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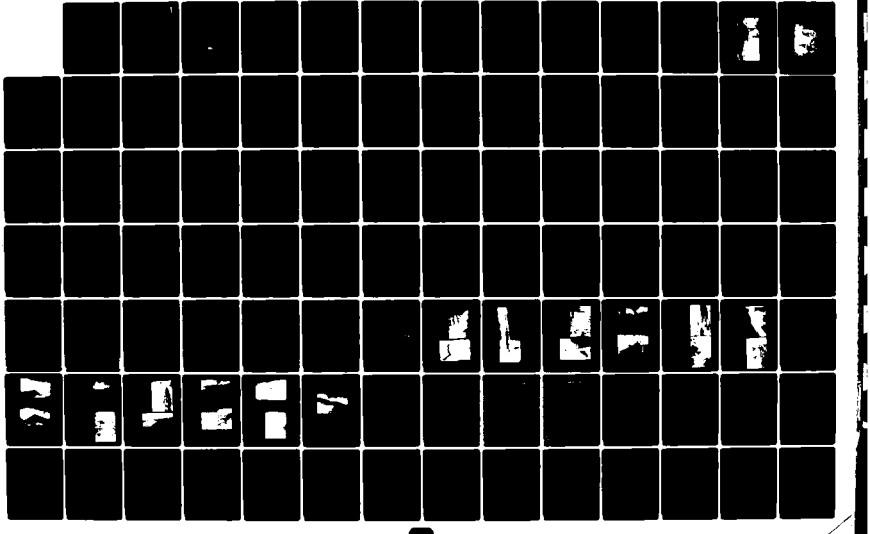

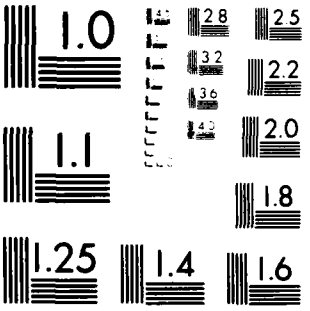

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NAUGATUCK RIVER BASIN

WATERTOWN & THOMASTON, CONNECTICUT

WIGWAM RESERVOIR DAM
CT 00615
WIGWAM RESERVOIR SOUTH DAM
CT 00676

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

MAY 1979

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

DAMS, INSPECTION, DAM SAFETY,

Naugatuck River Basin
Watertown & Thomaston, Connecticut

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Wigwam Reservoir Dam is a 390 foot cement rubble masonry dam and has a maximum height of 67 feet. The twp width of the dam is 13 feet. Wigwam Reservoir South Dam is another dam on the same reservoir as Wigwam. It is a 476 ft. long earth embankment dam and has a maximum height of 32 feet. The top width of the dam is 15 ft. The visual inspection indicated that the dam is in fair condition. Based on its intermediate size and low hazard classification the test flood is equal to ½ PMF.

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WIGWAM RESERVOIR DAM
CT 00615

WIGWAM RESERVOIR SOUTH DAM
CT 00676

NAUGATUCK RIVER BASIN
WATERTOWN AND THOMASTON, CONNECTICUT

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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NATIONAL DAM INSPECTION PROGRAM
PHASE I - INSPECTION REPORT
BRIEF ASSESSMENT

Identification No. and Name of Dam:	CT 00615 - Wigwam Reservoir Dam CT 00676 - Wigwam Reservoir South Dam
Town:	Watertown and Thomaston
County and State:	Litchfield, Connecticut
Stream:	Branch Brook
Date of Inspection:	December 5, 1978

Wigwam Reservoir Dam is a 390 foot cement rubble masonry dam and has a maximum height of 67 feet. The top width of the dam is 13 feet. The spillway is located on the left (north) side of the embankment. Engineering data available consisted of a drawing dated 1893 showing plan, elevation and sections of the dam. No construction specifications or design calculations were available.

Wigwam Reservoir South Dam is another dam on the same reservoir as Wigwam. It is a 476 foot long earth embankment dam and has a maximum height of 32 feet. The top width of the dam is 15 feet. The spillway is located on the left (north) side of the embankment. The dam has no gates. Engineering data available consisted of a drawing dated 1893. No construction specifications or design calculations were available.

The visual inspection of Wigwam Reservoir Dam indicated that the dam is in fair condition. The inspection revealed extensive tree growth has occurred adjacent to the downstream embankment toe. Water was observed flowing near the right (south) side of the south gate structure, near the downstream toe of the embankment that could be attributed to melt water. The inspection also revealed erosion up to 1 foot in depth at the intersection of the upstream face of the dam and the right (south) abutment as seen in Photo 1. Erosion up to 8 inches in depth was observed on the downstream toe of the dam near the right (south) abutment. Water was observed flowing through a joint in the masonry wall immediately downstream of the spillway crest on the left (north) side of the spillway weir as shown in Photo 6. The downstream spillway channel is overgrown with brush and trees up to 3 inches in diameter as may be seen in Photos 5, 7 and 10. The downstream channel is heavily treed and trees up to 15 inches in diameter are growing out of the vertical bedrock section of the south side of the outlet channel.

The visual inspection of Wigwam Reservoir South Dam indicated that the dam is in fair condition. The inspection revealed that a seepage area exists at the toe of the embankment approximately 125 feet right (south)of the spillway. A minor surficial bulge is located about 6 feet below the crest approximately 240 feet right (south) of the spillway. There is some erosion of the embankment adjacent to the spillway training wall. Also, the spillway contains numerous small trees up to 6 inches in diameter.

Based on its intermediate size and low hazard classification in accordance with the Corps guidelines, the test flood is equal to 1/2 Probable Maximum Flood. The test flood would overtop Wigwam by not more than 0.15 feet with 2.4 feet of freeboard remaining on Wigwam South Dam.

Based on the finding of the visual inspection and hydrologic and hydraulic analysis, there is no need for further engineering studies or for major alterations to Wigwam Dam. Provisions should be made by the owner to remove all trees and growth within 10 feet of the toe of the dam and in particular the large trees on the left (north) portion. Also, all trees and brush growing within the spillway channel and outlet channel should be removed.

Based on the findings of the visual inspection and hydrologic and hydraulic analysis, there is need for further engineering studies for Wigwam Reservoir South Dam. Provisions should be made by the owner to obtain appropriate corrective measures for the seepage that occurs at the toe of the embankment. Also, the spillway channel should be cleared of the trees and brush growing from the floor.

The recommendations and remedial measures are described in section 7 and should be addressed within one year after receipt of this Phase I Inspection Report by the owner.

Robert L. Jones, P.E.
Project Manager

Philip W. Genovese & Associates, Inc.
Hamden, Connecticut

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation and analyses involving topographic mapping, subsurface investigations, testing and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established guidelines, the Spillway Test Flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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U.S ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.	NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS	OVERVIEW PHOTO WIGWAM RES SOUTH DAM BRANCH BROOK WATERTOWN, CONN.
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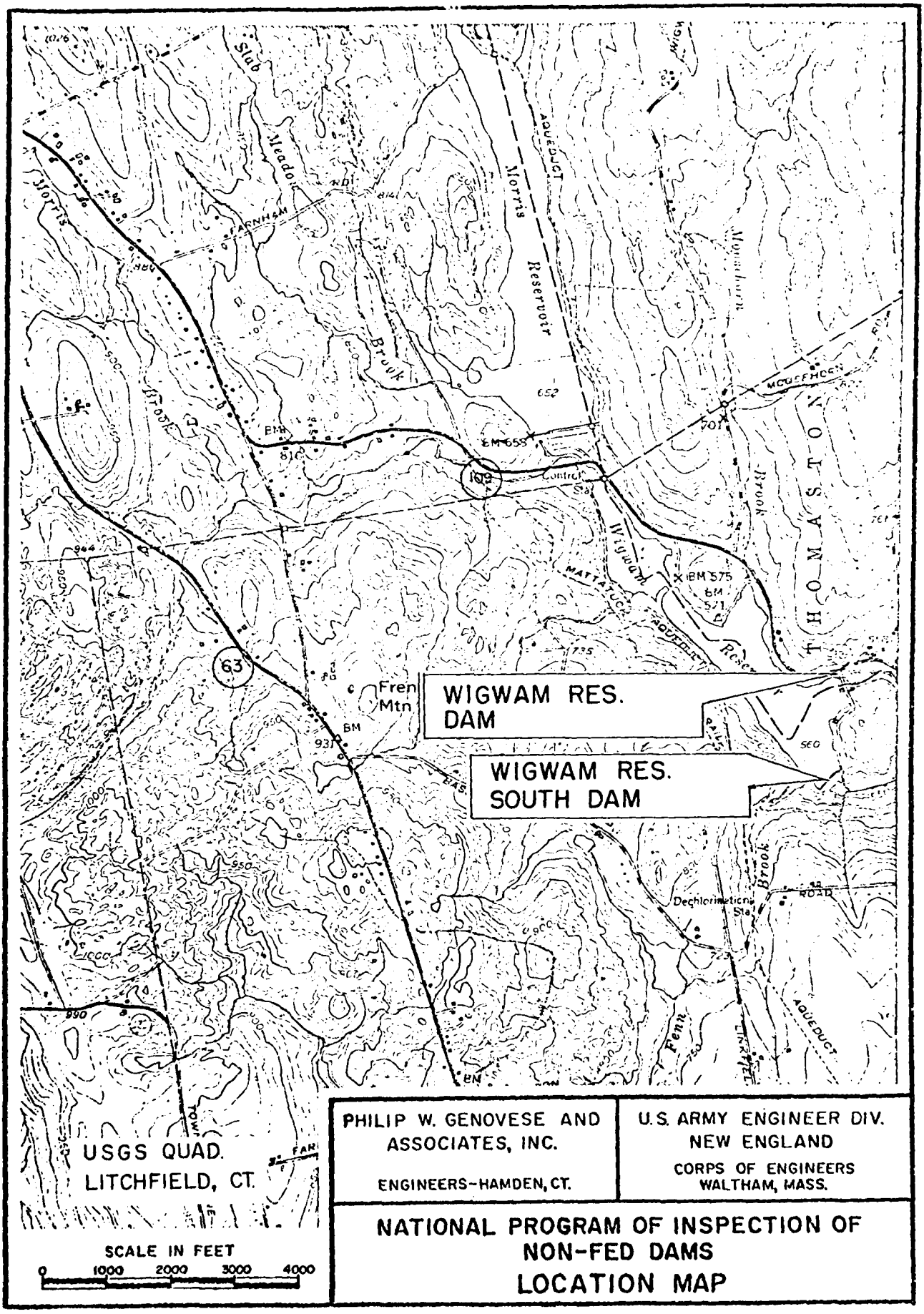

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NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

LOCATION MAP

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT

SECTION 1
PROJECT INFORMATION

1.1 General

a. Authority. Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Philip W. Genovese and Associates, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of Connecticut. Authorization and notice to proceed were issued to Philip W. Genovese and Associates, Inc., under a letter of November 28, 1978 from Max B. Scheider, Colonel, Corps of Engineers. Contract No. DACW33-79-C0019 has been assigned by the Corps of Engineers for this work.

b. Purpose.

(1) To perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.

(2) To encourage and prepare the states to initiate quickly effective dam safety programs for non-Federal dams.

(3) To update, verify and complete the National Inventory of Dams.

1.2 Description of Project

a. Location. Wigwam Reservoir Dam is located on Branch Brook in the Towns of Watertown and Thomaston, Connecticut. The dam is approximately 1.3 miles upstream from the Corps of Engineers' Black Rock Dam. The dam is shown on U.S.G.S. Quadrangle, Litchfield, Connecticut with coordinates approximately N41°-39.8', W 73°-07.7', Litchfield County, Connecticut. The location of the dam is shown on the Location Map immediately preceding this page.

Wigwam Reservoir South Dam is on Branch Brook in the Town of Watertown, Connecticut. The dam is approximately 1.3 miles

upstream from Corps of Engineers' Black Rock Dam. The dam is shown on U.S.G.S. Quadrangle, Litchfield, Connecticut with coordinates approximately N 41°- 39.6', W 73°-07.7', Litchfield County, Connecticut. The location of the dam is shown on the Location Map immediately preceding this page.

b. Description of Dam and Appurtenances. Wigwam Reservoir Dam consists of a cement rubble masonry section with a total length of approximately 390 feet. The spillway has three weirs with a total length of 46.5 feet and is located on the left (north) side of the dam. The top of the dam is 13 feet wide.

The maximum structural height, according to existing plans is 67 feet. The existing plans indicate that the dam is founded on bedrock.

The appurtenant structures consist of cement rubble masonry spillway, spillway channel and an outlet works structure. The spillway section consists of three weirs each 15.5 feet long with crest elevation of 560 feet.

The outlet works consist of an intake channel, a control tower containing six valves and downstream gatehouse. Of the six gates, four control intake and two control discharge from the gate chamber. Plans do not indicate the elevation of control valves. However, two blow-off pipes are shown at elevation 492.

Figure 1, located in Appendix B, shows the plan of the dam and it : appurtenant structures. Photographs of each structure are shown in Appendix C. Sketches of the dam and its appurtenances are in Appendix C.

Wigwam Reservoir South Dam consists of an earth embankment section approximately 476 feet long.

The maximum structural height, according to existing plans is 32 feet. The existing plan indicates that the north portion of the dam is founded on bedrock.

The appurentenant structures consist of a concrete spillway and a spillway channel. The spillway consists of a 60' section and 112' section with the longitudinal axis at a 45° angle. The concrete weir has four downstream steps on the 112' section and two downstream steps on the 60' section. The crest of the weir is at elevation 560 feet and has one-inch anchor bolts at 5 foot intervals. The only outlet is the spillway which has 4 foot high concrete training walls and a bedrock channel.

Figure 2, located in Appendix B, shows the plan of the dam and its appurtenant structures. Photographs of each structure are shown in Appendix C. Sketches of the dam and its appurtenances are in Appendix D.

c. Size Classification. Wigwam Reservoir Dam intermediate hydraulic height- 67 feet high, storage 2946 acre-feet) based on storage (≥1,000 to 50,000 acre-feet) as given in Recommended Guidelines for Safety Inspection of Dams.

Wigwam Reservoir South Dam intermediate (hydraulic height- 32 feet high, storage 3226 acre-feet) based on storage (≥1,000 to 50,000 acre-feet) as given in Recommended Guidelines for Safety Inspection of Dams.

d. Hazard Classification. The dams' potential for damage rates them as a low hazard classification. A classification of significance could have been selected and the test flood (1/2 PMF) would still be appropriate. A major breach could result in discharge downstream approximately 7000 feet through an uninhabited valley into the Corps of Engineers' Black Rock Dam. Black Rock has about 7000 acre-feet of storage compared to 3200 acre-feet for Wigwam Reservoir. No structures would be affected by a dam breach.

e. Ownership. These dams are owned by the City of Waterbury, 236 Grand Street, Waterbury, Connecticut.

f. Operator. These dams are maintained and operated by the City of Waterbury, Connecticut Bureau of Water. The Superintendent of Reservoirs is Mr. Leonard J. Assard, telephone 203-283-9139.

g. Purpose of Dam. These dams are used for water supply for the City of Waterbury.

h. Design and Construction History. Based on construction plans on file in the owner's office (City Engineer) the dams were constructed about 1893.

i. Normal Operating Procedure. All controls for the reservoir are located on Wigwam Dam. Wigwam South has no gates. No data was disclosed for maintenance of reservoir water levels. Under normal operation, the reservoir is kept full. Water may be drawn from the reservoir to the intake chamber and discharged to the downstream gatehouse and then to water supply. Water can also be discharged directly downstream through two blow-off pipes.

1.3 Pertinent Data

a. Drainage Area. The drainage area tributary to Wigwam Reservoir consists of approximately 17.28 square miles of mountainous terrain. In addition to the reservoir, 10 percent of the basin is made up of lake and swamp area. Elevations in the basin range from about 650 feet to 1150 feet MSL.

The reservoir consists of about 97 acres at the normal (top of spillway) pool elevation. No dwellings are located along the reservoir shores.

b. Discharge at Dam Site

(1) Outlet works for the reservoir are located on Wigwam Dam and consist of four lines to the intake chamber and two outlets to the downstream gatehouse. Water from the downstream gatehouse is discharged to Waterbury's water supply system. Water can be discharged directly downstream through two blow-off pipes.

(2) There are no records of maximum discharge at the dam site, however, on August 19, 1955, a depth of flow of 6.5 feet was measured at the crest of the Wigwam spillway. This would give a discharge of approximately 11,600 cfs when Wigwam and Wigwam South spillway capacities are combined.

(3) Wigwam Reservoir Dam spillway capacity with a water surface at the top of dam (elevation 567.1) would be approximately 13,132 cfs when both spillway capacities are combined.

Wigwam Reservoir South Dam spillway capacity with a water surface at the top of dam (elevation 569.6) would be approximately 25,255 cfs when both spillway capacities are combined and Wigwam Dam is overtopped by 2.5 feet.

(4) The spillways capacities with the water surface at the test flood elevation of 567.25 feet is approximately 13,320 cfs when both spillway capacities are combined.

(5) The total project discharge at the test flood elevation of 567.25 feet is 13,750 cfs.

c. Elevation (feet above MSL).

(1) Streambed at centerline of dam - Wigwam Reser- Dam 500.1, Wigwam Reservoir South Dam 537.6 .

(2) Maximum tailwater - N/A

(3) Upstream portal invert diversion tunnel - N/A

(4) Recreation pool - N/A

(5) Full flood control pool - N/A

(6) Spillway crest (permanent spillway) 560.0

(7) Design surcharge - unknown

(8) Top dam - Wigwam Reservoir Dam

567.1, Wigwam Reservoir South Dam 569.6.

(9) Test flood surcharge - 567.25

d. Reservoir (miles)

(1) Length of maximum pool - 1.2

(2) Length of recreational pool - N/A

(3) Length of flood control pool - N/A

e. Gross Storage (acre-feet)

(1) Recreation pool - N/A

(2) Flood control pool - N/A

(3) Spillway crest pool - 2166

(4) Top of dam - 2946

f. Reservoir Surface (acres)

(1) Recreation pool - N/A

(2) Flood control pool - N/A

(3) Spillway crest - 97

(4) Test flood pool - 115

(5) Top dam - 114

g. Dam

(1) Type - Wigwam Reservoir Dam - Cement Rubble Masonry -- Wigwam Reservoir South Dam - Earth Embankment.

