

AD-A144 570 NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
PITCH RESERVOIR DAM (U) CORPS OF ENGINEERS WALTHAM
MA NEW ENGLAND DIV MAY 79

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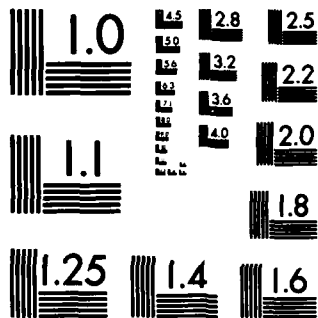
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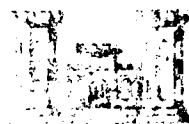
AD-A144 570

NAUGATUCK RIVER BASIN

MORRIS, CONNECTICUT

PITCH RESERVOIR DAM CT 00474

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM



DEPARTMENT OF THE ARMY

ENGINEERING CORPS OF ENGINEERS

WATERWAYS DIVISION, WASH DC 20314

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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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 Morris, Connecticut		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) Pitch Reservoir Dam is a 920 foot long earth embankment and concrete dam. The earth embankment section is 800 feet long and has a maximum height of 94 feet. The visual inspection of Pitch Reservoir Dam indicated that the dam is in good condition and well maintained. Based on its intermediate size and significant hazard classification the test flood is equal to the PMF.		

PITCH RESERVOIR

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NAUGATUCK RIVER BASIN
MORRIS, 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.: CT 00474

Name of Dam: Pitch Reservoir Dam

Town: Morris

County and State: Litchfield, Connecticut

Stream: Pitch Brook

Date of Inspection: December 6, 1978

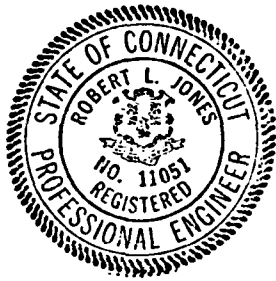
Pitch Reservoir Dam is a 920 foot long earth embankment and concrete dam. The earth embankment section is 800 feet long and has a maximum height of 94 feet. The concrete section is 120 feet long with a height of about 40 feet. The spillway is located on the left (east) side of the dam. The top width of the earthen embankment is 20 feet and the concrete section is 12 feet. Engineering data available consisted of a set of plans dated October, 1941 showing, plan, elevation and details of the dam. No construction specifications or design calculations were available.

The visual inspection of Pitch Reservoir Dam indicated that the dam is in good condition and well maintained. The inspection revealed that efflorescence of the joints of the concrete section of the dam existed and an animal burrow was found beneath the toe of this section. Water was observed flowing from a perforated pipe adjacent to the service road in the vicinity of the west embankment. Minor deterioration and slight seepage through joints was observed near the top of the spillway wall.

Based on its intermediate size and significant hazard classification in accordance with the Corps guidelines the test flood is equal to the Probable Maximum Flood. The spillway will pass the test flood outflow of 4725 cfs with a pool elevation 731.1 feet which is 4.9 feet below the top of the dam.

Based on the findings of the visual inspection and hydrologic and hydraulic analysis, there is no need for further engineering studies or for major alterations to the dam. Provisions should be made by the owner to repair the animal burrow at the toe of the concrete section and monitor the flow of water through the perforated pipe adjacent to the service road.

The recommendations and remedial measures are described in Section 7 and should, unless otherwise specified, be addressed within two years after receipt of this Phase I - Inspection Report by the owner.



A handwritten signature in cursive script, reading "R. L. Jones".

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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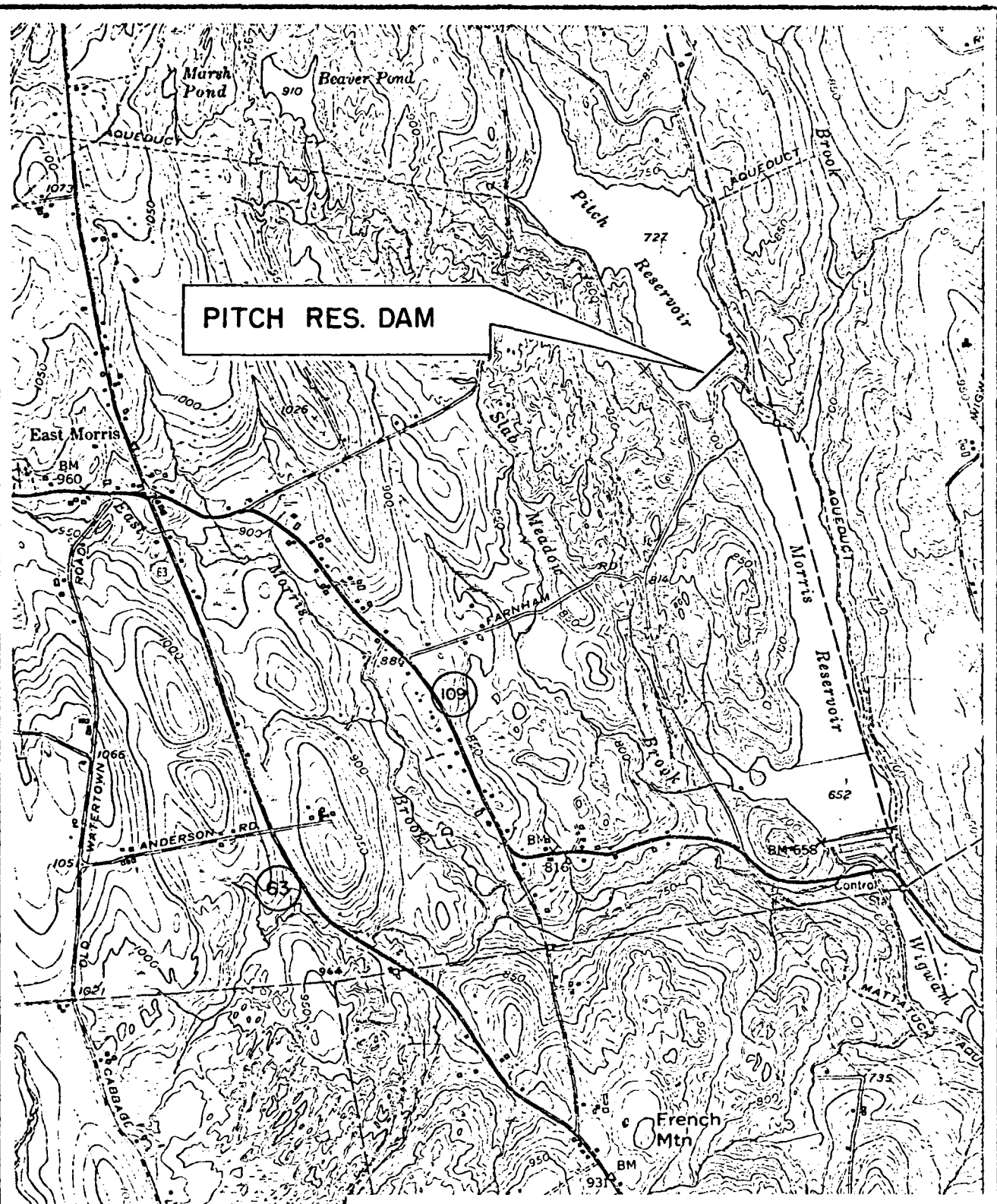
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U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.	NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS	OVERVIEW PHOTO PITCH RES. DAM PITCH BROOK MORRIS, CONN. CE NO. _____ DATE _____ PAGE _____
PHILIP W. GENOVESE AND ASSOCIATES, INC. ENGINEERS - HAMDEN, CT.		



USGS QUAD.
LITCHFIELD, CT.



PHILIP W. GENOVESE AND ASSOCIATES, INC. ENGINEERS-HAMDEN, CT.	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.
NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS LOCATION MAP	

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT
PITCH RESERVOIR DAM

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. Pitch Reservoir Dam is located on Pitch Brook in the Town of Morris, Connecticut. The dam is immediately upstream from Morris Reservoir. The dam is shown on U.S.G.S. Quadrangle, Litchfield, Connecticut with coordinates approximately N 41° 41.4', W 73° 08.9', Litchfield County, Connecticut. The location of the dam is shown on the Location Map immediately preceding this page.

b. Description of Dam and Appurtenances. Pitch Reservoir Dam consists of an earthen embankment section and concrete section. The earth embankment section is approximately 800 feet in length and is cut-off by the concrete section. The concrete section is approximately 300 feet long including the spillway which is 150 feet long. The Maximum Structural height according to existing plans is 94 feet. The downstream slope of the embankment contains four berms. The top width of the earth section is 20 feet and the concrete section is 12 feet.

The appurtenant structures consist of a concrete spillway, spillway channel and an outlet works structure. The spillway consists of a 150 foot wide section with has a crest elevation of 727.0. The spillway is an ogee side channel overflow weir and is located on the left (east) side of the dam.

The outlet works consist of an intake channel, a control tower with 2 chambers containing 4 gates and a discharge channel. Four gates control intake, four control discharge from the gate chamber. Two discharge to the spillway channel and two discharge to a water supply line. Intake gates and conduits are located at elevation 704.5 $\pm$ and the discharge gates and conduits are at elevation 704.0 $\pm$ to water supply and at elevation 701.0 $\pm$ to the spillway channel.

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

c. Size Classification. Intermediate (hydraulic height - 94 feet high, storage 4,200 acre-feet) based on storage ($\geq 1,000$ to 50,000 acre-feet) as given in Recommended Guidelines for Safety Inspection of Dams.

d. Hazard Classification. The dam's potential for damage rates it as a significant hazard classification. There are no permanent structures or human habitation immediately downstream that would be jeopardized by breaching the dam. However, Pitch Reservoir is the highest structure in a series of three impoundments (Pitch, Morris and Wigwam.) The dam is also within 6 feet of the height qualification for "Large". A major breach of dam would probably result in a downstream flood stage that would be absorbed in Morris Reservoir.

e. Ownership. This dam is owned by the City of Waterbury, 236 Grand Street, Waterbury, Connecticut.

f. Operator. This dam is 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. This dam is used for water supply for the City of Waterbury. Water treatment occurs downstream at the plant located on Wigwam Reservoir.

h. Design and Construction History. Based on State of Connecticut files the dam was constructed between 1941 and 1944. Preliminary Construction Permit is dated December 23, 1941 and Certificate of Approval is dated August 16, 1944. Plans are on file with the owner. No other design or construction data other than plans were disclosed.

i. Normal Operating Procedure. No data was disclosed for maintenance of reservoir water levels. Under normal operation, four 24 inch cast iron pipes transmit water from the reservoir to the gatehouse. From the gatehouse, two 24 inch pipes discharge downstream through the spillway channel to Morris Reservoir and two 24 inch pipes discharge to a 39 inch water supply line.

1.3 Pertinent Data

a. Drainage Area. The drainage area tributary to Pitch Reservoir consists of approximately 2.35 square miles of mountainous terrain. In addition to the reservoir, 7 percent of the basin is made up of lake and swamp area. Elevations in the basin range from about 750 feet to 1,180 feet MSL.

The reservoir consists of about 110 acres at the normal (top of spillway) pool elevation. No dwellings are located along the reservoir shores.

b. Discharge at Dam Site

(1) The outlet works for the reservoir consists of four 24 inch diameter intake lines all at G_L elevation of 704.5 feet MSL. Water is discharged by two 24 inch diameter pipes into the spillway channel and by two 24 inch diameter pipes into a 39 inch water supply line which transports water to the City of Waterbury Treatment Plant.

