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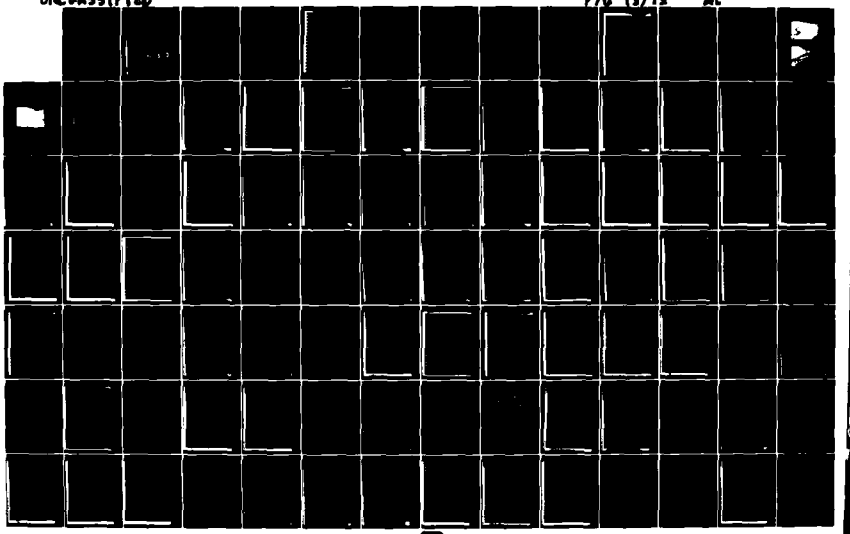

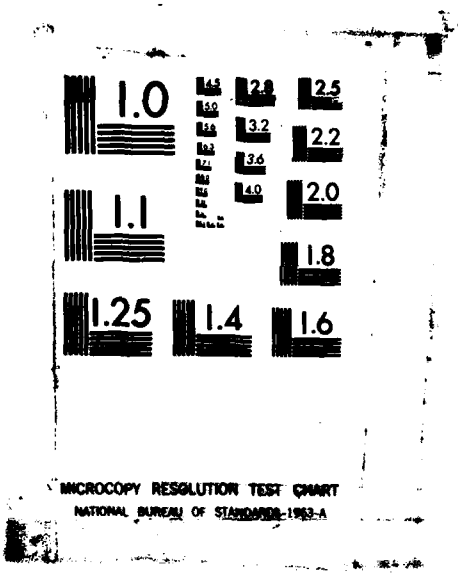
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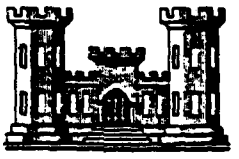
(2)

CONNECTICUT RIVER BASIN
WARE, MASSACHUSETTS

WINSOR DAM MA 00588
QUABBIN SPILLWAY MA 00589
GOODNOUGH DIKE MA 00590

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM



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

SEPTEMBER 1978

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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,

Ware, Massachusetts
Connecticut River Basin

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

The structures are all classified as being large in size. The projects are in excellent to good condition. There were no obvious signs of failure or conitions which would warrent urgent remedial treatment. It has a hazard potential of high.

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DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

REPLY TO
ATTENTION OF:

NEDED

NOV 29 1978

Honorable Michael S. Dukakis
Governor of the Commonwealth of
Massachusetts
State House
Boston, Massachusetts 02133

Dear Governor Dukakis:

I am forwarding to you a copy of the Windsor Dam, Quabbin Spillway & Goodnough Dike Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Department of Environmental Quality Engineering, the cooperating agency for the Commonwealth of Massachusetts. In addition, a copy of the report has also been furnished the owner, the Metropolitan District Commission, Commonwealth of Massachusetts, 80 Somerset Street, Boston, Massachusetts 02108, ATTN: Mr. Martin Weis, Chief Engineer.

Copies of this report will be made available to the public, upon request, by this office under the Freedom of Information Act. In the case of this report the release date will be thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Department of Environmental Quality Engineering for your cooperation in carrying out this program.

Sincerely yours,

JOHN P. CHANDLER
Colonel, Corps of Engineers
Division Engineer

Incl
As stated

WINSOR DAM MA 00588
QUABBIN SPILLWAY MA 00589
GOODNOUGH DIKE MA 00590

CONNECTICUT RIVER BASIN
WARE, MASSACHUSETTS

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

BRIEF ASSESSMENT

PHASE I INVESTIGATION REPORT
NATIONAL DAM INSPECTION PROGRAM

Identification No. and Name:	MA 00588	Winsor Dam
	MA 00589	Quabbin Spillway
	MA 00590	Goodnough Dike
Town:	Ware	
County:	Hampshire	
State:	Massachusetts	
Date of Site Visit:	29 June 1978	

Quabbin Reservoir was created by the Metropolitan District Commission in the late 1930's by construction of Winsor Dam, Quabbin Spillway and Goodnough Dike. By virtue of both storage and height, the structures are classified as "large" in size.

Winsor Dam and Goodnough Dike are full hydraulic fill earth embankments, having maximum heights of 170 and 135 ft. and lengths of 2640 and 2140 ft., respectively. Quabbin Spillway is an ungated masonry weir, having a maximum height of approximately 14 ft. and an overall length of 405 ft.

The projects are in excellent to good condition. There were no obvious signs of failure or conditions which would warrant urgent remedial treatment.

Hydraulic analyses indicate that the Quabbin Spillway in combination with the auxiliary spillway at Winsor Dam, are adequate in size to safely pass the test flood, calculated from the probable maximum flood, without overtopping Winsor Dam or Goodnough Dike.

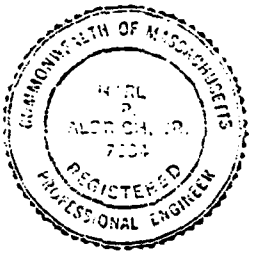
Because of the importance of these structures for water supply to the Greater Boston area, because of the high hazard potential in the event of a failure, and because the embankments are hydraulic fill with relatively steep slopes, it is recommended that the MDC undertake a

BRIEF ASSESSMENT (continued)

detailed investigation of embankment stability under static and earthquake loading.

HALEY & ALDRICH, INC.
by:

Harl Aldrich
President



This Phase I Inspection Report on Windsor Dam, Quabbin Spillway & Goodnough Dik has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

Charles G. Tiersch

CHARLES G. TIERSCH, Chairman
Chief, Foundation and Materials Branch
Engineering Division

Fred J. Ravens Jr.

FRED J. RAVENS, Jr., Member
Chief, Design Branch
Engineering Division

Saul Cooper

SAUL COOPER, Member
Chief, Water Control Branch
Engineering Division

APPROVAL RECOMMENDED:

Joe B. Fryar

JOE B. FRYAR
Chief, Engineering Division

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 investigations are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the test flood is based on the estimated "probable maximum flood" for the region (greatest reasonably possible storm runoff), or a fraction 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.

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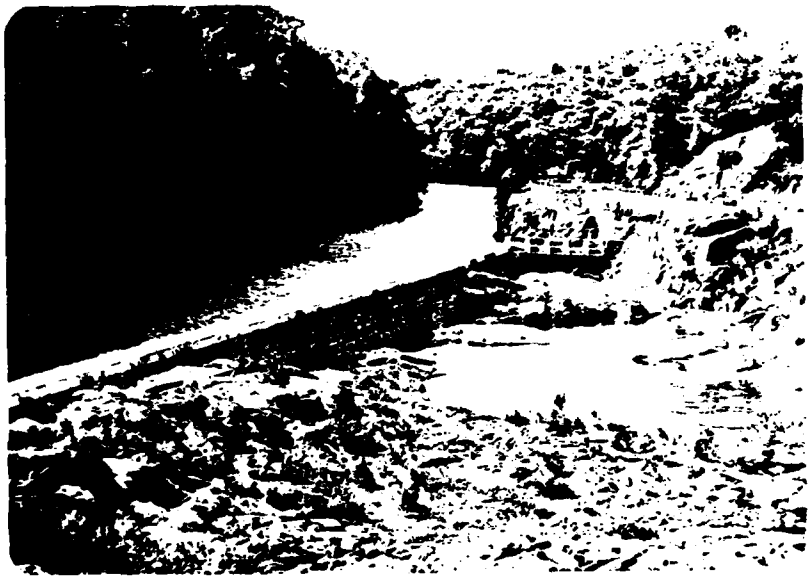
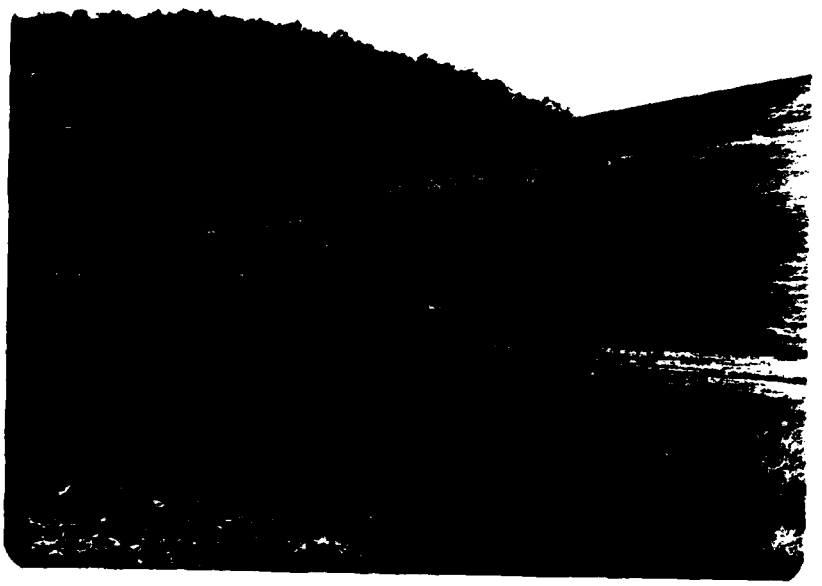
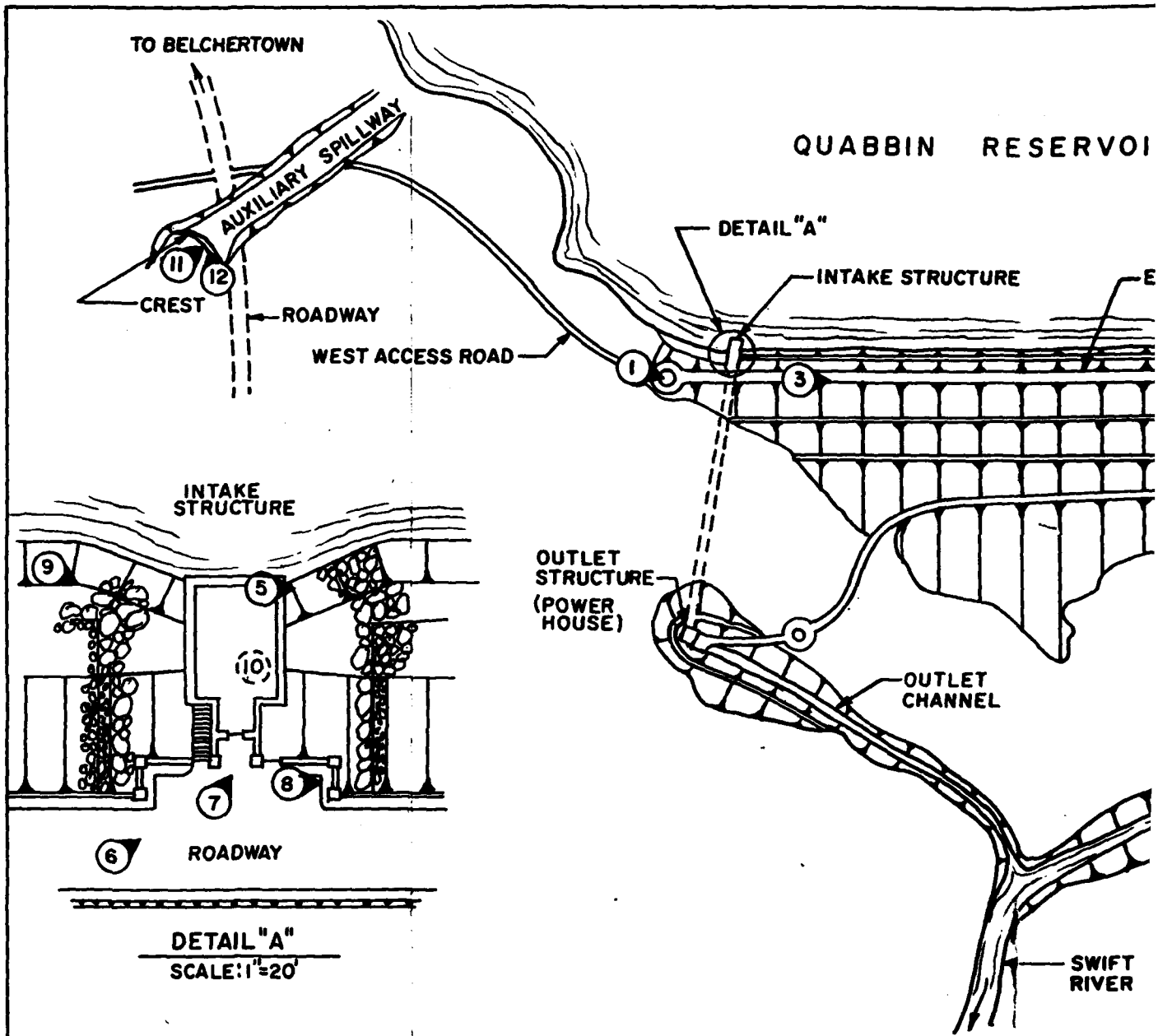
Overview Photo of Winsor Dam



Overview Photo of Quabbin Spillway



Overview Photo of Goodnough Dike



NOTE:

PLAN DEVELOPED FROM M.D.C. CONSTRUCTION DRAWINGS NO. NO. 17, ACC. 24117 SHOWN IN APPENDIX B AND HALEY & ALD ON 29 JUNE 1978.

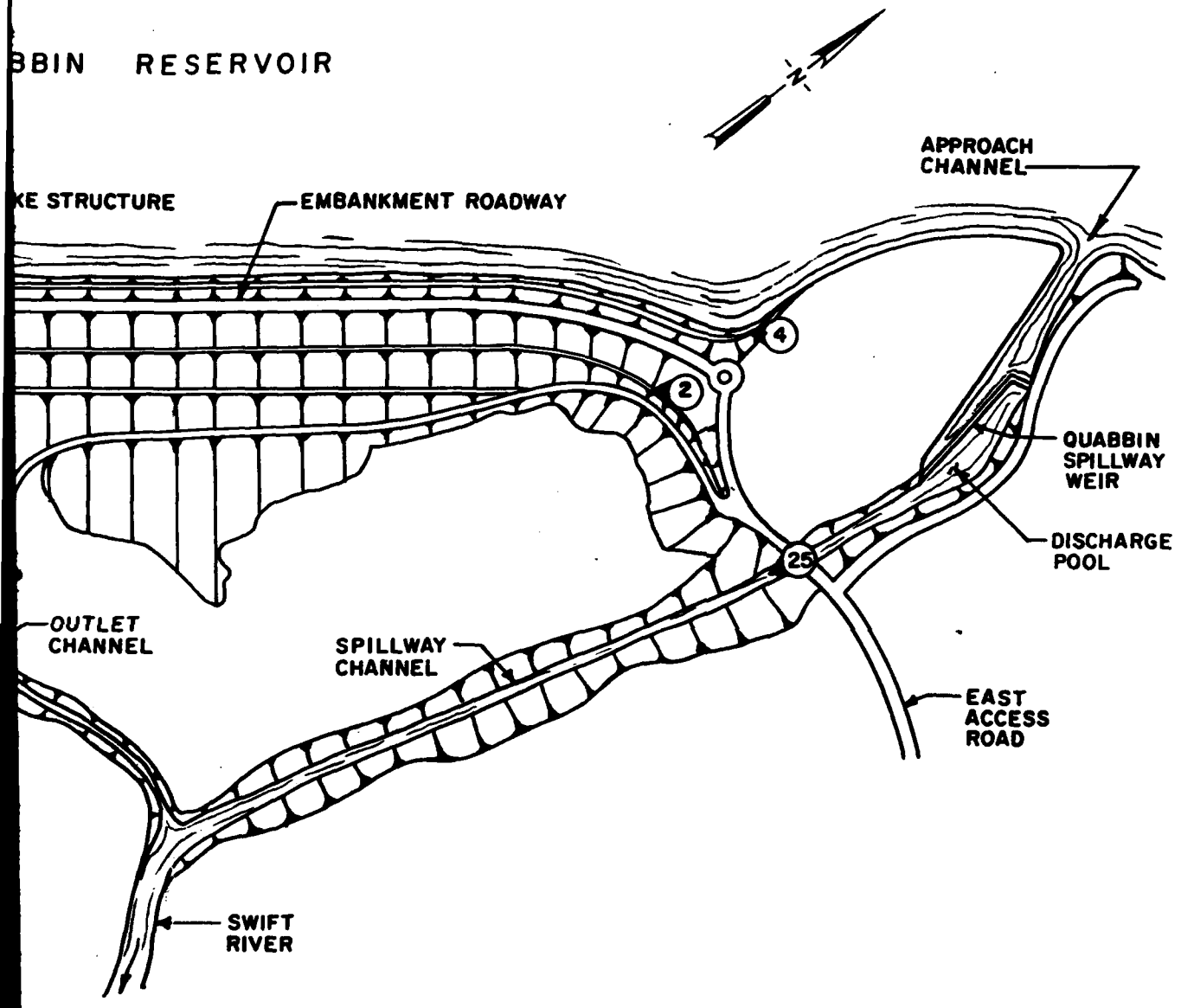
LEGEND:

(6) PHOTOGRAPH NUMBER AND DIRECTION OF VIEW.

FILE NO. 416000 B28

HALEY & ALDRICH, INC.
CAMBRIDGE, MASSACHUSETTS

BBIN RESERVOIR



UCTION DRAWINGS NO. 2, ACC. 24102 AND
X B AND HALEY & ALDRICH FIELD OBSERVATIONS

RECTION OF VIEW.

WINSOR DAM AND
QUABBIN SPILLWAY
QUABBIN RESERVOIR

SITE SKETCH PLAN

SCALE: 1" = 400' SEPTEMBER 1978

(2)

PHASE I INVESTIGATION REPORT
NATIONAL DAM INSPECTION PROGRAM
WINSOR DAM MA 00588
QUABBIN SPILLWAY MA 00589
GOODNOUGH DIKE MA 00590

I. 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.

Haley & Aldrich, 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 were issued to Haley & Aldrich, Inc. under a letter dated 26 April 1978 from Colonel Ralph T. Garver, Corps of Engineers. Contract No. DACW33-78-C-0301 has been assigned by the Corps of Engineers for this work. Camp, Dresser & McKee, Inc. was retained as consultant to Haley & Aldrich, Inc. on the structural, mechanical/electrical and hydraulic/hyrologic aspects of the investigation

B. Purpose. The primary purposes of the National Dam Inspection Program are to:

1. 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. 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 PROJECT DESCRIPTION

A. Location. Winsor Dam is located on the Swift River, at the boundary between the towns of Belchertown and Ware, Massachusetts. The Quabbin Spillway and Goodnough Dike are located nearby in the town of Ware. The Location Map on page viii shows the location of the three structures.

At the time of construction, a portion of Winsor Dam as well as Quabbin Spillway and Goodnough Dike were located in the Town of Enfield, the corporate existence of which was eliminated when Quabbin Reservoir was constructed.

B. Dam, Spillway, Dike and Appurtenances. Winsor Dam consists of a 2640 ft. long full hydraulic fill earth embankment, an intake structure discharging through a tunnel to an outlet structure and powerhouse, and an auxiliary spillway, as shown in Appendix B-54 and Appendix C-1.

The maximum height of the embankment is about 170 ft. and the crest is approximately 35 ft. wide. A paved roadway on the crest spans the length of the embankment. The normal operating level of the reservoir is El. 530, 20 ft. below the top of the dam. The upstream face is sloped at about 2 horizontal to 1 vertical above a berm at El. 535 and paved with light riprap. Below the berm, heavy riprap was placed at 1.5:1 and flattening to 3:1 below the wave break. The downstream face is grassed and slopes at 2:1, 2.5:1 and 2.75:1 with berms for drainage at the changes in slope. A concrete core wall extends from an elevation about 25 to 30 ft. above the bottom of the dam to the surface of rock, below which is a grout curtain 20 ft. into rock. The embankment is shown in Photos No. 2, 3, 4, 5 and 8 in Appendix C. A profile and a cross-section at the top of the dam are shown in Appendix B-58 and B-59, respectively.

An intake structure, Photo No. 9, is located on the right side. The 157-ft. long "intermediate intake" shown in Appendix B-60 upstream of the intake structure feeds a 68-in. diameter conduit and a 48-in. diameter conduit which go to a power house at the outlet structure downstream. The outlet channel from the power house discharges into the Swift River. Regulating outlets are further described in Section 1.3J.

An auxiliary spillway located beyond the right abutment of Win-

sor Dam consists of a gently sloped grassed approach channel and circular concrete cutoff wall with "quarry faced ashlar" at the crest. This spillway is only intended to provide emergency overflow at El. 536 in case of extreme high water. Photos No. 11 and 12 and Appendix B-61 show details of the auxiliary spillway.

Quabbin Spillway is located approximately 1000 ft. east of the left abutment of Winsor Dam. It consists of an approach channel, a 405 ft. long masonry concrete weir, discharge pool and spillway channel, shown in Appendix B-62 and Appendix C-2.

The approach channel is approximately 80 ft. wide and 650 ft. long, excavated into rock and shown in Photo No. 21. The channel bottom drops 8 ft. from Quabbin Reservoir to the spillway weir.

The spillway weir is 370 ft. long with a crest elevation of 530 and has a 34 ft. 8 in. long side discharge at El. 528. Currently 2 ft. of flashboards are in place on the short section. Refer the Photos No. 13, 14, 16, 19 and 20 for the correct configuration of the weir as shown sketched in Appendix C-2.

The discharge pool was excavated into rock, as was the long spillway discharge channel. The discharge channel has a width of approximately 30 ft. and length of 2300 ft. from the discharge pool to the convergence point with the Swift River. Photos No. 22, 23, 24 and 25 show features of the spillway discharge channel. Cross-sections of excavations for the spillway channel are shown in Appendix B-63.

Goodnough Dike consists of a 2140 ft. full hydraulic fill embankment with no appurtenances. The dike is shown in Appendix B-64 and Appendix C-3.

The maximum height of the embankment is about 135 ft. and the crest is approximately 35 ft. wide. A paved roadway on the crest spans the length of the embankment. The top of the dike is approximately 20 ft. high than the normal operating level of El. 530 at Quabbin Reservoir. The side slopes, zoning, impervious core and grout curtain for the embankment are of the same design and construction as Winsor Dam. Photos No. 27 through 32 show the Goodnough Dike embankment. Cross-sections and a profile on the centerline of the dike are shown in Appendices B-67 and B-68, respectively.

C. Size Classification. Winsor Dam, Quabbin Spillway and

Goodnough Dike impound a reservoir with a maximum storage estimated to be 1,810,000 acre-feet. Winsor Dam and Goodnough Dike have a maximum height of 170 and 135ft., respectively. Storage of more than 50,000 acre-feet and/or height greater than 100 ft. classifies these structures in the "large" category according to guidelines established by the Corps of Engineers.

D. Hazard Classification. The structures are currently classified as having a "high" hazard potential in the Corps of Engineers National Inventory of Dams. A failure of Winsor Dam or Goodnough Dike would cause a loss of life estimated in previous inspection reports between 2 and 300 persons. A review of the downstream conditions indicate that between 25 and 100 residential, industrial and commercial properties would be inundated in the developed areas of Beaver Lake, Palmer, and Three Rivers. There is no question that the economic losses associated with such an event would be catastrophic. A failure of Quabbin Spillway, however, would result in a much lesser flow which would not present any significant hazards downstream. Therefore, it is recommended that the "high" hazard potential classification be retained for the Winsor Dam and Goodnough Dike and that a "low" hazard classification be assigned to Quabbin Spillway.

E. Ownership. The three structures are owned by the Metropolitan District Commission, Water Division, of the Commonwealth of Massachusetts. The owner's address is 20 Somerset St., Boston, MA 02108

F. Operator. The following individual has day-to-day responsibility for the operation of the project:

Mr. Harold E. Mellin, Jr.
Metropolitan District Commission
Winsor Dam
Ware Road
Belchertown, MA 01007
(Phone: 413/323-6921)

Mr. Mellin represented the owner during this investigation.

G. Purpose of Dam. The primary purpose of Quabbin Reservoir is to provide a potable water supply for the Metropolitan Water District, a group of more than 30 cities and towns in the Greater Boston Area.

In addition, the reservoir and reservation provide recreation in the form of boating, fishing, hiking and picnicking. The Quabbin Reservoir Reservation is also an important wildlife habitat.

H. Design and Construction History. The design and construction history of Winsor Dam, Quabbin Spillway and Goodnough Dike which form the Quabbin Reservoir is well documented due to the size and importance of the project. Several technical papers addressing this interesting work were published in professional journals. The following narrative is based largely upon the papers by Dore[1] (1935) and Winsor[2] (1938).

The idea of forming Quabbin Reservoir to supply water to the City of Boston was conceived by the MDC prior to 1920. A number of test borings were made in 1920 and 1921 as part of a preliminary investigation concerning the general location of the dams. By 1929, a large number of borings, described in detail by Hammond[3] (1929) confirmed that the general sites chosen for the project were overlain by deep (greater than 100 ft.) glacial deposits of pervious sands, gravels, cobbles and boulders.

The valleys chosen for Winsor Dam and Goodnough Dike are long and wide, requiring construction of earth embankments rather than concrete gravity dams. Investigation of possible borrow areas revealed abundant materials suitable for earth-type dam construction. The water tables at the two sites were between 120 and 130 ft. above bedrock, presenting an additional construction consideration relating to excavation through pervious glacial deposits. It was decided to sink two exploratory caissons, one at each site, to further investigate the overburden characteristics, the feasibility and cost of open and

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1 "Design and Progress on the Construction of Dams for Quibbin Resevoir" by Stanley M. Dore, Journal of the Boston Society of Civil Engineers, July 1935.

2 "Quabbin Reservoir - Recent Developments in the Construction of the Ware-Swift Water Supply for the Metropolitan District" by Frank E. Winsor, Journal of the Boston Society of Civil Engineers.

3 "Diamond Drill Borings for the Swift River Dams" by N. Leroy Hammond, Journal of the Boston Society of Civil Engineers, January 1929.

pneumatic caisson construction and the possibilities of lowering the groundwater by pumping. The contract for this work was awarded in September 1931, and was completed about a year later.

The exploratory caissons measured 32 ft. long by 12 ft. wide. Open dredging methods proved unfeasible below depths of about 50 ft. in the dense granular soils. A compressed air method was then successfully adopted for sinking the caissons. Air locks were installed over the working wells and maximum air pressures of about 33 psi were used to advance and seal the caisson to ledge "in the dry" about 70 ft. below river level at the Winsor Dam site. Information obtained from the sinking of these caissons and the pumping carried on from them indicated the construction method was feasible for use as a cutoff wall at both sites and the most economical.

While the sinking of the exploratory holes was underway, work to divert the Swift River during construction was begun at the Winsor Dam site. The stream control works consisted mainly of the 30-ft. effective diameter rock tunnel under the right abutment. The conduit was concrete lined and about 1200 ft. long. The Swift River was diverted through the tunnel in June 1933.

Two exploratory caissons, in addition to the one already built, were excavated pneumatically and sealed to rock at the Winsor Dam site. Pumping from these three caissons from November 1934 to January 1935 lowered the water table to approximately 90 ft. below the river level and maintained it at that position until the start of core wall construction in May 1935.

The entire cutoff wall at Winsor Dam was formed by a total of forty reinforced concrete caissons, all except the first one being 45 ft. long by 9 ft. wide. Groundwater was effectively controlled by pumping from wells in completed caissons and wellpoints and sumps upstream of the construction. Due to the effects of pumping, less than 20% of the caisson work was done under compressed air conditions. Since the overburden soils became more pervious with depth, it was decided that the caissons would be sealed to rock and grout curtains installed 20 ft. into rock. The overburden and geological conditions at the site are shown in Appendices B-55, B-56 and B-57.

Prior to sinking the caissons, an open trench was excavated across the valley to a depth of about 30 ft. The trench was subsequently filled with impervious "topsoil" and compacted around the concrete core wall in six-inch thick lifts with sheepsfoot rollers. The concrete core wall extended a minimum of 25 ft. into this refill. This foundation work was completed in the early summer of 1936.

Full hydraulic fill construction of the embankments was considered to be the most economical and desirable for stability and uniformity of the slopes. Sluicing of the embankments at Winsor Dam began in 1936. Materials were brought to the hog box on belt conveyors and mixed with water jets to flow into a steeply sloped trough towards the sluicing line. The quality of the core material being pooled was continuously monitored and checked by sounding with a rod and sampled for inspection and laboratory analysis. Placement of the 4,000,000 cubic yards of fill required for Winsor Dam was completed in 1939. The top 30 ft. of dam embankment was placed by rolled-fill methods. The foundation and embankment are shown in profile in Appendix B-58. A cross-section through the top of the dam is shown in Appendix B-59.

Quabbin Spillway is located in a natural high valley to the east of the left abutment of Winsor Dam. This site was structurally desirable because the spillway channel would be formed entirely in rock from the spillway weir to the Swift River. A spillway weir length of about 400 ft. was chosen to allow passage of floods up to 10,000 cfs without flooding out the rock discharge channel. It was believed that floods up to 15,000 cfs could be carried with no important scour of the earth banks above the rock channel. A plan of the spillway is shown in Appendix B-62 and cross-sections are included in Appendix B-63.

Goodnough Dike was constructed in the period from approximately September 1931 to July 1938. The dike is nearly identical in design and construction to Winsor Dam. The core wall was built as previously described by excavating an open-cut trench, by sinking from the bottom reinforced concrete caissons sealed to each other and to rock, grouting below the concrete core wall, and by filling the wells of the caissons and the open-cut trench with impervious soils. The geological conditions at the dike site are shown in Appendices B-65 and B-66.

Beaver Brook was initially carried past the construction site in a wooden flume about 350 ft. long. It was then dried up upstream for over 1,000 ft. by subsequent pumping, and eventually the brook flow was through an 18-in. pipeline until its subsequent diversion across the divide to the Swift River. The groundwater surface was lowered approximately 90 ft. during foundation construction.

Placement of the embankment by full hydraulic methods began in December 1934 and was completed prior to July 1938. The method

of placement was substantially the same as that for Winsor Dam. A profile on the centerline of the dike and typical cross-sections are shown in Appendices B-67 and B-68, respectively.

1.3 PERTINENT DATA

Elevations shown on all record drawings and as used in this report are referenced to Boston City Base datum. To convert to the National Geodetic Vertical Datum (NGVD), subtract 6.049 ft. from elevations which are on Boston City Base.

A. Drainage Area. The Quabbin Reservoir was formed in the 1930's by impounding the watersheds of the East, Middle and West Branches of the Swift River. The 186 square mile drainage basin which is tributary to the Quabbin Reservoir Spillway consists of heavily forested rolling terrain. In addition to this, limited diversion from the Ware River watershed of 98 square miles is discharged to the Quabbin Reservoir between October 15 and June 15 when flows on the Ware River exceed 85 mgd.

The water surface area of the reservoir at normal pool elevation is 39.4 square miles or 21 percent of the 186 square mile watershed.

B. Discharge at Damsite. Following completion of the impoundment works in 1940, it took 7 years before the reservoir was filled to its capacity of 412 billion gallons. Quabbin's level fell to 45 percent of capacity in 1967, following a six-year drought. No spillway discharge occurred from 1961 to 1976. The maximum recorded spillway discharge elevation was 531.03 on April 18, 1953. Based on the available rating curve, this stage corresponds to a discharge of about 1600 cfs. The longest continuous spillway discharge occurred between April 16 and May 7, 1978 with a maximum reservoir elevation of 530.34 (270 cfs) on April 24 and 25, 1978.

In addition to Quabbin Spillway at crest El. 530.0, there is an auxiliary spillway at crest El. 536.0. At this elevation, the maximum discharge over Quabbin Spillway is reported to be 15,000 cfs. Discharges in excess of this amount will produce water surface elevations in the reservoir above El. 536.0 at which point the auxilary spillway will begin discharging.

An additional 70 to 75 mgd discharge capacity is available through the generating facilities at the intake structure.

C. Elevation (ft. above Boston City Base)

1. Top Winsor Dam and Goodnough Dike	550.0
2. Maximum pool-design surcharge	536.1
3. Design surcharge - original design	536+
4. Full flood control pool	536.1
5. Recreation pool	530.0
6. Spillway crest	530.0
7. Upstream portal invert diversion tunnel	Unknown
8. Streambed at centerline	
Winsor Dam	380.0
Goodnough Dike	415.0
9. Maximum tailwater	526.0

D. Reservoir

1. Length of maximum pool	18.0 miles at El. 536.0
2. Length of recreation pool	17.9 miles
3. Length of flood control pool	18.0 miles

E. Storage (acre-feet)

1. Top of dam	1,810,000 (Est.)
2. Test flood pool	1,417,600 (Est.)
3. Flood-control pool	1,417,600 (Est.)
4. Recreation pool	1,265,200 (Est.)
5. Spillway crest	1,265,200 (Est.)

F. Reservoir Surface (acres/sq. miles)

1. Top of dam	29,100/45.5 (Est.)
2. Test flood pool	26,120/40.8 (Est.)
3. Flood control pool	26,120/40.8 (Est.)
4. Recreation pool	25,216/39.4 (Est.)
5. Spillway crest	25,216/39.4 (Est.

G. Winsor Dam and Goodnough Dike

1. Type	Hydraulic Fill
2. Length	
Winsor Dam	2640 ft.
Goodnough Dike	2140 ft.

3. Height	
Winsor Dam	170 ft.
Goodnough Dike	135 ft.
4. Top Width	35 ft.
5. Side Slopes	
Upstream	2:1, 1.5:1 and 3:1
Downstream	2:1, 2.5:1 and 2.75:1
6. Zoning	Gradual, typical of hydraulic fill
7. Impervious core	Silt and clay puddle
8. Foundation cutoff	Concrete caisson core wall to rock
9. Grout curtain	20 ft. into rock from bottom of caisson

H. Diversion and Regulating Facilities. Not applicable

I. Quabbin Spillway

1. Type	Masonry, round crest, with side channel discharge
2. Length of weir	34 ft. 8 in. at El. 528 370 ft. at El. 530
3. Crest Elevation	530.0
4. Gates	2 ft. of flashboards on short section
5. U/S Channel	6 ft. rise in 500 ft.
6. D/S Channel	20 ft. drop in 700 ft. then 60 ft. drop in 100 ft.

Auxiliary Spillway

1. Type	3 ft. wide quarry stone, 0.5 ft. high, both U/S and D/S
2. Length of Weir	240 ft.
3. Crest Elevation	536.0
4. Gates	None
5. U/S Channel	1.5 ft. rise in 685 ft.
6. D/S Channel	1.5 ft. drop in 200 ft.

J. Regulating Outlets at Winsor Dam. Winsor Dam was originally constructed with three intakes. A "Lower Intake" was constructed during an early contract to provide a tunnel for stream diversion during construction of the dam. This intake tunnel now has a concrete plug below the intake structure and is therefore inactive. An "Intermediate Intake" with invert at El. 465 and an "Upper Intake" at El. 499 and located immediately upstream of the intake structure were also provided.

Fish screens with a sill at El. 471.75 and top of screened opening at El. 501.75 were installed in 1974. The balance of the intake channel was shut off during the installation of the screens. This effectively allows the use of the 157-foot long intermediate intake only. This intake is a reinforced concrete section 7 ft. wide by 8 ft. high. The intake feeds a 68-in. diameter conduit and a 48-in. diameter conduit which go to the power house. The 68-in. diameter conduit is installed inside the former stream diversion tunnel. Control at the inlet structure is by a 48-in. diameter 300 lb. test C.I. gate valve with Ludlow geared operator on a floor stand and a 48-in. by 72-in. sluice gate with Ludlow geared operator.

The two conduits are interconnected at the power house with a 36-in. pipe. The water may be fed by a 48-in. line to the Chicopee Aqueduct, may be discharged through the turbine generator or may be discharged through a 33-in. pipe bypassing the turbine. Control at the power house is by a 68-in. gate valve with geared operator, two 48-in. gate valves with geared operators, three 36-in. gate valves with geared operators, one 48-in. control valve with electric motorized operator and one 33-in. control valve with electric motorized operator. Orifice plates have been reported to be installed in the lines due to cavitation problems with the control valves.

I. Normal Operating Procedures. Quabbin Reservoir controls are used primarily to transmit water to the metropolitan area of Boston and the local communities of Chicopee through the Quabbin and Chicopee Aqueducts, respectively. They are operated based on demand. Also, a minimum of 20 MGD is released to the Swift River as required by law for low flow augmentation.

The water is released from Quabbin Reservoir via a 68-in. conduit and a 48-in. conduit interconnected with a 36-in. pipe at the power house. There the water may be discharged from the conduits through the turbine generator or through bypass pipes.

The gates for these conduits are at the power house. Additional gates are at the intake structure. The gates at the intake structure are normally left open and test operated twice a year.

II. ENGINEERING DATA

2.1 DESIGN RECORDS

Pertinent contract drawings for Winsor Dam, Quabbin Spillway and Goodnough Dike are listed and included in Appendix B. No original design criteria and calculations for the structures were available from the MDC. However, some items regarding the design for each structure are mentioned in the numerous articles published in technical journals about the subject projects.

2.2 CONSTRUCTION RECORDS

The original construction contract documents for the structures are listed in Appendix B-5. Pertinent drawings from these contracts are also listed and included in Appendix B. Many details of the actual construction are described in published technical papers and reports such as those in the Journal of the Boston Society of Civil Engineers and the Annual Report of the Metropolitan District Water Supply Commission.

Details shown on the contract drawings are in good agreement with field observations, with the exception of Appendix B-62 which shows an incorrect configuration for the spillway weir. The proper shape of the weir is shown on the Site Sketch Plan, Appendix C-2 and in Photo No. 13.

No construction modifications to the original structures following their completion in the 1930's are known to have taken place.

2.3 OPERATION RECORDS

Operational records kept by MDC Quabbin personnel are based primarily on daily reservoir discharges at the Winsor Dam outlet structure and test runs of the equipment.

2.4 EVALUATION

A. Availability. Design and construction records are available at the MDC, 20 Somerset St., Boston, MA 02108. Operation records are available at the MDC Quabbin, Ware Road, Belchertown, MA 01007.

B. Validity. With the exception of the change in configuration of the spillway weir described in Section 2.2, the contract documents appear to represent the the features of the presently existing structures, based on visual field observations.

C. Adequacy. The available data, in combination with the visual examinations described in the following section, are adequate for the purposes of the Phase I Investigation.

III. VISUAL EXAMINATION

3.1 FINDINGS

A. General. The Phase I visual examination of Winsor Dam, Quabbin Spillway and Goodnough Dike was conducted on 29 June 1978.

In general, the projects were observed to be in excellent to good condition. The earth embankments, spillways and intake structures are well maintained. A few minor deficiencies requiring correction have been noted.

Visual inspection checklists for the three structures are included in Appendix A and selected photographs of the projects are given in Appendix C.

B. Winsor Dam. Winsor Dam includes a large earth embankment, an intake structure and an auxiliary spillway. Photographs of this structure are numbered 1 through 12 in Appendix C.

The hydraulic fill embankment is in excellent condition. There was no visual evidence of settlement, lateral movement, seepage or other serious defects. The downstream slope, Photos No. 2 and 3, is covered by grass which is mowed frequently. Both the light and heavy riprap on the upstream slope appear to be stable and in good condition, with little weathering, Photos No. 4 and 5.

The roadway and stone walls across the crest of the embankment are in excellent condition. The near perfect horizontal alignment of the wall is shown in Photo No. 3. The roadway crest and walls are somewhat higher in grade toward the "center" of the embankment than they are at the abutments. At the time of construction, the embankment at its highest point above original ground, was built approximately 3 ft. higher than El. 550, the proposed final embankment grade. The cambered crest was established to allow for future settlement from consolidation of the hydraulic fill.

Settlement of the crest has been monitored at eight observation points located at the top of the riprap slope, immediately upstream of the stone wall. An MDC drawing which summarizes embankment settlements from 1939 to the last reading on 26 June 1973, is included in Appendix B-69.

The embankment, at its highest point between Sta. 18 and 21, settled 1.1 ft. between 1939 and 1952 (13 years). In the following 21 years to 1973, an additional 0.45 ft. of settlement occurred. Typically, settlements at the ends of the embankment are less.

Settlement of the embankment is evident where it interfaces with the intake structure, Photo No. 6. Photo No. 7 shows from 6 to 8 in. of settlement relative to masonry walls at roof level. In addition, settlement and lateral movement on the upstream slope are indicated by a crack in the stone masonry wall located immediately left of the intake structure, Photo No. 8. The wall at this location had been repaired in the past by pointing the crack.

The intake structure (control house), Photo No. 9, is in good to excellent condition and well maintained. There is some incidental rusting on the interior columns and some staining on the interior wall block. The exterior masonry does evidence loss of mortar from the lower joints. There is some efflorescence along the lower portion of the structure.

The power house lower floor is in excellent to good condition. Efflorescence is present on the walls near the slab. Water from an unknown source was present on the floor. The upper floor is also in good condition. No efflorescence was noted on the walls at this floor. The bond beam at the top of the wall does exhibit a number of shrinkage cracks. The underside of the roof appears to be stained.

The former diversion tunnel could not be in inspected in detail due to the lack of internal illumination. However, a number of cracks in the lining were observed. Moderate leakage was observed through the roof at what appeared to be an old patch along a crack located approximately 450 ft. from the power house. The condition of the lining of this tunnel is estimated to be from good to fair.

The outlet channel downstream of the power house is in satisfactory condition.

The auxiliary spillway, located right of the MDC administration building, is in excellent condition. The approach channel to the curved spillway is grass, recently mowed. There are three trees in the channel as shown in Photo No. 11. In addition, a gravel roadway which crosses the approach channel immediately upstream of the spillway weir creates a minor obstruction to flow, especially at the left side where some fill has been placed.

The crest of the weir itself is in good condition, Photo No. 12.

C. Quabbin Spillway. The Quabbin Spillway includes a masonry weir, a short approach channel and a long discharge channel to the Swift River. Photographs of this structure are numbered 13 through 25 in Appendix C.

The spillway masonry is in excellent to good condition. Vegetation is present in several spots along the top masonry joint. The bottom or bed joint of the masonry has been eroded somewhat. In addition, some of the lower joints in the weir have lost mortar.

Three vertical cracks were noted in the highest portion of the weir, one at each end and one near the center. The crack near the center is shown in Photos No. 17 and 18. Spot efflorescence is present on the downstream face of the highest portion of the weir. Moisture was noted in local areas along the downstream face of the weir, at cracks and at the near vertical junction of the weir with bedrock. At one location near the south end of the weir where its height is only a few feet, a fine amount of water is shooting out approximately 3 in.

The upstream face of the weir was not observable due to the high reservoir level.

The access bridge to the flashboards and the flashboards are well maintained and in good to excellent condition, Photos No. 19 and 20. The flashboard guides are in excellent condition.

The approach channel to the spillway weir is in satisfactory condition, Photo No. 21.

The discharge pool and discharge channel from the spillway are generally in good condition. Seepage was noted from joints in the rock and from 2.5-in. diameter drill holes at locations immediately below the weir. Photo No. 15 shows water flowing from one such drill hole.

At the entrance to the discharge channel, large blocks of rock have fallen from the left face of the rock cut, Photo No. 23. The right side, Photo No. 24, is in a more stable condition. The stability of the right side is enhanced by the generally infrequent spacing and favorable attitudes of joints in the gneiss making up the channel face, Photo 22. Some large blocks of gneiss, visible by the man in

Photo No. 24, appear to have dislodged from a fault plane at the entrance to the channel. Another rockfall occurs along the right side of the channel, about 280 ft. downstream from the channel entrance. The volume of rock is not large and does not constitute an appreciable obstacle to flow in the channel. At a point about 360 ft. south of the channel entrance, along the right side, relatively minor amounts of fault and joint-bounded rock blocks appear capable of falling as a result of future frost action. The maximum volume at a given location that could be produced by such frost effects is estimated at 75 cubic yards. Such a volume, occurring at one instance, would probably result in a cross-channel debris mound less than 15 ft. in height.

Rock falls along the left channel face have occurred to a greater volume than on the right side primarily due to adverse dips on many of the joints in the hornfels, gneiss, and schist exposed on the face. Such joint surfaces dip into the channel at angles of from 40 to 70 degrees from the horizontal. Rock fall debris from these joints occur at the entrance to the channel and at distances of about 85 to 110 ft., 235 ft., and 285 ft. south of the channel entrance.

The general condition of the discharge channel downstream of the arch bridge is shown in Photo No. 25.

B. Goodnough Dike. Goodnough Dike is a large earth embankment without appurtenant structures. Photographs of the dike are numbered 26 through 33 in Appendix C.

The hydraulic fill embankment is in excellent condition. There was no visual evidence of settlement, lateral movement or other serious defects. The downstream slope is covered with grass, with a few small bare spots, which is mowed frequently. Both the light and heavy riprap on the upstream slope appear to be stable and in good condition, with little weathering, Photo No. 32.

Two wet areas occur at the downstream toe of the dike, where the embankment is highest. The extent of the wet areas are defined by grass which has not been mowed, as shown in Photos No. 29 and 30. No flow was observed into or from the wet areas, and free water in small puddles was clear. It is understood that these areas are wet seasonally, and are apparently not related to reservoir water levels. Water was observed to be seeping through the asphalt concrete lining for a drainage ditch which runs parallel to the dike toe downstream of the wet area. This condition is shown in Photo No. 31. Water flows into a drop inlet shown near the center of Photo No. 30.

The roadway and stone walls across the crest of the embankment, Photo No. 27, are in excellent condition. Similar to Winsor Dam, Goodnough Dike was constructed with a camber, raising the crest above the nominal design grade at El. 550, to allow for settlement.

Settlement of the crest has been monitored at seven observation points, the protective casing for one of which is shown in Photo No. 33. The MDC drawing which summarizes embankment settlements from 1939 to the last reading on 26 June 1973, is included in Appendix B-70.

The embankment at his highest point between Sta. 17 and 20, settled about 1.2 ft. between 1939 and 1952 (13 years). In the following 21 years to 1973, an additional 0.4 and 0.3 ft. of settlement occurred at Sta. 17 and Sta. 20, respectively. Settlement at Sta. 17 was about 0.1 ft. greater than would have been expected from data available through 1952.

E. Quabbin Reservoir Area. The reservoir was not examined except for areas near Winsor Dam and Goodnough Dike. However, the Quabbin reservation and watershed are generally wooded. In this terrain, it is highly unlikely that landslides into the reservoir and/or surface erosion would be significant and would in any way endanger the safety of the structures.

F. Downstream Channels. The river channel immediately downstream of discharge channels from the Winsor Dam power house and Quabbin Spillway is the natural bed of the Swift River.

For several hundred yards downstream of Goodnough Dike, the former Beaver Brook channel is flat, wide and swampy with ponded water. Few trees have grown in this environment.

3.2 EVALUATION

Based on a visual examination of Winsor Dam, Quabbin Spillway and Goodnough Dike, the projects are well-maintained and in excellent to good condition. Minor deficiencies which have been observed should not have a serious effect on the performance or safety of the structures.

IV. OPERATIONAL PROCEDURES

4.1 PROCEDURES

The primary purpose of the three projects is to impound and store runoff in Quabbin Reservoir for the water supply of the Metropolitan Boston area. A degree of control of the reservoir water surface elevation can be exercised by discharging water through a turbine generator at the power house and/or a 33-inch bypass line into the Swift River. The law requires that the MDC release a minimum of 20 MGD to the Swift River. The reservoir level is also effected by the flow delivered to the Quabbin and Chicopee Aqueducts. Other than these controls, the maximum reservoir level is controlled by Quabbin Spillway weir crest at El. 530.0. (Flashboards can be removed from a 34 ft.-8 in. length of the weir which would lower the water level to El. 528.0.)

4.2 MAINTENANCE OF DAM

The Winsor Dam and Goodnough Dike embankments are regularly maintained by MDC field forces based at Winsor Dam in Belchertown, MA.

4.3 MAINTENANCE OF OPERATING FACILITIES

The equipment is well maintained and operated routinely, as required, to deliver water to the aqueducts, generate power and meet discharge requirements to the Swift River. Other equipment is test-operated at set intervals. No equipment was specifically operated during the visual examination on 29 June. The equipment was reported to be in good operational condition. It was also reported that a problem had existed with control valve cavitation at the power house and that orifice plates have been installed.

4.4 WARNING SYSTEMS IN EFFECT

There is no formal warning system in effect in the event of a failure or partial failure of the structures. The operations staff indicated that they do have radio communication capabilities and in case of difficulties, would warn the nearby civil defense center and the Metropolitan District Commission Headquarters.

4.5 EVALUATION

The operational procedures and dam and dike maintenance are satisfactory.

For a project of this size and importance, where a failure would cause major loss of life and property damage, a formal emergency preparedness plan and warning system should be adopted.

V. HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

A. Design Data. The Quabbin Reservoir was created in the 1930's by the MDC with the construction of Winsor Dam, Quabbin Spillway and Goodnough Dike. Proposed construction drawings for the facilities were found but only limited hydraulic/hydrologic design parameters have been located.

Hydraulic/hydrologic information contained in the July 1935 BSCE Journal, Vol. XXII, No. 3, indicates that a runoff of 12 inches in 24 hours would result in a spillway discharge of 9,000 cfs. The same article states that the spillway approach channel was designed to convey 15,000 cfs, at which point the reservoir water surface would be El. 536.0 and the auxiliary spillway would begin discharging.

The size classification of the project is "large" as the height is greater than 150 ft. and the storage is 412 billion gallons (1,264,000 acre-feet. Since the estimated loss of life in the event of failure had been previously estimated to be between 2 and 300 persons, the hazard potential classification is "high". Consequently, the recommended test flood is the probable maximum flood (PMF).

B. Experience Data. The peak inflow PMF was estimated by using the peak flow rate for rolling terrain, as developed by the Corps of Engineers, New England Division, and developing a unit hydrograph based on the September 1938 flood on the East Branch Swift River near Hardwick, Massachusetts, for the land portion of the drainage area which is approximately 146 square miles. To this inflow (peak rate of 134,000 cfs), the PMF resulting from 23 inches of rainfall in 6 hours was distributed over the area of the reservoir and added. The resulting peak inflow was determined to be 226,800 cfs. This peak inflow was routed through the reservoir and the PMF outflow was determined to be 15,200 cfs using both the main and auxiliary spillways. To date, the maximum spillway discharge has been approximately 1600 cfs.

C. Visual observations. No modifications have been made to the Quabbin Spillway since it was constructed in the 1930's. Two feet of flashboards were in place on the 34 ft.-8 in. section of spillway at the time of the inspection and the water surface elevation was

529.73. The spillway and its associated approach channel appear to be in excellent condition. The left wall of the discharge channel shows signs of weathering with fallen rock on the floor of the channel. However, the slope of the discharge channel at this location is sufficiently steep that the rock debris should not cause any hydraulic problems.

