lake dam into compliance with NYSDEC dam safety regulations, determine budget costs for these measures and compare the remedial work option with the option to decommission the dam. This section of the report deals with the remedial works options. The following section, Section 7, deals with the dam decommissioning options.

6.2 Remedial Works for Seven Hills Lake Dam

6.2.1 Scope

The remedial works required at Seven Hills Dam fall into three categories;

- Increase in spillway Capacity
- Repair of Right Abutment of the Dam
- Replacement of Low Level Outlet Gates

6.2.2 Increase in Spillway Capacity

The Seven Hills Lake Dam has been classified by NYSDEC as a Hazard Class B dam. The Spillway Design Flood for this dam is 150% of the 100-year flood. During the Spillway Design Flood (SDF) event, the reservoir is estimated to reach a peak stage of 3.7 feet above the top of dam, with a peak outflow of 6,820 cfs. Most of this flow would be over the dam with the drop inlet spillway passing less than 2,000 cfs. The discharge capacity of the existing drop inlet spillway is thus clearly insufficient. Moreover the flow in the drop inlet spillway at these high flows is governed by the box culvert flow regime which drowns out the crest of the spillway. There is thus very little scope for increasing the capacity of the existing spillway, even if the dam is raised significantly.

In order to pass the SDF without overtopping the dam, a combination of raising the dam and providing an auxiliary spillway would be necessary. The maximum level to which the reservoir level can be raised without flooding the adjacent road is about El 644. Thus the maximum dam raising would be about 5 feet to give a top of dam level of El 645, which would give 1 foot of freeboard.

Two types of auxiliary spillway were examined, one consisting of a high level box culvert system, and the other consisting of an Articulated Concrete Block (ACB) mat overflow spillway. For both options it was assumed that the dam would be raised by the maximum amount, i.e. about 5 feet to El 645. The two options are shown on Figures 5-4 and 5-5 and consist of the following components:

Seven Hills Dam – Remedial Works Option 1: Auxiliary Box Culvert Spillway

- Construct 7 concrete box culverts (9' by 12') within the dam for a width of 90 feet
- Excavate the downstream toe in the area of the box culverts to Elevation 633 and place rip-rap protection along the downstream toe
- Raise the remainder of the dam to Elevation 645
- Extend the existing spillway culvert section downstream though the added dam fill at the downstream shoulder of the dam

Seven Hills Dam – Remedial Works Option 2: Auxiliary ACB Overflow Spillway

- Cover 190 feet of the dam with Articulated Concrete Block (ACB) Mat
- Excavate the downstream toe of the Articulated Concrete Mat to Elevation 635 and place rip-rap protection along the downstream toe
- Raise the remainder of the dam to Elevation 645

Costs estimates for each of the two options are provided in Tables 5-5 and 5-6.

The estimated costs for the two options are;

- Option 1 : Auxiliary Box Culvert Spillway........................... $ 2,747,293
- Option 2 : Auxiliary ACB Overflow Spillway..........................$ 693,682

Option 1 involves a significant amount of dam fill and concrete construction, 1,250 and 475 cy respectively. This work would have to be scheduled for the dry season of the year to minimize cofferdam construction. The reservoir would need to be drawn down during construction, but it should be appreciated that a relatively small flood could fill the reservoir. For example it is estimated that the 5-year flood volume amounts to about 590 acre-feet, which is in excess of the 370 acre-feet reservoir volume. Note that the capacity of the low level outlet is too small to prevent reservoir filling during such a storm.

In contrast, Option 2 requires very little embankment fill and the ACB construction could be completed in a relatively short period during which time the existing spillway could comfortably handle any floods that are likely to occur.

It is recognized that the construction of an ACB spillway over the dam may not be in strict compliance with the NYSDEC Guidelines for the Design of Dams (1989). However the use of ACB construction for auxiliary overflow spillways for low dams is becoming fairly widespread in the US. This solution has been used successfully by AECOM in recent years. In view of the significant cost and schedule advantages of this approach, Option 2 is recommended for the Remedial Measures Option at Seven Hills Lake dam.

6.2.3 Repairs to Right Abutment of Dam

The downstream slope of the portion of Seven Hills Dam to the west of the DEP property line is very irregular and strewn with large rocks. There is also seepage at the toe of this portion of the dam. It is speculated that the dam may have overtopped in this area sometime in the past and has been repaired with rock fill. It should be noted that the dam is only capable of passing about the 15–year flood without overtopping. The probability of this having occurred during the 50 year life of the project is very high, in the order of 97%.

In this portion of the dam, the crest width is in excess of 20 feet, and the depth of fill is estimated to range from 4 to 8 feet. It is recommended that the downstream shoulder of the dam be removed down to foundation level and replaced with compacted fill as shown schematically on Figure 5-6. Rip-rap should be placed on the downstream face of the reconstructed dam to provide some erosion protection in the event of dam overtopping sometime in the future. If it is decided to proceed with the construction of the ACB Overflow Spillway discussed above, this reconstruction of the right abutment portion of the dam would be a good first step in providing uniform foundation conditions for the ACB mat.

The cost of this work is estimated at about $125,000. A budget cost breakdown for this estimate is given in Table 5-7.

6.2.4 Replacement of Low Level Outlet Sluice Gates

Two 24-inch sluice gates are located at the bottom of the spillway drop shaft to provide a low level outlet capability. These gates are over 50 years old. One of the gate stems is significantly bent from the vertical. Although it was not possible to inspect the gate leaves during the site inspection, it is suspected that the gates are now beyond their useful life and should be replaced. Stainless steel gates are recommended. The cost estimate for the replacement work is given in Table 5-8. The total budget is estimated at about $53,000.