(2) There are no records of maximum discharge at the dam site, however, in August, 1955, a depth of flow of 1 foot was measured at the crest of the spillway. This would give a discharge of approximately 510 cfs.

(3) The spillway capacity with a water surface at the top of dam (elevation 736) would be approximately 15,795 cfs.

(4) The spillway capacity with the water surface at the test flood elevation of 731.1 feet is approximately 4725 cfs.

(5) The total project discharge at the test flood elevation of 731.1 feet is 4725 cfs.

c. Elevation (feet above MSL)

- (1) Streambed at centerline of dam - 642
- (2) Maximum tailwater - Morris Reservoir is tailwater.
- (3) Upstream portal invert diversion tunnel - 653
- (4) Recreation pool - N/A
- (5) Full flood control pool - N/A
- (6) Spillway crest (permanent spillway) - 727
- (7) Design surcharge - unknown
- (8) Top dam - 736
- (9) Test flood surcharge - 731.1

d. Reservoir (miles)

- (1) Length of maximum pool - 1.04
- (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 - 3,120
- (4) Top of dam - 4,200

f. Reservoir Surface (acres)

- (1) Recreation pool - N/A
- (2) Flood control pool - N/A
- (3) Spillway crest - 110
- (4) Test flood pool - 122
- (5) Top dam - 131

g. Dam

- (1) Type - Earthen and concrete
- (2) Length - Earth - 800 feet; Concrete - 120 feet
- (3) Height - 94 feet (maximum)
- (4) Top width - Earth - 20 feet; Concrete - 12 feet
- (5) Side slopes - Upstream: 1:2.5; Downstream 1:2
with berms.
- (6) Zoning - None
- (7) Impervious core - "Rolled Selected Hardpan"
- (8) Cutoff - Yes
- (9) Grout curtain - 5 lines of holes found - 6 feet
centers.
- (10) Other - Excavated to ledge at ℄ 622.5 feet plus
or minus.

h. Diversion and Regulating Tunnel. See Section (i) below.

i. Spillway

- (1) Type - Ogee side channel overflow weir.
- (2) Length of weir - 150 feet
- (3) Crest elevation - 727 feet.
- (4) Gates - None

(5) Upstream channel - Class "A" concrete rectangular channel 150 feet wide and 9 feet deep.

(6) Downstream channel - Class "A" concrete rectangular channel of variable width and depth. Both sidewalls have 1 in 30 batter.

j. Regulating Outlets. The reservoir can be drained by a 72 inch outlet pipe set at approximately elevation 653 feet. This pipe is controlled by a gate valve located in the drain gate chamber which is in the crest of the earthen embankment.

The service gate chamber adjacent to the spillway contains four intakes controlled by 24 inch diameter gate valves and four outlets controlled by 24 inch diameter gate valves. Two outlets discharge to the spillway channel and two discharge to a 39 inch water supply line.

SECTION 2 ENGINEERING DATA

2.1 Design

Pitch Reservoir Dam was constructed between 1941 and 1944 for water supply purposes. A set of plans dated October 1941 as prepared by Malcolm Pirnie, showing plan, elevation, typical sections and details is available at the Office of the City Engineer, City Hall, Waterbury, Connecticut. No in-depth engineering data were found for this dam.

2.2 Construction

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

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 was found to be available.

b. Adequacy. The lack of in-depth engineering data did not allow for a definitive review. Therefore, the adequacy of this dam 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 Pitch Reservoir Dam substantially agree with those on the available plans.

SECTION 3 VISUAL INSPECTION

3.1 Findings

a. General. The field inspection of Pitch Reservoir Dam was made on December 6, 1978. The inspection team consisted of personnel from Philip W. Genovese & 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, the water level was approximately 0.11 feet above the permanent spillway elevation. Water was passing over the spillway. The upstream face of the dam could only be inspected above this water level.

b. Dam. The dam consists of an embankment section approximately 800 feet long and a concrete section about 120 feet long. The crest is at elevation 736 according to the design drawings.

According to the design drawings, the concrete section and about 800 feet of the earthen section is founded on bedrock. The appearance of bedrock outcrops at several locations downstream and adjacent to the spillway is consistent with the design drawings in this respect. The only indication of seepage was found in the concrete section where efflorescence was observed in joints as shown in Photo 10.

The embankment is covered with grass and showed no signs of distress. The upstream slope is covered with riprap and stone pavement to an elevation 5 feet above the flow line as seen in Photo 2.

An animal burrow 3 feet long, 1.5 feet wide and 1.5 feet deep was observed below the base of the concrete section approximately at the angle point. See Photo 14.

A small flow of water was observed from a perforated pipe adjacent to the service road approximately 100 feet downstream of the crest in the vicinity of the west abutment. See Photo 3.

There is limited information in the available design drawings as to whether the embankment section is founded on bedrock or not.

No seepage was observed at the downstream slope or downstream toe of the embankment. However, seepage under the earth dam at the deepest part of the valley could be obscured by water in Morris Reservoir which is immediately downstream.

c. Appurtenant Structures. Visual inspection of the concrete spillway, spillway channel and outlet works did not reveal any evidence of stability problems. The concrete surface and construction joints appeared to be in good condition with only minor deterioration and slight seepage through joints near the top of the spillway wall.

The spillway structure, shown in Photo 11 consists of an ogee-shaped concrete weir 150 feet long and two training walls. The concrete spillway surface is in good condition.

The outlet works consists of an inlet channel, two identical gate chambers with two control gates and two gated discharge conduits in each. One conduit from each chamber discharges to the spillway channel and one to water supply. As the intake structure was below water, it was not inspected. Of the gates located in the gate chambers, two in each chamber control inlet flow and two control outlet. The intake conduits are located at elevation 704.5 feet $\pm$. The discharge conduits are located at two levels. The conduits that discharge to water supply are located at elevation 704 feet $\pm$ and the conduits that discharge to the spillway channel are at elevation 701 feet $\pm$. 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 functional.

The spillway discharge channel is in good condition with the exception of minor deterioration and slight seepage through joints. This channel is shown in Photos 8, 9 and 12.

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. The outlet works discharge into the spillway discharge channel through two 24 inch conduits immediately downstream from the spillway. The spillway channel is mostly paved and part is bedrock. The entire channel appeared to be clean. However, the channel bottom was obscured by water and not visible. No loose blocks of rock or vegetation were observed.

3.2 Evaluation

Visual examination indicates that the dam is in good condition and well maintained. No significant seepage was observed from the foundation or abutments of either the concrete or embankment sections of the dam. The inspection revealed the following:

- a. Efflorescence of joints in the concrete section.
- b. An animal burrow below the base of the concrete section.
- c. Flow from a perforated pipe adjacent to the service road in the vicinity of the west abutment.
- d. Minor deterioration and slight seepage through joints near the top of the spillway wall.

SECTION 4 OPERATIONAL PROCEDURES

4.1 Procedure

Pitch Reservoir Dam creates 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 1.5 miles to the Treatment Plant on the Shepaug Reservoir. Water is also discharged through the spillway channel to Morris Reservoir.

4.2 Maintenance of Dam

This dam is 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 the dam are to insure that all problems encountered can be remedied within a reasonable period of time. The owner should establish a written operation and maintenance procedure 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

5.1 Evaluation of Features

Pitch Reservoir Dam is a composite structure consisting of an 800 foot long earthen section, a 120 foot long concrete section and a 150 foot long concrete spillway. The maximum structural height of the dam is 94 feet. Appurtenant structures other than the spillway consist of a spillway channel, an outlet works structure and a diversion conduit. The spillway crest is at elevation 727 feet. The outlet works consist of an intake channel, a gatehouse with two chambers and outlet conduits that discharge to the spillway channel. The 4 intake conduits and 4 outlet conduits are controlled by gate valves. Intake conduits are at elevation 704.5 feet $\pm$. Discharge conduits to water supply are at elevation 704 feet $\pm$, and to the spillway channel are at 701 feet $\pm$. Pitch Reservoir Dam is classified as being intermediate in size having a maximum storage of 4,200 acre-feet.

a. Design Data. No hydrologic or hydraulic design data were disclosed for this dam.

b. Experience Data. The maximum discharge at this dam site is unknown. The maximum observed condition was reported to be 12 inches over the spillway or about 510 cfs.

c. Visual Observations. No evidence of damage to any portion of the project 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 the Probable Maximum Flood (PMF) as determined by guide curves issued by the Corps of Engineers. Based on a drainage area of 2.35 square miles, it was estimated that the test flood flow at this dam would be 5,830 cfs. Following the guidance for Estimating Effect of Surge Storage on Maximum Probable Discharges results in a test flood discharge of 4,725 cfs. As the maximum spillway capacity at the top of the dam is 15,795 cfs, the spillway will pass the PMF without overtopping the dam.

e. Dam Failure Analysis. The impact of failure of the dam at test flood elevation was assessed using the "Rule of Thumb" Guidance for Estimating Downstream Dam Failure Hydrographs issued by the Corps of Engineers.

A major breach of dam would probably result in a downstream flood stage that would be absorbed in Morris Reservoir storage.

No permanent structures for human habitation were found downstream of the dam. However, Pitch Reservoir is the uppermost structure of a series of three permanent impoundments. The dam is also within 6 feet of the height classification for "Large" size.

Morris Reservoir is immediately downstream of Pitch Reservoir and a comparison of the two structures follows:

	Pitch Reservoir Dam	Morris Reservoir Dam
Storage Volume (Acre-feet)	4200	5865
Height (feet)	94	110
Spillway capacity (cfs)	15795	19420

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations. The visual examination 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 dam. They include general information regarding the overall dimensions of the dam and the appurtenances. This information is not sufficient to assess the stability of the dam and the safety must be judged primarily from visual observations. Grouting required by the plans included 5 lines of grout holes 6 feet apart along the $\mathbb{C}_L$ to a maximum depth of 18 feet into bedrock.

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

d. Post Construction Changes. Since original construction was completed in about 1944, no changes or additions have been made to the site.

e. Seismic Stability. The dam is 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. The visual examination indicates that the dam is in good condition. The inspection revealed:

- (1) Efflorescence of joints in the concrete section of the dam.
- (2) An animal burrow below the toe of the concrete section.
- (3) Flow from a perforated pipe adjacent to the service road in the vicinity of the west abutment.
- (4) Minor deterioration and slight seepage through joints near the top of the spillway wall.

b. Adequacy of Information. The lack of in-depth engineering data did not allow for a definitive review. Therefore, the adequacy of this dam 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. This dam is in good condition and no recommendations are required. The remedial measures described in Section 7.3 should be accomplished within 2 years 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 no need for additional investigations.

7.2 Recommendations

Based on the findings of the visual inspection and hydrologic and hydraulic analysis, there is no need for further engineering studies or for major alterations to the dam.

7.3 Remedial Measures

(a) The animal burrow at the toe of the concrete wall should be backfilled with suitable fill and appropriate grass cover planted.

(b) Seepage downstream of the dam flowing from the perforated drainage pipe should be monitored on a weekly basis. Records of the quantity of seepage, its color and solids content and photographs

should be included in the monitoring program. The monitoring program should be commenced at once.

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

d. A biennial technical inspection program should be developed.

