DESIGN REPORT
for the
RECONSTRUCTION of the STARBUCKVILLE DAM

Prepared for:

Schroon Lake Park District
Essex and Warren Counties, New York

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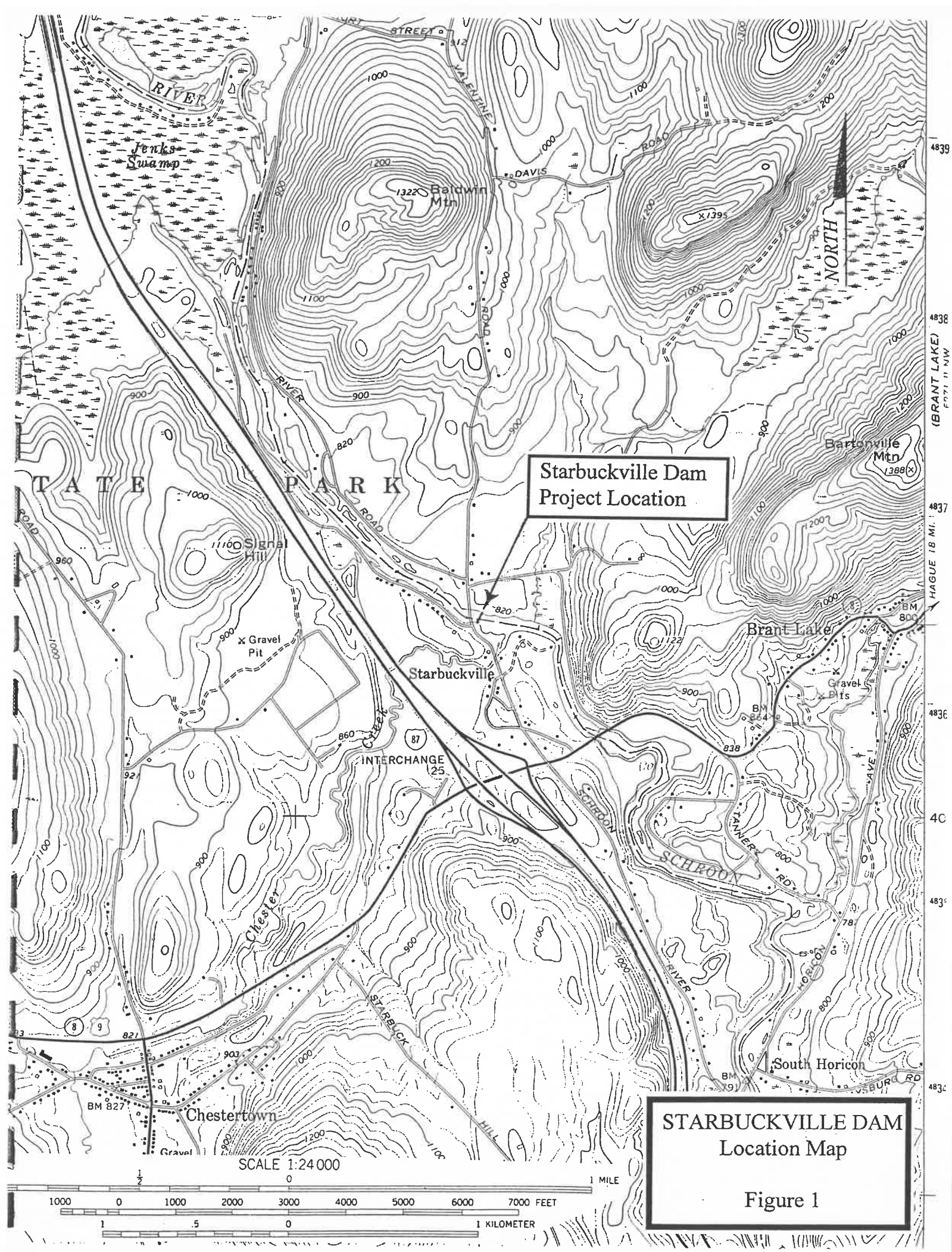
INTRODUCTION

The Starbuckville Dam is situated on the Schroon River approximately 2 miles northeast of Chestertown, New York. The dam is located at longitude 73°, 46 minutes west and latitude 43°, 41 minutes north. Although the dam is just over 5 river miles downstream from Schroon Lake, it controls and regulates the lake level on Schroon Lake. Figure 1 shows the location of the dam and surrounding area.