(2) Length - Wigwam Reservoir Dam- 390 feet: Wigwam Reservoir South Dam- 476 feet.

(3) Height - Wigwam- 67; Wigwam South -32

(4) Top width- Wigwam- 13; Wigwam South-15

(5) Side slopes - Wigwam Upstream vertical; Downstream vertical at top, 8 horizontal on 11 vertical in lower portion. Wigwam South Upstream-2:1; Downstream 2:1 with 5' berm.

(6) Zoning - None

(7) Impervious core - Wigwam- N/A; Wigwam South Masonry corewall (elevation 532 to 563).

(8) Cutoff- Excavation to rock at approximately elevation 478 feet.

(9) Grout curtain - Unknown - both dams.

(10) Other- Wigwam - Unknown; Wigwam South "clay" at base of embankment. "Puddle wall" at upstream toe.

h. Diversion and Regulating Tunnel - None - both dams.

i. Spillway

(1) Type - Wigwam, cement rubble masonry with stone steps; Wigwam South, concrete with steps.

(2) Length of weir - Wigwam 46.5 feet (3 at 15.5 feet each) Wigwam South - 172 feet.

(3) Crest elevation - Wigwam 560 feet, (top of flashboards - 561 feet); Wigwam South - 560 feet.

(4) Gates - None - both dams.

(5) Upstream channel - None visible, both dams.

(6) Downstream channel - Wigwam - Cement rubble masonry block (steps) variable width and depth. Wigwam South - concrete steps with concrete training walls - four steps on 112 foot long section and two steps on 60 foot long section. Both sections are on bedrock.

j. Regulating Outlets - All controls are located on Wigwam Reservoir Dam. The reservoir can be drained by two 36 inch blow-off pipes set at approximately elevation 492 feet. These pipes are controlled by a valve, located in a downstream gatehouse. The four water supply intakes feed a service tower with two chambers. The intakes are controlled by gates. Two 30 inch outlet pipes are connected to a downstream gatehouse which contains a valve for each pipe. Below the downstream gatehouse the two pipes are joined at a "Y" connection to a 36" pipe which is connected to Waterbury's water supply system.

SECTION 2
ENGINEERING DATA

2.1 Design

These dams were constructed in about 1893 for water supply purposes. Plans dated 1893 as prepared by R.A. Cairns, City Engineer, City of Waterbury showing plan, elevation, typical sections and details are available at the office of the owner (City Engineer). No in-depth engineering data were found for these dams.

2.2 Construction

No construction records were available for use in evaluating the dams.

2.3 Operation

No engineering operational data were disclosed.

2.4 Evaluation

a. Availability. Other than the set of plans described above, no additional engineering data were found to be available.

b. Adequacy. The lack of in-depth engineering data did not allow for a definitive review. Therefore, the adequacy of these dams could not be assessed from the standpoint of reviewing design and construction data, but is based primarily on visual inspection, past performance history and sound engineering judgment.

c. Validity. The field investigation indicated that the external features of Wigwam Reservoir Dam and Wigwam Reservoir South Dam substantially agree with those on the available plans. One apparent change is in the spillways.

SECTION 3
VISUAL INSPECTION

3.1 Findings

a. General. The field inspection of Wigwam Reservoir Dam and Wigwam Reservoir South Dam was made on December 5, 1978. The inspection team consisted of personnel from Philip W. Genovese and Associates, Inc. and Geotechnical Engineers, Inc. Representatives of the City of Waterbury, Bureau of Water, were also present during portions of the inspection. Inspection checklists, completed during the visual inspection are included in Appendix A. At the time of the inspection of Wigwam Reservoir Dam the water level was approximately 0.14 feet above the permanent spillway elevation. No water was passing over the spillway because of flash boards. The upstream face of the dam could only be inspected above this water level.

At the time of the inspection of Wigwam Reservoir South Dam the water level was approximately 0.14 feet above the permanent spillway elevation and was passing over the spillway. The upstream face of the dam could only be inspected above this water level.

b. Dam. The Wigwam Reservoir Dam consists of a cement rubble masonry section about 390 feet long. The crest is at elevation 567.1 according to the design drawings.

According to the design drawings, the entire section is founded on bedrock. The appearance of bedrock outcrops at several locations downstream of the dam is consistent with the design drawings in this respect.

Extensive tree growth has occurred adjacent to the downstream toe of the left (north) portion of the embankment with trees ranging up to 2 feet in diameter as shown in photos 9 and 11. One three inch tree is growing out of the masonry wall near the downstream toe.

Water was observed flowing near the right (south) side of the right (south) downstream gatehouse near the toe of the embankment that is believed to be melt water.

Erosion up to 12 inches deep has occurred at the intersection of the upstream face of the dam with the right (south) abutment which is shown in photo 1. Also, erosion up to 8 inches deep has occurred at the downstream toe of the dam near the right (south) abutment.

There is limited information in the available design drawings as to whether the embankment section is founded on bedrock.

No seepage was observed at the downstream slope or downstream toe of the embankment.

The Wigwam Reservoir South Dam consists of an earth embankment section about 476 feet long. The crest is at elevation 570 according to the design drawings.

According to the design drawings, the left (north) portion is founded on bedrock. The appearance of bedrock outcrops in the spillway channel is consistent with the design drawings in this respect.

The embankment section is covered with grass and riprap up to elevation 565 feet on the upstream slope. No lateral or horizontal movement of the crest was observed.

An area of seepage was observed at the toe of the downstream slope approximately 125 feet right (south) of the spillway. The area is about 16 feet wide and extends from the toe to about 7 feet up the slope, as shown in photos 9 and 10.

A minor surficial bulge was observed about 6 feet below the crest on the downstream slope approximately 240 feet right (south) of the spillway.

Some slight erosion was observed at the contact with the spillway training wall.

Some brush was observed at the waterline of the upstream slope of the embankment.

There is limited information in the available design drawings as to whether the embankment section is founded on bedrock.

c. Appurtenant Structures. Wigwam Reservoir Dam - Visual inspection of the cement rubble masonry spillway, spillway channel and outlet works did not reveal any evidence of stability problems. The spillway surface and construction joints appeared to be in good condition although water was observed flowing through a joint in the left (north) wall of the weir as seen in Photo 6. The spillway channel is overgrown with brush and trees up to 3 inches in diameter.

The spillway structure, shown in Photos 3 and 6 consists of three weirs of cement rubble masonry with walls and flashboards. The spillway surface is in good condition.

The outlet works consist of an intake service chamber containing 6 control gates and a downstream gatehouse containing 2 gates. As

the intake structure was below water, it was not inspected. Of the 6 gates located in the gate chamber, 4 control intake and 2 control outlet. The intakes are located at elevations 450, 469, 490 and 513. The discharge conduits are located at elevation 445. As all gates were below water in the gate chamber, they could not be inspected. However, all parts of the gate chamber that could be inspected appeared to be in good condition. All gates are reported to be operable.

The spillway discharge channel is generally in good condition except for the overgrowth of brush and trees.

Wigwam Reservoir South Dam - Visual inspection of the concrete spillway and spillway channel did not reveal any evidence of stability problems. The concrete surface and construction joints appeared to be in good condition.

The spillway structure, shown in Photos 4 and 8 consists of a concrete weir with steps and training walls. The concrete spillway surface is in good condition.

The spillway discharge channel is generally in good condition except for the tree growth in the floor of the channel.

d. Reservoir Area. The reservoir area has mountainous terrain, partially wood covered. A more detailed description of the drainage area is included in Section 1.3 of this report. There was no development observed along the shoreline.

e. Downstream Channel. Wigwam Reservoir Dam - Two blow-off pipes and the spillway discharge channel flow into the downstream channel. The right (south) side of the downstream channel is heavily treed in same areas.

Wigwam Reservoir South Dam - Thespillway discharge channel becomes the downstream channel which flows into Branch Brook. The downstream channel is bedrock as shown in Photo 4.

3.2 Evaluation

Wigwam Reservoir Dam - Visual examination indicates that the dam is in fair condition. No seepage was observed from the foundation or abutments of the dam. The inspection revealed the following:

a. Extensive tree growth adjacent to the downstream toe of the left (north) portion of the embankment and abutment with trees up to 2 feet in diameter and a 3 inch tree growing out of the masonry wall near the downstream toe.

b. Water flowing near the right (south) side of the right (south) downstream gatehouse near the downstream toe that is believed to be melt water.

c. Erosion up to 12 inches deep at the intersection of the upstream face of the dam with the right (south) abutment. Also, erosion up to 8 inches deep at the downstream toe near the right (south) abutment.

d. Water flowing through a joint in the left (north) wall of the spillway weir, downstream from the crest.

d. Overgrowth of the spillway channel with brush and trees up to 3 inches in diameter.

f. Heavy growth of trees up to 15 inches in diameter on the right (south) side of the downstream channel.

Wigwam Reservoir South Dam - Visual examination indicates that the dam is in fair condition. Seepage was observed from the embankment section of the dam. The inspection revealed the following:

a. Seepage at the toe of the downstream slope.

b. A minor surficial bulge on the downstream slope.

c. Slight erosion of the embankment at the spillway training wall.

d. Tree growth in the spillway channel and downstream channel.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedure

Wigwam Reservoir Dam and Wigwam Reservoir South Dam create an impoundment of the water which is used primarily as a water supply source for the City of Waterbury. The normal operational procedure is to draw water from the reservoir and pipe it approximately 7 miles to Waterbury. Water can also be discharged to the downstream channel through two blow-offs. All controls are located on Wigwam Reservoir Dam. Wigwam Reservoir South Dam has no outlet other than the spillway.

4.2 Maintenance of Dam

These dams are visited on a frequent basis by personnel of the City of Waterbury, Bureau of Water. These visits are primarily for surveillance of the reservoir for water quality control purposes. General maintenance is accomplished during these visits.

4.3 Maintenance of Operating Facilities

Maintenance on the operating facilities is done on a regular basis.

4.4 Description of Warning Systems

There are no warning systems in effect at this facility.

4.5 Evaluation

The current operating and maintenance procedures for these dams is to insure that all problems encountered can be remedied within a reasonable period of time. The owner should establish a written operation and maintenance proceedure as well as establishing a warning system to follow in event of flood flow conditions or imminent dam failure.

SECTION 5
HYDROLOGY AND HYDRAULIC ANALYSIS

Wigwam Reservoir has two dams, one known as Wigwam Reservoir Dam and the other Wigwam Reservoir South Dam. The top of Wigwam South Dam (an earthen structure) is 2.5 feet higher than Wigwam (a rubble masonry structure) which could probably be overtopped without severe damage.

Wigwam Reservoir Dam consists of a 390 foot long cement rubble masonry dam and a 46.5 feet long cement rubble masonry spillway. The maximum structural height of the dam is 67 feet. Appurtenant structures other than the spillway consist of a spillway channel, an outlet works, 2 blow-offs and 2 downstream gatehouses. The spillway crest is at elevation 560 feet without flashboards. The outlet works consists of an intake tower with two chambers and a downstream gatehouse. Intake conduits are located at elevations 450, 469, 490 and 513. Discharge conduits are at elevation 445.

Wigwam Reservoir Dam is classified as being intermediate in size having a maximum storage of 2946 acre-feet.

Wigwam Reservoir South Dam consists of a 476 foot long earth embankment dam and a 172 foot long concrete spillway. The maximum structural height of the dam is 32 feet. The only appurtenant structure is the spillway whose crest is at elevation 560 feet.

Wigwam Reservoir South Dam is classified as being intermediate in size having a maximum storage of 3226 acre-feet.

a. Design Data. No hydrologic or hydraulic design data were disclosed for these dams.

b. Experience Data. The maximum discharge at this dam site is unknown. The maximum observed condition was reported to be 6.5 feet over the spillways or about 11,600 cfs on August 19, 1955.

c. Visual Observations. No evidence of damage to any portion of the projects from overtopping was visible at the time of the inspection.

d. Test Flood Analysis. As no detailed design and operational information are available, hydrologic evaluation was performed using dam information gathered by field inspection, watershed size and an estimated test flood equal to 1/2 Probable Maximum Flood (PMF) as determined by guide curves issued by the Corps of Engineers. Based on a drainage area of 17.28 square miles, it was estimated that the test

flood flow at this dam would be 15, 120 cfs. Following the guidance for Estimating Effect of Surcharge Storage on Maximum Probable Discharges results in a test flood discharge of 13, 750 cfs. As the maximum spillway capacity at the top of Wigwam Reservoir Dam (elevation 567. 1 feet) is 13, 130 cfs, the test flood will overtop the dam by 0. 15 feet with 2. 4 feet of freeboard remaining at Wigwam Reservoir South Dam.

e. Dam Failure Analysis. The impact of failure of the dam at maximum pool (top of dam) was not assessed using the "Rule of Thumb" Guidance for Estimating Downstream Dam Failure Hydrographs issued by the Corps of Engineers.

Breaching the dams and running downstream with the resulting water profiles would not alter the classification because of the lack of habitation in the 7000 feet reach between the Wigwam Dams and Black Rock Dam.

Black Rock Dam has approximately 7000 acre-feet of storage compared to 3200 acre-feet of storage for Wigwam Reservoir to the top of the dams.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations. The visual examinations did not disclose any immediate stability problems. Routine maintenance should be sufficient to prevent any long-term problems.

b. Design and Construction Data. Design drawings are available for the dams. They include general information regarding the overall dimensions of the dams and their appurtenances. This information is not sufficient to assess the stability of the dams and the safety must be judged primarily from visual observations.

c. Operating Records. No operating records pertinent to the structural stability of the dams were available.

d. Post Construction Changes. Since original construction was completed in about 1893 no major changes have been added at the site. No changes have been made to the dams.

e. Seismic Stability. The dams are located in Seismic Zone 1, and in accordance with recommended Phase I guidelines does not warrant seismic analysis.

SECTION 7
ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition - Wigwam Reservoir Dam. The visual examination indicates that the dam is in fair condition. The inspection revealed:

1. Extensive tree growth adjacent to the downstream toe of the left (north) portion of the embankment and abutment with trees up to 2 feet in diameter.

2. Water flowing near the right (south) side of the right (south) downstream gatehouse near the downstream toe that is believed to be melt water.

3. Erosion up to 12 inches deep at the intersection of the upstream face of the dam with the right (south) abutment. Also, erosion up to 8 inches deep at the downstream toe near the right (south) abutment.

4. Water flowing through a joint in the left (north) wall of the spillway weir, downstream from the crest.

5. Overgrowth of the spillway channel with brush and trees up to 3 inches in diameter.

6. Heavy growth of trees up to 15 inches in diameter on the right (south) side of the downstream channel.

Wigwam Reservoir South Dam - The visual examination indicates that the dam is in fair condition. The inspection revealed:

1. An area of seepage at the toe of the downstream slope of the embankment approximately 125 feet right (south) of the spillway.

2. A minor surficial bulge on the downstream slope of the embankment approximately 240 feet right (south) of the spillway.

3. Slight erosion of the embankment adjacent to the spillway training wall.

4. Tree growth in the spillway channel and downstream channel.

5. Minor growth of brush at the water line on the upstream slope of the embankment.

b. Adequacy of Information. The lack of in-depth engineering data did not allow for a definitive review. Therefore, the adequacy of these dams could not be assessed from the standpoint of reviewing design and construction data, but is based primarily on visual inspection, past performance history and sound engineering judgment.

c. Urgency. These dams are in fair condition. The recommendations and remedial measures described in Sections 7.2 and 7.3 should be accomplished within one year after receipt of this Phase I Inspection Report by the owner.

d. Need for Additional Investigation. The findings of this inspection indicate that there is need for additional investigations for Wigwam Reservoir South Dam.

7.2 Recommendations

Based on the findings of the visual inspection and hydrologic and hydraulic analysis, there is need for further engineering studies of the dam. The owners should engage a professional engineer with knowledge in this field to design appropriate correction for the seepage at the toe of the downstream slope embankment of Wigwam Reservoir South Dam.

7.3 Remedial Measures

An operational procedure and formal warning system for emergency conditions should be established.

A biennial technical inspection program should be developed.

Wigwam Reservoir Dam

a. All trees and growth within 10 feet of the toe of the dam should be removed. Removal and backfill should be supervised by a professional engineer knowledgeable in the field.

b. Trees and brush within the spillway channel should be removed.

c. Trees growing out of the outlet channel should be removed.

d. The downstream toe of the embankment should be inspected to verify the assumption that flowing water observed during inspection was melt water.

e. Areas of erosion should be backfilled with well compacted suitable material.

f. Water flowing through the joint in the wall of the spillway should be prevented by repairing the joint.

Wigwam Reservoir South Dam.

a. Trees and brush in the spillway channel and downstream channel should be removed.

b. Brush on the upstream slope of the embankment should be removed.

7.4 Alternatives

There is no practical alternative to the recommendations in Section 7.2 and 7.3.

APPENDIX A

INSPECTION CHECKLIST

WIGWAM RESERVOIR DAM

WIGWAM RESERVOIR SOUTH DAM

VISUAL INSPECTION CHECKLIST
PARTY ORGANIZATION

PROJECT: WIGWAM RESERVOIR DAM DATE December 5, 1978

TIME 13:00

WEATHER Clear-40°-45°

W.S. ELEV. 560.14 U.S.

PARTY

1. Bob Jones	Party Chief	
2. Don Ballou	Hydrology/Hydraulics	
3. Karl Dalenberg	Geotechnical	
4. Dick Murdock	"	
5. Leonard Assard	Owner's Rep.	