7.4 Alternatives

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

APPENDIX A

INSPECTION CHECKLIST

VISUAL INSPECTION CHECKLIST

PARTY ORGANIZATION

PROJECT PITCH DAM

DATE December 6, 1978

TIME 0830

WEATHER Sunny 40°-50°

W.S. ELEV. 727.11 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

INSPECTED BY

REMARKS

1. _____

2. _____

4. _____

7. _____

8. _____

9. _____

10. _____

PERIODIC INSPECTION CHECKLIST

PROJECT: PITCH DAM DATE December 6, 1978

PROJECT FEATURE Earthen Dam Embankment NAME

DISCIPLINE NAME

AREA EVALUATED		CONDITION
<u>DAM EMBANKMENT</u>		
OB	Crest Elevation	736.0 USGS
DB	Current Pool Elevation	727.11
BJ	Maximum Impoundment to Date	728 ±
GEI	Surface Cracks	None
GEI	Pavement Condition	Not paved - gravel access road
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	None
GEI	Trespassing on Slopes	None
GEI	Sloughing or Erosion of Slopes of Abutments	None
GEI	Rock Slope Protection- Riprap Failures	Good - no failures
GEI	Unusual Movement or Cracking at or Near Toe	None observed
GEI	Unusual Embankment or Downstream Seepage	None observed
GEI	Piping or Boils	None observed
GEI	Foundation Drainage Features	None observed
GEI	Toe Drains	None observed
GEI	Instrumentation System	None
GEI	Vegetation	Well maintained grass slopes
A-2		

PERIODIC INSPECTION CHECKLIST

PROJECT: PITCH DAM DATE December 6, 1978
 PROJECT FEATURE Concrete Dam Embankment NAME _____
 DISCIPLINE _____ NAME _____

AREA EVALUATED		CONDITION
<u>DIKE EMBANKMENT</u>		
J	Crest Elevation	736.08
BJ	Current Pool Elevation	727.11
J	Maximum Impoundment to Date	728
GEI	Surface Cracks	None
GEI	Pavement Condition	Good
EI	Movement or Settlement of Crest	None apparent
GEI	Lateral Movement	None apparent
EI	Vertical Alignment	Good
GEI	Horizontal Alignment	Good
EI	Condition at Abutment and at Concrete Structures	Good
GEI	Indications of Movement of Structural Items on Slopes	None
GEI	Trespassing on Slopes	None
GEI	Sloughing or Erosion of Slopes or Abutments	None
GEI	Rock Slope Protection-Riprap Failures	
GEI	Unusual Movement or Cracking at or Near Toes	Animal burrow near toe
GEI	Unusual Embankment or Downstream Seepage	Slight seepage & efflorescence at joints
GEI	Piping or Boils	None
GEI	Foundation Drainage Features	None
GEI	Toe Drains	None
GEI	Instrumentation System	None
GEI	Vegetation	None
A-3		

PERIODIC INSPECTION CHECKLIST

PROJECT: PITCH DAM DATE December 6, 1978
 PROJECT FEATURE Spillway, Approach Channel NAME _____
 DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE</u>	
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	
BJ Condition of Concrete	Good
BJ Stop-Logs and Slots	None visible
A-4	

PERIODIC INSPECTION CHECKLIST

PROJECT: PITCH DAM DATE December 6, 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
BJ	Visible Reinforcing	None
BJ	Rusting or Staining of Concrete	None
BJ	Any Seepage or Efflorescence	None
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: PITCH DAM DATE December 6, 1978

PROJECT FEATURE _____ NAME _____

DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - TRANSITION AND CONDUIT</u> 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: PITCH DAM DATE December 6, 1978

PROJECT FEATURE Outlet Works - Channel NAME

DISCIPLINE NAME

AREA EVALUATED		CONDITION
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL		
BJ	General Condition of Concrete	Good
BJ	Rust or Staining	Some
BJ	Spalling	None observed
BJ	Erosion or Cavitation	None
BJ	Visible Reinforcing	None
BJ	Any Seepage or Efflorescence	Some
BJ	Condition at Joints	Good
GEI	Drain holes	None observed
GEI	Channel	Concrete bottom and sides
GEI	Loose Rock or Trees Overhanging Channel	None
GEI	Condition of Discharge Channel	Good

PERIODIC INSPECTION CHECKLIST

PROJECT: PITCH DAM

DATE December 6, 1978

PROJECT FEATURE Outlet Works- Spillway Weir
Approach Channel

NAME

DISCIPLINE

NAME

AREA EVALUATED

CONDITION

OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS

a. Approach Channel

GEI	General Condition	Under water, not observable
GEI	Loose Rock Overhanging Channel	None
GEI	Trees Overhanging Channel	None
GEI	Floor of Approach Channel	

b. Weir and Training Walls

BJ	Weir under water good	
	General Condition of Concrete	
3J	Rust or Staining	None
BJ	Spalling	None
3J	Any Visible Reinforcing	None
	Any Seepage or Efflorescence	Water seeping from top of right wall
GEI	Drain Holes	Staining and slight flow of water through holes

c. Discharge Channel

GEI	General Condition	Good
GEI	Loose Rock Overhanging Channel	None
GEI	Trees Overhanging Channel	None
GEI	Floor of Channel	Concrete lined at each end, irregular bedrock in between, good condition
GEI	Other Obstructions	None

PERIODIC INSPECTION CHECKLIST

PROJECT: PITCH DAM DATE December 6, 1978

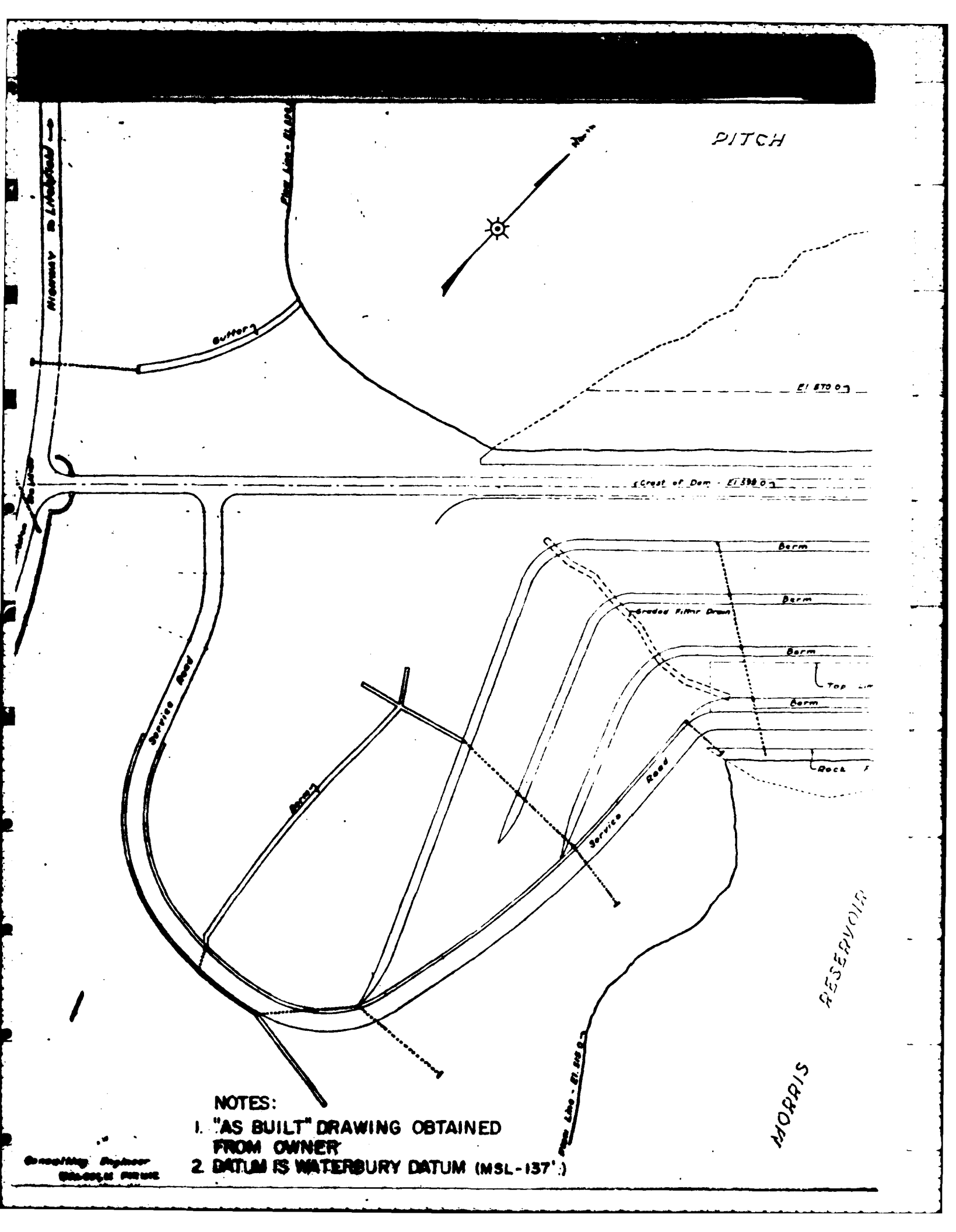
PROJECT FEATURE _____ NAME _____

DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - SERVICE BRIDGE</u> 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 A-9	