The dam consists of a timber crib spillway with a vertical sluicegate and sluiceway on its west side. An earthen embankment with protective riprapping extends on each side to higher banks. The timber crib spillway is 141-feet long and approximately 8-feet high. The sluiceway structure is 16 feet wide with a 16' x 7' high vertically operated gate.

This report deals with the current condition and classification of the existing dam, and what improvements may be needed to insure its structural integrity and bring the structure into conformance with current DEC standards.


Starbuckville Dam
Project Location
STARBUCKVILLE DAM
Location Map
Figure 1
SCALE 1:24 000
1 MILE
7000 FEET
1 KILOMETER
Baldwin Mtn
Signal Hill
Starbuckville
Brant Lake
Bartonville Mtn
Chestertown
South Horicon
INTERCHANGE 25
Jenks Swamp
TATE PARK
RIVER
Chester Creek
SCHROON RIVER
NORTH HORICON
(BRANT LAKE)

EXISTING DAM

According to the records of the New York State Department of Transportation and Department of Environmental Conservation, the Starbuckville Dam was originally constructed in the latter half of the 19th century. The dam was originally constructed for logging operations in the upstream basin area. The past records indicate that there was a 28-foot wide sluiceway on either end of a rock filled timber crib spillway. The two sluiceways were adjacent to each riverbank. It appears that sometime during the 1940's or 1950's the two old sluiceways were abandoned and the current concrete sluiceway with vertical steel gate was constructed on the west bank. There is further indication that the timber crib spillway was extensively rehabilitated in the early 1980's.

The existing dam consists of the following elements. The description is given looking downstream with the left bank being the east bank.

1. Earth fill and rock riprapped embankment extending approximately 100 feet from the natural bank on the left to the end of the timber crib spillway. There is no abutment wall separating the earth embankment and rock fill from the timber crib spillway.

2. A rock filled timber crib spillway 141-feet long and approximately 8-feet high extends from the left embankment across the river. Most of the timber crib upstream from the crest is covered with silt deposits.

3. A concrete sluiceway and vertical lift gate with a 16-foot wide opening is adjacent to the right end of the timber crib. The vertical lift gate is operated by a motor driven screw lift.

4. An earthen embankment with upstream protecting riprap extends approximately 100-feet from the sluiceway to the right where it connects to the west bank. This earth embankment has a width of approximately 40-feet at the sluicegate structure and extends very rapidly in width to well over 100-feet a short distance from the sluice structure. This embankment is used as a parking area for the general public.

It is believed that the existing concrete sluiceway was constructed in or on the location of the old west sluiceway and that the old east sluiceway was located in the embankment. This old sluiceway on the east side was removed and filled with soil material and heavy riprap. The tops of the embankments are approximately 6-feet above the crest of the spillway. Figure 2 shows the existing dam in more detail. The concrete sluiceway on the west side appears to be setting on part of the old timber crib sluiceway.

Hazard Classification

The New York State Department of Environmental Conservation has classified the Starbuckville Dam as a Class B Hazard Structure. Class B is defined as "dam failure can damage homes, main highways, minor railroads, or interrupt use or service of relatively important public utilities". During a field inspection on October 7, 1998, we toured the downstream area and made approximate elevation references from existing structures and roads to the current dam crest. Based on our observations we concur in the New York State DEC classification of the structure as a Class B Hazard.