D. Overtopping Potential. The stage-discharge relationship for the spillway utilizes the spillway rating curve developed by the MDC for spillages up to 3 feet, to El. 533.0. Between El. 533.0 and El. 536.0, a straight line interpolation was made recognizing the stated design discharge of 15,000 cfs at a maximum pool of El. 536.0.* Above this level, the auxiliary spillway will pass flows from an extreme flooding event.

Neglecting the capacity of the auxiliary spillway channel, it was determined that the PMF would generate a peak outflow rate of 16,300 cfs which would cause the water level in the reservoir to rise to El. 536.54. Considering the additional capacity afforded by the auxiliary spillway, treating same as a broad-crested weir, the maximum water level in the reservoir is lowered to El. 536.07 (peak outflow equals 15,200 cfs). Therefore, the main spillway in combination with minimal usage of the auxiliary spillway is adequate for the PMF. Since the crest of the dam is approximately 14 ft. above maximum water level, there is no possibility of overtopping.

E. Evaluation. Passage of the PMF by the main spillway with a minor portion of the flow over the auxiliary spillway should offer no flooding problems in the immediate area of the dam. The main spillway discharge channel, which is excavated in rock, has a base width in excess of 30 ft. with bottom slopes no less than 1.0 percent upstream of the arch bridge. Just downstream of the bridge, the channel bottom drops more than 50 ft. in less than 100 ft. to form a cascade while downstream, the discharge channel continues in rock with a base width in excess of 30 ft. with the bottom slope averaging 6.0 percent before flattening and merging with the original streambed of the Swift River. Downstream of this point, the Swift River Channel has ample capacity for the PMF flows from the main and auxiliary spillways as well as any contribution from the power station discharge channel. In conclusion, the spillway and downstream channels are more than adequate to pass the routed PMF as developed in the Guidelines.

* "Design and Progress on Construction of Dams for Quabbin Reservoir" by Stanley M. Dore, Journal of the Boston Society of Civil Engineers, July 1935, Pg. 173.

The estimated peak failure outflow should Quabbin Spillway fail is 13,000 cfs. Since this outflow is less than the test flood, the downstream channels and the Swift River are more than adequate to handle a failure of this structure.

Because of Quabbin Reservoir's vast storage capacity, as well as the height of both the Winsor Dam and Goodnough Dike, a failure of either the dam or dike would result in significant downstream damage as well as loss of life.

If Winsor Dam or Goodnough Dike were to fail, the peak outflows have been estimated (using "Rule of Thumb" guidelines developed by the C. of E.) to be 1,533,000 cfs for Winsor Dam and 958,000 cfs for Goodnough Dike. Since the effects of these flood waves would be experienced for many miles downstream, flood routing is beyond the scope of this investigation. Nevertheless, the following qualitative analysis is presented to indicate the magnitude of the downstream hazard potential.

Failure of Goodnough Dike would result in rapid inundation of Peppers Mill Pond one mile downstream, after which the flood wave would likely scour out a section of Route 9 to convey the flows which would be greatly in excess of the capacity of the existing 12 ft. wide by 9 ft. high multi-plate arch which carries Beaver Brook beneath Route 9. About 2 miles downstream of Goodnough Dike, the flood wave would enter Beaver Lake where it would be dissipated somewhat, but not before damage to houses and cottages around Beaver Lake and possible loss of life. Downstream of Beaver Lake, the flood wave would flow through a swampy area before the confluence with the Ware River about one mile downstream of Beaver Lake.

Failure of the Winsor Dam would produce a flood wave which would first scour out a section of Route 9, since the existing Swift River bridge opening would not be adequate to convey the flood flows. The State Fish Hatchery about one-half mile downstream of Route 9 would next be affected including a few houses along the river valley in the immediate area. About 4 miles downstream of Route 9, the flood wave would reach the village of Bondsville in the town of Palmer. The flood flow would pass both the upper and lower dams in Bondsville and for the most part not affect too many homes here as most of them are 20-40 ft. above the river bed. More damage would likely occur just downstream of where the Swift River meets the Ware River in the village of Three Rivers, where some of the housing is relatively low with respect to the river bed.

VI. STRUCTURAL STABILITY

6.1 EVALUATION OF EMBANKMENT STRUCTURAL STABILITY

A. Visual Observations. There was no visual evidence of embankment instability at either Winsor Dam or Goodnough Dike during the site of examination on 29 June 1978. Seepage at Goodnough Dike, as evident by wet areas at the toe of the dike, is not considered a potential hazard to the stability of the downstream slope.

B. Design and Construction Data. MDC drawings are available which show the design cross-sections for the dam and dike, both of which are full hydraulic fill structures. However, no design criteria for embankment stability or calculations are available. Furthermore, there are no construction records available which define soil properties.

A theoretical analysis of the structural stability of the dam and dike embankments was not possible due to lack of pertinent design and construction data. Nevertheless, the downstream slopes of 2 horizontal to 1 vertical above El. 499 and 2.5 to 1 below that grade, are considered reasonable for a hydraulic fill embankment of this height.

C. Operating Records. Records of crest settlement are available from surveys on settlement pins located at the top of light riprap on the upstream slope. The results of settlement observations have been discussed in Section III and are shown on figures in Appendix B-69 and B-70.

Generally, crest settlements are reasonable, in particular the time-settlement relationship of one point to another, and do not suggest any embankment instability. However, the settlement at Sta. 17 at Goodnough Dike, from 1952 to 1973, was about 0.1 ft. greater than would be expected. This result may be due to a survey error or to a local movement of the monument. While it does not suggest embankment instability in this area, it should be checked.

D. Post-Construction Changes. It is understood that there have been no significant post-construction changes to the dam and dike embankments. To accommodate differential settlement, some reconstruction, including repaving and pointing, has been undertaken where the Winsor Dam embankment interfaces with the intake structure.

E. Seismic Stability. The Quabbin Reservoir projects are located in Seismic Zone 2. According to C. of E. guidelines, projects in this zone are "assumed to present no hazard from earthquake provided static stability conditions are satisfied and conventional safety margins exist." At the present time, it is not known whether conventional safety factors exist for static stability analyses.

Because of the importance of these structures for water supply to the Greater Boston area, because of the high hazard potential in the event of a failure, and because the embankments are hydraulic fill with relatively steep slopes, a detailed investigation of embankment stability under static and earthquake loading is recommended.

6.2 EVALUATION OF STRUCTURAL STABILITY, QUABBIN SPILLWAY

A. Visual Observations. No visual evidence was noted that would indicate a structural stability problem with the masonry spillway. One small pressure leak was observed during the inspection which should be attended to to minimize the uplift force on the weir.

B. Design and Construction Data. Design data in the form of record drawings for the spillway and construction data in the form of construction photographs are available. Utilizing these data, a stability check was performed on the spillway weir, and the structural design was found to be adequate for the PMF.

C. Operation Records. Operation records in the form of water surface elevation since the time of construction are available.

D. Post-Construction Changes. A comparison of the visual appearance of the spillway weir and the record drawings indicate that no major modifications have been made to the spillway.

E. Seismic Stability. The spillway weir is deemed adequate for seismic stability in that it is located in a Zone 2 region and is adequate for normal loadings up to and including a probable maximum flood.

VII. ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 ASSESSMENT

A. Condition. The visual examination of Winsor Dam, Quabbin Spillway and Goodnough Dike, and review of available documents, did not reveal any evidence of failure or conditions which would warrant urgent remedial treatment. The projects are well maintained and are in excellent to good condition.

The Quabbin Spillway and auxiliary spillway at Winsor Dam are adequate to safely pass the the test flood, estimated to be 16,300 cfs, without overtopping the dam. The estimated maximum discharge since the project was completed 40 years ago, was 1600 cfs in April 1953.

B. Adequacy of Information. Generally, available drawings and other information were adequate for this Phase I Investigation. However, there is insufficient information to evaluate embankment stability under static loads and forces due to earthquakes.

C. Urgency. The recommendations for additional investigations and remedial measures outlined in Sections 7.2 and 7.3, respectively, should be undertaken by the MDC within 24 months after receipt of this Phase I Inspection Report.

D. Need for Additional Investigation. Additional investigations should be performed by the Owner as outlined in Section 7.2.

7.2 RECOMMENDATIONS

1. An investigation to assess the stability of the downstream slopes for both Winsor Dam and Goodnough Dike, under static and earthquake loading. The assessment should include the potential for a failure and/or excessive movement during a seismic event. To perform the required analyses, test borings and detailed laboratory testing will be required to provide data.

2. A new level survey on seven settlement observation points at Goodnough Dike, in particular to check the 1973 data at

Sta. 17. If the survey indicates a continued rate of settlement greater than at adjacent pins, consideration should be given to expanding the study to investigate the cause of greater subsidence and the area affects.

7.3 REMEDIAL MEASURES

A. Alternatives. Not applicable.

B. Operating and Maintenance Procedures. The following remedial work should be undertaken by the MDC to correct deficiencies noted during the visual examination:

1. Repair the lining of the former diversion tunnel at Winsor Dam. While the cracks and leakage in this tunnel pose no threat to the dam itself, a collapse of the tunnel roof could cause the rupture of an outlet conduit and reduce the control capabilities of the reservoir level.

2. Repoint the Quabbin Spillway weir masonry to maintain the structure in good condition.

3. Periodically remove brush, saplings and rockfalls from the spillway discharge pool and discharge channel.

4. Due to the size of the project and the "high" hazard potential classification, the MDC should develop a formal emergency preparedness plan and warning system, in cooperation with local officials in communities downstream of the project.

5. Make periodic visual observations of wet areas downstream of Goodnough Dike, noting carefully the extent of the wet area, evidence of active seepage into the area and related information for correlation with rainfall, snowmelt, reservoir level, etc. The objective of this activity will be to determine whether the wet areas are related to reservoir stage or are merely surface manifestations of seasonal effects of rainfall, etc.

6. Repoint the lower courses of the Intake Structure stone masonry exterior walls.

7. Fill animal burrow holes on upper berm of Winsor Dam near right abutement.

APPENDIX A
INSPECTION TEAM ORGANIZATION AND CHECK LIST

VISUAL INSPECTION PARTY ORGANIZATION

NATIONAL DAM INSPECTION PROGRAM

Dam: Quabbin Reservoir: Winsor Dam, Quabbin Spillway and Goodnough Dike

Date: 29 June 1978

Time: 8:30 a.m. to 5:00 p.m.

Weather: Clear to partly cloudy, hot

Water Surface Elevation Upstream: El. 529.73 (B.C.B. Datum)

Stream Flow: Not applicable

Inspection Party:

Harl P. Aldrich, Jr. Haley & Aldrich, Inc.	- Soils
Allen W. Hatheway Haley & Aldrich, Inc.	- Geology
Roger H. Wood Camp, Dresser & McKee, Inc.	- Structural
Charles E. Fuller Camp, Dresser & McKee, Inc.	- Hydraulic/Hydrologic
Charles Loveridge Camp, Dresser & McKee, Inc.	- Mechanical/Electrical

Present During Inspection:

Harold E. Mellin, Jr., M.D. C.
David Ashendon, M.D.C.
Harold Willey, M.D. C.

VISUAL INSPECTION CHECK LIST
NATIONAL DAM INSPECTION PROGRAM

DAM: Quabbin Reservoir: Winsor Dam DATE: 29 June 78

AREA EVALUATED	CONDITION
WINSOR DAM EMBANKMENT	
Crest Elevation	Originally, approximately El. 551 to El. 553 to allow for settlement
Current Pool Elevation	El. 529.73 (B.C.B. Datum)
Maximum Impoundment to Date	El. 531.03 on April 18, 1953
Surface Cracks	None observed
Pavement Condition	Very good; minor random transverse cracks in asphalt concrete
Movement or Settlement of Crest	None observed (see text for crest settlement data)
Lateral Movement	None observed
Vertical Alignment	Excellent
Horizontal Alignment	Excellent
Condition at Abutment and at Concrete Structures	Approximately 6 to 8 in. of embankment settlement adjacent to intake structure is visible
Indications of Movement of Structural Items on Slopes	No structural items on slopes. However, stone wall adjacent to intake structure has moved laterally and has settled (see photographs)
Trespassing on Slopes	Frequent, no restrictions on downstream grass slope
Animal Burrows in Embankment	Several noted on upper berm near right abutment
Vegetation on Embankment	Grass in good condition, mowed recently
Sloughing or Erosion of Slopes or Abutments	None observed of any significance
Rock Slope Protection - Riprap Failures	Light dumped riprap on upstream slope above berm, heavy riprap below berm; irregular but in good condition; no failures observed
Unusual Movement or Cracking at or near Toes	None observed
Unusual Embankment or Downstream Seepage	None observed
Piping or Boils	None observed
Foundation Drainage Features	None

FILE NO. 4960

HALEY & ALDRICH, INC.
CAMBRIDGE, MASSACHUSETTS

VISUAL INSPECTION CHECK LIST
NATIONAL DAM INSPECTION PROGRAM

DAM: Quabbin Reservoir: Winsor Dam DATE: 29 June 78

AREA EVALUATED	CONDITION
Toe Drains	None
Instrumentation Systems	Eight "pins" for measuring settlement of crest of dam (see text) Two abandoned (lost) observation wells
OUTLET WORKS - CONTROL BUILDING	
a. Concrete and Structural	
General Condition	Good to excellent
Condition of Joints	Some mortar missing in exterior joints at riprap level
Spalling	None noted
Visible Reinforcing	None noted
Rusting or Staining	Incidental rust on interior steel columns
Any Seepage or Efflorescenee	Efflorescence at bottom courses of block
Joint Alignment	Good
Unusual Seepage or Leaks in Gate Chamber	Not observable
Cracks	No major cracks noted
b. Mechanical and Electrical	Equipment reported to be in operable condition, no apparent deficiencies observed
OUTLET WORKS - CONDUIT	
General Condition	Mainly not observable, underground; top of 68-in. conduit exposed in former stream diversion tunnel; tunnel not illuminated Former stream diversion tunnel lining contains numerous cracks; moderate leak in roof of tunnel 450 ft. from power house at apparently old patch and cracks.

FILE NO. 4160

HALEY & ALDRICH, INC.
CAMBRIDGE, MASSACHUSETTS

VISUAL INSPECTION CHECK LIST
NATIONAL DAM INSPECTION PROGRAM

DAM: Quabbin Reservoir: Winsor Dam DATE: 29 June 78

AREA EVALUATED	CONDITION
OUTLET WORKS - OUTLET STRUCTURE (POWER HOUSE) AND OUTLET CHANNEL	
a. General Condition of Concrete and Masonry	Good condition
Rust or Staining	Underside of roof stained
Spalling	Shrinkage cracks in bond beam below roof
Visible Reinforcing	None observed
Any Seepage or Efflorescence	Efflorescence present lower portion of walls lower floor. Water on floor from unknown source
Condition at Joints	Good
b. Electrical-Mechanical	Equipment reported to be in operable condition - no apparent deficiencies observed. Reported cavitation, problem with control valves corrected by orifice plates
c. Channel	
Loose Rock or Trees Overhanging Channel	A few trees overhanging channel
Condition of Discharge Channel	Good - riprap
AUXILIARY SPILLWAY AT WINSOR DAM	
a. Channel Upstream of Weir	
General Condition	Excellent
Floor of Channel	Flat, covered with grass mowed recently; three trees; some brush at entrance to channel; gravel road crossing channel floor just upstream of weir creates minor obstruction to flow

FILE NO. 4490

VISUAL INSPECTION CHECK LIST
NATIONAL DAM INSPECTION PROGRAM

DAM: Quabbin Reservoir: Winsor Dam DATE: 29 June 78

AREA EVALUATED	CONDITION
b. Weir	
Crest	El. 536
General Condition	Only crest of circular weir visible; crest topped by large rectangular granite stones, typically 4 to 5 ft. long and 3 ft. wide; good condition
c. Channel Downstream of Weir	Grass lined then wooded; cross-country flow

FILE NO. 4160

HALEY & ALDRICH, INC.
CAMBRIDGE, MASSACHUSETTS

VISUAL INSPECTION CHECK LIST
NATIONAL DAM INSPECTION PROGRAM

DAM: Quabbin Reservoir: Quabbin Spillway DATE: 29 June 78

AREA EVALUATED	CONDITION
QUABBIN SPILLWAY - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
a. Approach Channel	
General Condition	Good
Loose Rock Overhanging Channel	None of any significance observed
Trees Overhanging Channel	A few small trees overhanging channel, but not significant
Floor of Approach Channel	Not observable
b. Weir and Training Walls	
General Condition of Masonry Joints	Good; several spots of vegetation in upper joint; some mortar missing especially in lower portion; bottom joint eroded
Rust or Staining	None observed
Cracks	Vertical cracks at each end and center of highest portion of weir
Any Visible Reinforcing	None observed
Any Seepage or Efflorescence	Seepage observed at highest joint; trace of moisture along bottom of high portion; seepage at end of high weir portion where it abuts rock; efflorescence present in high portion of weir - at junction with rock, mid-height and lower portions of weir
Drain Holes	None observed
c. Service Bridge	
General Condition	Good
Walkway	Good condition
Guides	Excellent condition
Flashboards	Good condition

FILE NO. 4160

HALEY & ALDRICH, INC.
CAMBRIDGE, MASSACHUSETTS

VISUAL INSPECTION CHECK LIST
NATIONAL DAM INSPECTION PROGRAM

DAM: Quabbin Reservoir: Quabbin Spillway DATE: 29 June 78

AREA EVALUATED	CONDITION
d. Discharge Channel	
General Condition	Good
Loose Rock Overhanging Channel	Evidence of prior rock falls from left face (see text)
Trees Overhanging Channel	Young trees at top of rock walls; few in channel but not significant
Floor of Channel	Irregular bedrock surface; some blocks of rock from rock cuts, especially at entrance to channel
Other Obstructions	Some brush growth

FILE NO. 4160

HALEY & ALDRICH, INC.
CAMBRIDGE, MASSACHUSETTS

VISUAL INSPECTION CHECK LIST
NATIONAL DAM INSPECTION PROGRAM

DAM: Quabbin Reservoir: Goodnough Dike DATE: 29 June 78

AREA EVALUATED	CONDITION
GOODNOUGH DIKE EMBANKMENT	
Crest Elevation	Originally, approximately El. 551 to El. 553 to allow for settlement
Current Pool Elevation	El. 529.73 (B.C.B. Datum)
Maximum Impoundment to Date	El. 531.03 on April 18, 1953
Surface Cracks	None observed
Pavement Condition	Excellent; a few minor random transverse cracks in asphalt concrete
Movement or Settlement of Crest	None observed (See text for crest settlement data)
Lateral Movement	None observed
Vertical Alignment	Excellent
Horizontal Alignment	Excellent
Condition at Abutment and at Concrete Structures	Good (no concrete structures); dike abuts rock at both ends
Indications of Movement of Structural Items on Slopes	No structural items on slopes
Trespassing on Slopes	Frequent, no restrictions on downstream grass slope
Animal Burrows in Embankment	None observed
Vegetation on Embankment	Grass in good condition, a few small bare areas; grass mowed recently
Sloughing or Erosion of Slopes or Abutments	None observed of any significance
Rock Slope Protection - Riprap Failures	Light dumped riprap on upstream slope above berm, heavy riprap below berm; irregular but in good condition; no failures observed
Unusual Movement or Cracking at or near Toes	None observed
Unusual Embankment or Downstream Seepage	Two unmowed areas at downstream toe of embankment; water clear; no flow observed (See photos)
Piping or Boils	None observed
Foundation Drainage Features	None

FILE NO. 4160

HALEY & ALDRICH, INC.
CAMBRIDGE, MASSACHUSETTS

VISUAL INSPECTION CHECK LIST
NATIONAL DAM INSPECTION PROGRAM

DAM: Quabbin Reservoir: Goodnough Dike DATE: 29 June 78

AREA EVALUATED	CONDITION
Toe Drains	None
Instrumentation Systems	Seven "pins" for measuring settlement of crest of dike (See text) One abandoned (lost) observation well

FILE NO. 4160

HALEY & ALDRICH, INC.
CAMBRIDGE, MASSACHUSETTS

APPENDIX B
LIST OF AVAILABLE DOCUMENTS AND PRIOR INSPECTION REPORTS

DRAWINGS

LIST OF AVAILABLE DOCUMENTS
WINSOR DAM

DOCUMENT	CONTENTS	LOCATION
"Construction of Core Wall at Main Dam", MDC Contract No. 38, Sheet 11, Acc. 4311, 21 December 1934	Overburden and geological data from borings, test pits and exploratory caissons shown on profiles	MDC, 20 Somerset St., Boston, MA (Appendix B-55)
"Construction of Core Wall at Main Dam:, MDC Contract No. 38, Sheet 12, Acc. 4312, 21 December 1934	Overburden and geological data from borings and test pits shown on profiles	MDC, 20 Somerset St., Boston, MA (Appendix B-56)
"Construction of Core Wall at Main Dam", MDC Contract No. 38, Sheet 13, Acc. 4313, 21 December 1934	Overburden and geological data from the three exploratory caissons	MDC, 20 Somerset St., Boston, MA (Appendix B-57)
"Main Dam Embankment", MDC Contract No. 52, Sheet 2, Acc. 24102, 1 June 1936	General plan	MDC, 20 Somerset St., Boston, MA (Appendix B-54)
"Main Dam Embankment", MDC Contract No. 52, Sheet 4, Acc. 24104, 1 June 1936	Profile on centerline of dam	MDC, 20 Somerset St., Boston, MA (Appendix B-58)
"Main Dam Embankment", MDC Contract No. 52, Sheet 10, Acc. 24110, 1 June 1936	Cross-section of top of dam	MDC, 20 Somerset St., Boston, MA (Appendix B-59)

DOCUMENT	CONTENTS	LOCATION
"Main Dam Embankment", MDC Contract No. 52, Sheet 17, Acc. 24117, 1 June 1936	Plan and sections of intake works	MDC, 20 Somerset St., Boston, MA (Appendix B-60)
"Main Dam Embankment", MDC Contract No. 52, Sheet 16, Acc. 24116, 1 June 1936	Plan, profile and sections of auxiliary spillway	MDC, 20 Somerset St., Boston, MA (Appendix B-61)
"Winsor Dam Embankment Settlement", MDC Acc. 17792, 28 October 1940	Settlements of embankment and roadway from 7 July 1939 to 26 June 1973	MDC, 20 Somerset St., Boston, MA (Appendix B-69)

LIST OF AVAILABLE DOCUMENTS
QUABBIN SPILLWAY

DOCUMENT	CONTENTS	LOCATION
"Main Dam Embankment", MDC Contract No. 52, Sheet 2, Acc. 24102, 1 June 1936	General plan showing spillway and Winsor Dam	MDC, 20 Somerst St., Boston, MA (Appendix B-54)
"Main Dam Embankment", MDC Contract No. 52, Sheet 11, Acc. 24111, 1 June 1936	Plan and profile at spillway channel	MDC, 20 Somerset St., Boston, MA (Appendix B-62)
"Main Dam Embankment", MDC Contract No. 52, Sheet 12, Acc. 24112, 1 June 1936	Selected cross-sections through spillway channel	MDC, 20 Somerset St., Boston, MA (Appendix B-63)

LIST OF AVAILABLE DOCUMENTS
GOODNOUGH DIKE

DOCUMENT	CONTENTS	LOCATION
"Construction of Core Wall at Dike", MDC Contract No. 36, Sheet 8, Acc. 3908, 4 November 1932	Overburden and geological data from borings, test pits and the exploratory caisson shown on profiles	MDC, 20 Somerset St., Boston, MA (Appendix B-65)
Construction of Core Wall at Dike", MDC Contract No. 36, Sheet 9, Acc. 3909, 4 November 1932	Overburden and geological data from borings and test pits shown on profiles	MDC, 20 Somerset St., Boston, MA (Appendix B-66)
"Embankment of Dike", MDC Contract No. 50, Sheet 2, Acc. 23402, 1 October 1934	General plan	MDC, 20 Somerset St., Boston, MA (Appendix B-64)
"Embankment of Dike", MDC Contract No. 50, Sheet 4, Acc. 23404, 1 October 1934	Profile on centerline of dike	MDC, 20 Somerset St., Boston, MA (Appendix B-67)
"Embankment of Dike", MDC Contract No. 50, Sheet 3, Acc. 23403, 1 October 1934	Typical cross-sections	MDC, 20 Somerset St., Boston, MA (Appendix B-68)
"Dike Embankment, Settlement of the Embankment", MDC Acc. 17641, 10 October 1939	Settlements of embankment and roadway from 8 December 1936 to 27 June 1973	MDC, 20 Somerset St., Boston, MA (Appendix B-70)

LIST OF AVAILABLE DOCUMENTS
QUABBIN RESERVOIR CONTRACTS

The following list is intended as a guide to obtaining additional documents on Winsor Dam, Quabbin Spillway and Goodnough Dike available at the MDC, 20 Somerset St., Boston, MA

Contract No.	
2	Borings Swift Dam Site
3	Air Photos, Swift Valley
23	Borings - Belchertown, Enfield, Ware
30	Stream Control Works at Main Dam
32	Constructing Exploratory Caissons
36	Constructing Core Wall at Dike
38	Construction Core Wall at Winsor Dam
45	Explor. by Shovel Cuts - Main Dam and Dike
50	Embankment at Dike
52	Main Dam Embankment
118	Misc. Construction at Winsor Dam and Dike
119	Pylons at Winsor Dam
148	Sale of Power - Winsor Dam
149A	Hydraulic Turbine - Winsor Dam
149B	Generator - Winsor Dam
149C	Switchgear, Bus Reactor, Metering Outfit, Control Panel - Winsor Dam
149D	Transformer - Winsor Dam
149E	Substation - Winsor Dam
149F	Storage Battery and Charging Equipment - Winsor Dam
150	Installation of Power Plant

WINSOR DAM

C. Quabbin Dike, Winsor Dam and Spillway

The grass cover on the embankment forming the dike was noted to be o.k. The toe area of the dry side was in good condition and dry. The road on top of the embankment was in good condition and there was no evidence of settlement, sunken areas or cracks. The rock fill slope on the reservoir side of the dike is in good condition. Water in storage was observed to be quite low but appeared to be higher in elevation than at the time of the previous inspection.

The main dam, Winsor Dam, was noted to be in good condition. The turf cover on the downstream slope was good. Some areas apparently are being re-loamed, treated and seeded. The toe area of this main dam was dry.

The rock filled portion of the main dam on the reservoir side was in good condition. The road across the dam was o.k.

The spillway structure was again observed to be completely dry. The spillway has not been wet for many years. However, the level of water observed this year is at the entrance to the spillway forebay and thus is the highest noted in many years. The stone masonry of the spillway and the crest were observed to be o.k.

In the opinion of the undersigned, the dam, the dike and spillway are in the same good condition as previously reported and are safe.

INSPECTION REPORT - DAMS AND RESERVOIRS

1. LOCATION:

~~River~~Town Ware. County Hampshire. Dam No. 2-8-309-1A.

Name of Dam Quabbin "Winsor" Dam
Mass. Rect.

Topo Sheet No. 14D. Coordinates: N 469,000, E 371,500.

Inspected by: R. C. Sells, P.E., On Feb. 26, 1974. Date Last Inspection 1970.
See also Quabbin Spillway No. 2-8-309-1B & Goodnough Dike No. 2-8-309-1C

2. OWNER/S: As of November 1972

per: Assessors X, Reg. of Deeds ____, Prev. Insp. ____, Per. Contact X.

	Name	St. & No.	City/Town	State	Tel. No.
1.	Metropolitan District Commission, Winsor Dam - Ware Rd.,		Belchertown,	Mass.	
2.					
3.					

3. CARETAKER: (if any) e.g. superintendent, plant manager, appointed by absentee owner, appointed by multi owners.

Mr. John W. Copitherne, Supt.

Name	St. & No.	City/Town	State	Tel. No.
Quabbin Reservoir, M.D.C. Winsor Dam, Ware Rd.,		Belchertown,	Mass.	413-323-6021

4. DATA:

No. of Pictures Taken None. Sketches See description of Dam.
Plans, Where In M.D.C. office at Quabbin.

5. DEGREE OF HAZARD: (if dam should fail completely)*

1. Minor ____.
2. Moderate ____.
3. Severe ____.
4. Disastrous X.

Comments: Assuming complete failure.

*This rating may change as land use changes (future development).

APPENDIX B-7

(6.) OUTLETS: OUTLET CONTROLS AND DRAWDOWN

No. 1 Location and Type: Intake structure at southwesterly end of dam for 48" diam. and 68" diam. conduits in outlet tunnel.

Controls Yes, TYPE: Gate valve and slide valve.

Automatic____. Manual X. Operative Yes X, No____.

Comments: At time of inspection automatic screens being installed.

No. 2 Location and Type: See Quabbin Spillway - Dam No. 2-8-309-13.

Controls Yes, Type: Flashboards.

Automatic____. Manual X. Operative Yes X, No____.

Comments: Spillway has not functioned as yet.

No. 3 Location and Type: Auxiliary spillway 1200 ft. southwesterly of end of dam.

Controls No, Type:____.

Automatic____. Manual____. Operative Yes____, No____.

Comments: Crest of auxiliary spillway 6 ft. above reservoir flow line or about 17 ft. below top embankment.

Drawdown present Yes X, No____. Operative Yes X, No____.
Comments: See No. 1 above - lower intake.

(7.) DAM UPSTREAM FACE: Slope Varies - 1½:1 to 3:1, Depth Water at Dam 140 ft. ±.

Material: Turf____. Brush & Trees____. Rock fill X. Masonry____. Wood____.
10' thick

Other 3 berms on slope.

Condition: 1. Good X. 3. Major Repairs____.

2. Minor Repairs____. 4. Urgent Repairs____.

Comments: For details of slope see sketches - sheet #2.

(8.) DAM DOWNSTREAM FACE: Slope 2:1 to 2 3/4:1.

Material: Turf X. Brush & Trees____. Rock Fill____. Masonry____. Wood____.

Other 2 berms on slope. Slope drainage installed.

Condition: 1. Good X. 3. Major Repairs____.

2. Minor Repairs____. 4. Urgent Repairs____.

Comments: Access road to powerhouse; outlet structure and beginning of Chicopee aqueduct crosses slope.

Dwg NO. 2-8-309-1A

6. OUTLETS: OUTLET CONTROLS AND DRAWDOWN

No. 1 Location and Type: Quabbin Aqueduct at N500,700, E389,500.

Controls Yes, TYPE: In District 3 - Worcester County.

Automatic____. Manual____. Operative Yes X, No____.

Comments: Aqueduct to Wachusetts Reservoir and to Boston.

No. 2 Location and Type:_____.

Controls_____, Type:_____.

Automatic_____. Manual_____. Operative Yes_____, No_____.

Comments:_____.

No. 3 Location and Type:_____.

Controls_____, Type:_____.

Automatic_____. Manual_____. Operative Yes_____, No_____.

Comments:_____.

Drawdown present Yes_____, No_____. Operative Yes_____, No_____.
Comments:_____.

7. DAM UPSTREAM FACE: Slope_____, Depth Water at Dam_____.

Material: Turf_____. Brush & Trees_____. Rock Fill____. Masonry____.Wood____.

Other_____.

Condition: 1. Good_____. 3. Major Repairs_____.

2. Minor Repairs_____. 4. Urgent Repairs_____.

Comments:_____.

8. DAM DOWNSTREAM FACE: Slope_____.

Material: Turf_____. Brush & Trees____. Rock Fill_____. Masonry_____. Wood_____.

Other_____.

Condition: 1. Good_____. 3. Major Repairs_____.

2. Minor Repairs_____. 4. Urgent Repairs_____.

Comments:_____

(9.) EMERGENCY SPILLWAY: Available Yes. Needed No.

Height Above Normal Water 6 Ft. auxiliary spillway

Width 200± Ft. Height 3-4 Ft. Material Earth channel Masonry weir.

Condition: 1. Good X. 3. Major Repairs_____.

2. Minor Repairs_____. 4. Urgent Repairs_____.

Comments: See sheet 6 of sketches - Note: See also Quabbin spillway, Dam No. 2-8-309-1B.

(10.) WATER LEVEL AT TIME OF INSPECTION: 35± Ft. Above_____. Below_____.

Top Dam X P.L. Principal Spillway_____.

Other_____.

Normal Freeboard 23 Ft.

(11.) SUMMARY OF DEFICIENCIES NOTED:

Growth (Trees and Brush) on Embankment None.

Animal Burrows and Washouts None seen.

Damage to Slopes or Top of Dam None. Note precise levels in 1970 show embankment has settled 1.50 ft. ±.

Cracked or Damaged Masonry None seen.

Evidence of Seepage Minor seepage - handled by drainage system.

Evidence of Piping None seen.

Leaks None seen.

Erosion None noted.

Trash and/or Debris Impeding Flow None.

Clogged or Blocked Spillway No. - Note automatic screening equipment being installed at time of inspection.

Other_____.

DAM NO. 2-8-309-1A

(12.) OVERALL CONDITION:

1. Safe X.
2. Minor repairs needed_____.
3. Conditionally safe - major repairs needed_____.
4. Unsafe_____.
5. Reservoir impoundment no longer exists (explain)

   Recommend removal from inspection list_____.

(13.) REMARKS AND RECOMMENDATIONS: (Fully Explain)

This dam across the Swift River forms the Quabbin Reservoir. It is an earth embankment 2600 feet long and over 155 feet high. There is a concrete caisson core wall with its top somewhere near the original ground line which extends to bedrock located on the centerline of the embankment. The earth embankment is a full hydraulic fill structure with a riprap shell on the upstream face and with a loam and turf surface on the downstream slope.

An examination of the embankment, the intake structure, and the outlet structure or powerhouse found no visible defects. The examination included viewing the interior of the outlet tunnel and viewing the interior of one of the intake structure wells in an unwatered condition. At the time of the inspection automatic screening devices were being installed in the intake wells and as a part of this work the bearing brackets for the gate operating shafts were being rehabilitated.

Core drillings of the concrete in the interior of the intake well obtained from the drilling of anchor bolt holes for the installation of the screening device showed the concrete to be in excellent condition.

The two observation wells originally installed in this dam are no longer usable and no information on recent observation was available. Precise levels were taken on the top of the dam at frequent intervals until 1957 and again in 1973. These showed a settlement of about 1½ feet in 1973 with about a third of the total settlement occurring between 1957 and 1973, a period when the reservoir was at a relatively low level. This dam was originally designed with a 2 foot camber to allow for settlement.

Mr. Mellin, the Assistant Superintendent, accompanied us on our inspection.

RCS/js/vz

DESCRIPTION OF DAM

DISTRICT 2

Submitted by R. C. Sells, P.E. Dam No. 2-8-309-1A

Date February 26, 1974 Town Ware

Name of Dam Quabbin "Winsor" Dam

See also Dam No. 2-8-309-1B - Quabbin Spillway & No. 2-8-309-1C Goodnough Dike

1. Location: Topo Sheet No. 14D Mass. Rect. Coordinates N 460,000 E 351,500

Provide 8½" x 11" in clear copy of topo map with location of Dam clearly indicated.

Access from Ware Rd. "Rte. 9" about 2½ mi. easterly from Junction with Rte. 21 - About 2500 ft. (½ mile) northerly from Rte. 9 on Winsor Dam Rd. - road goes over dam

2. Year built 1936 - 38 Year/s of subsequent repairs 1970

3. Purpose of Dam: Water Supply X Recreational _____
Flood Control _____ Irrigation _____ Other _____

4. Drainage Area: 186 sq. mi. plus limited diversion from Ware River watershed of 98 sq. mi. sq. mi. _____ acres.
Type: City, Bus. & Ind. _____ Dense Res. _____ Suburban _____ Rural, Farm 15%
Wood & Scrub Land 85% Slope: Steep 15% Med. 75% Slight 10%.

5. Normal Ponding Area: ~~38.6~~ 24,704 sq. mi. Acres; Ave. Depth _____
Impoundment: 412 billion gals.; Max. water depth 150 ft. Acre ft.
Silted in: Yes _____ No _____ Approx. Amount Storage Area Unknown

6. No. and type of dwellings located adjacent to pond or reservoir _____
i.e. summer homes etc. Only residences of operating personnel

7. Dimensions of Dam: Length 2600 ft. Max. Height 155± ft.
Freeboard 23 to top embankment when full at crest of spillway
Slopes: Upstream Face Varies 1½ to 1 to 3:1 riprap
Downstream Face Varies 2: to 2 3/4:1 turf
Width across top 34 3/4 - paved roadway
See sketches attached.

APPENDIX B-12

8.

Classification of Dam by Material:

Earth X Conc. Masonry _____ Stone Masonry _____
Hydraulic fill embankment
Timber _____ Rockfill _____ Other Concrete caisson core wall

8A.

Dam Type: Gravity X Straight X Curved, Arched _____ Other Slight curve at east end
Embankment
Overflow _____ Non-overflow X

9.

A. Description of present land usage downstream of dam:

90 % rural; 10 % developed villages of Bondsville & Three Rivers

B. Is there a storage area or flood plain downstream of dam which could accommodate the impoundment in the event of a complete dam failure? Yes _____ No X

C. Character Downstream Valley: Narrow X Wide _____ Developed 10%
Rural 90% Urban _____

10.

Risk to life and property in event of complete failure. *See note below.

No. of people Say 2 - 300 before Chicopee River

No. of homes 30± houses before villages of Bondsville & Three Rivers - say 2 - 300 homes before Chicopee River

No. of businesses Numerous in villages

No. of industries _____ Type Several light manufacturing plants

No. of utilities 4 Type Water supply - pole lines for telephone & electric plus electrical power plant & transmission lines

Railroads Boston & Maine & Vermont Central R. R.

Other dams Bondsville Upper Dam No. 3-7-227-11 & Bondsville Lower Dam No. 3-7-227-1

Other State Fish Hatchery - numerous town highways and bridges and Route 9 State Highway

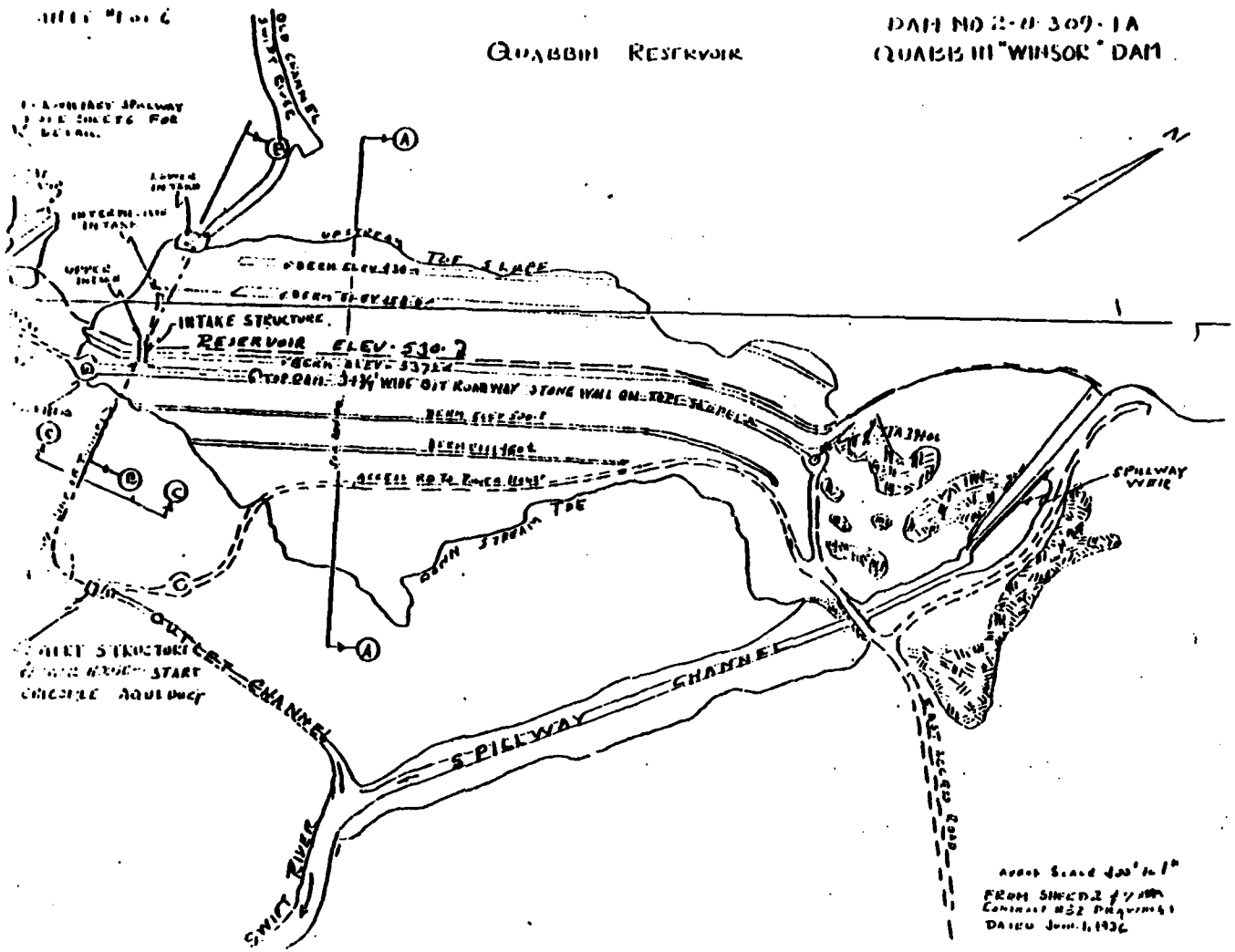
---

11.

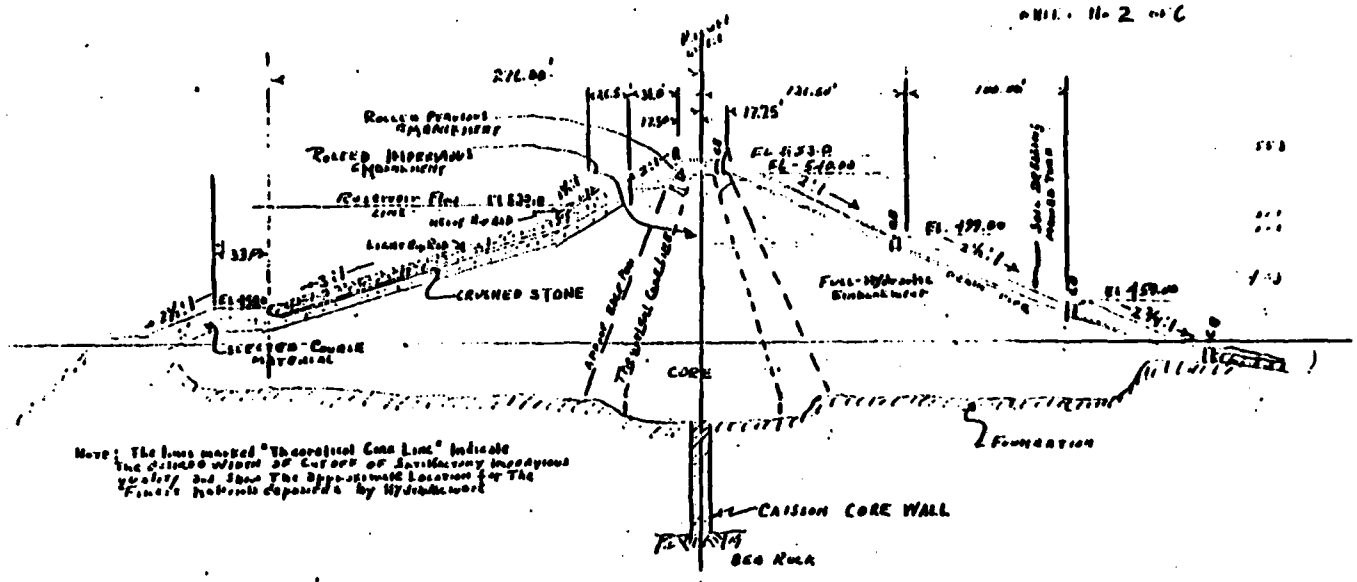
Attach Sketch of dam to this form showing section and plan on 8½" x 11" sheet.
Sketch - 2 sheets

RCS/vk
Attachments
Locus Plan
Sketches

* Note: Risk to life and property only along Swift River considered. Damage is likely on Chicopee River, also.



