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INDIAN ORCHARD (MA 00 (U) CORPS OF ENGINEERS WALTHAM
MA NEW ENGLAND DIV JUN 79

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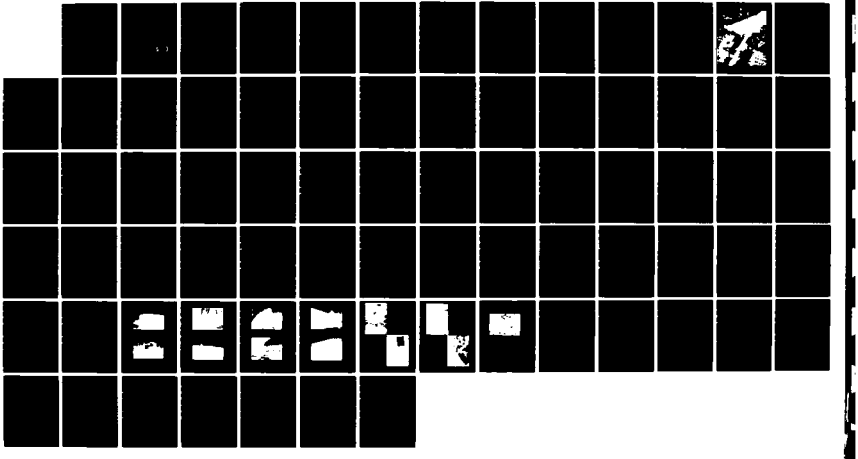

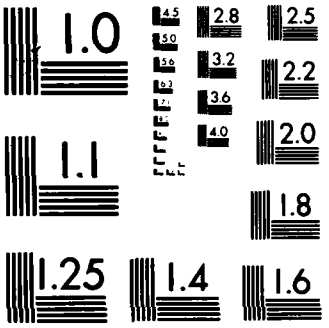

(2)

CONNECTICUT RIVER BASIN

SPRINGFIELD/LUDLOW, MASSACHUSETTS

INDIAN ORCHARD
MA 00722

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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

JUNE 1979

UNCLASSIFIED
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Cover program reads: Phase I Inspection Report, National Dam Inspection Program; however, the official title of the program is: National Program for Inspection of Non-Federal Dams; use cover date for date of report.

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

DAMS, INSPECTION, DAM SAFETY,

Connecticut River Basin
Springfield/Ludlow, Massachusetts
Chicopee River

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

The dam is generally comprised of a 401± ft. long, 10 to 28 ft. high main spillway, a headgate building, an overflow canal spillway and a canal leading to two 8 ft. diameter penstocks used in electrical power generation. It is small in size and has a hazard classification of high. The overall condition of the dam is considered to be fair due to lack of adequate draw down capacity. The visual inspection did not disclose any findings that indicate an immediate condition.

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NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT
BRIEF ASSESSMENT

Identification Number: MA 00722

Name of Dam: Indian Orchard

City: Springfield/Ludlow

County and State: Hampden County, Massachusetts

Stream: Chicopee River

Date of Inspection: December 6, 1978 and April 12, 1979

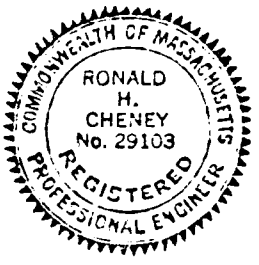
The dam is generally comprised of a 401± foot long, 10 to 28 foot high main spillway, a headgate building, an overflow canal spillway and a canal leading to two 8 foot diameter penstocks used in electrical power generation. There are two inoperable gates located in the main dam. The dam is normally operated with two feet of flashboards above the spillway crest. No records were located which indicate when the dam was constructed. The headgate building is dated 1915. The dam is owned, operated and maintained by the Western Massachusetts Electric Company for the purpose of electric power generation.

The visual inspection did not disclose any findings that indicate an immediate unsafe condition.

The dam has a size classification of small and a hazard classification of high. Based on Crops guidelines, the test flood has a range between the 1/2 and full Probable Maximum Flood (PMF). The 1/2 PMF test flood used will produce an inflow/outflow of 70,830 cfs. The dam is a run-of-the-river type and the spillway crest would be overtopped by about 14 feet. The spillway has a capacity of 29,500 cfs (42 percent of 1/2 PMF outflow) at elevation 166.6, top of non-overflow section. The non-overflow section is overtopped by about six feet. This flow would not overtop the upstream training walls which are at elevation 174.0.

The overall condition of the dam is considered fair due to the lack of adequate draw down capacity. Remedial measures consist of removing vegetation from the downstream face of dam, further observation of seepage at the right abutment, repair the wooden crest cover, and develop a formal warning system to warn downstream areas in case of an emergency. Also, around the clock monitoring of the facility should be provided during periods of intense rainfall. It is recommended that the owner retain the services of a qualified engineer to evaluate the potential for modifying existing, or providing new draw down facilities. These remedial measures and recommendations should be implemented by the owner within one year after receipt of this Phase I Inspection Report.

During both inspections, water was overflowing the dam sufficiently to prevent a close up inspection of the downstream face and the toe of the dam. The owner should engage a qualified engineer to inspect these areas during a period of no overflow. This inspection should be accomplished within one year after receipt of this Phase I report by the owner.



Ronald H. Cheney, P. E.
Associate

Hayden, Harding & Buchanan, Inc.
Boston, Massachusetts

Indian Orchard

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Inspections. 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.

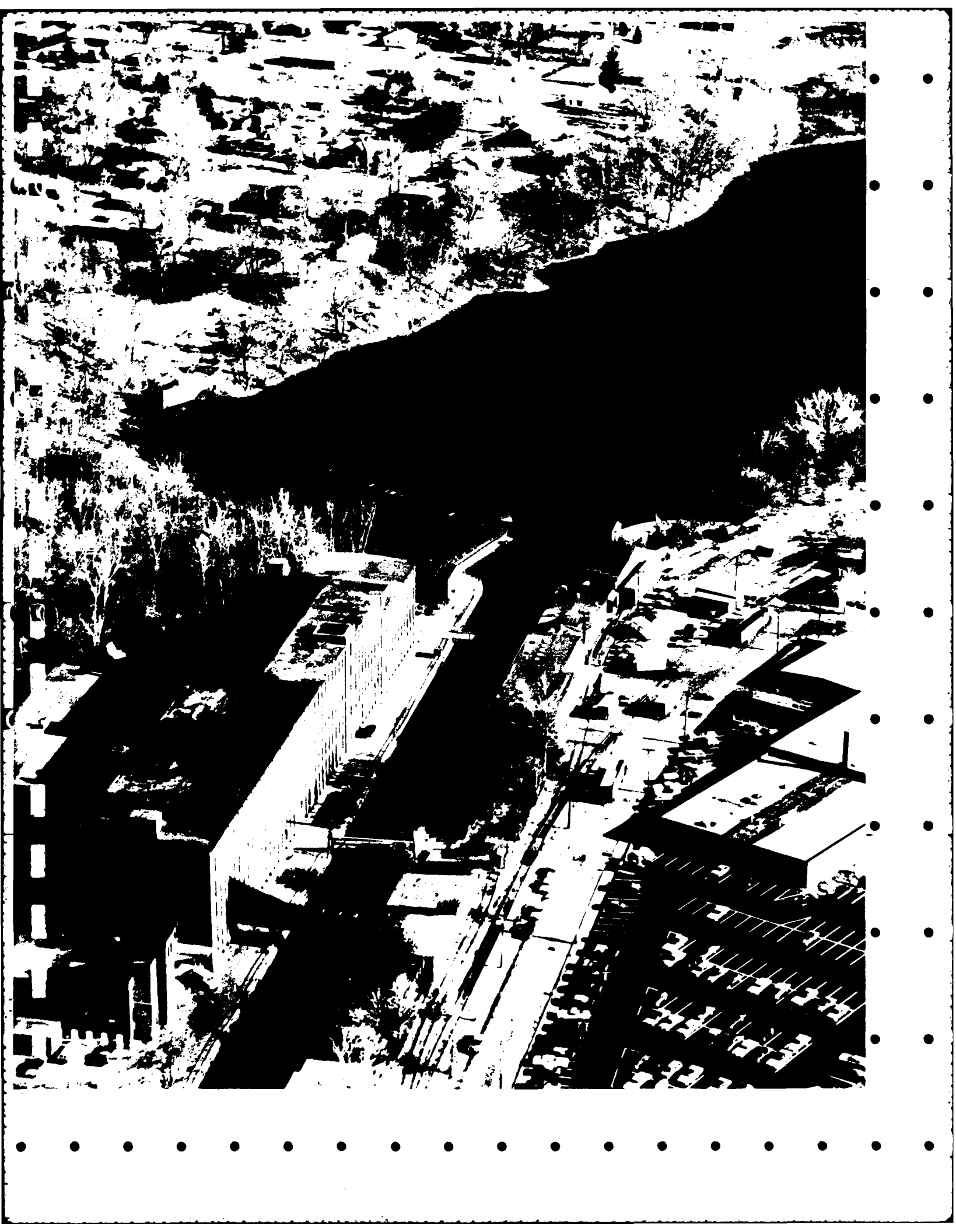
In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving 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 a 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.

CONTENTS

Indian Orchard



PHASE I
NATIONAL DAM INSPECTION PROGRAM

NAME OF DAM: INDIAN ORCHARD

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. Hayden, Harding & Buchanan, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of Massachusetts. Authorization and notice to proceed was issued Hayden, Harding & Buchanan, Inc. under a letter of 28 November 1978 from Max B. Scheider, Colonel, Corps of Engineers. Contract No. DACW 33-79-C-0012 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

The dam, Indian Orchard, is located on the Town line between the City of Springfield, and the Town of Ludlow, in Hampden County, Massachusetts. The dam is located on the Chicopee River about two miles upstream from the Robinson Bridge. The dam is shown on the Springfield North, Massachusetts Quadrangle and has the approximate coordinates of north 42° 9' 38", west 72° 30' 52".

b. Dam and Appurtenances

The dam is generally comprised of a main stone masonry spillway, an overflow canal spillway, a headgate building and a canal. The main spillway has a crest length of 401± feet, a crest width of about 7 feet and has wooden planks to prevent water from flowing onto the downstream face. The downstream height varies from 10 to 28 feet. There are two apparently inoperable 2'-6" wide by 6'-0" high gated sluiceways located about midstream of the downstream face of the spillway.

Approximately 2 feet of flashboards were atop the spillway.

At the left of the main spillway abutment, water flows through a headgate building into the canal. Downstream to the right of this building is an overflow canal spillway which contains 2 gated drain outlet openings. This spillway has a length of about 87 feet and a crest elevation of 160.9 which is approximately 1½ feet above the crest of the main spillway (elevation 159.3). The downstream face is a dumped rock fill sloped at 1.5H:1V and the upstream masonry wall is vertical. The water flows through the canal approximately 1300 feet downstream into two 8 foot diameter penstocks. Water flows through the penstocks into the Indian Orchard power station and exits into the Chicopee River. There is a concrete training wall extending upstream of the left edge of the headgate building. See photographs 1,2,3 and 4 for general views.

There is a concrete training wall upstream of the main spillway's right abutment. A 51 foot sandstone wall extends to the right of this abutment.

c. Size Classification

The dam is classified as small, based upon its height of 28 feet and impounding capacity of 482 acre-feet.

d. Hazard Classification

The dam has a high hazard potential due to downstream development. Should the dam fail, flood stages would rise 6 to 10 feet above base flow stages of 10 to 16 feet. Additional flood depths of 6 to 10 feet could occur. About 30 industrial buildings, work yards, 7 storage tanks, and a sewage treatment plant would be damaged by flood water from dam failure outflow added to a high base flow level.

e. Ownership

The dam is owned by the Western Massachusetts Electric Company.

f. Operator

The dam is maintained by Western Massachusetts Electric Company, Canal Street, Holyoke, Massachusetts 01040. Mr. Carl Schmidt is the designated caretaker (tel.-413-781-4300).

g. Purpose of Dam

The dam was built for power generation and is still used for that purpose.

h. Design and Construction History

There are no records which could be located to indicate when this dam was built. The headgate building at the entrance to the power generating plant canal is dated 1915.

i. Normal Operational Procedure

The dam is normally operated with about 2 feet of flashboards to provide extra head for power generation. Flow is diverted through the headgate building for power generation. Flashboards are shown in photograph 4.

1.3 Pertinent Data

a. Drainage Area

The drainage area of 440,320 acres (688 s.m.) consists of both rural and urban areas. The Chicopee River begins at Three Rivers (near Palmer) at the confluence of the Quaboag, Ware and Swift Rivers. It flows

west, for 25 miles, into the Connecticut River. The dam is located on the Chicopee River about 9 miles upstream of the Connecticut River. A large portion (252 s.m.) of the drainage area is controlled by other dams. The largest are Quabbin Reservoir, Conant Brook, and Barre Falls. Direct runoff is received from 436 s.m. of land (flat to rolling terrain). Peak outflows from these dams are not assumed to coincide with the peak flow from the 436 s.m. direct runoff area.

b. Discharge at Damsite

There are two 2'-6" wide x 6'-0" high sluice openings on the main dam at invert elevation 132±. No other conduits exist. There is no indication of the existence of controls for these gates or of the gates being operated. The maximum known flood occurred on September 21, 1938. The flood peak was 45,200 cfs at elevation 169.0±. The ungated spillway capacity at the top of abutment, elevation 166.6, is 29,500 cfs. At the test flood elevation of 173.0 a capacity of 69,250 cfs is reached.

c. Elevation (ft. above MSL)

(1) Streambed at centerline of dam ----------131

(2) Maximum tailwater ----------152.75

(3) Upstream portal invert diversion tunnel------none

(4) Recreation pool ----------161± top of flashboards

(5) Full flood control pool----------N/A

(6) Spillway crest ----------159.35±

(7) Design surcharge (Original Design)--------unknown

(8) Top Dam ----------166.6

(9) Test flood design surcharge ----------173.0

d. Reservoir

(1) Length of maximum pool---------- 6000'

(2) Length of recreation pool----------4000'

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

e. Storage (acre-feet including base storage)

(1) Spillway crest pool----------482

(2) Recreation pool--------(top of flashboards) 591

(3) Flood control pool----------N/A

(4) Top of dam----------1022

(5) Test flood pool----------1620

f. Reservoir Surface (acres)

(1) Spillway crest----------62

(2) Recreation pool----------69

(3) Flood-control pool---------- N/A

(4) Top dam ---------- 84

(5) Test flood pool----------99

g. Dam

(1) Type -------gravity, granite masonry, concrete

(2) Length----------516'

(3) Height----------28'

(4) Top Width----------7'

(5) Side Slopes ----------9"H:5'V D.S. 1:1 U.S.