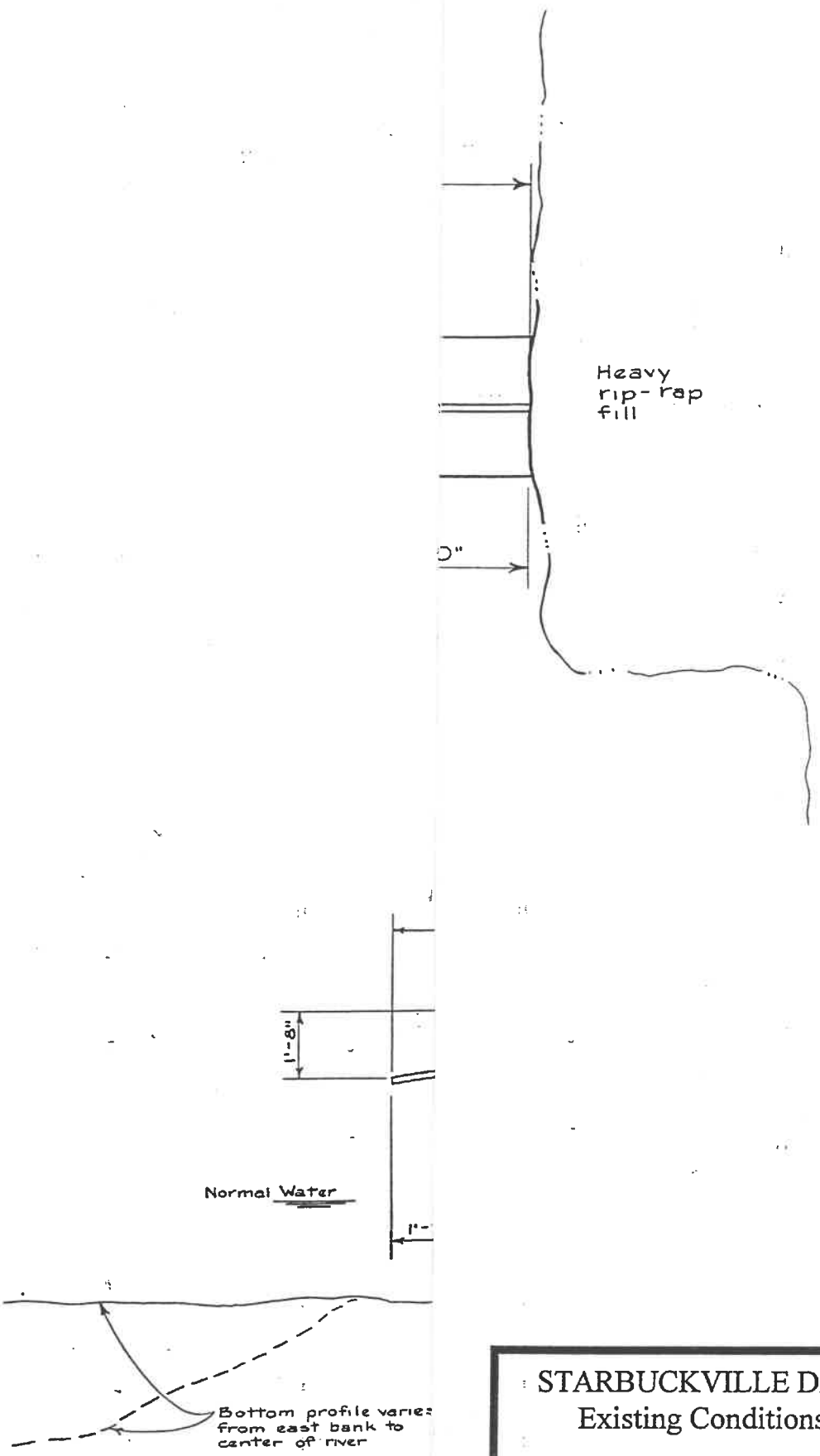
FIELD INSPECTION

On October 7, 1998 we conducted an inspection of the Starbuckville Dam. The water surface was approximately 1-foot below the top of the timber crib spillway and the upstream planking had approximately 4-feet of exposed wood surface. Most of the planking upstream of the crest beam was covered with silt. The entire downstream slope of the timber crib was exposed. The tailwater was 3-feet below the downstream edge of the timber planking on top of the spillway. Figure No. 2 shows the existing configuration of the dam as found on our inspection.

We removed top planks from the spillway in two locations on the downstream surface to allow inspection of the timber cribbing below the deck. In addition we were able to walk along part of the timber cribbing in the tailrace to inspect the downstream face of the cribbing.

Our inspection indicated that the overall condition of the logs in the crib structure were in fairly good condition. There were some small pockets of rot detected in the western most area of deck removal, but nothing of any significance. The area of weakness that was discovered during this inspection was at the ends of many of the timber logs that make up the crib. Rot had penetrated into approximately a quarter of the ends that we could see, thus weakening the end and allowing the weight of logs, decking and rocks to compress and crush the ends of the timbers and thus sag the crib itself. This condition will very likely continue to spread and allow more settlement and sagging.

In both of the inspection areas where decking was removed it was obvious that some of the smaller rocks in the cribbing had been washed out, which allowed the overall rock fill to settle. This settlement has left a void between the top of the rock fill and the underside of the timber decking of 12 to 32 inches. This separation appears to extend over the full length of the spillway.