APPENDIX B-14



"X" SECTION AT STATION 20+00 APPROX. SCALE 40'± 1"

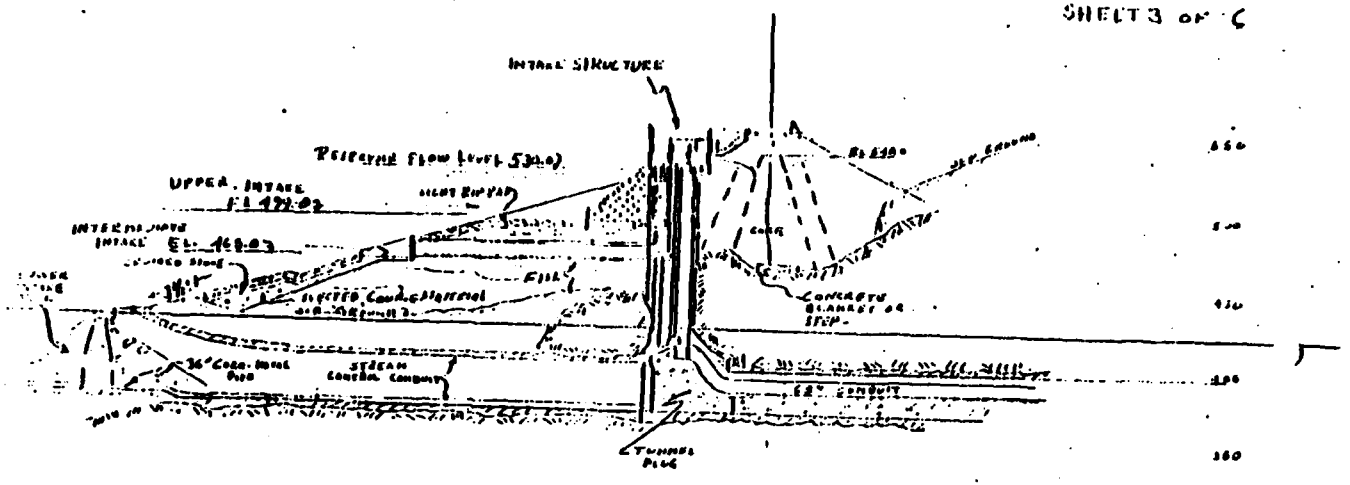
X SECTION "AA"

FROM SHEET 3
CONTRACT #52 DRAWINGS
DATED JUNE 1, 1936

DAM NO 2-8-309-1A
QUABBIN "WINSOR" DAM

APPENDIX B-15

SHEET 3 OF 6

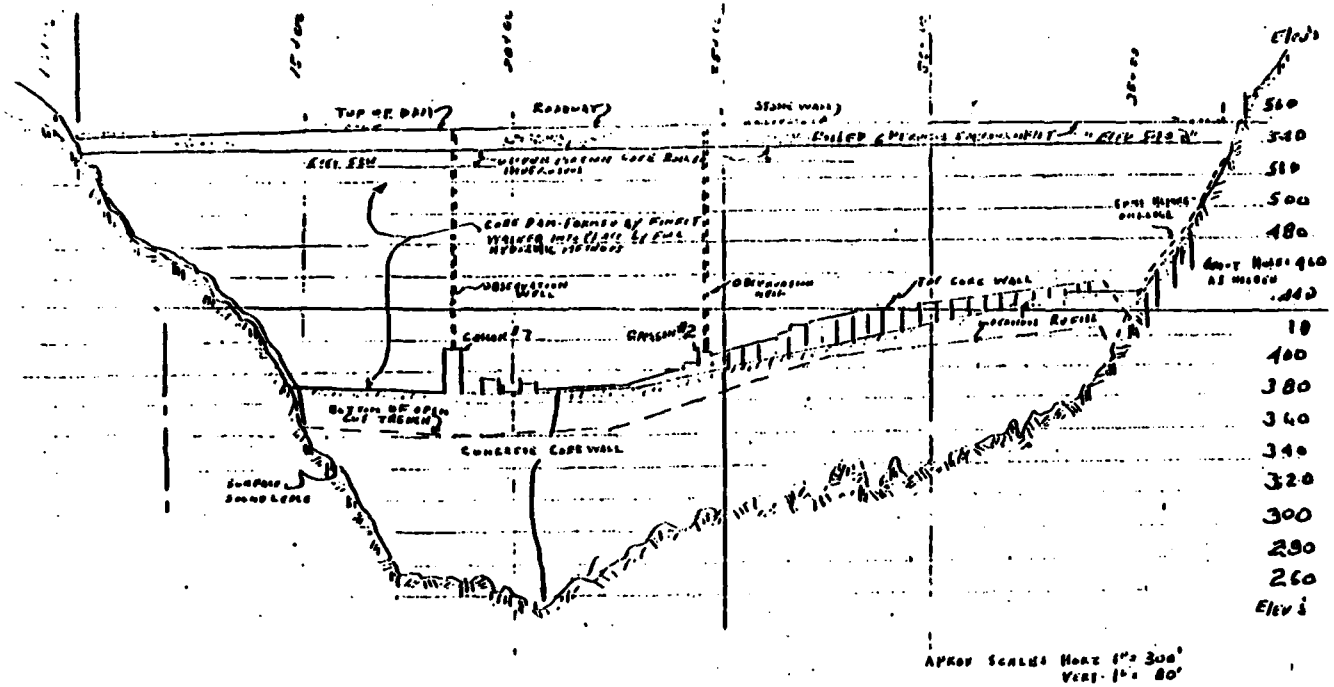


X SECTION THRU INTAKES & STRUCTURE CONTROL TUNNEL

Y SECTION "BB"

FROM SHEET # 3
CONTRACT # 52
DATED JUNE 1, 1936

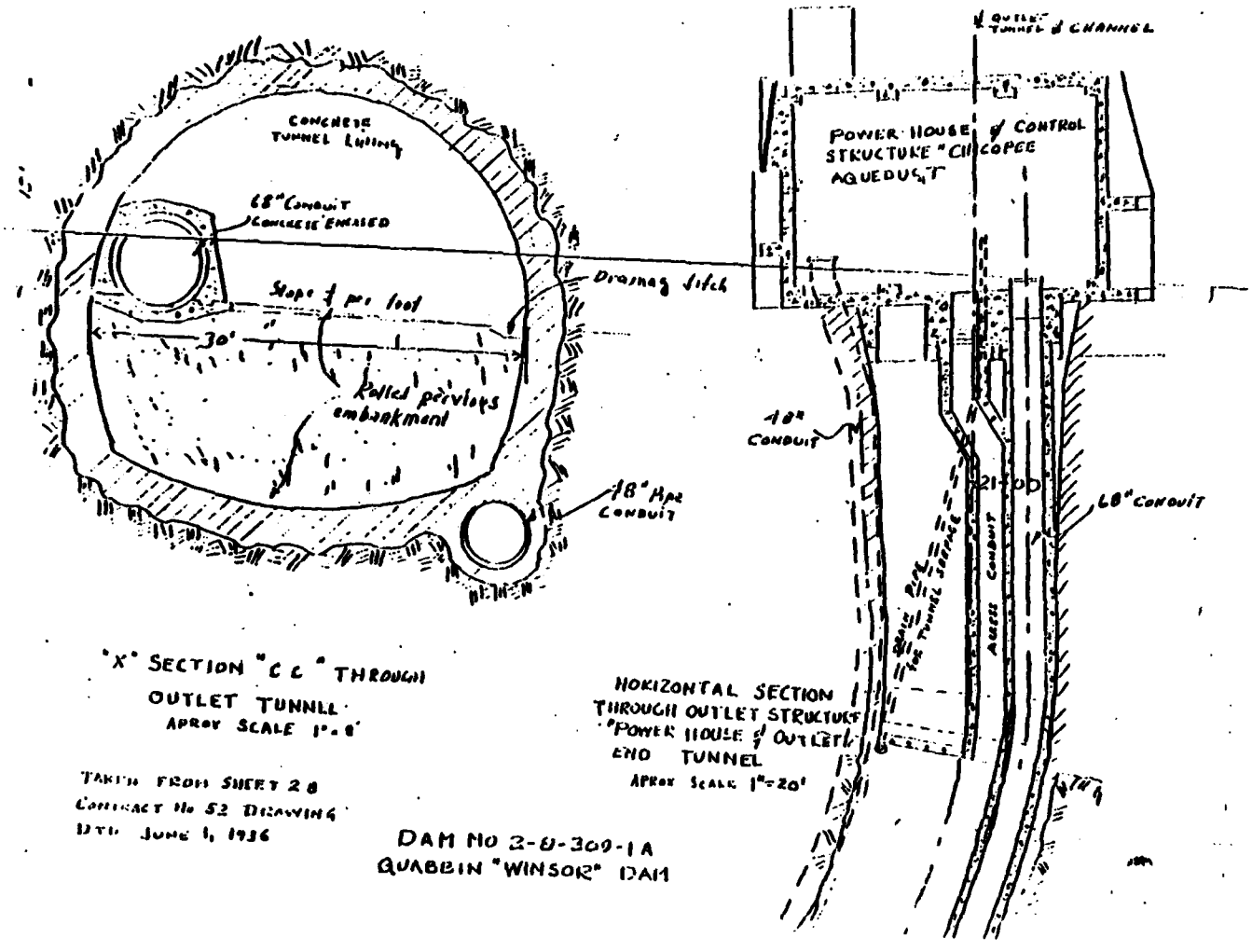
DAM NO 2-7-309-1 Am
QUABBIN "WINSOR" DAM



PROFILE ON CENTERLINE WINSOR DAM

FROM SHEET 4.
CONTRACT No 62
DATED JUNE 1, 1936

DAM N02-8-309-1A
QUABBIN "WINSOR" DAM



"X" SECTION "C C" THROUGH OUTLET TUNNEL
APPROX SCALE 1"=8'

TAKEN FROM SHEET 28 CONTRACT No 52 DRAWING DTD JUNE 1, 1936

HORIZONTAL SECTION THROUGH OUTLET STRUCTURE "POWER HOUSE & OUTLET" END TUNNEL
APPROX SCALE 1"=20'

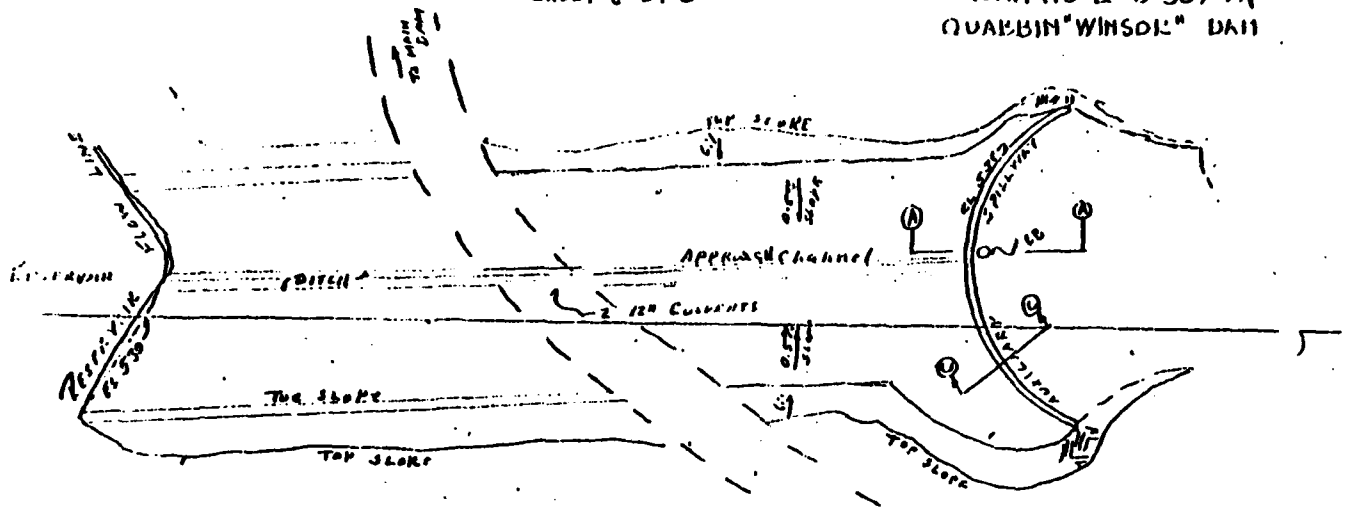
DAM NO 2-0-309-1A
QUABBIN "WINSOR" DAM

APPENDIX B-18

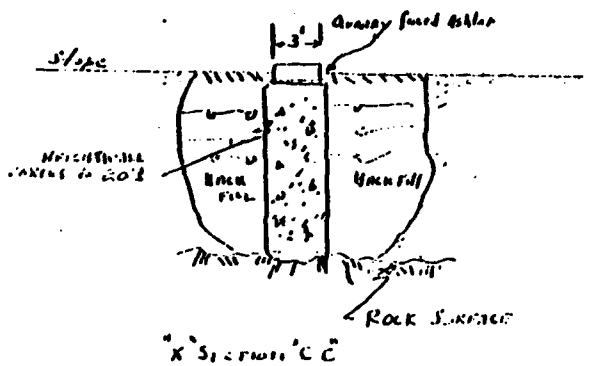
SHEET 6 OF 6

DAM NO 2-11-309-14

QUABBIN "WINSOR" DAM



PLAN



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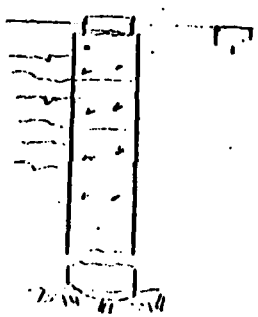
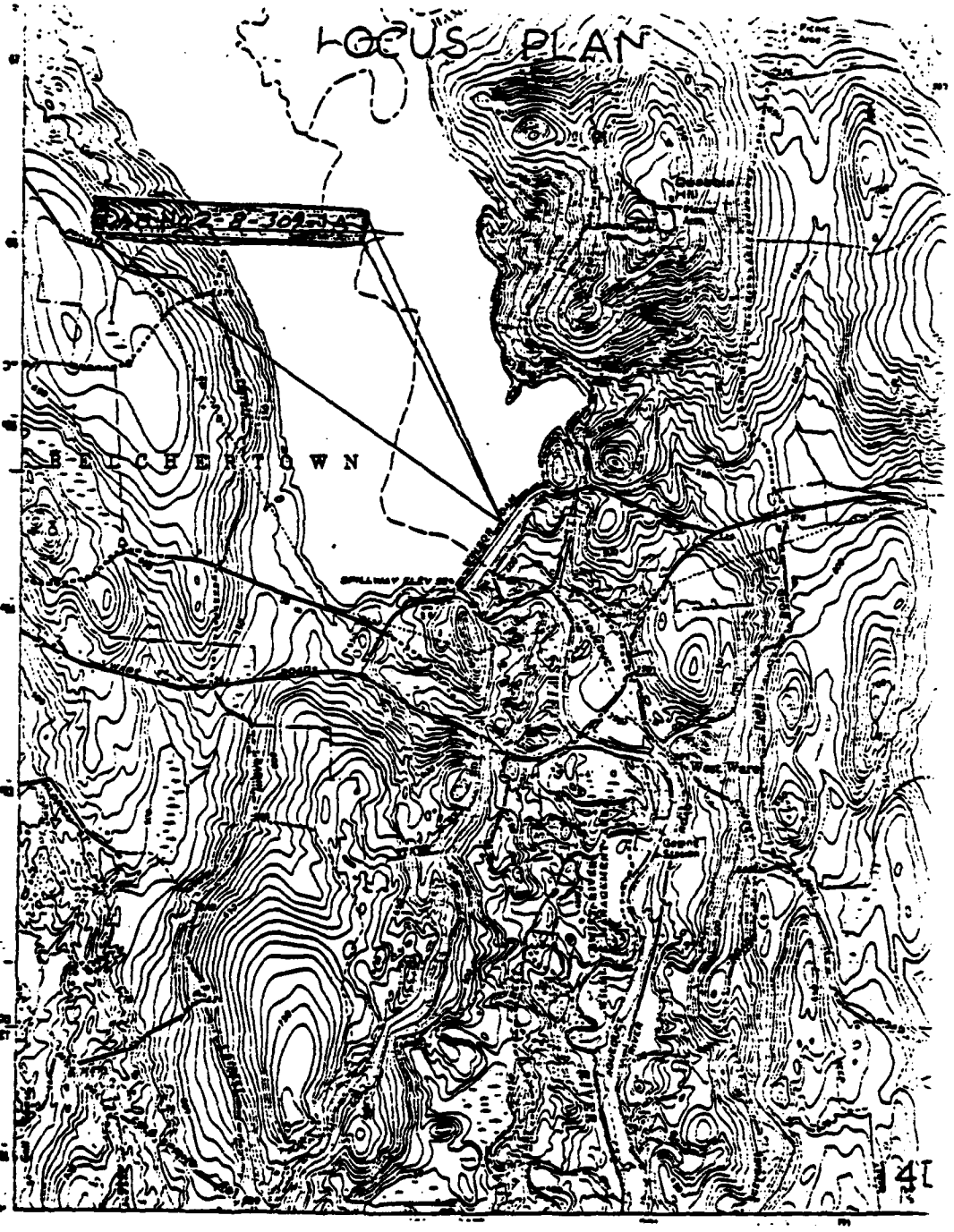


X SECTION AA

FROM CONTRACT 11S2 PLANS SHEET 11

SKETCHES OF AUXILIARY SPILLWAY EXCAVATION

APPENDIX B-19


LOCUS PLAN
BELCHERTOWN

INSPECTION REPORT - DAMS AND RESERVOIRS

1. LOCATION:

City/Town Ware. County Hampshire. Dam No. 2-8-309-1A

Name of Dam Quabbin "Winsor Dam" Mass. Rect.

Topo Sheet No. 140. Coordinates: N 469,000, E 371,500.

Inspected by: Harold T. Shumway, On March 23,1976. Date Last Inspection 2-26-74.

See also Quabbin Spillway No. 2-8-309-1B and Goodnough Dike No. 2-8-309-1C.

2. OWNER/S: As of March 23, 1976

per: Assessors____, Reg. of Deeds____, Prev. Insp. X, Per. Contact X.

1. Metropolitan District Commission, Winsor Dam, Ware Road, Belchertown, Mass.
Name | St. & No. | City/Town | State | Tel. No.

2. _____
Name | St. & No. | City/Town | State | Tel. No.

3. _____
Name | St. & No. | City/Town | State | Tel. No.

3. CARETAKER: (if any) e.g. superintendent, plant manager, appointed by absentee owner, appointed by multi owners.

Supt. of Quabbin Reservoir
M. D. C. Winsor Dam, Ware Road, Belchertown, Mass. 413-323-6921
Name | St. & No. | City/Town | State | Tel. No.

4. DATA:

No. of Pictures Taken None. Sketches See description of Dam.
Plans, Where In M.D.C. office files at Winsor Dam Headquarters.

5. DEGREE OF HAZARD: (if dam should fail completely)*

1. Minor____. 3. Severe____.

2. Moderate____. 4. Disastrous X.

Comments: Assuming complete failure.

*This rating may change as land use changes (future development).

(6.) OUTLETS: OUTLET CONTROLS AND DRAWDOWN

No. 1 Location and Type: South westerly end of dam-Intake structure for 48" diameter and 68" diameter conduits in outlet tunnel.

Controls Yes, TYPE: Gate valve and slide valve.

Automatic ____. Manual X. Operative Yes X, No ____.

Comments: All in good condition per M.D.C. personnel.

No. 2 Location and Type: See Quabbin Spillway Dam No. 2-8-309-18

Controls Yes, Type: Flash boards.

Automatic ____. Manual X. Operative Yes X, No ____.

Comments: Minor seepage in drop wall, see Dam No. 2-8-309-18 report.

No. 3 Location and Type: Auxiliary spillway 1200 ft. south westerly of end of dam.

Controls No, Type: ____

Automatic ____. Manual ____. Operative Yes ____, No ____.

Comments: Crest of auxiliary spillway 6 ft. above reservoir flow line or about 17 ft. below top embankment.

Drawdown present Yes X, No ____. Operative Yes X, No ____.

Comments: See No. 1 above-lower intake.

(7.) DAM UPSTREAM FACE: Slope 1½:1 variable to 3:1, Depth Water at Dam 152' ±

Material: Turf ____. Brush & Trees ____. Rock fill X 18' thick. Masonry ____. Wood ____.

Other 3 berms on slope

Condition: 1. Good X. 3. Major Repairs ____.

2. Minor Repairs ____. 4. Urgent Repairs ____.

Comments: All slopes appeared stable, alignment and grade appeared good.

(8.) DAM DOWNSTREAM FACE: Slope 2:1 to 2 ½/4:1

Material: Turf X. Brush & Trees ____. Rock Fill ____. Masonry ____. Wood ____.

Other 2 berms on slope, slope drainage installed.

Condition: 1. Good X. 3. Major Repairs ____.

2. Minor Repairs ____. 4. Urgent Repairs ____.

Comments: Access road to power house; outlet structures and beginning of Chicopee aqueduct crosses slope. Slope appeared stable.

Dwll NO. 2-8-309-1A

(9.) EMERGENCY SPILLWAY: Available Yes. Needed ____.

Height Above Normal Water 6 Ft.

Width 200 ± Ft. Height 3 to 4 Ft. Material Masonry weir earth channel.

Condition: 1. Good X. 3. Major Repairs ____.

2. Minor Repairs ____. 4. Urgent Repairs ____.

Comments: See also Quabbin Spillway Dam No. 2-8-309-18

(10.) WATER LEVEL AT TIME OF INSPECTION: 23½ Ft. Above ____. Below X.

Top Dam X F.L. Principal Spillway ____.

Other ____.

Normal Freeboard 23 Ft.

(11.) SUMMARY OF DEFICIENCIES NOTED:

Growth (Trees and Brush) on Embankment None found.

Animal Burrows and Washouts None found.

Damage to Slopes or Top of Dam None found. Note: precise levels in 1970 show embankment has settled 1½".

Cracked or Damaged Masonry None found.

Evidence of Seepage Minor seepage, handled by drainage system.

Evidence of Piping None found.

Leaks None found.

Erosion None found.

Trash and/or Debris Impeding Flow None.

Clogged or Blocked Spillway ____.

Other ____

APPENDIX B-23

DAM NO. 2-8-309-1A

(8) OVERALL CONDITION:

1. Safe X.
2. Minor repairs needed_____.
3. Conditionally safe - major repairs needed_____.
4. Unsafe_____.
5. Reservoir impoundment no longer exists (explain)

   Recommend removal from inspection list_____.

---

(9) REMARKS AND RECOMMENDATIONS: (Fully Explain)

This is the main dam forming the Quabbin Reservoir. It is an earthen embankment with a concrete caisson core wall. The embankment is 2600 feet long and 155' ± high.

The riprap stone shell on the upstream side appeared stable as did the turfed slope of the downstream side. Some slight seepage was noted but did not appear to be of any hazard to dam. It was not possible on this inspection to view the interior of outlet tunnel or intake wells but all exterior surfaces were checked and appeared good.

MTS/at

QUABBIN SPILLWAY

G. Quabbin Dike, Winsor Dam and Spillway

The grass cover on the embankment forming the dike was noted to be o.k. The toe area of the dry side was in good condition and dry. The road on top of the embankment was in good condition and there was no evidence of settlement, sunken areas or cracks. The rock fill slope on the reservoir side of the dike is in good condition. Water in storage was observed to be quite low but appeared to be higher in elevation than at the time of the previous inspection.

The main dam, Winsor Dam, was noted to be in good condition. The turf cover on the downstream slope was good. Some areas apparently are being re-loamed, treated and seeded. The toe area of this main dam was dry.

The rock filled portion of the main dam on the reservoir side was in good condition. The road across the dam was o.k.

The spillway structure was again observed to be completely dry. The spillway has not been wet for many years. However, the level of water observed this year is at the entrance to the spillway forebay and thus is the highest noted in many years. The stone masonry of the spillway and the crest were observed to be o.k.

In the opinion of the undersigned, the dam, the dike and spillway are in the same good condition as previously reported, and are safe.

INSPECTION REPORT - DAMS AND RESERVOIRS

1. LOCATION:

~~River~~/Town Ware. County Hampshire. Dam No. 2-8-309-1B.

Name of Dam Quabbin "Spillway"

Topo Sheet No. 14D. Coordinates: N 470,200 (Mass. Rect.), E 373,000.

Inspected by: R. C. Sells, P.E., On Feb. 26, 1974. Date Last Inspection 1970.

See also Quabbin Winsor Dam No. 2-8-309-1A and Goodnough Dike No. 2-8-309-1C

2. OWNER/S: As of November 1972

per: Assessors X, Reg. of Deeds ____, Prev. Insp. ____, Par. Contact X.

1. Metropolitan District Commission, Winsor Dam - Ware Rd., Belchertown, Mass.
Name | St. & No. | City/Town | State | Tel. No.

2. ____
Name | St. & No. | City/Town | State | Tel. No.

3. ____
Name | St. & No. | City/Town | State | Tel. No.

3. CARETAKER: (if any) e.g. superintendent, plant manager, appointed by absentee owner, appointed by multi owners.

Mr. John W. Copithorne, Supt.
Quabbin Reservoir, M.D.C. - Winsor Dam - Ware Rd., Belchertown, Mass. 413 - 323-6921
Name | St. & No. | City/Town | State | Tel. No.

4. DATA:

No. of Pictures Taken 1. Sketches See description of Dam.
Plans, Where At M.D.C. office at Quabbin.

Copy of photo attached.

5. DEGREE OF HAZARD: (if dam should fail completely)*

1. Minor ____.
2. Moderate ____.
3. Severe X.
4. Disastrous ____.

Comments: Assuming complete failure.

*This rating may change as land use changes (future development).

(6.) OUTLETS: OUTLET CONTROLS AND DRAWDOWN See Inspection Report for Quabbin "Winsor Dam" No. 2-8-309-1A

No. 1 Location and Type:_____.

Controls_____, TYPE:_____.

Automatic____. Manual____. Operative Yes____, No____.

Comments:_____.

No. 2 Location and Type:_____.

Controls_____, Type:_____.

Automatic_____. Manual_____. Operative Yes_____, No_____.

Comments:_____.

No. 3 Location and Type:_____.

Controls_____, Type:_____.

Automatic_____. Manual____. Operative Yes____, No____.

Comments:_____.

Drawdown present Yes X, No____. Operative Yes____, No____.
Comments: See Item 6 sub. 1 - Winsor Dam Inspection Report.

(7.) DAM UPSTREAM FACE: Slope 1 to 3.27, Depth Water at Dam crest of dam - El. 530 *Reservoir flow line at

Material: Turf____. Brush & Trees____. Rock fill___. Masonry Cut granite X .Wood___.

Other_____.

Condition: 1. Good X. 3. Major Repairs_____.

2. Minor Repairs_____. 4. Urgent Repairs_____.

Comments: * At time of inspection water about 10' to 12' below crest of spillway.

(8.) DAM DOWNSTREAM FACE: Slope 1:1.

Material: Turf____. Brush & Trees___. Rock Fill____. Masonry Cut granite X. Wood____.

Other_____.

Condition: 1. Good X. 3. Major Repairs_____.

2. Minor Repairs_____. 4. Urgent Repairs_____.

Comments: This spillway has not functioned for years.

Dwg NO. 2-8-309-12

(9.) EMERGENCY SPILLWAY: Available Yes. Needed No.

Height Above Normal Water 6 Ft.

Width 200± Ft. Height 3 - 4 Ft. Material Earth channel Masonry weir.

Condition: 1. Good X. 3. Major Repairs_____.

2. Minor Repairs_____. 4. Urgent Repairs_____.

Comments: See sheet No. 6 of sketch with description of Winsor Dam.

(10.) WATER LEVEL AT TIME OF INSPECTION: 12 Ft. Above_____. Below X.

Top Dam X F.L. Principal Spillway_____.

Other 12 ft. below crest of this spillway crest.

Normal Freeboard 23 Ft.

(11.) SUMMARY OF DEFICIENCIES NOTED:

Growth (Trees and Brush) on Embankment None.

Animal Burrows and Washouts None.

Damage to Slopes or Top of Dam None.

Cracked or Damaged Masonry None found.

Evidence of Seepage None seen - no water in approach channel.

Evidence of Piping None seen - no water in approach channel.

Leaks None seen - no water in approach channel.

Erosion None.

Trash and/or Debris Impeding Flow None.

Clogged or Blocked Spillway None.

Other_____.

(12.) OVERALL CONDITION:

1. Safe X .
2. Minor repairs needed _____ .
3. Conditionally safe - major repairs needed _____ .
4. Unsafe _____ .
5. Reservoir impoundment no longer exists (explain)

   Recommend removal from inspection list _____ .

(13.) REMARKS AND RECOMMENDATIONS: (Fully Explain)

This is the overflow spillway for the Quabbin Reservoir and is located northwesterly from the westerly end of the Winsor Dam about 1500 feet. It consists of a side channel spillway structure with granite stone masonry weir crest 370 feet long with its crest at elevation 530 or at the reservoir flow line elevation. There is a short 39 3/4 foot long weir section with the granite stone masonry walls crest at elevation 528.0 but with provisions for stop logs to elevation 530.0. A picture of this portion of the spillway weir is attached. This weir wall varies in height with a maximum of around 13 feet. The approach channel, the side channel trough and the downstream slope are all in rock excavation.

At the time of the inspection water in the reservoir was below to elevation of the bottom of the approach channel. Mr. Mellin, Assistant Superintendent, who accompanied us on our inspection, said that last year was the first time in many years that there was sufficient water in the reservoir so that a boat could enter the approach channel and that no water had flowed over spillway weir wall since 1961.

The Quabbin Spillway appeared to be in excellent condition with all the masonry of the crest and spillway wall without any evidence of deterioration, not even a mortar joint requiring pointing.

RCS/js/vk

DESCRIPTION OF DAM

DISTRICT 2.

Submitted by R. C. Salls, P.E. Dam No. 2-8-309-13

Date February 26, 1974 ~~County~~/Town Ware

Name of Dam Quabbin "Spillway"

1. Location: Topo Sheet No. 14D Mass. Rect. Coordinates N 470,200 E 373,000

Provide 8½" x 11" in clear copy of topo map with location of Dam clearly indicated.

Access from Ware Rd. "Rte. 9." about 2½ miles easterly from junction with Rte. 21 - about 5000 ft. (1 mi.) north from Rte. 9 on Winsor Dam Rd. - Just after crossing Winsor Dam.

2. Year built 1936 - 38 Year/s of subsequent repairs Unknown

3. Purpose of Dam: Water Supply X Recreational _____
Flood Control _____ Irrigation _____ Other _____

4. Drainage Area: 186 sq. miles - plus limited diversion from Ware River - watershed 98 sq. miles sq. mi. _____ acres.
Type: City, Bus. & Ind. _____ Dense Res. _____ Suburban _____ Rural, Farm 15%
Wood & Scrub Land 85% Slope: Steep 15% Med. 75% Slight 10%

5. Normal Ponding Area: 38.6 sq. mi. 24,704 Acres; Ave. Depth _____ Max. water depth 150 ft.
Impoundment: 412 billion gals.; _____ acre ft.
Silted in: Yes _____ No _____ Approx. Amount Storage Area _____

6. No. and type of dwellings located adjacent to pond or reservoir _____
i.e. summer homes etc. Residences of operating personnel

7. Dimensions of Dam: Length * 404 3/4 See Note Max. Height 10 ft. ±
Freeboard 23' when reservoir at flow level
Slopes: Upstream Face 1:3.27 batter - granite masonry
Downstream Face 1:1 batter - granite masonry
Width across top Crest
*370' masonry crest at 530 plus 34 3/4' stop log

APPENDIX B-30

Dam No. 2-8-309-18

8.

Classification of Dam by Material:

Earth _____ Conc. Masonry _____ Stone Masonry Granite X

Timber _____ Rockfill _____ Other _____

8A.

Dam Type: Gravity X Straight _____ Curved, Arched _____ Other _____

Overflow X Non-overflow _____

9.

A. Description of present land usage downstream of dam:

90 % rural; 10 % developed - villages of Bondsville and Three Rivers

B. Is there a storage area or flood plain downstream of dam which could accommodate the impoundment in the event of a complete dam failure? Yes _____ No X

C. Character Downstream Valley: Narrow X Wide _____ Developed 10%

Rural 90% Urban _____

10.

Risk to life and property in event of complete failure. * See note below.

No. of people Say 2 - 300 before Chicopee River

No. of homes 70+ houses before villages of Bondsville and Three Rivers - Say 2 - 300 housed before Chicopee River

No. of businesses Numerous in villages

No. of industries Several light manufacturing plants Type _____

No. of utilities 4 Type Water supply - pole lines for telephone and electric plus electric transmission line

Railroads Boston & Maine and the Central Vermont R. R.

Other dams Bondsville Upper Dam No. 3-7-227-11 and Bondsville Lower Dam No. 3-7-227-12 on Swift River

Other State Fish Hatchery - numerous town highway and bridges - also Route 9 State Highway

---

11.

Attach Sketch of dam to this form showing section and plan on 8½" x 11" sheet.

Sketch - 3 sheets.

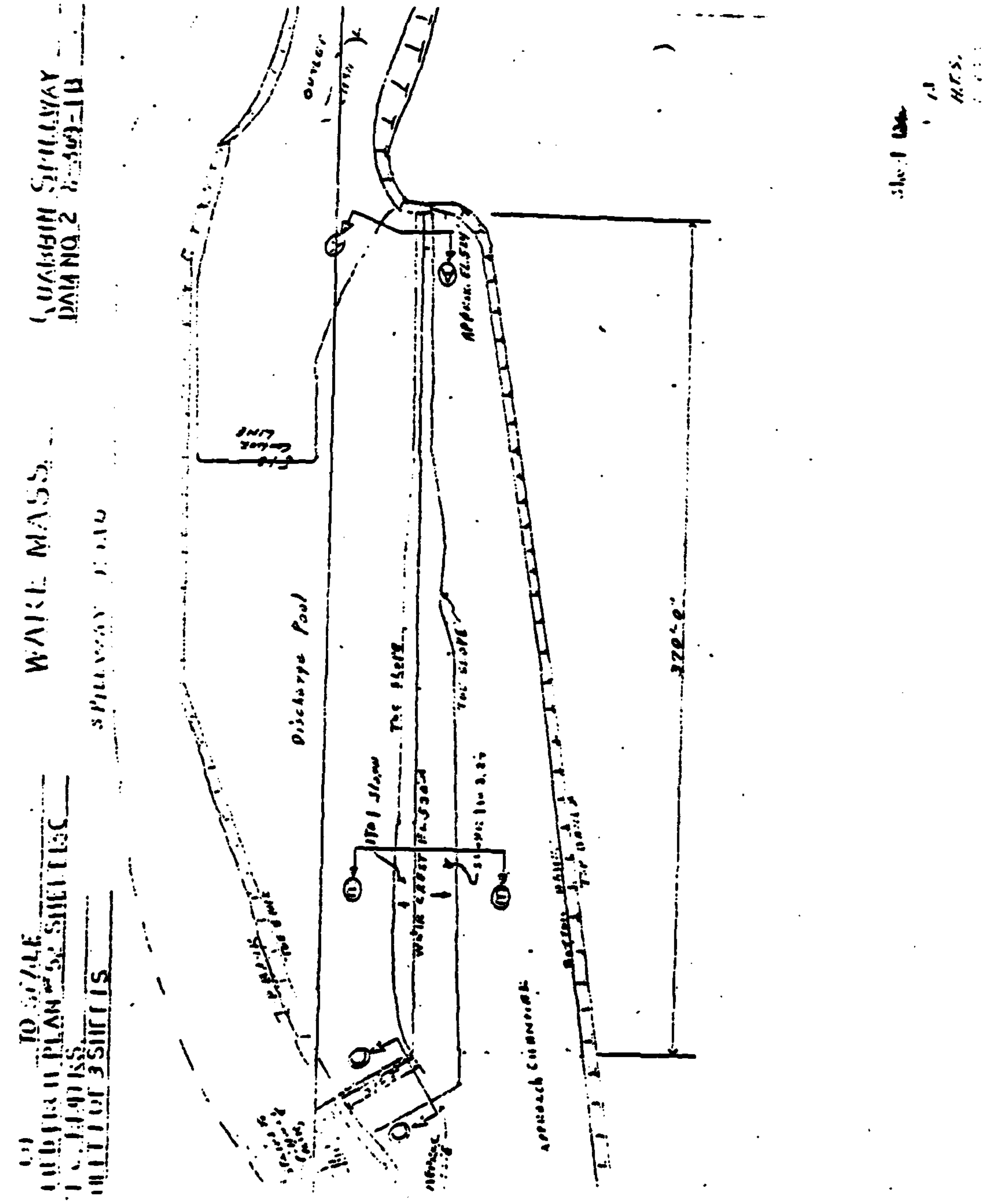
RCS/vk

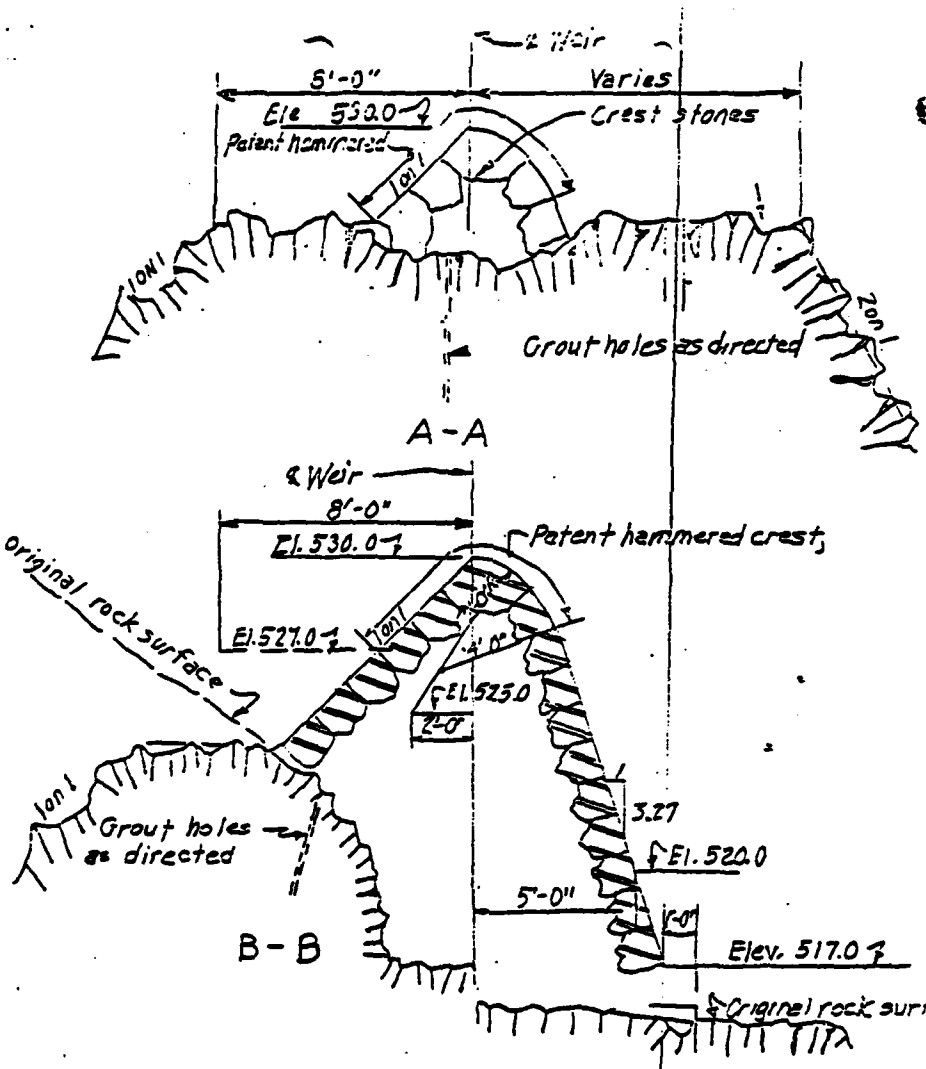
Attachments

Locus Plan

Sketches

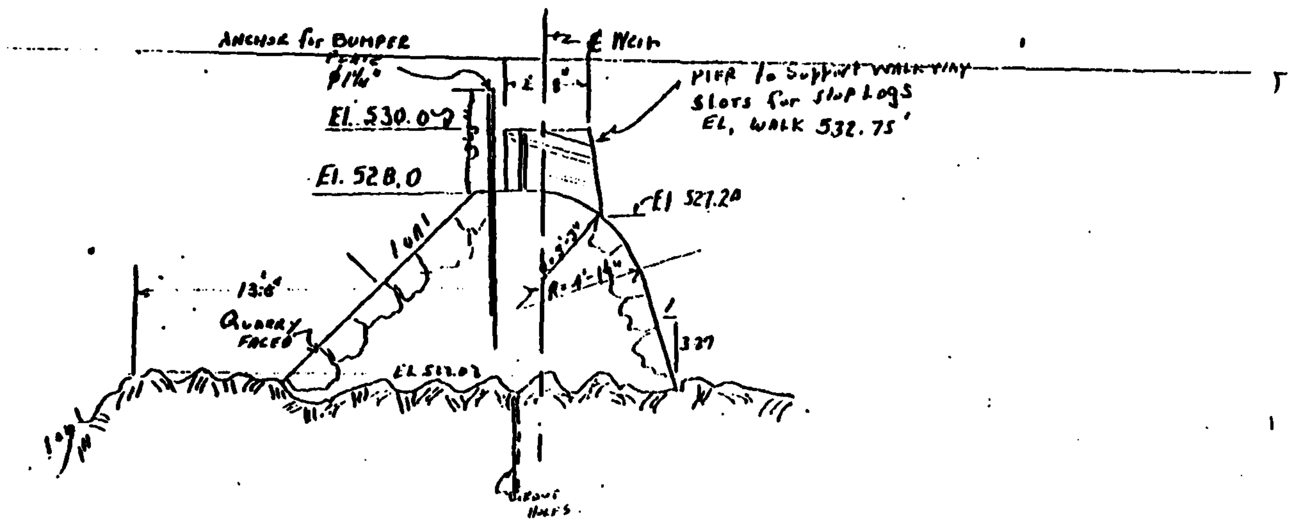
* Note: Risk to life and property shown along Swift River only. Damage is also likely on Chicopee River.


WARE MASS.
Discharge Pool
320'-0"

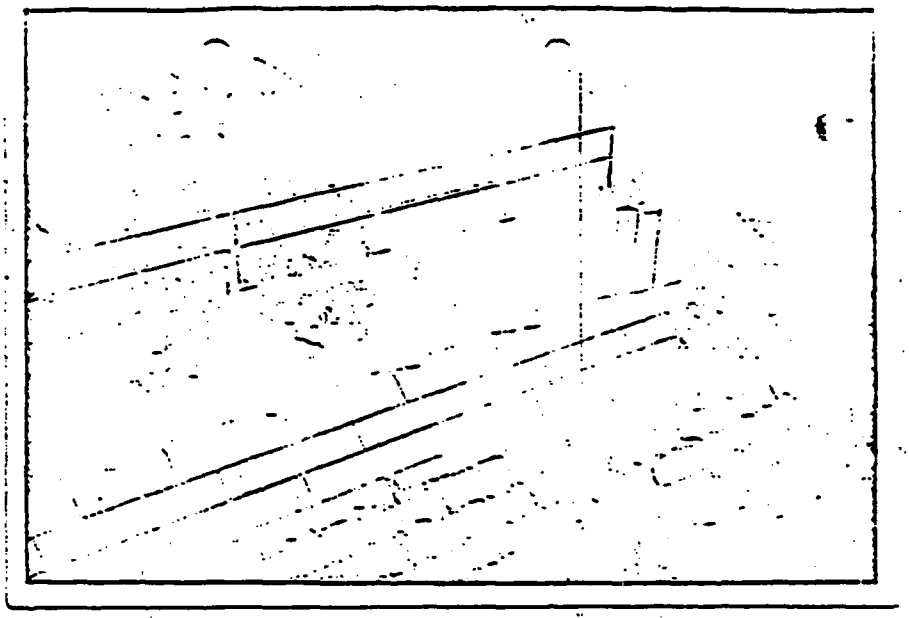

℄ Weir
5'-0"
Varies
Ele 530.0
Crest stones
Patent hammered
1on1
1on1
2on1
Grout holes as directed
A-A
℄ Weir
8'-0"
El. 530.0
Patent hammered crest
original rock surface
El. 527.0
1on1
El. 525.0
2'-0"
1on1
Grout holes as directed
3.27
El. 520.0
5'-0"
Elev. 517.0
Original rock surface
B-B

SHEET No 3 of 3
Copied from Contract #52 Plan
Sheet No 13 D, 1st of C

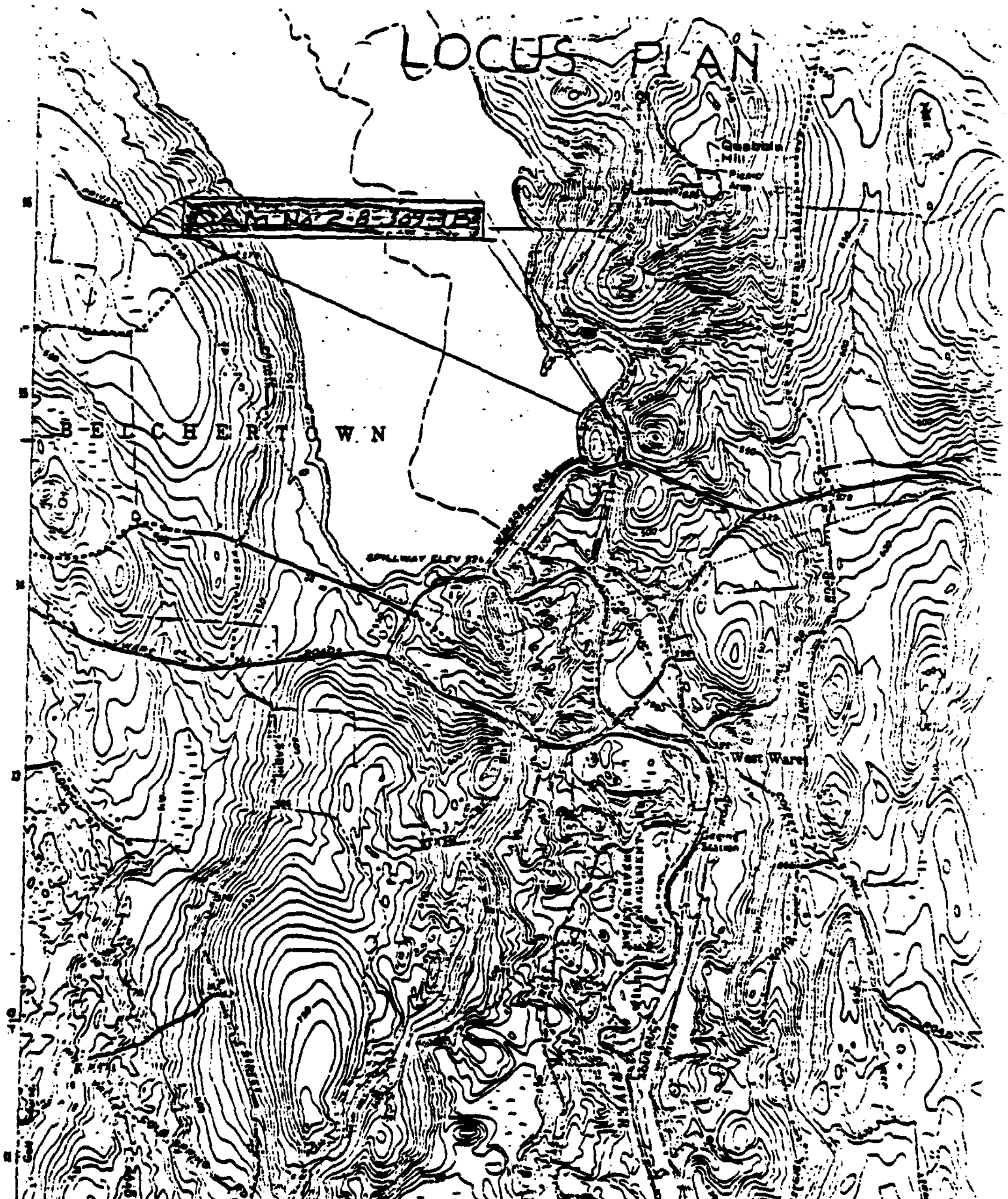
DAM No. 2-8-309-1 B
QUABBIN SPILLWAY



Sheet 13 D, 1st/C



DAM No 2-5-309-1 B ATTACH to INSPECTION REPORT - STD FEB 24, 1976



Mapped, edited, and published by the Geological Survey

14D

The Commonwealth of Massachusetts

EXECUTIVE OFFICE OF ENVIRONMENTAL AFFAIRS
DEPARTMENT OF ENVIRONMENTAL QUALITY ENGR.
DIVISION OF WATERWAYS

Metropolitan District Commission
Windsor Dam
Ware Road
Belchertown, Ma.

100 Nashua Street. Boston 02114

March 2, 1977

Re: Inspection Dam #2-8-309-18
Quabbin Spillway Dam

Dear Sir:

On March 23, 1976, an Engineer from the Massachusetts Department of Public Works made a visual inspection of the above dam. Our records indicate the owner to be Metropolitan District Commission. If this information is incorrect will you please notify this office.

The inspection was made in accordance with the provisions of Chapter 253 of the Massachusetts General Laws as amended (Dam Safety Act). Chapter 706 of the Acts of 1975 transferred the jurisdiction of the so-called "Dams Safety Program" to the Commissioner of the Department of Environmental Quality Engineering.

The results of the inspection indicate that this dam is safe; however, the following conditions were noted that require attention:

SEE REMARKS AND RECOMMENDATIONS ON REVERSE SIDE.

We call these conditions to your attention before they become serious and more expensive to correct. With any correspondence please include the number of the Dam as indicated above.

Very truly yours,

John J. Hannon, P.E.
Chief Engineer

AMc:

cc: Francis J. Hoey
Russell Salls
Supt. Quabbin Reservoir
M.D.C. Windsor Dam
Ware Road
Belchertown, Ma.

APPENDIX B-37

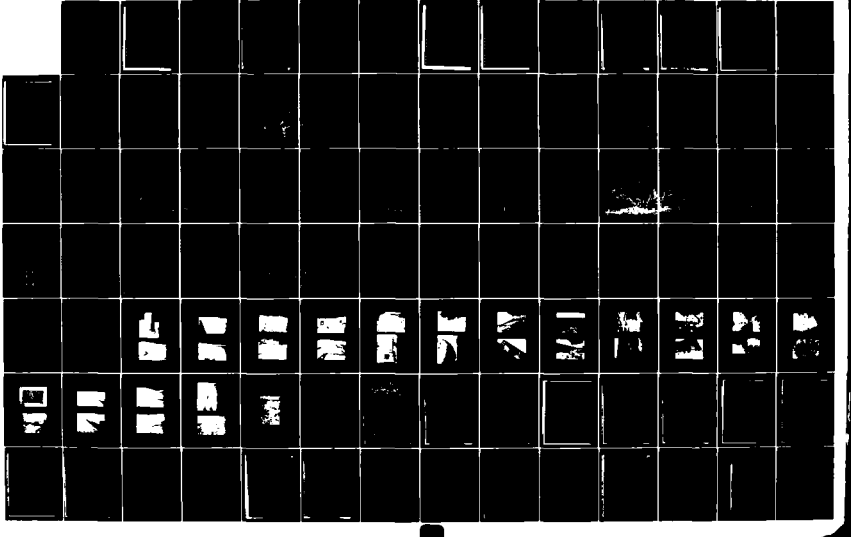
REMARKS AND RECOMMENDATIONS

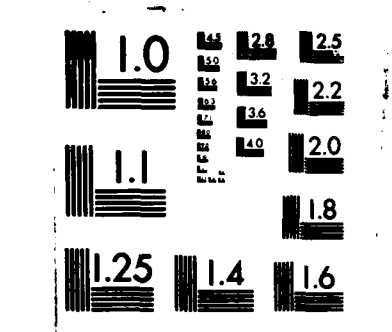
This is an overflow spillway for Quabbin Reservoir built of granite stone masonry and is 370' long with its crest elevation at 530.0. This spillway runs in a northerly-southerly direction and at the northerly end there is a short spillway 34.5 long running east-west. This spillway crest is at elevation 528.0 with provisions for stop logs to elevation 530.0. One stop log was in place at time of inspection with water overtopping this stop log 10" to 12" or just 6" below crest of main spillway. This is the first time since 1961 that the water level of reservoir has reached this elevation.

Mr. Donald Slongwhite of the M.D.CQ Winsor Dam Headquarters accompanied the inspection tour. He stated that the seepage from the spillway dropwall would be closely checked and the masonry joints would be investigated as soon as feasible.

AD-A155 515 NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS 1/3
WINSOR DAM (MA 00588)..(U) CORPS OF ENGINEERS WALTHAM
MA NEW ENGLAND DIV SEP 78

UNCLASSIFIED F/G 13/13 NL





INSPECTION REPORT - DAMS AND RESERVOIRS

1. LOCATION:

City/Town Ware. County Hampshire. Dam No. 2-8-309-13.

Name of Dam Quabbin "Spillway"
Mass. Rect.

Topo Sheet No. 14 D. Coordinates: N 870,200, E 373,000.

Inspected by: Harold T. Shumsky, On March 23, 1976. Date Last Inspection 2-26-74.

2. OWNER/S: As of March 23, 1976

per: Assessors ____, Reg. of Deeds ____, Prov. Insp. X, Per. Contact X.

1. Metropolitan District Commission, Winsor Dam, Ware Rd., Belchertown, Mass.
Name St. & No. City/Town State Tel. No.

2. ____
Name St. & No. City/Town State Tel. No.

3. ____
Name St. & No. City/Town State Tel. No.

3. CARETAKER: (if any) e.g. superintendent, plant manager, appointed by absentee owner, appointed by multi owners.
Superintendent, Quabbin Reservoir,
M.D.C. - Winsor Dam, Ware Rd., Belchertown, Mass.
Name St. & No. City/Town State Tel. No.

4. DATA:
No. of Pictures Taken None. Sketches See description of Dam.
Plans, Where At M.D.C. Office at Quabbin Headquarters - Winsor Dam.

5. DEGREE OF HAZARD: (if dam should fail completely)*

1. Minor ____. 3. Severe X.

2. Moderate ____. 4. Disastrous ____.

Comments: ____.

*This rating may change as land use changes (future development).

6. OUTLETS: OUTLET CONTROLS AND DRAWDOWN

No. 1 Location and Type: Northerly end of main spillway - quarry stone faced crest overflow spillway - 34'-8" W. x 2'H. to level of main spillway elevation.

Controls Yes, TYPE: Stop logs.

Automatic____. Manual X. Operative Yes X, No____.

Comments: One 8" high stop log in place at time of inspection.

No. 2 Location and Type: 700' to 800' northeasterly of Winsor Dam - quarried stone faced main spillway - 370' W. x 23'- H.

Controls None, Type:____.

Automatic____. Manual____. Operative Yes____, No____.

Comments: Crest of main spillway at elevation 530' - normal flow line of reservoir.

No. 3 Location and Type:____.

Controls____, Type:____.

Automatic____. Manual____. Operative Yes____, No____.

Comments:____.

Drawdown present Yes X, No____. Operative Yes____, No____.
Comments: See Item 6 - Sub.1 - Winsor Dam Report No. 2-8-309-1A.

---

7. DAM UPSTREAM FACE: Slope 1:1.27, Depth Water at Dam 6' to 12'.

Material: Turf____. Brush & Trees____. Rock fill____. Masonry Cut Granite X. Wood____.

Other____.

Condition: 1. Good X. 3. Major Repairs____.

2. Minor Repairs____. 4. Urgent Repairs____.

Comments:____.

---

8. DAM DOWNSTREAM FACE: Slope 1:1.

Material: Turf____. Brush & Trees____. Rock Fill____. Masonry Cut Granite X. Wood____.

Other____.

Condition: 1. Good____. 3. Major Repairs____.

2. Minor Repairs X. 4. Urgent Repairs____.

[illegible] through joints between granite blocks - water level within [illegible].

Dall NO. 2-8-309-13

(9.) EMERGENCY SPILLWAY: Available Yes. Needed ____.

Height Above Normal Water 6 Ft.

Width 200± Ft. Height 3 to 4 Ft. Material Earth channel Masonry weir.

Condition: 1. Good X. 3. Major Repairs ____.

2. Minor Repairs ____. 4. Urgent Repairs ____.

Comments: This ditch and weir appears to be well maintained and stable.

(10.) WATER LEVEL AT TIME OF INSPECTION: 1/2 Ft. Above ____. Below X.

Top Dam ____ P.L. Principal Spillway X.

Other Water level at elev. 529.5.

Normal Freeboard 2±___ Ft.

(11.) SUMMARY OF DEFICIENCIES NOTED:

Growth (Trees and Brush) on Embankment None found

Animal Burrows and Washouts None found

Damage to Slopes or Top of Dam None found.

Cracked or Damaged Masonry None found.

Evidence of Seepage Minor seepage noted on main spillway dropwall.

Evidence of Piping None noted.

Leaks None noted

Erosion None noted.

Trash and/or Debris Impeding Flow None found.

Clogged or Blocked Spillway None found.

Other

DAM NO. 2-8-309-18

- 4 -

(2) OVERALL CONDITION:

1. Safe_____.
2. Minor repairs needed X.
3. Conditionally safe - major repairs needed_____.
4. Unsafe_____.
5. Reservoir impoundment no longer exists (explain)

   Recommend removal from inspection list_____.

---

(3) REMARKS AND RECOMMENDATIONS: (Fully Explain)

This is an overflow spillway for Quabbin Reservoir built of granite stone masonry and is 370' long with its crest elevation at 530.0. This spillway runs in a northerly-southerly direction and at the northerly end there is a short spillway 34.5 long running east-west. This spillway crest is at elevation 528.0 with provisions for stop logs to elevation 530.0. One stop log was in place at time of inspection with water overtopping this stop log 10" to 12" or just 6" below crest of main spillway. This is the first time since 1961 that the water level of reservoir has reached this elevation.

Mr. Donald Slenguhite of the M.D.C. Wincor Dam Headquarters accompanied the inspection tour. He stated that the seepage from the spillway dropwall would be closely checked and the masonry joints would be investigated as soon as feasible.

This spillway structure appears basically sound and safe at time of inspection.