The gate removal and replacement work could be completed in a few weeks, during which time the reservoir would be completely drawn down. The work would be scheduled for an anticipated dry period and a pump should be available to handle any inflows that may occur.

Table 6-1: Budget Estimate for Option 1: Auxiliary Box Culvert Spillway

Item Description	Quantity	Unit	Unit Price	Total Direct Cost
Direct Costs				
Excavation (including haul to disposal area)	800	CY	$ 80.00	$ 64,000
Fill Placement (including borrow and haul)	1250	CY	$ 65.00	$ 81,250
Rip-rap Protection	275	CY	$ 150.00	$ 41,250
Cast-in-Place Reinforced Concrete	475	CY	$ 1,500.00	$ 712,500
Surface Preparation		SF	$ 10.00	$ -
Filter Material (crushed stone)	0	CY	$ 120.00	$ -
Filter Material (geotextile and geogrid)	0	SF	$ 2.00	$ -
Articulated Concrete Mat	0	SF	$ 10.00	$ -
			Total Direct Cost:	$ 899,000
Indirect Project Costs:				
Mobilization/Demobilization			10%	$ 89,900
General Conditions			15%	$ 148,335
			Total Indirect Cost:	$ 238,235
Add-Ons:				
Miscellaneous Items			10%	$ 113,724
Contractor Markup (OH&P)			21%	$ 262,701
Contractor Bonds/Insurance			10%	$ 151,366
Project Contingency			50%	$ 832,513
			Total Construction Cost	**$ 2,497,539**
Engineering Services			10%	$ 249,754
			TOTAL	**$ 2,747,293**