	PROJECT FEATURE	INSPECTED BY	REMARKS
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PERIODIC INSPECTION CHECKLIST

PROJECT: WIGWAM RESERVOIR DAM DATE December 5, 1978

PROJECT FEATURE Cement Rubble Masonry Dam Embankment NAME

DISCIPLINE NAME

	AREA EVALUATED	CONDITION
	DAM POINTED MASONRY	
DB	Crest Elevation	567.10' USGS
DB	Current Pool Elevation	560.14' USGS
BJ	Maximum Impoundment to Date	566.5' ±
GEI	Surface Cracks	Frequent cracks & occasional heave
GEI	Pavement Condition	of concrete road on crest
GEI	Movement or Settlement of Crest	None observed
GEI	Lateral Movement	None
GEI	Vertical Alignment	Good
GEI	Horizontal Alignment	Good
GEI	Condition at Abutment and at Concrete Structures	Right abutment, slight erosion along upstream contact from surface runof
GEI	Indications of Movement of Structural Items on Slopes	N/A
GEI	Trespassing on Slopes	None, vertical masonry walls
GEI	Sloughing or Erosion of Slopes or Abutments	None observed at abutments except as noted above
GEI	Rock Slope Protection- Riprap Failures	N/A
GEI	Unusual Movement or Cracking at or Near Toe	None observed
GEI	Unusual Embankment or Downstream Seepage	Slight seepage observed near gate control structure- may be surface runoff from melting snow.
GEI	Piping or Boils	None observed
GEI	Foundation Drainage Features	None
GEI	Toe Drains	None
GEI	Instrumentation System	None
GEI	Vegetation	Extensive tree growth adjacent to toe of slope

PERIODIC INSPECTION CHECKLIST

PROJECT: WIGWAM RESERVOIR DAM DATE December 5, 1978

PROJECT FEATURE Earthen Dam Embankment NAME

DISCIPLINE NAME

	AREA EVALUATED	CONDITION
	DIKE EMBANKMENT	
	Crest Elevation	N/A
	Current Pool Elevation	
	Maximum Impoundment to Date	
GEI	Surface Cracks	
GEI	Pavement Condition	
GEI	Movement or Settlement of Crest	
GEI	Lateral Movement	
GEI	Vertical Alignment	
GEI	Horizontal Alignment	
GEI	Condition at Abutment and at Concrete Structures	
GEI	Indications of Movement of Structural Items on Slopes	
GEI	Trespassing on Slopes	
GEI	Sloughing or Erosion of Slopes or Abutments	
GEI	Rock Slope Protection- Riprap Failures	
GEI	Unusual Movement or Cracking at or Near Toes	
GEI	Unusual Embankment or Downstream Seepage	
GEI	Piping or Boils	
GEI	Foundation Drainage Features	
GEI	Toe Drains	
GEI	Instrumentation System	
GEI	Vegetation	

PERIODIC INSPECTION CHECKLIST

PROJECT: WIGWAM RESERVOIR DAM DATE December 5, 1978

PROJECT FEATURE Spillway-Approach Channel NAME

DISCIPLINE NAME

	AREA EVALUATED	CONDITION
	OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE	
	a. Approach Channel	Under water, not observable
GEI	Slope Conditions	
GEI	Bottom Conditions	
GEI	Rock Slides or Falls	
	Log Boom	
	Debris	
	Condition of Concrete Lining	
GEI	Drains or Weep Holes	
	b. Intake Structure	
	Condition of Concrete	
	Stop Logs and Slots	

PERIODIC INSPECTION CHECKLIST

PROJECT: WIGWAM RESERVOIR DAM DATE December 5, 1978

PROJECT FEATURE Outlet Works-Control Tower NAME

DISCIPLINE NAME

	AREA EVALUATED	CONDITION
	OUTLET WORKS - CONTROL TOWER	
	a. Concrete and Structural	
BJ	General Condition	Good
BJ	Condition of Joints	Good
BJ	Spalling	None observed
BJ	Visible Reinforcing	None observed
BJ	Rusting or Staining of Concrete	Some
BJ	Any Seepage or Efflorescence	None observed
BJ	Joint Alignment	Good
BJ	Unusual Seepage or Leaks in Gate Chamber	None
BJ	Cracks	None
BJ	Rusting or Corrosion of Steel	None
	b. Mechanical and Electrical	
	Air Vents	
	Float Wells	
	Crane Hoist	
	Elevator	
	Hydraulic System	
	Service Gates	
	Emergency Gates	
	Lightning Protection System	
	Emergency Power System	
	Wiring and Lighting System	

PERIODIC INSPECTION CHECKLIST

PROJECT: WIGWAM RESERVOIR DAM DATE December 5, 1978

PROJECT FEATURE NAME

DISCIPLINE NAME

AREA EVALUATED	CONDITION
OUTLET WORKS- TRANSITION AND CONDUIT	
General Condition of Concrete	
Rust or Staining on Concrete	
Spalling	
Erosion or Cavitation	
Cracking	
Alignment of Monoliths	
Alignment of Joints	
Numbering of Monoliths	

PERIODIC INSPECTION CHECKLIST

PROJECT: WIGWAM RESERVOIR DAM DATE December 5, 1978

PROJECT FEATURE Outlet Works-Channel Structure NAME

DISCIPLINE NAME

	AREA EVALUATED	CONDITION
	OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	
	General Condition of Concrete	
BJ	Rust or Staining	Some
	Spalling	
	Erosion or Cavitation	
	Visible Reinforcing	
BJ	Any Seepage or Efflorescence	Some
BJ	Condition at Joints	Fair to good
GEI	Drain holes	None observed
GEI	Channel	Bedrock and riprap lined channel
GEI	Loose Rock or Trees Overhanging Channel	Many trees present adjacent to left side of channel
GEI	Condition of Discharge Channel	Fair, vegetation and some debris present.

PERIODIC INSPECTION CHECKLIST

PROJECT: WIGWAM RESERVOIR DAM . DATE December 5, 1978

PROJECT FEATURE Outlet Works - Spillway Channel NAME

DISCIPLINE NAME

	AREA EVALUATED	CONDITION
	OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
	a. Approach Channel	Under water-upstream face of dam
GEI	General Condition	
GEI	Loose Rock Overhanging Channel	
GEI	Trees Overhanging Channel	
GEI	Floor of Approach Channel	
	b. Weir and Training Walls	
BJ	General Condition of Concrete	Fair to good
BJ	Rust or Staining	Some
	Spalling	
	Any Visible Reinforcing	
BJ	Any Seepage or Efflorescence	Some
GEI	Drain Holes	None
	c. Discharge Channel	
GEI	General Condition	Fair
GEI	Loose Rock Overhanging Channel	Some present along left side
GEI	Trees Overhanging Channel	None
GEI	Floor of Channel	Very irregular bedrock surface
GEI	Other Obstructions	Considerable brush and debris, some rocks in channel.

PERIODIC INSPECTION CHECKLIST

PROJECT: WIGWAM RESERVOIR DAM DATE December 5, 1978

PROJECT FEATURE NAME

DISCIPLINE NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - SERVICE BRIDGE	
a. Super Structure	
Bearings	
Anchor Bolts	
Bridge Seat	
Longitudinal Members	
Underside of Deck	
Secondary Bracing	
Deck	
Drainage System	
Railings	
Expansion Joints	
Paint	
b. Abutment and Piers	
General Condition of Concrete	
Alignment of Abutment	
Approach to Bridge	
Condition of Seat and Backwall	

APPENDIX A

INSPECTION CHECKLIST

WIGWAM RESERVOIR SOUTH DAM

VISUAL INSPECTION CHECKLIST
PARTY ORGANIZATION

PROJECT WIGWAM RESERVOIR DAM

DATE December 5, 1978

TIME 1500

WEATHER Clear, 40°

W.S. ELEV. 566.14 U.S.

PARTY

1. Bob Jones	Party Chief	
2. Don Ballou	Hydraulics/Hydrology	
3. Karl Dalenberg	Geotechnical	
4. Dick Murdock	"	
5. Leonard Assard	Owner's Rep.	

	PROJECT FEATURE	INSPECTED BY	REMARKS
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PERIODIC INSPECTION CHECKLIST

PROJECT: WIGWAM RESERVOIR SOUTH DAM DATE December 5, 1978

PROJECT FEATURE Earthen Dam Embankment NAME

DISCIPLINE NAME

	AREA EVALUATED	CONDITION
	DAM EMBANKMENT	
BJ	Crest Elevation	569.6' USGS
BJ	Current Pool Elevation	560.14' USGS
BJ	Maximum Impoundment to Date	566.5' ±
GEI	Surface Cracks	None observed
GEI	Pavement Condition	Not paved, grass surface
GEI	Movement or Settlement of Crest	None observed
GEI	Lateral Movement	None
GEI	Vertical Alignment	Good
GEI	Horizontal Alignment	Good
GEI	Condition at Abutment and at Concrete Structures	Good
GEI	Indications of Movement of Structural Items on Slopes	N/A
GEI	Trespassing on Slopes	None, slopes well maintained
GEI	Sloughing or Erosion of Slopes or Abutments	Slight surface slough-downstream face, above reservoir water elevation
GEI	Rock Slope Protection- Riprap Failures	Very good - no failures
GEI	Unusual Movement or Cracking at or Near Toe	None observed
GEI BJ	Unusual Embankment or Downstream Seepage	Ground soft and soggy at base of toe 125' west of spillway
GEI	Piping or Boils	None
GEI	Foundation Drainage Features	None
GEI	Toe Drains	None
GEI	Instrumentation System	None
GEI	Vegetation	Slopes grassed-well maintained

PERIODIC INSPECTION CHECKLIST

PROJECT: WIGWAM RESERVOIR SOUTH DAM DATE December 5, 1978

PROJECT FEATURE Other Dam Embankment NAME

DISCIPLINE NAME

	AREA EVALUATED	CONDITION
	DIKE EMBANKMENT	
	Crest Elevation	N/A
	Current Pool Elevation	
	Maximum Impoundment to Date	
GEI	Surface Cracks	
GEI	Pavement Condition	
GEI	Movement or Settlement of Crest	
GEI	Lateral Movement	
GEI	Vertical Alignment	
GEI	Horizontal Alignment	
GEI	Condition at Abutment and at Concrete Structures	
GEI	Indications of Movement of Structural Items on Slopes	
GEI	Trespassing on Slopes	
GEI	Sloughing or Erosion of Slopes or Abutments	
GEI	Rock Slope Protection- Riprap Failures	
GEI	Unusual Movement or Cracking at or Near Toes	
GEI	Unusual Embankment or Downstream Seepage	
GEI	Piping or Boils	
GEI	Foundation Drainage Features	
GEI	Toe Drains	
GEI	Instrumentation System	
GEI	Vegetation	

PERIODIC INSPECTION CHECKLIST

PROJECT: WIGWAM RESERVOIR SOUTH DAM DATE December 4, 1978

PROJECT FEATURE Outlet Works NAME

DISCIPLINE NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE	
a. Approach Channel	None present
Slope Conditions	
Bottom Conditions	
Rock Slides or Falls	
Log Boom	
Debris	
Condition of Concrete Lining	
Drains or Weep Holes	
b. Intake Structure	
Condition of Concrete	
Stop Logs and Slots	

PERIODIC INSPECTION CHECKLIST

PROJECT: WIGWAM RESERVOIR SOUTH DAM DATE December 5, 1978

PROJECT FEATURE Outlet Works NAME

DISCIPLINE NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - CONTROL TOWER	
BJ a. Concrete and Structural	None
General Condition	
Condition of Joints	
Spalling	
Visible Reinforcing	
Rusting or Staining of Concrete	
Any Seepage or Efflorescence	
Joint Alignment	
Unusual Seepage or Leaks in Gate Chamber	
Cracks	
Rusting or Corrosion of Steel	
b. Mechanical and Electrical	
Air Vents	
Float Wells	
Crane Hoist	
Elevator	
Hydraulic System	
Service Gates	
Emergency Gates	
Lightning Protection System	
Emergency Power System	
Wiring and Lighting System	

PERIODIC INSPECTION CHECKLIST

PROJECT: WIGWAM RESERVOIR SOUTH DAM DATE December 5, 1978

PROJECT FEATURE Outlet Works NAME

DISCIPLINE NAME

	AREA EVALUATED	CONDITION
3J	OUTLET WORKS- TRANSITION AND CONDUIT	None
	General Condition of Concrete	
	Rust or Staining on Concrete	
	Spalling	
	Erosion or Cavitation	
	Cracking	
	Alignment of Monoliths	
	Alignment of Joints	
	Numbering of Monoliths	

PERIODIC INSPECTION CHECKLIST

PROJECT: WIGWAM RESERVOIR SOUTH DAM DATE December 5, 1978

PROJECT FEATURE Outlet Works NAME

DISCIPLINE NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	
General Condition of Concrete	None present
Rust or Staining	
Spalling	
Erosion or Cavitation	
Visible Reinforcing	
Any Seepage or Efflorescence	
Condition at Joints	
Drain Holes	
Channel	
Loose Rock or Trees Overhanging Channel	
Condition of Discharge Channel	

PERIODIC INSPECTION CHECKLIST

PROJECT: WIGWAM RESERVOIR SOUTH DAM DATE December 5, 1978

PROJECT FEATURE Outlet Works - Weir Channel NAME

DISCIPLINE NAME

	AREA EVALUATED	CONDITION
	OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
	a. Approach Channel	Underwater - not observable
GEI	General Condition	
GEI	Loose Rock Overhanging Channel	
GEI	Trees Overhanging Channel	
GEI	Floor of Approach Channel	
	b. Weir and Training Walls	
BJ	General Condition of Concrete	Good
BJ	Rust or Staining	None
BJ	Spalling	None
BJ	Any Visible Reinforcing	None
BJ	Any Seepage or Efflorescence	None
	Drain Holes	
	c. Discharge Channel	
	General Condition	Good
	Loose Rock Overhanging Channel	None observed
	Trees Overhanging Channel	None
	Floor of Channel	Irregular bedrock surface
	Other Obstructions	Minor vegetation in channel floor and few trees 1-2 inches, one tree @ 6" diameter

PERIODIC INSPECTION CHECKLIST

PROJECT: WIGWAM RESERVOIR SOUTH DAM DATE December 5, 1978

PROJECT FEATURE Outlet Works NAME

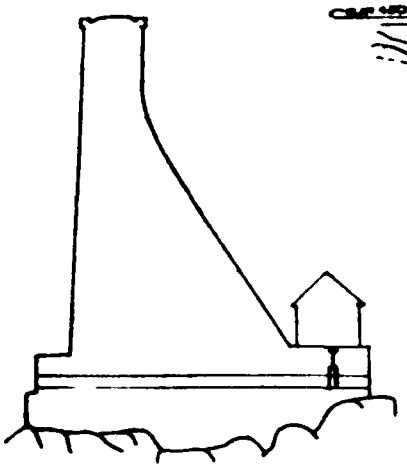
DISCIPLINE NAME

AREA EVALUATED	CONDITION
OUTLET WORKS- SERVICE BRIDGE	
a. Super Structure	None
Bearings	
Anchor Bolts	
Bridge Seat	
Longitudinal Members	
Underside of Deck	
Secondary Bracing	
Deck	
Drainage System	
Railings	
Expansion Joints	
Paint	
b. Abutment and Piers	
General Condition of Concrete	
Alignment of Abutment	
Approach to Bridge	
Condition of Seat and Backwall	