RTS/vk

GOODNOUGH DIKE

G. Quabbin Dike, Winsor Dam and Spillway

The grass cover on the embankment forming the dike was noted to be o.k. The toe area of the dry side was in good condition and dry. The road on top of the embankment was in good condition and there was no evidence of settlement, sunken areas or cracks. The rock fill slope on the reservoir side of the dike is in good condition. Water in storage was observed to be quite low but appeared to be higher in elevation than at the time of the previous inspection.

The main dam, Winsor Dam, was noted to be in good condition. The turf cover on the downstream slope was good. Some areas apparently are being re-loamed, treated and seeded. The toe area of this main dam was dry.

The rock filled portion of the main dam on the reservoir side was in good condition. The road across the dam was o.k.

The spillway structure was again observed to be completely dry. The spillway has not been wet for many years. However, the level of water observed this year is at the entrance to the spillway forebay and thus is the highest noted in many years. The stone masonry of the spillway and the crest were observed to be o.k.

In the opinion of the undersigned, the dam, the dike and spillway are in the same good condition as previously reported and are safe.

INSPECTION REPORT - DAMS AND RESERVOIRS

1. LOCATION:

~~TOWN~~/Town Ware. County Hampshire. Dam No. 2-8-309-1C.

Name of Dam Quabbin "Goodnough Dike"

Mass. Rect.

Topo Sheet No. 14D. Coordinates: N 873,900, E 384,000.

Inspected by: R. C. Sells, P.E., On Feb. 26, 1974. Date Last Inspection 1970.

See also Quabbin "Winsor" Dam No. 2-8-309-1A and Quabbin "Spillway" No. 2-8-309-1B

2. OWNER/S: As of November 1972

per: Assessors X, Reg. of Deeds ____, Prev. Insp. ____, Per. Contact X.

1. Metropolitan District Commission, Winsor Dam, Ware Rd., Belchertown, Mass.
Name St. & No. City/Town State Tel. No.

2. ____
Name St. & No. City/Town State Tel. No.

3. ____
Name St. & No. City/Town State Tel. No.

3. CARETAKER: (if any) e.g. superintendent, plant manager, appointed by absentee owner, appointed by multi owners.

Mr. John W. Copithorne, Supt.
Quabbin Reservoir - M.D.C. Winsor Dam - Ware Rd., Belchertown, Mass. 413-323-6021
Name St. & No. City/Town State Tel. No.

4. DATA:

No. of Pictures Taken None, Sketches See description of Dam.
Plans, Where At M.D.C. office at Quabbin.

5. DEGREE OF HAZARD: (if dam should fail completely)*

1. Minor ____.
2. Moderate ____.
3. Severe ____.
4. Disastrous X.

Comments: Assuming complete failure.

*This rating may change as land use changes (future development).

(6.) OUTLETS: OUTLET CONTROLS AND DRAWDOWN See Inspection Report for Quabbin "Winsor Dam" No. 2-8-309-1A.

No. 1 Location and Type:_____.

Controls_____, TYPE:_____.

Automatic_____. Manual_____. Operative Yes_____, No_____.

Comments:_____.

No. 2 Location and Type:_____.

Controls_____, Type:_____.

Automatic_____. Manual_____. Operative Yes_____, No_____.

Comments:_____.

No. 3 Location and Type:_____.

Controls_____, Type:_____.

Automatic_____. Manual_____. Operative Yes_____, No_____.

Comments:_____.

Drawdown present Yes X, No_____. Operative Yes_____, No_____.
Comments: See Item 6 - Sub. 1 - Winsor Dam Inspection Report.

(7.) DAM UPSTREAM FACE: Slope Varies 1½:1 to 3:1, Depth Water at Dam 135±.

Material: Turf_____. Brush & Trees_____. Rock fill X. Masonry_____. Wood_____.

Other 2 berms on slope - rock fill thickened 10' thick at reservoir flow line elevation

Condition: 1. Good X. 3. Major Repairs_____.

2. Minor Repairs_____. 4. Urgent Repairs_____.

Comments: For details see sketch - sheet 3.

(8.) DAM DOWNSTREAM FACE: Slope 2:1 and 2½:1.

Material: Turf X. Brush & Trees_____. Rock Fill_____. Masonry_____. Wood_____.

Other 2 berm on slope - slope drainage in place catch basin and underdrain.

Condition: 1. Good X. 3. Major Repairs_____.

2. Minor Repairs_____. 4. Urgent Repairs_____.

Comments: Note: One fresh woodchuck hole found on lower southwesterly portion of slope. Swamp and/or beaver impoundment just south of east access road - about 500 ft. from toe.

(9.) EMERGENCY SPILLWAY: Available Yes. Needed No.

Height Above Normal Water 6 Ft. auxiliary spillway

Width 200± Ft. Height 3 to 4 Ft. Material Earth channel Masonry weir.

Condition: 1. Good X. 3. Major Repairs_____.

2. Minor Repairs_____. 4. Urgent Repairs_____.

Comments: See sheet 6 of sketches for Winsor Dam No. 2-8-309-1A.

See also Quabbin Spillway No. 2-8-309-1B.

(10.) WATER LEVEL AT TIME OF INSPECTION: 35 Ft. Above_____. Below X.

Top Dam X F.L. Principal Spillway_____.

Other_____.

Normal Freeboard 23 Ft.

(11.) SUMMARY OF DEFICIENCIES NOTED:

Growth (Trees and Brush) on Embankment None.

Animal Burrows and Washouts One fresh woodchuck hole on lower portion of southwestern downstream slope.

Damage to Slopes or Top of Dam None. Slope mowed and turf cared for.

Cracked or Damaged Masonry None.

Evidence of Seepage Minor seepage - handled by drainage system.

Evidence of Piping None seen.

Leaks None seen.

Erosion None seen.

Trash and/or Debris Impeding Flow None.

Clogged or Blocked Spillway None.

Other_____.

(12.) OVERALL CONDITION:

1. Safe X.
2. Minor repairs needed_____.
3. Conditionally safe - major repairs needed_____.
4. Unsafe_____.
5. Reservoir impoundment no longer exists (explain)

   Recommend removal from inspection list_____.

(13.) REMARKS AND RECOMMENDATIONS: (Fully Explain)

This dike closes a low area westerly about 2½ miles of the Winsor Dam and closes off the head of the Beaver Brook valley. It is a full hydraulic fill embankment 135 feet high and 2600 feet long with a concrete caisson core wall from the approximate level of the original ground to sound bedrock along the centerline of the dam. The embankment upstream slope has a riprap shell in good condition. The downstream slope is covered with a mowed turf in good condition with surface water and seepage controlled by a drainage system. A single woodchuck hole of recent origin was found on the lower southwesterly portion of the slope but Mr. Mallin, Assistant Superintendent, said that this would be taken care of during spring maintenance.

There was originally an observation well near the center of the dam which was abandoned around 1941 and filled with loam so no recent observations are available.

Precise levels were taken along the top of the dam at frequent intervals until 1957 and a set was taken in 1971. These showed a total settlement of about 1½ feet in 1971 with about 1/3 of this settlement occurring during the period from 1957 to 1971. This dam was originally designed with a 2 foot camber to allow for settlement.

RCS/js/vk

DESCRIPTION OF DAM

DISTRICT 2

Submitted by R. C. Salls, P.E. Dam No. 2-8-309-1C

Date Feb. 26, 1974 Town Ware

Name of Dam Quabbin "Goodnough Dike"

1. Location: Topo Sheet No. 14D Mass. Rect. Coordinates N 873,900 E 784,000

Provide 8½" x 11" in clear copy of topo map with location of Dam clearly indicated.

Access from Rte. 9, about 2½ mi. westerly from Ware Center at Quabbin Park Cemetery northerly via Enfield Rd. about 8/10 mi., then right on Dike Rd. for 5/10 mile. Road goes over dike. Dike closes off Beaver Brook valley.

2. Year built 1936 - 38 Year/s of subsequent repairs 1970

3. Purpose of Dam: Water Supply X Recreational _____
Flood Control _____ Irrigation _____ Other _____

4. 186 sq. mi. plus limited diversion from Ware River watershed of 98 sq. mi.
Drainage Area: _____ sq. mi. _____ acres.
Type: City, Bus. & Ind. _____ Dense Res. _____ Suburban _____ Rural, Farm 15%
Wood & Scrub Land 85% Slope: Steep 15% Med. 75% Slight 10%.

5. 38.6 sq. mi.
Normal Ponding Area: 247.704 Acres; Ave. Depth _____
Impoundment: 412 billion gals.; Max. depth 150 ft. acre ft.
Silted in: Yes _____ No _____ Approx. Amount Storage Area Unknown

6. No. and type of dwellings located adjacent to pond or reservoir _____
i.e. summer homes etc. Residences of operating personnel

7. Dimensions of Dam: Length 2140 ft. Max. Height 125 ft.
Freeboard 23' to top of embankment when full or at crest of spillway
Slopes: Upstream Face Varies 1½ to 1 to 3:1 riprap
Downstream Face Varies 2 to 2½:1 - turf
Width across top 38 3/4 - paved roadway

Dam No. 2-8-309-1C

8.

Classification of Dam by Material:

Earth X Conc. Masonry _____ Stone Masonry _____
Hydraulic fill embankment
Timber _____ Rockfill _____ Other Concrete caisson core wa

8A.

Dam Type: Gravity X Straight X Curved, Arched _____ Other _____
Overflow _____ Non-overflow X

9.

A. Description of present land usage downstream of dam:

100 % rural; _____ % ~~urban~~ developed

B. Is there a storage area or flood plain downstream of dam which could accommodate the impoundment in the event of a complete dam failure? Yes _____ No X

C. Character Downstream Valley: Narrow X Wide _____ Developed _____
Rural _____ Urban _____

10.

Risk to life and property in event of complete failure. * See note below.

No. of people 5

No. of homes 5 full time homes - 17± cottages

No. of businesses None

No. of industries None Type _____

No. of utilities 3 Type City of Boston water supply; Electric and telephone lines; Electrical transmission line

Railroads None

Other dams Pepper Mill Pond Dam No. 2-8-309-2; Beaver Lake Dam No. 2-8-309-3

Other Route 9 - plus 2 town roads

11.

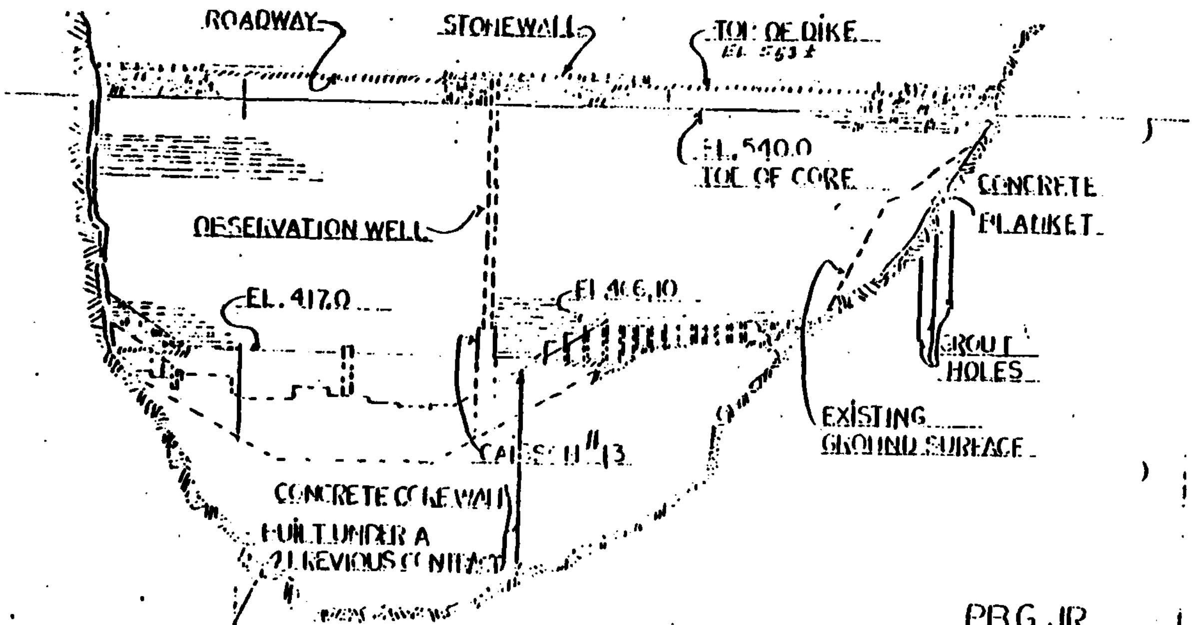
Attach Sketch of dam to this form showing section and plan on 8½" x 11" sheet.

RCS/vk
Attachments
Locus Plan
Sketches

* Risk to life and property only on Beaver Brook, possibility of extensive damage along Ware River in Palmer.

TCH
NOT TO SCALE
ATTACHED TO PAGE 4
SHEET 2 OF 3 SHEETS

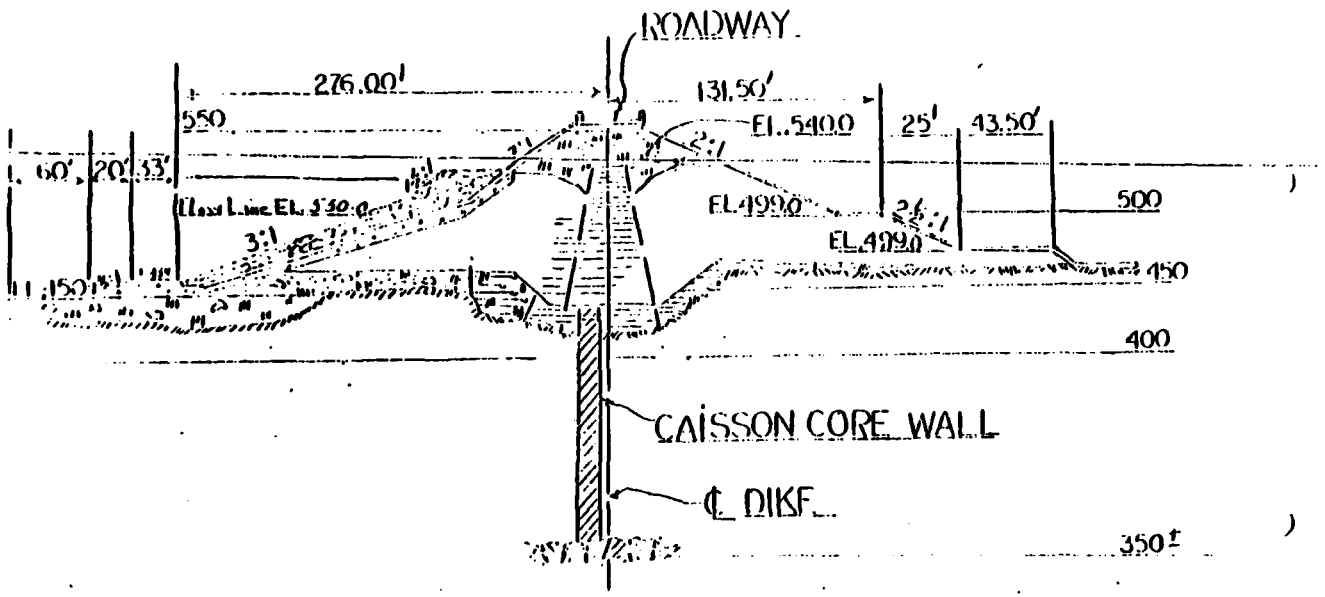
QUABBIN GOODNOUGH DIKE
WARE, MASS



PRG JR.
2/26/74

DIKE EMBANKMENT—PROFILE ON CENTER LINE OF DIKE

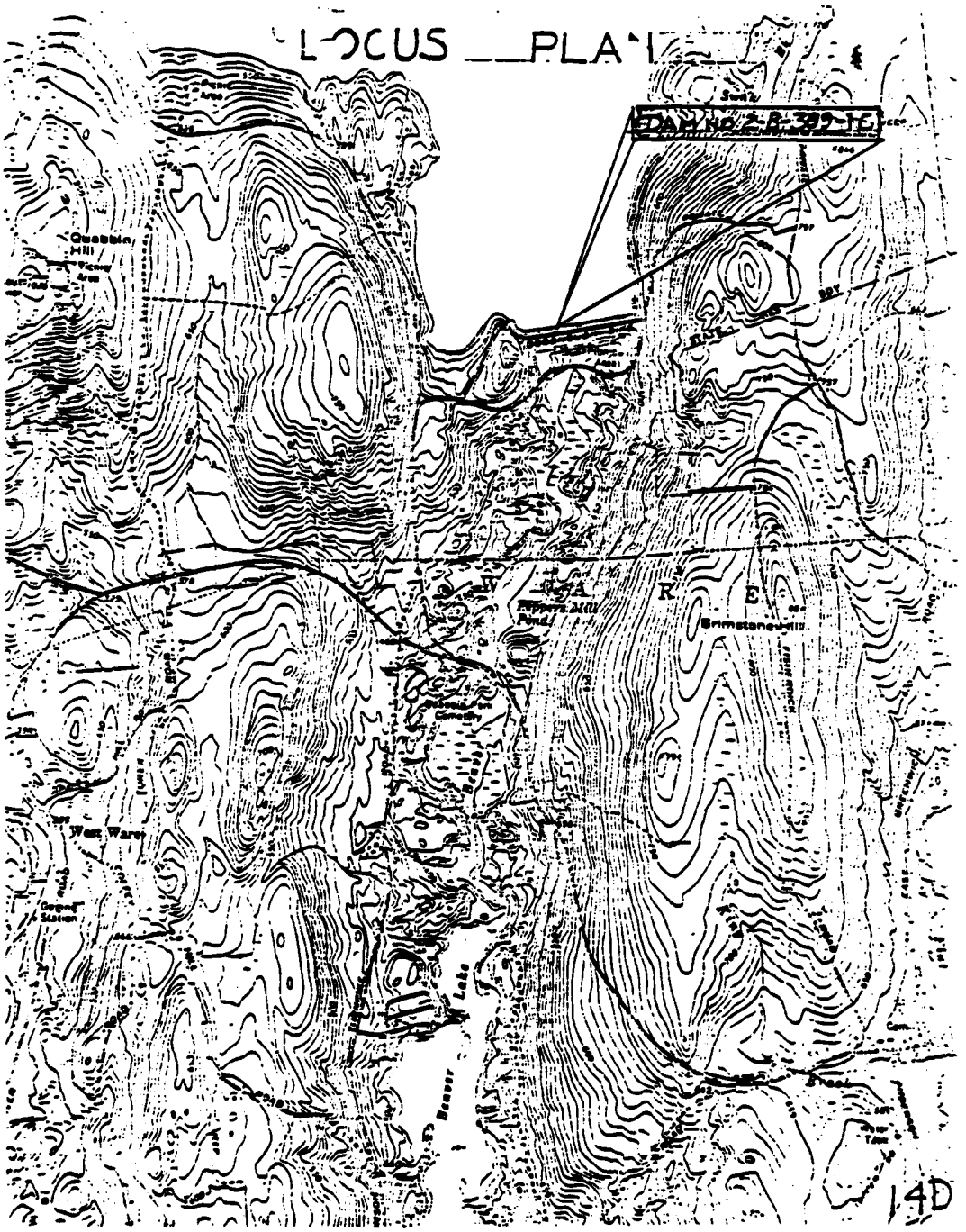
QUABBIN GOODNOUGH DIKE DAM NO. 2[illegible]
WARE, MASS.
SHEET 3 OF 3 SHEETS



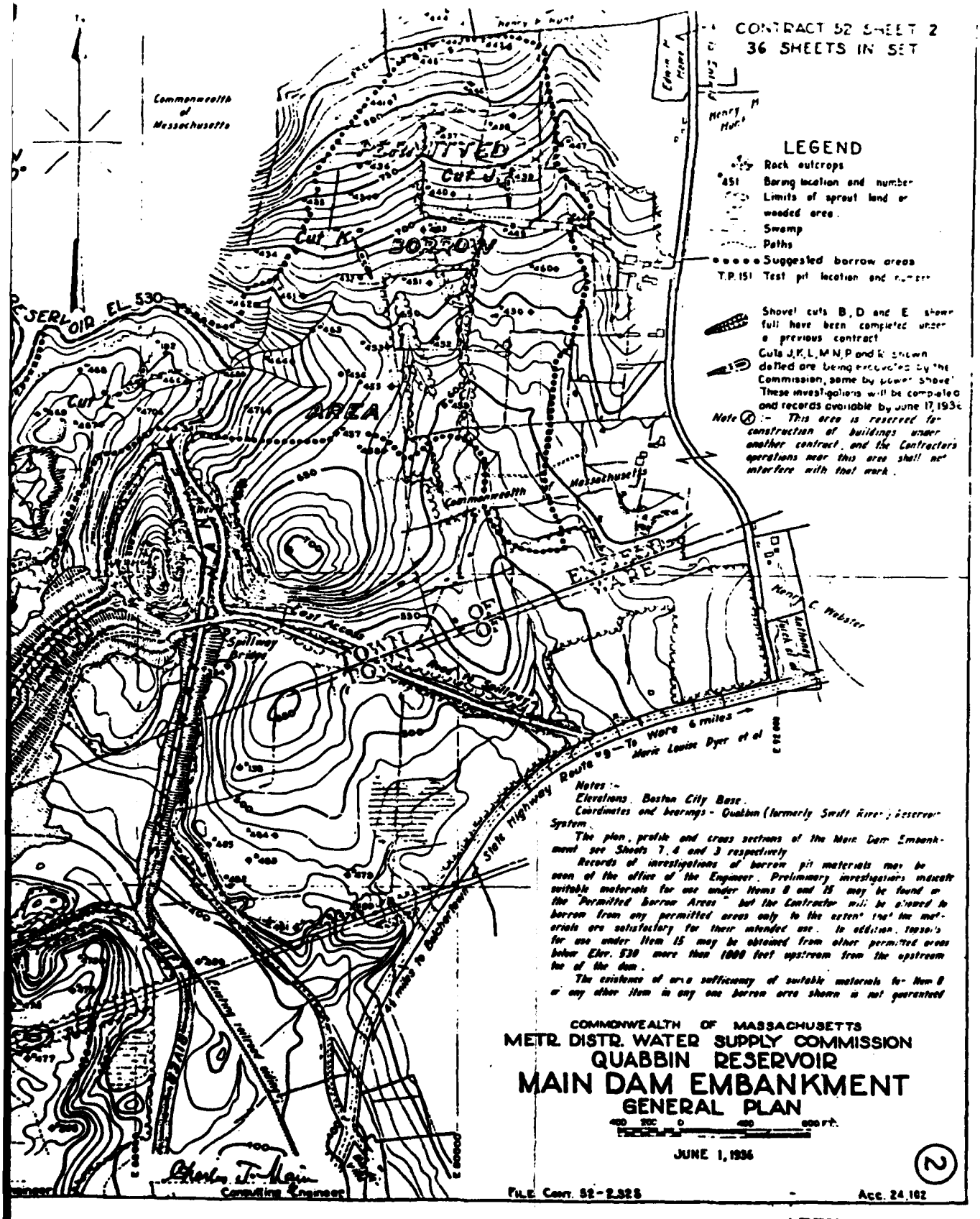
X—SECTION STA. 25+40

P.B.G. JR
2/26/74

APPENDIX B-52

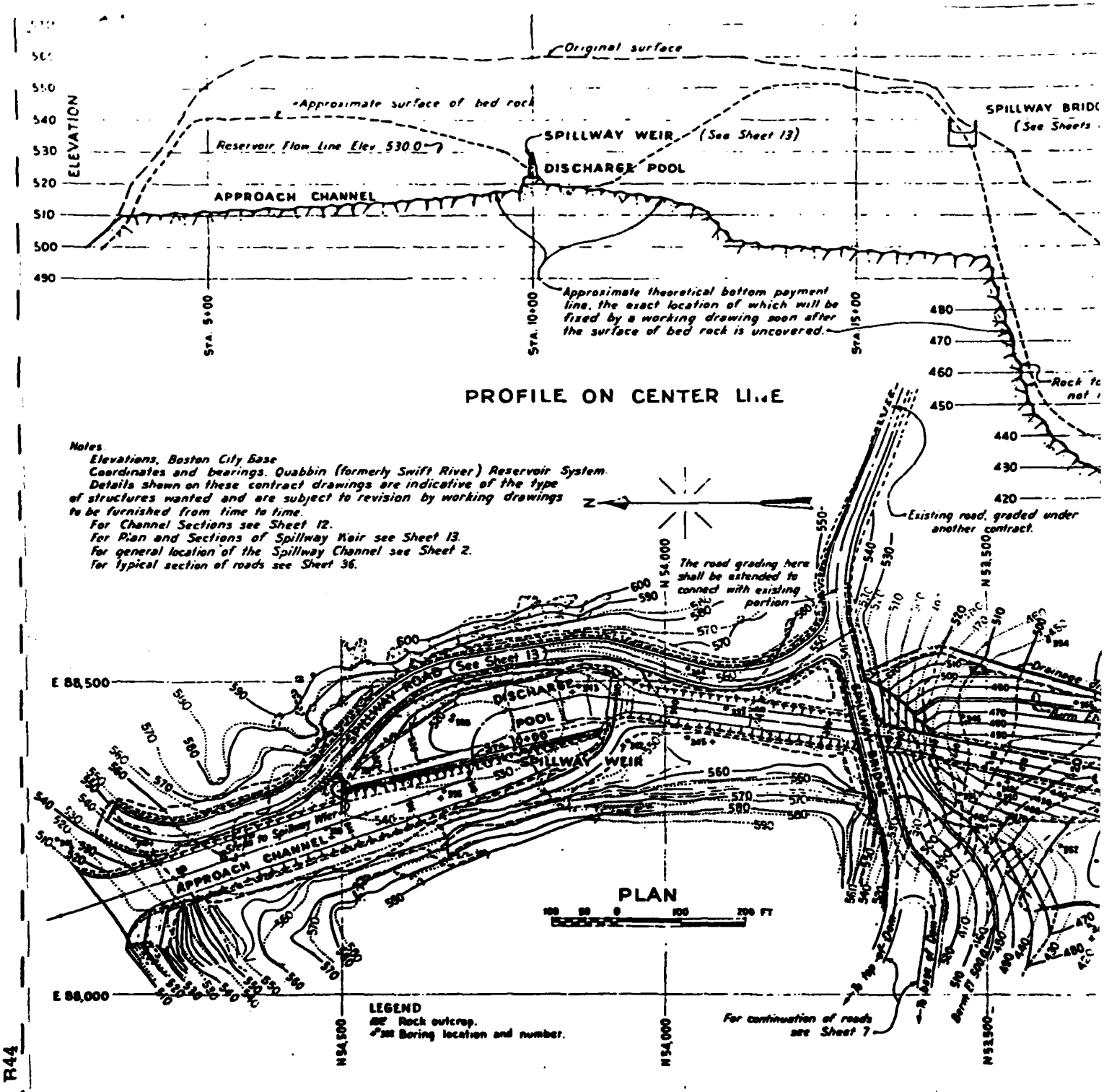

LOCUS PLAN
DAM NO. 2-R-392-TC
Quaddick Hill
West Ware
Brimstone Hill
Lake
14D


FLOW LINE OF PROPOSED RESERVOIR EL 530
PERMITTED BORROW AREA
Commonwealth of Massachusetts
TOWN OF ENFIELD
TOWN OF BELCHERTOWN
PERMITTED BORROW AREA
Shovel Cut "D"
Shovel Cut "B"
Borrow Pit for concrete aggregate for previous contract
Shovel Cut "N"
Shovel Cut "E"
Shovel Cut "M"
Soil stripped from these areas under another contract. Areas in addition to these shown may have also been stripped under another contract.
CENTRAL MASSACHUSETTS ELECTRIC COMPANY 22,000-Volt Transmission line
115,000 Volt Transmission Line
NEW ENGLAND POWER COMPANY
To Belchertown
To Enfield
THIS AREA RESERVED
Outlet Structure
Intake Structure
Overflow ditch
N 54000
N 52000
Drawn
Traced
Checked
Asst. Chief Engineer
Chief Engineer



APPENDIX B-54

(2)



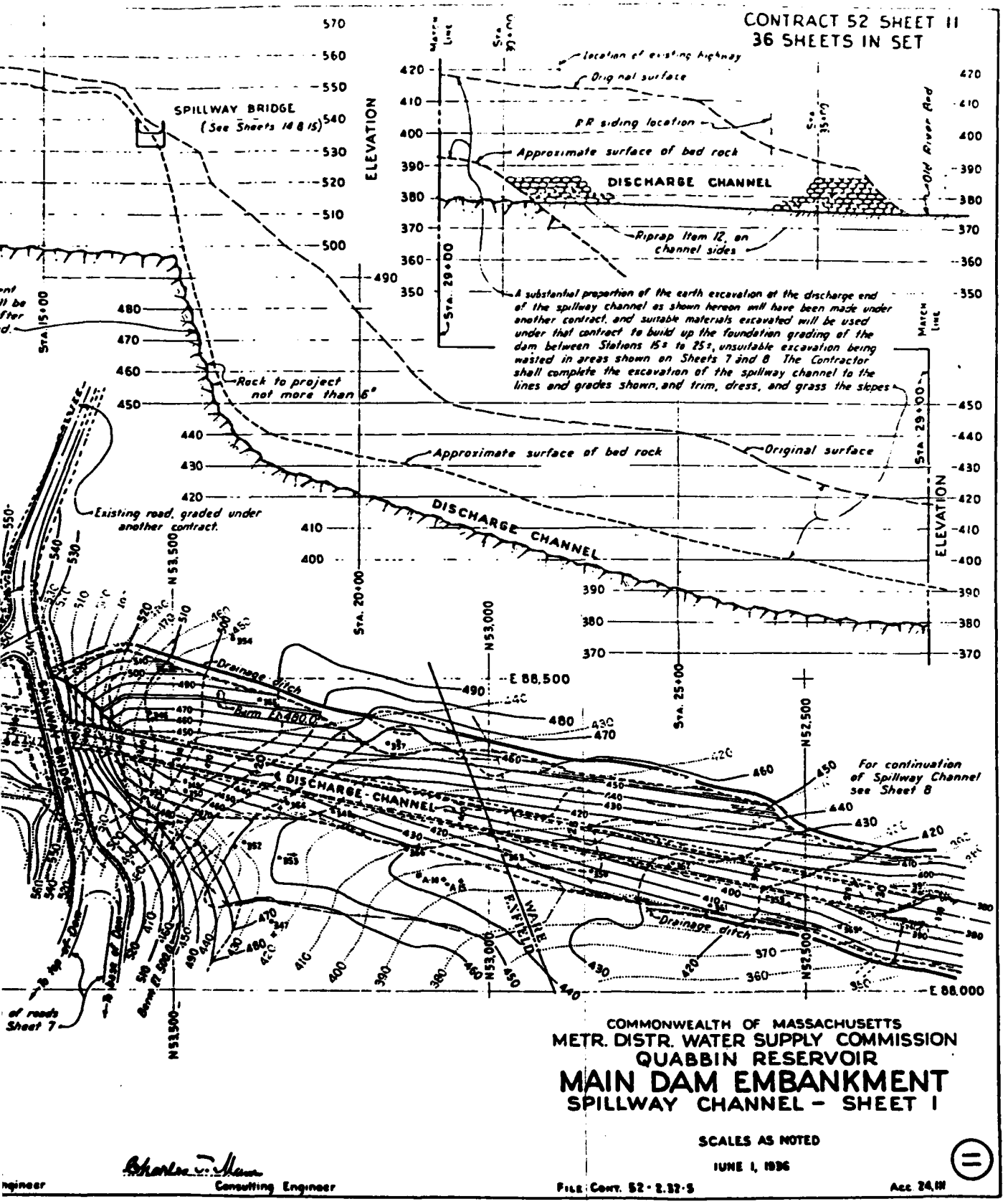
File 4160 R44

Designed
Drawn
Traced
Checked

Asst Chief Engineer

Chief Engineer

Consulting



COMMONWEALTH OF MASSACHUSETTS
METR. DISTR. WATER SUPPLY COMMISSION
QUABBIN RESERVOIR

MAIN DAM EMBANKMENT
SPILLWAY CHANNEL - SHEET 1

SCALES AS NOTED

JUNE 1, 1936

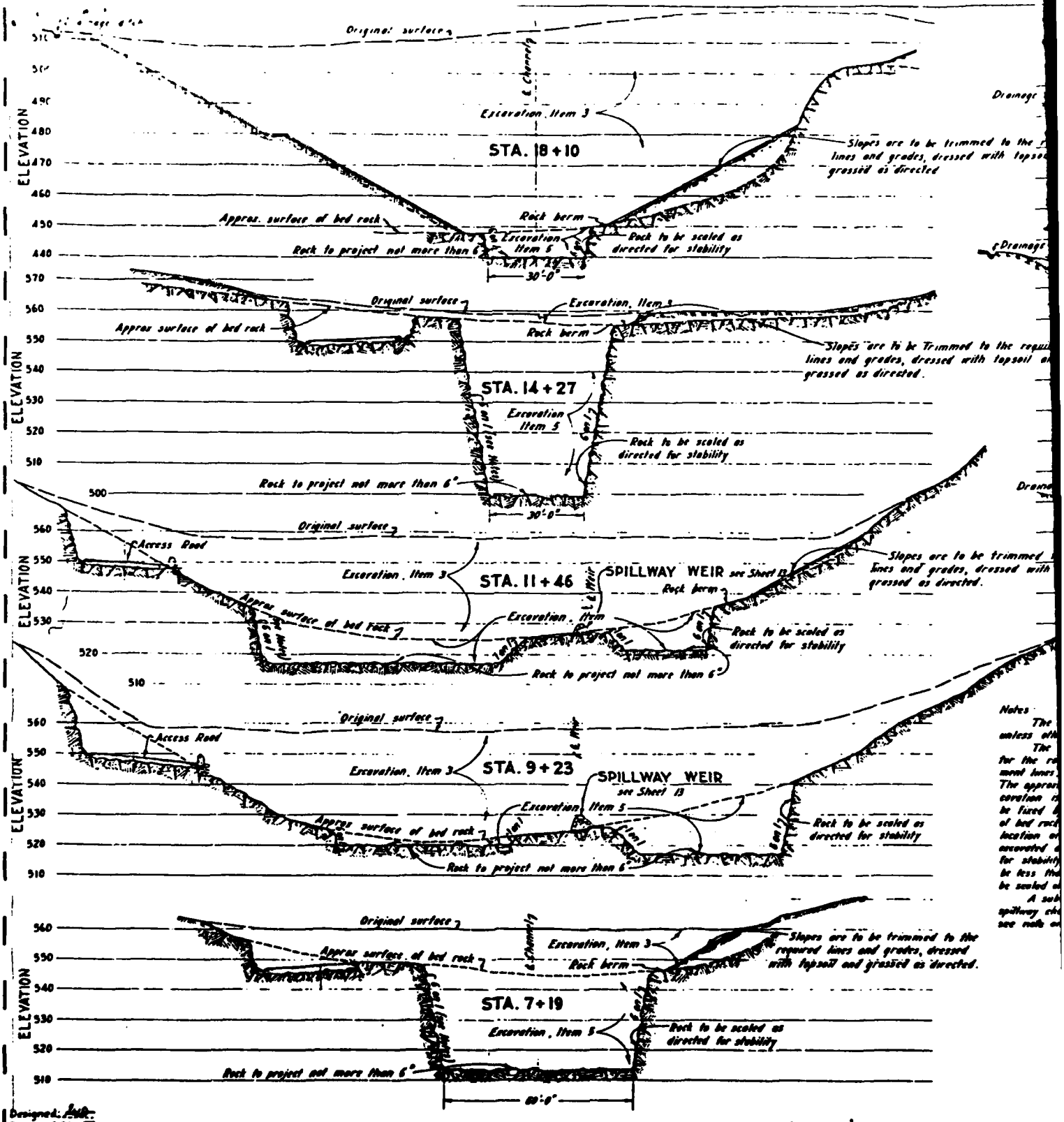
Charles T. Main
Consulting Engineer

FILE CONT. 52 - 2.32-S

Acc 24,111

APPENDIX B-55

(2)



File 4160 B45

Designed: [illegible]
Drawn: [illegible]
Traced: [illegible]
Checked: [illegible]

Ass't. Chief Engineer

Chief Engineer

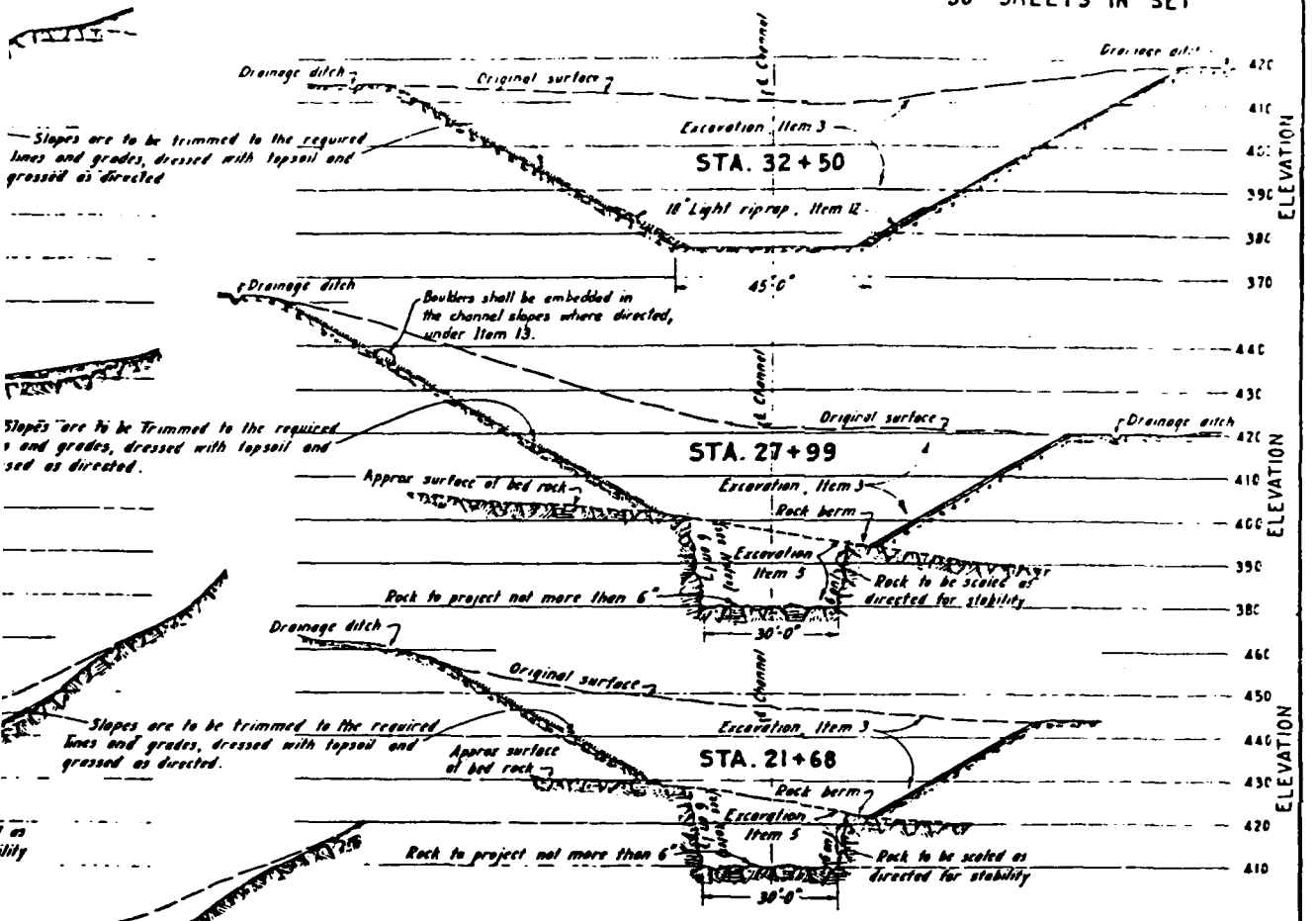
Notes

The ... unless oth...

The ... for the re... ment lines ... The approx... coration ... be fixed ... of bed rock ... location o... excavated ... for stability ... be less tha... be sealed ...

A sub... spillway cha... see note ...

CONTRACT 52 SHEET 12
36 SHEETS IN SET



Notes

The rock berms shown are to be about 5 feet wide unless otherwise directed.

The theoretical side slope and bottom lines shown for the rock excavation of the spillway channel are payment lines, regardless of the quantities actually excavated. The approximate elevation of the bottom of this rock excavation is shown on Sheet 11. The exact location will be fixed by a working drawing soon after the surface of bed rock is uncovered. The bottom widths for this location are fixed as shown. The "6 on 1" slopes are to be excavated as steep as the character of the rock allows for stability. The width of the channel shall not be less than the bottom width shown, and the sides shall be scaled of loose fragments.

A substantial proportion of the earth excavation of the spillway channel will have been made under another contract; see note on profile of Sheet 11.

Notes:

Elevations, Boston City Base.

For locations of the channel sections and for plan and profile of Spillway Channel see Sheet 11.

For plan and details of Spillway Weir see Sheet 13.

Details shown on these contract drawings are indicative of the type of structures wanted and are subject to revision by working drawings to be furnished from time to time.

COMMONWEALTH OF MASSACHUSETTS
METR. DISTR. WATER SUPPLY COMMISSION
QUABBIN RESERVOIR

MAIN DAM EMBANKMENT
SPILLWAY CHANNEL - SHEET 2

20 10 0 20 40 FT

JUNE 1, 1936.

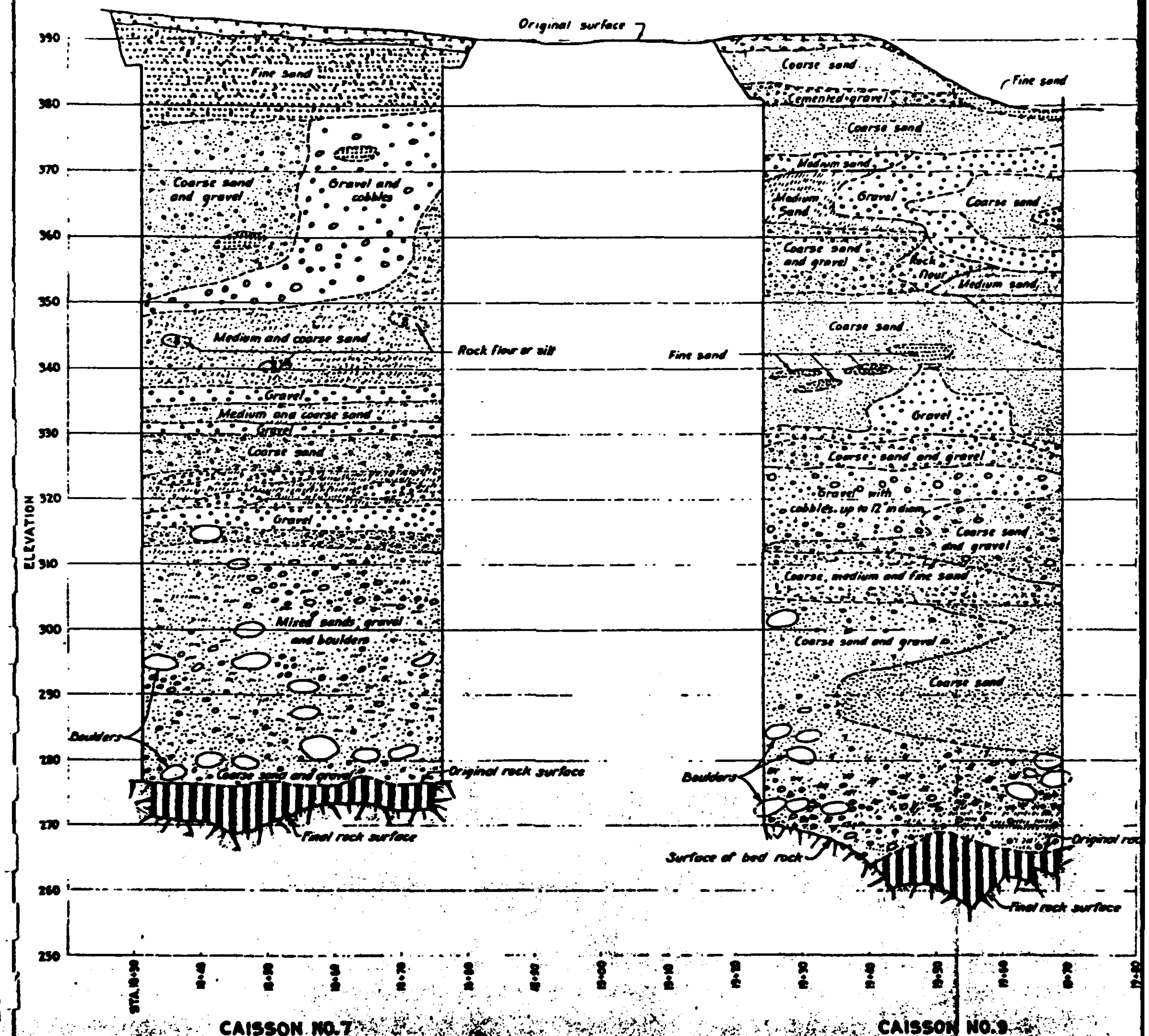
(12)

Chief Engineer

Charles T. Main
Consulting Engineer

File Cont. 52-2.325

Acc 24 112



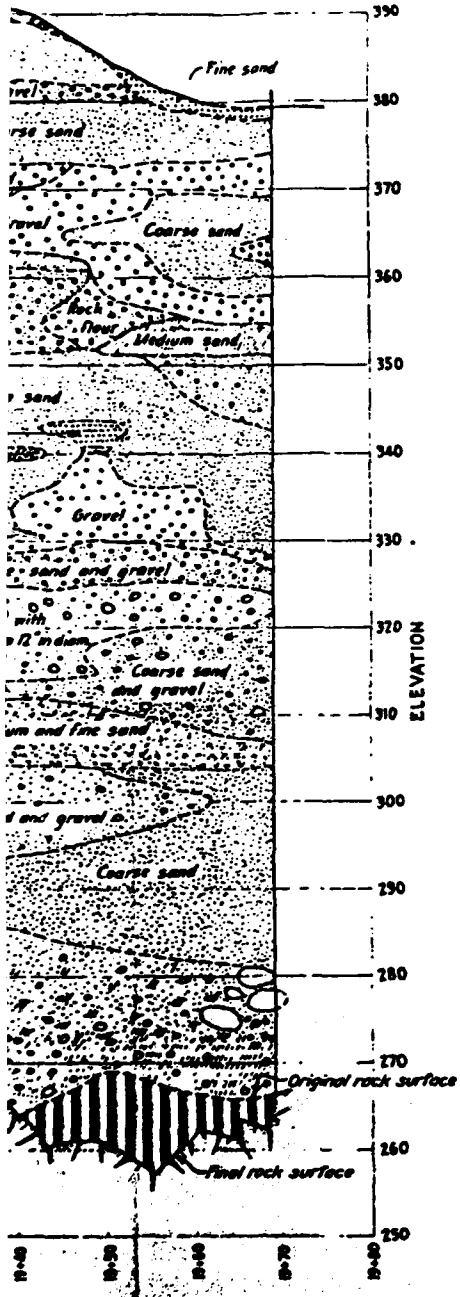
Drawn: P.M.L. & E.T.M.
Traced: E.T.M.
Checked: J.F.R. [illegible]

Asst. Chief Engineer

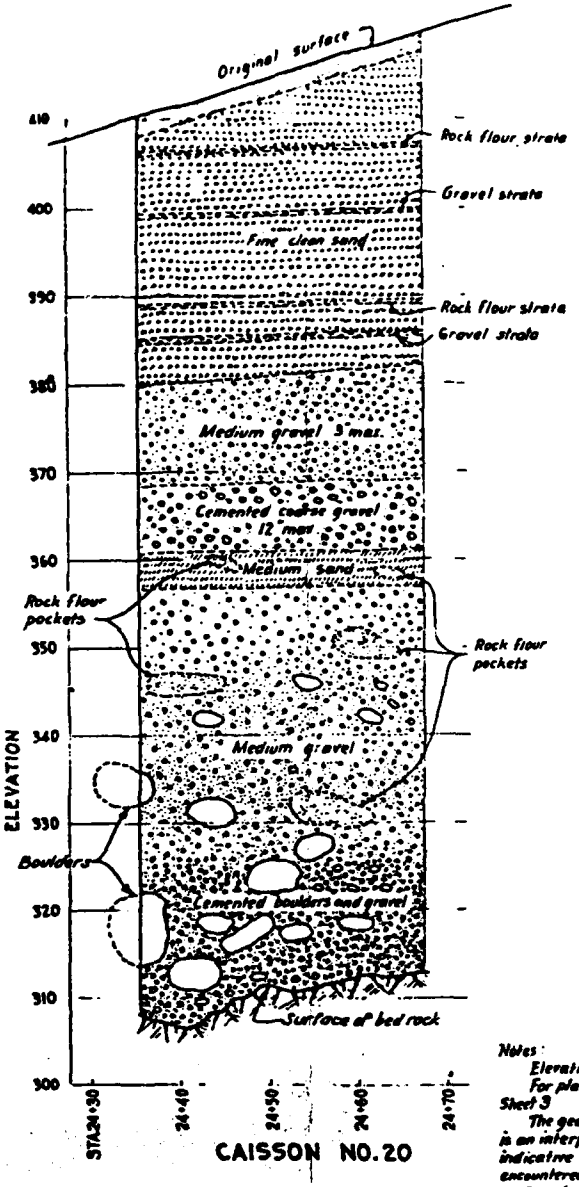
Chief Engineer

File 4160-B37

CONTRACT 38 SHEET 13
20 SHEETS IN SET



CAISSON NO.9



CAISSON NO.20

LEGEND

M Muck
L Loam
1 Gravel, uniform
2 Coarse sand, uniform
3 Coarse sand, variable
4 Medium sand, uniform
5 Medium sand, variable
6 Fine sand, uniform
7 Fine sand, variable
8 Rock flour or silt, uniform
9 Rock flour or silt, variable
B Boulders
Rock

"Uniform" means that only a small percentage of the material has particles larger or smaller than the average.
"Variable" means that a considerable number of particles is larger, smaller or both than the average.
The names given the numbered classes differentiate them according to their relative pervious qualities, and each variable class contains a considerable number of larger particles.