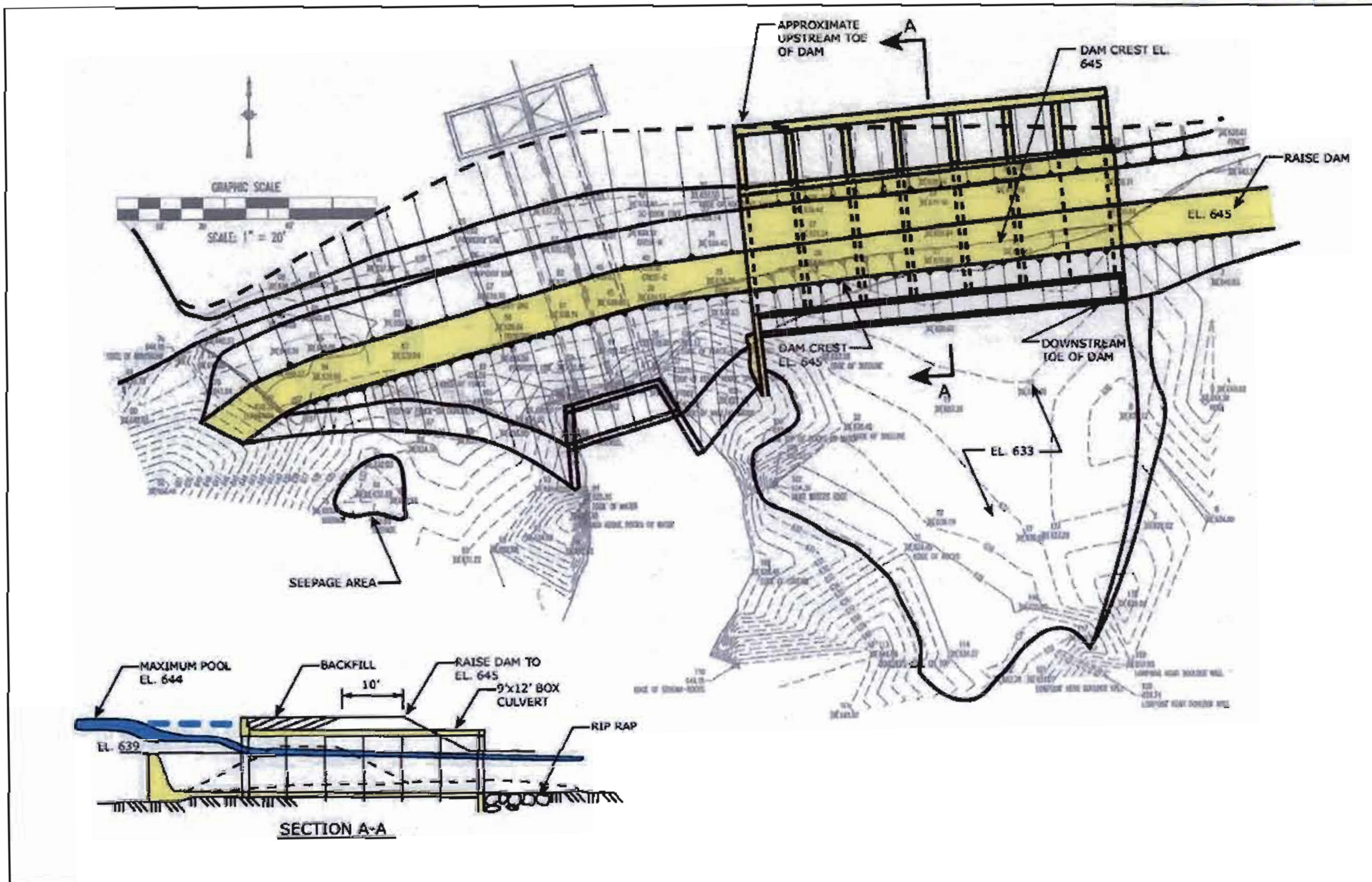


Figure 6-1: Remedial Work Option 1: Auxiliary Box Culvert Spillway

NO TEXT ON THIS PAGE

Table 6-2: Budget Estimate for Option 2: Auxiliary ACB Overflow Spillway

Item Description	Quantity	Unit	Unit Price	Total Direct Cost
Direct Costs				
Excavation (including haul to disposal area)	250	CY	$ 80.00	$ 20,000
Fill Placement (including borrow and haul)	275	CY	$ 65.00	$ 17,875
Rip-rap Protection	375	CY	$ 150.00	$ 56,250
Surface Preparation	4500	SF	$ 10.00	$ 45,000
Filter Material (crushed stone)	200	CY	$ 120.00	$ 24,000
Filter Material (geotextile and geogrid)	4500	SF	$ 2.00	$ 9,000
Articulated Concrete Mat	4500	SF	$ 10.00	$ 45,000
			Total Direct Cost:	$ 217,125
Indirect Project Costs:				
Mobilization/Demobilization			10%	$ 21,713
General Conditions			15%	$ 35,826
			Total Indirect Cost:	$ 57,538
Add-Ons:				
Miscellaneous Items			10%	$ 27,466
Contractor Markup (OH&P)			21%	$ 63,447
Contractor Bonds/Insurance			10%	$ 36,558
Project Contingency			50%	$ 201,067
			Total Construction Cost	$ 603,201
Engineering Services			15%	$ 90,480
			TOTAL	**$ 693,682**

NO TEXT ON THIS PAGE

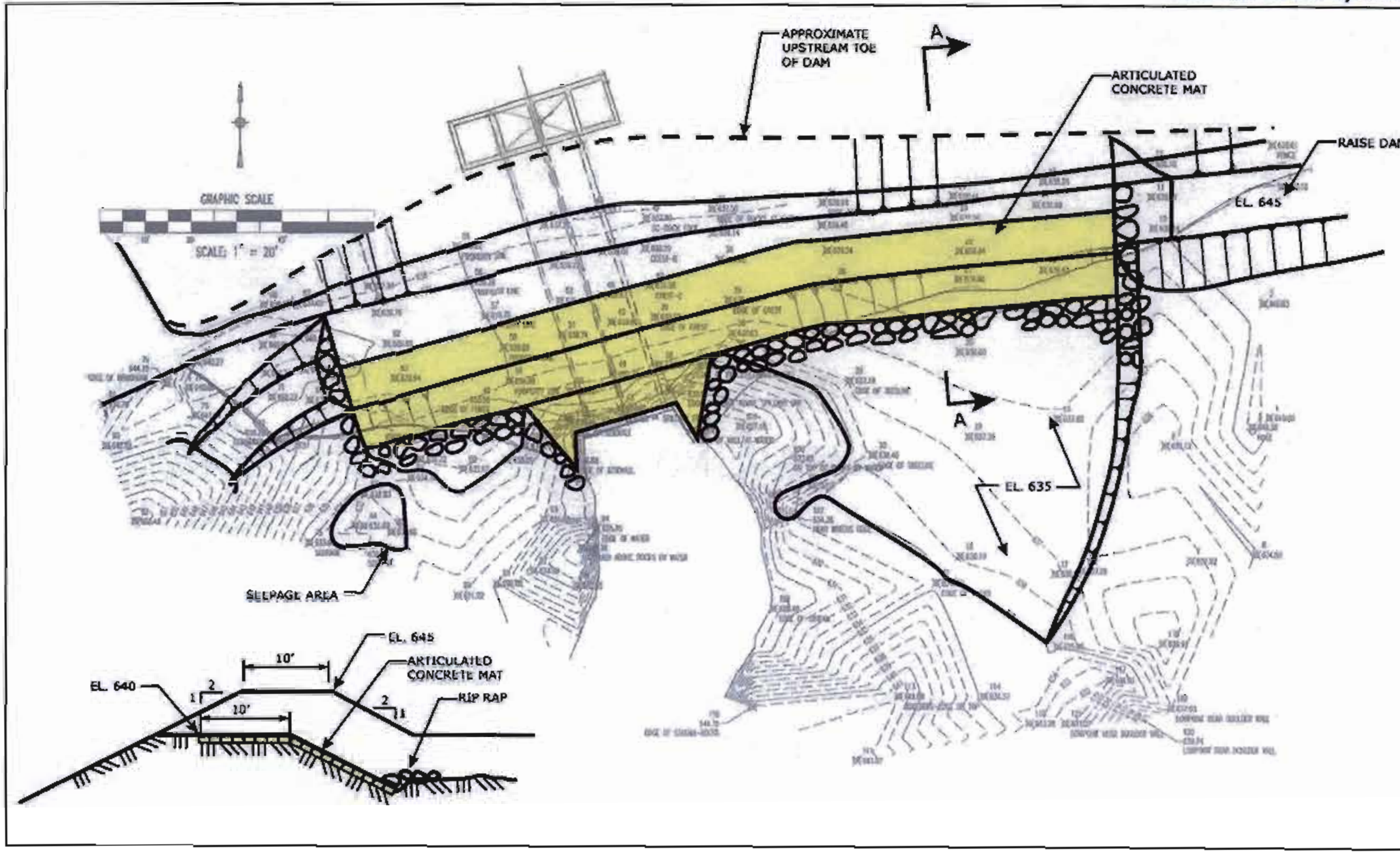


Figure 6-2: Remedial Work Option 2: ACB Auxiliary Overflow Spillway

AECOM

NO TEXT ON THIS PAGE

Table 6-3: Budget Estimate for Reconstruction of Right Abutment Portion of the Dam