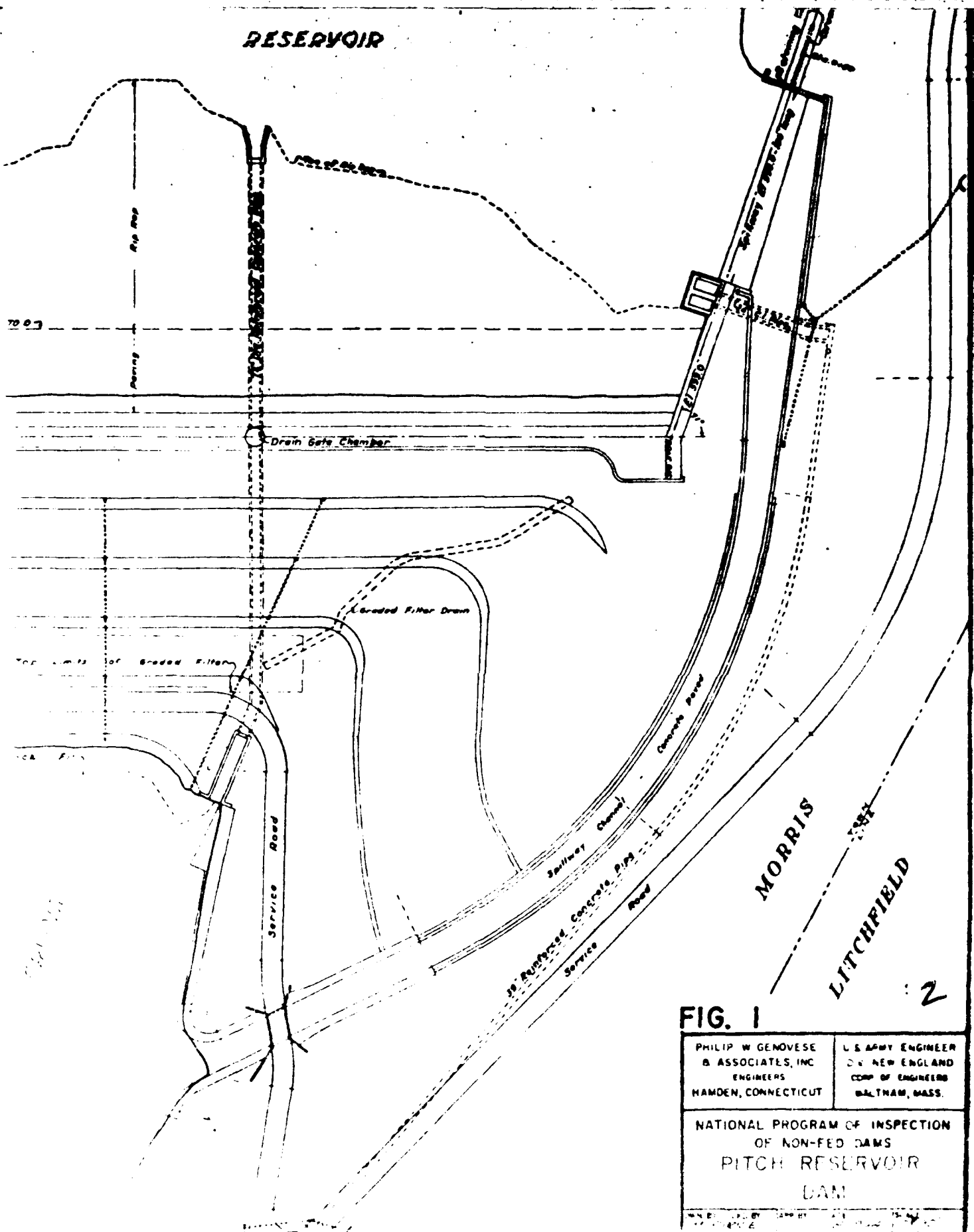
APPENDIX B

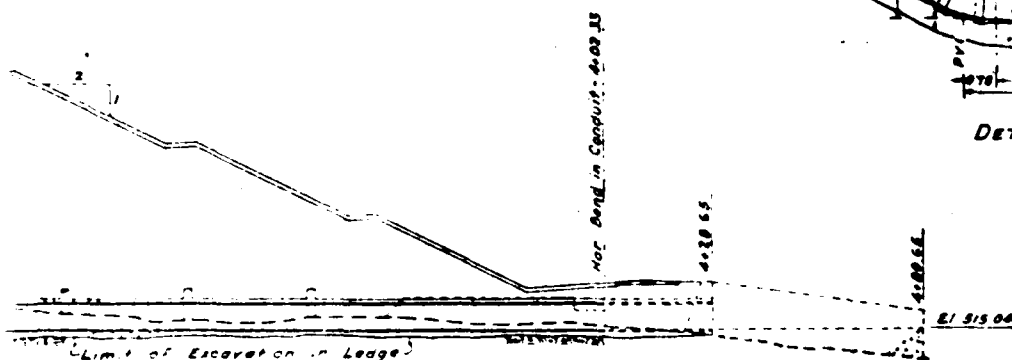
ENGINEERING DATA



NOTES:

1. "AS BUILT" DRAWING OBTAINED FROM OWNER
2. DATUM IS WATERBURY DATUM (MSL-137')





2.

1. "AS BUILT" DRAWING OBTAINED FROM OWNER
2. DATUM IS WATERBURY DATUM (MSL-137')

FIG. 2

PHILIP W GENOVESE
 & ASSOCIATES, INC.
 ENGINEERS
 HAMDEN, CONNECTICUT

U.S. ARMY ENGINEER
DISTRICT NEW ENGLAND
CORPS OF ENGINEERS
WILTHAM, MASS.

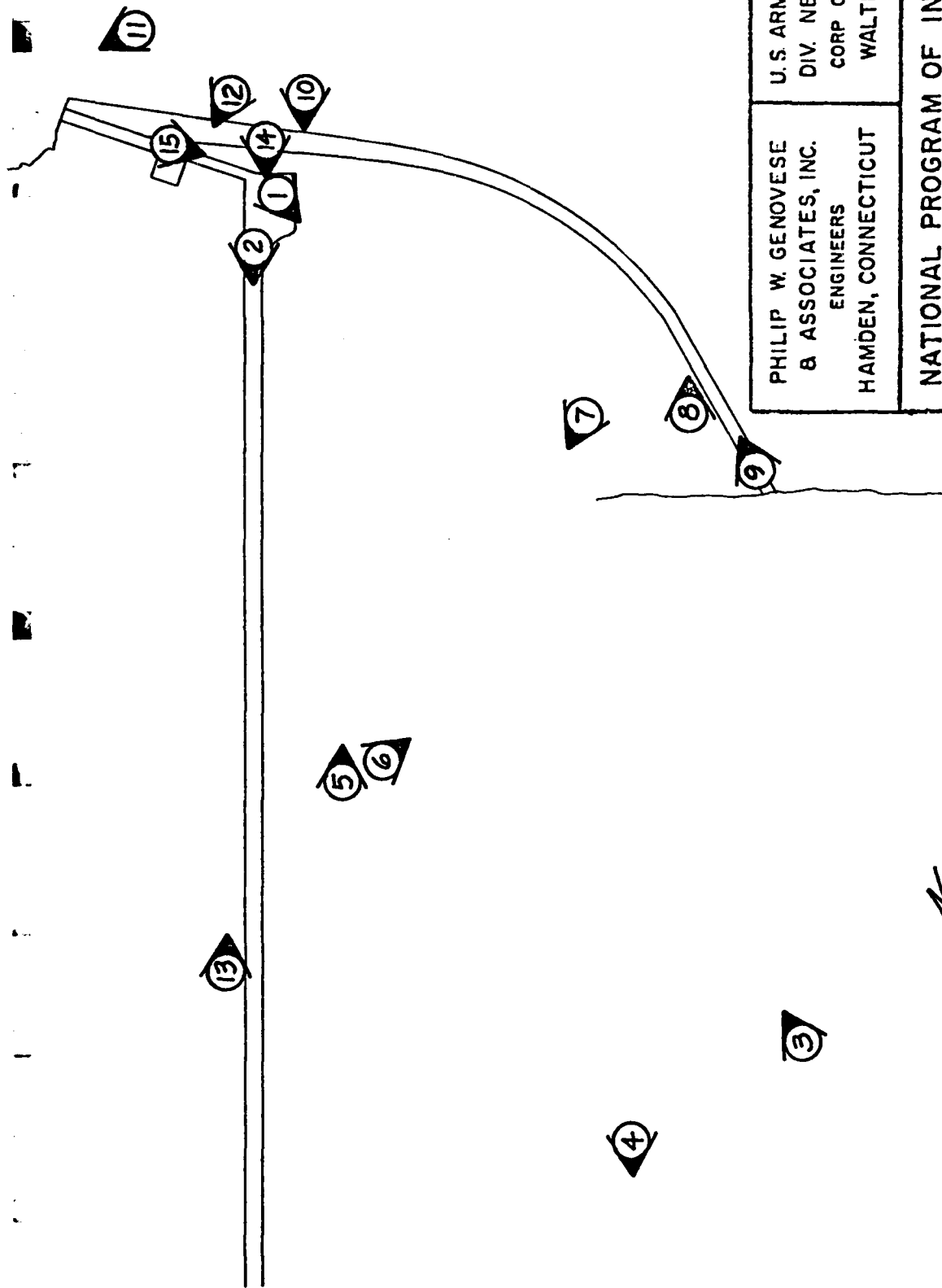
NATIONAL PROGRAM OF INSPECTION
OF NON-FED DAMS
PITCH RESERVOIR
DAM

CHK BY M. PIRNIE	CR2 BY	APP BY	DATE 8/19/44	PCAS 1745
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501500

APPENDIX C

PHOTOGRAPHS



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
**PITCH RESERVOIR
DAM**

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



PHOTO NO. 1 - Looking toward right (west) abutment
along downstream face of embankment
from crest of concrete section.



PHOTO NO. 2 - Looking toward right (west) abutment along
upstream face from concrete section.

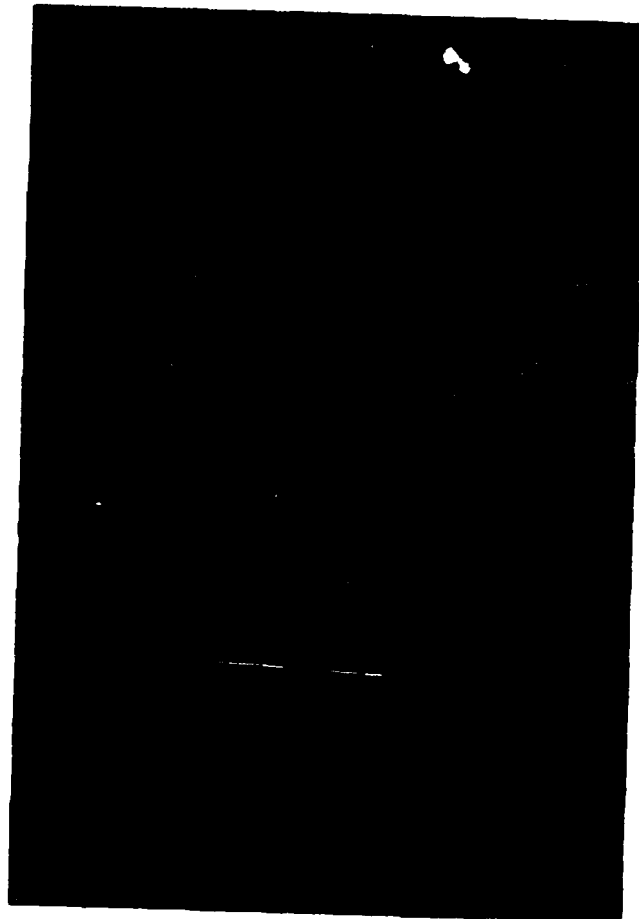


PHOTO NO. 3

Drainage feature on right (west) abutment 400'[±] downstream of dam, 4" flexible perforated black plastic pipe, surrounded by gravel, constructed summer 1976; slight flow of water, ditch 3' wide, adjacent to roadway, rule extended 3 feet.

PHOTO NO. 4

Drainage feature on right (west) abutment leading to first berm, rule extending to 3 feet.



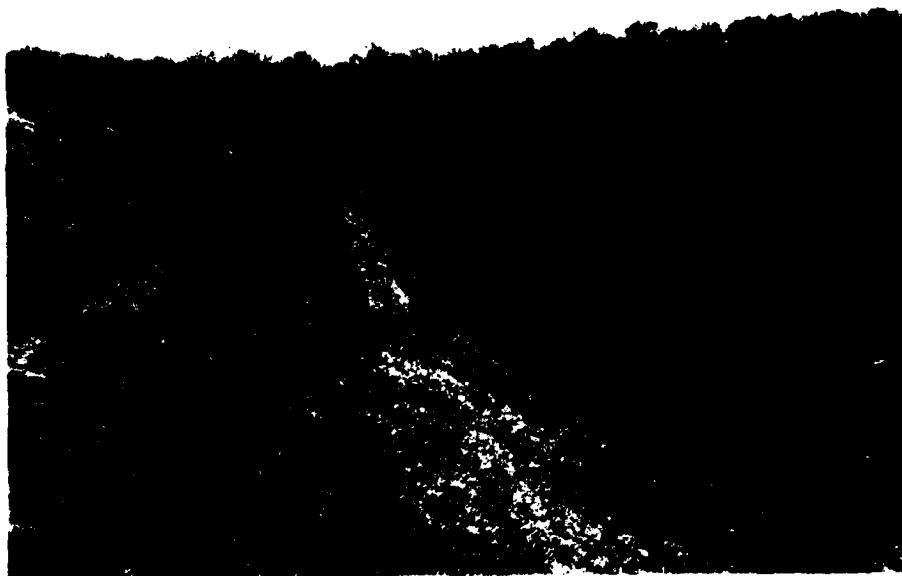


PHOTO NO. 5 - General photo looking downstream at slope and spillway channel, from 90 feet right (west) of drain chamber on first berm.