Notes:
Elevations - Boston City Base
For plan location of caissons see Sheet 3
The geological data shown on this sheet is an interpretation of the samples and is indicative only of the types of materials encountered (see Art. 17 of the contract)
Sample boxes of the materials encountered during the sinking of Caissons No. 7, 9, and 20 have been prepared (full scale in depth) for inspection at the site of the Main Dam. Spoil excavated from these caissons may also be seen at the site.
For additional geological data see Sheets 11 and 12

COMMONWEALTH OF MASSACHUSETTS
METR. DISTR. WATER SUPPLY COMMISSION
QUABBIN RESERVOIR
MAIN DAM CORE WALL
OVERBURDEN - GEOLOGICAL DATA - SHEET 3

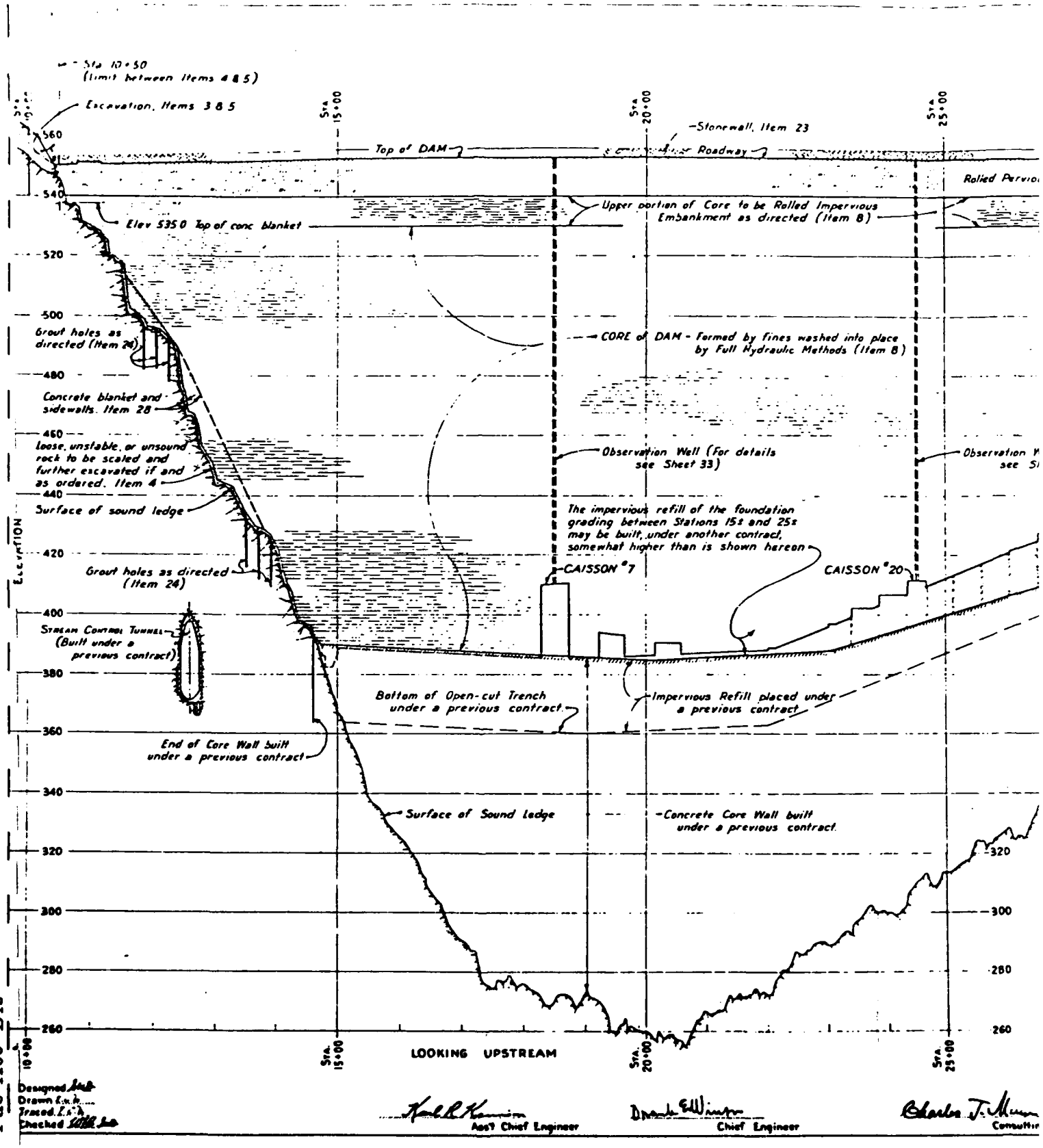
DECEMBER 21, 1934

Consulting Engineers.

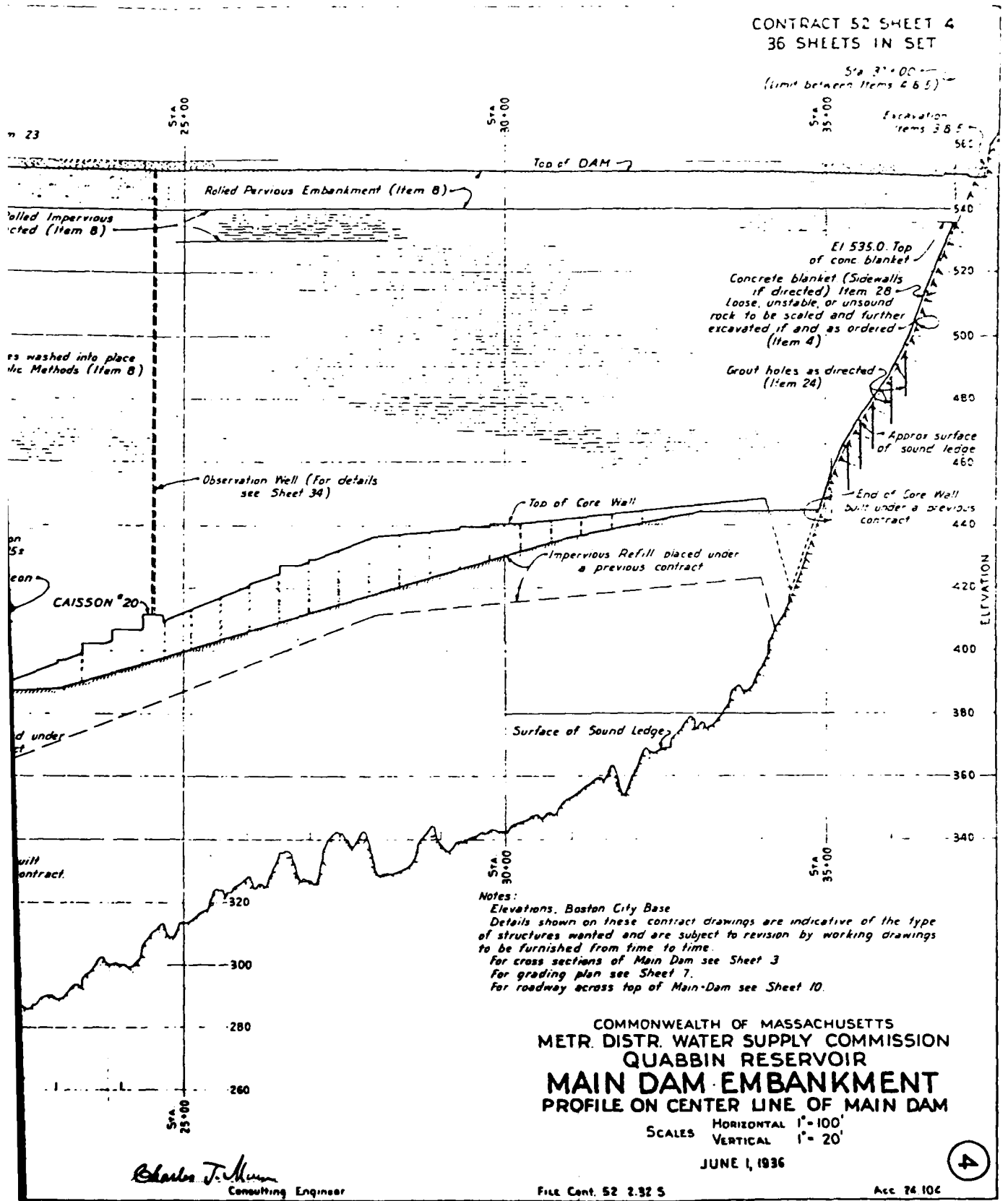
FILE CONT. 38 2.313

Acc. 4303

APPENDIX B-57


Sta 10+50
(limit between Items 4 & 5)
Excavation, Items 3 & 5
Sta 10+00
Sta 15+00
Sta 20+00
Sta 25+00
Stonewall, Item 23
Top of DAM
Roadway
Rolled Pervio
Upper portion of Core to be Rolled Impervious Embankment as directed (Item 8)
Elev 535.0 Top of conc. blanket
560
540
520
500
480
460
440
420
400
380
360
340
320
300
280
260
Elevation
Grout holes as directed (Item 24)
Concrete blanket and sidewalks, Item 28
Loose, unstable, or unsound rock to be scaled and further excavated if and as ordered, Item 4
Surface of sound ledge
Grout holes as directed (Item 24)
Stream Control Tunnel (Built under a previous contract)
End of Core Wall built under a previous contract
CORE of DAM - Formed by fines washed into place by Full Hydraulic Methods (Item 8)
Observation Well (For details see Sheet 33)
Observation W
see Sh
The impervious refill of the foundation grading between Stations 15± and 25± may be built under another contract, somewhat higher than is shown hereon
CAISSON #7
CAISSON #20
Bottom of Open-cut Trench under a previous contract
Impervious Refill placed under a previous contract
Surface of Sound Ledge
Concrete Core Wall built under a previous contract
LOOKING UPSTREAM
File 4160 B42
Designed
Drawn
Traced
Checked
Asst Chief Engineer
Chief Engineer
Consultin

CONTRACT 52 SHEET 4
36 SHEETS IN SET



Notes:
Elevations, Boston City Base
Details shown on these contract drawings are indicative of the type of structures wanted and are subject to revision by working drawings to be furnished from time to time.
For cross sections of Main Dam see Sheet 3
For grading plan see Sheet 7.
For roadway across top of Main Dam see Sheet 10.

COMMONWEALTH OF MASSACHUSETTS
METR. DISTR. WATER SUPPLY COMMISSION
QUABBIN RESERVOIR

MAIN DAM EMBANKMENT

PROFILE ON CENTER LINE OF MAIN DAM

SCALES HORIZONTAL 1" = 100'
VERTICAL 1" = 20'

JUNE 1, 1936

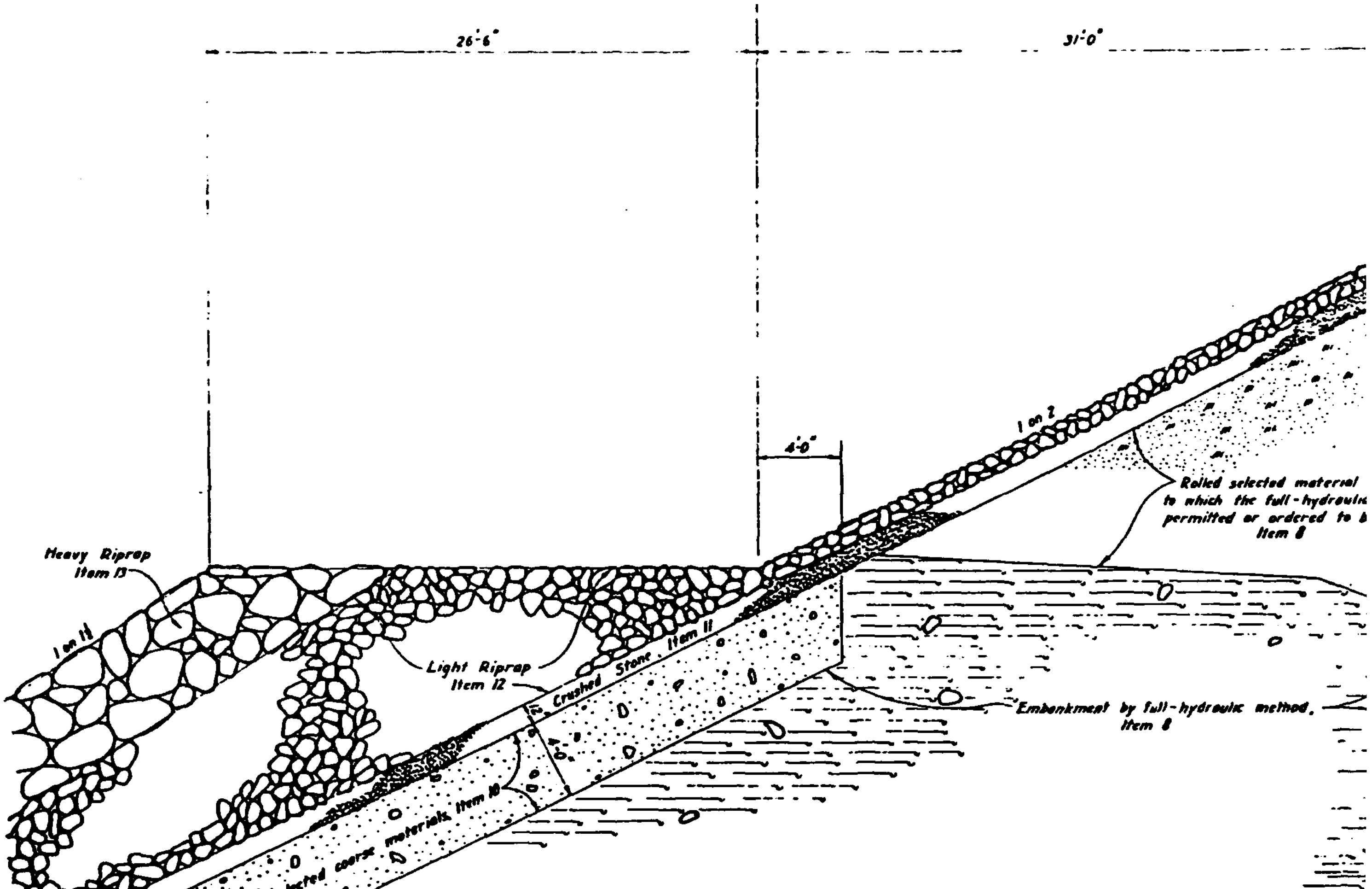
4

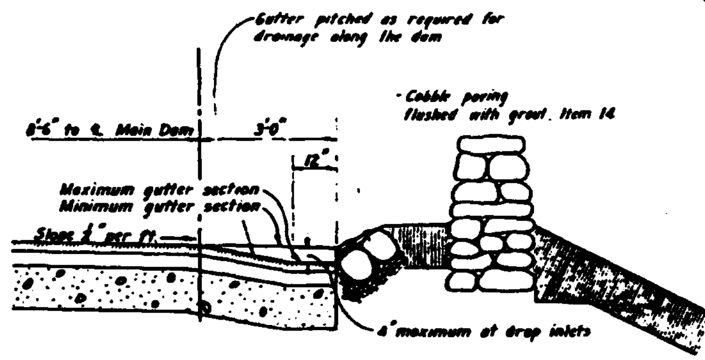
Charles J. Mann
Consulting Engineer

FILE Cont. 52 2.32 S

Acc. 24.106

(2)





DETAIL OF GUTTER

2 1 0 2 4 FT.

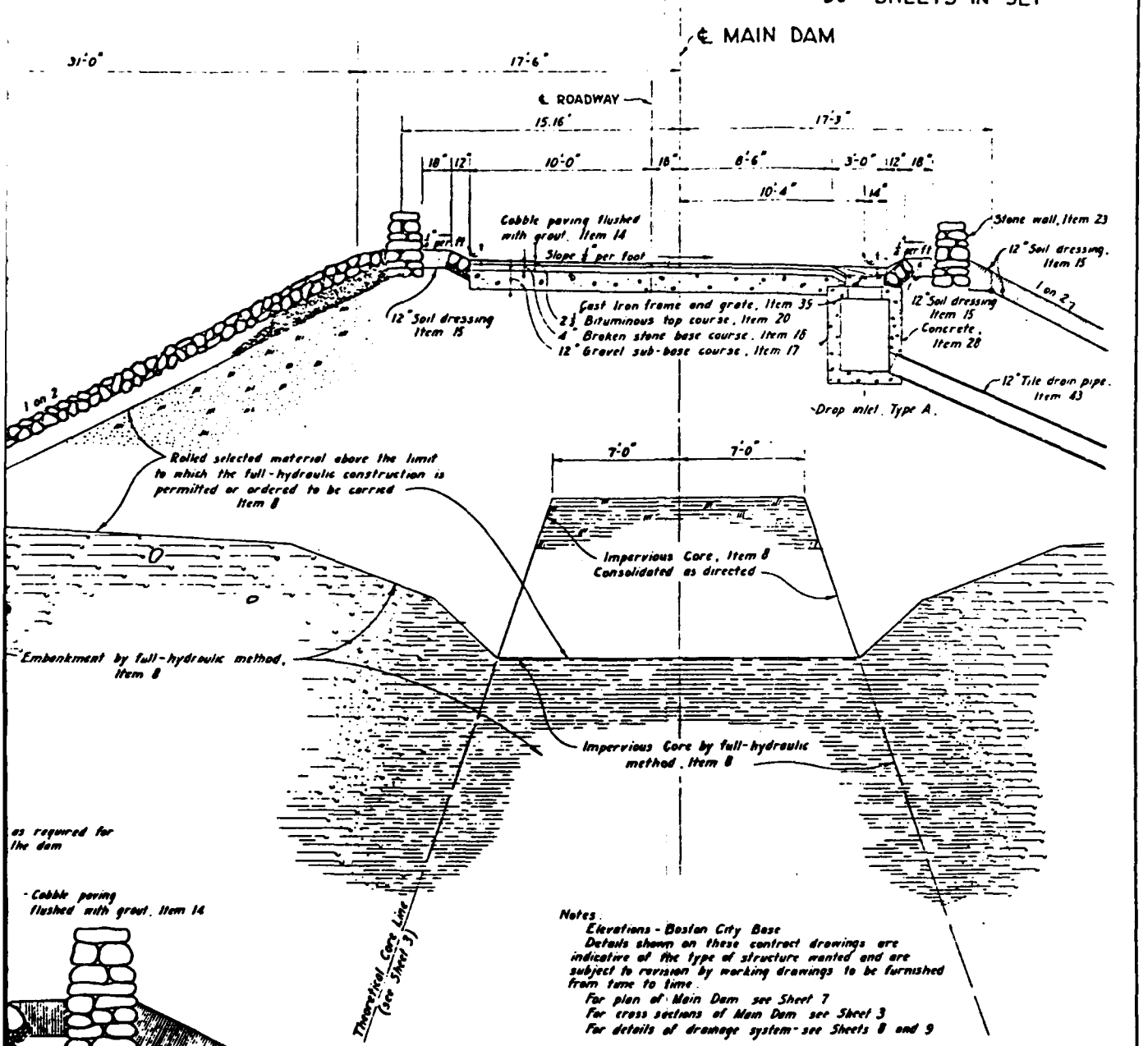
Designed:
Drawn:
Traced:
Checked:

Asst. Chief Engineer

Chief Engineer

File 4160 B43

CONTRACT 52 SHEET 10
36 SHEETS IN SET



Notes.
Elevations - Boston City Base
Details shown on these contract drawings are indicative of the type of structure wanted and are subject to revision by working drawings to be furnished from time to time.
For plan of Main Dam see Sheet 7
For cross sections of Main Dam see Sheet 3
For details of drainage system - see Sheets 8 and 9

COMMONWEALTH OF MASSACHUSETTS
METR. DISTR. WATER SUPPLY COMMISSION
QUABBIN RESERVOIR

MAIN DAM EMBANKMENT

CROSS SECTION OF TOP OF MAIN DAM

4 2 0 4 8 FT

EXCEPT AS NOTED
JUNE 1, 1936

(8)

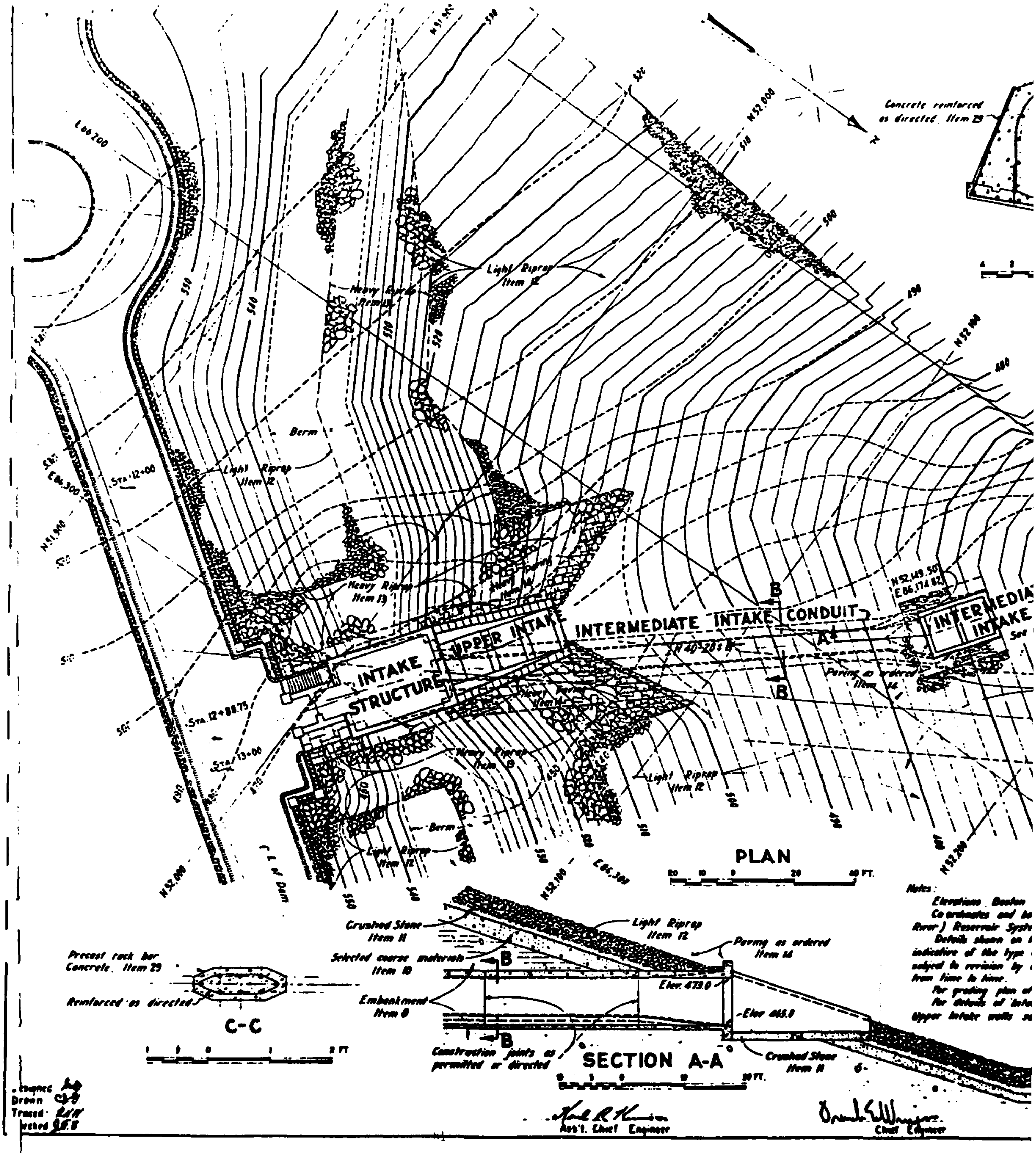
Chief Engineer

Charles T. Main
Consulting Engineer

File Cont 52-2.32 S

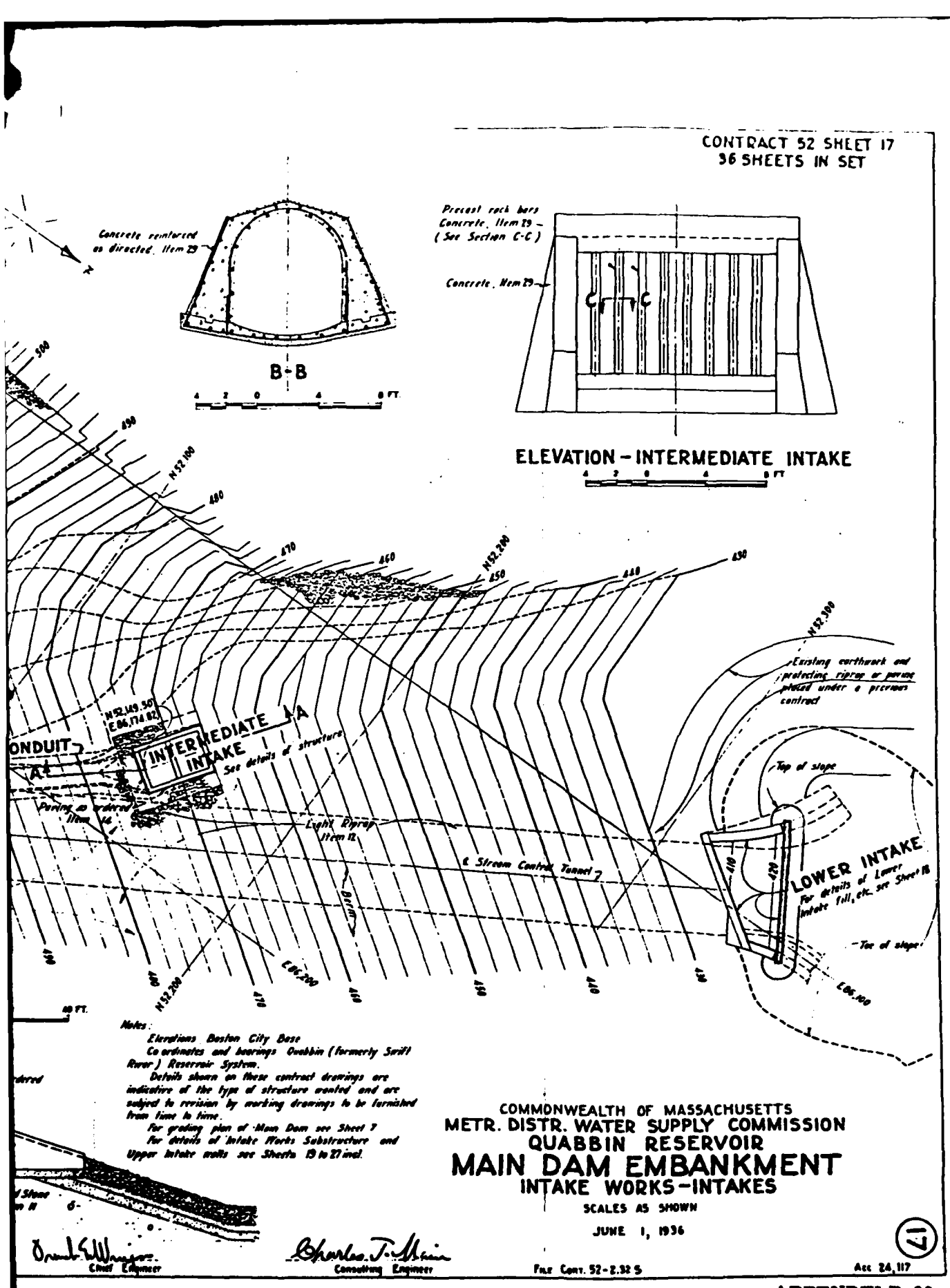
Acc 24,110

APPENDIX B-59


INTAKE STRUCTURE
UPPER INTAKE
INTERMEDIATE INTAKE CONDUIT
INTERMEDIATE INTAKE
Concrete reinforced as directed. Item 29
Light Riprap Item 12
Heavy Riprap Item 13
Berm
Paving as ordered Item 14
Sta. 12+00
Sta. 12+88.75
Sta. 13+00
N 52,000
N 52,100
N 52,200
N 51,900
E 86,300
N 52,149.50
E 86,174.82
PLAN
C-C
Precast rack bar Concrete. Item 29
Reinforced as directed
SECTION A-A
Crushed Stone Item 11
Selected coarse materials Item 10
Embankment Item 8
Construction joints as permitted or directed
Elev. 479.0
Elev. 465.0
Notes:
Ass't. Chief Engineer
Chief Engineer
Drawn
Traced

6

CONTRACT 52 SHEET 17
36 SHEETS IN SET



Notes:
Elevations Boston City Base
Co ordinates and bearings Quabbin (formerly Swift River) Reservoir System.
Details shown on these contract drawings are indicative of the type of structure wanted and are subject to revision by working drawings to be furnished from time to time.
For grading plan of Main Dam see Sheet 7
For details of Intake Works Substructure and Upper Intake walls see Sheets 19 to 27 incl.

COMMONWEALTH OF MASSACHUSETTS
METR. DISTR. WATER SUPPLY COMMISSION
QUABBIN RESERVOIR
MAIN DAM EMBANKMENT
INTAKE WORKS – INTAKES
SCALES AS SHOWN
JUNE 1, 1936

(17)

Chief Engineer

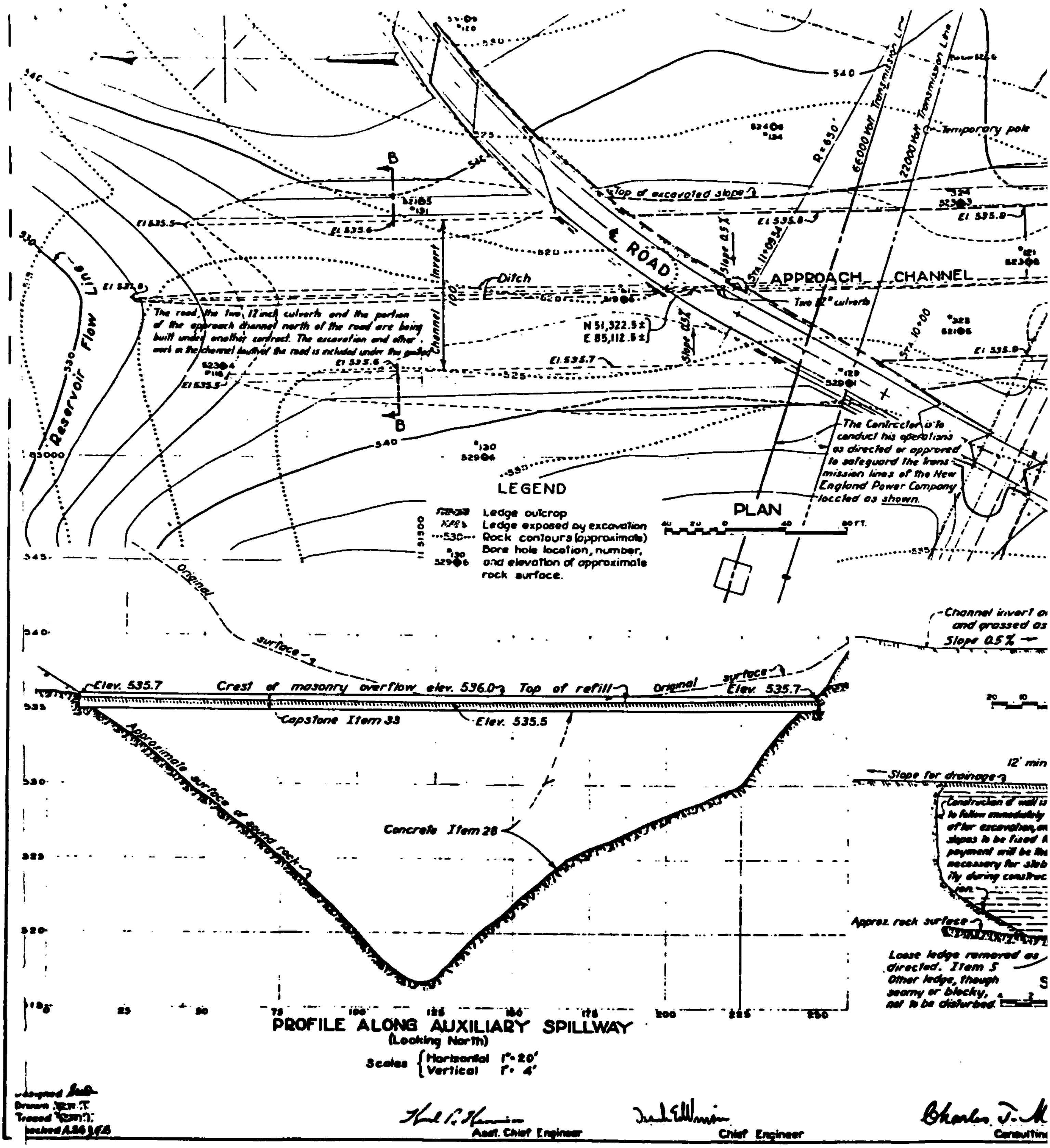
Consulting Engineer

File Cont. 52-2.32 S

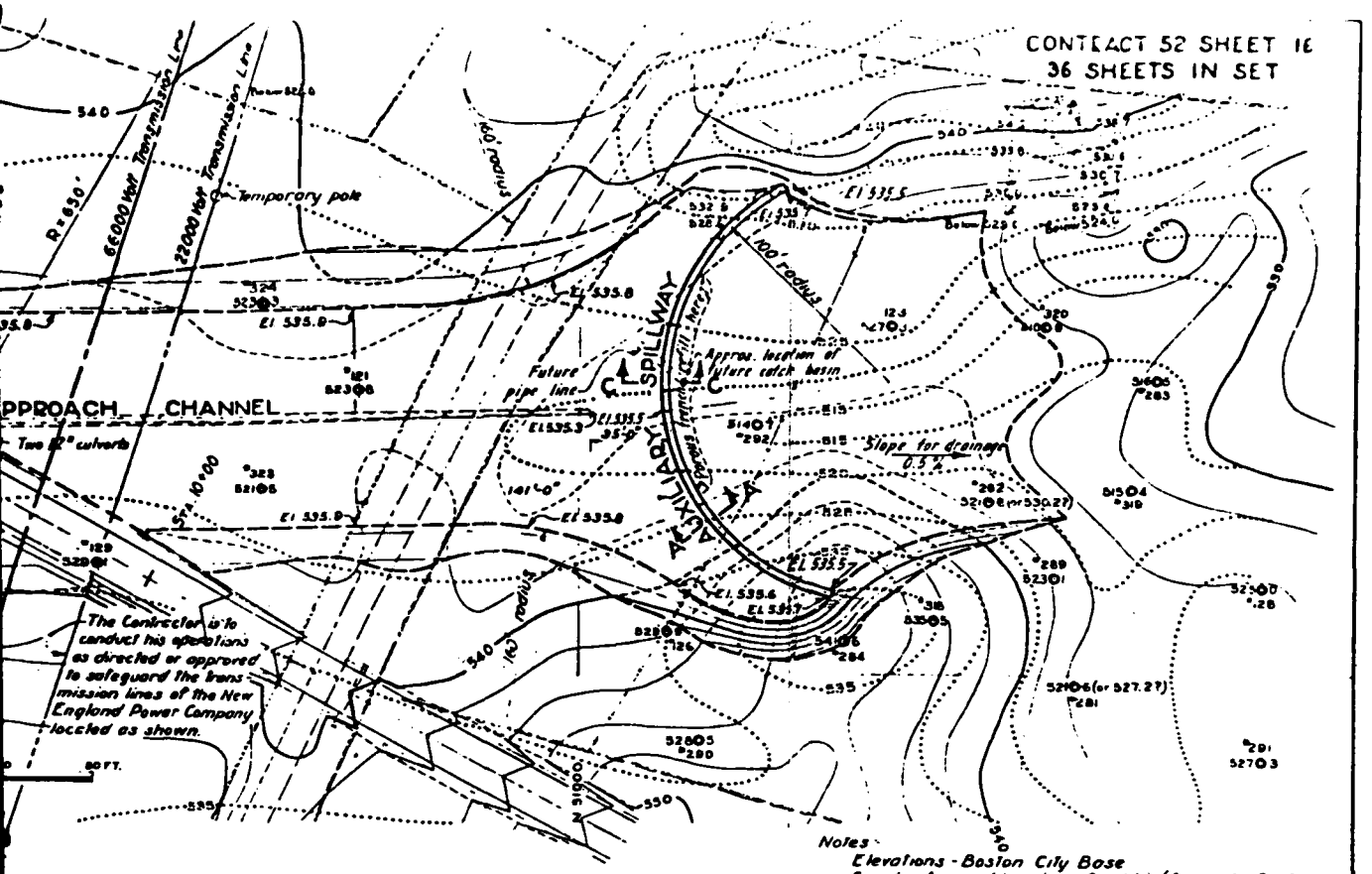
Acc 24,117

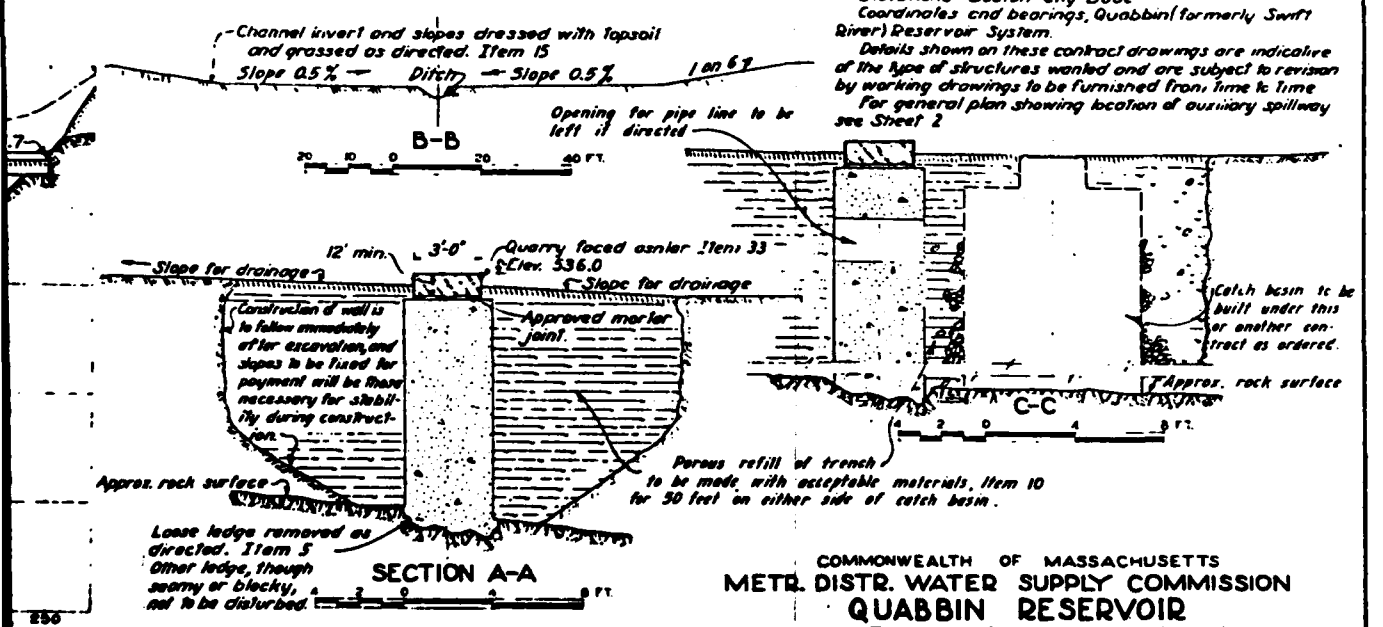
APPENDIX B-60

(2)



540
Temporary pole
66000 Volt Transmission Line
22000 Volt Transmission Line
R=650'
Top of excavated slope
El. 535.8
El. 535.5
El. 535.6
El. 535.7
El. 535.9
℄ ROAD
Slope 0.5%
Sta. 11+09.34
APPROACH CHANNEL
Two 12" culverts
Ditch
Channel Invert 100'
The road, the two 12 inch culverts and the portion of the approach channel north of the road are being built under another contract. The excavation and other work in the channel south of the road is included under this contract.
N 51,322.5±
E 85,112.5±
Sta. 10+00
Reservoir Flow Line
B
The Contractor is to conduct his operations as directed or approved to safeguard the transmission lines of the New England Power Company located as shown.
LEGEND
Ledge outcrop
Ledge exposed by excavation
---530--- Rock contours (approximate)
Bore hole location, number, and elevation of approximate rock surface.
PLAN
N 51900
E 85000
Original surface
Elev. 535.7
Crest of masonry overflow elev. 536.0
Top of refill
Original surface
Capstone Item 33
Elev. 535.5
Approximate surface of sound rock
Concrete Item 28
Channel invert and grassed as
Slope 0.5%
12' min
Slope for drainage
Construction of wall is to follow immediately after excavation, and slopes to be fixed ... payment will be ... necessary for stability during construction.
Approx. rock surface
Loose ledge removed as directed. Item 5
Other ledge, though seamy or blocky, not to be disturbed.
PROFILE ALONG AUXILIARY SPILLWAY
(Looking North)
Scales { Horizontal 1" = 20' / Vertical 1" = 4'
Designed
Drawn
Traced
Checked
Asst. Chief Engineer
Chief Engineer
Consulting





COMMONWEALTH OF MASSACHUSETTS
METR. DISTR. WATER SUPPLY COMMISSION
QUABBIN RESERVOIR

MAIN DAM EMBANKMENT
AUXILIARY SPILLWAY

SCALES AS NOTED

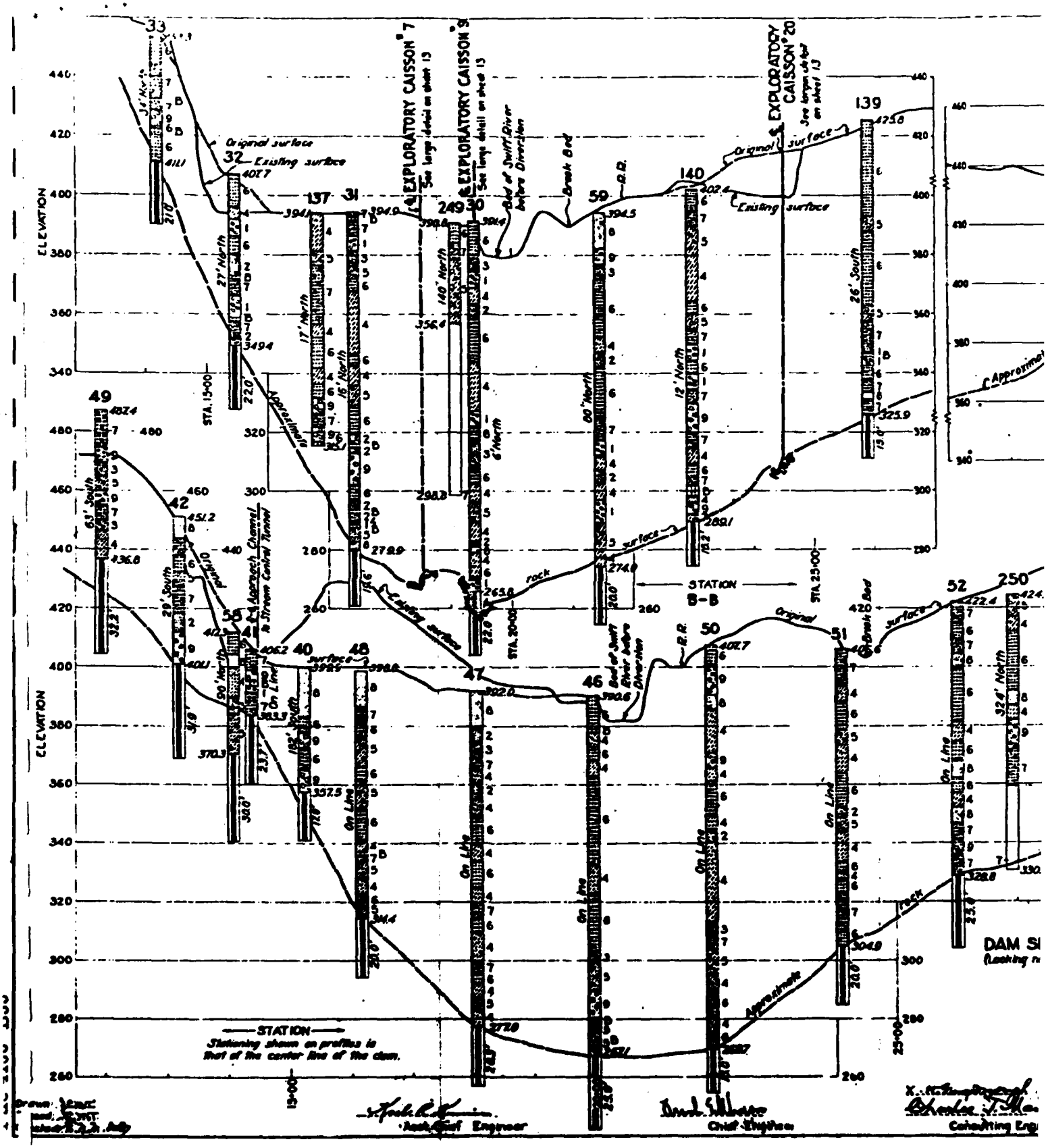
JUNE 1, 1936

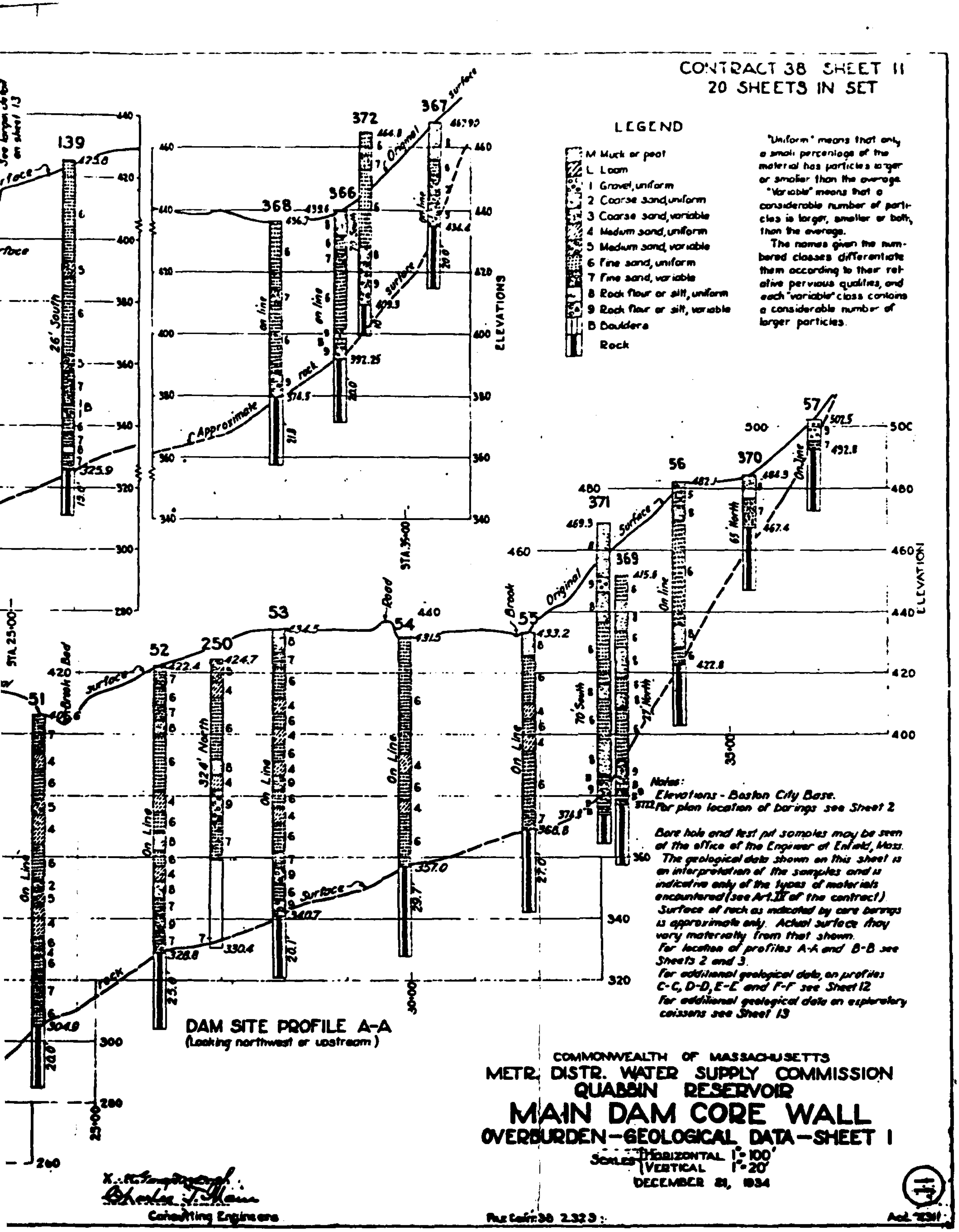
(61)

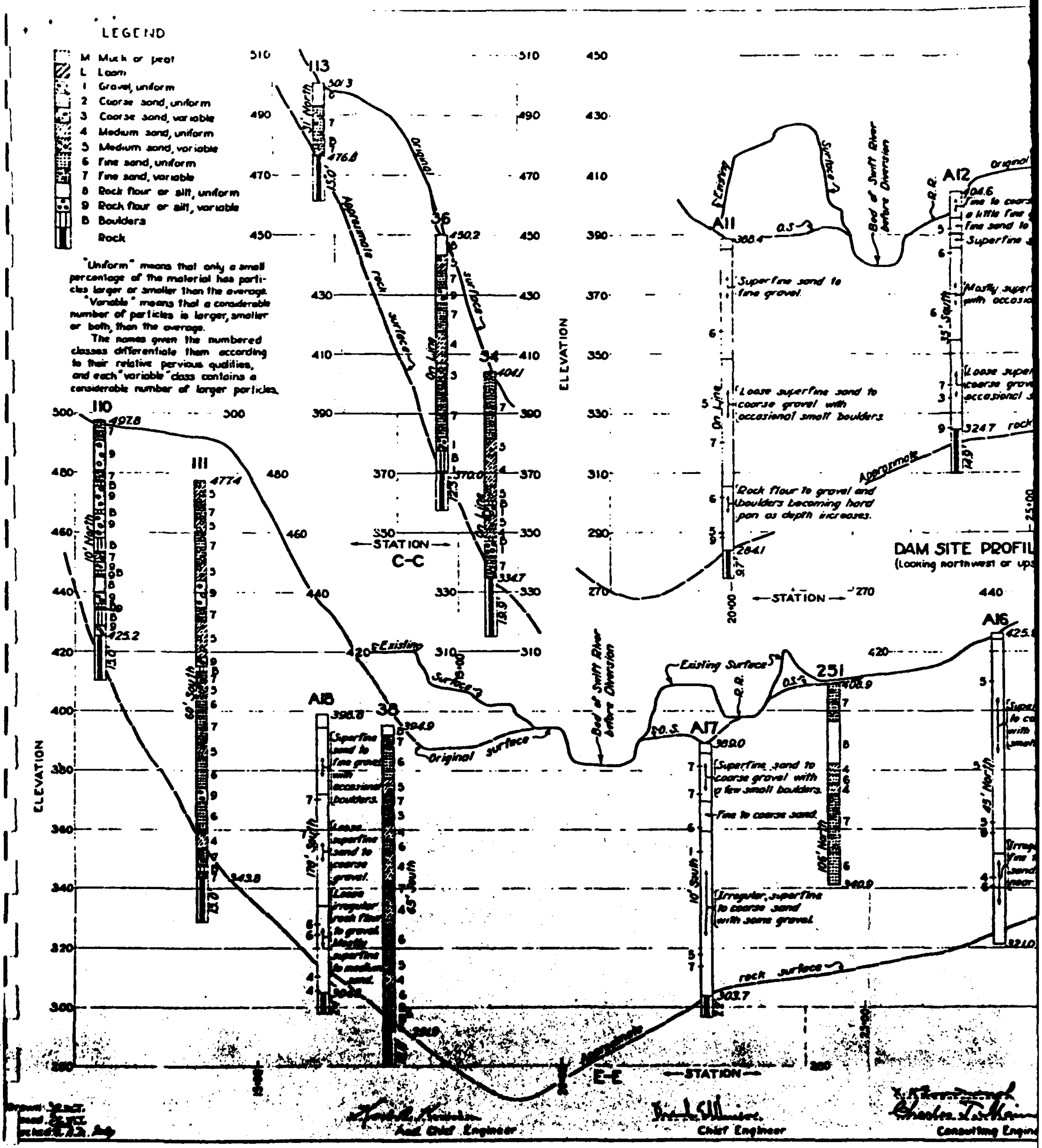
Charles T. Main
Consulting Engineer

FILE CONT. 52-2.32 S

ACC. 24116

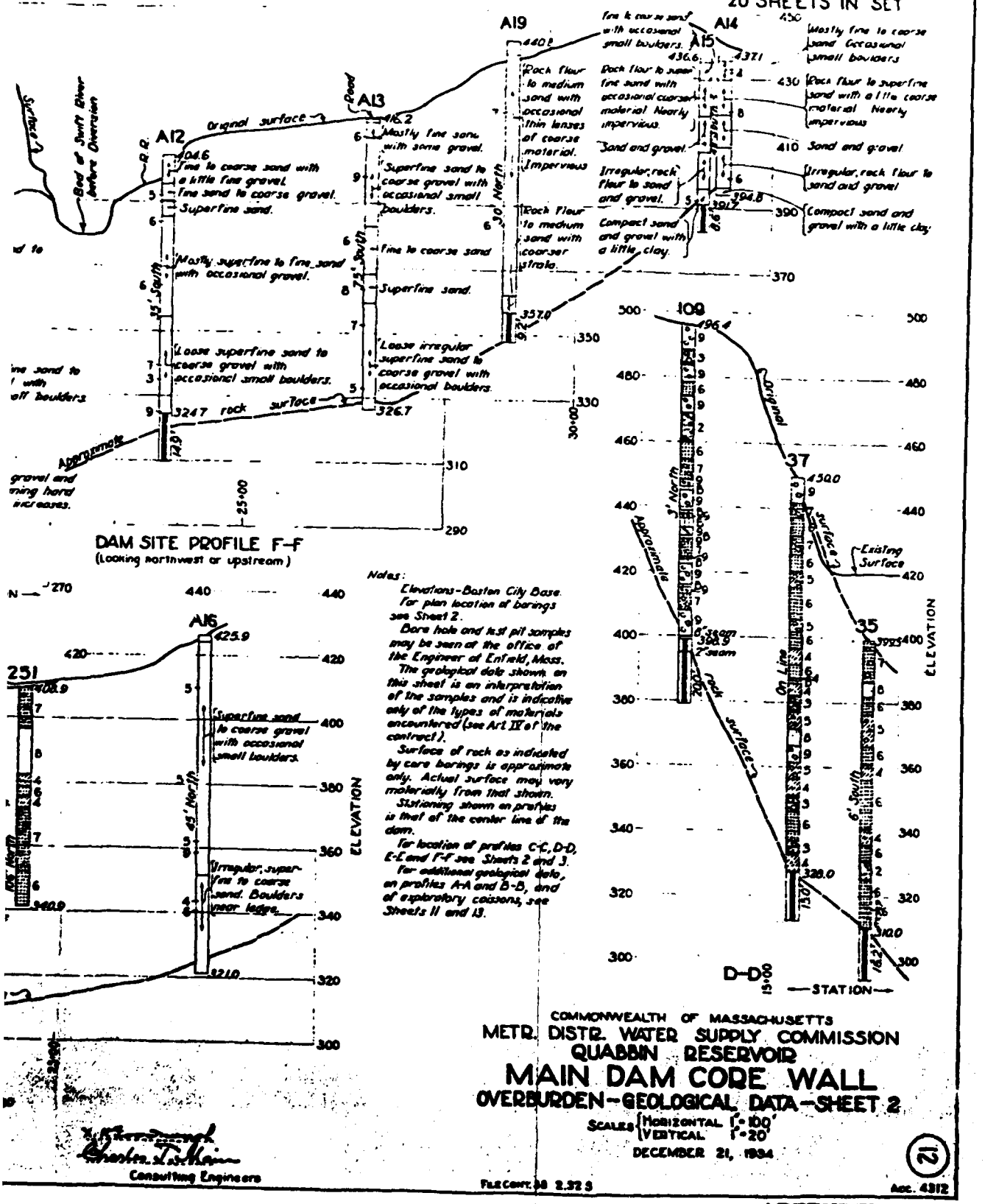

EXPLORATORY CAISSON #7
See large detail on sheet 13
EXPLORATORY CAISSON #9
See large detail on sheet 13
EXPLORATORY CAISSON #20
See large detail on sheet 13
Original surface
Existing surface
Approximate
Approach Channel & Stream Control Tunnel
Bed of Swift River before Diversion
Brook Bed
B.R.
rock
STATION
B-B
STA. 15+00
STA. 20+00
STA. 23+00
ELEVATION
On Line
STATION
Stationing shown on profiles is that of the center line of the dam.
DAM SI
Chief Engineer
Consulting Engr


CONTRACT 38 SHEET 11
20 SHEETS IN SET
LEGEND
M Muck or peat
L Loam
1 Gravel, uniform
2 Coarse sand, uniform
3 Coarse sand, variable
4 Medium sand, uniform
5 Medium sand, variable
6 Fine sand, uniform
7 Fine sand, variable
8 Rock flour or silt, uniform
9 Rock flour or silt, variable
B Boulders
Rock
"Uniform" means that only a small percentage of the material has particles larger or smaller than the average.
"Variable" means that a considerable number of particles is larger, smaller or both, than the average.
The names given the numbered classes differentiate them according to their relative pervious qualities, and each "variable" class contains a considerable number of larger particles.
ELEVATIONS
DAM SITE PROFILE A-A
(Looking northwest or upstream)
Notes:
Elevations - Boston City Base.
For plan location of borings see Sheet 2
Bore hole and test pit samples may be seen at the office of the Engineer at Enfield, Mass.
The geological data shown on this sheet is an interpretation of the samples and is indicative only of the types of materials encountered (see Art. IX of the contract)
Surface of rock as indicated by core borings is approximate only. Actual surface may vary materially from that shown.
For location of profiles A-A and B-B see Sheets 2 and 3.
For additional geological data, on profiles C-C, D-D, E-E and F-F see Sheet 12
For additional geological data on exploratory caissons see Sheet 13
COMMONWEALTH OF MASSACHUSETTS
METR. DISTR. WATER SUPPLY COMMISSION
QUABBIN RESERVOIR
MAIN DAM CORE WALL
OVERBURDEN-GEOLOGICAL DATA-SHEET 1
SCALES: HORIZONTAL 1"=100'
VERTICAL 1"=20'
DECEMBER 31, 1934
Consulting Engineers


LEGEND
M Muck or peat
L Loam
1 Gravel, uniform
2 Coarse sand, uniform
3 Coarse sand, variable
4 Medium sand, uniform
5 Medium sand, variable
6 Fine sand, uniform
7 Fine sand, variable
8 Rock flour or silt, uniform
9 Rock flour or silt, variable
B Boulders
Rock
"Uniform" means that only a small percentage of the material has particles larger or smaller than the average. "Variable" means that a considerable number of particles is larger, smaller or both, than the average.
The names given the numbered classes differentiate them according to their relative pervious qualities, and each "variable" class contains a considerable number of larger particles.
ELEVATION
STATION
C-C
E-E
DAM SITE PROFIL
(Looking northwest or ups
Bed of Swift River before Diversion
Existing Surface
Original surface
Approximate rock surface
Superfine sand to fine gravel.
Loose superfine sand to coarse gravel with occasional small boulders.
Rock flour to gravel and boulders becoming hard pan as depth increases.
Superfine sand to coarse gravel with a few small boulders.
Fine to coarse sand.
Irregular, superfine to coarse sand with some gravel.
Asst. Chief Engineer
Chief Engineer
Consulting Engine

6

CONTRACT 38 SHEET 12
20 SHEETS IN SET



Notes:

Elevations - Boston City Base.