Item Description	Quantity	Unit	Unit Price	Total Direct Cost
Direct Costs				
Excavation (including haul to disposal area)	200	CY	$ 80.00	$ 16,000
Fill Placement (including borrow and haul)	160	CY	$ 65.00	$ 10,400
Rip-rap Protection	40	CY	$ 150.00	$ 6,000
Filter Material (crushed stone)	0	CY	$ 120.00	$ -
Filter Material (geotextile and geogrid)	0	SF	$ 2.00	$ -
			Total Direct Cost:	$ 32,400
Indirect Project Costs:				
Mobilization/Demobilization			10%	$ 3,240
General Conditions			15%	$ 5,346
			Total Indirect Cost:	$ 8,586
Add-Ons:				
Miscellaneous Items			10%	$ 4,099
Contractor Markup (OH&P)			21%	$ 9,468
Contractor Bonds/Insurance			10%	$ 5,455
Project Contingency			50%	$ 30,004
			Total Construction Cost	$ 90,011
Engineering Services				$ 35,000
			TOTAL	**$ 125,011**

NO TEXT ON THIS PAGE

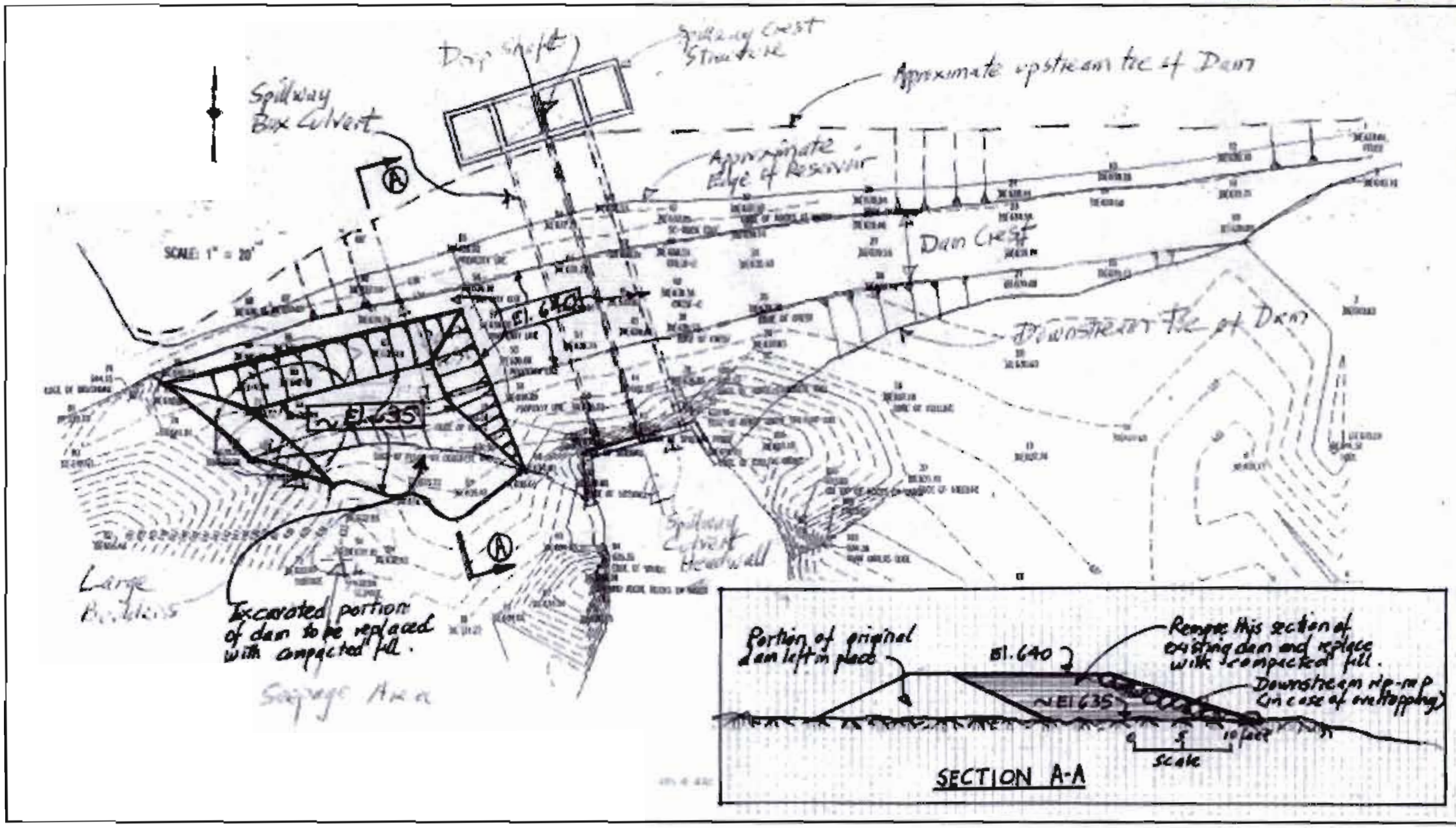


Figure 6-3: Reconstruction of Right Abutment Portion of the Dam

NO TEXT ON THIS PAGE

Table 6-4: Budget Estimate for Replacing Low Level Outlet Gates

Item Description	Quantity	Unit	Unit Price	Total Direct Cost
Direct Costs				
Dewatering and Maintaining Reservoir Level	1	LS	$ 5,000.00	$ 5,000
Removal of Existing Two Sluice Gates				
Laborer (Crew of 2 x 1 week)	80	MH	$ 65.00	$ 5,200
Supply New Sluice Gates	2	EA	$ 5,000.00	$ 10,000
Installation of Two New Sluice Gates				
Laborer (Crew of 2 x 1 week)	80	MH	$ 65.00	$ 5,200
			Total Direct Cost:	$ 25,400
Indirect Project Costs:				
Mobilization/Demobilization			5%	$ 1,270
General Conditions			0%	$ -
			Total Indirect Cost:	$ 1,270
Add-Ons:				
Miscellaneous Items			5%	$ 1,334
Contractor Markup (OH&P)			21%	$ 5,881
Contractor Bonds/Insurance			10%	$ 3,388
Project Contingency			30%	$ 11,182
			Total Construction Cost	$ 48,454
Engineering Services			10%	$ 4,845
			TOTAL	$ 53,300

6.3 Stability Analyses for Selected Remedial Work Options

6.3.1 Scope of Stability Analyses

Stability analyses were undertaken for the Seven Hills Lake Dam.