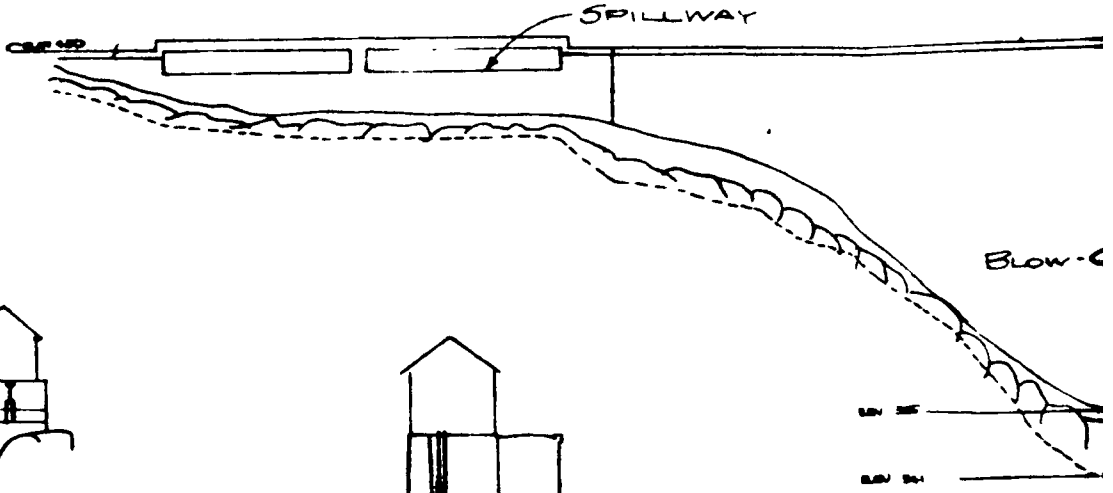
APPENDIX B

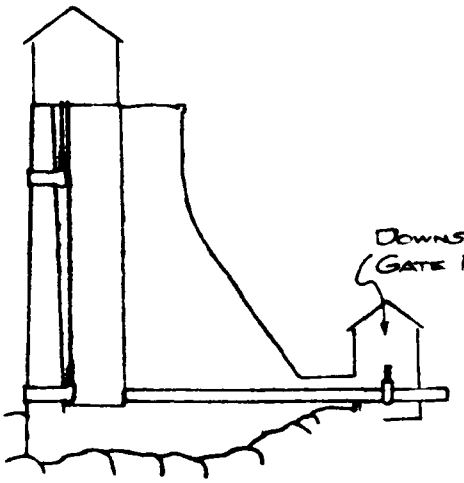
ENGINEERING DATA

CONTROL T

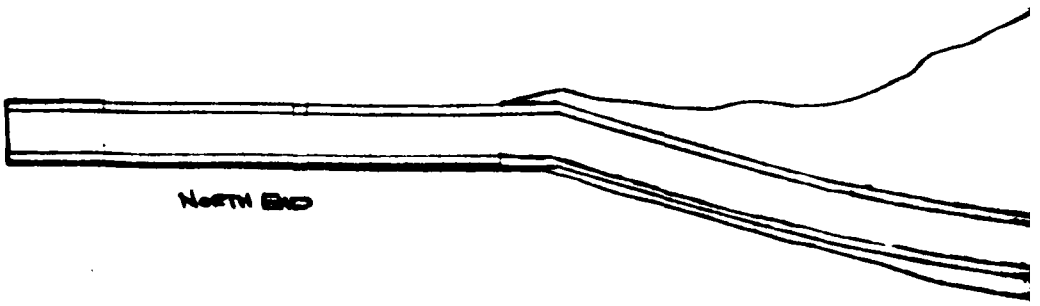


SECTION





SECTION THROUGH SOUTH CHAMBER

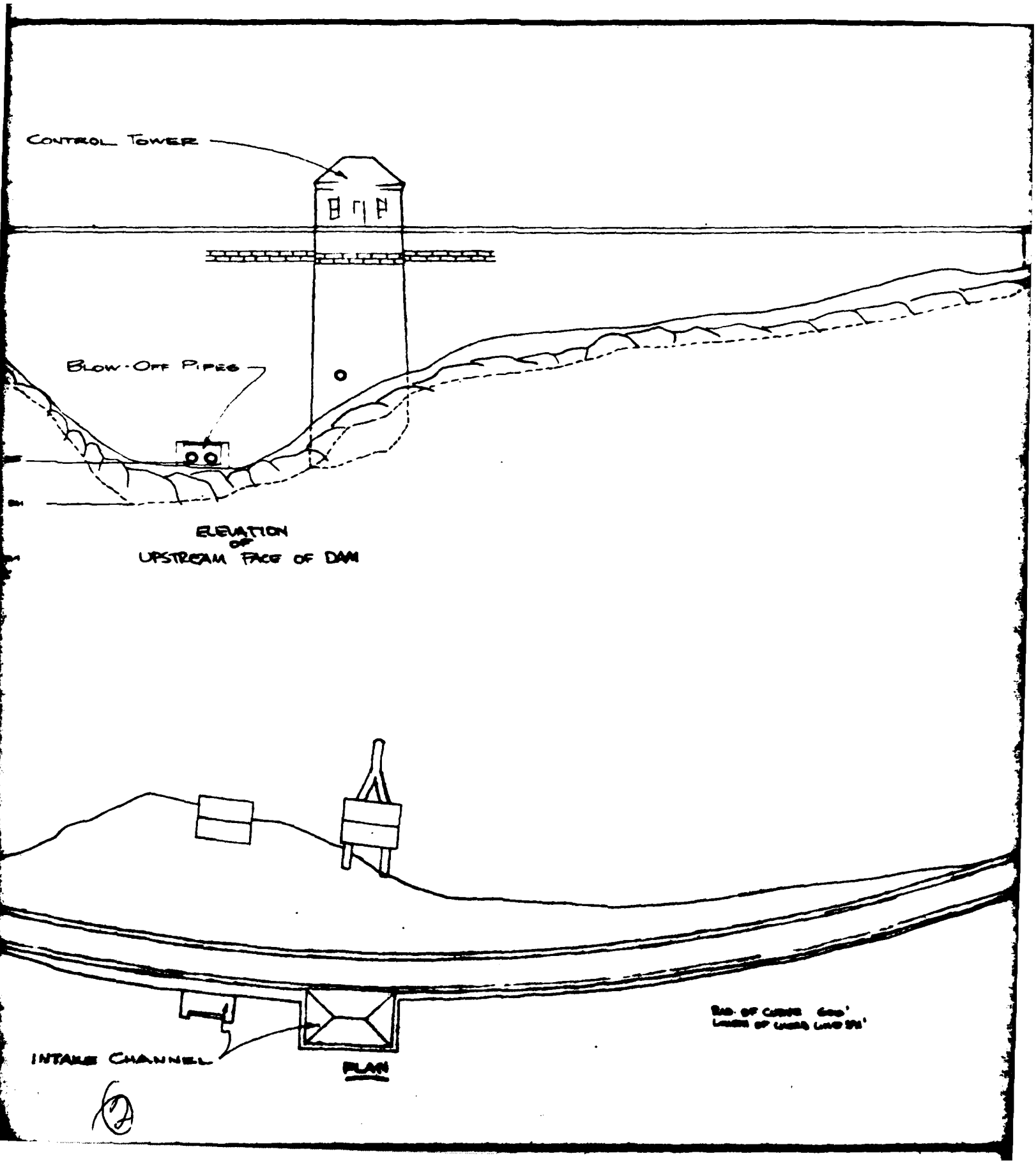


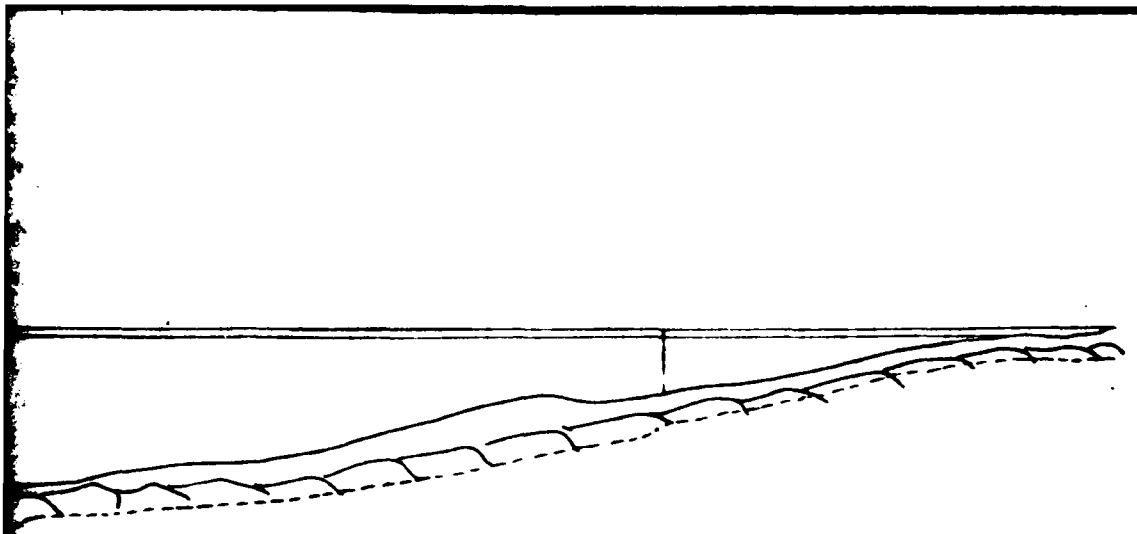
NORTH END

NOTES:
1. APPURTENANCES IDENTIFIED BY PHILIP W. GEHRINGER AND ASSOC., INC.
2. SPILLWAY IS INCORRECT. SEE SKETCH IN APPENDIX D.

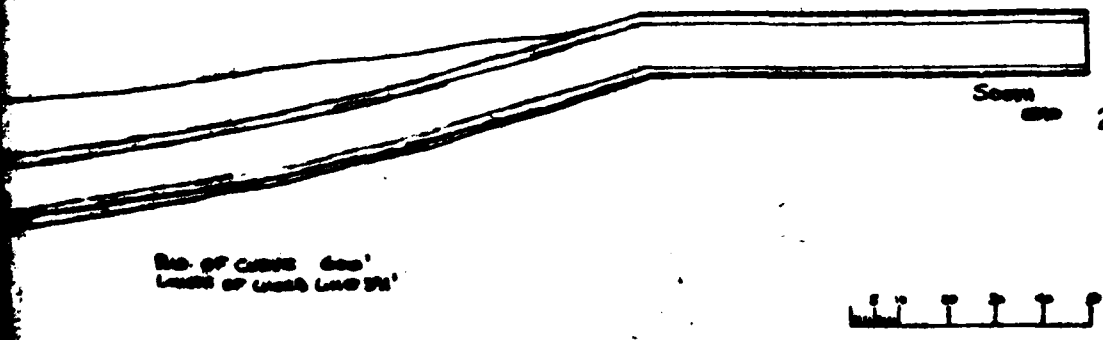
INTAKE

(1)


CONTROL TOWER
BLOW-OFF PIPES
ELEVATION
OF
UPSTREAM FACE OF DAM
INTAKE CHANNEL
PLAN



ADDITIONAL WATER SUPPLY
PLAN AND ELEVATION
OF
THE WIGWAM DAM
1893



NOTES:

1. TRACING OF DRAWING OBTAINED FROM OWNER
2. DATUM IS WATERBURY DATUM (MSL-137')

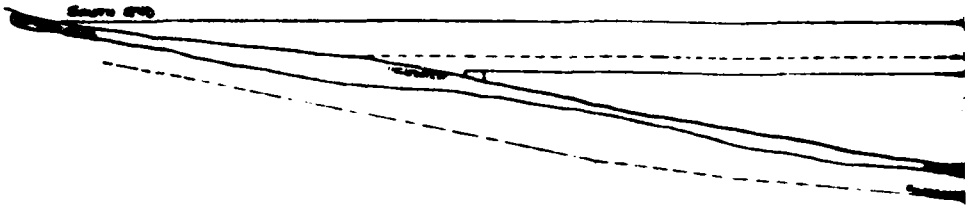
PHILIP W. GENOVESE & ASSOCIATES, INC. ENGINEERS HAMDEN, CONNECTICUT	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

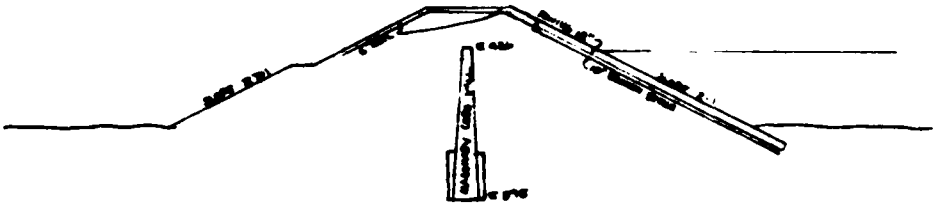
NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

WIGWAM RESERVOIR DAM

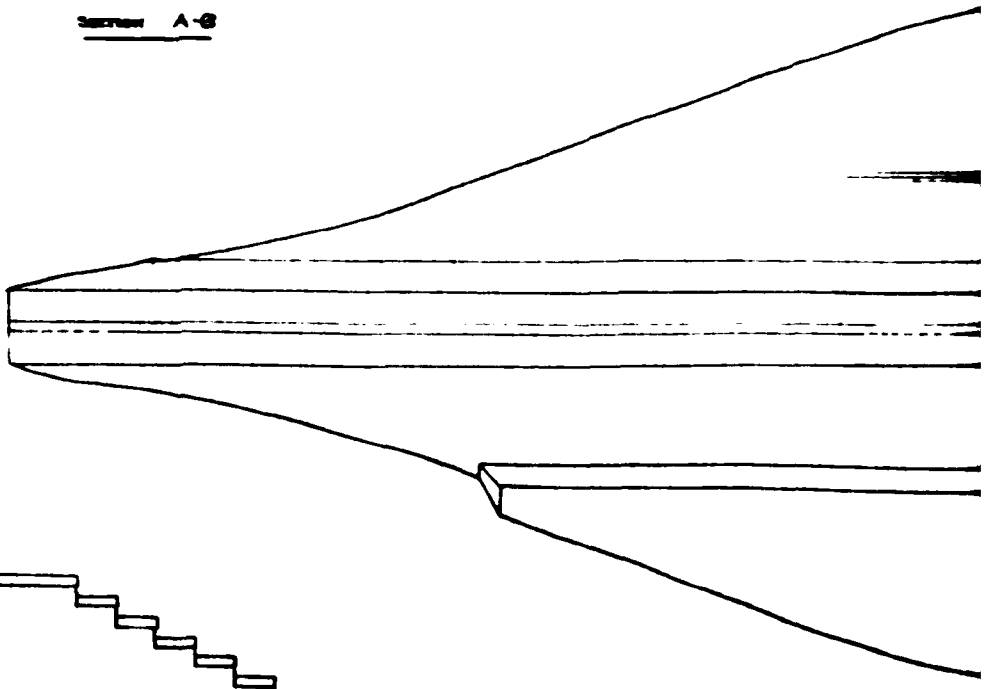
(3)