STARBUCKVILLE DAM
Existing Conditions

Figure 2

There was only one significant leak noted in the timber crib spillway and that was near the eastern inspection point. It appeared to be primarily due to wide cracks in the upstream planking between two or three adjacent planks that were not covered with soil or filled in with silt. This type of leak is not unusual for timber crib dams and could be corrected easily with board overlays.

The sluiceway and sluicegate appear to be constructed on top of a timber crib foundation. The structure is in good condition with only a couple of areas that should receive attention. The first area is the toe of the sluiceway structure that has suffered some erosion under the end of the concrete slab and around the supporting timber crib. The second area is a separation in one of the construction joints where the westerly retaining wall abuts the concrete gate support structure. Both of these areas can be repaired with concrete.

The east embankment is protected with heavy riprap over earth fill and shows no signs of seepage or leakage. The west embankment has riprap on the upstream face and does have a significant leak exiting approximately 1/3 of the way up the downstream embankment face and approximately 40-feet from the sluiceway.

A soil boring was put down at each end of the dam. The borings indicate that the dam sits on boulders, cobbles and gravel. Boring refusal was encountered at 2 to 5 feet below the dam but this refusal may very well be large boulders.

PROPOSED RECONSTRUCTION

Because of the deterioration that is beginning to take place in the timber crib, and the extreme deficiency in flood capacity, (see Hydrology and Hydraulics), we are proposing to remove the existing dam and construct a new concrete gravity overflow/drop spillway with a new 12-foot east side sluicegate. The spillway crest elevation will remain the same and the existing sluicegate/sluiceway will remain in place.

The timber crib spillway will be replaced with a 143-foot long labyrinth spillway. It will act as a drop spillway and the apron has been designed to reduce downstream turbulence in the tailwater area. The labyrinth spillway will be constructed in a 14'-4" long repeating pattern. There will be nine-14'-4" segments for a total labyrinth spillway length of 129-feet. This new spillway will sit on the footprint of the existing timber crib spillway.

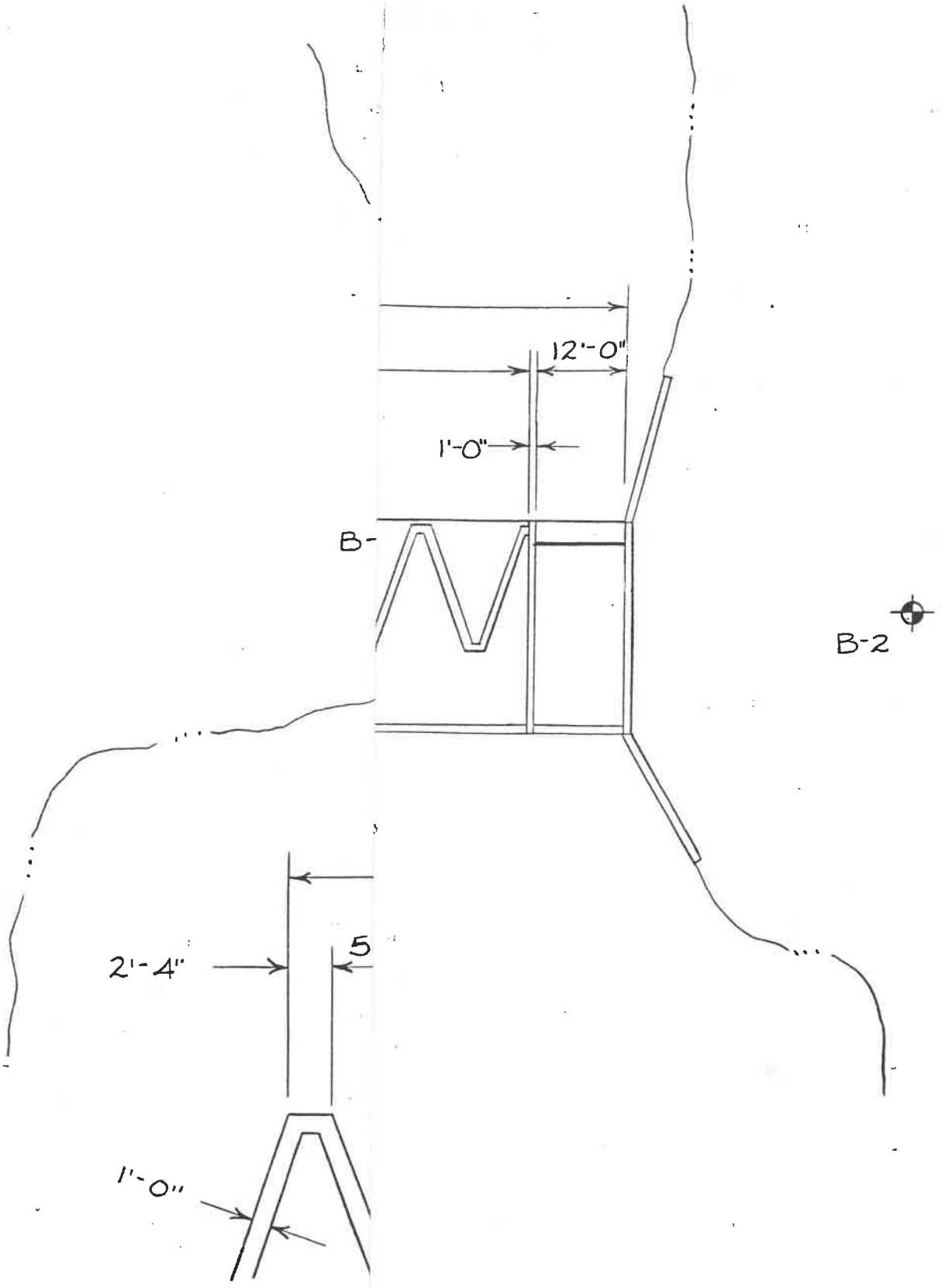
The center 12-foot section of the spillway will be a standard overflow gravity spillway section that will fit into the foundation width and length of the labyrinth pattern. This sloping spillway portion is added to accommodate upstream fish passage. Although it does not follow any specific fish ladder design, it provides a gentle sloping surface with water flowing down and a head differential of only 5 feet. The depth of water will vary from 2" to 6" during most fall conditions. Spring conditions will be more water but less head. The cost differential between providing this spillway and continuing the labyrinth design is insignificant.