(6) Zoning ----------rubble fill - cut stone face

(7) Impervious Core----------unknown

(8) Cutoff----------unknown

(9) Grout curtain----------unknown

h. Diversion and Regulating Tunnel ---------- none

i. Spillway

(1) Type---------- broad crested

(2) Length of weir----------401'±

(3) Crest elevation----------159.35

(4) Gates----------none

(5) U/S Channel---------- river bed

(6) D/S Channel---------- river bed

- General----------has flashboard and planking

j. Regulating Outlets

The principal regulating outlet is at the headgate building. Here, control gates are used to regulate flow into the canal and power generating station. There are 7 wooden gates 8½ feet high by 10 feet wide gating 7½ feet high by 9 feet wide openings in the headgate building. The gates are normally controlled manually, however, there is a semi-automatic electrical control capable of closing down the gates should there be an excess flow within the generating station.

According to Western Massachusetts Electric Company personnel, the inverts of the gate openings are elevation 151.5, which would represent the lowest potential draw down. However, the outflow capacity of the generators and the two 36 inch canal drains compared to the lowest river inflow would indicate that achievement of draw down to this level is highly unlikely. Furthermore the gates can not be considered as main

drains for the spillway as the base of the dam is at elevation 131±.

The two 2'-6" wide by 6' high sluice gates located within the center of the main spillway are believed to be inoperable. These are shown in photograph 3.

SECTION 2

ENGINEERING DATA

2.1 Design

Original plans detailing construction were not located. Plans from Western Massachusetts Electric Company were found which give some indication of construction details. Design calculations were not found.

2.2 Construction

Construction data was not located.

2.3 Operation

There were no formal records of operational procedures for the dam. Water is regulated through the headgate building and canal for electric power generation. There is no record of the main spillway sluice gates being operated.

2.4 Evaluation

a. Availability

Plans and calculations for the original dam construction were not found. Plans prepared in 1971 by Western Massachusetts Electric Company were made available.

Inspection reports for this dam were not available.

b. Adequacy

The lack of indepth engineering data does not allow for a definitive review. Therefore the adequacy of this dam, structurally and hydraulically, can not be assessed from the standpoint of review of design calculations, but must be based primarily on the visual inspection, past performance history, and sound engineering judgement.

c. Validity

The visual inspection of this facility showed no reason to question the validity of the limited information located.

SECTION 3

VISUAL INSPECTION

3.1 Findings

a. General

The Phase I inspection of this dam was made on April 12, 1979 and December 6, 1978. During both inspections, water was flowing over the spillway and prohibited inspection of the downstream face of the dam.

b. Dam

The dam is constructed of stone masonry and has a spillway crest about 401 feet in length. Photograph 4 shows the upstream face of the dam viewed from the left abutment area. On the left abutment is a headgate building which controls flow of water into a canal which parallels the downstream channel for a distance of about 1,300 feet. The canal routes water to Indian Orchard Power Station. The canal has an 87 foot long overflow spillway adjacent to the dam. The headgate building is shown in photographs 1 and 7.

The dam was inspected on December 6, 1978 and April 12, 1979. On December 6, icy conditions and water flow over the crest prevented a thorough inspection of the downstream face. On April 12, water was flowing over the dam and the downstream face could not be inspected.

The upstream face of the dam was completely submerged during both inspections.

During the December 6 inspection, the water depth over the crest was shallow enough to permit a visual assessment that there was no horizontal or vertical misalignment of the crest, photograph 2.

Observations of the downstream face could be made from a distance during the December inspection. The entire stone masonry dam appears to be founded on sandstone bedrock. Near the right abutment the bedrock support of the dam is obvious as shown in photograph 8. The bedrock elevation is lower at the central and left portions of the dam and could be seen for nearly the entire length of the dam on December 6, 1978. The observed bedrock elevations at the base of the dam are consistent with a design drawing of the dam dated May 28, 1971 which shows the dam supported on bedrock for its entire length with bedrock being higher at the right end of the dam.

Vegetation was abundant on the upper 10 feet of the downstream face, as shown in photographs 4, 7 and 8.

It could not be determined if seepage occurs through the downstream face of the dam beneath the wooden planking because water was flowing over the crest of the dam at the time of both inspections.

Seepage was observed on April 12, 1979 from the base of a sandstone block wall on the right abutment. Seepage through this wall was not observed during the December 6, 1978 inspection. Three areas of seepage were observed through the sandstone wall and are described below:

Seep 1: Overall view shown in photograph 9 and close up view shown in photograph 10. Seepage was coming from beneath the lowest row of stone blocks and was about 40 feet to the right of the right end of the right abutment wall and about 6 to 7 feet below the crest. The water appeared to be clear.

Seep 2: A very small seep was observed at the inside corner of the stone block wall at its base photograph 11. This seep was about 15 feet from the spillway crest and about 6 to 7 feet below the crest.

Seep 3: A small seep was observed near the outside corner of the stone block wall at its base, photograph 12. This seep was about 12 feet from the spillway crest and about 6 to 7 feet below the crest.

It is not known with certainity if the above seeps are related to the reservoir level of if they are caused by natural groundwater flow.

A topographic low area observed downstream of the dam to the right of the sandstone block wall had small amounts of standing water which is probably the result of natural groundwater seepage. This standing water is at approximately the same elevation as the seeps mentioned above.

Numerous small seeps were observed along the right bank of the spillway discharge channel through the soil-rock interface and along rock joints. A typical seep is shown in photograph 13. It is not known if this seepage is related to the reservoir level, but the nature and elevation of all the seeps and standing water point to their source being the groundwater in the area. This conclusion is consistent with the results of the December 6, 1978 inspection when none of the seeps were observed and when the groundwater level would be lower than during the April 12, 1979 inspection.

c. Appurtenant Structures

The right side of the canal on the left abutment is formed by a concrete wall backed by a rock fill. This fill is shown in photograph 5. Photograph 6 shows erosion of the downstream slope of the spillway caused by opening a canal drain pipe which exits on the fill slope. This condition does not endanger the masonry dam. It was noted that some timber supports for the wooden spillway cover were missing. These should be replaced as the wooden cover protected the sandstone masonry of the dam. According to Western Massachusetts Electric Company personnel, the composition of the 2'-6" wide by 6'-0" high gates, located at the base of the dam at the center, are unknown and the gates are inoperable. The headgate building contains 7 wooden sluice gates covering 7½ foot high by 9 foot wide intake openings. The opening inverts are at elevation 151.5.

d. Reservoir Area

A detailed description of the drainage area is given in Section 1.3 of this report. Development occurs along the river banks at certain locations, site conditions allowing. Heavy siltation may have occurred within the base storage pool of the dam.

e. Downstream Channel

The downstream channel is in good condition.

3.2 Evaluation

The lack of draw down capabilities does not allow for dewatering in the event of an emergency or the lowering of the water level to allow for proper inspection. As such the overall condition of the dam is considered fair.

Assuming that no major seepage is occurring through the downstream face of the dam beneath the planking, visual inspection indicates the dam is in good condition with respect to the geotechnical aspects. Minor seepage was observed through the downstream face of the sandstone block wall to the right of the spillway section on April 12, 1979. Vegetation was growing on the upper 10 feet of the downstream face of the dam.

It is necessary to make a closer inspection of the downstream face of the dam when no water is passing over the crest.

SECTION 4

OPERATIONAL PROCEDURE

4.1 Procedure

There is no formal operational procedure for the dam. The sluice gates are not used and the inlets may be silted-in. Flashboards are normally used to provide additional head for power generation.

4.2 Maintenance of Dam

The dam is maintained by the Western Massachusetts Electric Company. Little maintenance, other than replacing flashboards, has been recently performed.

4.3 Maintenance of Operating Facilities

Other than replacing damaged flashboards, there is no formal maintenance procedure. The sluice gates have no record of being operated or maintained.

4.4 Description of Warning Systems

There are no warning systems in effect at this facility.

4.5 Evaluation

There is no formal maintenance program for this dam. The dam should be inspected every 2 years by qualified personnel who can identify conditions of concern which if left unchecked could jeopardize the safety of the dam.

SECTION 5

HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. General

The dam was built for power generation. It is a run-of-the-river type project having high spillage and low storage capacity. It was originally constructed of sandstone masonry with a wood cap protector and flashboard. It was later modified, near the abutments, by the addition of concrete walls and riprap.

b. Design Data

Design data was not located. Some modification occurred in 1915 consisting of installation of the gate house and electric generation plant.

c. Experience Data

Both the 1938 (45,200 cfs) and 1955 (40,500 cfs) floods passed the dam without causing any apparent problems. With the electrical power generation station, substantial flow is diverted away from the spillway. About two feet of wooden flashboards are normally used to provide additional operating head.

d. Visual Observations

Development along the downstream channel is concentrated at an industrial site along the south river bank.

Little other development, except for a bridge and dam, occurs near the river channel until Robinson Bridge, some two miles downstream.

e. Test Flood Analysis

Based on Corps guidelines for the size and hazard potential, the test flood range is the ½ to full PMF. The ½ PMF test flood was used. This dam receives runoff from a 688 s.m. area of which only 436 s.m. produces contributing runoff. The remaining areas drain into other reservoirs (the Quabbin Reservoir and the Corps of Engineers Barre Falls and Conant Brook flood control reservoirs) and controlled discharge occurs. Peak outflows from these reservoirs and the uncontrolled drainage areas are not assumed to coincide. Thus, the test flood was developed for the 436 s.m. direct runoff area.

The test flood will produce an inflow/outflow of 70,830 cfs. Stage storage reduction of the inflow is not significant. At this outflow, the river stage elevation will be 173.0 , or about 14 feet over the spillway crest. The flow will be retained within the upstream training walls which are at elevation 174.

With water to elevation 166.6, top of non-overflow section, the spillway capacity is 29,500 cfs, 42% of the test flood. The test flood will overtop the non-overflow area by six feet. However, as noted in the preceeding, the upstream training walls will maintain the flow within the upstream channel. Flashboards were not considered in place for these calculations.

f. Dam Failure Analysis

Dam failure was analyzed with water at two levels. The first condition was with water at spillway crest, elevation 159.35. At this elevation, little base flow would exist downstream and dam failure would release a flow of 32,885 cfs. Within the first 3000 feet downstream, there is an industrial complex. Flood stage would be about nine feet. Buildings here could be damaged by one to five feet of floodwater.

The next area, 5000 to 7000 feet downstream, is an industrial complex. There, flood stage would be about eight feet. Buildings along this reach could be damaged by one to three feet of floodwater. At 9000 feet downstream there is a sewerage treatment plant. Flood stage here is about nine feet. The plant is above the floodwater level.

Considering a second condition, with water level at elevation 166.6, there is a base outflow of 29,500 cfs just prior to dam failure. Water released from storage causes an increase in outflow of 34,900 cfs, for a total outflow of 64,400 cfs. It should be noted that prior to dam failure the base outflow of 29,500 cfs would have caused significant flooding. Dam failure increases the flood stages.

Within the first 3000 feet downstream, flood stage including dam failure outflow, varies from 16 to 20 feet. This is an increase of about 6 to 10 feet above the base flow condition just prior to failure. It appears that about 2 buildings will receive about 6 to 8 feet of flood-

water damage from dam failure. Base flow floodwater depths at the buildings would be about two feet prior to dam failure.

Near 6400 feet downstream there is an industrial area. Combined flood stage is about 20 feet, an increase of eight feet over the base flow stage of 12 feet. Base flow floodwater depths at building locations would be about four to seven feet. About 12 buildings would receive flood damage. Dam failure would cause an additional eight feet of floodwater damage above that caused by the base flow. It appears that an additional 28 buildings, or more, and seven storage tanks would receive floodwater damages.

At 9000 feet downstream, there is a sewerage treatment plant. Dam failure flood stage is about 25 feet, nine feet higher than the base flow stage. Flood water depth from dam failure would be about 9 feet compared to about one foot from the base flow condition.

Beyond this location, more damage could occur if structures are located close to the river channel.

SECTION 6

STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

The visual observations did not disclose any immediate stability problems; however it is necessary to inspect the downstream face of the dam when water is not spilling over the crest to adequately assess the stability of the dam for a Phase I Level Investigation.

b. Design and Construction Data

A design drawing of the dam indicates that the downstream face is battered at 9"H:5'V with a total height which varies with elevation of the supporting sandstone bedrock. The base thickness of the dam is 30 feet. The thickness of the crest is about 7 feet.

Details of the wooden planking on the dam crest are given on the May 28, 1971 drawing, shown in Appendix B.

Cross sections through the canal spillway are given along with cross sections through the upstream and downstream training walls along the left abutment.

c. Operating Records

No operating records were disclosed.

d. Post-Construction Changes

Plans dated May 28, 1971 indicate modifications to the headgate area. Concrete channel walls were constructed, the date is not known.

e. Seismic Stability

The dam is located in Seismic Zone 2 and in accordance with the recommended Phase I guidelines does not warrant seismic analysis.

SECTION 7

ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 Assessment

a. Condition

The condition of the dam could not be completely assessed because the downstream face of the dam could not be inspected due to water flow over the crest. In general, the dam appears to be in good condition. However due to the absence of adequate dewatering facilities, the overall condition of the dam is considered to be fair.

b. Adequacy of Information

The information made available, along with the visual inspection, is adequate for a Phase I Level Investigation.

c. Urgency

The additional investigation outlined in Section 7.1.d, as recommended in Section 7.2.2, should be made within one year after receipt of this Phase I report by the owner.

The remaining items associated with the recommendations of Section 7.2 and remedial measures of Section 7.3 should be implemented by the owner within one year after receipt of this Phase I Report.

d. Need for Additional Information

For a thorough investigation to be made, it is necessary to inspect more closely the condition of the downstream face of the dam beneath the wooden planking. In order to make this inspection, the elevation of the reservoir must be below the elevation of the spillway crest. During our field visits, this part of the investigation was prohibited by water flowing over the spillway crest.

7.2 Recommendations

1. The dam in its present condition has no operational draw down facility. The sluice gates in the main spillway are silted in and contain no apparent controls. The power station intakes are not capable of drawing the water level down. The lack of draw down prevents thorough inspection of the dam and rapid dewatering capabilities during emergency conditions. This lack of draw down capabilities is considered a major deficiency. The owner should engage a qualified engineer to evaluate the potential of restoring or modifying the existing draw down facilities and/or design of a new draw down facility.