PHOTO NO. 6 - Spillway channel from downstream slope.



PHOTO NO. 7 - View of downstream face of dam from a site downstream of crest looking at downstream face; station with red flagging on right side of photo is 100' right (west) of chamber.



PHOTO NO. 8 - End of left (east) spillway training wall looking upstream, note drain holes, channel bottom and irregular bedrock.



PHOTO NO. 9 - Spillway from service bridge over spillway looking upstream.

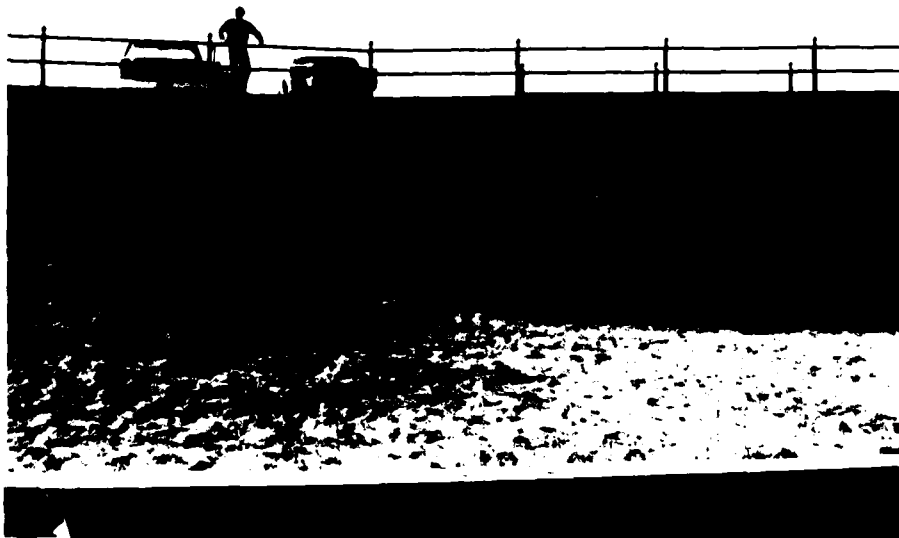


PHOTO NO. 10 - Looking toward concrete section of dam from left (east) side of spillway training wall.



PHOTO NO. 11 - Looking upstream along spillway channel
from left (east) side of spillway training wall.



PHOTO NO. 12
Looking upstream
along spillway
channel from left
(east) side of spill-
way training wall.



PHOTO NO. 13 - Looking toward spillway structure from
area of right (west) abutment.

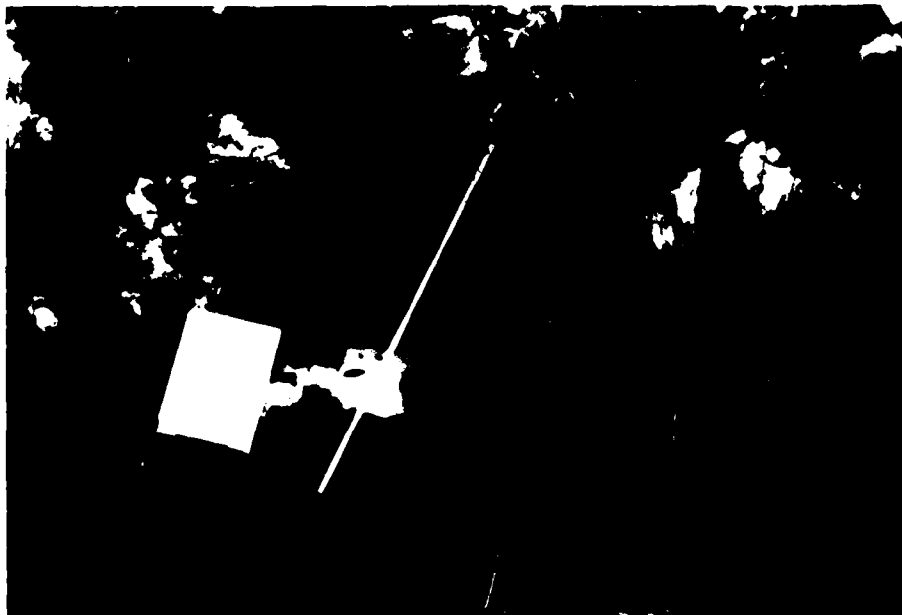


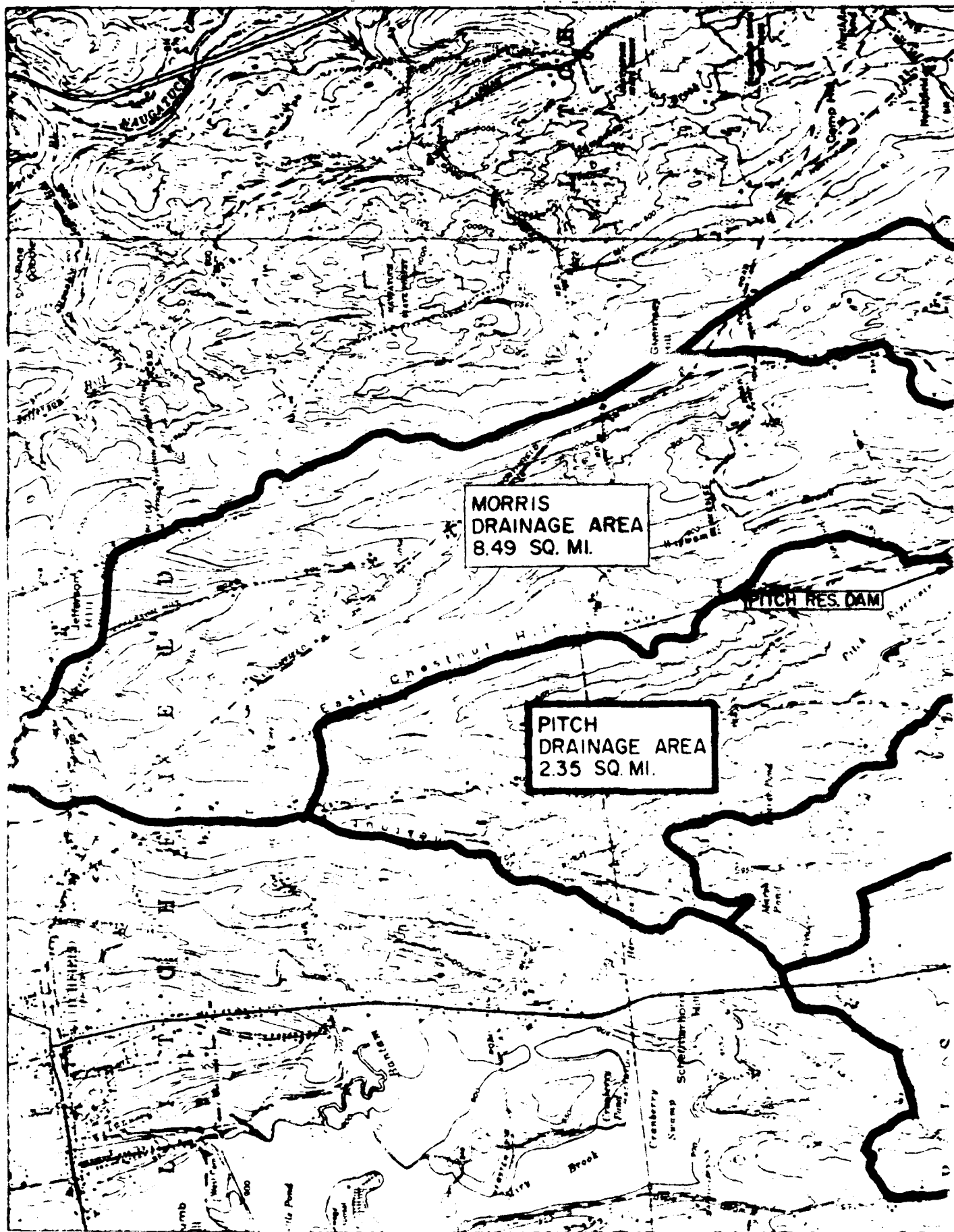
PHOTO NO. 14 - Large diameter animal burrow (adjacent)
to concrete structure.



PHOTO NO. 15 - Looking south along left (east) side of
concrete dam with spillway channel on
left, from gatehouse.