For plan location of borings see Sheet 2.

Bore hole and test pit samples may be seen at the office of the Engineer at Enfield, Mass.

The geological data shown on this sheet is an interpretation of the samples and is indicative only of the types of materials encountered (see Art IV of the contract).

Surface of rock as indicated by core borings is approximate only. Actual surface may vary materially from that shown.

Stationing shown on profiles is that of the center line of the dam.

For location of profiles C-C, D-D, E-E and F-F see Sheets 2 and 3.

For additional geological data, on profiles A-A and B-B, and of exploratory caissons, see Sheets 11 and 13.

COMMONWEALTH OF MASSACHUSETTS
METR. DISTR. WATER SUPPLY COMMISSION
QUABBIN RESERVOIR

MAIN DAM CORE WALL
OVERBURDEN - GEOLOGICAL DATA - SHEET 2

SCALES { HORIZONTAL 1" = 100'
VERTICAL 1" = 20'

DECEMBER 21, 1934

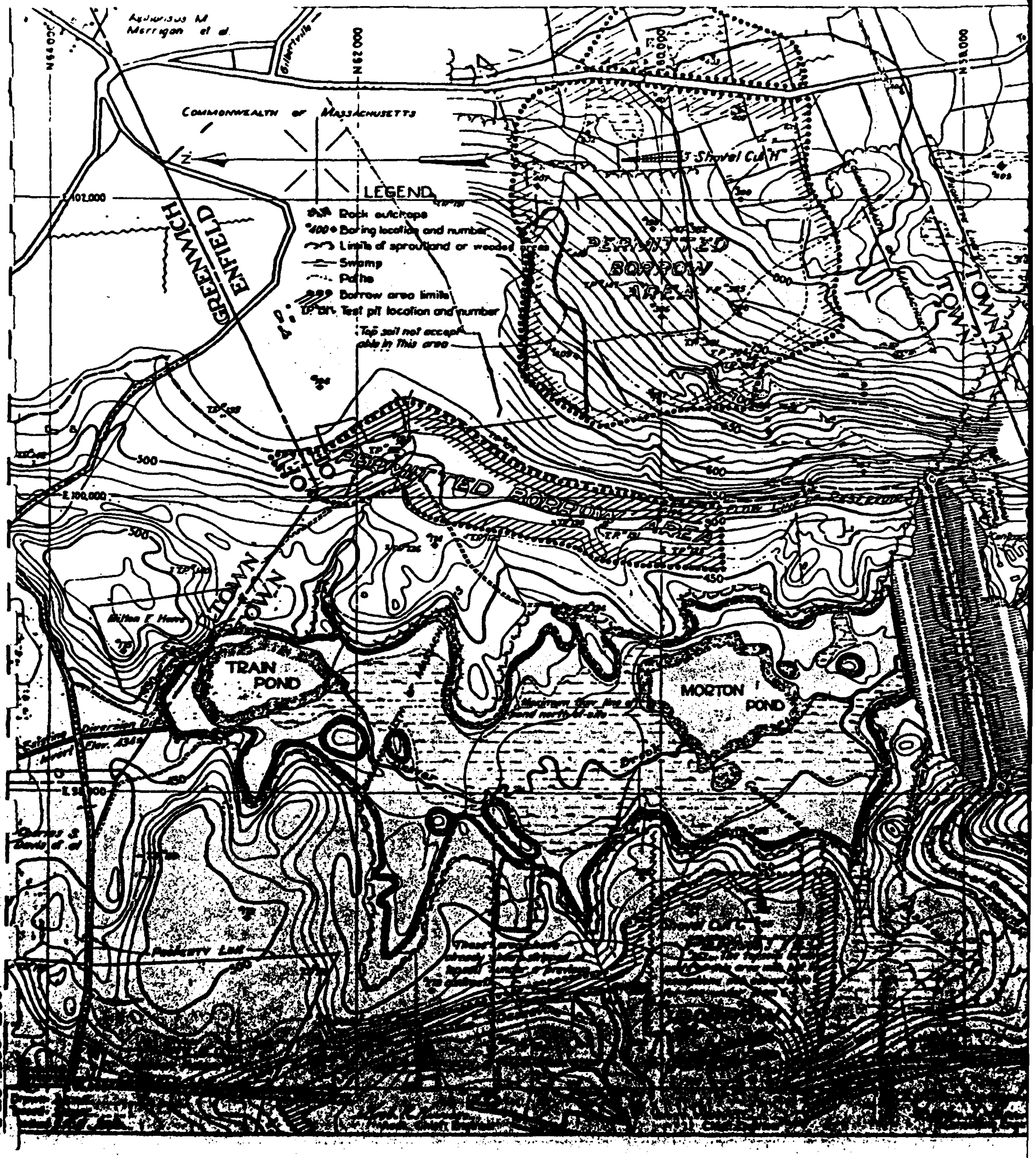
Charles T. Main
Consulting Engineers

FILE CONT. 38 2.32 S

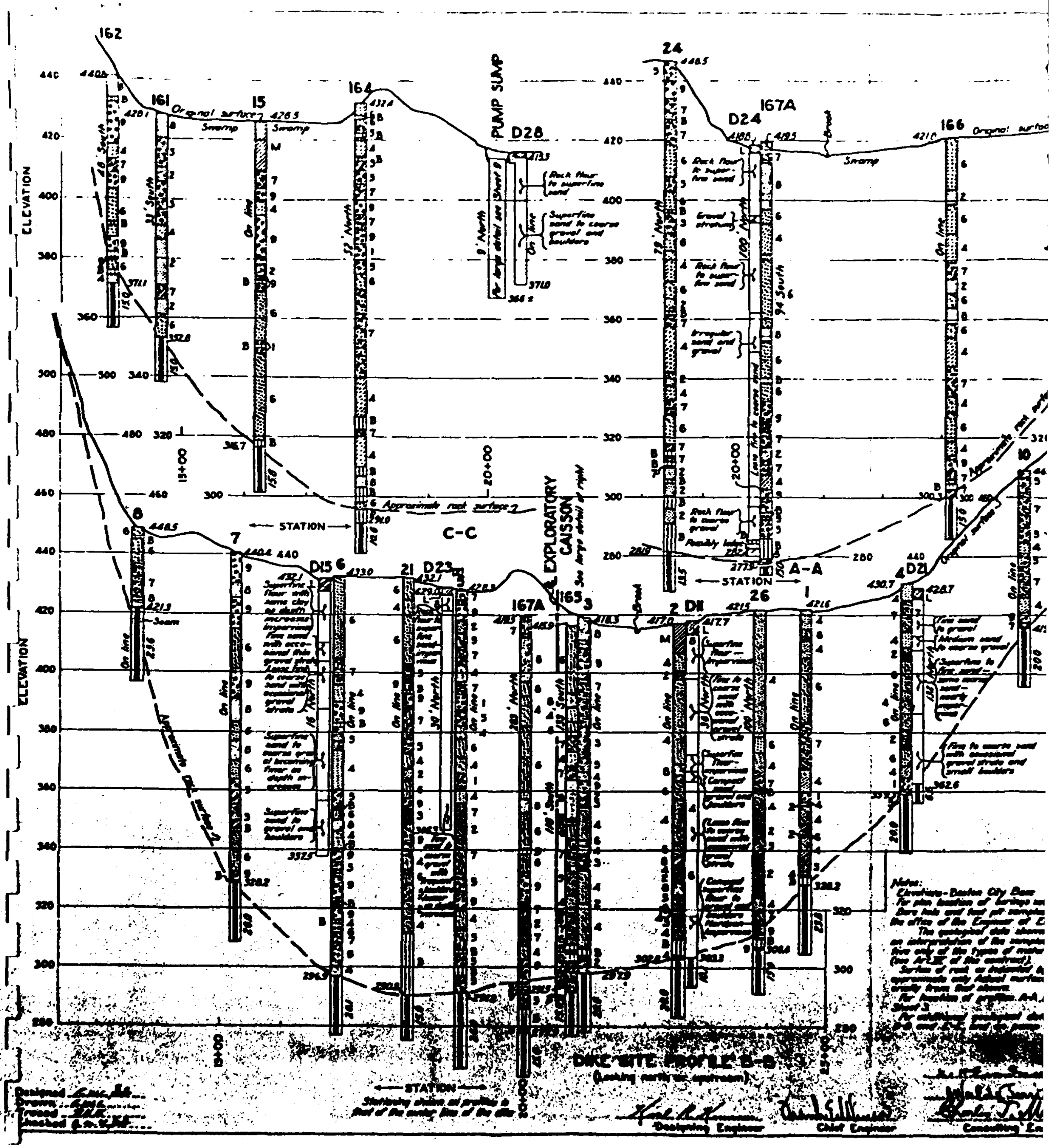
21

Acc. 4312

APPENDIX B-63

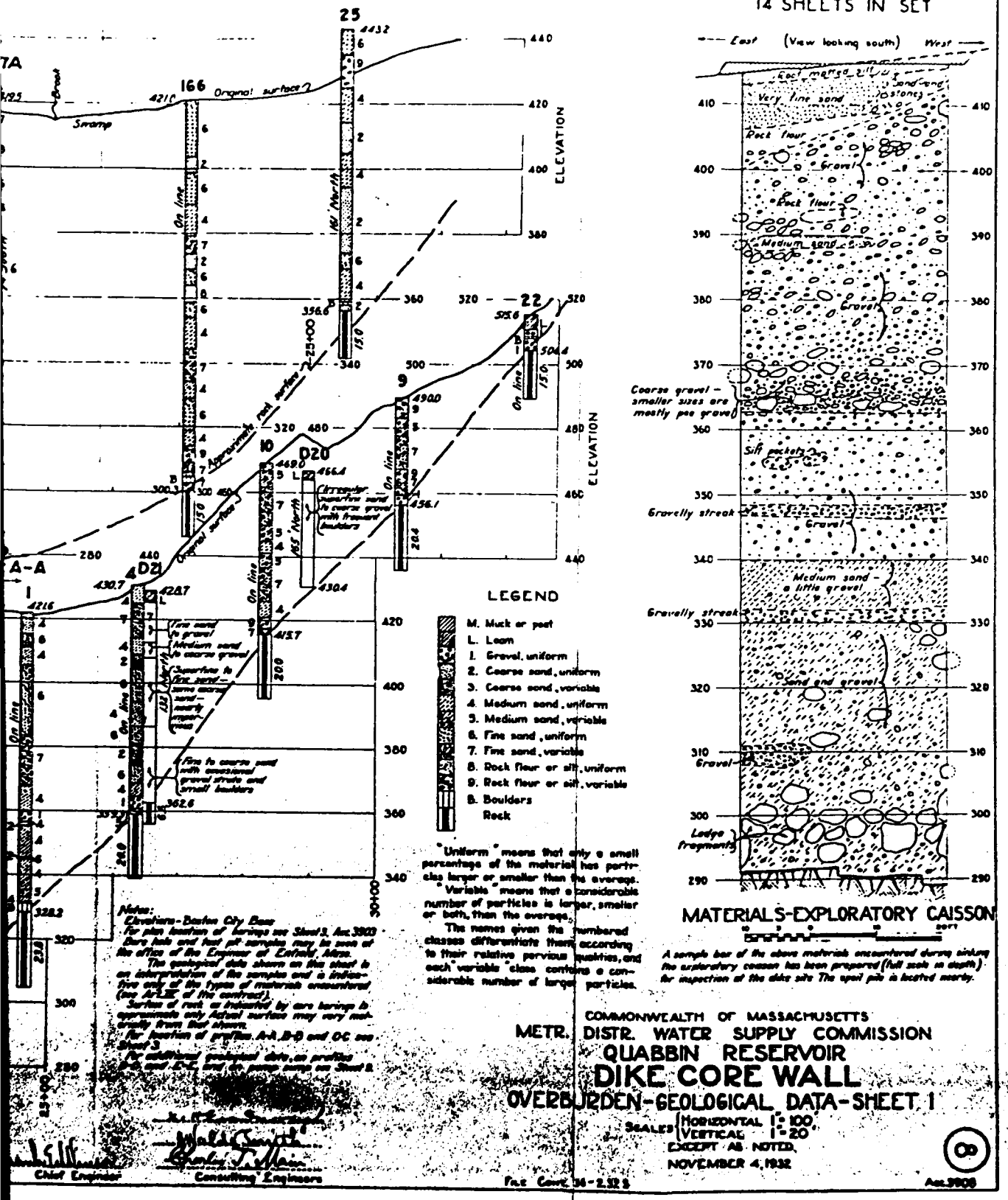

COMMONWEALTH OF MASSACHUSETTS
LEGEND
Rock outcrops
Boring location and number
Limits of sproutland or wooded area
Swamp
Paths
Borrow area limits
Test pit location and number
Top soil not acceptable in this area
GREENWICH
ENFIELD
PERMITTED BORROW AREA
PERMITTED BORROW AREA
TRAIN POND
MORTON POND
TOWN
N 62,000
E 102,000
E 100,000
500
450


CONTRACT 50 SHEET 2
15 SHEETS IN SET
Notes
Elevations - Boston City Base
Coordinates and bearings - Swift River (now Quabbin) Reservoir System
For plan, profile and cross sections of dike embankment see Sheets 3 4 and 10 and for details of roads see Sheets 10 and 13
Preliminary investigations indicate suitable materials may be found for Items 5, 6, 7, 8 and 13 in the "Permitted Borrow Areas" except as noted, but the Contractor will be allowed to borrow from any permitted areas only to the extent that the materials are satisfactory for their intended use.
In addition, impervious soil may be obtained from areas which will be designated northwesterly of the dike near the Enfield-Ware road.
The existence of or a sufficiency of suitable materials for Item 8 or any other item at any one borrow area shown is not guaranteed.
Note:- Records of investigations of borrow pit materials may be seen at the office of the Engineer.
N 58,000
N 56,000
N 54,000
E 102,000
E 100,000
E 98,000
NEW ENGLAND POWER COMPANY
66,000-volt transmission line
22,000-volt transmission line
Thomas Judd et ux.
PROPERTY LINE
Joseph DeSantis
COMMONWEALTH OF MASSACHUSETTS
TOWN OF
ENFIELD
WARE
Engineer's Office
PEPPERS MILL POND
Access Road
500
600
COMMONWEALTH OF MASSACHUSETTS
METR. DISTR. WATER SUPPLY COMMISSION
QUABBIN RESERVOIR
DIKE EMBANKMENT
GENERAL PLAN

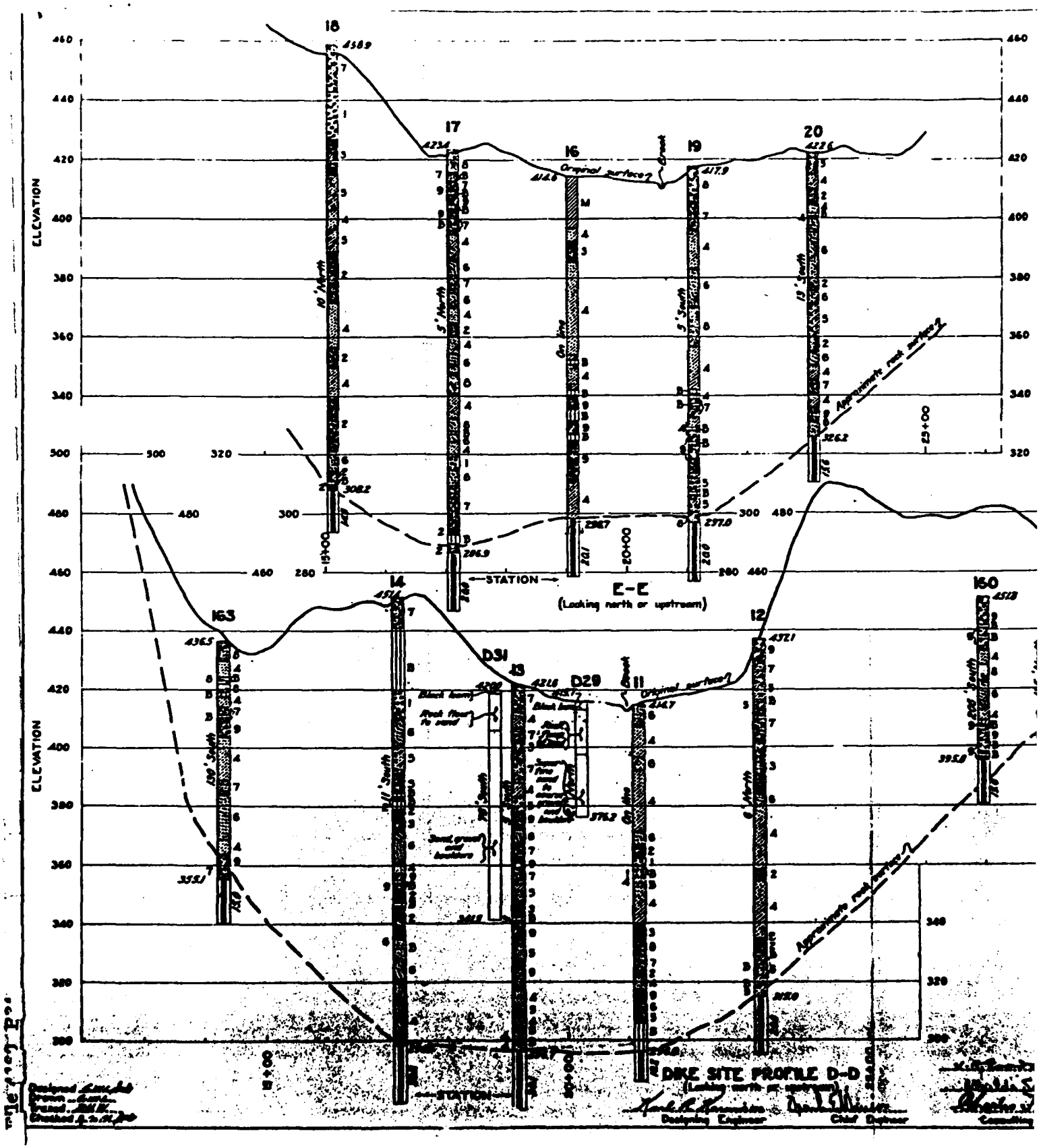


ELEVATION
Original surface
Swamp
PUMP SUMP
D28
Approximate rock surface
STATION
C-C
EXPLORATORY CAISSON
A-A
Notes:
DIKE SITE PROFILE B-B
(Looking north to upstream)
Designing Engineer
Chief Engineer
Consulting Engineer

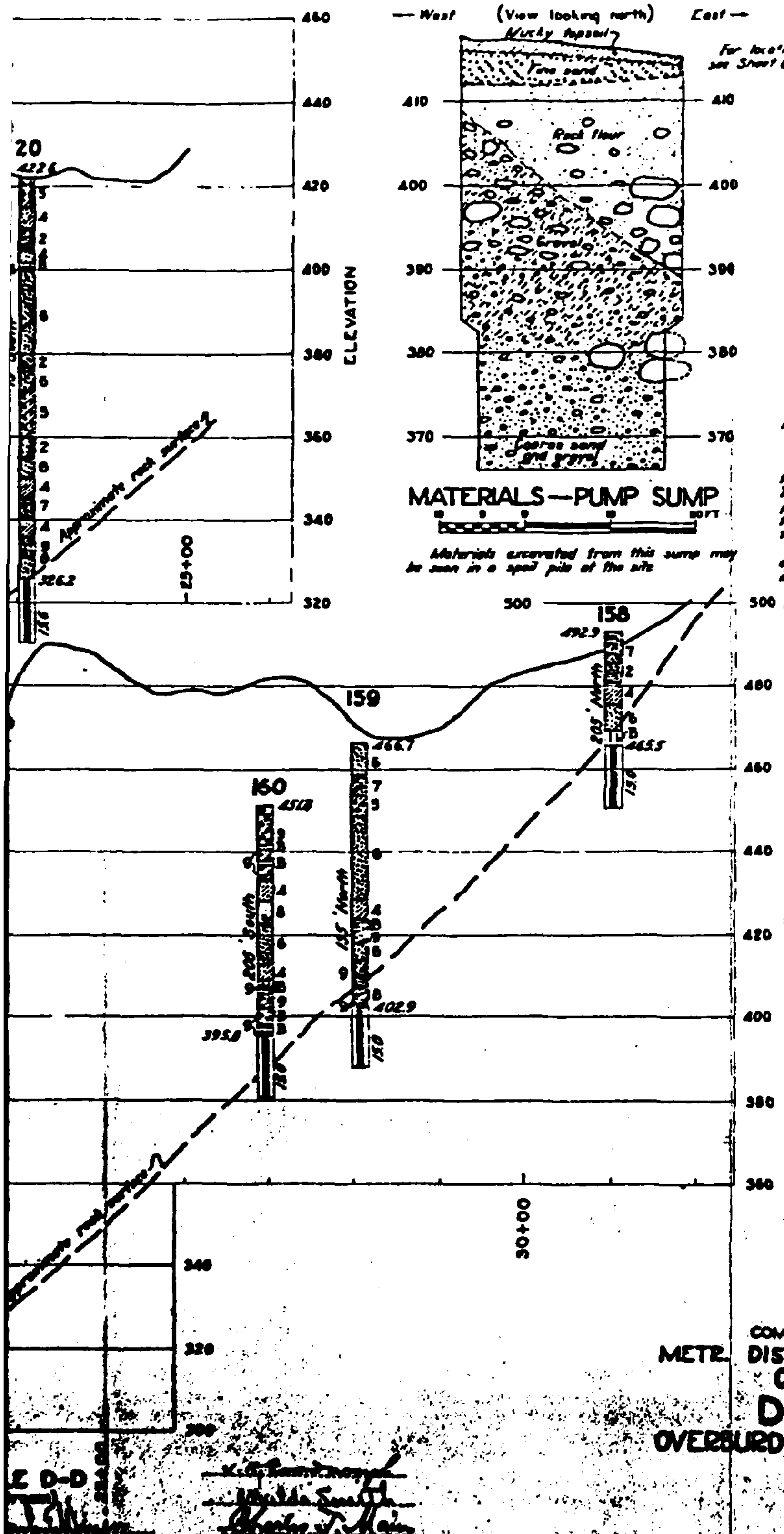
CONTRACT 36 SHEET 8
14 SHEETS IN SET



COMMONWEALTH OF MASSACHUSETTS
METR. DISTR. WATER SUPPLY COMMISSION
QUABBIN RESERVOIR
DIKE CORE WALL
OVERBURDEN-GEOLOGICAL DATA-SHEET 1
SCALES: HORIZONTAL 1" = 100'
VERTICAL 1" = 20'
EXCEPT AS NOTED.
NOVEMBER 4, 1932
Asc. 3908


ELEVATION
STATION
E-E
(Looking north or upstream)
Approximate rock surface
Original surface
DIKE SITE PROFILE D-D
(Looking north or upstream)
Designing Engineer
Chief Engineer

CONTRACT 36 SHEET 9
14 SHEETS IN SET



Notes:
Elevations - Boston City Base
For plan location of borings see Sheet 3 Acc. 3903
Bore hole and test pit samples may be seen at the office of the Engineer at Enfield, Mass.
The geological data shown on this sheet is an interpretation of the samples and is indicative only of the types of materials encountered (see Art. IX of the contract).
Surface of rock as indicated by core borings is approximate only. Actual surface may vary materially from that shown.
Stationing shown on profiles is that of the center line of the dike.
For location of profiles D-D and E-E see Sheet 3
For additional geological data, on profiles A-A, B-B and C-C, and an exploratory caisson, see Sheet 8

LEGEND

- M Muck or peat
- L Loam
- 1 Gravel, uniform
- 2 Coarse sand, uniform
- 3 Coarse sand, variable
- 4 Medium sand, uniform
- 5 Medium sand, variable
- 6 Fine sand, uniform
- 7 Fine sand, variable
- 8 Rock flour or silt, uniform
- 9 Rock flour or silt, variable
- B Boulders
- Rock

"Uniform" means that only a small percentage of the material has particles larger or smaller than the average.
"Variable" means that a considerable number of particles is larger, smaller or both, than the average.
The names given the numbered classes differentiate them according to their relative pervious qualities; and each "variable" class contains a considerable number of larger particles.

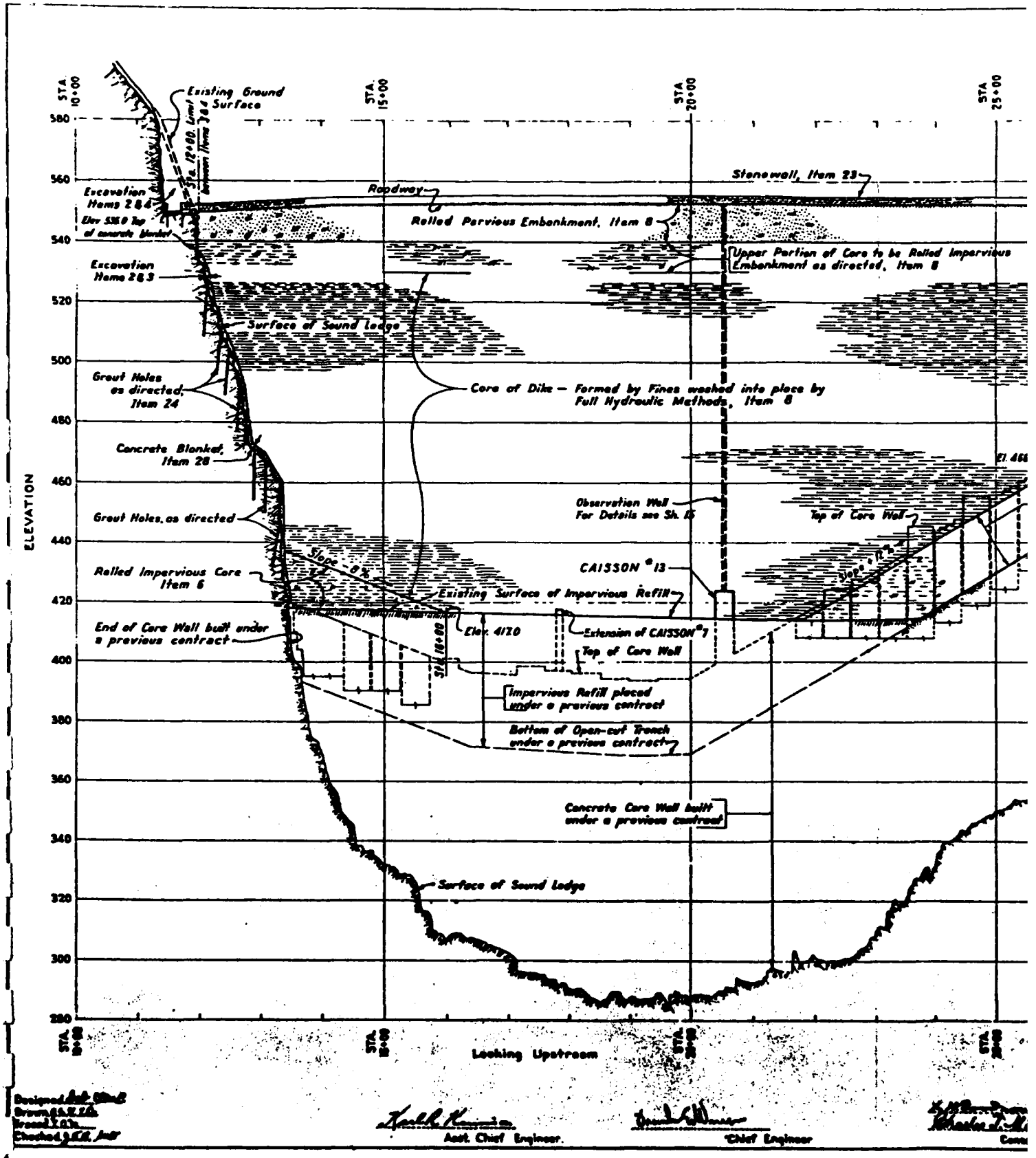
COMMONWEALTH OF MASSACHUSETTS
METR. DISTR. WATER SUPPLY COMMISSION
QUABBIN RESERVOIR
DIKE CORE WALL
OVERBURDEN—GEOLOGICAL DATA—SHEET 2

SCALES {HORIZONTAL 1" = 100, VERTICAL 1" = 20} EXCEPT AS NOTED
NOVEMBER 4, 1932

Chief Engineer — Consulting Engineers

File Case 36-2323 — Acc. 3909

10



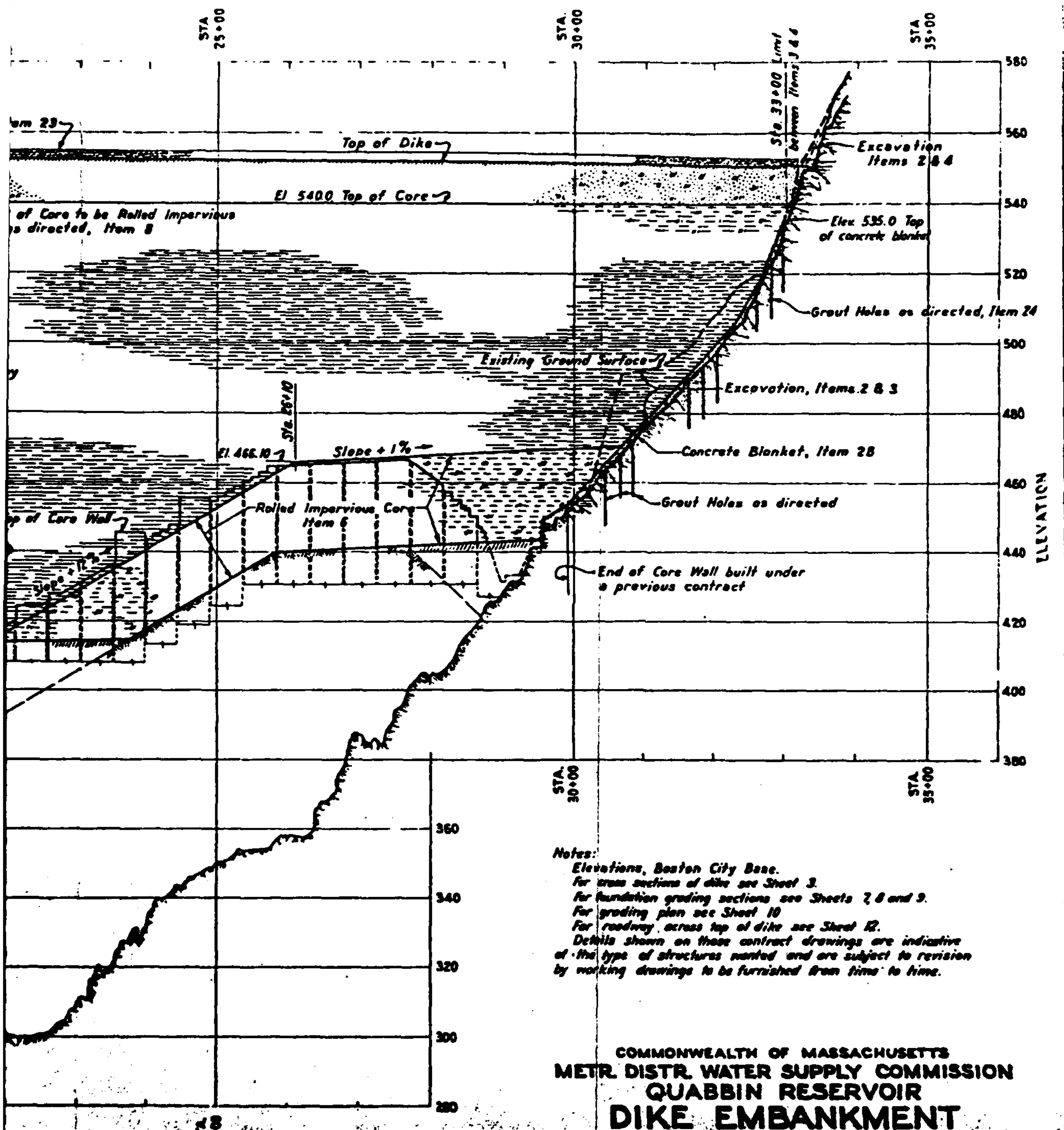
File 4160-B40

Designed
Drawn
Traced
Checked

Asst. Chief Engineer

Chief Engineer

CONTRACT 50 SHEET 4
15 SHEETS IN SET



Notes:
Elevations, Boston City Base.
For cross sections of dike see Sheet 3.
For foundation grading sections see Sheets 7, 8 and 9.
For grading plan see Sheet 10
For roadway across top of dike see Sheet 12.
Details shown on these contract drawings are indicative of the type of structures wanted and are subject to revision by working drawings to be furnished from time to time.

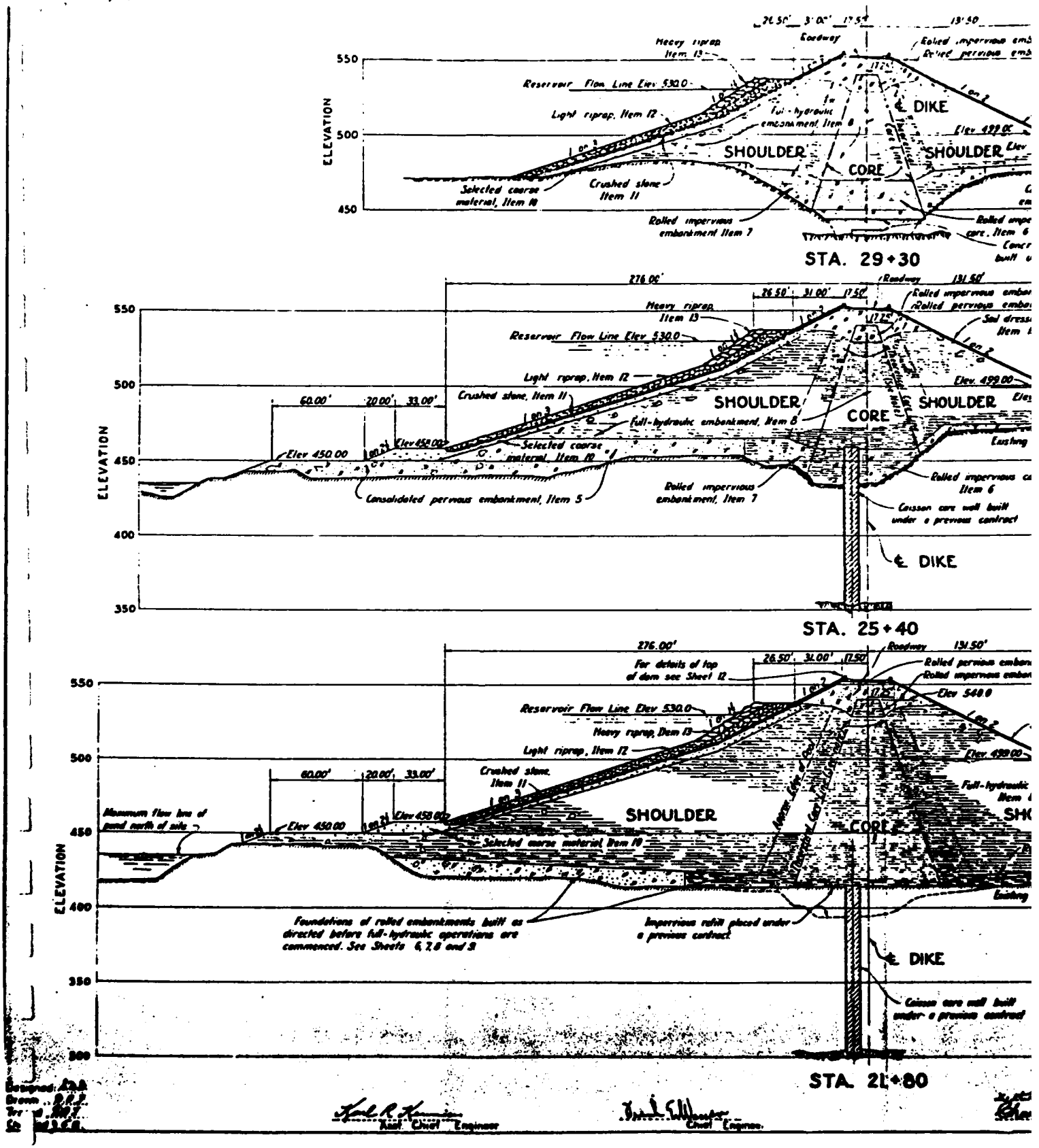
COMMONWEALTH OF MASSACHUSETTS
METR. DISTR. WATER SUPPLY COMMISSION
QUABBIN RESERVOIR
DIKE EMBANKMENT
PROFILE ON CENTER LINE OF DIKE
SCALES { HORIZONTAL 1" = 100' / VERTICAL 1" = 20'
OCTOBER 1, 1934

Charles T. Main
Consulting Engineers

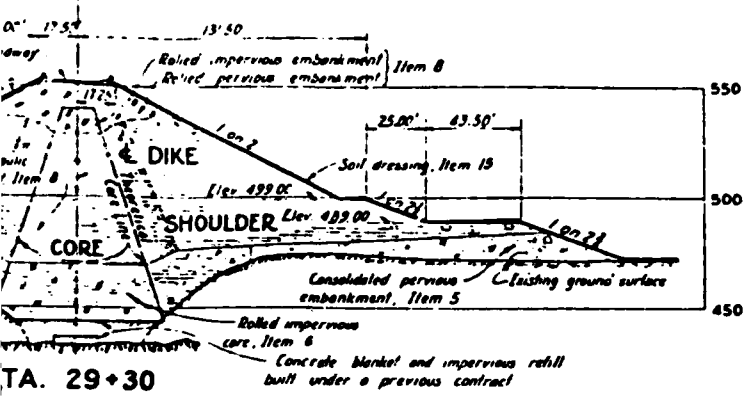
FILE CONT. 50, 2.32 S

APPENDIX B-67

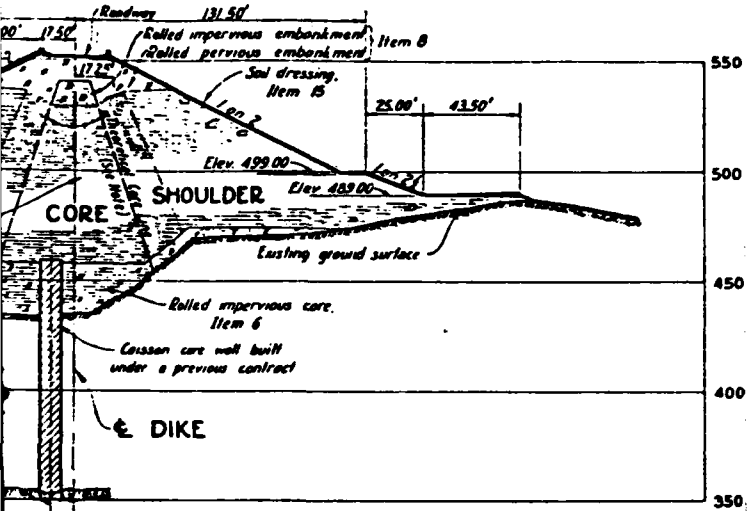
(2)


ELEVATION
550
500
450
Heavy riprap Item 13
Reservoir Flow Line Elev 530.0
Light riprap, Item 12
Selected coarse material, Item 10
Crushed stone Item 11
Rolled impervious embankment Item 7
Roadway
DIKE
SHOULDER
CORE
SHOULDER
STA. 29+30
276.00'
26.50'
31.00'
17.50'
131.50'
Elev 499.00
60.00'
20.00'
33.00'
Crushed stone, Item 11
Full-hydraulic embankment, Item 8
Elev 450.00
Consolidated pervious embankment, Item 5
Caisson core wall built under a previous contract
400
350
STA. 25+40
For details of top of dam see Sheet 12
Elev 548.0
Maximum flow line of pond north of axis
Foundations of rolled embankments built as directed before full-hydraulic operations are commenced. See Sheets 6, 7, 8 and 9
Impervious refill placed under a previous contract
STA. 21+80

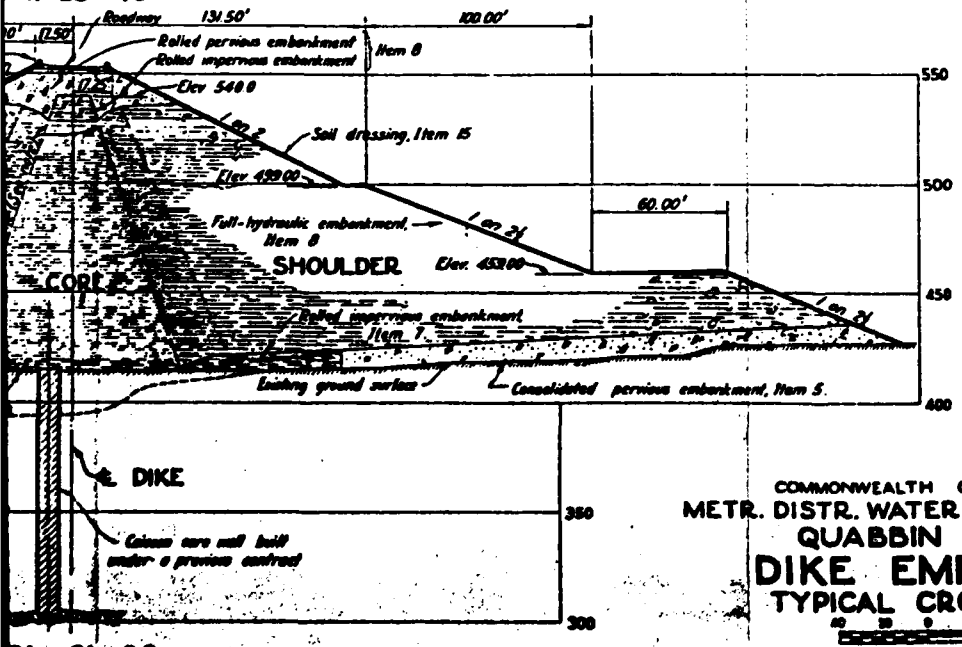
CONTRACT 50 SHEET 3
15 SHEETS IN SET



TA. 29+30



TA. 25+40



TA. 21+80

Note:
The lines marked "Theoretical Core Line" indicate the desired width of cutoff of satisfactory, impervious quality and show the approximate location for the finest materials deposited by the hydraulic work under Item 8.

Notes
Elevations, Boston City Base.
Details shown on these contract drawings are indicative of the type of structures wanted and are subject to revision by working drawings to be furnished from time to time
For plan and sections of foundation embankments see Sheets 6, 7, 8 and 9
For profile of dike see Sheet 4.
For grading plan of dike see Sheet 10
For details of roadway on top of dike see Sheet 12

COMMONWEALTH OF MASSACHUSETTS
METR. DISTR. WATER SUPPLY COMMISSION
QUABBIN RESERVOIR

DIKE EMBANKMENT
TYPICAL CROSS SECTIONS

40 20 0 40 80FT.