2. The owner should retain the services of a qualified engineer to investigate the downstream face of dam as indicated in 7.1.d.

7.3 Remedial Measures

a. Operating and Maintenance Procedures

1. The owner should remove vegetation from the downstream face of the dam.

2. The owner should observe the seepage through the sandstone block wall to the right of the spillway noted in Section 3.1.b at the times of known low groundwater.

3. The owner should replace or repair missing or damaged timber supports and planks for the wooden spillway crest cover.

4. The owner should develop a formal warning system to warn the downstream area in case of an emergency. Around the clock monitoring of the facility should be provided during periods of intense rainfall.

5. This dam should be inspected every two years by qualified personnel who can identify areas of concern which, if left unchecked, could jeopardize the safety of the dam.

7.4 Alternatives

There are no practical alternatives for this dam.

APPENDIX A

INSPECTION CHECKLIST

VISUAL INSPECTION CHECKLIST
PARTY ORGANIZATION

PROJECT Indian Orchard

DATE December 6, 1978 *

TIME 10:30 A.M.

WEATHER Cloudy

W.S. ELEV. 161+ U.S. DN.S.

PARTY:

1. Ron Cheney HHB
2. David Vine HHB
3. Dan LaGatta GEI
4. Joe Clark Western Mass Electric
5. Ed Zaik Northeast Util.
6. Mike Angieri HHB
7. Tom Keller GEI
8.
9.
10.

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.	Main Spillway	Ron Cheney, Dave Vine, Mike Angieri	
2.	Canal and Canal Spillway	Ron Cheney, Dave Vine, Mike Angieri	
3.	Abutments	Dan LaGatta, Tom Keller	
4.	Hydraulic/Hydrologic	Mike Angieri	
5.			
6.			
7.			
8.			
9.			
10.			

* Reinspected on April, 12, 1979 clear 55° W.S. elevation 161.5.

PERIODIC INSPECTION CHECKLIST

PROJECT Indian Orchard DATE December 6, 1978

PROJECT FEATURE Dam Embankment NAME Ron Cheney

DISCIPLINE Structural Engineer NAME Dan LaGatta
Geotechnical Engineer

AREA EVALUATED	CONDITION
DAM EMBANKMENT	
Crest Elevation	Dam is a stone masonry spillway. This section does not apply.
Current Pool Elevation	
Maximum Impoundment to Date	
Surface Cracks	
Pavement Condition	
Movement or Settlement of Crest	
Lateral Movement	
Vertical Alignment	
Horizontal Alignment	
Condition at Abutment and at Concrete Structures	
Indications of Movement of Structural Items on Slopes	
Trespassing on Slopes	
Sloughing or Erosion of Slopes or Abutments	
Rock Slope Protection - Riprap Failures	
Unusual Movement or Cracking at or Near Toes	
Unusual Embankment or Downstream Seepage	
Piping or Boils	
Foundation Drainage Features	
Toe Drains	
Instrumentation System	
Vegetation	

LIST OF ENGINEERING DATA

1. Plan dated May 28, 1971, furnished by Western Massachusetts Electric Company, Canal Street, Holyoke, Massachusettt 01040

Indian Orchard

APPENDIX B

ENGINEERING DATA

PERIODIC INSPECTION CHECKLIST

PROJECT: Indian Orchard — DATE: December 6, 1978

PROJECT FEATURE: Service Bridge — NAME: Ron Cheney

DISCIPLINE: Structural Engineer / Geotechnical Engineer — NAME: Dan LaGatta

AREA EVALUATED	CONDITION
OUTLET WORKS - SERVICE BRIDGE	
a. Super Structure	There is a wooden cat walk with steel handrails traversing the canal overflow spillway. There is a concrete walkway with steel handrails located upstream of the head gate building. Both are in good condition with no apparent signs of distress.
Bearings	
Anchor Bolts	
Bridge Seat	
Longitudinal Members	
Underside of Deck	
Secondary Bracing	
Deck	
Drainage System	
Railings	
Expansion Joints	
Paint	
b. Abutment & Piers	
General Condition of Concrete	
Alignment of Abutment	
Approach to Bridge	
Condition of Seat & Backwall	

PERIODIC INSPECTION CHECKLIST

PROJECT Indian Orchard — DATE December 6, 1978

PROJECT FEATURE Spillway — NAME Ron Cheney

DISCIPLINE Structural Engineer / Geotechnical Engineer — NAME Dan LaGatta

AREA EVALUATED	CONDITION
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	Spillway is the main section of Dam.
a. Approach Channel	The approach channel is the Chicopee River
General Condition	Good
Loose Rock Overhanging Channel	None observed
Trees Overhanging Channel	None observed
Floor of Approach Channel	River bed trees in some areas but do not prevent flow
b. Weir and Training Walls	
General Condition of Concrete	Stone mansonry in good condition
Rust or Staining	None observed
Spalling	At several locations corbels supporting wood planking sheared off.
Any Visible Reinforcing	None
Any Seepage or Efflorescence	Overflow prevented thorough inspection
Drain Holes	None
c. Discharge Channel	Discharge channel is river channel
General Condition	Good
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	None of significance
Floor of Channel	Unobstructed
Other Obstructions	None

PERIODIC INSPECTION CHECKLIST

PROJECT Indian Orchard DATE December 6, 1978

PROJECT FEATURE Outlet Works NAME Ron Cheney

DISCIPLINE Structural Engineer
Geotechnical Engineer NAME Dan LaGatta

AREA EVALUATED	CONDITION
OUTLET WORKS - TRANSITION AND CONDUIT	There is no transition or conduit. There is a 1300 Ft. canal to the power station which appeared to be in good condition.
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 Indian Orchard — DATE December 6, 1978

PROJECT FEATURE - Outlet Structure — NAME Ron Cheney

DISCIPLINE Structural Engineer
Geotechnical Engineer — NAME Dan LaGatta

AREA EVALUATED	CONDITION
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	There is no outlet structure.
General Condition of Concrete	
Rust or Staining	
Spalling	
Erosion or Cavitation	
Visible Reinforcing	
Any Seepage or Efflorescence	
Condition at Joints	
Drain holes	Draingates in canal spillway have caused erosion of downstream slope of canal spillway.
Channel	
Loose Rock or Trees Overhanging Channel	
Condition of Discharge Channel	

PERIODIC INSPECTION CHECKLIST

PROJECT Indian Orchard — DATE December 6, 1978

PROJECT FEATURE Gate House — NAME Ron Chenev

DISCIPLINE Structural Engineer — NAME Dan LaGatta
Geotechnical Engineer

AREA EVALUATED	CONDITION
OUTLET WORKS - CONTROL TOWER	
a. Concrete and Structural	Brick gate house with concrete slab at head of canal.
General Condition	Good
Condition of Joints	Good
Spalling	None observed
Visible Reinforcing	None observed
Rusting or Staining of Concrete	None observed
Any Seepage or Efflorescence	None
Joint Alignment	Good
Unusual Seepage or Leaks in Gate Chamber	None observed
Cracks	None observed
Rusting or Corrosion of Steel	None observed
b. Mechanical and Electrical	Gates in canal gate house manually operated.
Air Vents	Sluice gates in main spillway have no apparent controls.
Float Wells	
Crane Hoist	
Elevator	
Hydraulic System	
Service Gates	
Emergency Gates	
Lightning Protection System	
Emergency Power System	
Wiring and Lighting System	

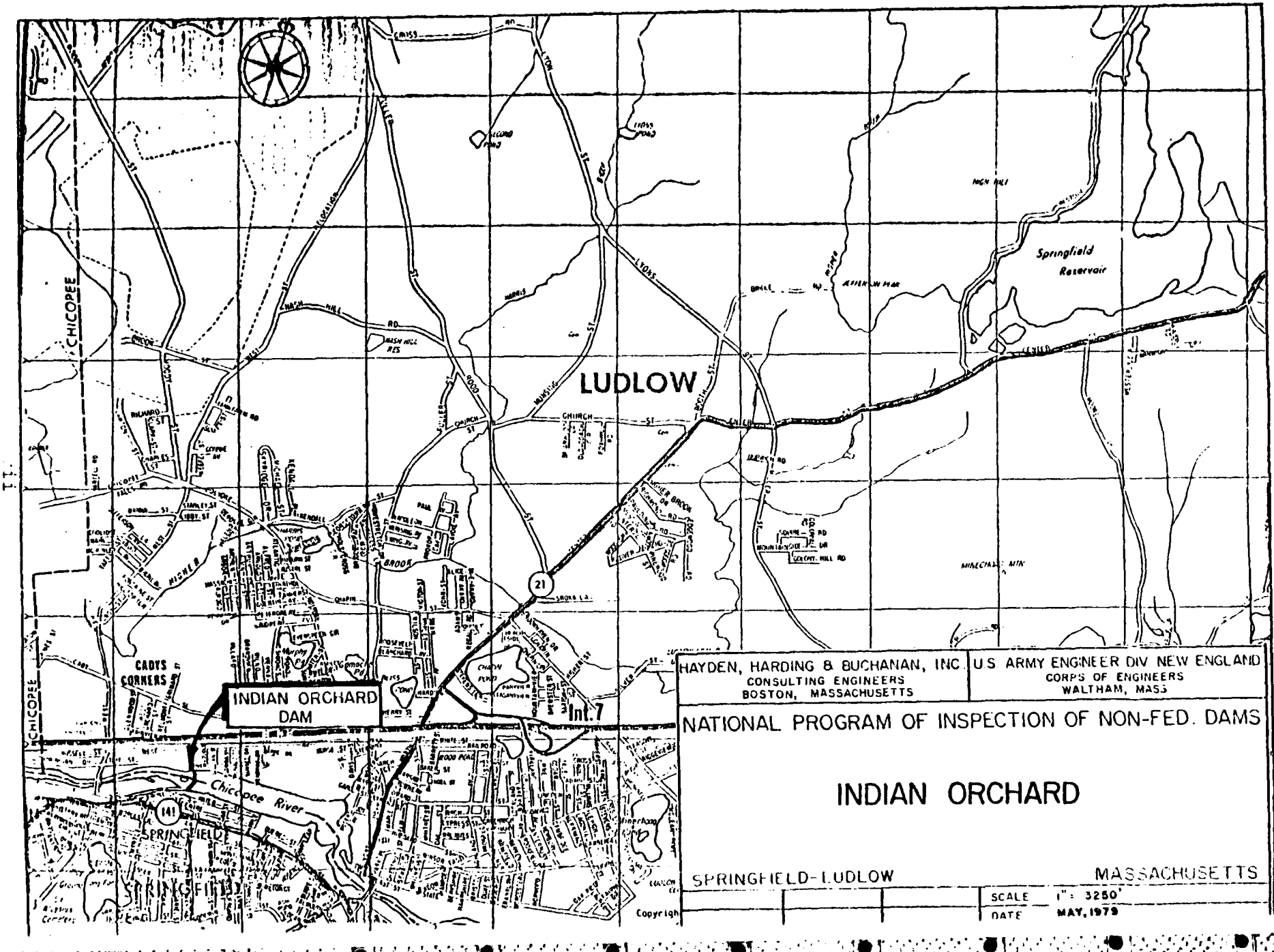
PERIODIC INSPECTION CHECKLIST

PROJECT Indian Orchard DATE December 6, 1978

PROJECT FEATURE Intake Channel & Structure NAME Ron Cheney

DISCIPLINE Structural Engineer NAME Dan LaGatta
Geotechnical Engineer

AREA EVALUATED	CONDITION
OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE	
a. Approach Channel	No approach channel
Slope Conditions	
Bottom Conditions	
Rock Slides or Falls	
Log Boom	
Debris	
Condition of Concrete Lining	
Drains or Weep Holes	
b. Intake Structure	No Intake structure
Condition of Concrete	
Stop Logs and Slots	



HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON, MASSACHUSETTS

U.S. ARMY ENGINEER DIV NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS

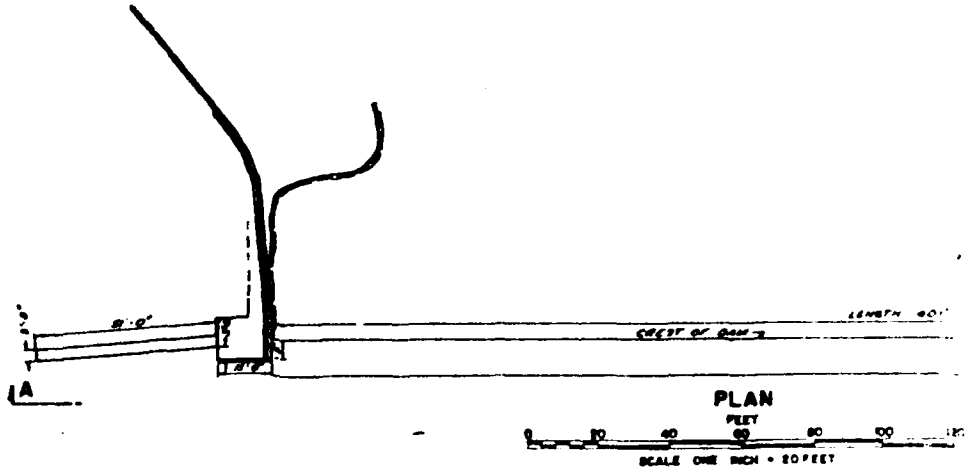
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

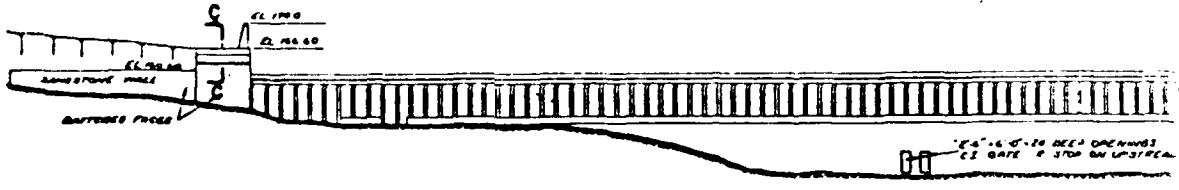
INDIAN ORCHARD

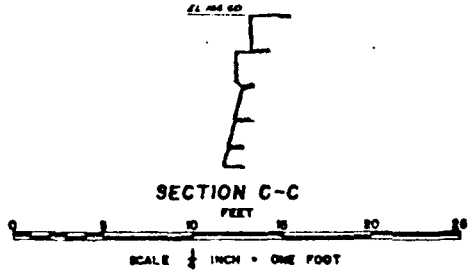
SPRINGFIELD-LUDLOW MASSACHUSETTS

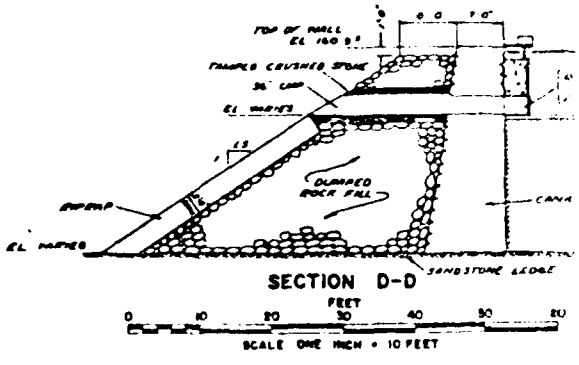
SCALE 1" = 3250'