A new 12-foot wide sluicegate will be constructed on the east end of the new labyrinth spillway. This gate will be constructed in the earth embankment adjacent to the existing timber crib spillway. The gate will have a motor driven lift and a bottom sill elevation of 800.0.

The existing sluiceway and gate will remain in place and have the downstream end of the apron slab encased in a concrete wall to stop further erosion. We will also change the drive for the hoisting mechanism at the existing gate to facilitate a faster operation.

Both embankments will be raised approximately 1-foot so that we have the top of the embankment at 7-feet above the crest of the dam on both sides of the river. At the same time a grouting program will be undertaken to seal off the leak that exists in the west side embankment.

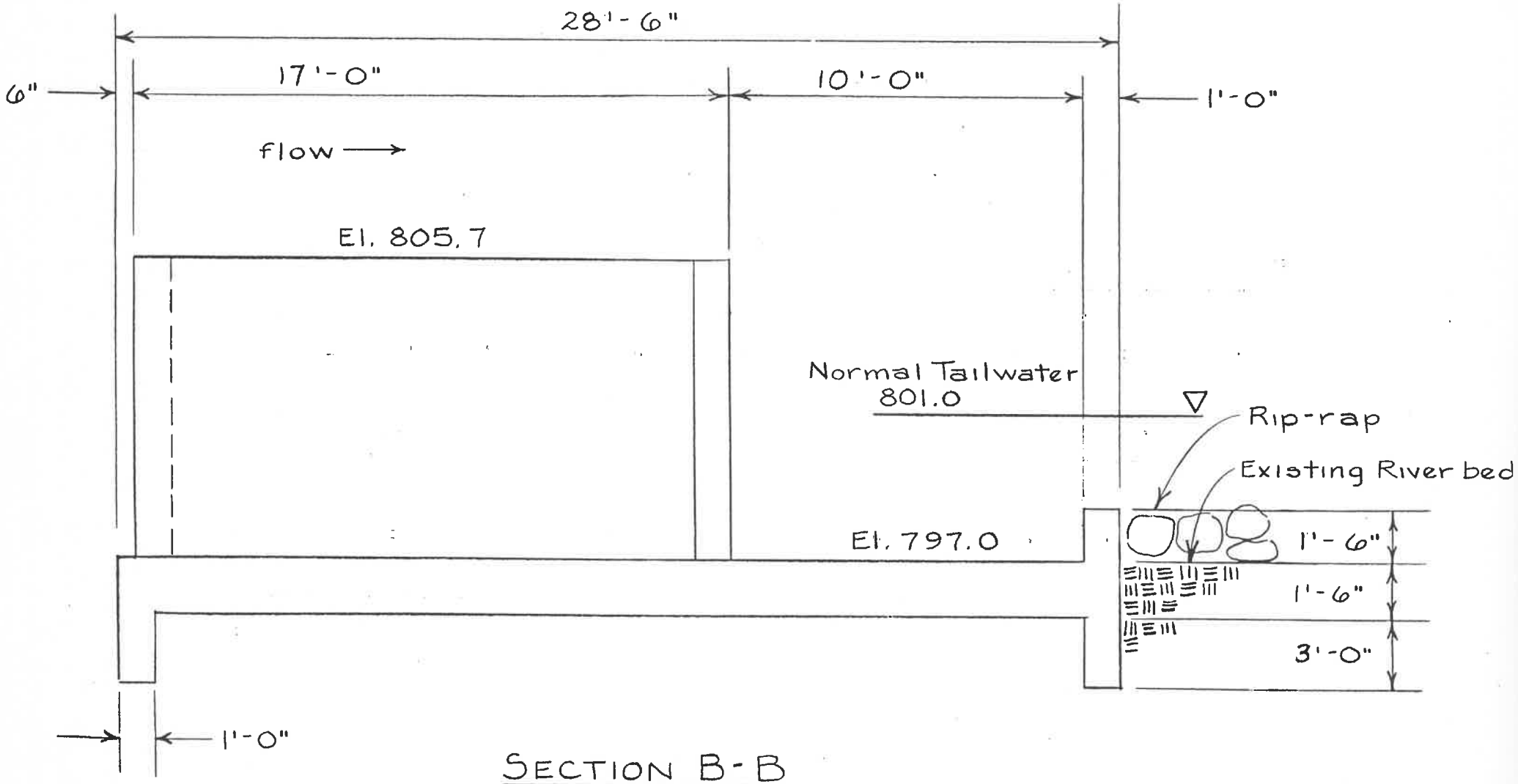
The new construction will be carried out in two phases using a cofferdam system. The first phase will be to isolate the eastern half of the existing spillway and complete all of the construction in that segment. This would include the new 10-foot sluicegate. It is anticipated that during this time most of the water can be passed through the existing sluiceway with the eastern half of the timber crib being maintained for emergency flood conditions. Once the eastern portion is complete, the cofferdam will be removed and reconstructed to isolate the western half of the structure. We will then construct the remainder of the new spillway and conduct the repair work to the existing sluiceway. It is anticipated that during this portion of the work all of the water will pass through the new sluicegate, with the new spillway being utilized as necessary. Figures 3, 4 and 5 show the proposed facilities.



LABY
Scale:

STARBUCKVILLE DAM
Proposed Conditions
And Detail

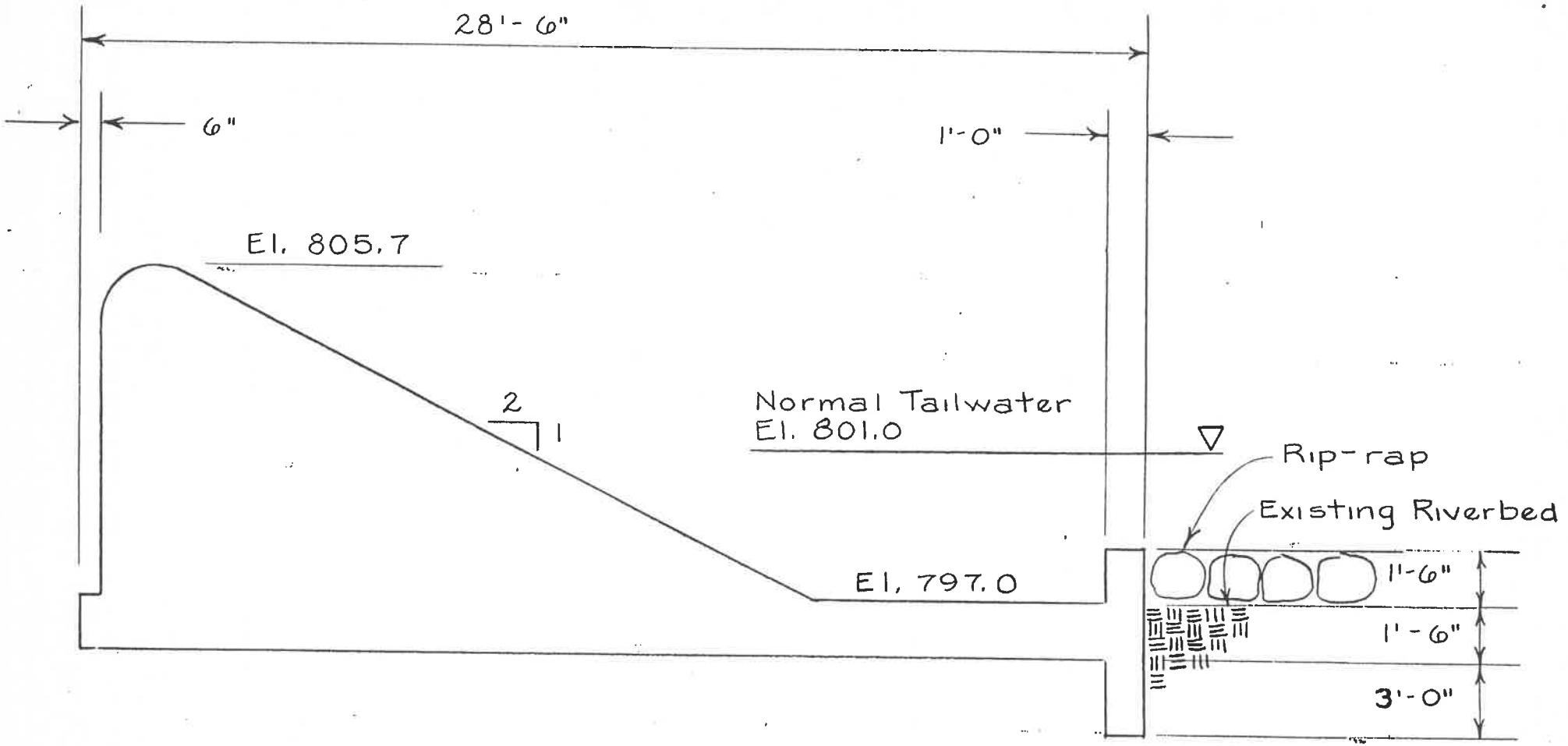
Figure 3



SECTION B-B
Scale : 1/4" = 1'-0"

STARBUCKVILLE DAM
Spillway Section

Figure 4



SECTION C-C

Scale: 1/4" = 1'-0"

STARBUCKVILLE DAM
Spillway Section

Figure 5

SAFETY ASPECTS

The design of the new spillway will reduce the turbulence in the tailwater area that has been a dangerous situation for fishermen over the years. However the sluicegates, when opened, will cause turbulence and undercurrents much greater than the spillway area. When flood conditions exist that require that the gates to be opened, and there is a significant volume of water going over the spillway, there will still be dangerous undercurrent conditions in the tailwater area of the dam.

On the upstream side of the dam we would recommend that floating log booms or rope barriers be strung across the river channel. These should be placed in the river at the earliest convenience in the spring and left in place until ice formation is about to begin. The barriers should include an arrow directing canoers or rafters to one of the banks to take-out. The barriers could either be placed between the bridge and the dam, or directly above the bridge with take-out directed to the east bank. With the proposed design for the new drop spillway no canoeing, boating or rafting traffic should be allowed near the spillway location.

HYDROLOGY AND HYDRAULICS

The drainage basin above the Starbuckville Dam has an area of 437 square miles. Although there is no active flow gage located on the Schroon River at this time, there was a USGS Gage No. 01317000 with a drainage area of 527 square miles located at Riverbank, New York, downstream from the Starbuckville Dam. This gage operated from 1907 until 1970. A Log Pearson Type 3 Regression Analysis for this gage was received from the USGS Water Resources Division and has been used as the basis for flood flows in this analysis (see Appendix A).

The 100 year flood flow developed from the Riverbank gage is 11,200 cubic feet per second (cfs). This flow was then prorated on the basis of drainage area to the Starbuckville Dam. The drainage basin adjustment factor is 82.9% and yields a 100-year flood at the dam of 9,285 cfs.

The New York State DEC requirements for spillway capacity at an existing Class B dam is 150% of the 100 year flood level. Therefore, for the Starbuckville Dam the inflow design flood that must be safely passed by the structure is 13,930 cfs.