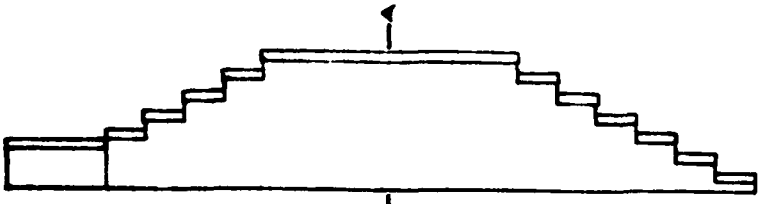
FIG. 1



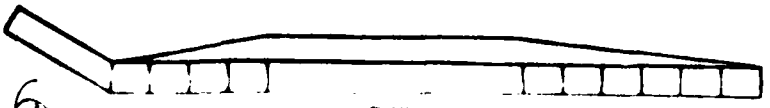


SECTION A-B



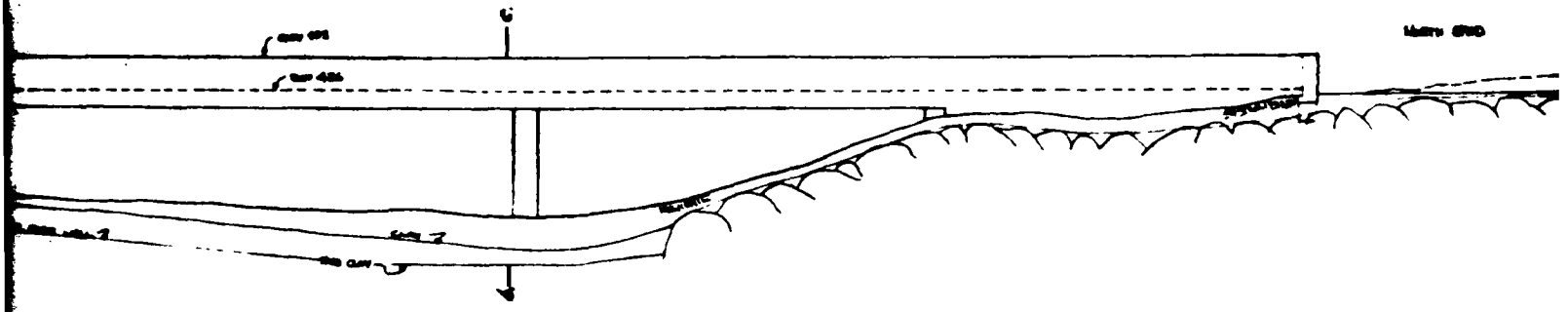


ELEVATION

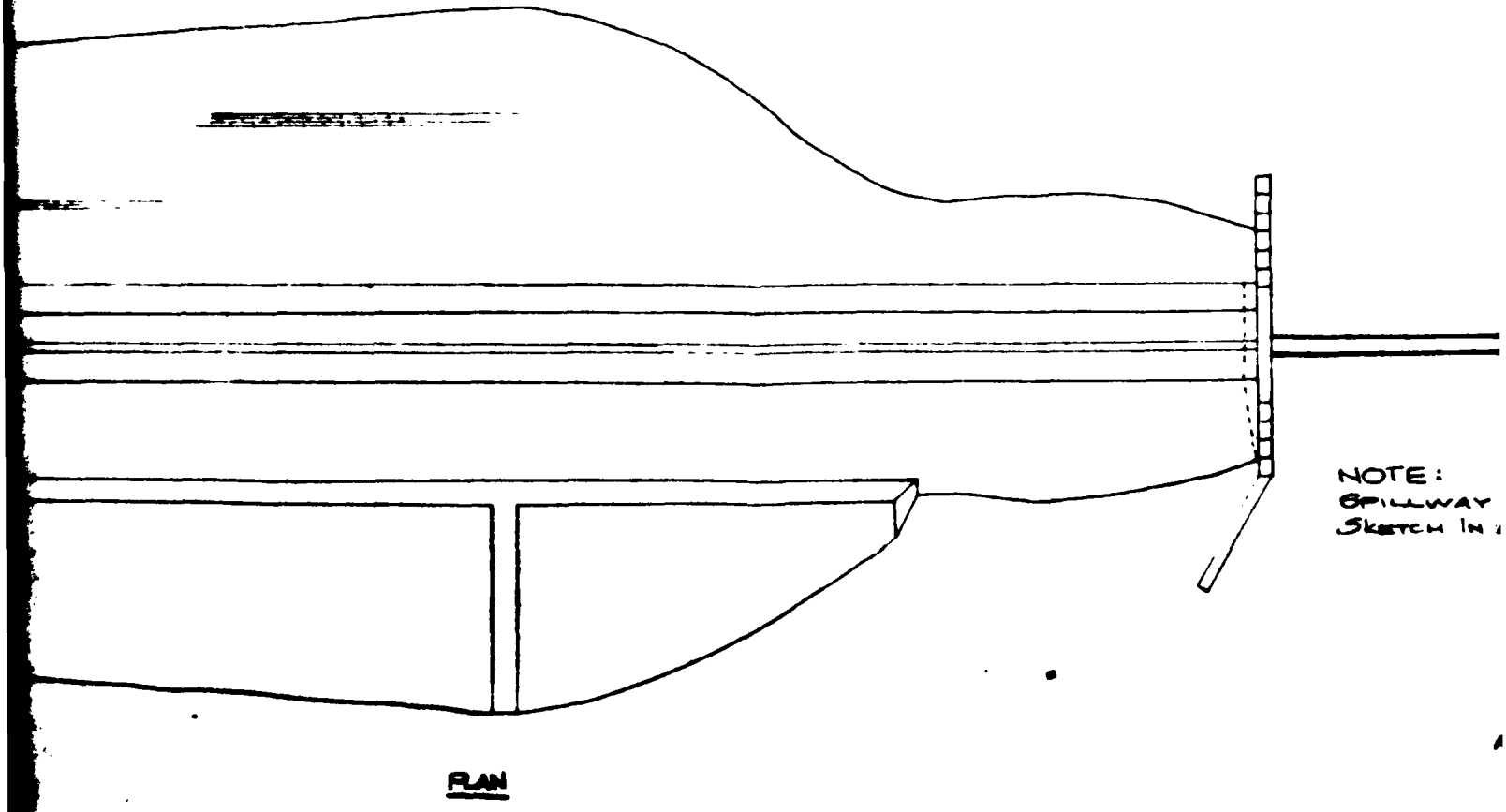


PLAN

HEAD WALL



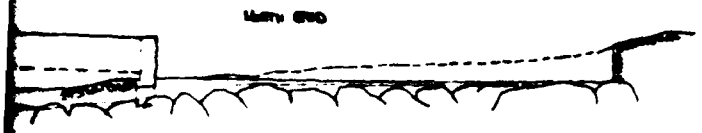
ELEV. OF DOWN STREAM FACE

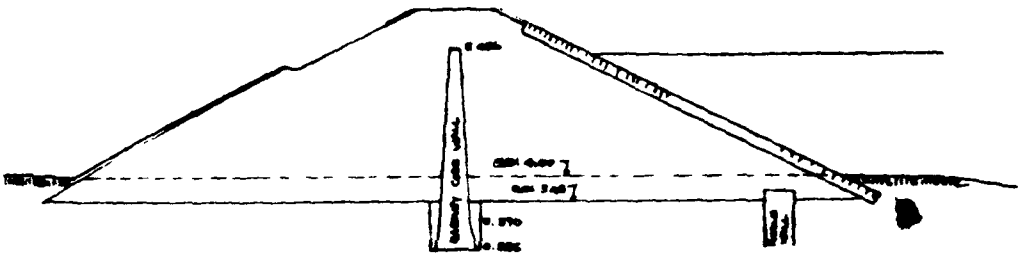


NOTE:
SPILLWAY
SKETCH IN

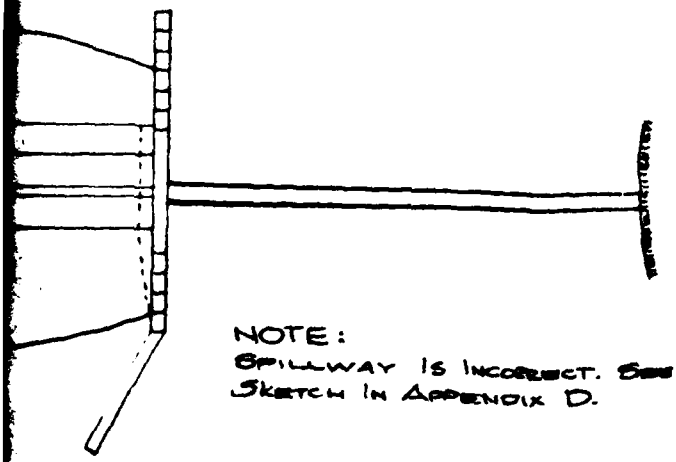
PLAN

(2)

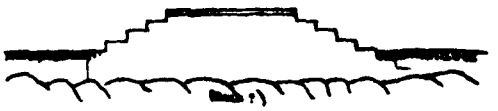




SECT. C-b.



NOTE:
SPILLWAY IS INCORRECT. SEE SKETCH IN APPENDIX D.



HEAD WALL

NOTES:
1. TRACING OF DRAWING OBTAINED FROM OWNER
2. DATUM IS WATERBURY DATUM (MSL-137')

ADDITIONAL WATER SUPPLY
PLAN, ELEVATION AND SECTIONS
OF
SOUTH DAM

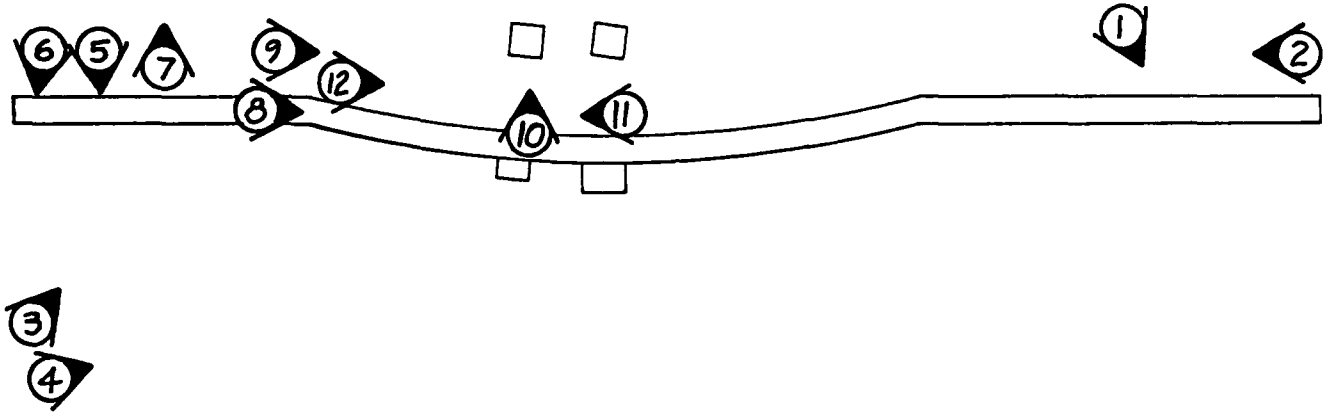
FIG. 1

PHILIP H. DEMOVENE & ASSOCIATES, INC. ENGINEERS HAMDEN, CONNECTICUT	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS
WIGWAM RESERVOIR
SOUTH DAM

APPENDIX C

PHOTOGRAPHS



LEGEND

④ NUMBER REFERS TO CAPTION. ARROW INDICATES DIRECTION OF PHOTOGRAPH.

PHILIP W. GENOVESE & ASSOCIATES, INC. ENGINEERS HAMDEN, CONNECTICUT	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORP OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

WIGWAM RESERVOIR DAM

DWN. BY	CKD BY	APP. BY	DATE	SCALE
MJS	NRS	RLJ	2/21/79	N.T.S.

PHOTO NO. 1
View of erosion adjacent to right (south) wingwall: erosion is approximately 12" deep.

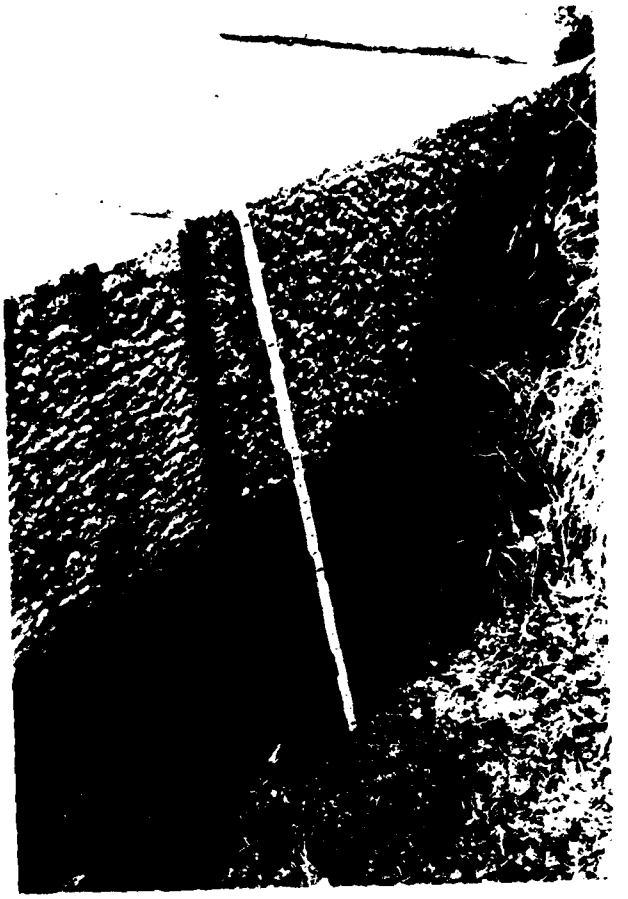


PHOTO NO. 2 - View along toe of dam looking left (north) from downstream of south abutment.

PHOTO'S NO. 3 and 4 - Panorama view (left to right) from north reservoir bank, looking toward spillway channel with flashboards.

PHOTO NO. 5
Left (north) portion
of spillway.

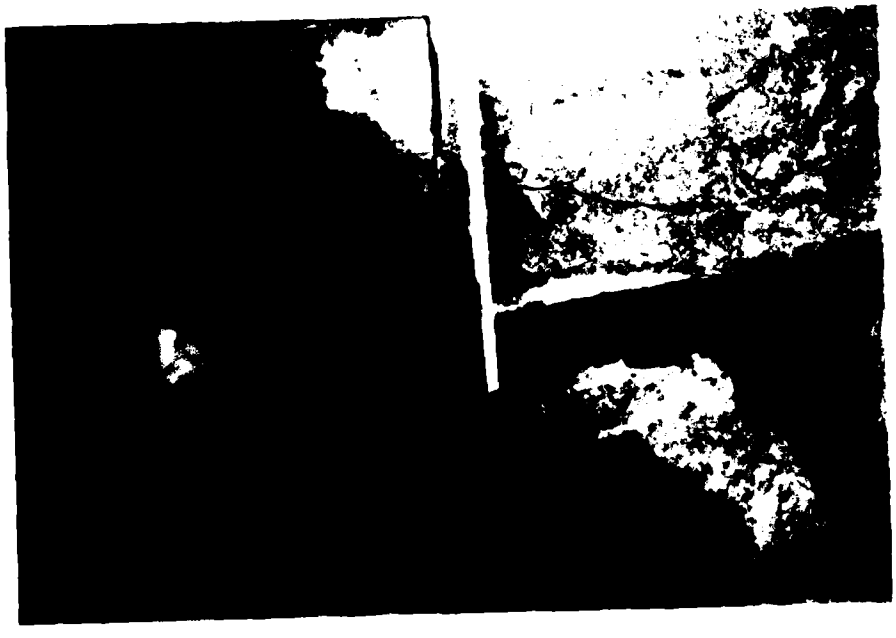


PHOTO NO. 6 - Leakage through joint on left (north) side approximately 18.5" below spillway crest.

PHOTO NO. 7 - View looking east along spillway channel from location approximately 8' downstream from spillway crest.

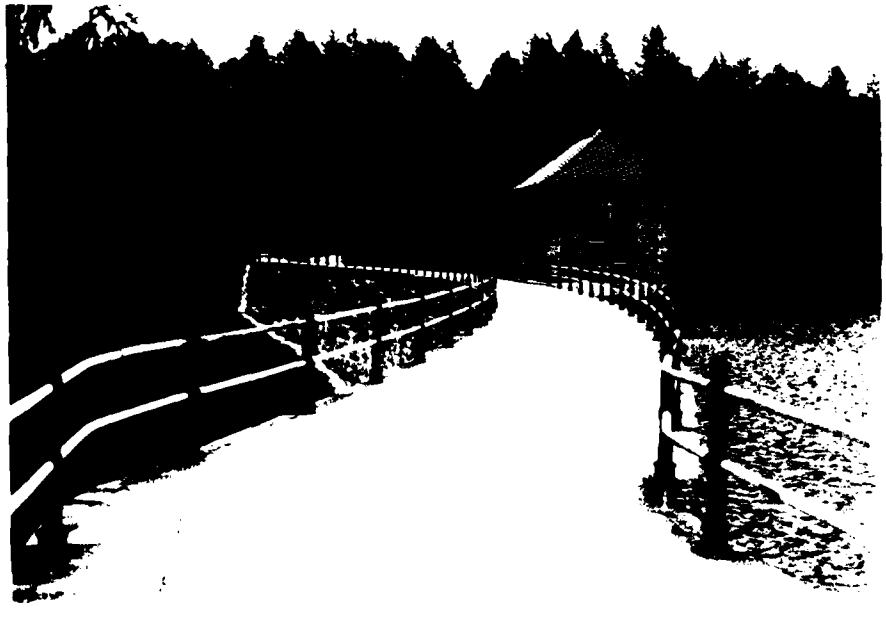


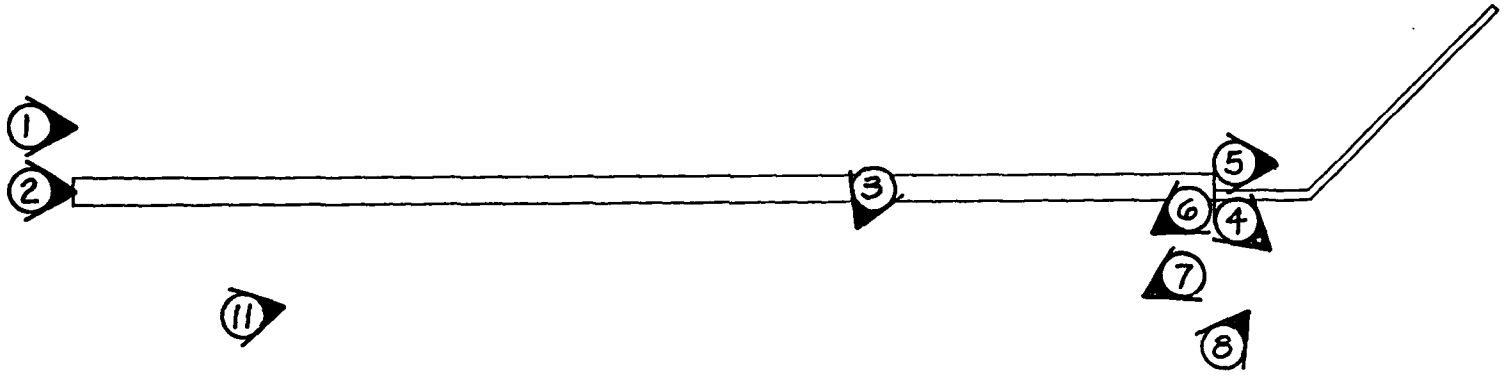
PHOTO NO. 8 - Looking along crest toward right (south) abutment.

PHOTO NO. 9
View along toe of slope toward right (south) abutment from left (north) side.

PHOTO NO. 10
View of downstream along outlet channel from left (north) chamber.

PHOTO NO. 11
Looking toward left (north) side of dam from crest at right (south) chamber.

PHOTO NO. 12
Looking toward right (south) side of dam from crest in area of spillway.



LEGEND

(4) NUMBER REFERS TO CAPTION. ARROW INDICATES DIRECTION OF PHOTOGRAPH.

PHILIP W. GENOVESE & ASSOCIATES, INC. ENGINEERS HAMDEN, CONNECTICUT	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORP OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

WIGWAM RESERVOIR SOUTH DAM

DWN. BY	CKD. BY	APP. BY	DATE	SCALE
MJS	NRS	RLJ	2/21/79	N.T.S.

PHOTO NO. 1 - Upstream face of dam from right (south) abutment.

PHOTO NO. 2 - Looking left (north) along crest of dam from area of right (south) abutment.

PHOTO NO. 3 - Looking along downstream face of dam from 100 feet right (south) of spillway. Apparent wet area near toe of slope, topographic suggestion of drainage channel.

PHOTO NO. 4 - Looking downstream at spillway channel from crest of dam at right (south) side of spillway.

PHOTO NO. 5
Looking left (north) across spillway weir from dam crest.

PHOTO NO. 6 - Looking at downstream slope from dam crest on right (south) side of spillway.

PHOTO NO. 7 - Looking toward right (south) abutment from toe of dam adjacent to spillway channel.

PHOTO NO. 8 - Looking upstream along right (south) side of spillway channel from toe of dam.

PHOTO NO. 9 - Area of seepage near toe of slope about 125 feet right (south) of spillway.