As presented in Section 4, the dam has insufficient spillway capacity to pass the 150% of a 100-year flood an NYSDEC requirement and significant modifications to the project are required as discussed earlier in this section. Stability analyses were undertaken to demonstrate that the modified dam met stability requirements.

6.3.2 Approach and Assumptions

The required factors of safety against embankment slope sliding were derived from USACOE guideline EM-1110-2-1902, October 2003, 'Stability of Slopes for Earth and Rockfill Dams' adopted by NYSDEC. The applicable loading cases analyzed taken from Table 3.1 of EM-1110-2-1902 and are summarized in Table 6-5 below.

Table 6-5: Minimum Required Factors of Safety: New Earth and Rock-Fill Dams

Analysis Condition	Required F of S	Slope
1. End-of-Construction (including staged construction)	1.3	Upstream and Downstream slopes
2. Long-term (Steady seepage, maximum storage pool, spillway crest, or top of gates	1.5	Downstream slope
3. Maximum surcharge pool	1.4	Downstream slope
4. Rapid Drawdown	1.1+1.3	Upstream Slope

The earth embankment was assumed to be of homogeneous earth construction of local available subsurface materials, typically a mix of gravel, sand, silt and clays. Bedrock, in general, was assumed 15 to 20 ft below existing ground surface/dam foundation. The overburden above bedrock, forming the dam foundations, was assumed to be reworked glacial tills and alluvials. Permeability values were selected on the basis of best estimates of above material classification.

The engineering properties adopted for the earth dams and foundations are summarized in Table 7-4.

Table 6-6: Assumed Material Properties

Material	Unit Weight γ in pcf	Effective cohesion c in psf	Effective internal friction angle Φ in degrees	Permeability k in ft/sec
Dam Material	135	50	33	3e-7
Upstream Protection	140	0	46	1e-1
Downstream Protection	140	0	46	1e-1
Sediment	85	0	25	1e-6
Earth Foundation	137	50	37	1e-7
Bedrock	150	-	-	1e-10

The stability analyses performed using Program Code 'Slide v.6' from Rocscience of Toronto, Canada (www.rocscience.com). The software is well established, known and recognized. It meets acceptable modern soil mechanics standards and practice. The F of S indicated herein for the embankment dams are based on slip circle failure planes using the Bishop and Spencer methods of calculation.

6.3.3 Results of Stability Analyses

The resulting Factors of Safety (F of S) from the analyses are summarized in Table 7-5.

Table 6-7: Seven Hills Lake Dam Summary of Stability Analyses

Loading Case	Required F of S	Computed F of S		
		Existing Dam	Raised Dam	ACB Spillway Section
Normal Max. Pool	1.5	1.82	1.51	1.82
Maximum Flood Pool	1.4	1.78	1.45	1.33
Rapid Draw-Down	1.1 – 1.3	1.45	1.85(1)	2.06 (1)

Note (1) Based on transient draw-down condition

Thus on the basis of the assumptions made it may be concluded that Seven Hills Dam would be stable if the proposed modifications were to be implemented.

NO TEXT ON THIS PAGE

7 Dam Decommissioning Options

7.1 Objectives and Scope

One of the objectives of the study is to define the options for decommissioning the dam. These options are then compared with the remedial works options described in Section 6, allowing a plan for dealing with the Seven Hills Lake Dam to be formulated.

The major cost components associated with dam decommissioning are:

- Permitting efforts
- Removal of materials making up the dam and appurtenant works
- Removal of sediment from the reservoir area
- Development of access roads where required to facilitate the removal efforts
- Channel and reservoir area restoration.

7.2 Types of Dam Decommissioning

Decommissioning can range from complete project removal to restore the natural conditions prior to dam construction, down to breaching of the dam so that the dam no longer impounds water.

The first option, referred to herein as **dam removal**, involves the removal of all dam features above original ground, and the removal of sediment accumulated in the reservoir area. The second option, referred to herein as **dam breaching**, involves the minimum amount of work to ensure that the dam no longer is capable of impounding water. Such a breached dam would be classified as a Class D dam under NYSDEC Part 673 Dam Safety Regulations. This classification refers to a dam that poses negligible or no hazard.

Both of these dam decommissioning options have been evaluated for the Seven Hills Lake dam.

7.3 Decommissioning Process

Dam decommissioning involves a series of steps including:

- Initial reconnaissance and preliminary design
- Stakeholder/community meetings
- Permitting
- Engineering and restoration design
- Project implementation

The present studies are in the reconnaissance/preliminary design stage. At this stage the main objectives are to determine any major issues with removal (such as community opposition, the presence of rare species habitat or sediment contamination), development of decommissioning concepts (including the strategy for dealing with sediment), and establishing budget costs for the two decommissioning concepts.