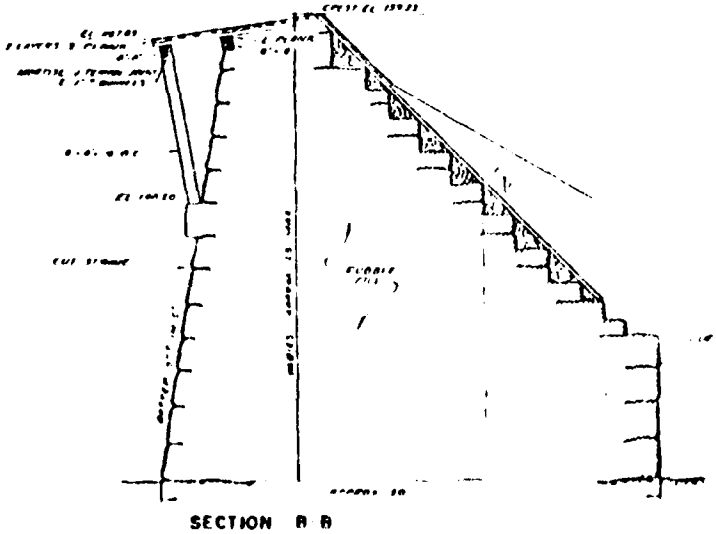
DATE MAY, 1979

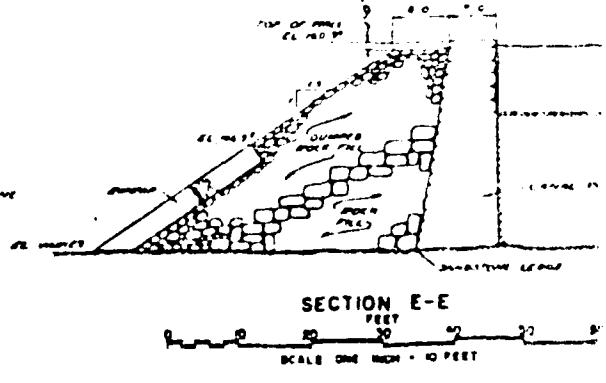


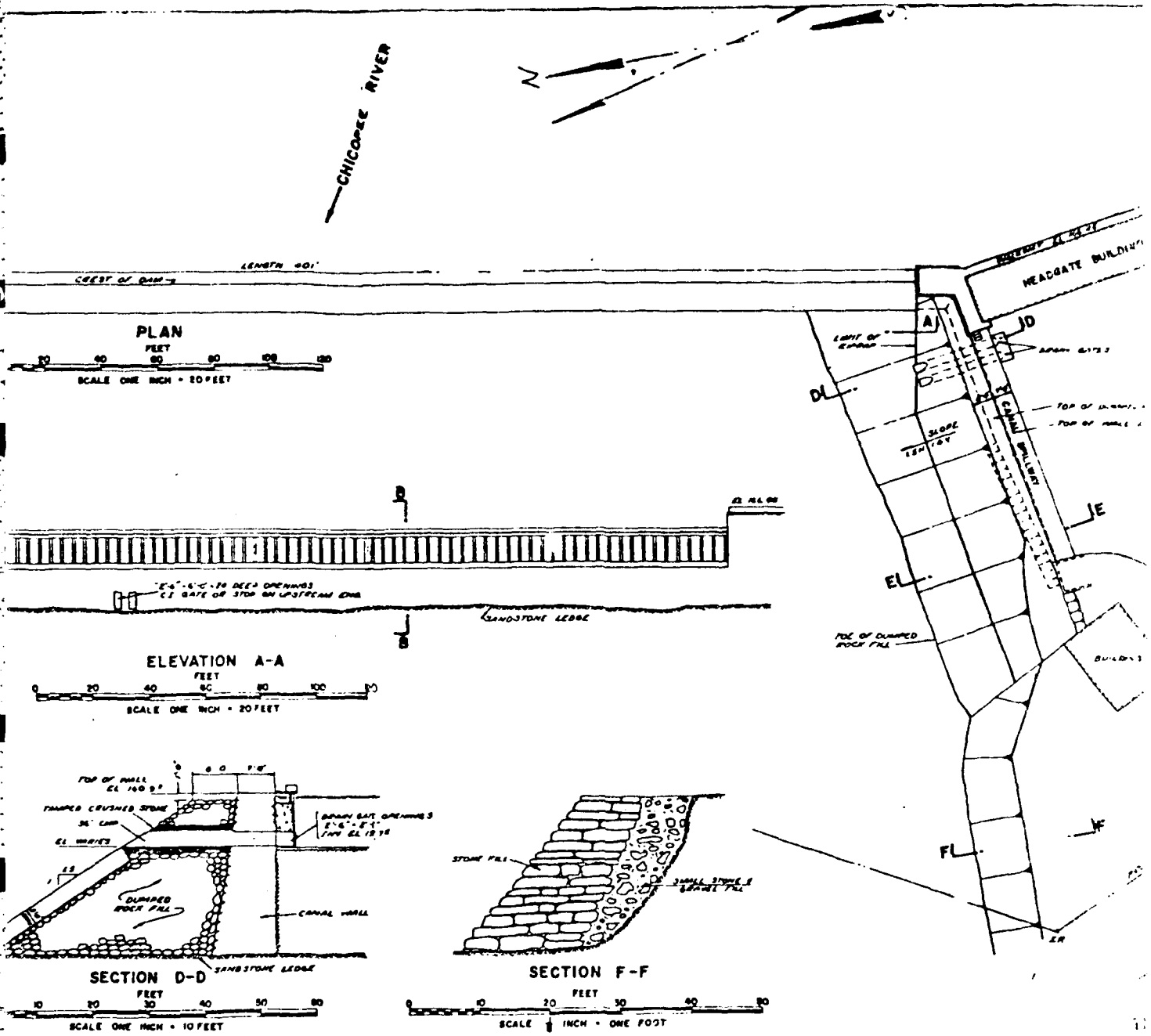












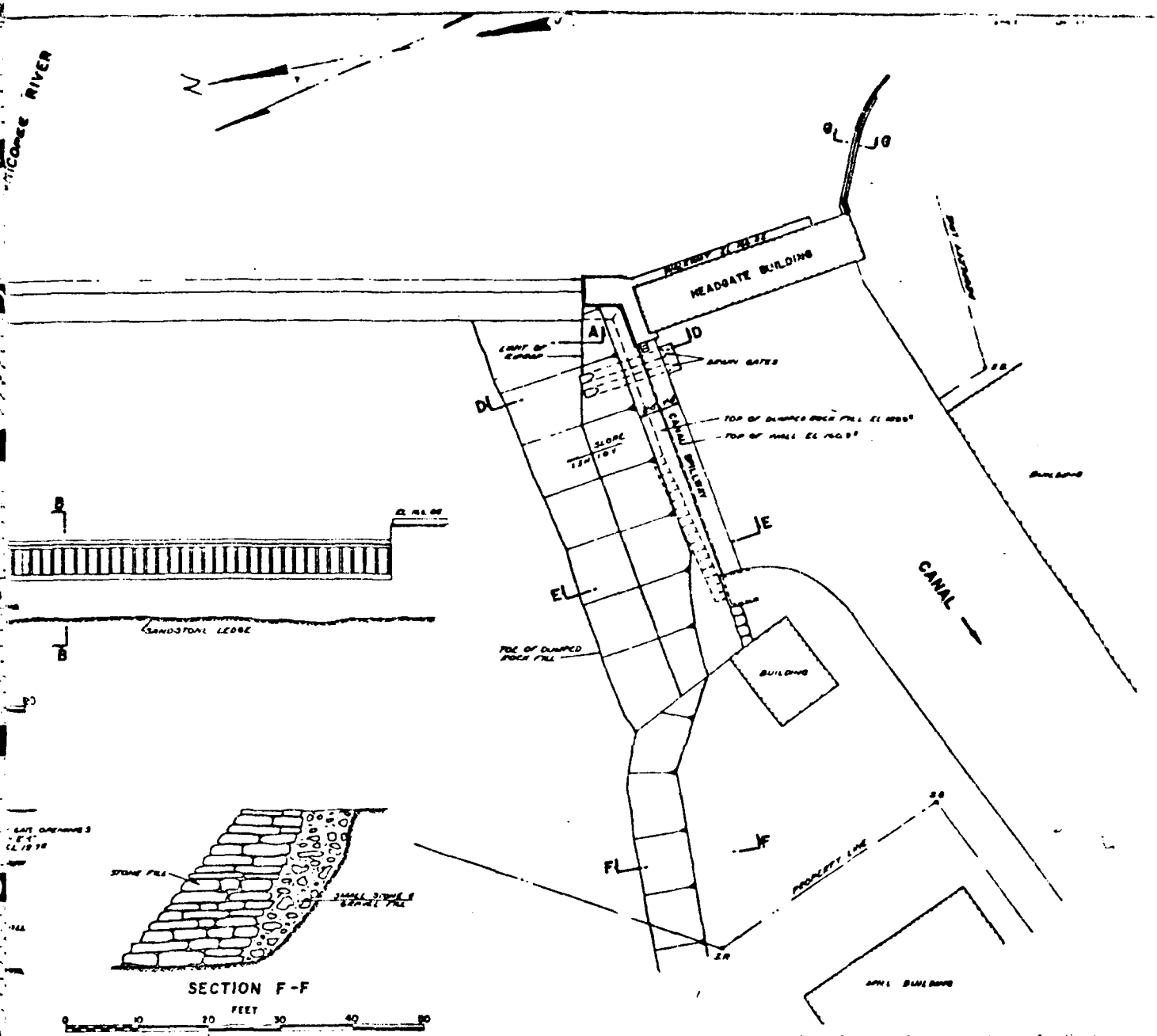
HAYDEN, HARDING & BUCHANAN,
CONSULTING ENGINEERS
BOSTON, MASSACHUSETTS

NATIONAL PROGRAM OF

INDIAN

SPRINGFIELD-LUDLOW

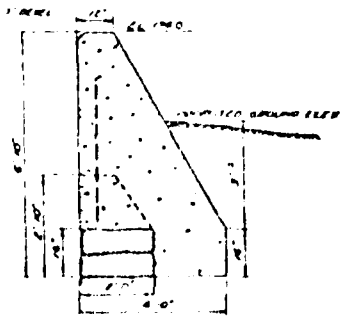
1 12



SECTION F-F

FEET 0 10 20 30 40 50

SCALE 1 INCH = ONE FOOT



SECTION G-G

FEET 0 5 10 15

SCALE 1 INCH = ONE FOOT

This Drawing is a part of the Application for License made by the undersigned this 28th day of May 1971

Western Massachusetts Electric Company

by _____ Vice President

HAYDEN, HARDING & BUCHANAN, INC CONSULTING ENGINEERS BOSTON, MASSACHUSETTS	U.S. ARMY ENGINEER DIV. NEW ... CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED...

INDIAN ORCHARD

SPRINGFIELD-LUDLOW

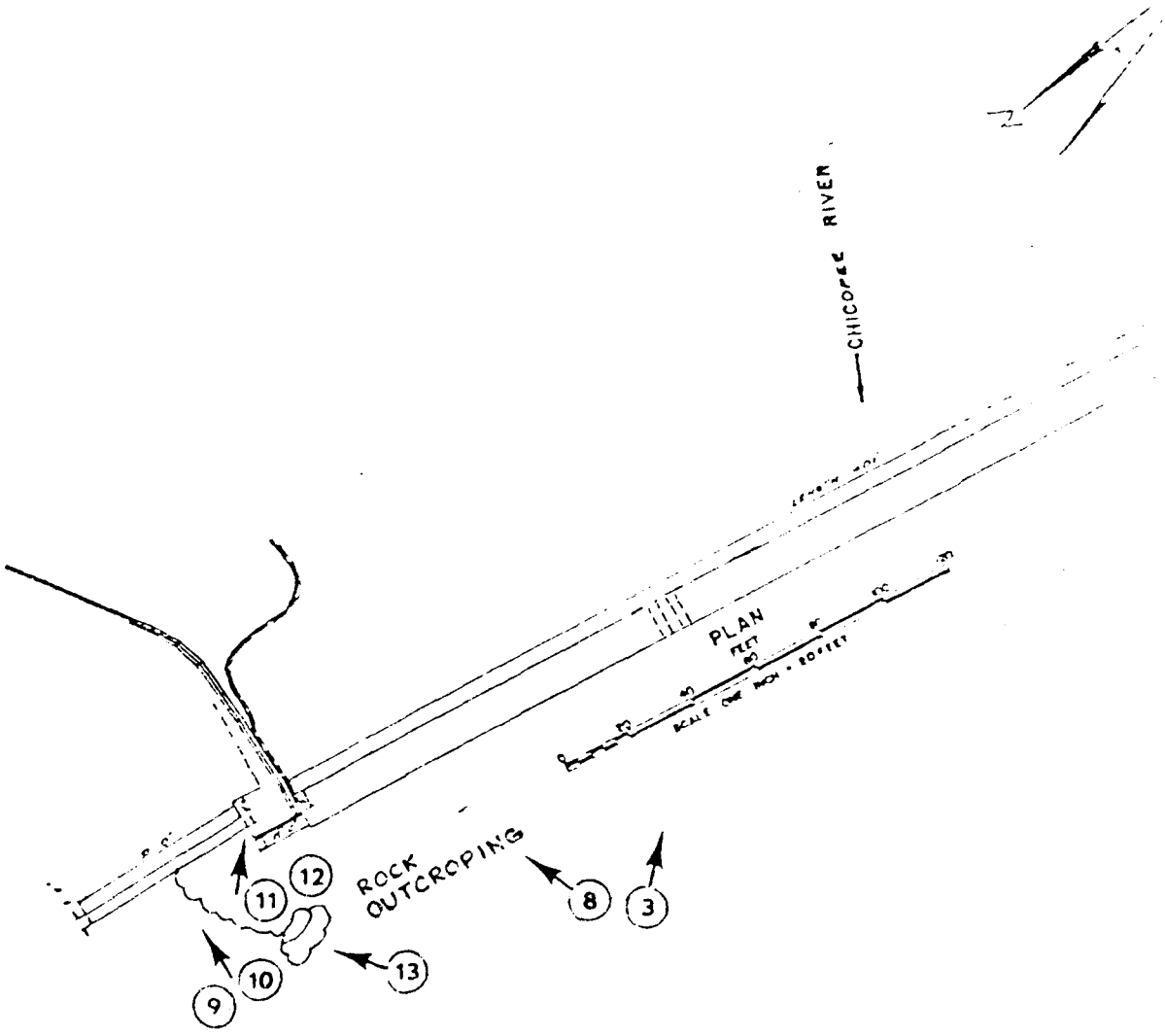
MASS. A...