APPENDIX D

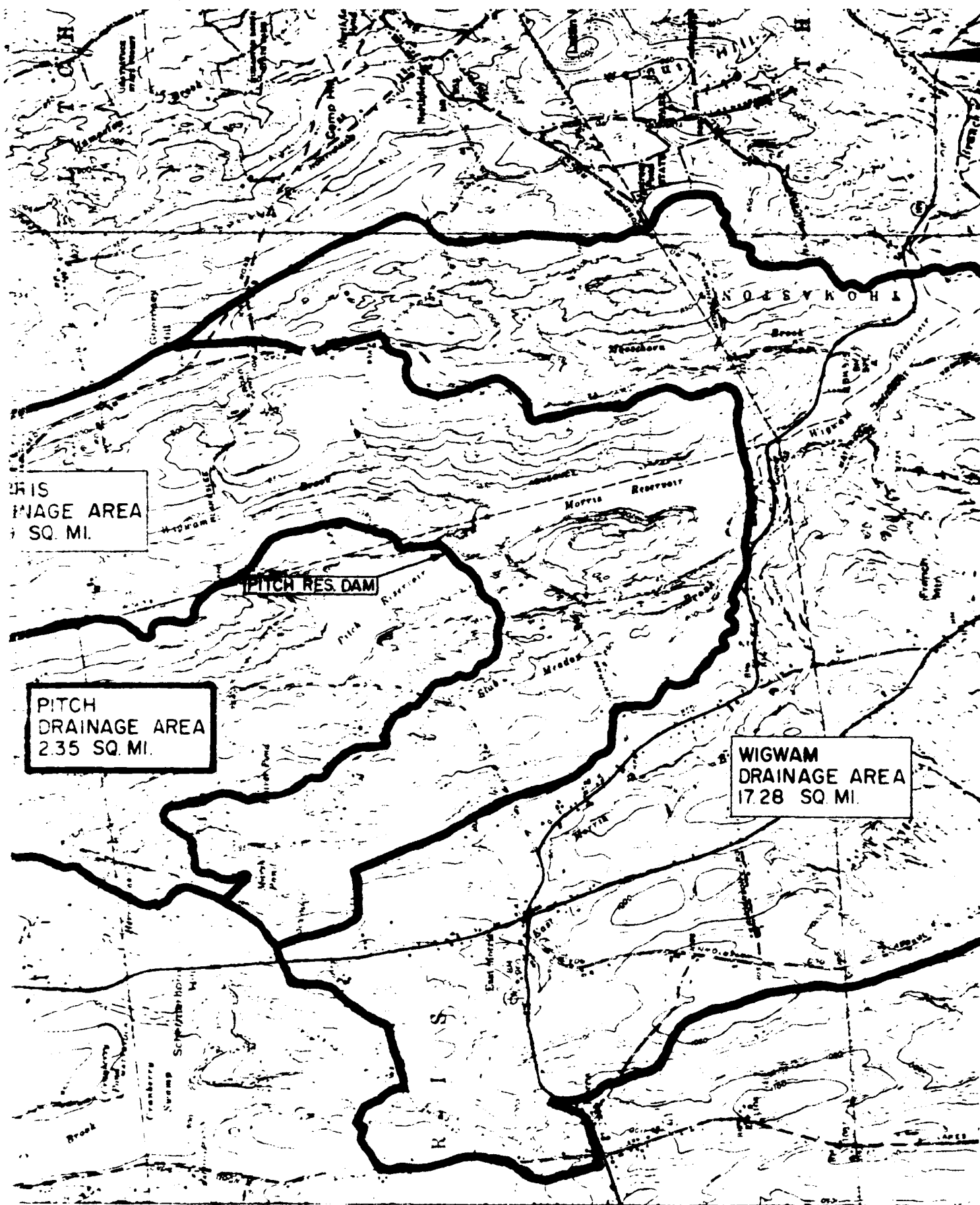
HYDROLOGIC AND HYDRAULIC COMPUTATIONS

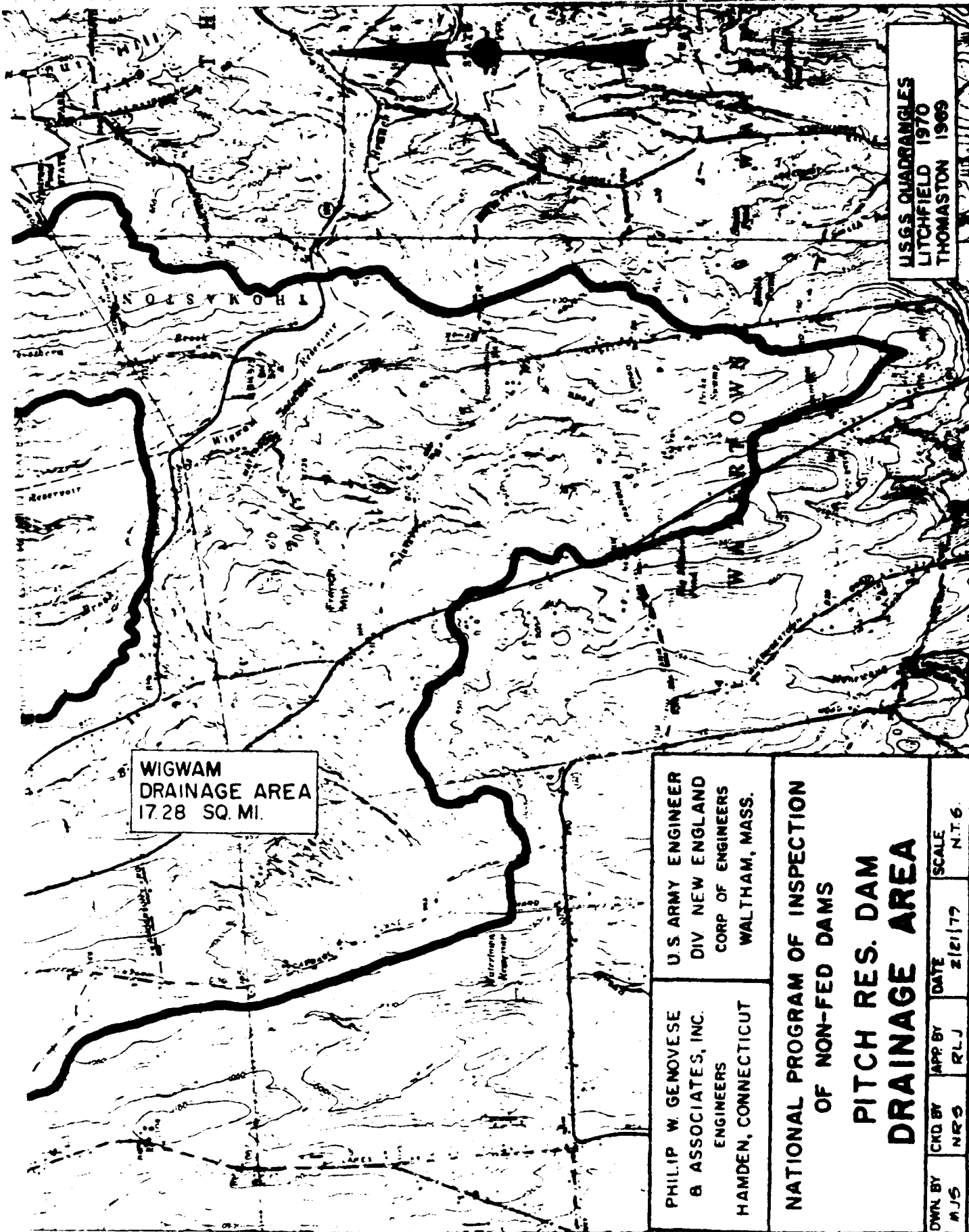


MORRIS
DRAINAGE AREA
8.49 SQ. MI.

PITCH
DRAINAGE AREA
2.35 SQ. MI.

PITCH RES. DAM





21

Jan. 1979

Name ——— Pitch Reservoir Dam

Location ——— Morris, Conn.

Drainage Area ——— 1,502 acres / 2.35 sq-mi

Flow Line Area ——— 110.4 acres

Flow Line ——— Elev 727.0 (USGS)

Top of Dam ——— Elev 736.0 (USGS)

Dam Height ——— 94 Feet

Size ——— Intermediate

Hazard ——— Significant

Test Flood(TF) ——— PMF

PMF Runoff ——— 19 inches

PMF- Q_{peak} ——— 5830 CFS (Inflow)

PMF Volume ——— 2378 Ac-Ft

Spillway Capacity ——— 15,795 CFS (No Freeboard)

Stage Elev @ Q_{peak} ——— Elev 731.6 (No Routing)

Routed Stage Elev ——— Elev 731.1 (Maximum Stage)

Q_{peak} Outflow ——— 4725 cfs

Spillway Type ——— Concrete Ogee shaped
with side channel spillway

Pitch Reservoir

Jan 1979

Determine "Size" & "Hazard Potential" of structure in order to determine the recommended "spillway design flood" (SDF) to be utilized as a test storm.

Use Tables 1, 2 & 3 of the D.O.A., O.C.E. guidelines dated November 1976

Determine Size Classification:

From page 1

(a) Dam height = $736 - 642 = 94$ feet

(b) Reservoir area @ flow line = 110 acres;
approximate volume below the flowline = $\frac{1}{3} \times 85 \times 110 = 3,117$ Ac-Ft.
Area @ Top of dam = 131 acres.
Volume between flow-line and top of dam = $[(131 \text{ acres} + 110 \text{ acres})/2][9'] = 1085$ Ac-Ft

finally: Total approx. Storage = 4,201 Ac-Ft

∴ Size Classification = Intermediate

Determine Hazard Potential Classification

while there does not appear to be any permanent structures for human habitation below the dam & would therefore allow a category of "Low" to be assigned, a Category of Significant will be assigned due to the fact that this reservoir is the uppermost structure in a series of three permanent

Pitch Reservoir

Jan 1979

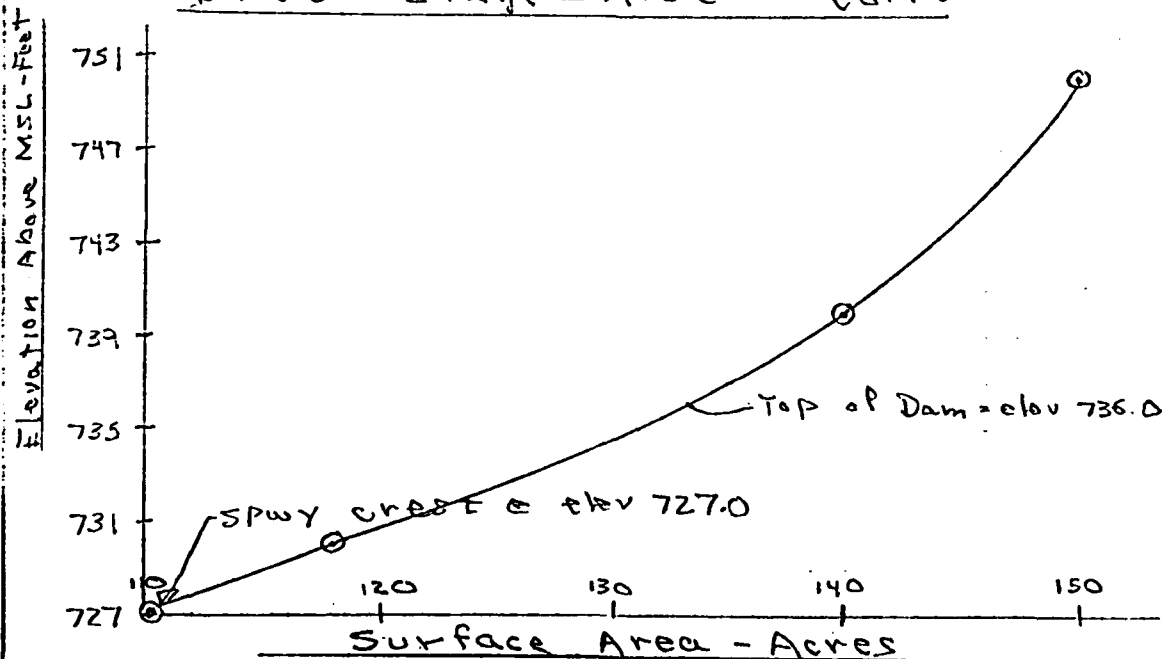
impoundments. The dam is also within 6' of of the height qualification for "Large" size. Pitch is also a water supply reservoir for Waterbury, Conn. As a result of the "size" and "hazard" classifications the "Recommended Spillway Design Flood" (SDF) may vary from $\frac{1}{2}$ PMF $\rightarrow$ PMF according to Table 3 in the O.C.E. guidelines