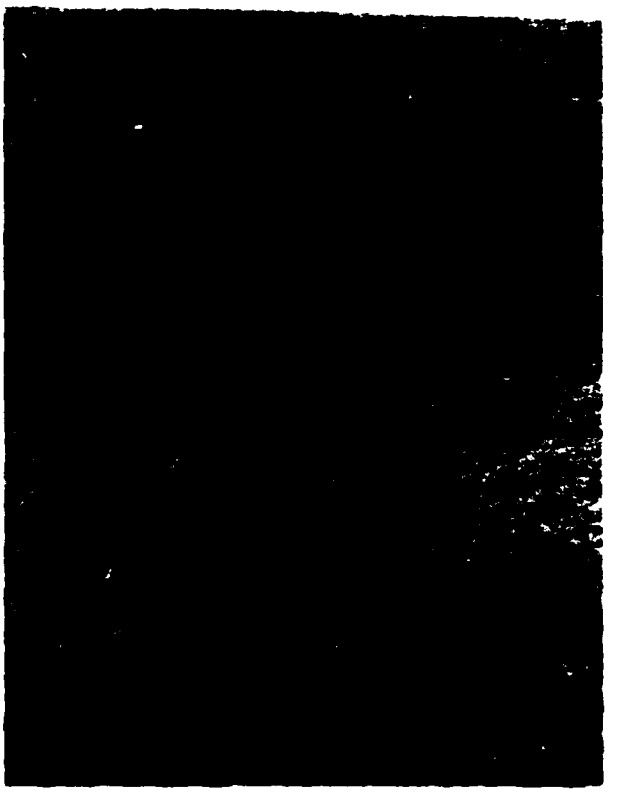
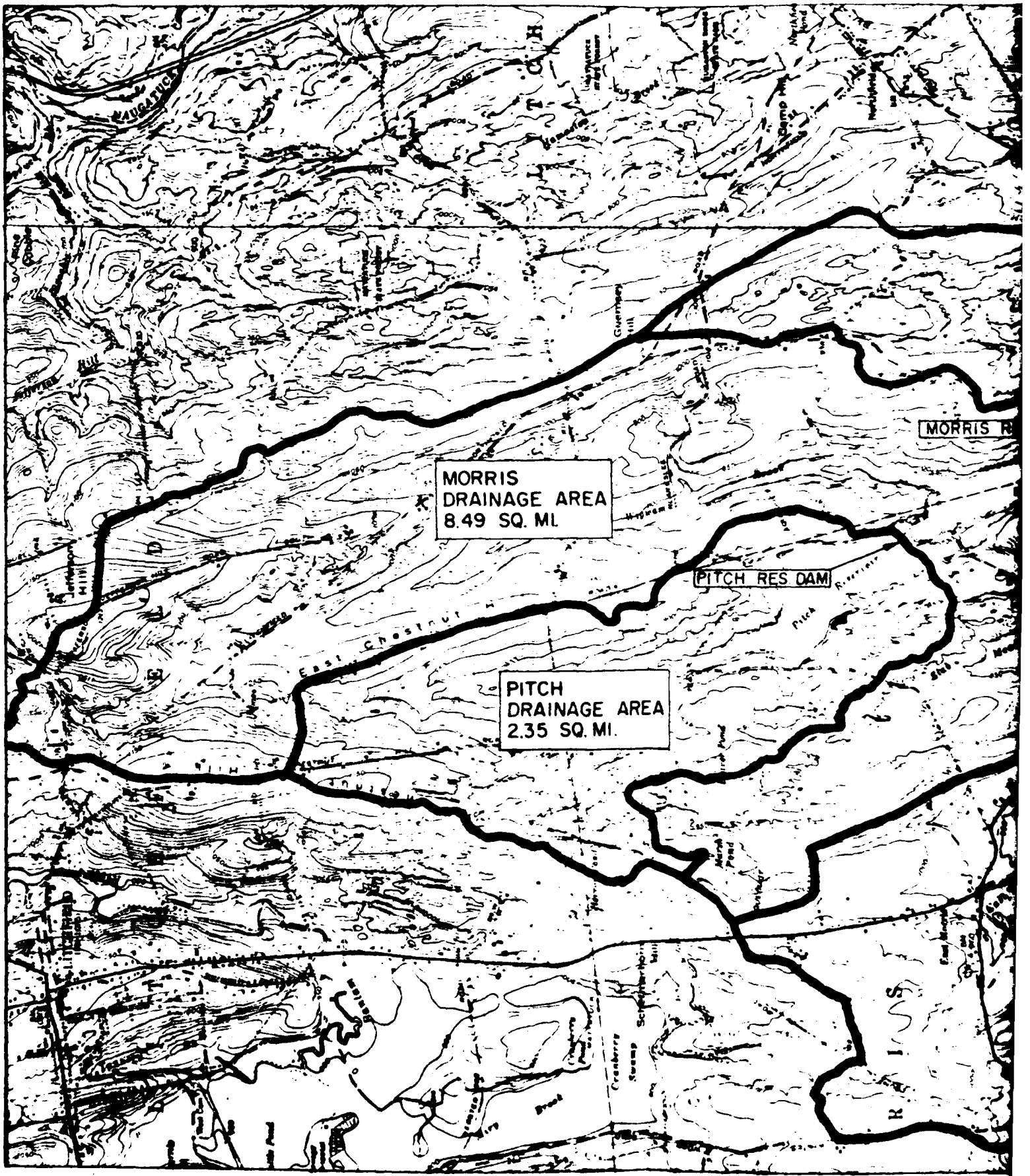


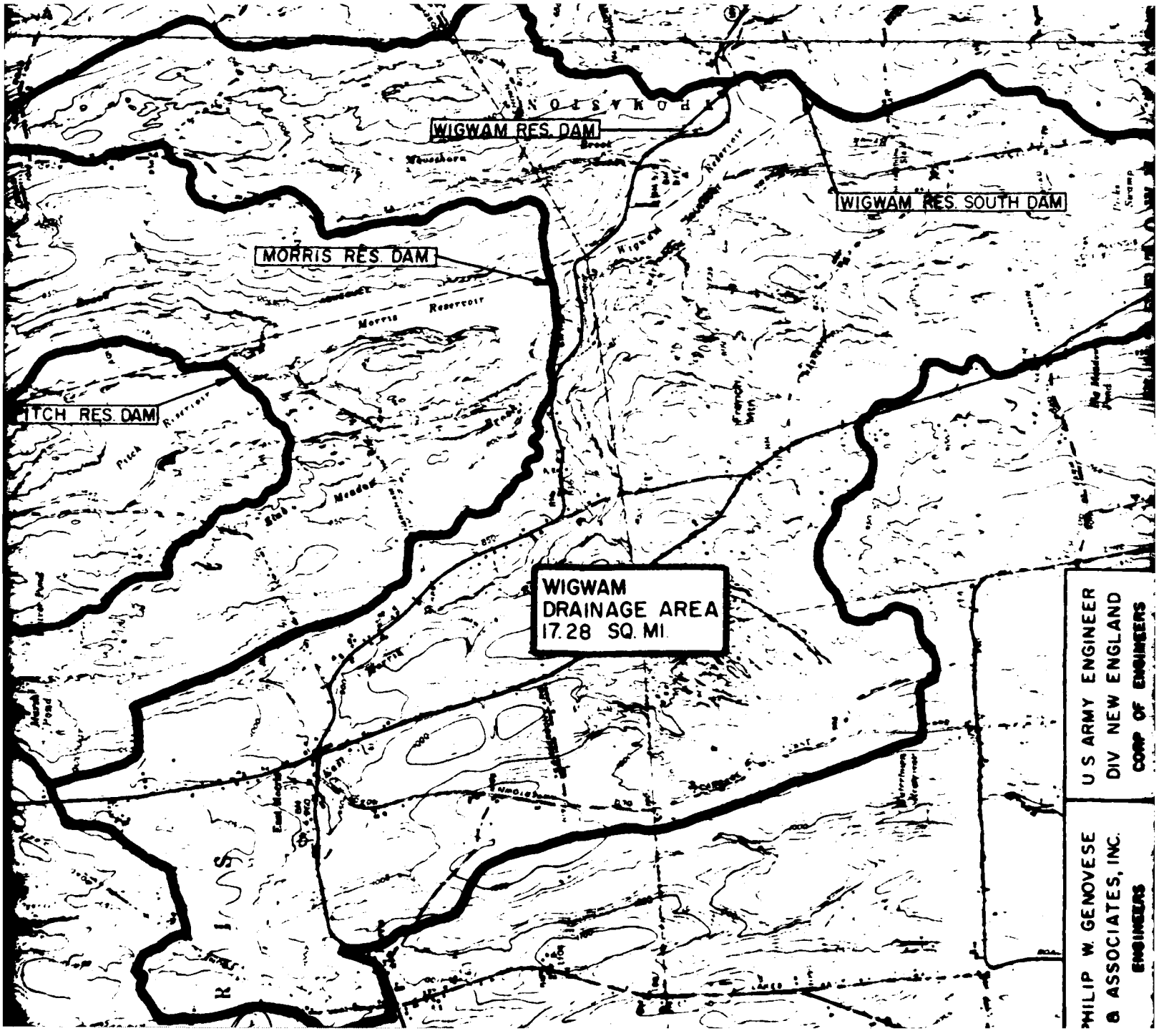
PHOTO NO. 10
Area of seepage in foreground, from approximately 50 ft. downstream from toe about 125 feet right (south) of spillway.

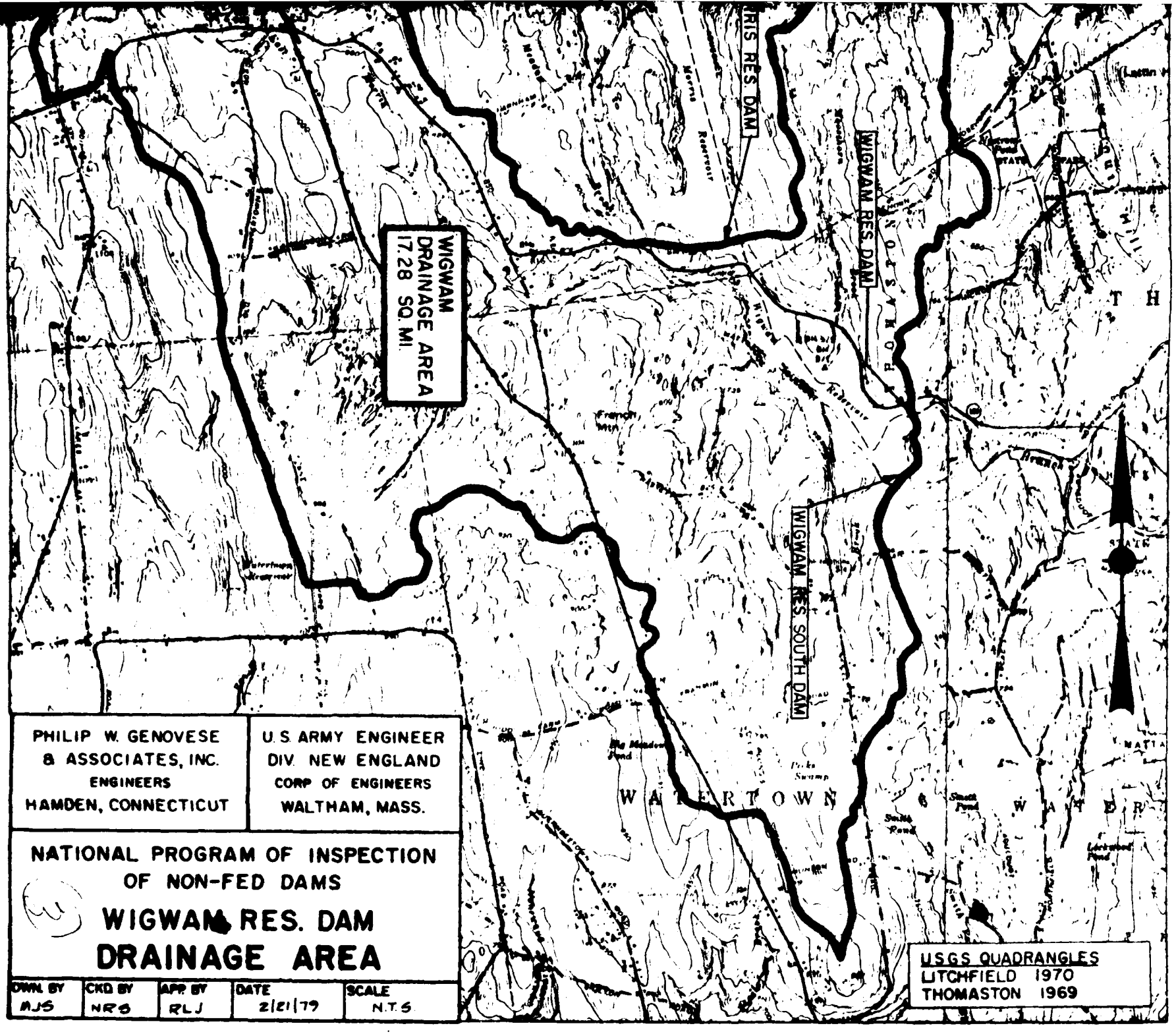
PHOTO NO. 11 - Looking along toe of dam toward left (north) abutment, from approximately 350 feet right (south) of spillway.

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS


MORRIS
DRAINAGE AREA
8.49 SQ. MI.
PITCH
DRAINAGE AREA
2.35 SQ. MI.
PITCH RES DAM
MORRIS R
WAUGATUCK
East Chestnut H


WIGWAM RES. DAM
WIGWAM RES. SOUTH DAM
MORRIS RES. DAM
ITCH RES. DAM
WIGWAM
DRAINAGE AREA
17.28 SQ. MI.
U S ARMY ENGINEER
DIV NEW ENGLAND
CORP OF ENGINEERS
PHILIP W. GENOVESE
& ASSOCIATES, INC.
ENGINEERS


WIGWAM DRAINAGE AREA 17.28 SQ. MI.
RIS RES. DAM
WIGWAM RES. DAM
NORFOLK
WIGWAM RES. SOUTH DAM
WATERTOWN
W A T E R
T H
PHILIP W. GENOVESE & ASSOCIATES, INC.
ENGINEERS
HAMDEN, CONNECTICUT
U.S. ARMY ENGINEER
DIV. NEW ENGLAND
CORP OF ENGINEERS
WALTHAM, MASS.
NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS
WIGWAM RES. DAM
DRAINAGE AREA
DWN. BY MJS
CKD. BY NRS
APP. BY RLJ
DATE 2/21/79
SCALE N.T.S
USGS QUADRANGLES
LITCHFIELD 1970
THOMASTON 1969

Name	Wiquam Dam	Wiquam South Dam
Location	Thomaston, Watertown, Ct	Watertown, Conn.
Drainage Area	11,059 Acres / 17.28 sq-mi	11,059 Acres / 17.28 sq-miles
Flow Line	Elev 560.0 (USGS)	Elev 560.0 (USGS)
Top of Dam	Elev 567.1	Elev 569.5
Height of Dam	67 Feet	32 Feet
Size	Intermediate	Intermediate
Hazard	Low	Low
Test Flood (T.F.)	½ PMF	½ PMF
T.F. Peak Discharge	15,120 cfs	15,120 cfs
T.F. Runoff	9.5 inches	9.5 inches
T.F. Volume	8,749 Ac-Ft	8,749 Ac-Ft
Available Spillway Storage	780 Ac-Ft No freeboard	1,050 Ac-Ft No freeboard
Q peak Out flow	2,250 cfs	11,500 cfs
Stage @ Q peak Outflow	Elev 567.25	Elev 567.25
Spillway Storage @ Q peak Outflow	795 Ac-Ft	795 Ac-Ft
Total Storage to Top of Dam	2946 Ac-Ft	3226 Ac-Ft

Wigwam Reservoir South Dam

Feb 1979
By: D T Ballou

Note: The hydraulics & hydrology have to be coordinated with Wigwam Reservoir Dam as both dams serve the same Reservoir

Evaluate the "size" & "hazard" classification

Size Classification

Top of Dam: Elev 569.6
Downstream low point Elev 537.6
Height of Dam = 32 Feet

Reservoir area @ flow line = 97 acres, The estimated volume below the spillway crest will be the same as derived for the Wigwam Res. Dam; i.e. ½ 97 x 67' = 2166 AC-Ft. Volume between flow line & top of dam = 1060 Ac-Ft which yields a total of 3226 AC-Ft

∴ From Table #1 of O.C.E. guides a size classification of Intermediate is recommended

Hazard Potential

Black Rock Dam is about 7000 feet downstream is appears intended for flood control. There appears to be no human habitation between Wigwam South Dam & Black Rock Dam, ∴ a classification of Low is recommended.

Wigwam Reservoir Dam

Feb 1979
By D. T. Ballou

Note: The hydraulics & hydrology will have to be run in conjunction with Wigwam Reservoir South Dam as both dams serve the same reservoir.

Evaluate the "size" & "hazard" classification in order to obtain the SDF (test storm)

Size classification

Top of Dam: Elev 567.1
Downstream Low Point: Elev 500.1
Height of Dam = 67 feet

Reservoir Area @ flow line = 97 acres
hence, estimated volume below the spillway crest $\cong \frac{1}{2}bh = \frac{1}{2} \times 97 \times 67 = 2166$ Ac-Ft

Volume between flow line & Top of Dam = 780 Ac-Ft, which yields a grand total of 2946 Ac-Ft

Finally, from table #1 of the O.C.E. guides a size classification of Intermediate is recommended.

Hazard Potential

Black Rock Dam lies about 7000 feet downstream and appears to be primarily for flood control. There appears to be no human habitation between Wigwam & Black Rock Dam, so a classification of Low will be selected

Wigwam Reservoir South Dam &
Wigwam Reservoir Dam

Feb 1979
By: D.T. Ballou

Spillway Design Storm (SDF) (Test Storm)

From table #3 of the O.C.E. guides, entering with "Low" & "Intermediate" we obtain a "SDF" of 100 year → ½ PMF.