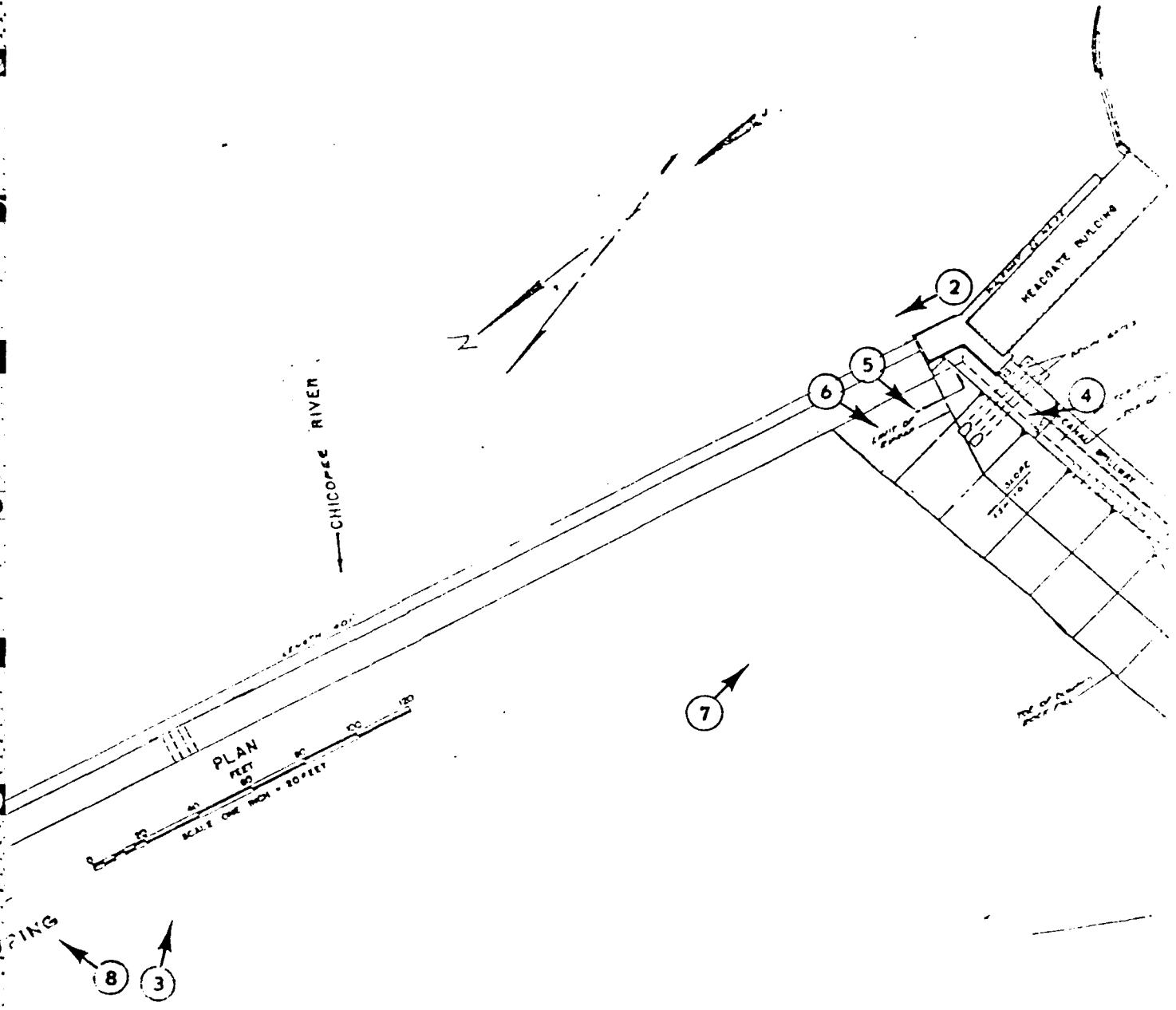
SCALE AS NOTED

DATE MAY ... 71

APPENDIX C

PHOTOGRAPHS





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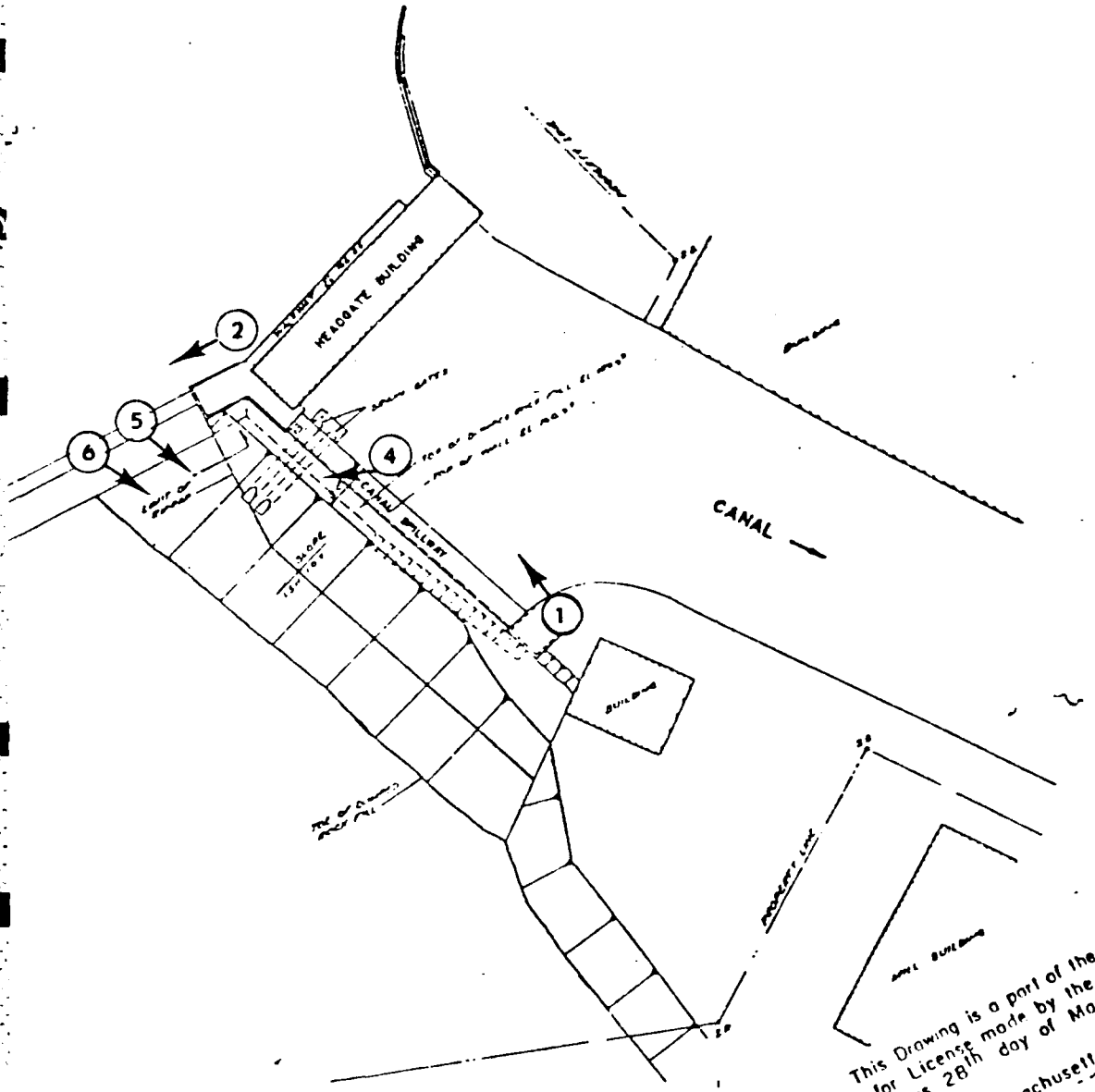


This Drawing is a part of the Application for License made by the undersigned this 28th day of May 1971.

Western Massachusetts Electric Company

by _____ Vice President

HAYDEN, HARDING & BUCHANAN, INC CONSULTING ENGINEERS BOSTON, MASSACHUSETTS	U.S. ARMY ENGINEER DIV. N.E.W.P. CORPS OF ENGINEERS WALTHAM, MASS

NATIONAL PROGRAM OF INSPECTION OF NON-FED.

LOCATION OF PHOTOGRAPHS
INDIAN ORCHARD

SPRINGFIELD/LUDLOW MASSACHUSETTS

3

SCALE NOT TO SCALE
DATE MAY 19, 1972

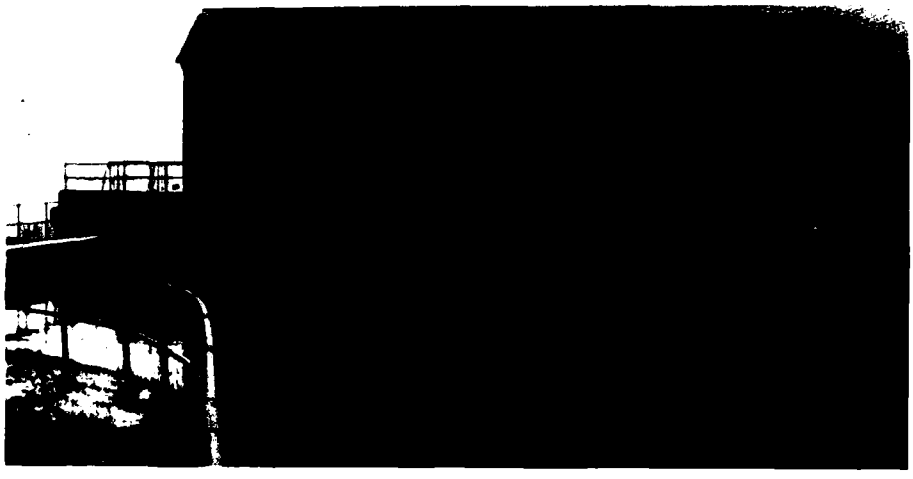


PHOTO NO. 1 - View looking upstream at headgate building.

PHOTO NO. 2 - Crest of dam as viewed from left abutment.

PHOTO NO. 3 - View looking upstream at 2'6" X 6'0" gated sluiceways.

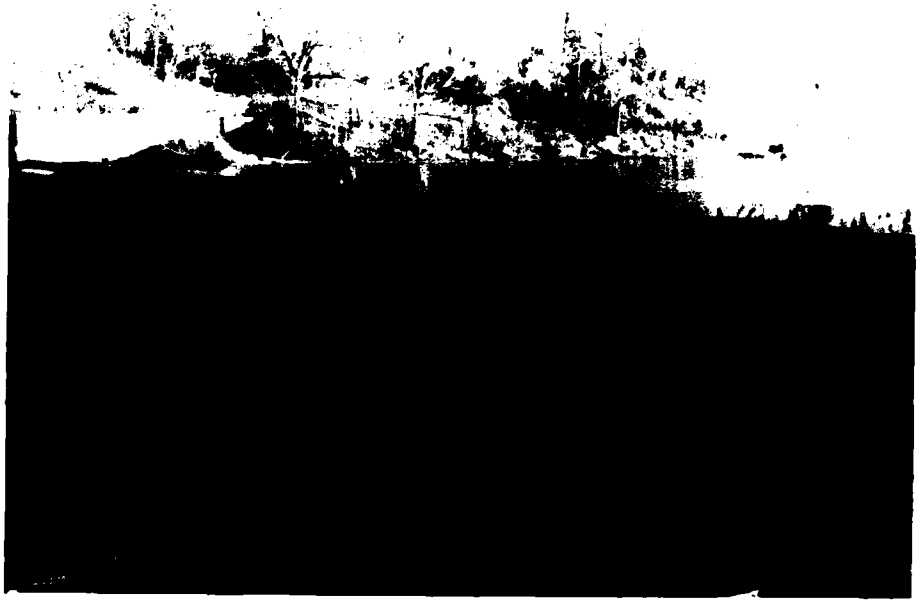


PHOTO NO. 4 - Downstream face of dam as viewed from canal.

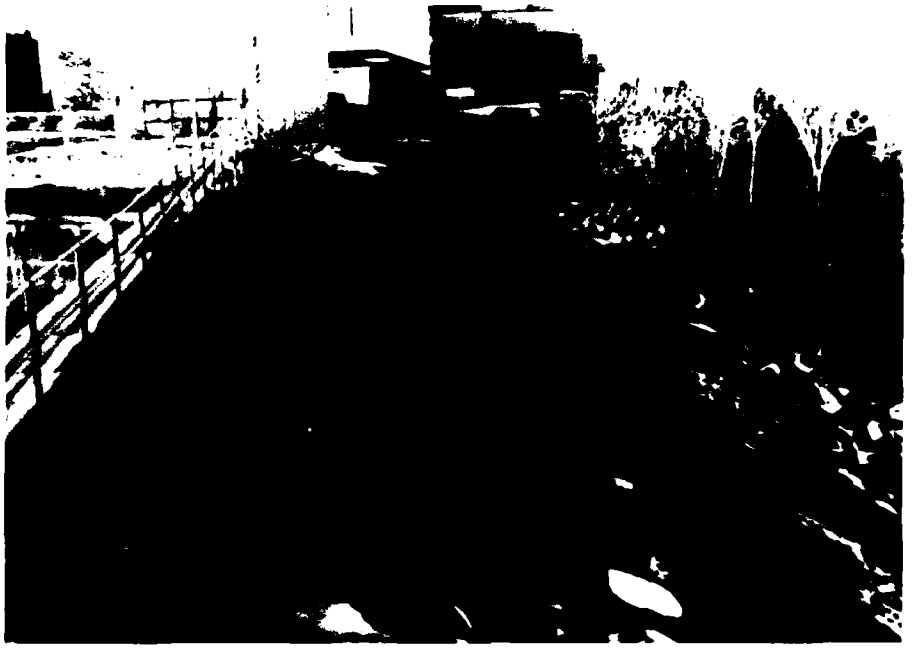


PHOTO NO. 5 - Downstream slope of canal spillway.