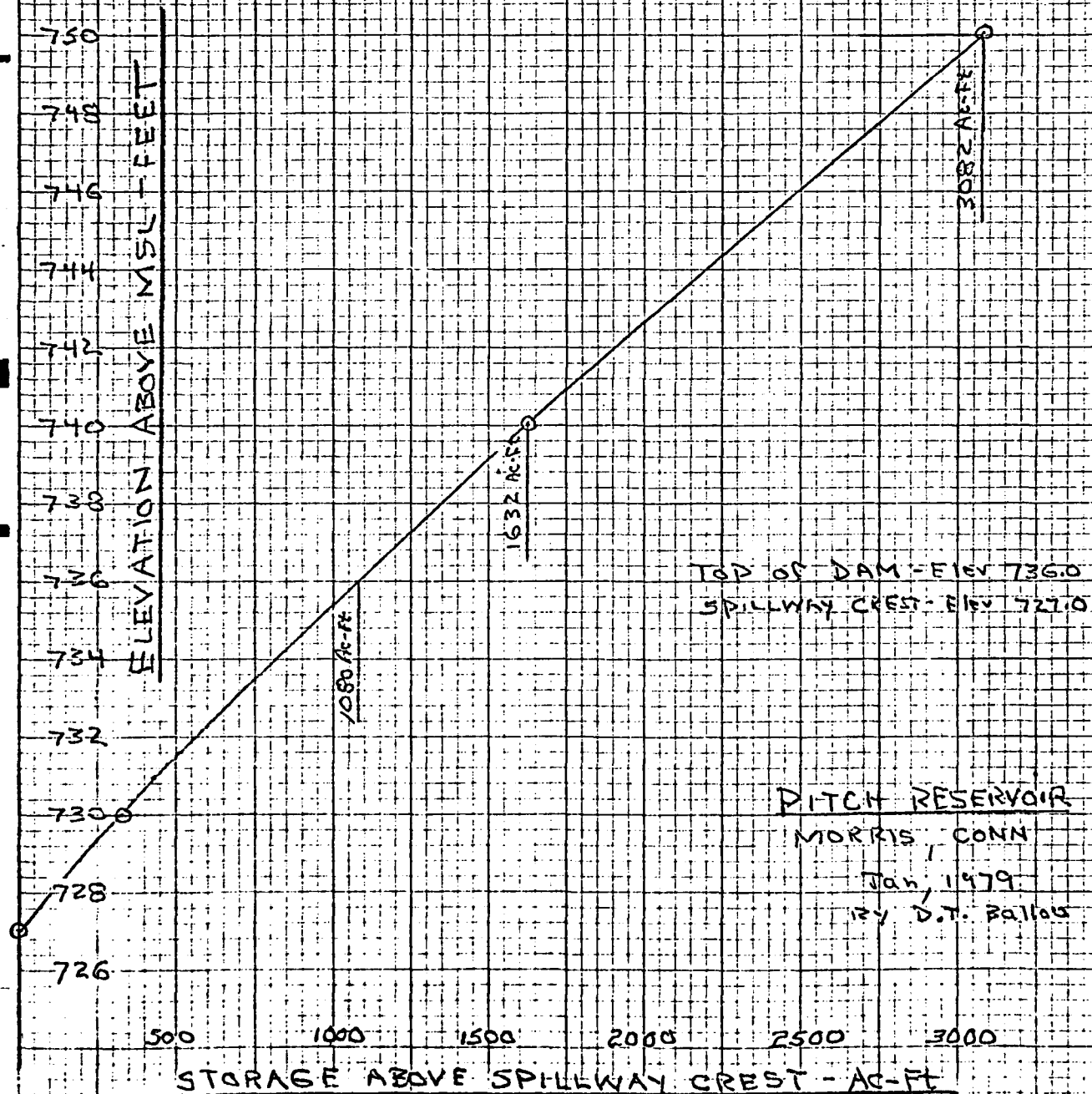
At this point we are ready to determine the PMF (Probable Maximum Flood). Use data furnished by Corp N.E.D.

Entering with D.A. = 2.35 sq-miles & utilizing the range of data identified as "Mountainous" we extract a value of 2480 cfs/sq-mi for the PMF.

$$\therefore 2480 \text{ cfs/mi}^2 \times 2.35 = \text{PMF} = 5830 \text{ CFS}$$

Draw stage - Area Corr





Jan 1979

Pitch Reservoir

Determine Volume of PMF

Note that there is 19 inches of runoff being utilized for PMF

$$\text{Volume} = \text{D.A.} \times \text{Runoff}$$

$$= 1562 \text{ Acres} \times 19" \times 1 \frac{1}{12}" = 2378 \text{ Ac-ft}$$

$$= \text{Volume of water under inflow hydrograph}$$

$$\text{Note: } T = 5 \times 24.2 \times \frac{1}{\phi} = 9.9 \text{ hours (interesting)}$$

Work up Spillway Rating Curve

From "Kings Handbook of Hydraulics" page 5-27 fig 5-18; This approximates the existing spillway crest — The crest is essentially an Oggee shaped overflow section and as such will have a variable coefficient of discharge (See Table 5-13, page 5-50 in "Kings")

The crest is 150' long and has a 9' height before overtopping the dam.

Compute

$$Q_w = C L H^{3/2}$$

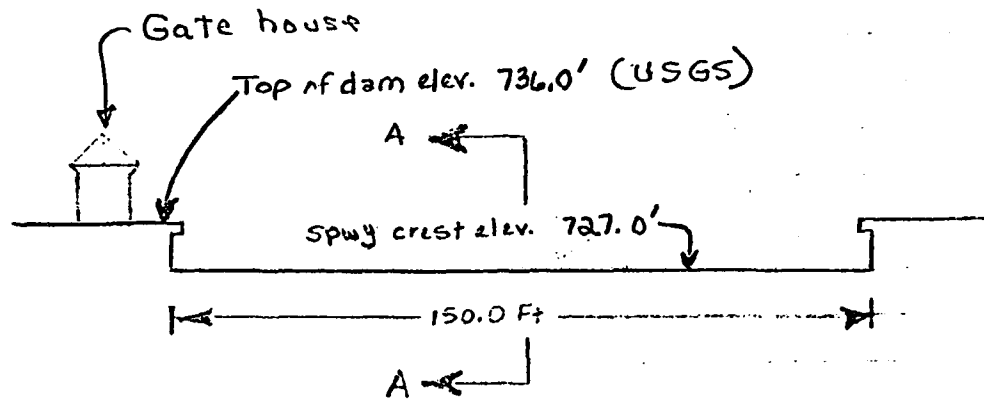
Elev	Head-H ft	$H^{3/2}$	C	Q_w cfs
728	1.0	1	3.45	510
729	2.0	2.83	3.75	1591
730	3.0	5.20	3.87	3016
731	4.0	8	3.90	4680
732	5.0	11.18	3.90	6546
733	6.0	14.7	3.90	8598
736	9.0	27.0	3.90	15795

Note: None of the conduits will be utilized in the routing of the last flood.

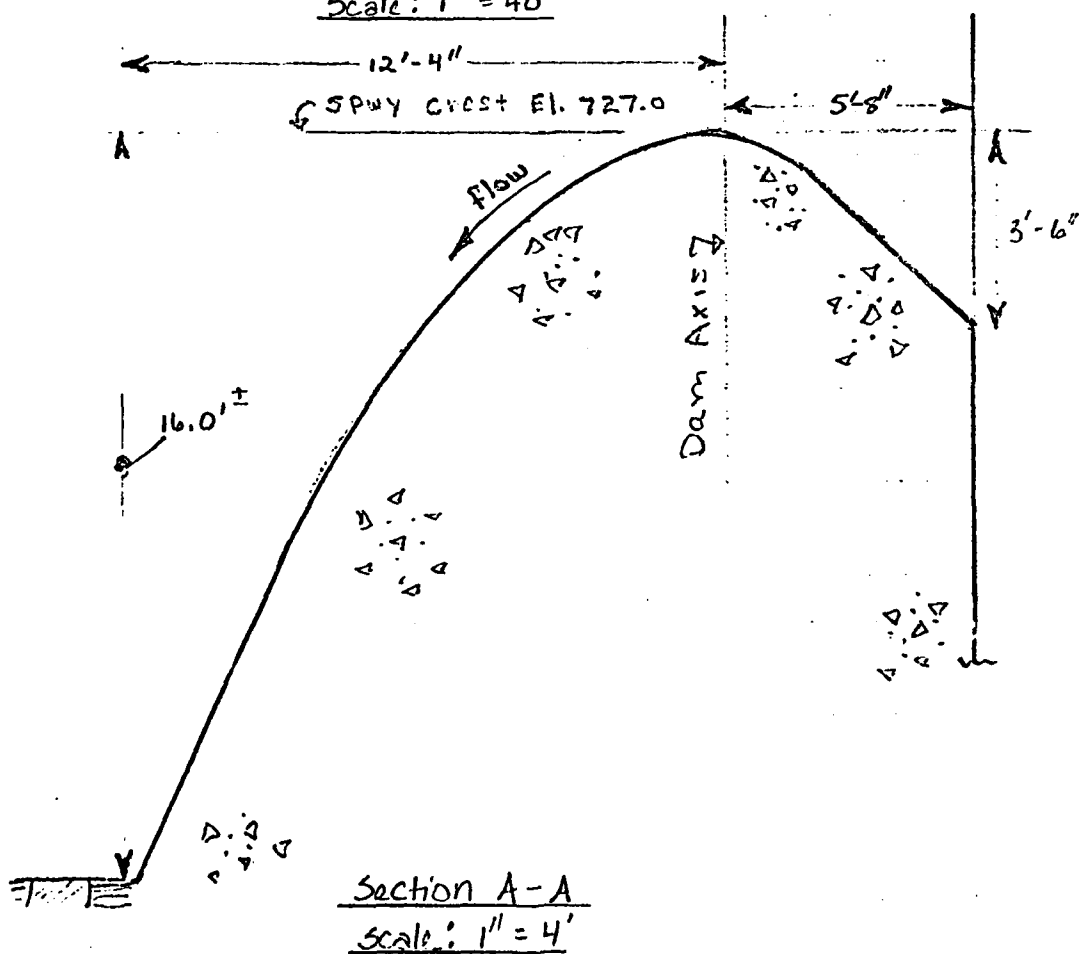
Jan. 1979

Pitch Reservoir, Morris, Conn

SERVICE SPILLWAY



Elevation View
Looking Upstream
Scale: 1" = 40'



Elevation Above MSL - Feet

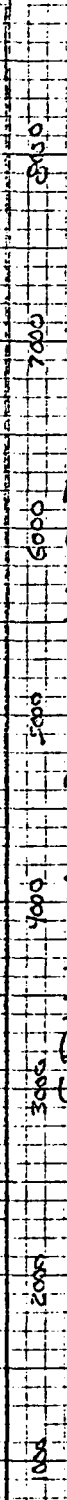
Elev 736 (Top of Dam)

see Page 3
Peak Outflow = 4725 cfs @ Elev 731.05
Pitch Reservoir
Morris Dam
Jan, 1979

SPILLWAY CREST @ ELEV 727.0

SPILLWAY DISCHARGE - CFS

Page 6



Pitch Reservoir

Jan 1979

Commence short-cut routing of surcharge

$$Q_{p1} = 5830 \text{ cfs (see pg 3)}$$

$$Q_{p2} = Q_{p1} \left(1 - \frac{\text{Stor}_1}{19}\right)$$

From pg 6 surcharge height to pass

$$Q_{p1} = \text{elev } 731.6 - 727 = 4.6'$$

from pg 4 elev 731.6 yields 525 Ac-ft
 $E' (525 \text{ Ac-ft} / 1502 \text{ acres}) (12' / \text{ft}) = 4.2" = \text{Stor}_1$

and

$$Q_{p2} = 5830 \text{ cfs} \left(1 - \frac{4.2"}{19}\right) = 4530 \text{ cfs}$$

Surcharge height H2 from pg 6 = el 730.9
 $- 727 = 3.9'$

from pg 4, elev 730.9 yields 425 Ac-ft
 $E' (425 / 1502) (12) = 3.4" = \text{Stor}_2$

$$(\text{Stor}_1 + \text{Stor}_2) / 2 = 3.8"$$

$$Q_{p3} = 5830 \left(1 - \frac{3.8}{19}\right) = 4664 \text{ cfs}$$

$$\text{Stor}_{avg} = 3.8 \times 1502 \times \frac{1}{12} = 475 \text{ Ac-ft}$$

$$\text{Stor}_3 \text{ for } Q_{p3} = 430 \text{ Ac-ft for elev } 731$$

$$(\text{Stor}_{avg} + \text{Stor}_3) / 2 = (475 + 430) / 2 = 452.5 \text{ Ac-ft}$$

$$\text{and: } 452.5 \times 12 / 1502 = 3.62"$$

$$Q_{p4} = 5830 \left(1 - \frac{3.62}{19}\right) = 4720 \text{ cfs}$$

E' 4720 yields 430 Ac-ft O.K.