We have analyzed the current capacity of the spillway and sluicegate, allowing for 2-feet of freeboard to the top of the earth embankments, and have determined that the existing spillway and sluiceway can safely handle a flow of approximately 5,000-cfs.

Because of this inadequate spillway capacity, and other factors, we are proposing to construct a new spillway with an additional sluicegate to increase the hydraulic capacity of the structure. A labyrinth spillway will be constructed in the place of the timber crib spillway with one new 10-foot wide sluicegate on the eastern bank. We will also increase the height of the two earthen embankments by about 1-foot, which will allow a maximum design head of 5-feet over the spillway, while still maintaining a 2-foot freeboard on the embankments.

With this 5-foot head condition the existing sluiceway is capable of passing 1,244 cfs. We will add one 12-foot wide sluicegate to the structure, with a bottom sill elevation of 800.0, or 2.15 feet below the existing sluiceway. This gate, with a 5-foot head over the spillway, will discharge 1,512 cfs.

The labyrinth spillway, with a center Ogee section, will replace the timber crib spillway and has a maximum discharge at a head of 5-feet of 11,245 cfs. The total dam capacity will then be 14,000 cfs.

STRUCTURAL STABILITY

Structural stability calculations have been developed for the proposed dam and are presented in Appendix B.

A soil exploration boring was put down on either end of the dam and the results are shown in Appendix C. The location is shown on Figure 3. These soil borings encountered very well consolidated sand, gravel and boulders at elevations in the area of the new foundations. This material probably overlays bedrock at a deeper elevation. This foundation material, with a blow count greater than 40, would have a bearing capacity in excess of 6 k/s.f..

The ice loading condition is taken as a design load of 5,000 pounds per foot.

The structure was designed for full uplift at the upstream edge. The sliding resistance calculations used the resistance of the toe walls and the friction factor of safety approach with no cohesion included.

The soil pressure from the new spillway on the soil foundation is very low in comparison to the carrying capability of this material. A weighted-Creep Ratio was calculated by the Lane method for seepage under the dam. The ratio of 3.8 arrived at is above the minimum (3.0) recommended by Lane for this material.

The dam was analyzed for the following four loading conditions taken from the New York State Department of Environmental Conservation Guidelines for small dams.

TABLE 1
Design Conditions

Loading Condition	Loading Description	Required Factor of Safety for Sliding	Required Factor of Safety for Overturning*
Case I	Normal pool water level 806.0	1.5	Within mid-1/3 base
Case II	Water @ 805.5 plus ice load	1.25	Within mid-1/2 base
Case III	Inflow Design Flood at level 810.7	1.25	Within mid-1/2 base
Case IV	Normal pool level plus earthquake	1.0	Within base

*Location of resultant of all loads

The proposed improvement meets all of the safety factors for the four conditions shown above and are as presented in the following Table.

TABLE 2
Stability Results

Case	Load	Sliding F.S.	Resultant Location *	Max. Foundation Pressure
I	Normal Pool	3.06	0.62b	369 psf
II	Ice Load	1.29	0.36b	418psf
III	IDF	1.76	0.45b	234 psf
IV	Earthquake	2.20	0.60b	342 psf

NOTE: * Location of resultant is measured from toe of the section and is in terms of the base width. b = 28.5

COST ESTIMATE

The following costs are estimated using projected 1999 construction costs. This estimate reflects the project as proposed herein. Engineering costs include a full-time representative during construction.

1. Cofferdams & Dewatering		L.S.	$100,000
2. Access Road & removal		L.S.	20,000
3. Excavation & removal	1,600 c.y.	$40	64,000
4. Backfill	400 c.y.	$20	8,000
5. Concrete	600 c.y.	$300	180,000
6. Riprap (on-site)	1,200 c.y.	$10	12,000
7. Lift gate (new & existing rehab)		L.S.	65,000
8. Embankment fill	650 c.y.	$25	16,250
9. Grouting		L.S.	18,000
10. Electric service, safety barrier, etc.		L.S.	5,000
11. Finish and seed		L.S.	12,000
			$500,250
		Contingency Allowance	70,250
		Estimated Construction Cost	$570,500
		Engineering fees, design and construction	$79,500
		Bonding Costs (Legal and Financial)	$20,000
		Estimated Total Project Cost	**$670,000**

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