PHOTO NO. 6 - Downstream slope of spillway showing eroded area caused by opening canal drainpipes.

PHOTO NO. 7 - Downstream face of dam near left abutment and right portion of canal spillway. Note missing timber for wooden spillway crest cover.

PHOTO NO. 8 - Foundation bedrock (red sandstone) at right end of dam.

PHOTO NO. 9 - Overall view of seepage shown in PHOTO NO. 10

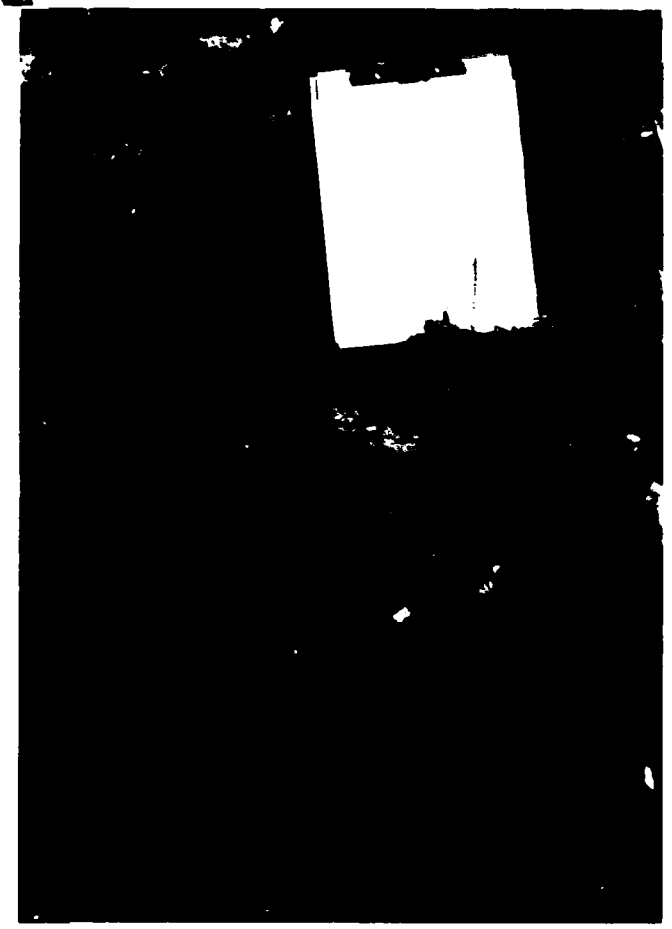


PHOTO NO. 10 - close-up view of seepage from under stone block wall forty feet right of spillway, downstream side.

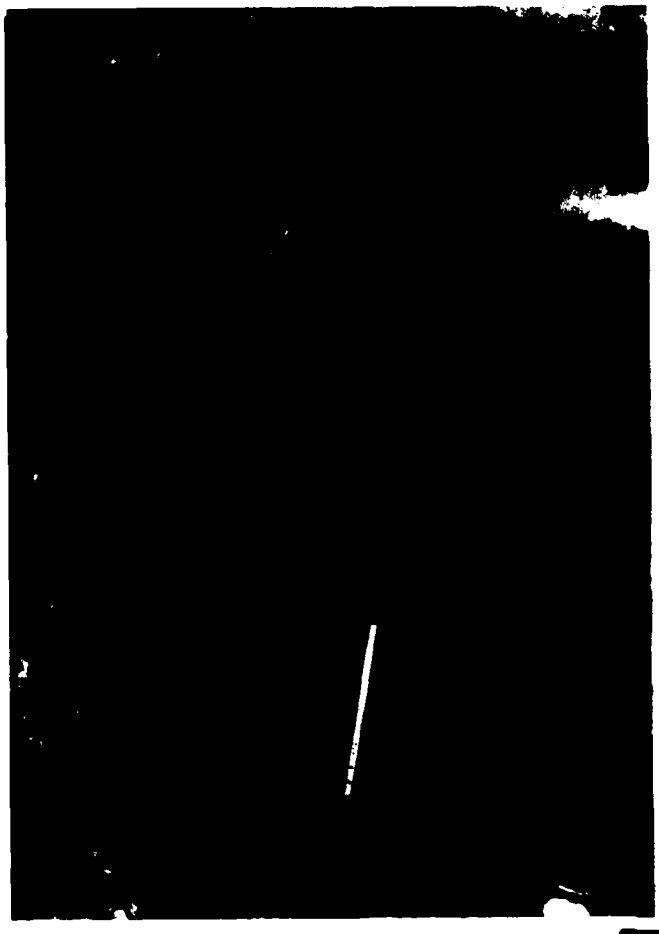


PHOTO NO. 11 - Seepage at inside corner of stone block wall to the right of the spillway, downstream side.

PHOTO NO. 12 - Seepage near outside corner of stone block wall to the right side of the spillway, downstream side.

PHOTO NO. 13 - Water seeping from ground 20 feet downstream of stone block wall and 30 feet right of the right edge of spillway.

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

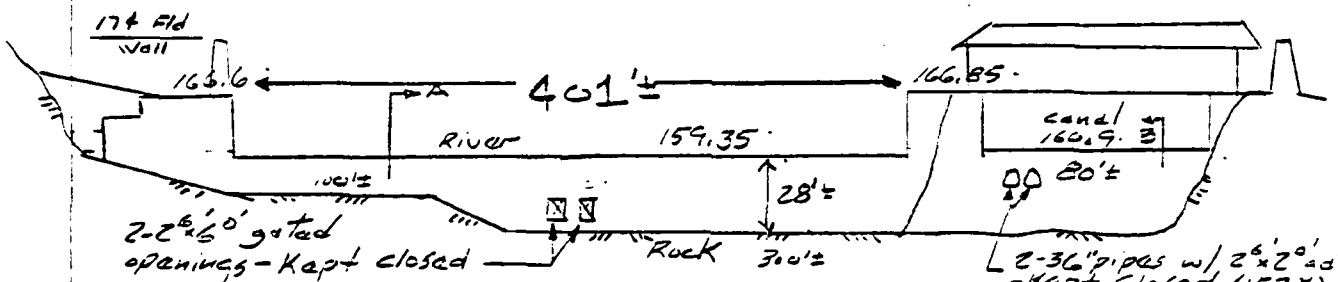
NO. 78.240.1
E 1122.1-G
Y MA
D BY FDD 3/5/79

HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON MASSACHUSETTS

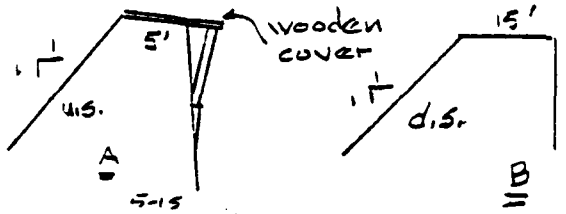
SHEET NO. 1
JOB Dams
SUBJECT Indian Orchard
CLIENT Corps

Indian Orchard - Built 1885±, Power Generation

GSC #377 · 688 s.m. drainage area, 80.7 cfs/sm (adj.)
dur 19, 1955 Q = 40,500 · (1938 45,200 cfs, 68± cfs/sm)



Top dam = 532'± (el. 166±)



Size Class: SMALL
Hydraulic Height ≈ 28'±
Storage Capacity ≈ 482± a-f. (may be silted-in)
Hazard Potential: High (Industrial Development)
TEST FLOOD: Range-½PMF to PMF: USE ½PMF

Drainage Area: 1) Quabbin Res 189 sm
2) Conant Brook: 8 sm; 3) Barre Falls: 55 sm
"Uncontrolled" direct drainage area ≈ 436 sm.
Assume peaks don't coincide due to size of dams and time-delays. Flat to Rolling Areas

Test Flood = 436 × 325 cfsm × ½ = 70,850. cfs

Dam Failure (See page 6 - high stage failure) Low stage

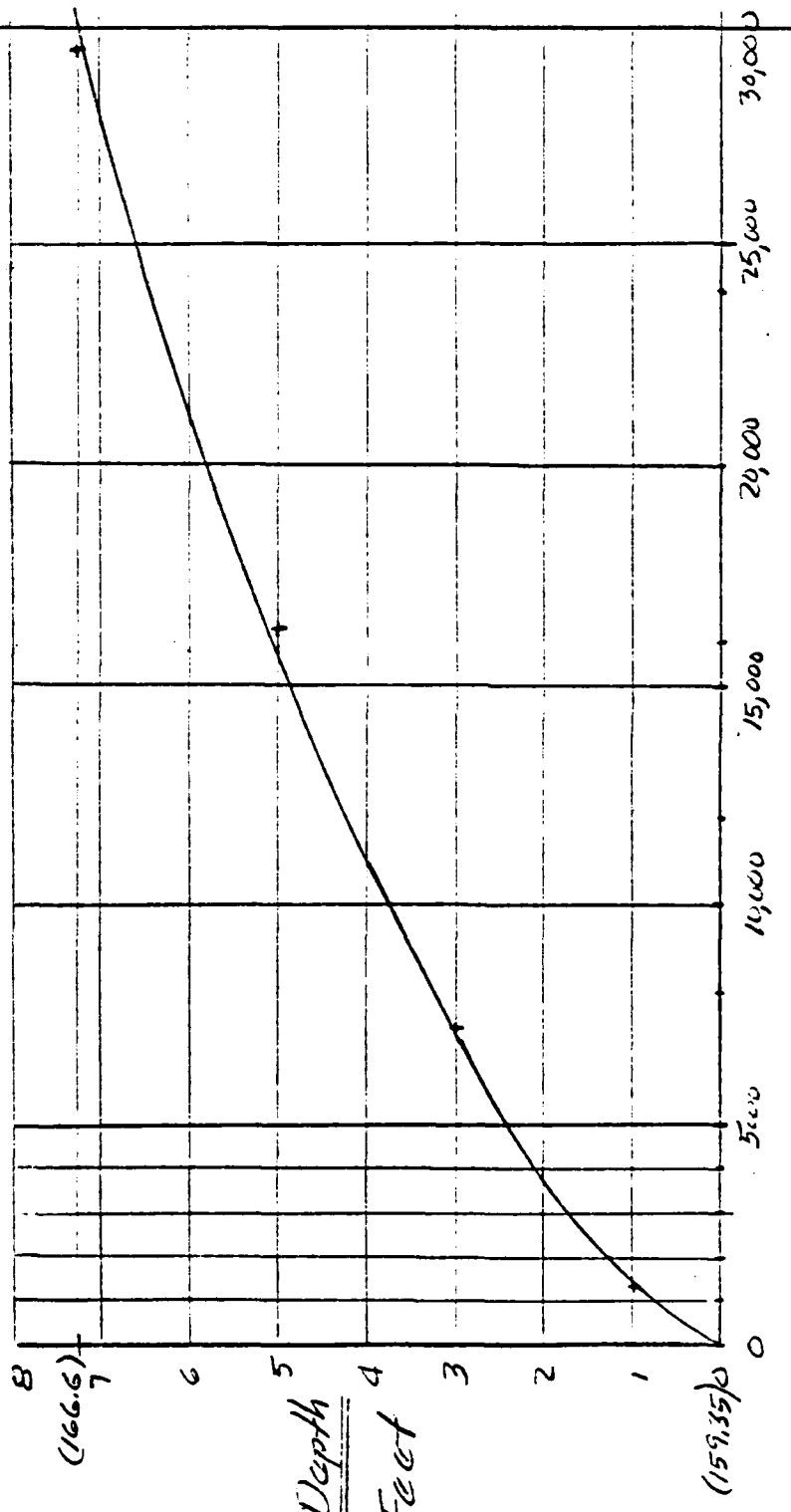
$Q = \frac{8}{27}(.4 \times 330)\sqrt{32.2}\,(28.)^{1.5} = 32,885.$ cfs

Sta	Stage Elev	Damage		Flood Stage
2+00±	145.5	Power Plant	0'±	10.5
29+00±	136.0	Bldgs - Bsmnts	5'± (4)	9'
64+00±	128.0	"	3'± (3)	8'
90+00±	125.0	Treat. Plant	Above Flooding	9'

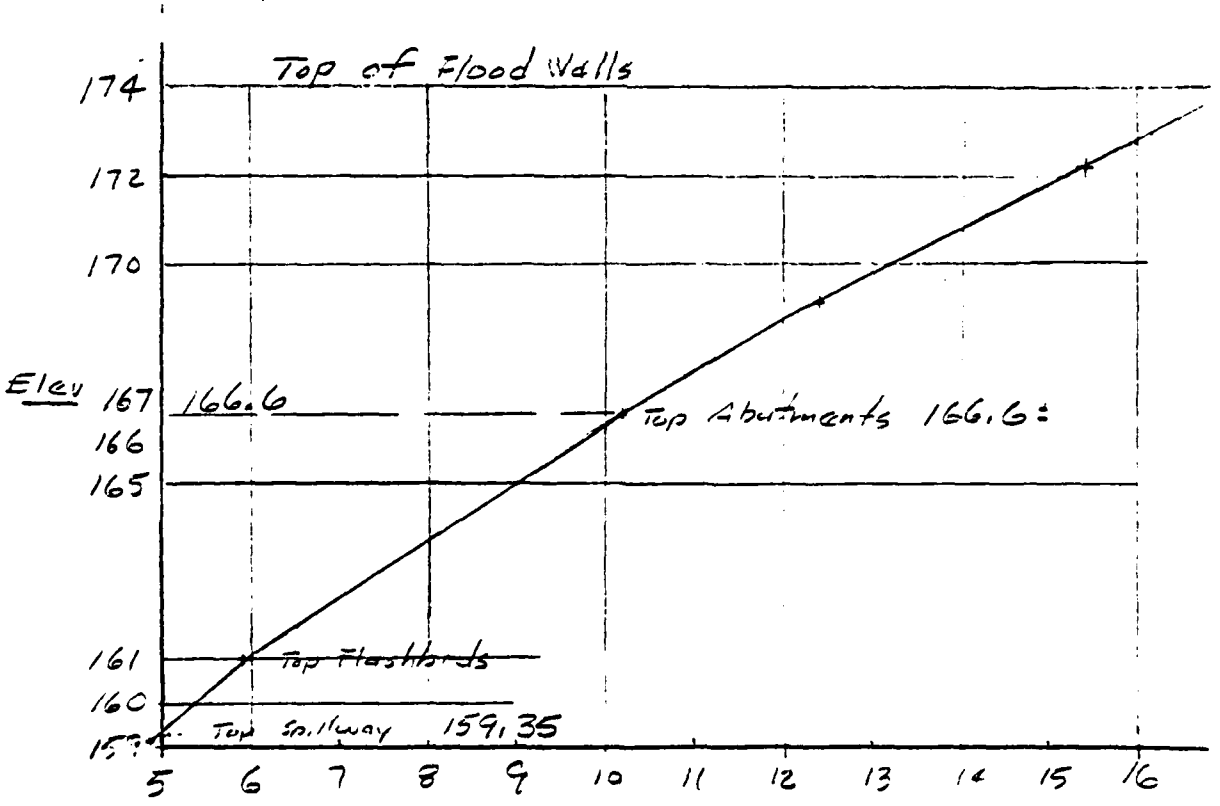
JOB NO. 78.244
DATE 6-15-79
BY WA
CH'D BY DBV 6.22.79

HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON MASSACHUSETTS

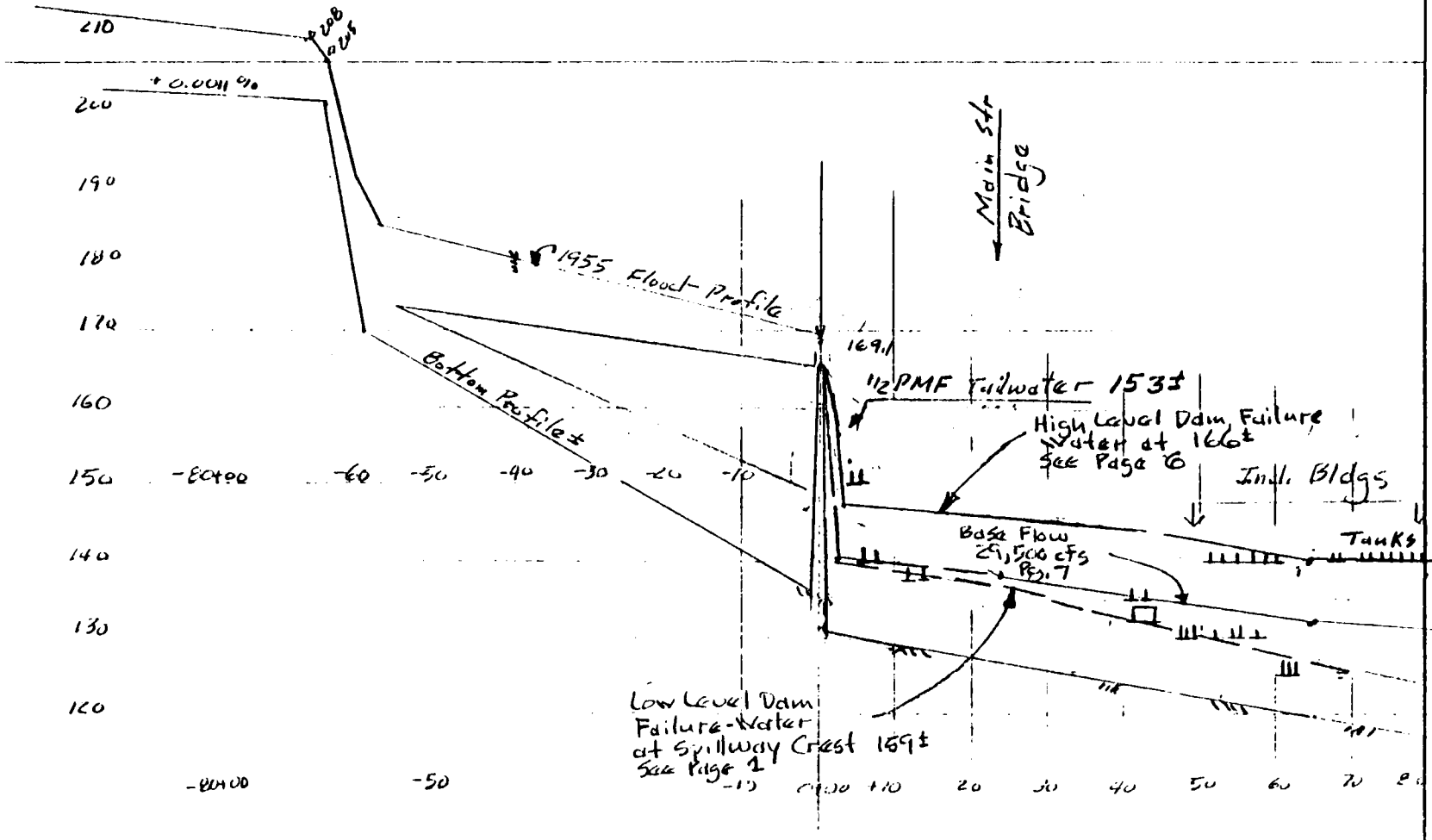
SHEET NO. 3
JOB Dam
SUBJECT Indian Creek
CLIENT Corps



Elev	D	Area	Avg. Area	Stor	Accum Stor
	ft.	a.	a.	a-f	a-f
135	0	—	—	—	—
140	5.	8.	4.	20.	20.
150	10.	24	16.	160.	180.
159.35	9.35	62	43.	402.	582
161	1.65	69	66.	109.	591
166.6	5.6	84	77	431.	1022
169.1	2.5	91	88.	220.	1242
170.	0.9	93.	92.	83.	1325
172.25	2.25	99	96.	216.	1541
180	7.75	117.			



Storage x 100 a-f
(NO Base Storage included)



* Exact building elevations unknown.

JOB NO 72,244.1
DATE 11/23/74
BY MH
CH'D BY COD 12/3/74

HH&B HAYDEN, HARDING & BUCHANAN, IN
CONSULTING ENGINEERS
BOSTON MASSACHUSETTS

JOB Dams
SUBJECT Hyd Engrg
CLIENT Corps

SHEET NO 5

JOB NO. 78.244.1
DATE 5/21/79
BY mA
CHK'D BY FDD 6/22/79

HH&B HAYDEN, HARDING & BUCHANAN, INC
CONSULTING ENGINEERS
BOSTON MASSACHUSETTS

SHEET NO. 6
JOB Davis
SUBJECT Indian Creek
CLIENT Corps

Dam Failure - High Stage Flow

Failure with water at elev 166.6, top of abutments.

Outflow-Failure $166.6 - 141 = 25.6'$

$Q = \frac{8}{27}(0.4 \times 401)\sqrt{32.2}\,(25.6)^{3/2} = 34{,}900$ cfs water released from storage by dam failure. add to base outflow below

Base Flow Prior to Failure

Spillway discharge = 29,500 cfs (depth = 14'),
+ 34900
Combined flow = 64,400 cfs

Flood Stage

Sta	Base Flow Stage	Failure Stage	Failure Increase
2+00	10.5± ft	16.5 ft	6.0 ft
24+00	10.5±	20 "	9.5 "
64+00	12.0±	20 "	8 "
90+00	14.75±	25 "	9 "

Flood Elevation - Failure

Sta to	Elev	Bldg Damage By Base Flow	Bldg Damage By Failure	Flooding Depth " Base Flow	Flooding Depth " Failure
2+00 ±(141)	147.±	0	0	0	0
24+00 ±(137.5)	147.0	2	2	2'	+ 8'±
64+00 ±(134)	140.0	12	28, 7 tanks	4' to 7'±	+ 8'±
90+00 ±(131)	140.0	0	treatment Plant	1	9 ±

Base Flow = ( )

+ = increase over base

JOB NO. 78.204.1
DATE 1/23/79
BY MA
CH'D BY FDD 2/5/79

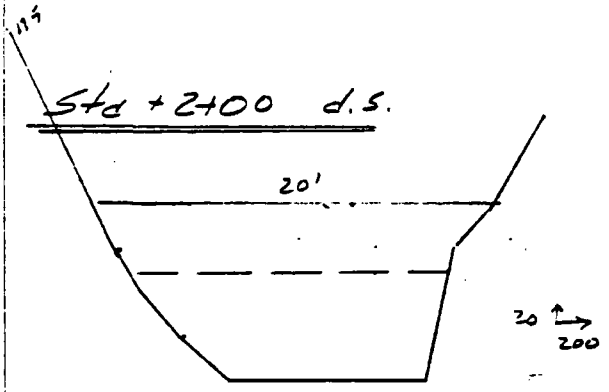
HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON MASSACHUSETTS

SHEET NO. 7
JOB Ddm
SUBJECT Indian Orchard
CLIENT Corps

½ PMF Outflow

$Q_{P_1} = 70,850$ cfs $El_1 = 173.0 \pm$ Stor = 1138 a-f
less than ½" storage

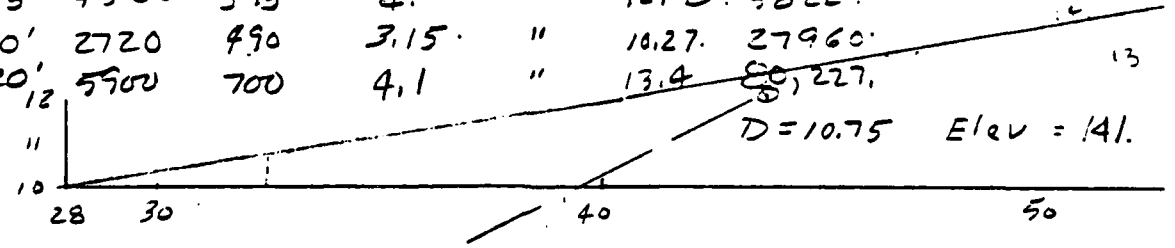
$Q_3 = Q_2 = Q_R = 70,850$ cfs "No effective storage"

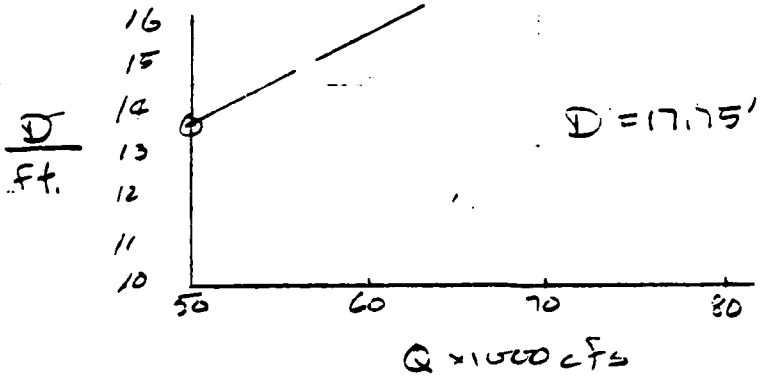


$Q_{55} = 40500$ cfs
$Q_{Fail} = 33,000$ cfs.

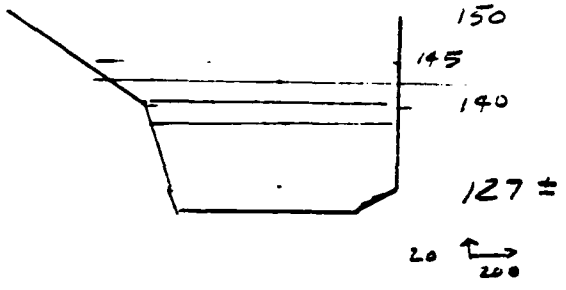
$A = \frac{358+220}{2}(12) = 3420$ sf
$V = 11.84$
$WP = 500$ $K = 3.26$
$R^{2/3} = 3.63$ $n = 0.0$

D	A	WP	$R^{2/3}$	K	V	Q
12	3420	500	3.63	3.26	11.84	40500
15	4500	575	4.-	"	12.93	58224
10'	2720	490	3.15	"	10.27	27960
20' 12	5500	700	4.1	"	13.4	80,227





Sta + 24+00 (near bridge)

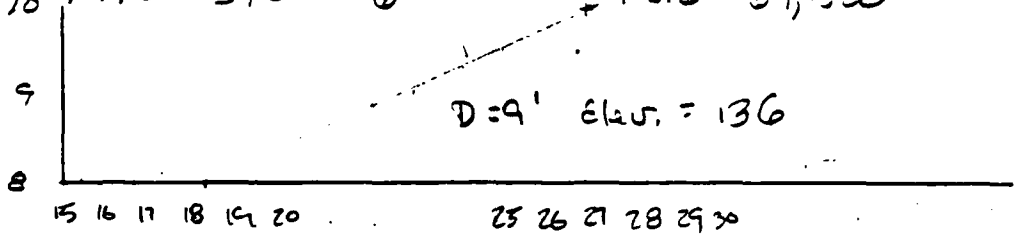


$$K = \frac{1.486}{n}(.00126)^{1/2}$$

$$n = \left(\frac{2.3(.0431)}{1.486}\right)^{-1}$$

$n = 0.02784$

D	A	WP	$R^{2/3}$	K	V	Q
12'	4290	330	5.6	2.3	12.82	55021
10'	2650	290	4.4	2.3	10.12	26837
8	2090	285	3.8	"	8.74	18,265
15/10	4910	340	6	"	13.8	67,500

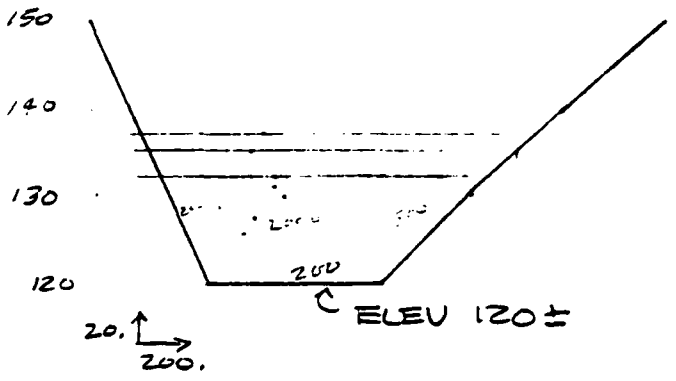


$Q_{P_1} = 33000$ $\quad Sto_{r_1} = \frac{3070+3210}{2} \times \frac{22}{43.56} = 159$ c.f.