Useful information on the above steps in the dam removal process were provided in the conference "How to Manage a Dam Removal Process in New York State" held on March 4, 2010, sponsored by NYSDEC, American Rivers, and Hudson River Estuary. Additional information related to sediment removal was provided at the conference "Dam Removal 201: Sediment Assessment and Management", dated November 22, 2010, sponsored by NYSDEC, Hudson River Estuary, American Rivers, New York State water resources Institute, and NEIWPCC.

7.4 Permitting Requirements for Dam Decommissioning

Decommissioning of a particular dam may eventually require a number of permits from local, state and federal agencies. Local permits include building permits which would be applied for when the final design has advanced sufficiently.

Several state permits are potentially required. These include Dam Safety permits, Protection of Water permits, 401 Water Quality Certification. Also the SEQR process will need to be followed, to develop either an EAF or an EIS. All the state permits are part of the state's coordinated management system, and may be processed through one Joint Application Form.

Federal permits include the Corps of Engineers Clean Water Act – Section 404 permit.

The detail and duration of the permitting process will vary from project to project depending on the pertinent environmental and community issues.

The permitting costs will vary depending on the complexity of the issues pertaining to the project. The range of costs could be typically between \$ 20,000 and \$ 100,000. The upper figure in that range, \$100,000, was utilized for a project such as the Seven Hills Lake dam that could face significant local opposition to dam decommissioning.

7.5 Removal of Dam and Appurtenant Works

For the dam removal option it has been assumed that;

- Virtually all the material making up the dam above grade will need to be removed and hauled to an acceptable disposal area. In the case of an embankment dam it has been assumed that the fill material cannot be spread over the local site area, but must be removed from the site. It is assumed that the fill materials making up the dams are not contaminated and therefore no special disposal areas need to be used for this material.
- The spillway and outlet works facilities will be demolished and removed from the site

For the dam breaching option it has been assumed that;

- A portion of the dam at the deepest section will be removed above stream bed level. The breach width was set to be 25 feet due to the size of the catchment feeding the stream. The side slopes of the breach were taken to be 1 V on 2 H up to the top of the existing dam.
- Spillway and outlet works would be removed

7.6 Removal of Sediment from Reservoir Area

7.6.1 Seven Hills Dam Sediment Survey

The Seven Hills Residents Association has commissioned surveys of sediment deposits at the head of Seven Hills Reservoir. Figure 7-1 shows the sediment delta at the head of Seven Hills Reservoir. This sediment has been carried by the stream from the 3.65 square miles of catchment area upstream of the reservoir. The volume of the sediment delta has been estimated as 10,100 cubic yards. Seven Hills Lake Dam was completed in 1957, giving a 53 year operating life to the date of the sediment survey. Thus, the average sediment yield from the stream amounts to 60 tons/square miles/year. This is well within the "Rule of Thumb" for dams in the North East, which gives sediment yields in the range of 20 to 90 tons/square mile/year.

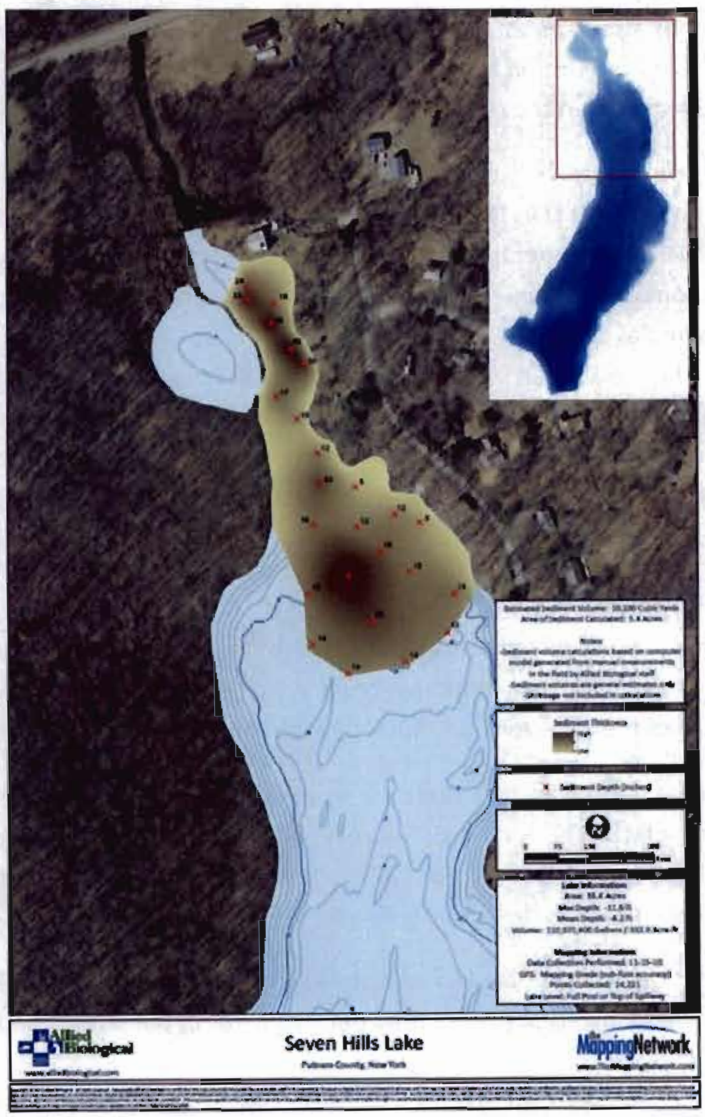


Figure 7-1: Sediment Depths in Seven Hills Reservoir

In addition there will be sediment deposits derived from the immediate catchment area directly surrounding the reservoir. From sediment measurement at other reservoirs in the area it appears that sediment yields from the sloping terrain directly surrounding the reservoir can be high. The total volume of sediment in the Seven Hills Lake is estimated to be about 21,500 cubic yards.