OCTOBER 1, 1934

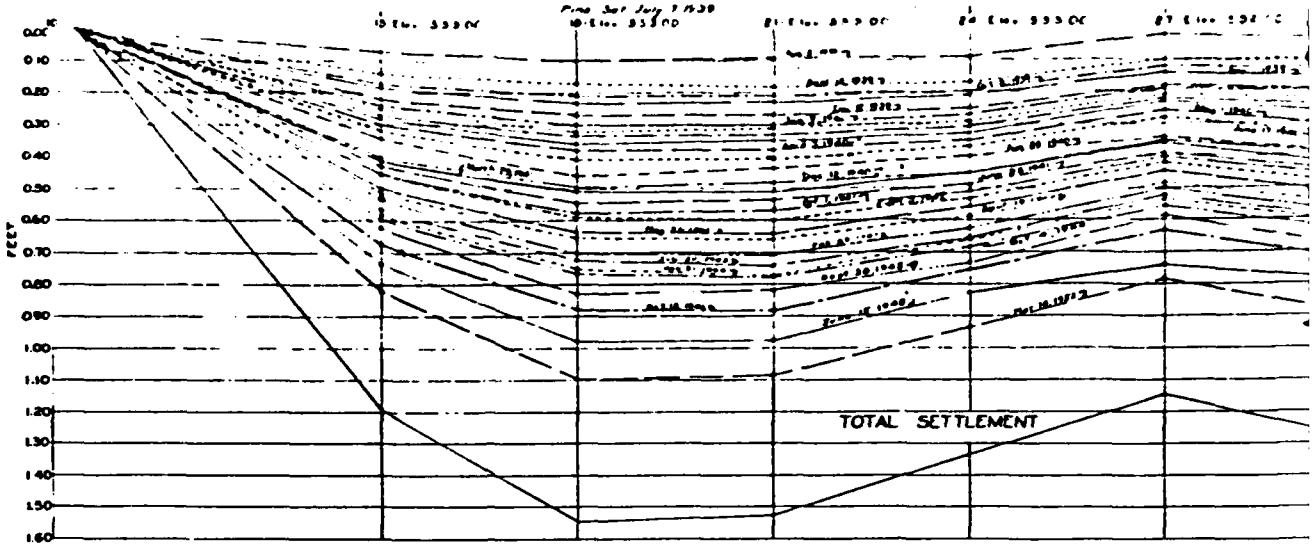
Charles T. Main
Consulting Engineers

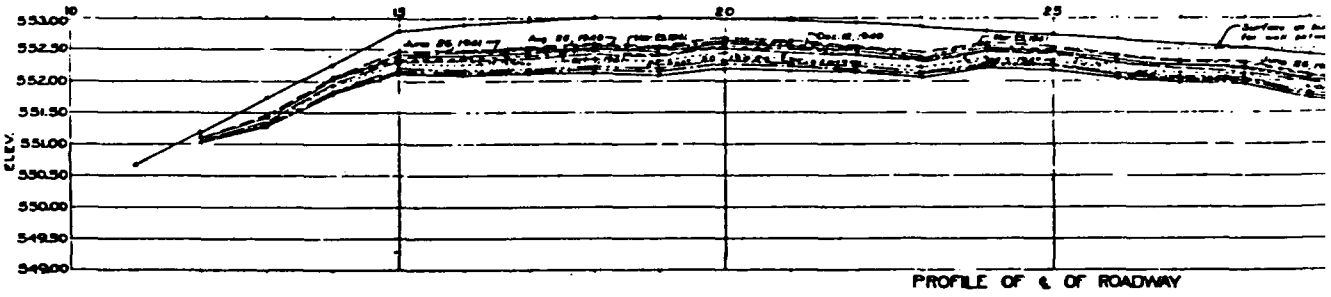
FILE CONT. 30-2.325

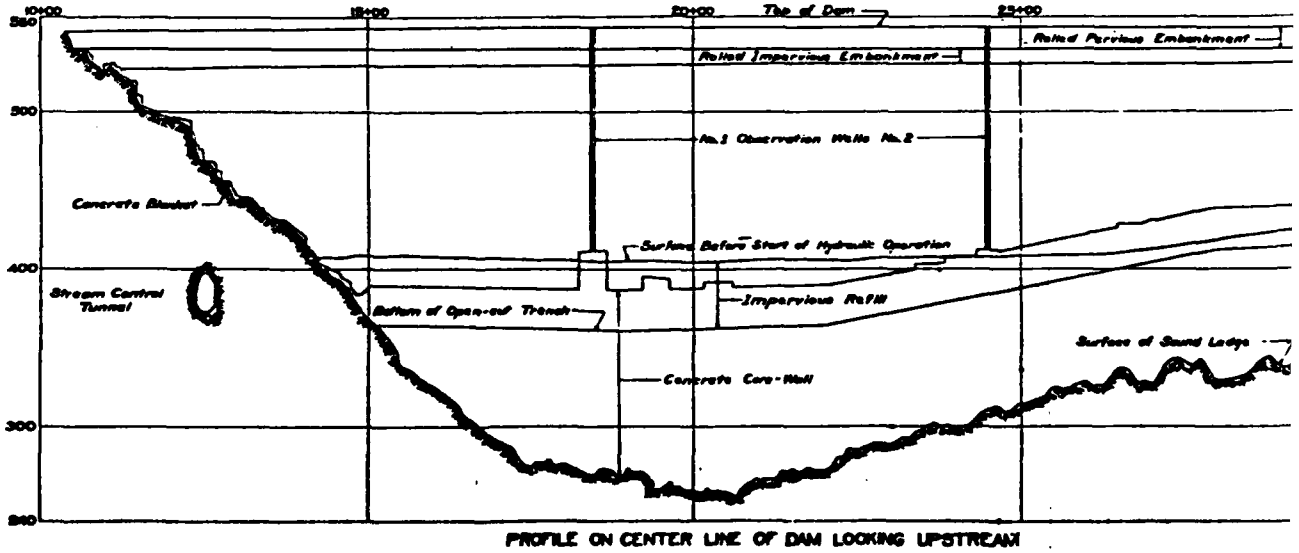
(3)

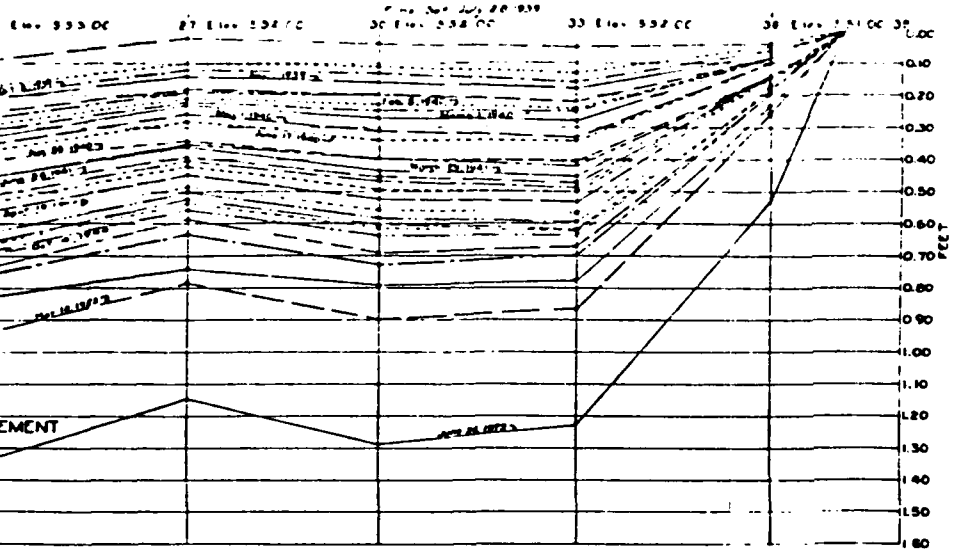
APPENDIX B-68

(2)

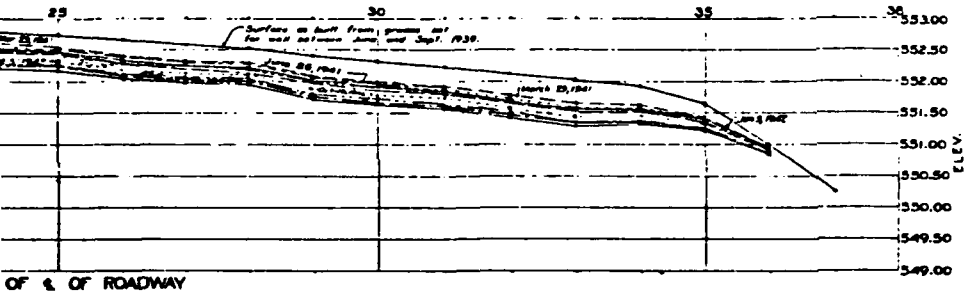

FEET
TOTAL SETTLEMENT

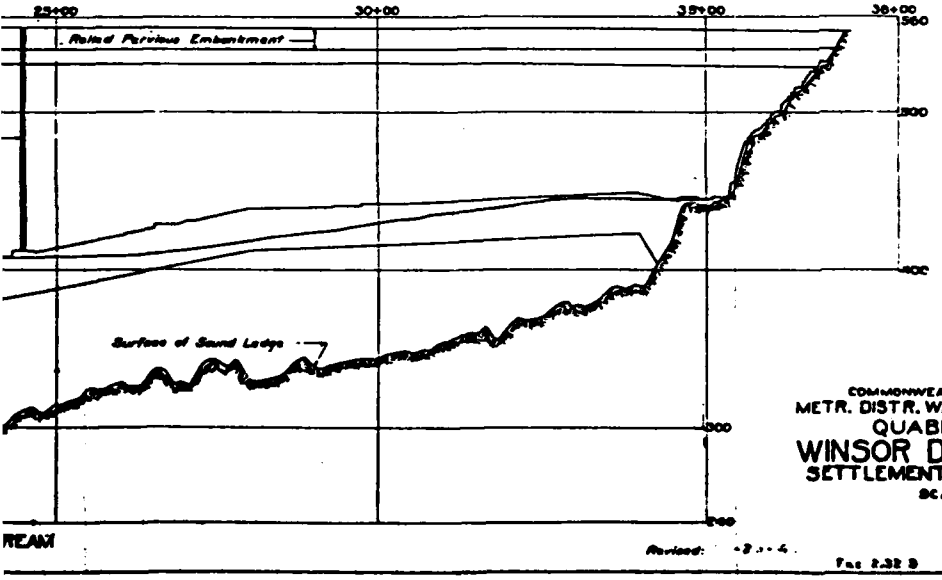

ELEV.
PROFILE OF ℄ OF ROADWAY


Top of Dam
Rolled Impervious Embankment
Rolled Pervious Embankment
No.1 Observation Wells No.2
Concrete Blanket
Surface Before Start of Hydraulic Operation
Stream Control Tunnel
Bottom of Open-cut Trench
Impervious Refill
Surface of Sound Ledge
Concrete Core-Wall
PROFILE ON CENTER LINE OF DAM LOOKING UPSTREAM



LOCATION OF SETTLEMENT PINS	
STATION	OFFSET FROM ℄
15+00	17.0' Lt
18+00	18.5 "
21+00	18.5 "
24+00	18.4 "
27+00	18.5 "
30+00	19.6 "
33+00	18.6 "
36+00	18.6 "





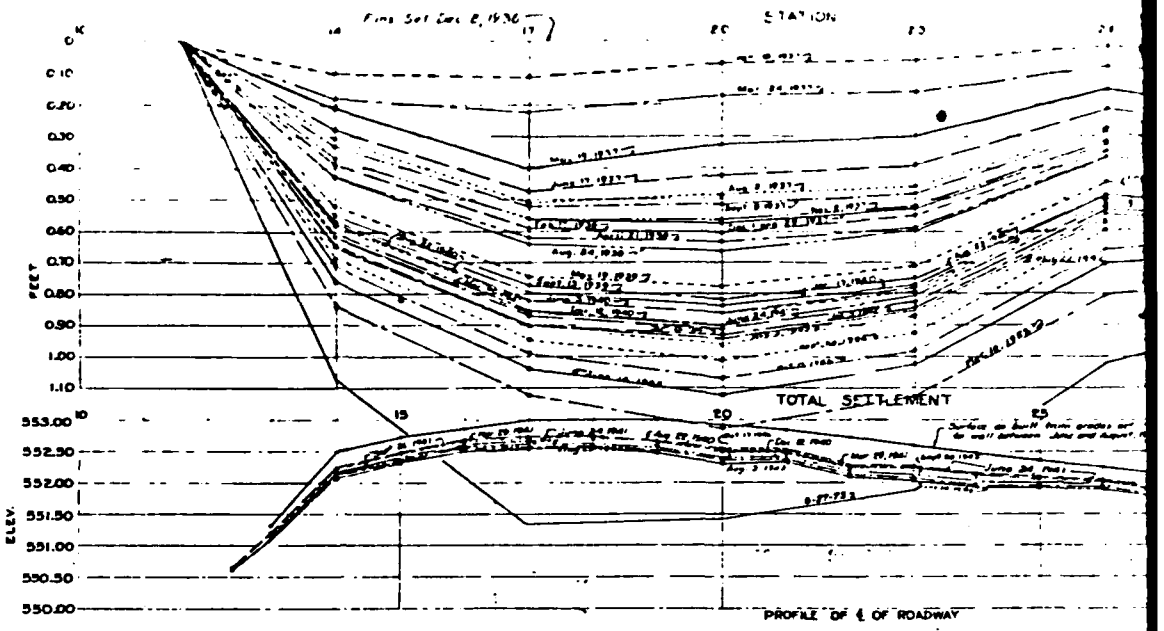
COMMONWEALTH OF MASSACHUSETTS
METR. DISTR. WATER SUPPLY COMMISSION
QUABBIN RESERVOIR
WINSOR DAM-EMBANKMENT
SETTLEMENT OF THE EMBANKMENT
SCALES AS SHOWN
OCTOBER 20, 1940

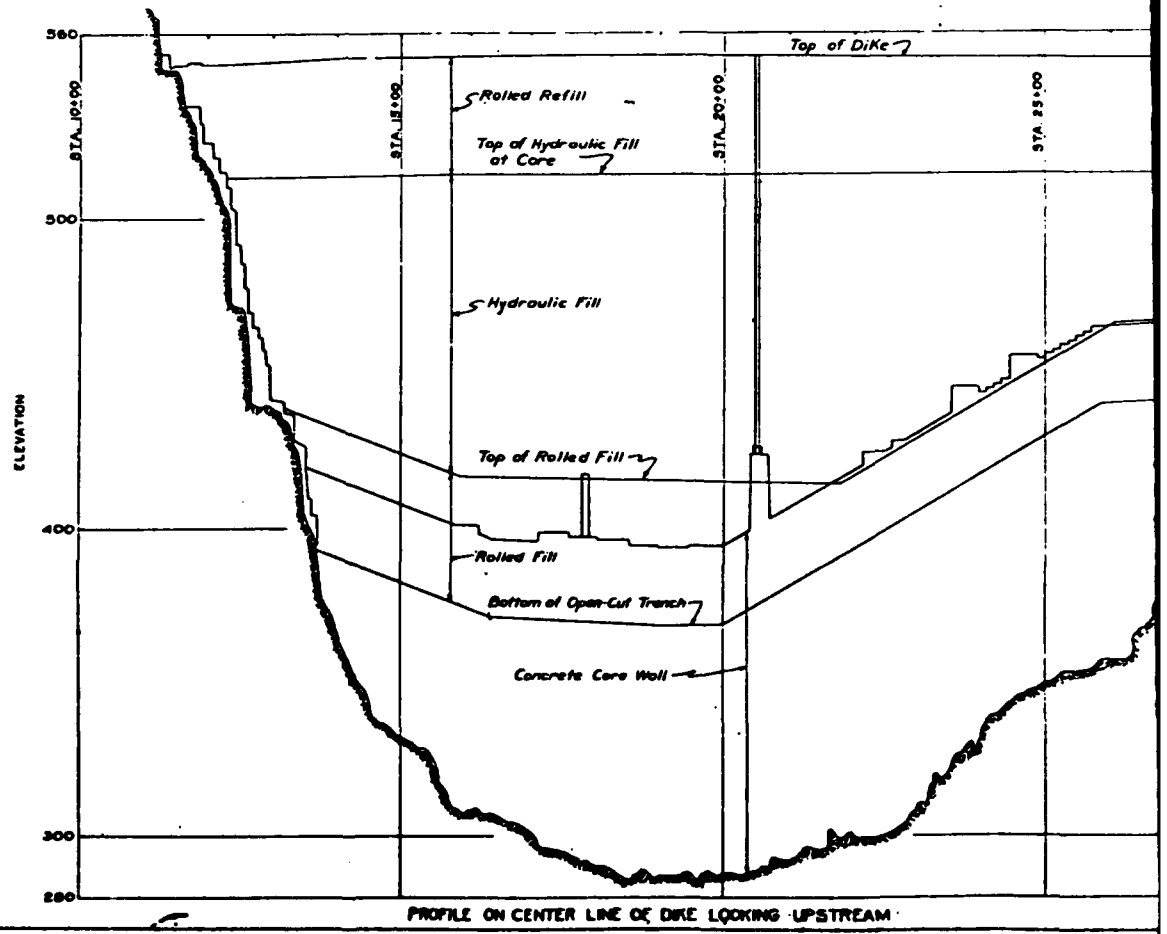
Revised: -2-4-

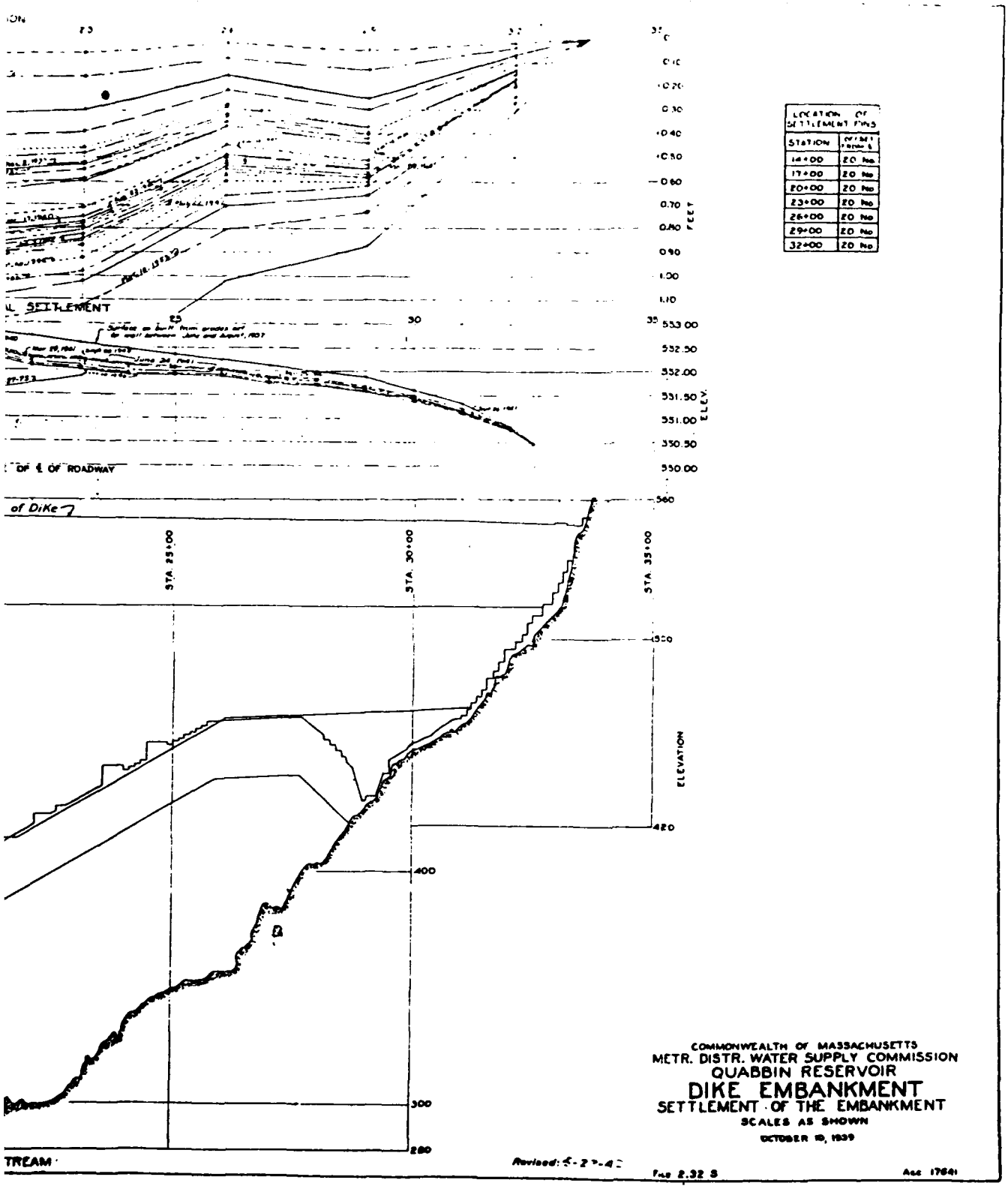
Fig. 2.32 B

Asst. 17792.

File 4160 B31





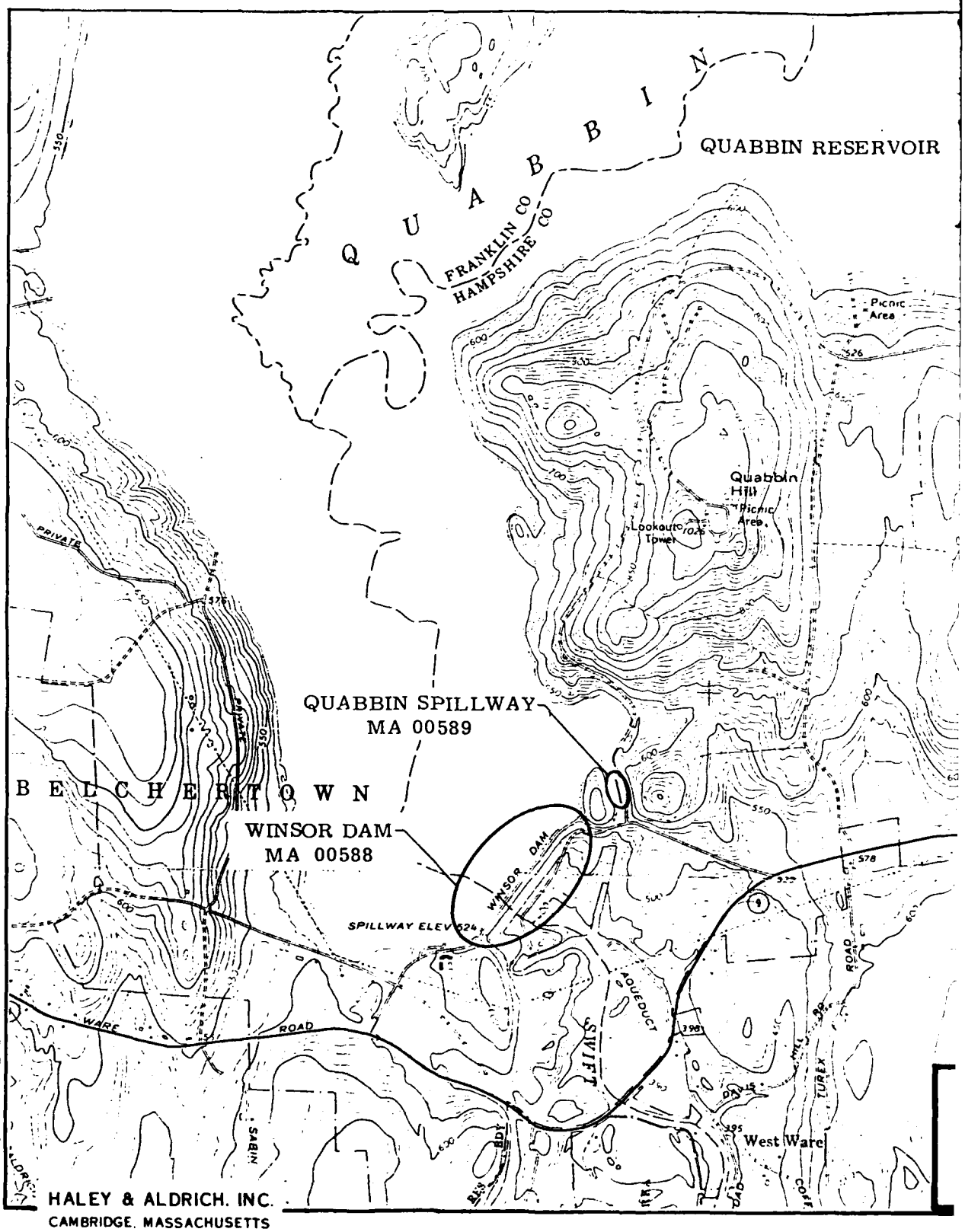

LOCATION OF SETTLEMENT PINS
STATION
POINTS
14+00
17+00
20+00
23+00
26+00
29+00
32+00
20 No.
SETTLEMENT
FEET
ELEV.
552.50
552.00
551.50
551.00
550.50
550.00
OF ℄ OF ROADWAY
of DiKe
STA. 25+00
STA. 30+00
STA. 35+00
ELEVATION
560
500
420
400
300
280
TREAM
COMMONWEALTH OF MASSACHUSETTS
METR. DISTR. WATER SUPPLY COMMISSION
QUABBIN RESERVOIR
DIKE EMBANKMENT
SETTLEMENT OF THE EMBANKMENT
SCALES AS SHOWN
OCTOBER 10, 1939
Revised:
Fig 2.32 S
Acc 17641

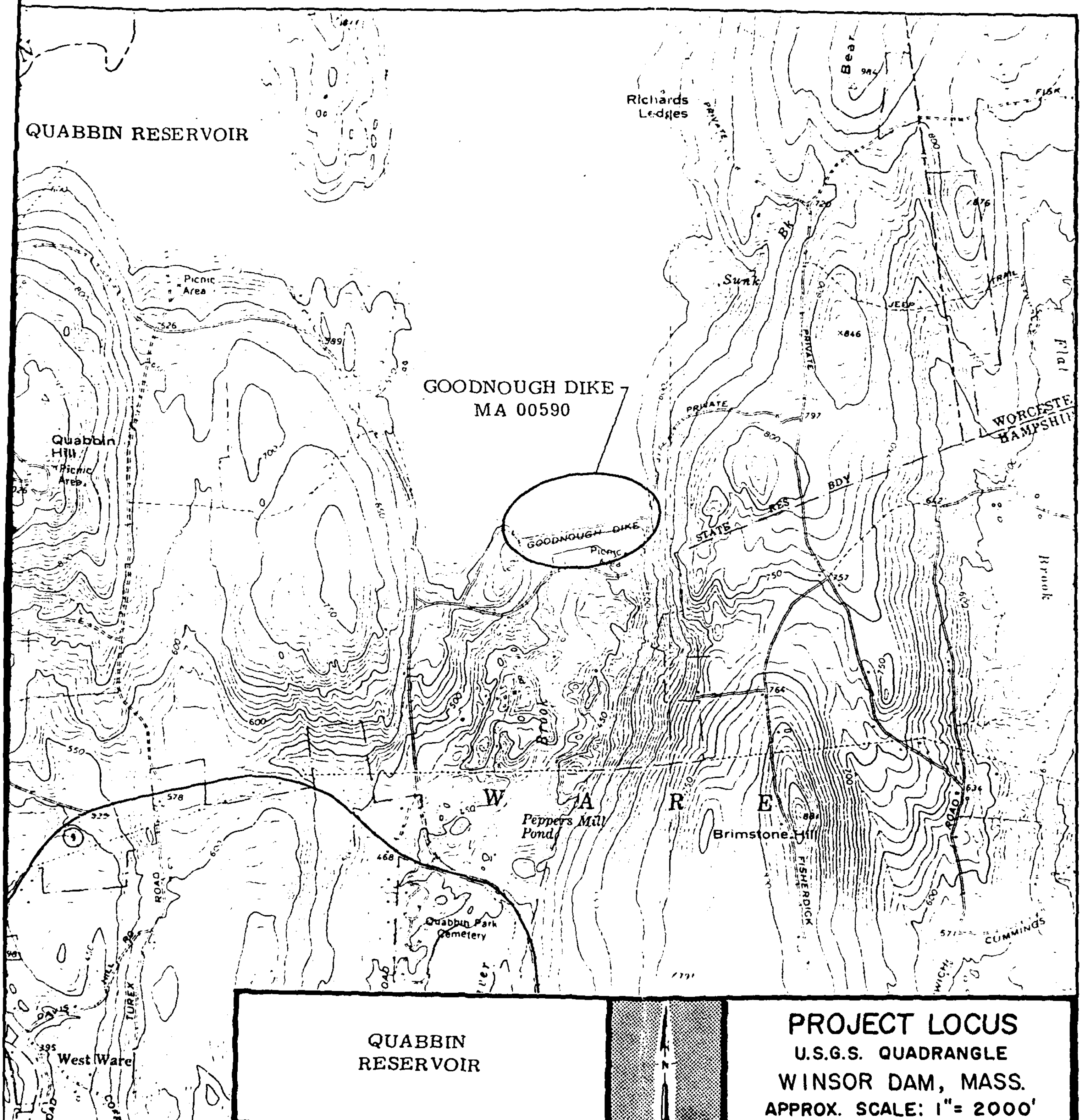
APPENDIX C
SELECTED PHOTOGRAPHS OF PROJECT

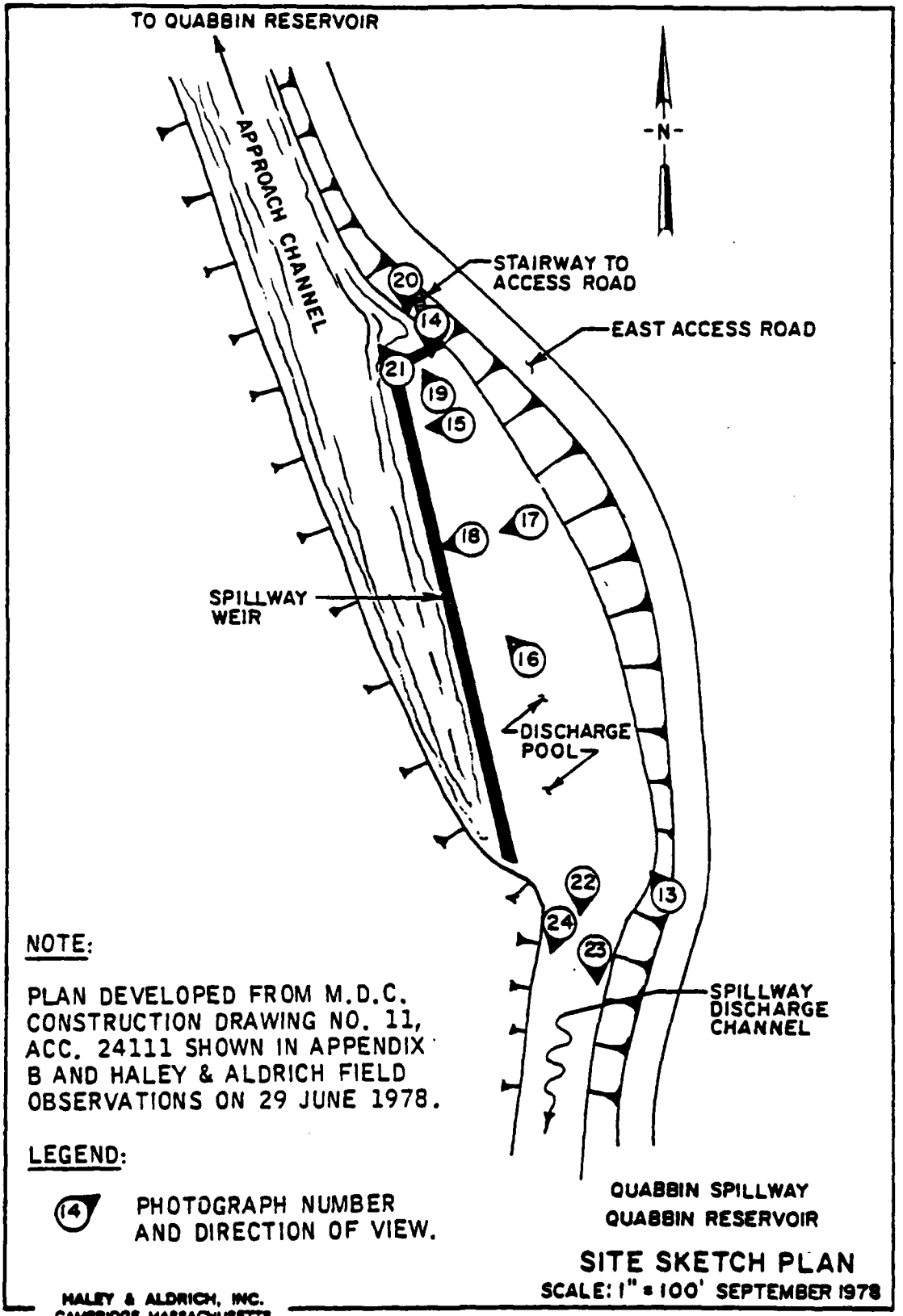
LOCATION PLANS

PHOTOGRAPHS

PHOTOGRAPHS (Continued)


QUABBIN RESERVOIR
Q U A B B I N
FRANKLIN CO
HAMPSHIRE CO
Picnic Area
Quabbin Hill
Picnic Area
Lookout Tower
PRIVATE
QUABBIN SPILLWAY
MA 00589
B E L C H E R T O W N
WINSOR DAM
MA 00588
WINSOR DAM
SPILLWAY ELEV 624
AQUEDUCT
SWIFT
WARE ROAD
ROAD
SABIN
West Ware
FILE NO. 4160 B12
HALEY & ALDRICH, INC.
CAMBRIDGE, MASSACHUSETTS

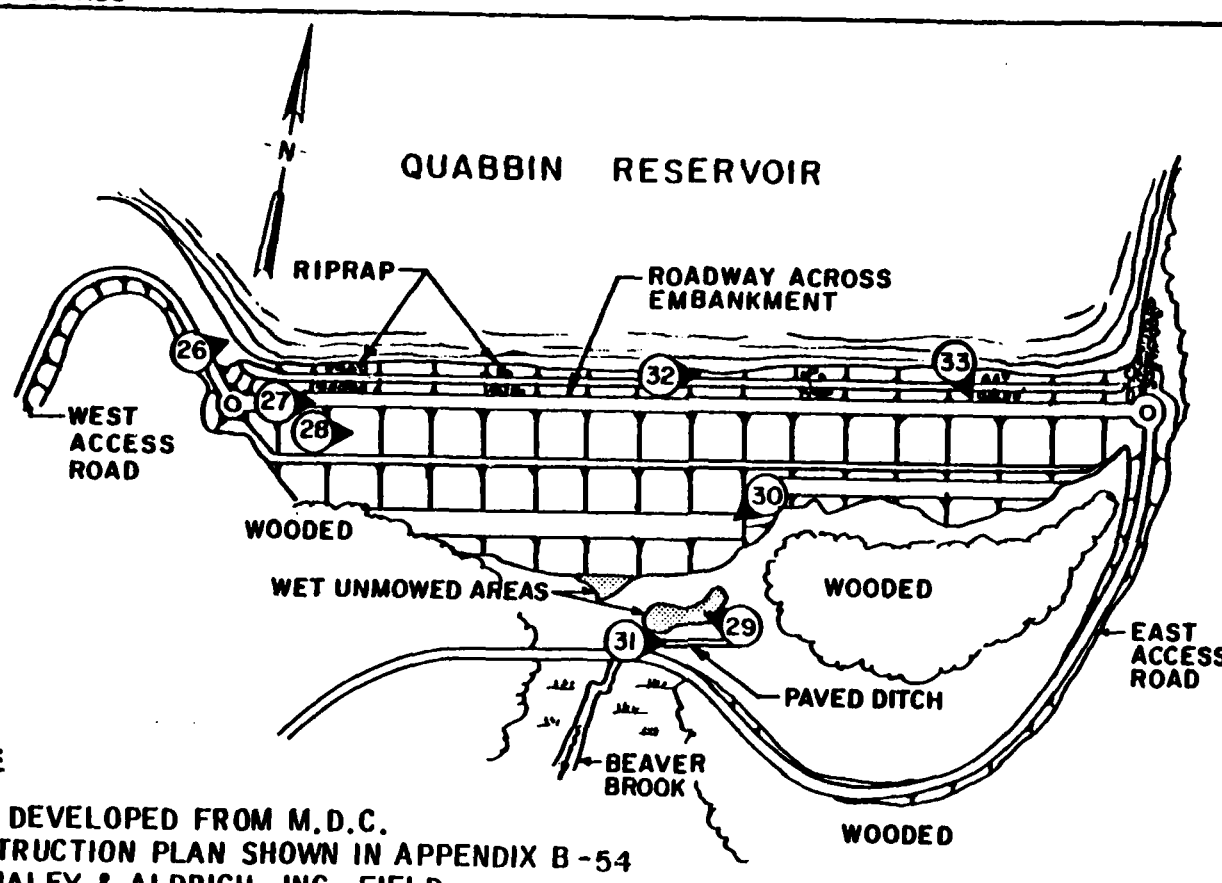

QUABBIN RESERVOIR
Richards Ledges
Bear
Sunk
Bk
GOODNOUGH DIKE
MA 00590
GOODNOUGH DIKE
Picnic Area
Quabbin Hill
Picnic Area
PRIVATE
JEEP
TRAIL
Flat
Brook
WORCESTER
HAMPSHIRE
STATE
RES
BDY
W A R E
Peppers Mill Pond
Brimstone Hill
FISHERDICK
ROAD
Quabbin Park Cemetery
CUMMINGS
TUREX
HILL
ROAD
West Ware
QUABBIN RESERVOIR
N
PROJECT LOCUS
U.S.G.S. QUADRANGLE
WINSOR DAM, MASS.
APPROX. SCALE: 1"= 2000'


TO QUABBIN RESERVOIR
APPROACH CHANNEL
N
STAIRWAY TO ACCESS ROAD
EAST ACCESS ROAD
SPILLWAY WEIR
DISCHARGE POOL
SPILLWAY DISCHARGE CHANNEL
20
14
21
19
15
18
17
16
22
24
23
13
NOTE:
PLAN DEVELOPED FROM M.D.C. CONSTRUCTION DRAWING NO. 11, ACC. 24111 SHOWN IN APPENDIX B AND HALEY & ALDRICH FIELD OBSERVATIONS ON 29 JUNE 1978.
LEGEND:
14 PHOTOGRAPH NUMBER AND DIRECTION OF VIEW.
QUABBIN SPILLWAY
QUABBIN RESERVOIR
SITE SKETCH PLAN
SCALE: 1" = 100' SEPTEMBER 1978
HALEY & ALDRICH, INC.
CAMBRIDGE, MASSACHUSETTS
FILE NO 4160 00 A29

APPENDIX C-2

FILE NO 4160 00 A30

HALEY & ALDRICH, INC.
CAMBRIDGE, MASSACHUSETTS



NOTE:

PLAN DEVELOPED FROM M.D.C. CONSTRUCTION PLAN SHOWN IN APPENDIX B-54 AND HALEY & ALDRICH, INC. FIELD OBSERVATIONS ON 29 JUNE 1978.

LEGEND:

(26) PHOTOGRAPH NUMBER AND DIRECTION OF VIEW.

GOODNOUGH DIKE
QUABBIN RESERVOIR

SITE SKETCH PLAN

SCALE: 1" = 400' SEPTEMBER 1978

APPENDIX C-3

1. Winsor Dam Monument, Located at Right Abutment

2. Downstream Slope, From Left Abutment

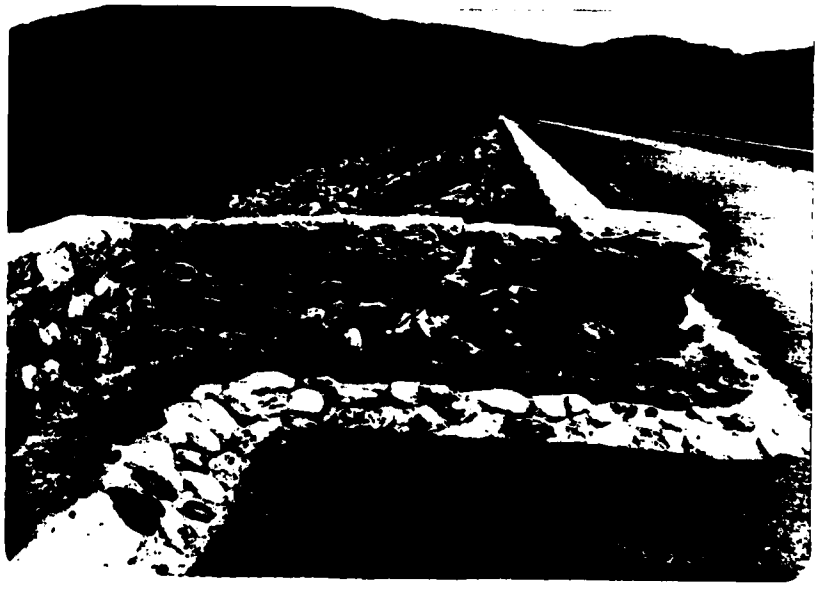
3. Roadway Crest and Downstream Slope, From Right Abutment

4. Upstream Slope Near Left Abutment

5. Upstream Slope From Roof of Intake Structure

6. Entrance to Intake Structure, at Crest of Dam

7. Stone Masonry Walls at Roof Level, Intake Structure



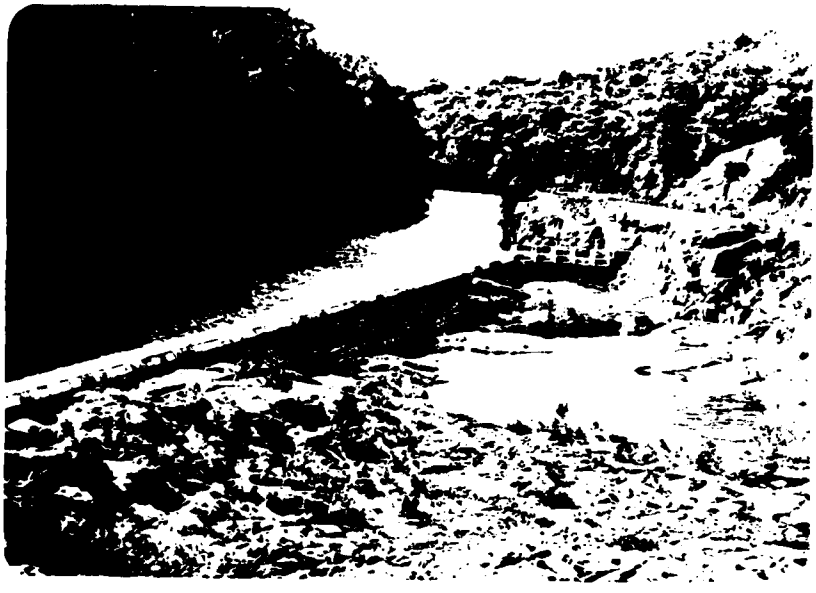
8. Stone Masonry Wall Left of Intake Structure

9. Intake Structure

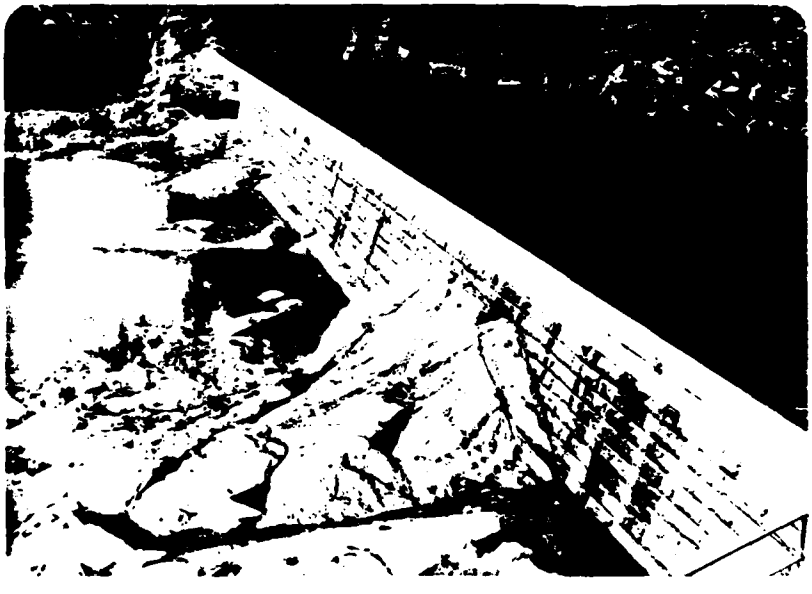
10. Gate and Screens Inside Intake Structure

11. Auxiliary Spillway and Approach Channel, Looking Toward Quabbin Reservoir

12. Crest of Auxiliary Spillway

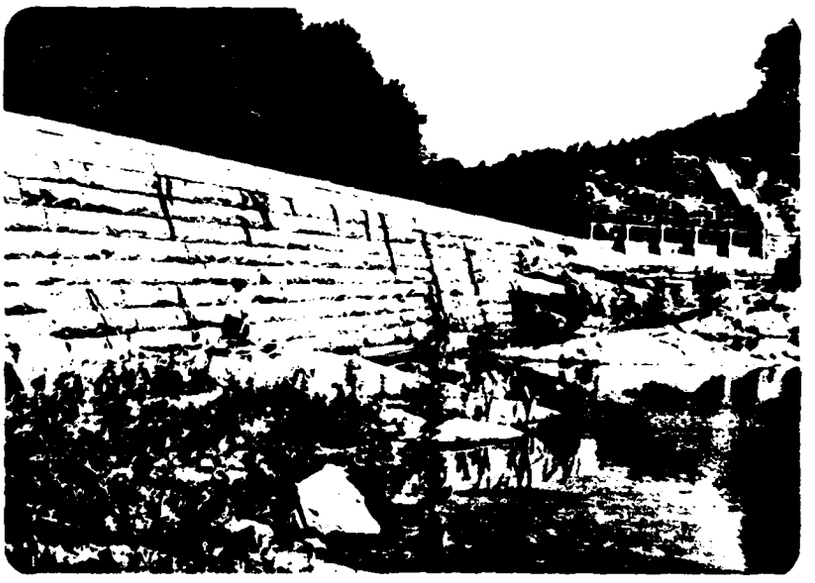


13. Quabbin Spillway, Overall View

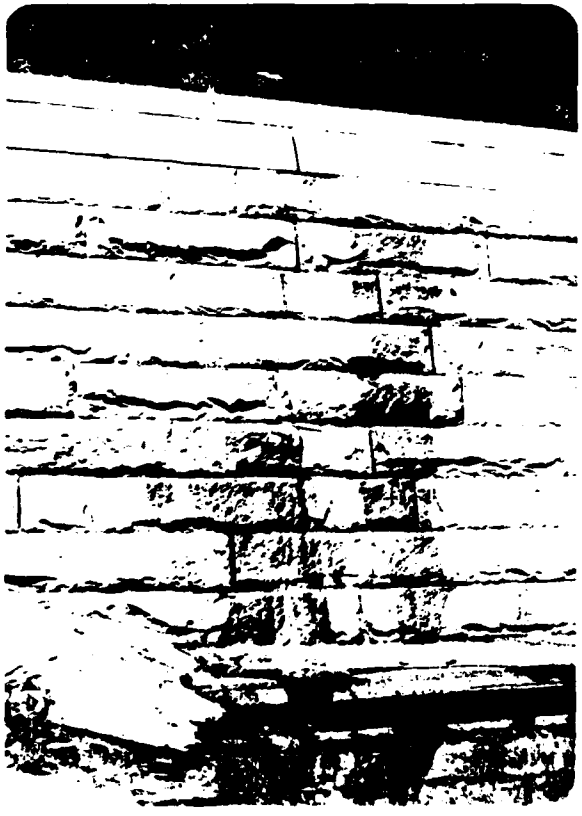


14. Quabbin Spillway Weir

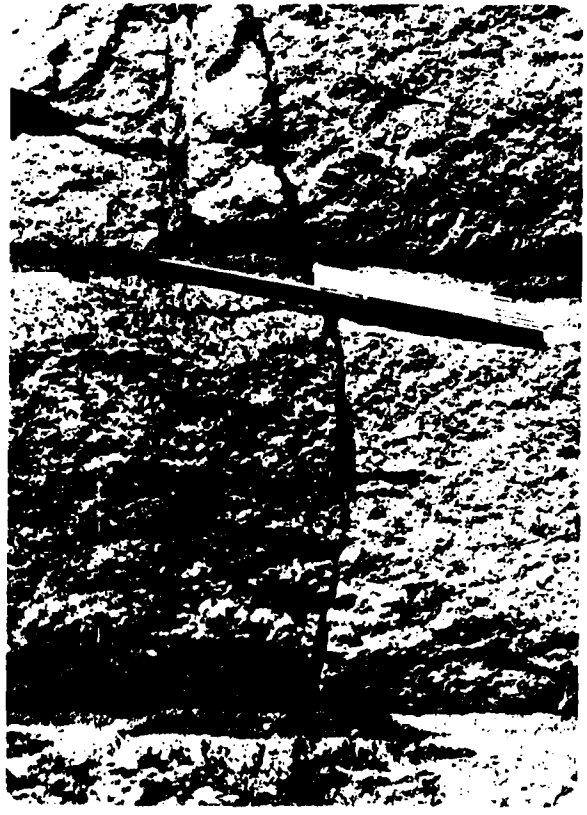
15. Spillway Weir and Bedrock, Water Flowing From Drill Holes



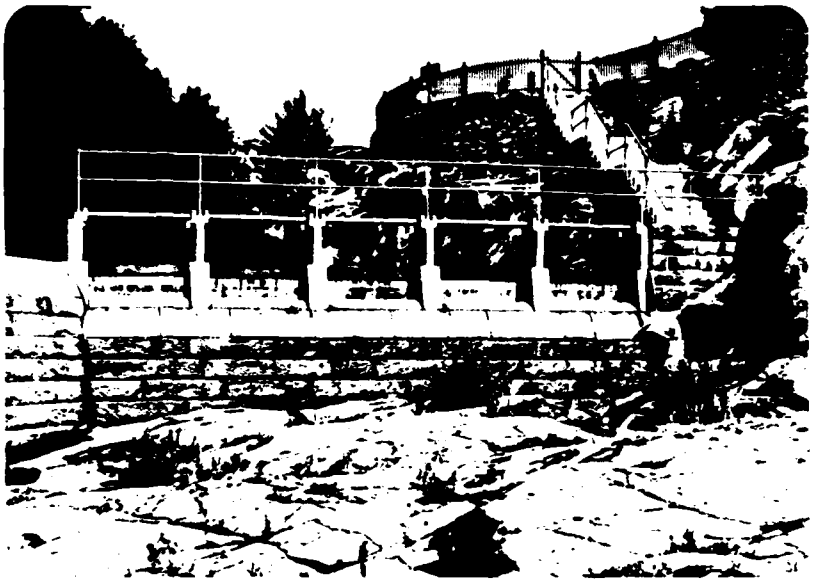
16. Spillway Weir at its Highest Point



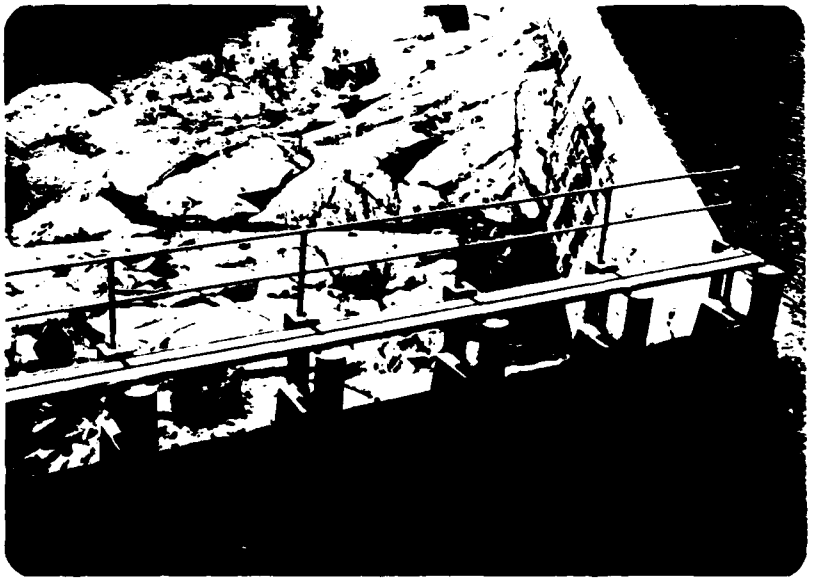
17. Spillway Weir Showing Vertical Crack in Granite Masonry



18. Closeup of Vertical Crack



19. Side Spillway with Stoplogs



20. Side Spillway and Walkway

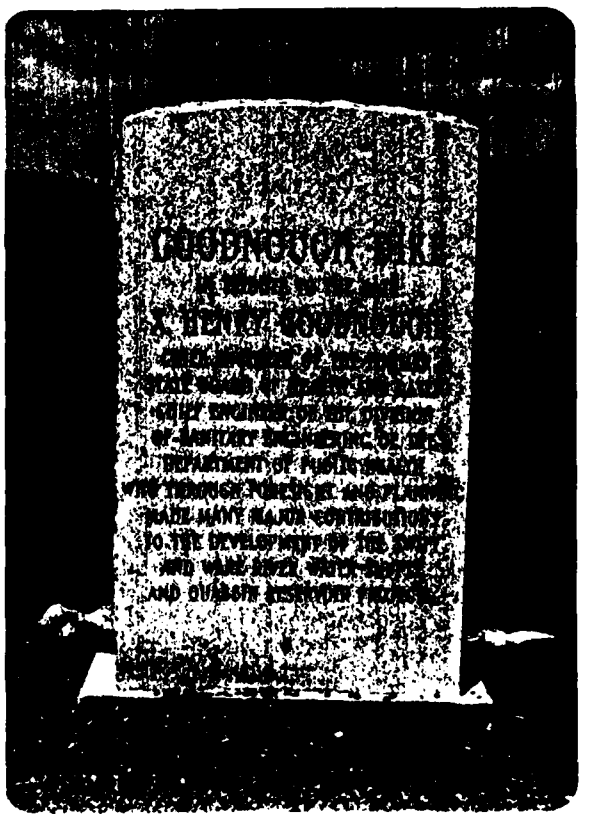
21. Approach Channel to Spillway

22. Discharge Channel From Spillway

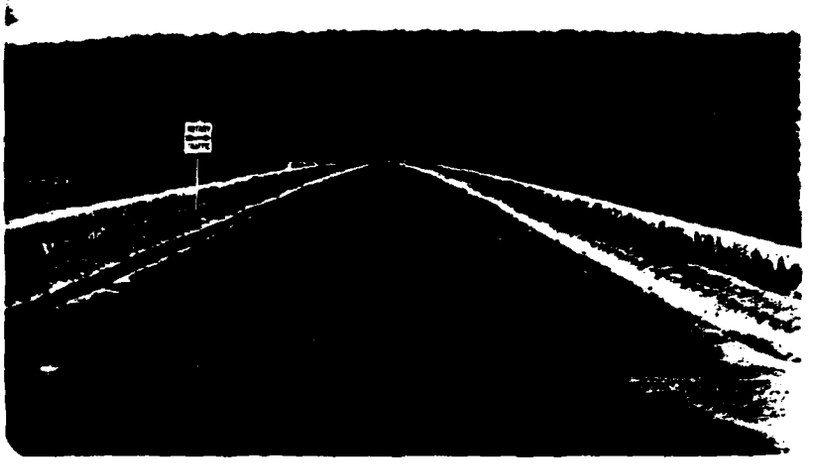
23. Rock Cut at Entrance to Spillway Discharge Channel, Left Side

24. Rock Cut at Entrance to Spillway Discharge Channel, Right Side

25. Spillway Discharge Channel Below Highway Bridge



26. Goodnough Dike Monument



27. Roadway Across Embankment

28. Downstream Slope From Right Abutment

29. Downstream Slope From Near Toe of Dike

30. Unmowed Wet Areas Near Downstream Toe

31. Seepage, Through Paved Ditch, Down-Stream of Wet Areas

32. Upstream Slope

33. Settlement Observation Pipe on Upstream Slope Near Crest of Dike

APPENDIX D
OUTLINE OF DRAINAGE AREA AND HYDRAULIC COMPUTATIONS

CAMP DRESSER & McKEE Inc. **Consulting Engineers** **Boston, Mass.**	N	QUABBIN RESERVOIR DRAINAGE AREA SCALE 1: 250 000

APPENDIX D-1

CAMP DRESSER & McKEE
Environmental Engineers
Boston, Mass.