Drainage Area = 17.28 square-miles

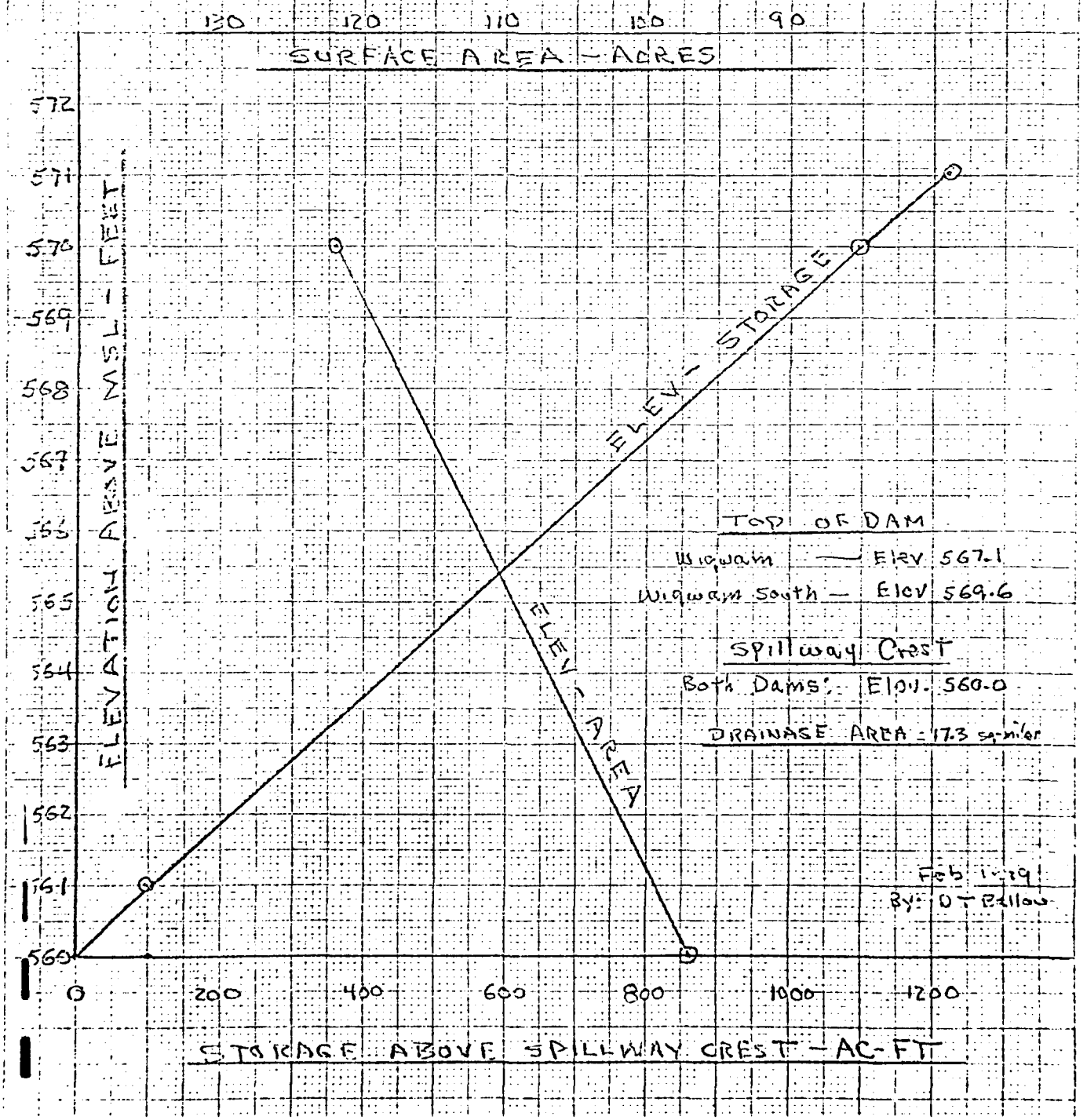
Using data furnished by the Corp of Engineers N.E.D. and a D.A. of 17.3 sq-mi we obtain 1750 cfs/mi for the PMF.
∴ use 1750/2 for ½ PMF.
and;

½ PMF = (1750/2)(17.28) = 15,120 cfs
and the 100 year storm is ≅ to ½(½ PMF), which yields 7,560 cfs

Use SDF = ½ PMF = 15,120 cfs

Volume of SDF = (53.3 AF/in/mi²)(17.28)(9.5") = 8,749 Ac-Ft

WIGWAM & WIGWAM SOUTH RESERVOIRS



TOP OF DAM

Wigwam — Elev 567.1

Wigwam South — Elev 569.6

Spillway Crest

Both Dams: Elev. 560.0

DRAINAGE AREA = 17.3 sq miles

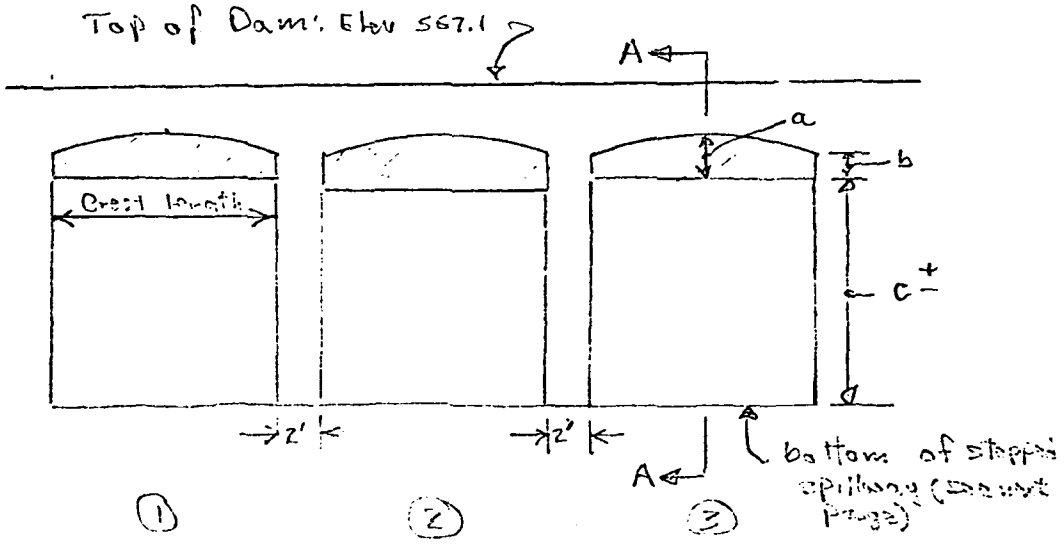
Feb 1979

By: DT Pillow

Feb 1979
By: D.T. Ballou

Wigwam Reservoir Dam

Service Spillway

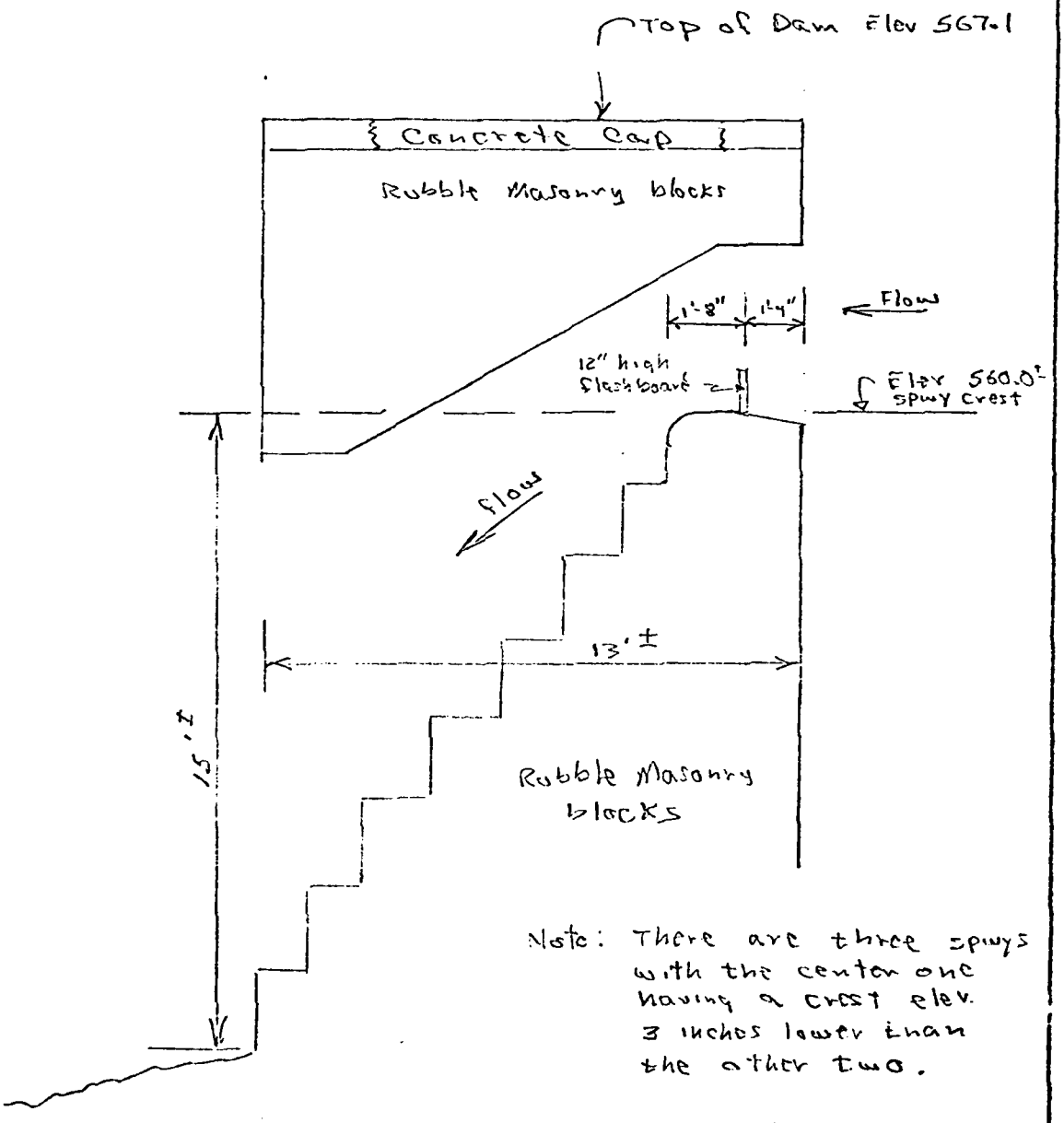


Elevation View
Looking upstream
N.T.S.

	1	2	3
Flow Area			
Flow Line Elev	560.0	559.75	560.0
Crest length	15.5'	15.5'	15.5'
"a"	4'-0½"	4'-3½"	4'-0½"
"b"	2'-0"	2'-3"	2'-0"
c'	15' ±	15' ±	15' ±

See next page for Section A-A

Wigwam Reservoir Dam
Service Spillway



Note: There are three spwys with the center one having a crest elev. 3 inches lower than the other two.

ELEVATION VIEW

SECTION A-A

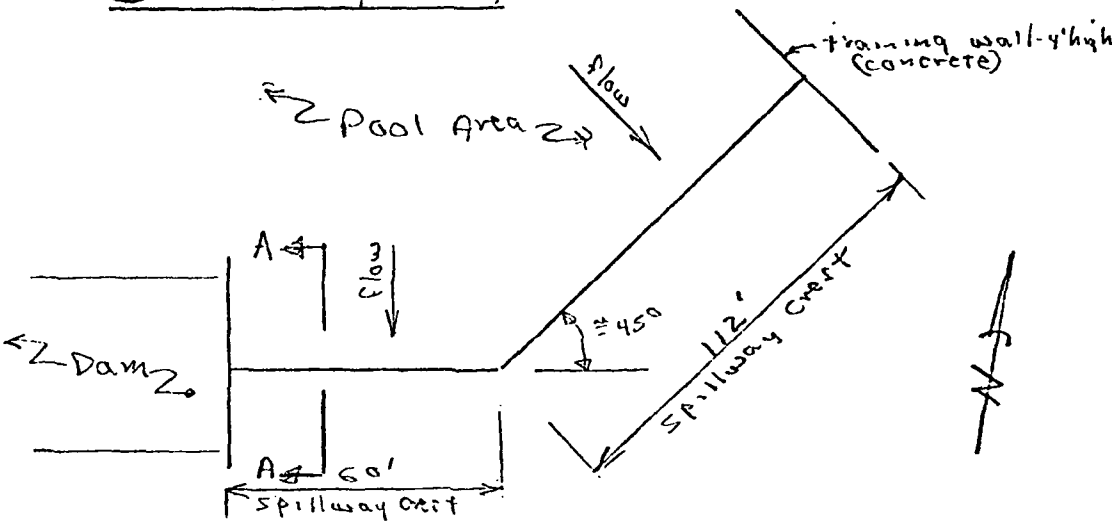
scale: 1/4" = 1'-0"

Note: See previous page for missing dimensions

Feb 1979
By: D.T. Ballou

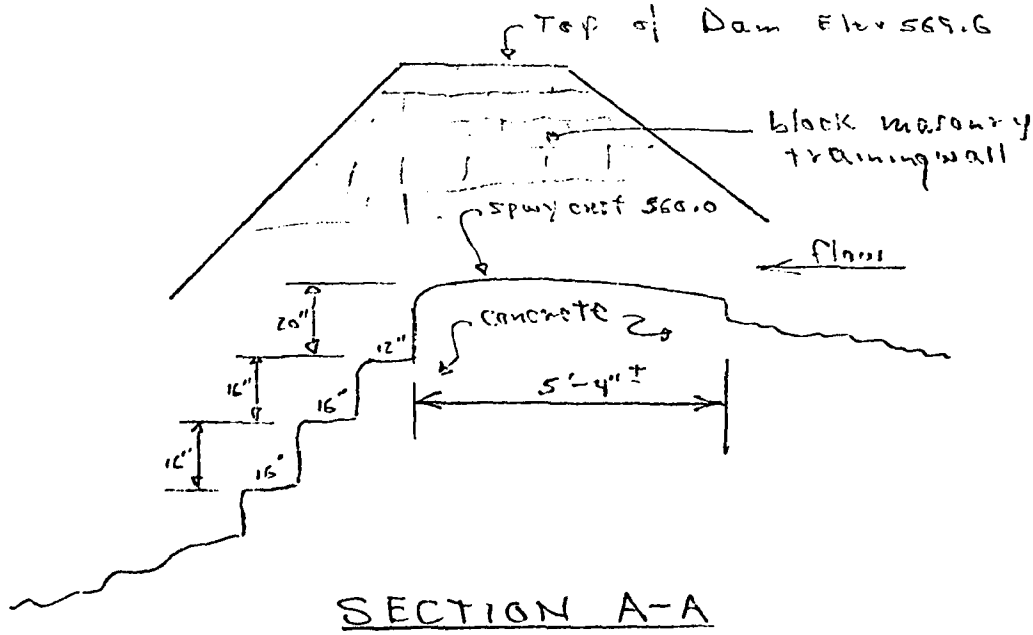
Wigwam Reservoir South Dam

Service Spillway



Top of Dam: Elev 569.6
Spillway Crest: Elev 560.0

PLAN VIEW
NTS



SECTION A-A
NTS

Wiquiam Reservoir Dam

Service Spillway Rating Curve

See page 5 & 6 for spillway details

Assumptions in evaluating flow thru the three spillways:

1. All 3 crests @ same elevation
2. Flash boards removed
3. Area of each spillway is equal
   (a) Area = $(2 \times 15\frac{1}{2} + 2 \times 15\frac{1}{2} \times \frac{3}{4})(3) \cong 163$ □ for use as orifice flow.
   (b) Treat 1st 30" height as weir flow, then go to h = 54" above for orifice flow.

Q_D = flow over dam top = $2.7 \times 500\, H_D^{3/2}$

$Q_W = CLH^{3/2} = 3.4 \times 46.5\, H^{3/2} = 158.1\, H^{3/2}$

$Q_O = CA\sqrt{2gh} = .7 \times 163 \times 8.02\, h^{1/2} = 915.6\, h^{1/2}$
where h_o = orifice = elev 562.0

Elev (ft)	H_w (ft)	h_o (ft)	H_D (ft)	Q_W (cfs)	Q_O (cfs)	Q_D (cfs)	ΣQ cfs
560.0	—	—	—	—	—	—	—
561.0	1	—	—	158	—	—	158
562.0	2	—	—	447	—	—	447
562.5	2.5	—	—	625	—	—	625
564.5	—	2.5	—	—	1448	—	1448
565.0	—	3.0	—	—	1586	—	1586
566.0	—	4.0	—	—	1831	—	1831
* 567.1	—	5.1	—	—	2068	—	2068
567.6	—	5.6	0.5	—	2167	477	2644
568.0	—	6.0	0.9	—	2243	1153	3396

* Top of Dam

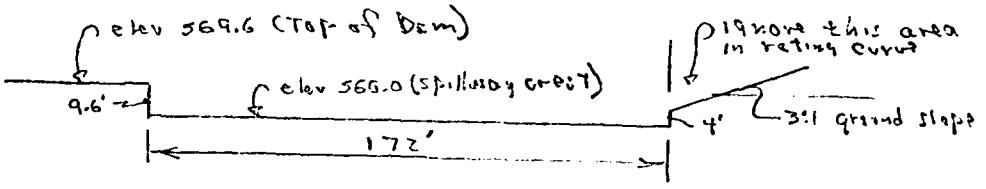
Note: Compute rating curve for Wiquiam Reservoir Intake Dam on next page & then add above flows.

Wigwam Reservoir South Dam

Feb 1979

By: D.T. Ballou

Service Spillway Rating Curve



Section Looking Upstream
Wigwam South Spillway

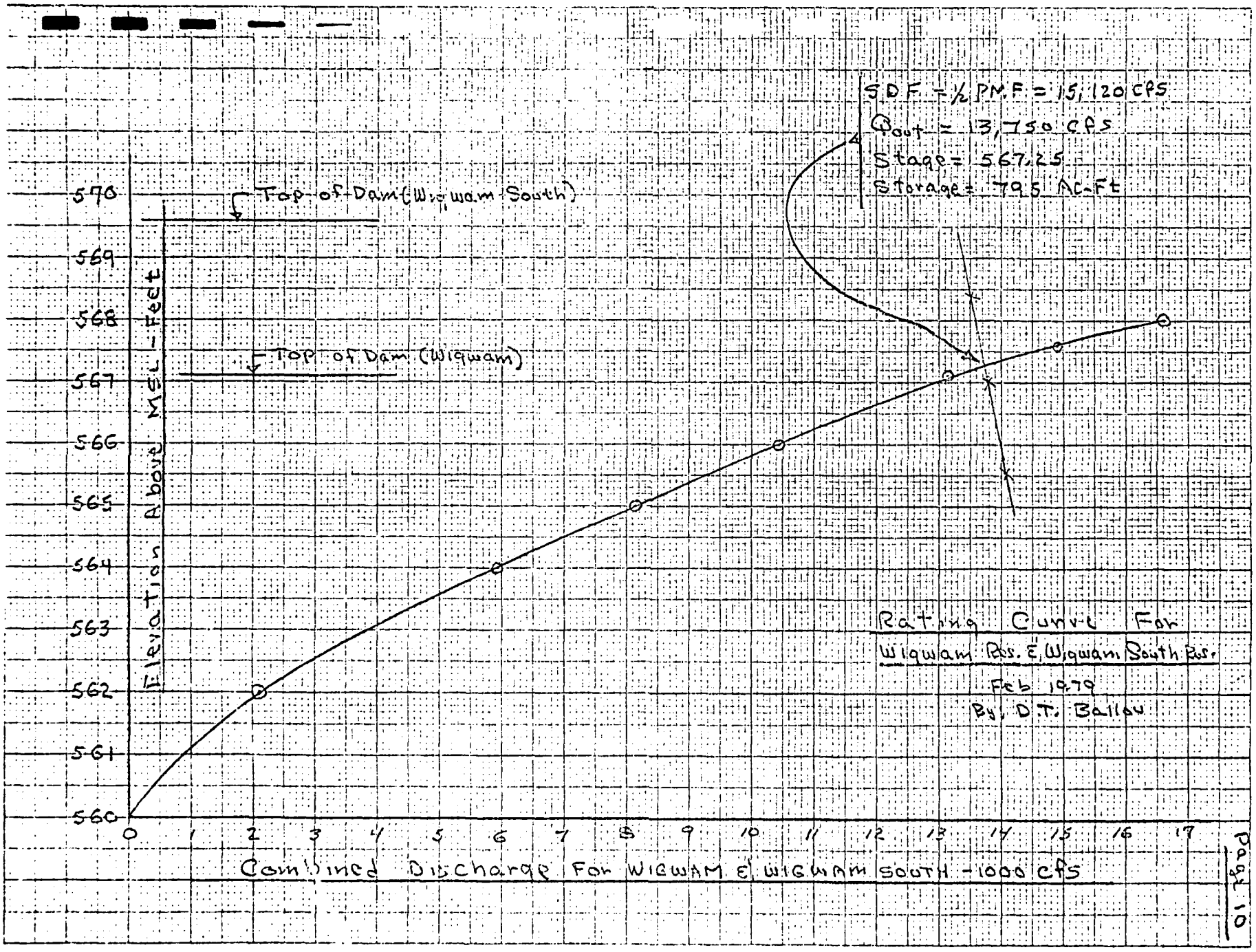
After a review of Kings handbook pages 5-26, 5-27 & page 5-50, Fifth edition; select a weir coefficient of 3.4

It was planned to use an effective weir length of 155', but decided to ignore overbank flow @ north end of spillway & use length as measured.