7.6.2 Management of the Sediment following Dam Removal

Clearly DEP does not want to release significant quantities of sediment from the Seven Hills reservoir that could eventually enter the water supply reservoirs: any sediment flushed from Seven Hills reservoir would pass through Frank Pond, where the storage is very small, and pass into Boyd Corner Reservoir.

It has been assumed that in the process of a dam removal, the reservoir would be lowered slowly to avoid the uncontrolled flushing of sediment downstream. Thus all sediment removal would be by mechanical means. It has also been assumed that most of the accumulated sediment would be removed, with only a small proportion left in place (assumed to be 30%). This will require the construction of a haul road within the reservoir following approximately the alignment of the original river channel.

The catchment area of the Seven Hills Lake dam consists of areas that are rural and agricultural in nature with no nearby industrial developments. It is to be expected therefore that there would be no significant contamination of the sediment deposits in the reservoir. It should be noted however that one of the sediment samples taken at Lower Chia Lin reservoir (as part of a previous study), within the Seven Hills Lake watershed, exhibited some minor contaminations of metals, semi-volatile organics, and DDD. Further sampling and testing of reservoir sediments are required prior to defining disposal areas for the sediment to be removed. The present budget estimates have been developed on the assumption that no special disposal areas need to be considered for the sediment excavated from Seven Hills reservoir.

7.6.3 Management of Sediment following Dam Breaching

Seven Hills reservoir has a wide aspect reservoirs and therefore it is possible leave most of the sediment in place following dam breaching. The breaching process would need to be carefully controlled to achieve a slow lowering of the reservoir and thereby to minimize the erosion of the sediment deposits.

Once the dam has been breached and the reservoir emptied, the sediment deposits would be allowed to drain and consolidate in place. The surface of the sediment deposits would be seeded to provide further stabilization. The natural stream flows will erode a new stream alignment through the sediment deposits, which will be stabilized as described below.

Seeding of the sediment deposits left in place and stream restoration will require the construction of a haul road in the reservoir following approximately the alignment of the stream bed.

7.7 Habitat and Stream Restoration Work

For both the dam removal option and the dam breaching option a natural stream alignment will be formed in the prior reservoir area. As part of the dam decommissioning process the stream will be stabilized and a natural habitat formed by special plantings and the strategic placement of rock and gravel material.

7.8 Budget Estimates for the Decommissioning Options.

The costs estimated for the dam removal and the dam breaching options are presented in Tables 7-1 and 7-2, respectively.

Table 7-1: Budget Estimate for Complete Dam Removal

Item Description	Quantity	Unit	Unit Price	Total Direct Cost
Direct Costs:				
Excavate Dam (including haul to disposal area)	3,800	CY	$ 40.00	$ 152,000
Excavate Sediment (including haul to disposal area)	15,068	CY	$ 30.00	$ 452,051
Develop Haul Roads	3,300	LF	$ 15.00	$ 49,500
Demolish Concrete Spillway	1	LS	$ 20,000.00	$ 20,000
Remove LLO Sluice Gates and Piping	1	LS	$ 5,000.00	$ 5,000
Seeding and Planting	55.3	Acre	$ 1,100.00	$ 60,830
Stream Stabilization	3,200	LF	$ 20.00	$ 64,000
			Total Direct Cost:	$ 803,381
Indirect Project Costs:				
Mobilization/Demobilization			10%	$ 80,338
General Conditions			15%	$ 132,558
			Total Indirect Cost:	$ 212,896
Add-Ons:				
Miscellaneous Items			10%	$ 101,628
Contractor Markup (OH&P)			21%	$ 234,760
Contractor Bonds/Insurance			10%	$ 135,266
Project Contingency			50%	$ 743,965
			Total Construction Cost	$ 2,231,896
Engineering Services			10%	$ 223,190
Permitting Services				$ 100,000
			TOTAL	$ 2,555,086

AECOM

#

Table 7-2: Budget Estimate for Dam Breaching

Item Description	Quantity	Unit	Unit Price	Total Direct Cost
Direct Costs:				
Excavate Dam (including haul to disposal area)	1,100	CY	$ 40.00	$ 44,000
Excavate Sediment (including haul to disposal area)	0	CY	$ 30.00	$ -
Develop Haul Roads	3,200	LF	$ 15.00	$ 48,000
Demolish Concrete Spillway	1	LS	$ 20,000.00	$ 20,000
Remove LLO Sluice Gates and Piping	1	LS	$ 5,000.00	$ 5,000
Seeding and Planting	55.3	Acre	$ 1,100.00	$ 60,830
Stream Stabilization	3,200	LF	$ 20.00	$ 64,000
			Total Direct Cost:	$ 241,830
Indirect Project Costs:				
Mobilization/Demobilization			10%	$ 24,183
General Conditions			15%	$ 39,902
			Total Indirect Cost:	$ 64,085
Add-Ons:				
Miscellaneous Items			10%	$ 30,591
Contractor Markup (OH&P)			21%	$ 70,666
Contractor Bonds/Insurance			10%	$ 40,717
Project Contingency			50%	$ 223,945
			Total Construction Cost	**$ 671,835**
Engineering Services			10%	$ 67,184
Permitting Services				$ 100,000
			TOTAL	**$ 839,019**

8 Recommended Development Plan

8.1 Scope

In order to define a strategy for dealing with the Seven Hills Lake dam, the costs of various development options were compared. Non-cost items were included in the comparison process, consisting mainly of flooding considerations, environmental impacts, and the perceived public support for the development options.