$Q_{P_2} = 33000\left(1 - \frac{163}{482}\right) = 21{,}840$ cfs $\quad Sto_{r_2} = \frac{2200+3070}{2}(\frac{1}{43.56}) = 132$

$Q_{P_3} = 33000\left(1 - \frac{146}{482}\right) = 23000.\pm$ cfs

Sta 64+00



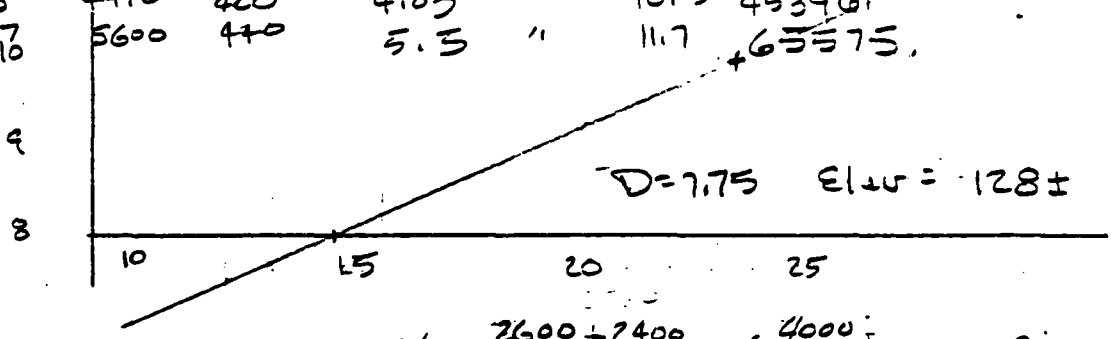
$S = \frac{10}{5400} = 0.00185$ ft/ft

$n = 0.03$

$K = \frac{1.486}{.03}(.0431) = 2.13$

$Q_{P_1} = 23{,}000.$ cfs

D	A	wp	$R^{2/3}$	K	V	Q
12'	3240	371	4.3	2.13	9.1	29,479.
10'	2600	340	3.9	2.13	9.	23,400.
8'	1960	310	3.44	2.13	7.33	14362
15	4410	420	4.83	"	10.3	45396
17 10	5600	470	5.5	"	11.7	65575.



D = 7.75 Elev = 128±

$Q_{P_1} = 23{,}000.$ $S_{tr} = \frac{2600 + 2400}{2}\left(\frac{4000}{43{,}560}\right) = 229$

$Q_{P_2} = 23{,}000.\left(1 - \frac{229}{482}\right) = 12{,}045.$ cfs

$S_{tr} = \frac{180 + 2400}{2}(0.092) = 194$

$Q_{P_3} = 23{,}000.\left(1 - \frac{211}{482}\right) = 12{,}931.$ cfs

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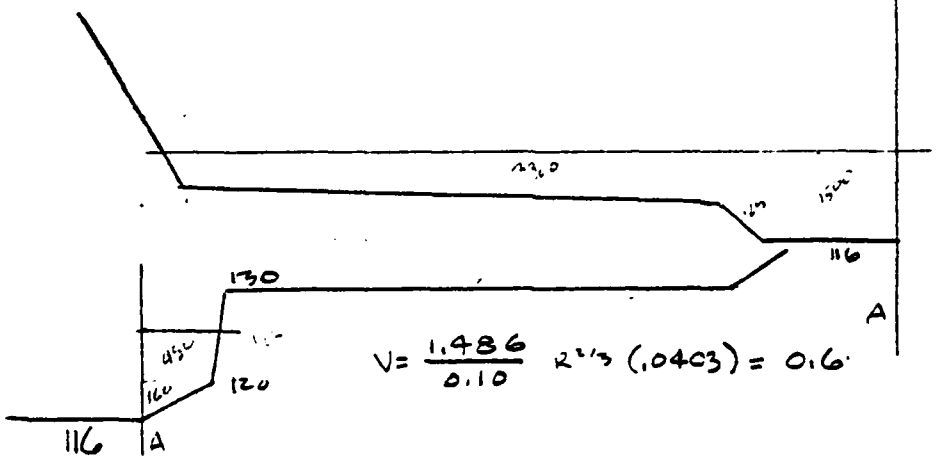
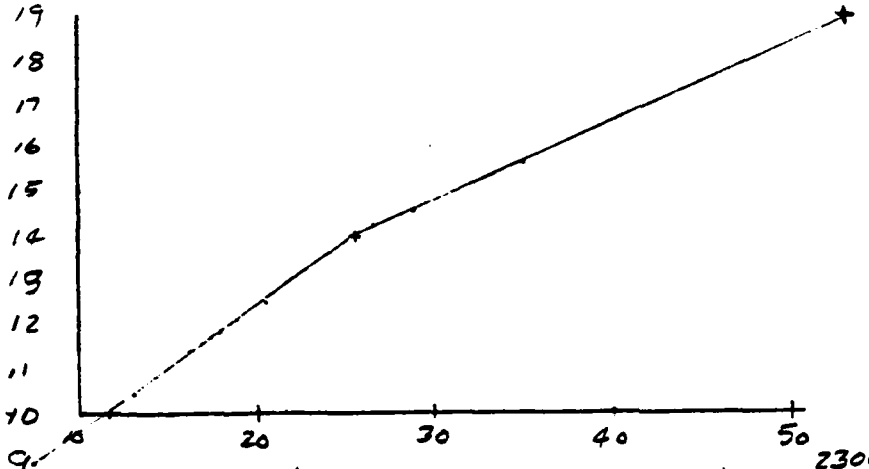
Sta 90+00

$Elev = 110 + \frac{3700}{6300}(10) = 110 + 5.9 \simeq 116' \pm$



$V = \frac{1.486}{0.10} R^{2/3} (.0403) = 0.6$

D	A	WP	$R^{2/3}$	K'	V	Q	ELEV
10'	5565	930	3.32	0.6	2.	11,072.	126
14	9265	940	4.6	0.6	2.8	25,750.	130
19	16940	1550	4.96	"	3.	50,312.	135

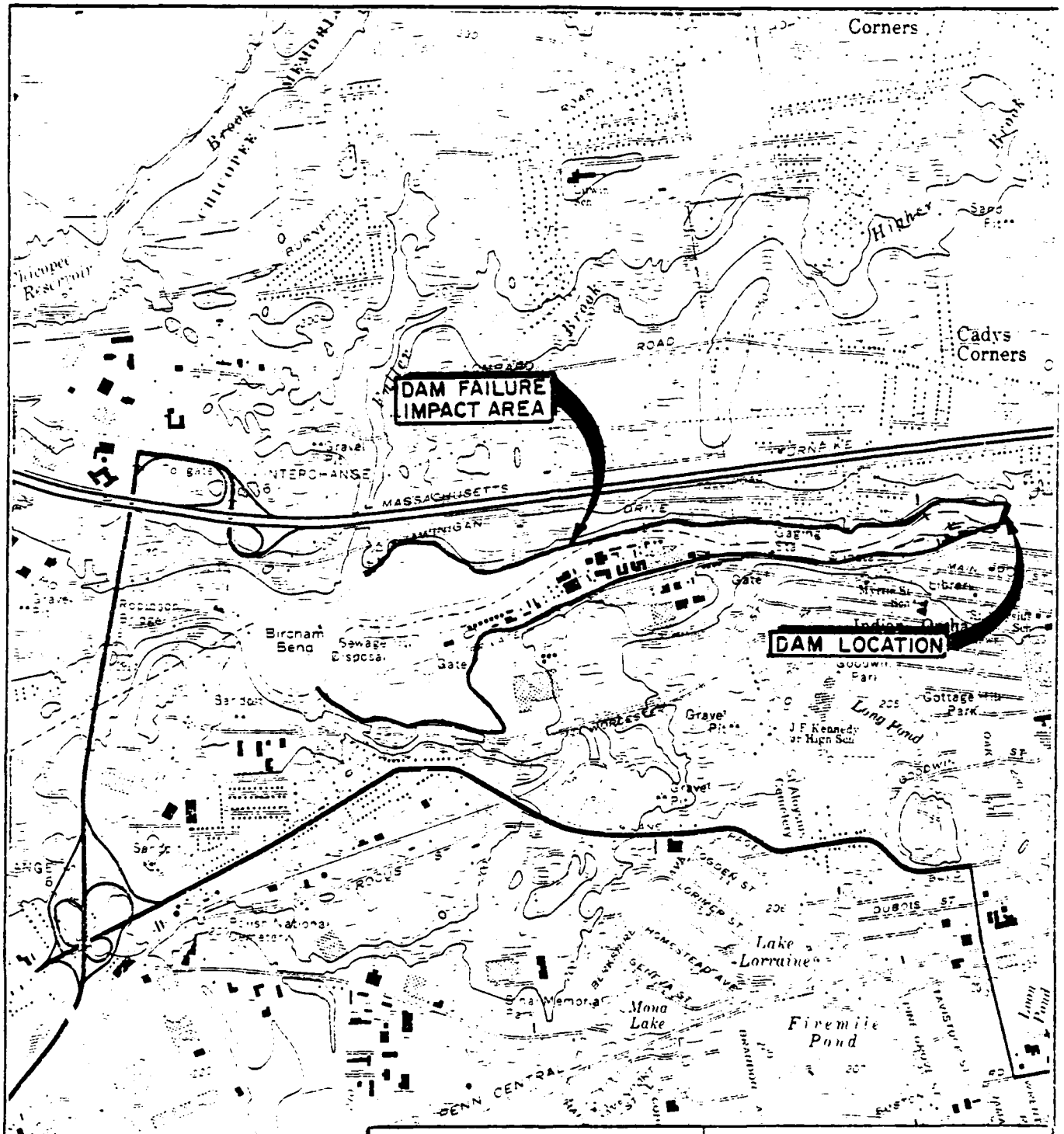


$Q_{P_1} = 13000^{\pm}$ cfs $El_1 = 10.5$ $Sto_1 = \frac{2300 + 6000}{2}\left(\frac{2600}{43550}\right) = 248$

$Q_{P_2} = 13000\left(1 - \frac{248}{482}\right) = 6311.$ $El_2 = 8.5$ $St_2 = 210$

Stave = 229.

$Q_{P_3} = 6825^{\pm}$ cfs $El_3 = 9.$ or $125 \pm$



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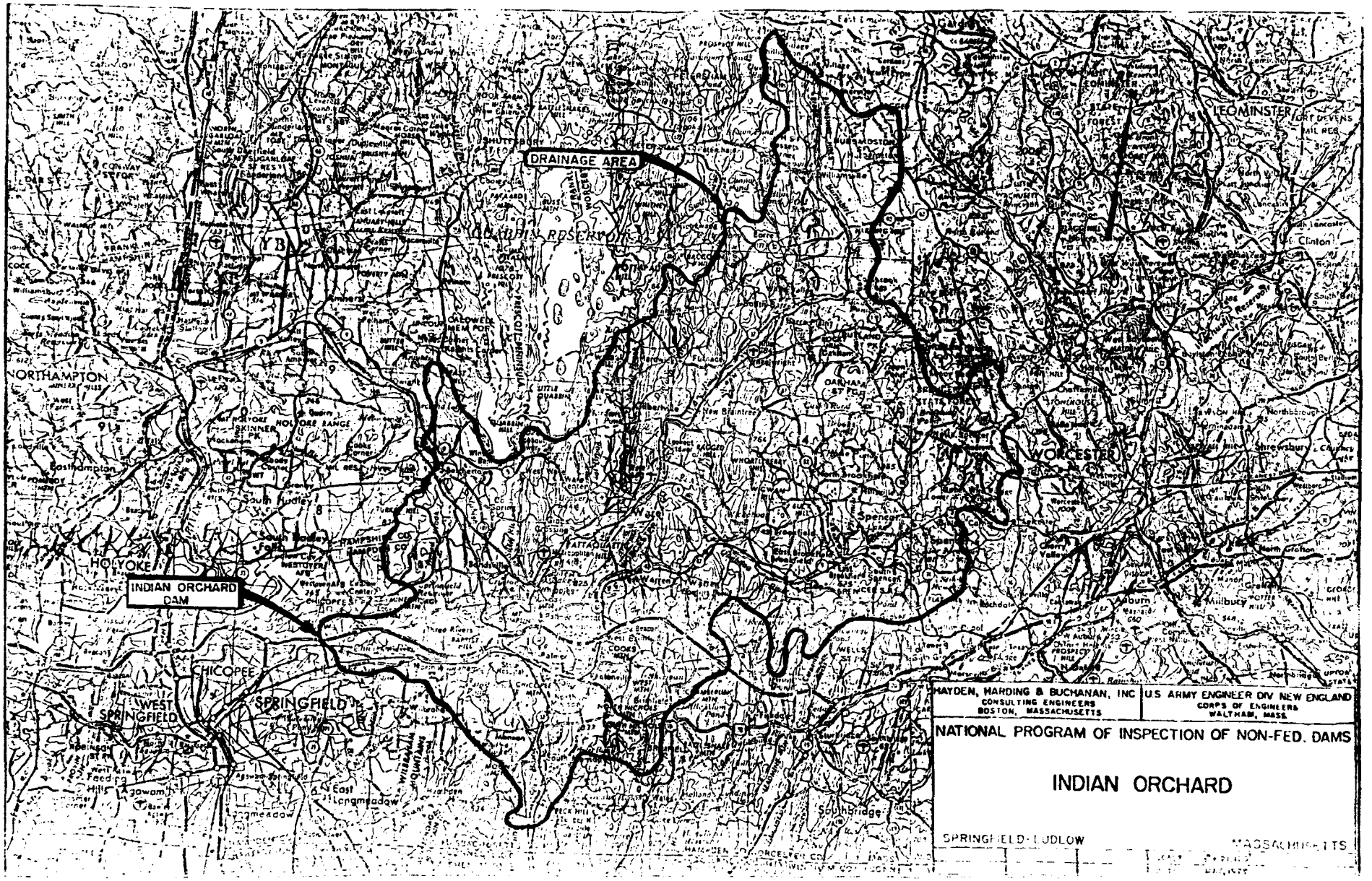
INDIAN ORCHARD

SPRINGFIELD-LUDLOW MASSACHUSETTS

			SCALE: 1" = 2000'
			DATE: MAY, 1979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INDIAN ORCHARD DAM
HOLYOKE
CHICOPEE
SPRINGFIELD
WEST SPRINGFIELD
NORTHAMPTON
WORCESTER
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