$\therefore Q_w = CLH^{3/2} = 3.4 \times 172\, H^{3/2} = 584.8\, H^{3/2}$

Elev (ft)	H (ft)	Q_w (cfs)	*Q cfs	ΣQ (cfs)
566.0	—	—	—	
568.0	2	1654	447	2101
570.0	4	4,678	1240	5918
571.0	5	6,538	1586	8124
572.0	6	8,595	1831	10 426
573.1	7.1	11,064	2068	13,132
573.6	7.6	12,253	2644	14,897
574.0	8.0	13,233	3396	16,629
575.0	9.0	15,789		

* See page 6 (Rating data from Wigwam Reservoir)


SDF = ½ PMF = 15,120 cfs
Qout = 13,750 cfs
Stage = 567.25
Storage = 795 Ac-Ft
Top of Dam (Wigwam South)
Top of Dam (Wigwam)
Rating Curve For
Wigwam Res. & Wigwam South Res.
Feb 1979
By D.T. Ballou
Elevation Above MSL - Feet
570
569
568
567
566
565
564
563
562
561
560
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
Combined Discharge For WIGWAM & WIGWAM SOUTH - 1000 cfs
Page 10

Wigwam Reservoir South Dam &
Wigwam Reservoir Dam

Short-cut Routing of ½ PMF = 15,120 cfs

Select surcharge storage associated with Q_p = 13,000 cfs.
From stage - Discharge curve for Q_p = 13,000 we obtain elev 567.0.
From stage - storage curve for elev 567.0 we obtain 765 AC-Ft
D.A. = 17.28 sq-mi = 11,059 acres

$$\frac{765 \text{ Ac-Ft}}{11{,}059 \text{ Acres}} \times 12\tfrac{''}{\text{Ft}} = 0.83'' \text{ of R.O.} = \text{Stor}_i$$

$$Q_{pi} = Q_{p_1}\left(1 - \frac{\text{Stor}_i}{9.5''}\right) \quad \text{where } Q_{p_1} = 15{,}120 \text{ cfs}$$
(└ R.O. for ½ PMF (SDF))

① Stor$_i$ inches	② $\left(1 - \frac{\text{Stor}_i}{9.5''}\right)$	③ Stor$_i$ (Ac-Ft) ① × Area	④ Q_{pi} (cfs) ② × 15,120 cfs	⑤ From page 4 for col ③ Elev
1.00	0.895	922	13528	568.4
0.83	0.913	765	13,799	567.0
0.65	0.932	599	14,085	565.5

The plot of column ④ & ⑤ is found on page 10. Wigwam South retains a freeboard of 2.4' while Wigwam is overtopped by 0.15'. Wigwam is a masonry dam with a concrete cap 8', an overtopping of 2 inches should not cause any undue concern.

Wigwam Reservoir Dam &
Wigwam Reservoir South Dam

April 1979
By D.T. Callou

Comments

1. A hazard classification of Low was selected and a test storm of ½ PMF used. Please note that a classification of significant could have been selected and the test storm utilized would still be appropriate.

The low classification was primarily based upon no habitation in the valley between Wigwam Dam and the Corp's Black Rock Dam that is approximately 7000' downstream.

A classification of Significant may very well be considered due to Wigwam being a key component in the City of Waterbury's water supply.

Breaching this dam and running downstream with the resulting water profile would not alter the classification due to the absence of habitation between the two dams.

Black Rock has about 7000 Ac-Ft of storage and Wigwam has about 3200 Ac-Ft of storage to the top of dam.

Wigwam Reservoir Dams

Commentary on Relationships of the 3 water supply Reservoirs in series when the upper reaches of the 2 downstream "reservoirs" are immediately down-stream of the upstream "dam."

Dam	Spillway Storage No Freeboard (AC-ft)	Total Storage No Freeboard AC-Ft	Spwy Crest Elev (USGS) (Ft)	Dam Height ft	Top Elev of Dam (USGS) (Ft)
Pitch	1085	4200	727.0	94	736.0
Morris	1275	~~4590~~ 5865	652.3	110	660.6
*Wigwam	780	2946	560.0	67	567.1
*Wigwam South	1060	3226	560.0	32	569.6

* These two Dams are on the same reservoir with essentially the same spillway crest elev, but top of dam varies by 2.5' from Wigwam → Wigwam South. Storage below Spwy Crest = 2166 AC-Ft, differences above involve Δ in spillway storage. See comments on following page on breaching, storage, & resulting approximations of water levels in downstream reservoirs.

Comments:

1. The breaching Q (on page 9) is 271,000 cfs for Pitch Reservoir

Utilizing rating equations for Morris Reservoir found on page 6 & 7, Appendix D of Morris E, adding a third rating equation for embankment overflow that would occur over 700' on the east end of the dam, it is found that a water surface of elev 678.7 will pass the 271,000 cfs. This represents an overtopping of 20.6 feet & therefore the dam would undoubtedly fail before this happens.

2. The total storage in Pitch with no freeboard is 4200 Ac-ft. Extending the stage-storage curve for Morris Reservoir would yield an elev of 678.0 required to contain the 4200 Ac-ft within the confines of Morris Reservoir.

Similar comments hold true for the reservoir behind the Wigwam Dams. A review of the volume on the previous page shows Morris with a Total storage of ~~4540~~ 5945 Ac-Ft as compared to 2346 to 3226 for the Wigwam Reservoir. Note that Morris Reservoir breaching Q = 459,000 cfs.

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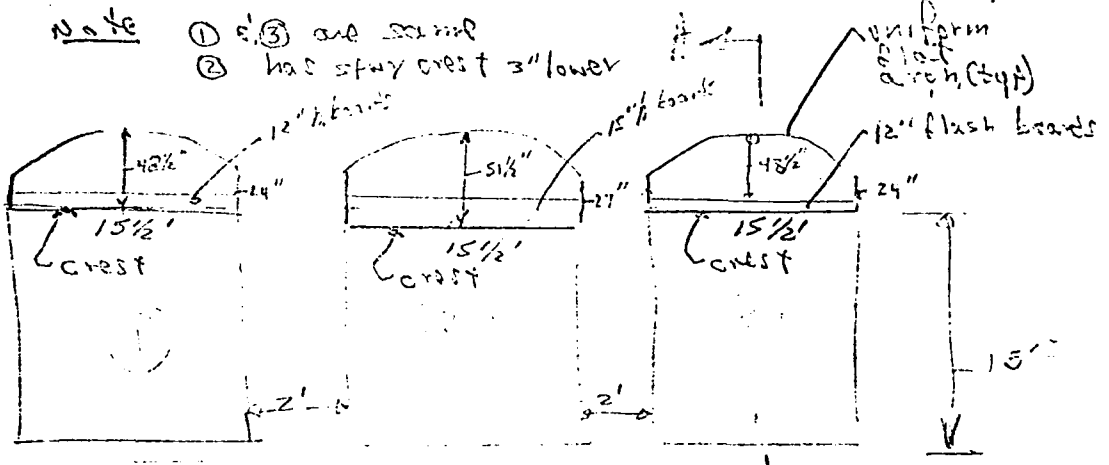
12/5/78
By DT Dallou

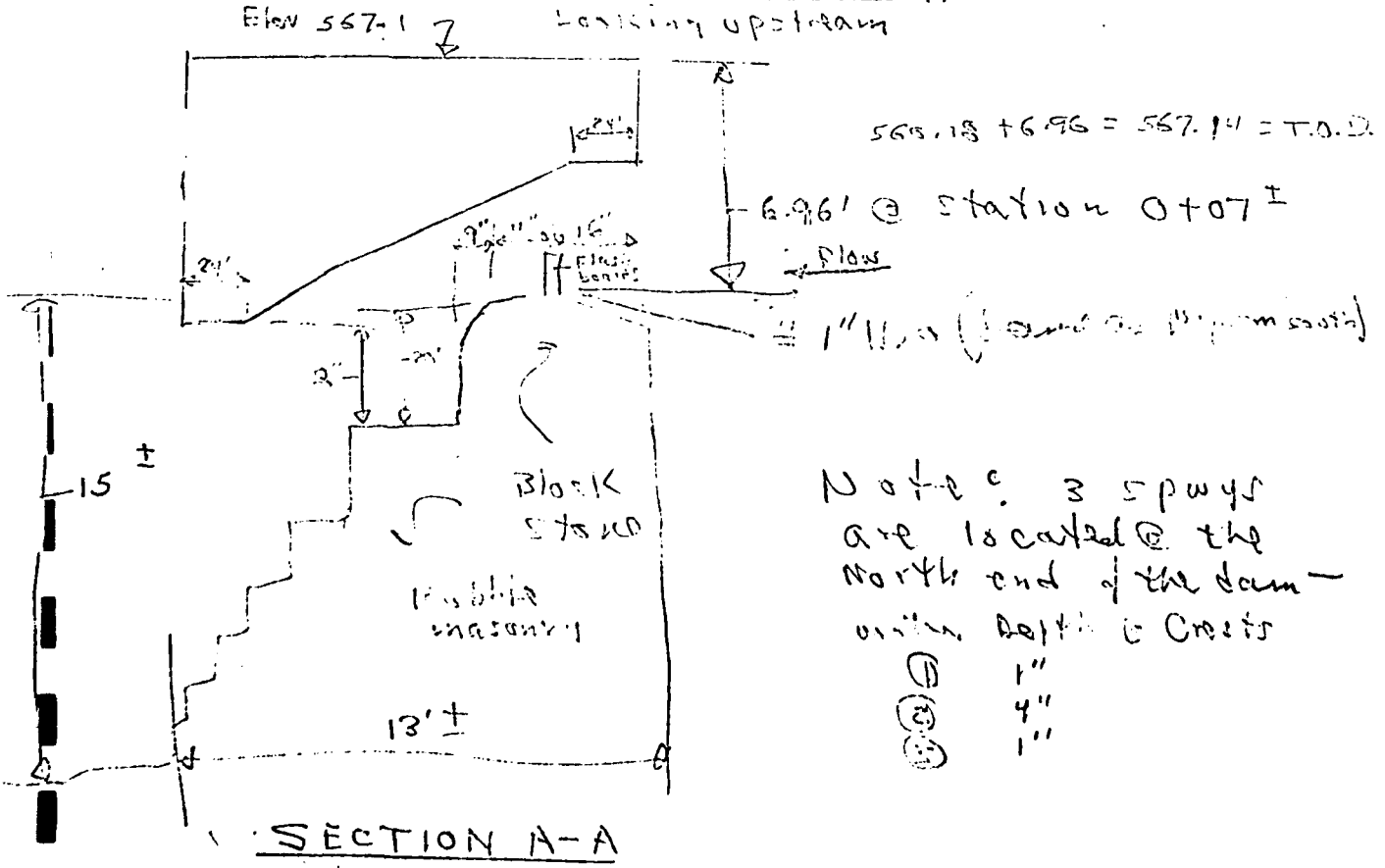
WIGWAM
North

WIGWAM North (Watertown & S. Thomaston) Dam

Note ① & ③ are same
② has spwy crest 3" lower



Elevation View A-A
Looking upstream



565.18 + 6.96 = 567.14 = T.D.

Note: 3 spwys are located @ the North end of the dam — uniform depth & Crests

①	1"
②	4"
③	1"

SECTION A-A

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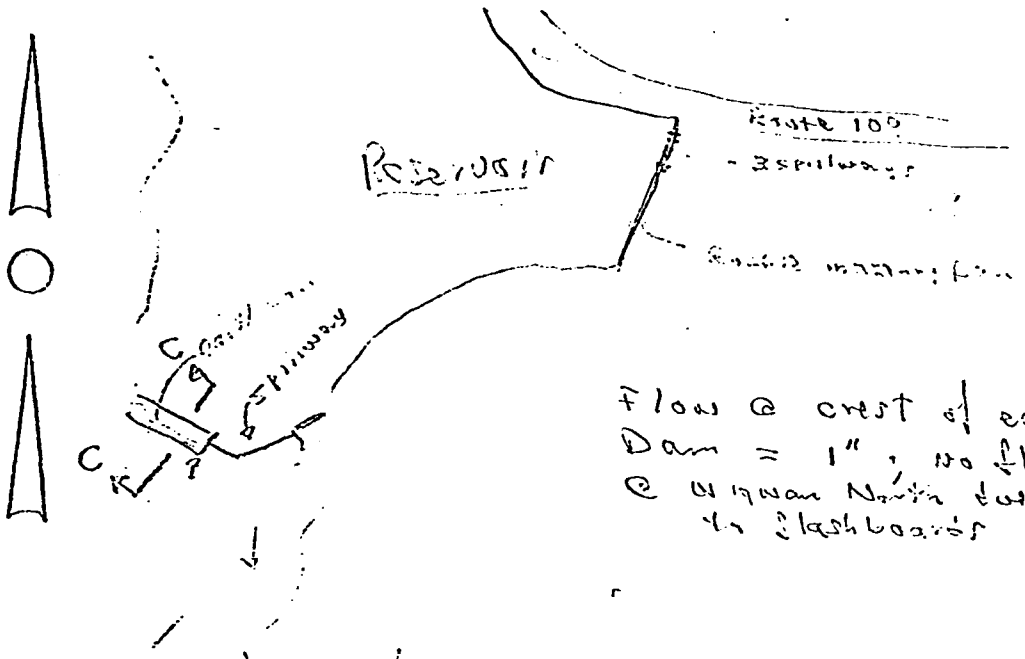
WIGWAM

South

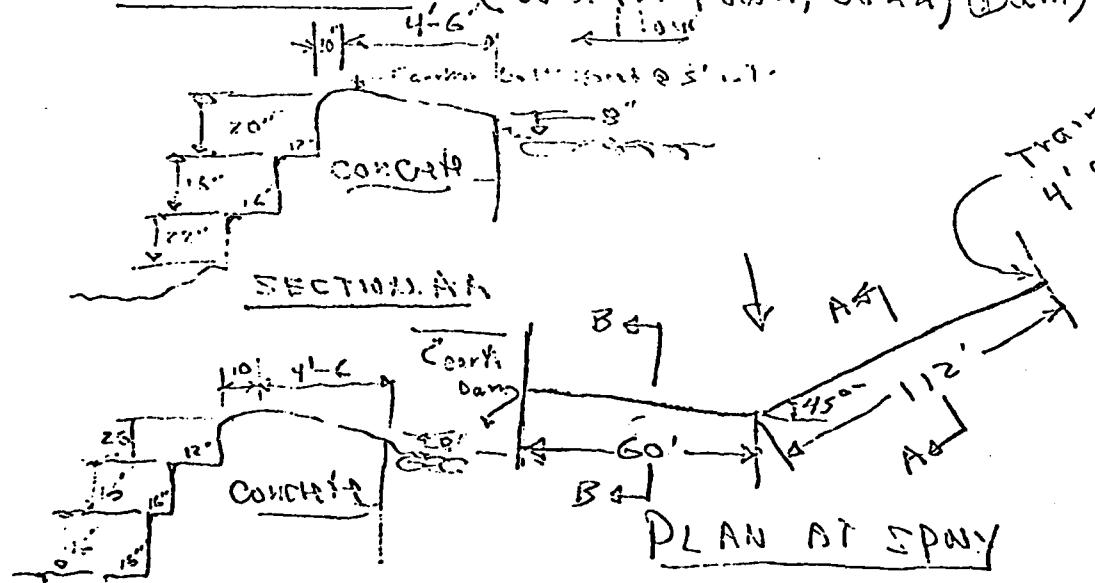
12/5/78
By DT Dallen



Flow @ crest of each Dam = 1", no flow @ Wigwam North due to flashboards

Plan View

WIGWAM South (Watertown, Conn) (Dam)



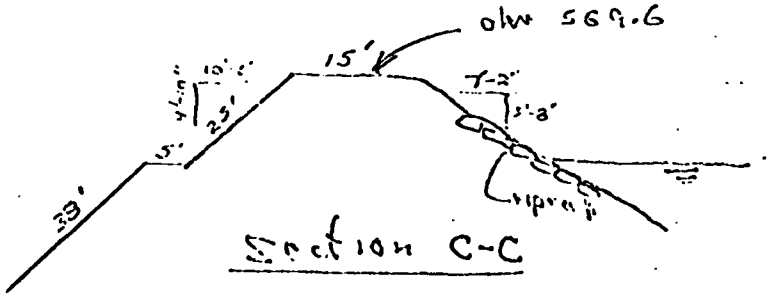
SECTION A-A

PLAN AT SPWY

SECTION B-B

HI = 573.83

Item	BS	FS	Elev
Dam Crest	13.83		560.0
Top Riprap		8.50	565.0
Top = level		13.65	560.18
Top Dam		4.25	569.6



Section C-C

APPENDIX E

INFORMATION AS CONTAINED IN THE

INVENTORY OF DAMS

END