8.2 Comparison of Development Option Costs

Three development options were evaluated:

- **Remedial Work Option**, in which the dams are upgraded as necessary to meet NYSDEC dam safety regulations and design guidelines.
- **Dam Removal Option**, in which the complete dam and most of sediment deposits are removed from the site, thereby restoring the natural conditions prior to dam construction.
- **Dam Breaching**, in which a portion of the dam is removed so that the dam can no longer impound water.

The remedial work options are presented in Section 6 of this report, and the two dam decommissioning options are presented in Section 7.

Remedial Works Option

Construction costs for the remedial option are presented in Section 7. Under this option the dams would continue to be maintained. Annual operation and maintenance (O&M) costs were evaluated in order to derive the full development costs associated with keeping the projects in operation. For a Class B dam, in addition to the regular inspections and maintenance schedule, the annual O&M costs include required Dam Safety Inspections every four years in accordance with NYSDEC Safety Regulations (673.12), and Engineering Assessments every 10 years (673.13). It has been assumed that all routine and annual inspections and maintenance activities will be undertaken by DEP staff. The Engineering Inspections and Engineering Assessments will be undertaken by an Engineer appointed by DEP. The costs for all these activities are presented in Table 8-1.

Table 8-1: Inspection and Maintenance Costs for Class B Dams

Item		Annual Level of Effort (man-hours)	Cost ($)
Routine Activities			
1	Monthly inspection	48	2,880
2	Annual inspection	8	480
3	Mowing grass (twice per year)	16	960
4	Annual clearing of vegetation and debris	32	1,920
5	Annual rip-rap replenishment and minor repairs		4,000
6	Annual operation of low level outlet	8	480
		Sub-total	**10,720**
Special Activities			
7	Safety Inspection (every 4 years)		**15,000**
8	Engineering Assessments (every 10 years)		**40,000**

The equivalent present value of the above stream of costs over a 30 year period of operation, assuming a discount rate of 5%, is estimated to be about $272,000.

The costs of the various development options are summarized in Table 8-2.

Table 8-2: Costs of Development Options

Development costs, comprising construction costs and O&M costs	
Construction	
Auxiliary Overflow Spillway	$694,000
Reconstruction of Right Abutment	$125,000
Low Level Outlet Gates	$53,000
Subtotal	$872,000
O&M Costs (equivalent 30-year present value)	$272,000
Total Development Cost	**$1,144,000**
Decommissioning option costs	
Dam Removal	$2,556,000
Dam Breaching	$839,000

From the cost viewpoint either the dam breaching or the remedial work options could be considered.

8.3 Review of Other Factors

Costs related to dam removal and dam decommissioning are not the only factors to be considered in determining the appropriate development option. Other important considerations are environmental impacts, community concerns, impact of dam decommissioning on flooding, and impact of dam decommissioning on downstream sediment releases.

Environmental Impacts

Fish (likely bass) were observed in Seven Hills Reservoir, and aquatic vegetation is present in the shallow water areas of the reservoir. The dominant vegetation surrounding the reservoir is a mixture of maple, oak, and birch, with an open grassed area along the south-eastern shoreline. Extensive wetland vegetation was observed at the inlet stream location, which is classified as Impounded Marsh (NYSDEC, January 2002). AECOM has assessed the relative difficulty of obtaining federal and state approvals for removal to be low.

Community Concerns

Seven Hills Lake Dam is jointly owned by DEP and the Seven Hills Residents Association. DEP's ownership is limited to about 25% of the dam itself. The Residents Association owns about 75% of the dam and the entire reservoir area. There are several residences bordering on the reservoir, and about 40 residences within close proximity that make use of the recreational facilities at the reservoir. These include a sanded beach and a basketball court as well as a grassed area, all at the south-eastern corner of the reservoir. The reservoir has a significant amenity value to the residents and therefore community opposition to breaching or removal can be expected to be high.

Impact of Dam Decommissioning on Flooding

Seven Hills reservoir has a small but significant flood reduction impact. For example the 100-year peak inflow to the reservoir of 5,419 cfs is reduced to 4,302 cfs as an outflow from the reservoir (see Section 4). Although the percentage reduction is low at 21%, a reduction of the flood peak 1,117 cfs is of significance to the dam project located downstream on Leetown Brook, namely Frank Pond Dam. During the 100-year flood conditions Frank Pond Dam would be overtopped by about 2 feet. If Seven Hills Dam were to be decommissioned, the overflow depth would increase by about 1 foot.

Impact of Dam Decommissioning on Downstream Sediment Releases

Seven Hills Lake dam discharges to Frank Pond Dam which in turn discharges to Boyd's Corner Reservoir via Leetown Brook. Decommissioning of Seven Hills Dam would need to be handled very carefully to avoid the risk of sediment discharges reaching Boyd's Corner Reservoir.

8.4 Recommended Option for Seven Hills Lake Dam Development

AECOM recommends that the remedial work option be followed for Seven Hills Dam. The construction cost for this option is of the same order of magnitude as the cost of breaching the dam. Dam breaching is not considered to be a realistic option in this case because of the expected strong opposition of the Seven Hills Residents Association, who are majority joint owners of the project.

It is envisaged that the remedial work program could be undertaken in two phases:

- **Phase 1 : Reconstruction of Right Abutment of the Dam**

  This work would be located in the portion of the dam at the right abutment owned by DEP. The cost of this work, including engineering design services, but excluding permitting work is estimated at $ 125,000. The construction period for this work would be about three months

- **Phase 2 : Increasing Spillway Capacity and Replacing Outlet Gates**

  This work would be located at the portion of the dam owned by the local residents association. The total cost for the work, including engineering design services is estimated at $ 747,000. The construction period for this work would be about five months.