Recheck this by Alternate
Surcharge Routing method

Pitch Reservoir

Jan 1979

In checking surcharge storage by alternate method find surcharge height for peak inflow of 5830 cfs then arbitrarily select several surcharge heights either side of initial height.

from page 7 the initial height = 4.2 inches E_i is called "Stor_i" - select intervals of 5", 4 1/2" & 3"

$$Q_{Pi} = Q_p \left(1 - \frac{\text{Stor}_i}{19''}\right)$$

Stor _i (inches)	$\left(1 - \frac{\text{Stor}_i}{19''}\right)$	Stor _i (Ac-Ft)	Q_{Pi} cfs	Elev from Page 4
5"	0.737	626	4296	732.6
4 1/2"	0.763	563	4449	732.0
3"	0.842	376	4909	730.5

See plot on page 6

Final $Q_{\text{peak (outflow)}} = 4725 \text{ cfs @ Elev } 731.05$

This represents a stage of 4.05' above the spillway crest and a storage volume of approx. 430 Ac-ft above the spillway crest

$$4725 / 5830 = 0.81$$

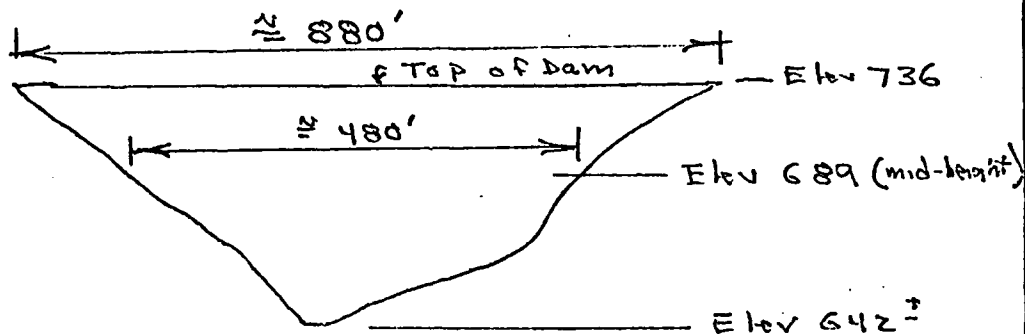
Overtopping.

In view of a 4' head on the spillway using the PMF as the test storm E_i a 5' freeboard remaining it would appear that concern from overtopping should not be warranted.

Pitch Reservoir

Tan 1979

Estimate Downstream Dam Breaching Hydrograph.



Elevation View
Looking Upstream
Not To Scale

Note: PMF routed thru spillway gave a flood crest @ elev 731.0, ∴ the Volume associated with this will be utilized & not the volume associated with the top of Dam.

From page 2 the Volume below the spillway crest = 3117 Ac-Ft

From page 4 the Volume stored when routing the PMF to elev 731.0 = 430 Ac-Ft, ∴ total volume for the downstream hydrograph will be 3117 + 430 = 3547 Ac-Ft.

Compute

$$\text{Peak Failure Outflow} = Q_{P_1} = \frac{8}{27} W_b \sqrt{g} \times Y_0^{3/2}$$

$$W_b = 480' \times 0.40 = 192'$$

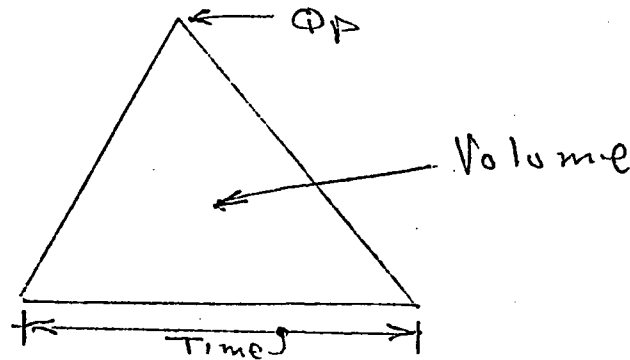
$$Y_0 = \text{elev } 731 - \text{elev } 642 = 89'$$

$$\text{and: } Q_{P_1} = \frac{8}{27} \times 192 \sqrt{32.2} \times 89^{3/2} = 271,031 \text{ cfs}$$

Pitch Reservoir

Jan 1979

Note that in any triangular hydrograph three elements exist.



we have two of them, Q_p & Volume & can therefore find the third, - time.

$$\text{Volume} = \frac{1}{2} \text{ base} \times \text{height}$$

$$3547 \text{ Ac-Ft} = \frac{1}{2} \times T \times 271,031 \text{ cfs} \times \frac{3600}{43560}$$

$$T_{\text{hours}} = 3547 \times 2 \times \frac{1}{271,031} \times 12.1$$
$$= 0.32 \text{ hours}$$

Morris Reservoir is immediately downstream of Pitch Reservoir & it may be that the volume of 3547 Ac-ft in the breaching hydrograph will be absorbed in the reservoir storage of Morris Lake. In any event the contiguity of Morris reservoir precludes the routing procedure associated with the breaching calculations.

Pitch Reservoir

Page 11
May 1979
By OT Ballou

Commentary on Relationships of the 3 water supply Reservoirs in Series when the upper reaches of the 2 downstream "reservoirs" are immediately downstream 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	4570 5015	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 $\rightarrow$ 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.

May 1979

By DT Ballou

Comments:

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

Utilizing rating equations for Morris Reservoir found on page 667, 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 happened.

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 Wiyam Dams. A review of the volume on the previous page shows Morris with a Total storage of ~~4200~~ 4200 Ac-ft as compared to 2946 to 3226 for the Wiyam Reservoir. Note that Morris Reservoir breaching $Q = 450,000$ cfs.

As requested, compute discharge capability of 72" drain conduit that runs under/through the dam

For purposes of determining the maximum capability of this system assume no losses. Under this condition the Bernoulli equation will reduce to:

$$\frac{V_1^2}{2g} + \frac{P_1}{\gamma} + z_1 = \frac{V_2^2}{2g} + \frac{P_2}{\gamma} + z_2 + \Sigma \text{Losses}^{(assumed)}$$

Select point ① @ Reservoir @ top of dam
Point ② @ E of drainage from outlet of conduit

$$V_2 = \sqrt{2g \Delta z}$$

$$\text{and } Q = AV$$

$$\therefore Q = A \sqrt{2g \Delta z}$$

$$= 785.6^2 \sqrt{64.4(736-655)}$$

$$= 28.26 \sqrt{5216.4}$$

$$= 2041 \text{ cfs}$$

Note: The spillway can handle ≈ 16000 cfs at once.

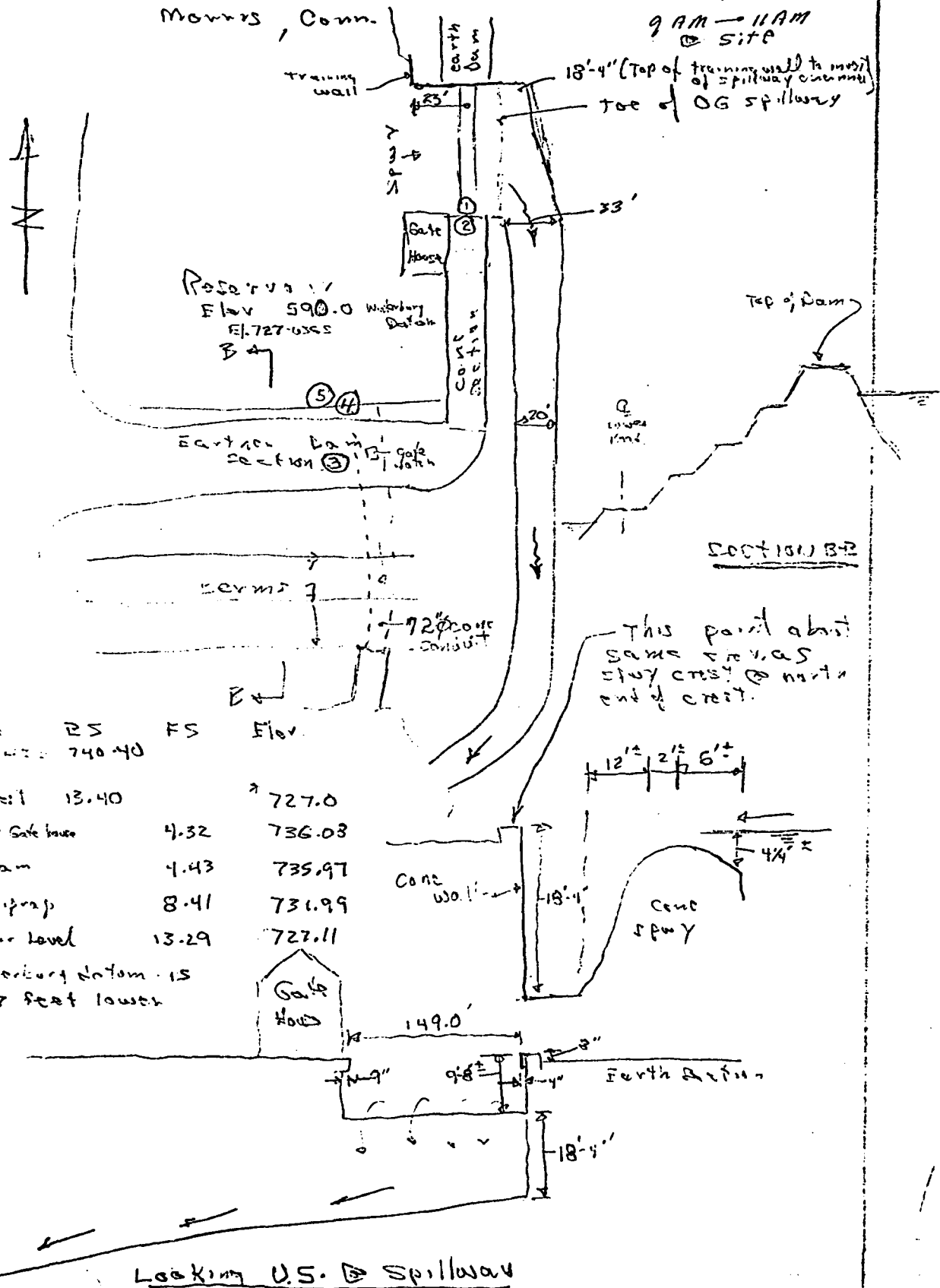
The 72" ϕ was not accounted for in routing the Test Flows.

PITCH RESERVOIR

Morris, Conn.

12/6/78

9 AM - 11 AM
@ Site



APPENDIX E

INFORMATION AS CONTAINED IN THE
INVENTORY OF DAMS

END

FILMED

10-84

DTIC