CLIENT HALEY & ALDRICH
PROJECT NAT'L DAM INSP. GR I
DETAIL QUABBIN SPILLWAY

JOB NO. 361-8-67
DATE CHECKED 9/25/78
CHECKED BY dlbd

PAGE A1
DATE 7-19-78
COMPUTED BY JED

SIZE CLASSIFICATION:

Height = 155'±
Storage = 412 billion gals. } LARGE

HAZARD POTENTIAL CLASSIFICATION:

Estimated loss of life is 2-300 persons

∴ Category is HIGH

TEST FLOOD:

HIGH Hazard & LARGE Size → Test flood = PMF

DRAINAGE AREA: 186 sq. mi. + diversion from Ware River

MAXIMUM PROBABLE FLOOD: (See attached pages B3 thru C13)

PMF INFLOW = 226,800 cfs

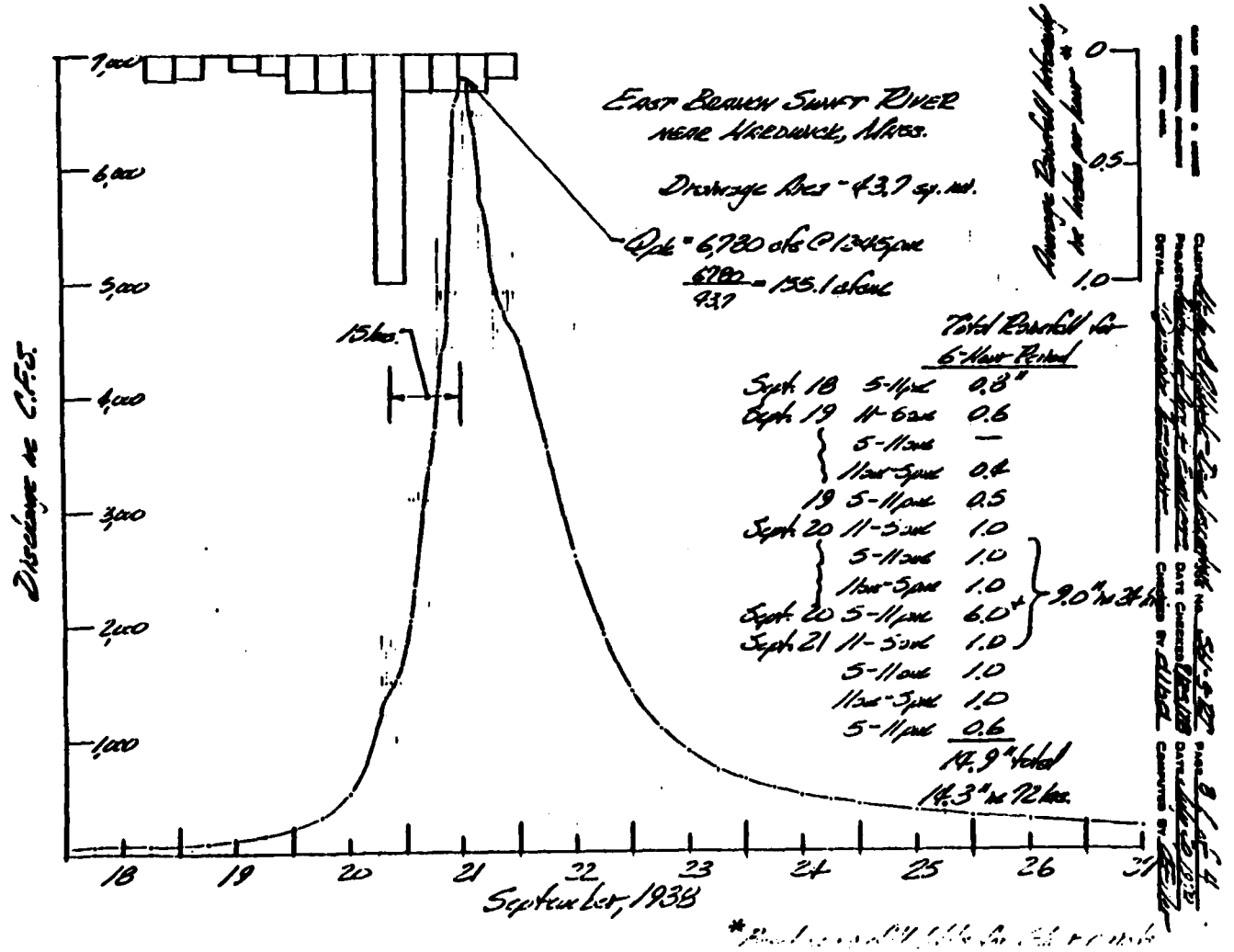
PMF OUTFLOW = 16,300 cfs

HISTORICAL DATA:

Maximum Recorded Spillway Discharge:

1,527 cfs on April 6, 1953

See field notes for other recorded discharge info.


East Branch Swift River
near Hardwick, Mass.
Drainage Area - 43.7 sq. mi.
Qpk = 6,780 cfs @ 1345 sec
6780/43.7 = 155.1 cfsm
15 hrs.
Discharge in C.F.S.
7,000
6,000
5,000
4,000
3,000
2,000
1,000
18
19
20
21
22
23
24
25
26
27
September, 1938
Drainage Basin Rainfall in Inches
0
0.5
1.0
Total Rainfall for 6-Hour Period
Sept. 18 5-11 pm 0.8"
Sept. 19 11-6 am 0.6
5-11 am —
11 am-5 pm 0.4
19 5-11 pm 0.5
Sept. 20 11-5 am 1.0
5-11 am 1.0
11 am-5 pm 1.0
Sept. 20 5-11 pm 6.0+
Sept. 21 11-5 am 1.0
5-11 am 1.0
11 am-5 pm 1.0
5-11 pm 0.6
14.9" total
14.3" in 72 hrs.
9.0" in 24 hrs.

APPENDIX D-3

CAMP DRESSER & McKEE
Environmental Engineers
Boston, Mass.

CLIENT: [illegible] JOB NO.: [illegible] PAGE: [illegible]
PROJECT: [illegible] DATE CHECKED: 9/25/79 DATE: [illegible]
DETAIL: [illegible] CHECKED BY: [illegible] COMPUTED BY: [illegible]

[illegible]

[illegible] of Unit Hydrograph – Storm of September 1938

Date	[illegible]	Base Flow	[illegible]	Unit Hydrograph Ordinate
				0
Sept 18	68 cfs	20 cfs	48 cfs	5.57 cfs
19	120	30	90	10.44
20	720	40	680	78.9
21	4690	50	4640	539.5
22	2750	60	2690	312.3
23	927	70	857	99.5
24	503	80	423	49.1
25	350	90	260	30.2
26	267	100	167	19.4
27	220	110	110	12.8
28	225	120	85	9.86
29	186	130	56	6.50
30	159	140	19	2.21

[illegible] (beside the Sept 22 row)

6790 / 437 = [illegible] (beside the Sept 26 and 27 rows)

Σ = 10125 cfs-day

Volume of Runoff = 10125 cfs-day (60)(60)(24) = 874,800,000 ft³

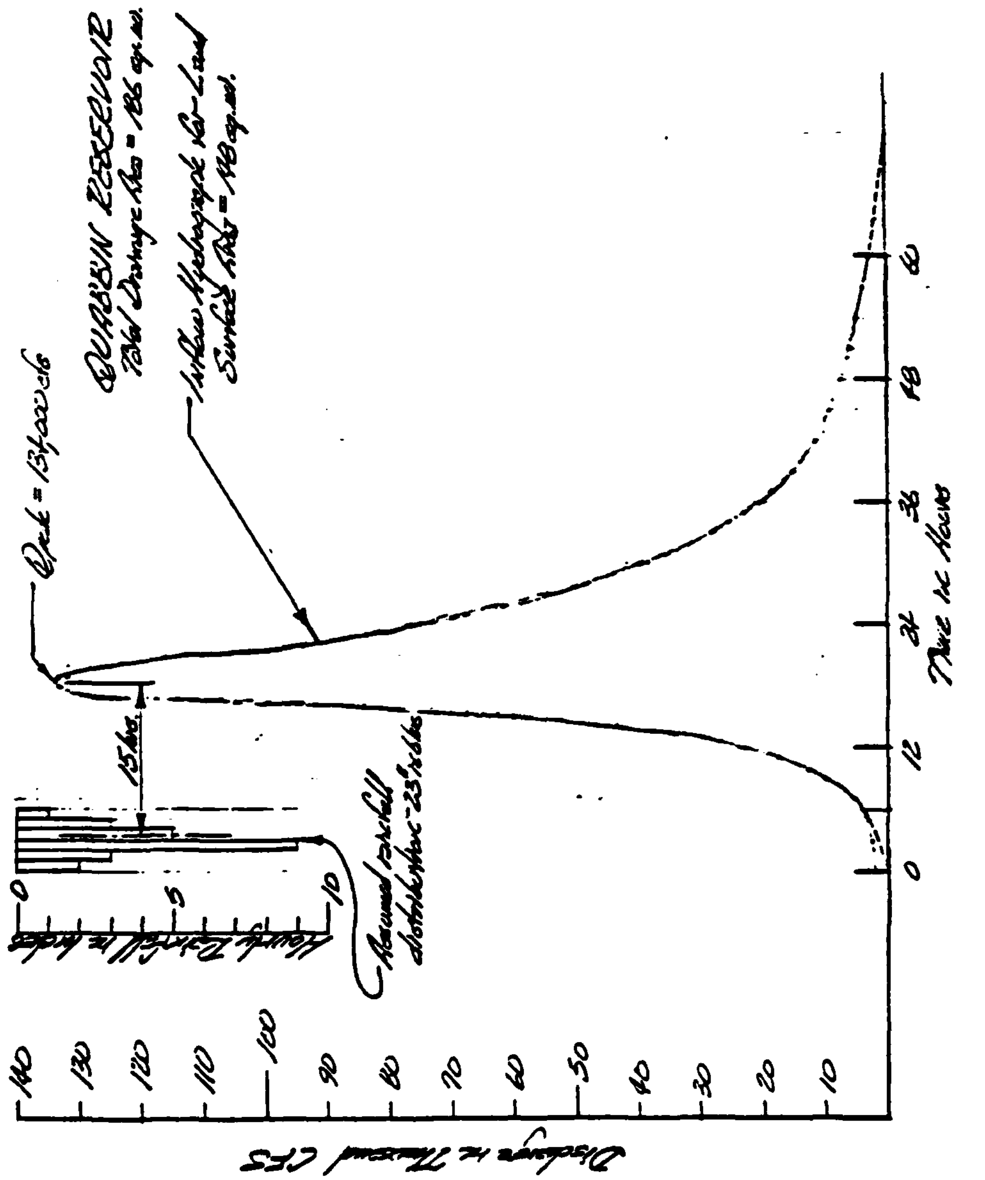
$$\text{Runoff} = \frac{874{,}800{,}000\ \text{ft}^3}{(437\ \text{sq mi})\left(\frac{5280}{\text{mi}}\right)^2} = 0.0718' = .862\ \text{in}$$

The September 1938 storm had the following [illegible] frequencies:

Total in.	Time	Frequency
6.0+	6 hr	> 1000 yr
9.0	24 hr	> 1000 yr
14.3	72 hr	> 1000 yr

APPENDIX D-4

CLIENT ... JOB NO. ... PAGE B-3 of 4
PROJECT ... DATE CHECKED ... DATE ...
DETAIL ... CHECKED BY ... COMPUTED BY ...



CAMP DRESSER & McKEE
Environmental Engineers
Boston, Mass.

CLIENT [illegible] JOB NO. [illegible] PAGE [illegible]
PROJECT [illegible] DATE CHECKED 9/25/78 DATE [illegible]
DETAIL [illegible] CHECKED BY [illegible] COMPUTED BY [illegible]

[illegible]

Drainage Area = 165 sq. mi.

Reservoir [illegible] Area = [illegible]

Land [illegible] = 165 - 3.86 = 161.4 [illegible] = [illegible] sq. mi.

PMP = 23" in 6 hrs

[illegible] = 23" (Total)

Duration	Factor	
6 hr	[illegible]	16.1"
12 hr	[illegible]	19.0"
24 hr	[illegible]	21.2"

Consider the impact of [illegible] rainfall on reservoir
water surface: only concerned with hydrograph [illegible]
[illegible] surface area

1 2 6 [illegible] 1 Σ = [illegible]
2 3 9 5 3 1 Σ = 23"

	Time in Hours	Assumed Rainfall Distribution (inches)	ft	Reservoir Water Surface Area = [illegible]	Inflow Volume Attributable to Rainfall on Reservoir	Inflow [illegible]
[illegible]	0	0	0	[illegible]		0
24,750	1	2	0.167	1,029,100,000	179,507,[illegible] ft³	49,863 cfs
24,800	2	3	0.250	1,0[illegible],200,000	269,799,750	74,944
24,850	3	9	0.750	1,08[illegible],444,000	811,833,750	225,[illegible]
24,900	4	5	0.417	1,08[illegible],644,000	451,[illegible]	125,51[illegible]
24,950	5	3	0.250	1,08[illegible],000	271,[illegible]	75,[illegible]
25,000	6	1	0.083	1,0[illegible],000,000	90,[illegible]	25,1[illegible]
	7	0	0			0

Total 23" 1.917'

CAMP DRESSER & MCKEE
Environmental Engineers
Boston, Mass.

CLIENT [illegible] JOB NO. [illegible]
PROJECT [illegible] DATE CHECKED 9/25/78
DETAIL [illegible] CHECKED BY dlbd

PAGE [illegible]
DATE [illegible]
COMPUTED BY [illegible]

[illegible]

CAMP DRESSER & McKEE Environmental Engineers Boston, Mass. — CLIENT [illegible] JOB NO. [illegible] PAGE [illegible]
PROJECT [illegible] DATE CHECKED 9/25/78 DATE [illegible]
DETAIL [illegible] CHECKED BY [illegible] COMPUTED BY [illegible]

Spillway Channel [illegible]

H = 1.0'
Assume Q = 1516 cfs WS @ spillway = 531.0

Channel depth = 531.0 − 514.0 = 17.0'

Channel area = 1063.4 ft² ∴ Channel velocity = 1516 cfs / 1063.4 ft² = 1.319 fps

$\frac{V^2}{2g} = 0.031'$

∴ EGL = 531.0 + 0.03 = 531.03'

Assume ave. vel. in approach channel = 1.25 fps = V

Then, $h_f = \left[\frac{1.25 \times 0.02}{1.486 (11.366)^{2/3}}\right]^2 \times 100 = 0.00455'$ n = 262, $R = \frac{1063.4}{60 + 2(17)} = 11.366$

Then EGL @ reservoir = 531.03 + 0.005 = 531.035 $C = \frac{1516}{[illegible] (1.035)^{3/2}}$

C = 3.583 / 1.035
C = 3.913 / 4.005

H = 1.5'
Assume Q = 2870 cfs WS @ spillway = 531.5

Channel depth = 531.5 − 514.0 = 17.5'

Channel area = 1101.2 ft² ∴ Channel velocity = 2870 cfs / 1101.2 ft² = 2.606 fps

$\frac{V^2}{2g} = 0.105'$

∴ EGL = 531.5 + 0.105' = 531.605'

Assume ave. vel. in approach channel = 2.45 fps = V

Then, $h_f = \left[\frac{2.45 \times 0.02}{1.486 (11.52)^{2/3}}\right]^2 \times 100 = 0.0174'$ n = 252, $R = \frac{1101.2}{60 + 2(17.5)} = 11.52$

Then EGL @ reservoir = 531.605 + 0.017 = 531.622 $C = \frac{2870}{[illegible] (1.622)^{3/2}}$

C = 3.733 / 1.622
C = 3.774 — 1.5174

CAMP DRESSER & McKEE
Environmental Engineers
Boston, Mass.

CLIENT _____ JOB NO. _____ PAGE _____
PROJECT _____ DATE CHECKED 9/25/78 DATE _____
DETAIL _____ CHECKED BY _____ COMPUTED BY _____

APPENDIX D-9

CAMP DRESSER & McKEE
Environmental Engineers
Boston, Mass.

CLIENT [illegible] JOB NO. [illegible] PAGE [illegible]
PROJECT [illegible] DATE CHECKED 7/25/78 DATE [illegible]
DETAIL [illegible] CHECKED BY dlbd COMPUTED BY [illegible]

H = 3.0
Assume Q = 7525 cfs   U.S.G. spillway = 533.0

Channel depth = 533.0 − 514.0 = 19.0'

Channel area = 1200 ft² ∴ Channel velocity $= \frac{7525}{1200} = 6.27$ fps

$\frac{V^2}{2g} = 0.610'$

∴ ES1 = 533.0 + 0.61 = 533.61'

Assume avg. vel. in approach channel = 5.9 fps = $\bar{V}$

n = 0.02

Then, $h_f = \left[\frac{5.9 \times 0.02}{1.486 (12.218)^{2/3}}\right]^2 \times 620 = 0.0938'$

$R = \frac{1200}{50 + 2 \times 19} = 12.218$

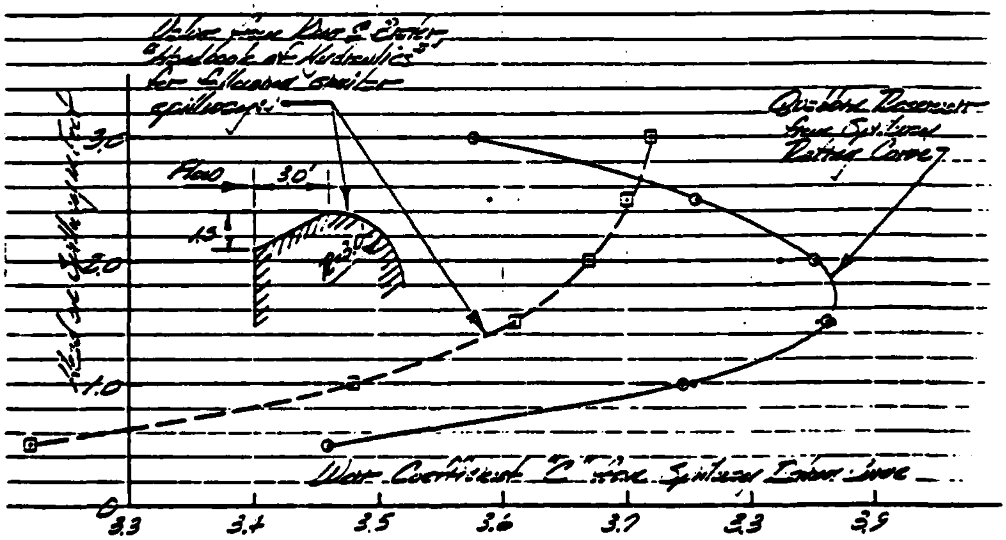
Then ES1 2 [illegible] = 533.61 + 0.094 = 533.704

APPENDIX D-10

Spillway Coefficients

$Q = 3.1\,L\,H^{3/2} = C(104.67)H^{3/2}$ (270+34.67)

W.S. Elev.	Discharge	Computed "C"
530.0	0	—
530.5	465	3.660
531.0	1516	3.766
531.5	2970	3.941
532.0	4410	3.853
532.5	6010	3.757
533.0	7525	3.579



CAMP DRESSER & McKEE
Environmental Engineers
Boston, Mass.

CLIENT [illegible] JOB NO. 541-9-270 PAGE [illegible]
PROJECT [illegible] DATE CHECKED 9/26/78 DATE [illegible]
DETAIL [illegible] CHECKED BY [illegible] COMPUTED BY [illegible]

Extrapolation of Spillway Rating Curve

Because the "C" coefficient as determined from the [illegible] Reservoir Spillway Rating Curve between Elev 530.0 and 533.0 reaches a maximum at H=1.7 ft before decreasing to 3.579 @ H=3.0, we must give the [illegible] engineer the benefit of the doubt and assume the coefficient "C" represents characteristics of this overflow spillway. Since the only point given above H=3.0' is Q=15,000 cfs for H=6.0 (Elev 536.0) we will adopt this and assume straight line between as follows:

U.S. Elev	Discharge	Calculated Coef "C"
533.0	9525 cfs	3.579
533.5	8760	3.306
534.0	10,000	3.089
534.5	11,240	2.910
535.0	12,480	2.758
535.5	13,740	2.632
536.0	15,000	2.522
536.5	16,280	2.428
537.0	17,500	2.335

than would require a larger rock cut, but the material quarried from this cut can be used for riprapping the upstream face of the dam.

The drainage area of the reservoir is that of the watersheds of the three branches of the Swift River, west, middle and east, and the drainage slopes of all three are largely brush land and woodland. Those of the west branch are much steeper than those of the other two, which are steep only at the headwaters and which are much more moderate below. Records of past floods indicate that the west branch yields its run-off quickly. Most of the flood flow from that branch passes the site of the Dam before the flows from the east and middle branches arrive. This condition gives a flood flow curve which has a flat peak of long duration. The maximum flood peak for the period of record of 21 years at the West Ware gaging station near the Main Dam site is about 2,300 cubic feet per second and occurred April, 1923, or about 13 cubic feet per second per square mile. This peak lasted, roughly, three days. The largest New England flood of record in recent years occurred in November, 1927, and was felt probably most severely in Rhode Island, in the vicinity of the Scituate Reservoir. Such a flood on the Quabbin Reservoir watershed, if it came at a time when the reservoir was full, would result in a spillway discharge of about 2,000 cubic feet a second for a spillway weir 400 feet long. Records of large storms in western Massachusetts have produced rainfalls as high as 12 inches. Such a rainfall in a storm similar to the November, 1927, storm might produce a spillway discharge of about 3,000 cubic feet a second. A run-off of 12 inches in 24 hours would result in a spillway discharge of about 9,000 cubic feet a second.

Studies of both spillway sites revealed that, considering the use of excavated rock as riprap, the easterly site was more economical, and that it offered the better location structurally, as a discharge channel in rock all the way from the spillway weir to the river would be obtained. Because of these economic and structural advantages the easterly site has been adopted for location of the spillway weir and channel, but the natural features of the westerly site are also to be utilized by preparing at a slight extra cost this latter site as an additional insurance against overtopping of the dams in case of an unanticipated extreme emergency.

The easterly spillway channel will probably provide for carrying floods up to 10,000 cubic feet a second, without flooding out the rock discharge channel, and floods of considerably greater magnitude, even up to 15,000, will be carried with no important scour of the earth banks above the rock channel. There is room at that site for a concrete overflow to be built in rock valley between hills about 400 feet long. With the reservoir full for flows over the spillway as high as 15,000 cubic feet a second the reservoir will not rise higher than 6 feet above Elev. 530.

At the same time, at slight expense, by doing a little excavating and grading of the westerly weir site, and by building a shallow concrete cut-off to ledge there, an emergency overflow can be provided at Elev. 536 so that in case of an unanticipated extreme emergency, such as the clogging of the easterly spillway approach or discharge channels, or in case of unprecedented and extremely high run-off with a full reservoir, a material rise in the reservoir surface above Elev. 536 will be practically prevented.

Cross Section of Dams

The design of the section of the Dam is in keeping with general practice on large earth dams elsewhere, as can be seen from Fig. 8. A section of the Dike is shown in Fig. 1, and a tabulation comparing the Main Dam and Dike of Quabbin Reservoir with other large earth dams is given in the *appended table*.

The top width of 35 feet has been chosen in order to provide a considerable width through the embankment at the higher elevations near the flow line in order to permit continuing the sluicing properly to as high an elevation as possible. The freeboard of 20 feet between the spillway elevation and the top of embankment compares with 24 feet on the Conklinville Dam, New York; 24 feet on the Paddy Creek Dam, North Carolina; 20 feet on the earth dams at Ashokan Reservoir, New York; 20 feet at Cobble Mountain, Massachusetts (7 feet of which are flashboards); 19 feet on the Wyman Dam, Maine; 15 feet on the dikes of Wachusett Reservoir, Massachusetts; 15 feet on the Wanaque Dam, New Jersey; 14 feet on the Davis Bridge Dam, Vermont; 13 feet on the Scituate Dam, Rhode Island, and 12 feet on the Saluda Dam, South Carolina. The downstream face has slopes of 1 on 2, 1 on 2½, and 1 on 2¾, with berms 15 feet wide to intercept the drainage at intervals of 35 to 50 feet vertically. On the upstream slope a wave break of heavy riprap with a horizontal berm 5 feet above the spillway level has been used, following generally the design of the Wachusett Reservoir Dike and the Scituate Dam for the city of Providence, which has proved very satisfactory. Below this wave break a constant slope of 1 on 3, protected by riprap, has been carried to Elev. 458 for the Main Dam. Studies of the anticipated water levels during the filling of the reservoir and subsequent draw-downs during use indicate that to riprap below this elevation is not required. The wide berm at Elev. 458 is constructed of selected coarse material, with the idea it would take

Reservoir Storage (Acre-Ft)
Reservoir Water Surface Elev. (Quabbin Datum)
Storage Curve
Quabbin Reservoir Surface Area vs Reservoir Water Surface Elevation
Reservoir Surface Area in Acres

page C6c

APPENDIX D-15

page C6d

APPENDIX D-16

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Calculation of [illegible] - Auxiliary Spillway [illegible]

Reservoir W.S. Elev.	Reservoir Area, A (acres)	Calc. Outflow (cfs)	Calc. S above Spillway (ac-ft)	$\frac{S}{\Delta t}$	$\frac{S}{\Delta t} - \frac{O}{2}$	$\frac{S}{\Delta t} + \frac{O}{2}$
530	24,700	0	0	0	0	0
531	24,950	1500	24,925	600,764	600,014	[illegible]
532	25,190	4400	49,995	1,207,[illegible]	1,205,[illegible]	[illegible]
533	25,440	5930	75,310	1,[illegible],290	1,217,[illegible]	[illegible]
534	25,680	7920	100,770	[illegible]	[illegible]	[illegible]
535	25,900	9930	126,560	3,062,752	3,257,[illegible]	3,267,[illegible]
536	26,120	11,830	152,570	3,[illegible]	[illegible]	[illegible]
537	26,340	13,230	178,800	4,[illegible],910	4,[illegible]	[illegible]
538	26,550	15,340	205,245	4,936,[illegible]	4,[illegible]	4,97[illegible]

Δt = 24 hr = [illegible]

Adjusted [illegible] Rates of Storage - Auxiliary Spillway [illegible]

Reservoir W.S. Elev.	Reservoir Area, A (acres)	Calc. Outflow (cfs)	Calc. S above Spillway (ac-ft)	$\frac{S}{\Delta t}$	$\frac{S}{\Delta t} - \frac{O}{2}$	$\frac{S}{\Delta t} + \frac{O}{2}$
530	24,700	0	0	0	0	
531	24,950	1,500	24,925	600,764	600,014	601,51[illegible]
532	25,190	4,400	49,395	1,207,[illegible]	1,205,[illegible]	1,20[illegible]
533	25,440	7,525	75,310	1,820,[illegible]	1,816,312	1,82[illegible]
534	25,680	10,000	100,770	2,432,[illegible]	2,[illegible],636	2,44[illegible]
535	25,900	12,730	126,560	3,062,75[illegible]	3,256,512	3,26[illegible]
536	26,120	15,000	152,570	3,692,19[illegible]	3,684,[illegible]	3,[illegible]
536.4	26,210	16,133	163,060	3,9[illegible]	3,937,735	3,954,[illegible]
536.8	26,300	17,276	173,550	4,199,510	4,191,[illegible]	4,[illegible]
537.0	26,340	18,246	178,800	4,3[illegible]	4,312,932	4,33[illegible]

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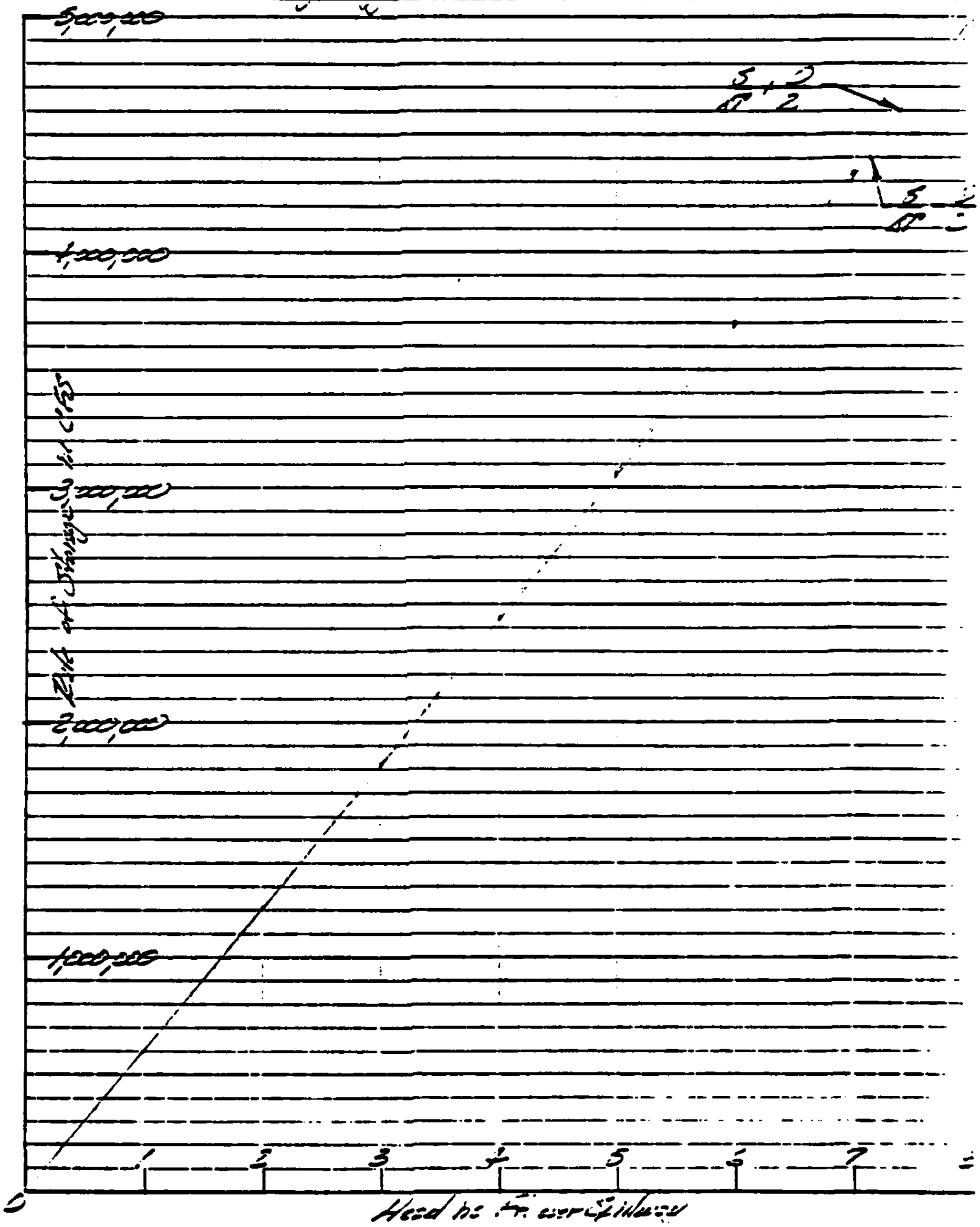

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Calculation of Reservoir Outflows – Auxiliary Spillway Evaluation

Time No. *	Obs. Inflow (cfs)	Average Inflow (cfs)	$\frac{S}{\Delta T} - \frac{O}{2}$	$\frac{S}{\Delta T} + \frac{O}{2}$	Head on Spillway (ft)	Outflow Q (cfs)
0	0	0			0.10	43
1	25,160	12,580	60,076	72,656	0.12	56
2	50,310	37,735	72,575	110,310	0.18	102
3	63,100	56,705	109,935	166,640	0.23	199
4	75,900	69,500	166,225	235,725	0.39	334
5	151,340	113,620	235,137	348,757	0.58	629
6	226,790	189,065	347,237	536,852	0.99	1256
7	177,220	201,995	535,613	737,663	1.23	2105
8	127,610	152,305	735,729	888,174	1.48	2303
9	103,960	115,785	885,959	1,001,744	1.66	3346
10	78,300	91,630	997,933	1,088,463	1.80	3730
11	53,840	66,070	1,083,646	1,150,716	1.92	4110
12	29,320	41,610	1,146,597	1,188,207	1.96	4250
13	2,200	16,040	1,183,909	1,199,949	1.93	4350
14	5,500	4,100	1,195,596	1,199,696	1.99	4350
15	6,350	5,925	1,195,344	1,201,269	1.99	4330
16	7,200	6,775	1,196,909	1,203,684	1.99	4330
17	8,600	7,900	1,199,312	1,207,212	2.00	4410
18	10,000	9,300	[illegible]	[illegible]	2.00	4410
19	11,400	10,700	1,207,713	1,218,413	2.01	4444
20	12,800	12,100	1,213,997	1,226,096	2.03	4511
21	15,100	13,950	1,221,656	1,235,606	2.04	4544
22	17,500	16,300	1,231,141	1,247,441	2.06	4616
23	20,200	18,850	1,242,947	1,261,797	2.09	4713
24	22,900	21,550	1,257,368	1,278,918	2.11	4793
25	26,200	24,550	1,274,247	1,298,797	2.15	4910
26	29,400	27,800	1,293,876	1,322,276	2.13	5066
27	36,500	33,050	1,317,387	1,350,447	2.23	5166
28	45,500	41,000	1,345,698	1,385,693	2.29	5352
29	51,700	47,600	1,380,963	1,428,463	2.36	5576
30	60,000	55,350	1,423,520	1,479,370	2.44	5811
31	76,000	68,000	1,474,301	1,542,301	2.52	6132
32	92,000	84,000	1,537,077	1,621,077	2.67	6507
33	108,500	100,250	1,615,659	1,715,908	2.83	7013
34	125,000	116,750	1,710,255	1,827,003	3.01	7555
35	129,100	127,050	1,821,070	1,948,120	3.20	8019
36	133,200	131,150	1,941,791	2,072,946	3.40	9513
37	134,000	133,600	2,066,220	2,199,820	3.61	9155
38	133,300	133,650	2,190,625	2,324,335	3.81	9523
39	129,200	131,250	2,319,785	2,450,035	4.01	10,025
40	125,000	127,100	2,442,055	2,569,155	4.20	10,476
41	119,000	122,000	2,560,520	2,682,520	4.33	10,940
42	113,000	116,000	2,674,207	2,790,207	4.56	11,339
43	105,300	109,250	2,781,187	2,890,447	4.71	11,761
44	94,000	98,750	2,880,[illegible]	2,978,[illegible]	4.86	12,133

* 30-minute increments

Time No.	Obs. Inflow (cfs)	Average Inflow (cfs)	S/Δt − O/2	S/Δt + O/2	Head on Spillway (ft)	Outflow Q (cfs)
45	88,350	91,425	2,969,272	3,060,699	4.99	[illegible]
46	83,700	86,025	3,050,841	3,137,116	5.11	13,757
47	79,350	81,525	3,127,016	3,203,541	5.2?	[illegible]
48	75,000	77,175	3,158,31?	3,235,339	5.33	13,31?
49	71,400	73,200	[illegible]	3,332,050	5.42	[illegible]
50	67,200	69,300	3,327,313	3,396,913	5.52	[illegible]
51	64,700	65,950	3,385,989	3,452,239	5.61	14,017
52	61,600	63,150	3,441,133	3,504,289	5.69	14,31?
53	58,300	59,950	3,493,023	3,55?,973	5.79	[illegible]
54	55,000	56,650	3,545,421	3,602,071	5.85	[illegible]
55	51,900	53,450	3,590,496	3,643,946	5.91	14,773
56	48,300	50,350	3,632,???	3,682,???	5.99	14,950
57	46,900	47,600	3,670,757	3,718,357	6.05	15,077
58	44,000	45,200	3,706,445	3,751,645	6.03	15,205
59	42,000	43,000	3,739,557	3,782,557	6.13	15,3??
60	40,000	41,000	3,770,451	3,811,451	6.13	15,461
61	37,750	38,875	3,798,315	3,837,190	6.22	15,5??
62	35,500	36,625	3,825,762	3,862,384	6.26	15,666
63	33,500	34,500	3,849,982	3,884,482	6.29	15,7??
64	31,500	32,500	3,872,031	3,904,531	6.32	15,81?
65	29,850	30,675	3,89?,003	3,922,677	6.35	[illegible]
66	28,200	29,025	3,910,091	3,939,116	6.38	15,975
67	26,850	27,525	3,926,973	3,954,003	6.40	16,0??
68	25,500	26,175	3,941,318	3,967,493	6.42	16,075
69	24,250	24,875	3,954,766	3,979,641	6.44	16,126
70	23,000	23,625	3,966,875	3,990,500	6.46	16,172
71	21,800	22,400	3,977,700	4,000,100	6.47	[illegible]
72	20,600	21,200	3,987,371	4,008,571	6.49	16,25?
73	19,450	20,025	3,995,614	4,015,639	6.50	[illegible]
74	18,300	18,875	4,002,760	4,021,635	6.51	[illegible]
75	17,450	17,875	4,008,23?	4,026,613	6.52	[illegible]
76	16,600	17,025	4,013,639	4,030,7??	6.52	[illegible]
77	15,800	16,200	4,017,29?	4,033,???	6.53	[illegible]
78	15,000	15,400	4,021,062	4,036,462	6.53	
79	14,300	14,650	4,023,507	4,038,162	6.53	16,3??
80	13,700	14,000	4,025,218	4,039,218	6.54	16,373
81	13,100	13,400	4,026,265	4,039,665	6.54	Max
82	12,500	12,800	4,026,710	4,039,510	6.54	
83	12,000	12,250	4,026,552	4,03?,8??	6.54	16,373
84	11,500	11,750	4,025,555	4,037,605	6.53	16,3??
85	11,000	11,250	4,024,257	4,035,?0?	6.53	
86	10,600	10,800	4,02?,???	4,032,7??	6.53	16,3??
87	10,200	10,400	4,020,???	4,031,???	6.52	16,3??
88	9,800	10,000	4,018,301	4,028,301	6.52	16,3??
89	9,500	9,650	4,015,38?	4,025,03?	6.51	16,3??
90	9,200	9,350	4,012,134	4,021,477	6.51	16,3??

Table 5-3 Values of C in the Formula $Q = CLH^{3/2}$ for Broad-crested Weirs

Measured head in feet, H	Breadth of crest of weir in feet											Rubble / Ashlar Surface
	0.50	0.75	1.00	1.50	2.00	2.50	3.00	4.00	5.00	10.00	15.00	
0.2	2.80	2.75	2.69	2.62	2.54	2.48	2.44	2.38	2.34	2.49	2.68	2.6
0.4	2.92	2.80	2.72	2.64	2.61	2.60	2.58	2.54	2.50	2.56	2.70	2.5
0.6	3.08	2.89	2.75	2.64	2.61	2.60	2.68	2.69	2.70	2.70	2.70	2.5
0.8	3.30	3.04	2.85	2.68	2.60	2.60	2.67	2.68	2.68	2.69	2.64	2.6
1.0	3.32	3.14	2.98	2.75	2.66	2.64	2.65	2.67	2.68	2.68	2.63	
1.2	3.32	3.20	3.08	2.86	2.70	2.65	2.64	2.67	2.66	2.69	2.64	2.65
1.4	3.32	3.26	3.20	2.92	2.77	2.68	2.64	2.65	2.65	2.67	2.64	2.75 2.65
1.6	3.32	3.29	3.28	3.07	2.89	2.75	2.68	2.66	2.65	2.64	2.63	2.85 2.7
1.8	3.32	3.32	3.31	3.07	2.88	2.74	2.68	2.66	2.65	2.64	2.63	
2.0	3.32	3.31	3.30	3.03	2.85	2.76	2.72	2.68	2.65	2.64	2.63	
2.5	3.32	3.32	3.31	3.28	3.07	2.89	2.81	2.72	2.67	2.64	2.63	
3.0	3.32	3.32	3.32	3.32	3.20	3.05	2.92	2.73	2.66	2.64	2.63	
3.5	3.32	3.32	3.32	3.32	3.32	3.19	2.97	2.76	2.68	2.64	2.63	
4.0	3.32	3.32	3.32	3.32	3.32	3.32	3.07	2.79	2.70	2.64	2.63	
4.5	3.32	3.32	3.32	3.32	3.32	3.32	3.32	2.88	2.74	2.64	2.63	
5.0	3.32	3.32	3.32	3.32	3.32	3.32	3.32	3.07	2.79	2.64	2.63	
5.5	3.32	3.32	3.32	3.32	3.32	3.32	3.32	3.32	2.88	2.64	2.63	

Table 5-4. Values of C in the Formula $Q = CLH^{3/2}$ for Models of Broad-crested Weirs with Rounded Upstream Corner

Name of experimenter	Radius of curvature in feet	Breadth of weir in feet, B	Height of weir in feet, P	Head in feet, H										
				[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Bazin	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]						
Bazin	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]						
U. S. Deep Waterways	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
U. S. Deep Waterways	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table 5-5 Values of C in the Formula $Q = CLH^{3/2}$ for Broad-crested Weirs with Crests Inclined Slightly Downward

(a)

Crest	Energy head = H_e								
	0.5	0.6	0.7	0.8	0.9	1.0	1.2	1.4	1.5
Level	2.79	2.79	2.80	2.81	2.82	[illegible]	[illegible]	[illegible]	[illegible]
Slope = [illegible]	[illegible]	2.91	2.91	2.91	2.91	2.90	[illegible]	2.87	2.87
Slope = [illegible]	3.07	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	

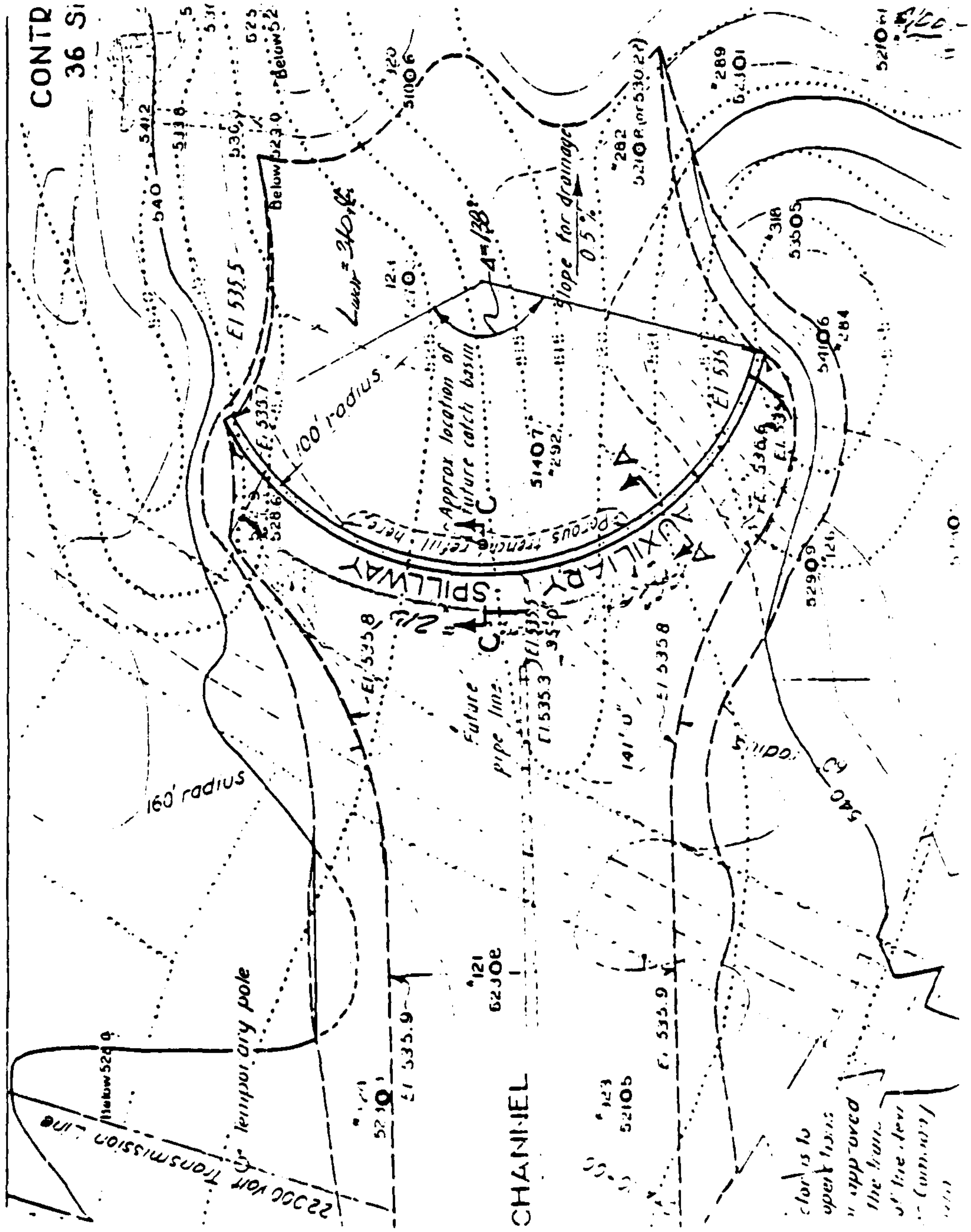
(b)

Slope of crest	Length of weir in feet	Head in feet, H						
		0.1	0.2	0.3	0.4	0.5	0.6	0.7
12 to 1	3.0	2.58	[illegible]	2.67	[illegible]	2.81	2.81	2.70
18 to 1	3.0	[illegible]	[illegible]	2.53	[illegible]	[illegible]	2.74	2.62
18 to 1	10.0	2.52	[illegible]	2.74	[illegible]	2.90	[illegible]	[illegible]

Table 5-6 Values of C in the Formula $Q = CLH^{3/2}$ for Weirs of Triangular Cross Section with Vertical Upstream Face and Sloping Downstream Face

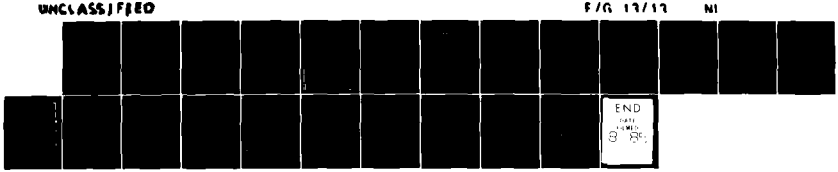
Slope of downstream face	Height of weir in feet, P	Head in feet, H										
Hor Vert		0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.2	1.5
1 to 1	2.46	[illegible]	3.85	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2 to 1	2.46	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3.51	3.51
2 to 1	1.64	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3 to 1	1.64		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5 to 1	2.46	. . .	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
10 to 1	2.46	. . .	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

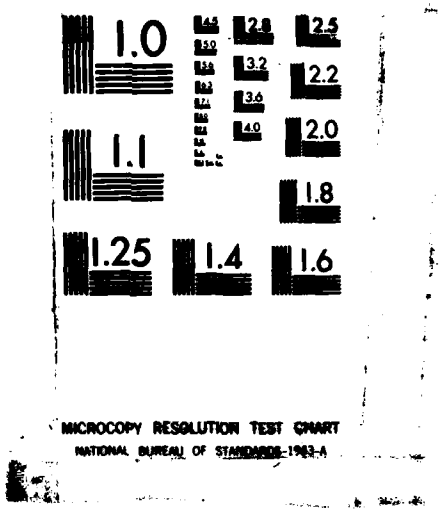
C/03 # 13


CONTR
AUXILIARY
SPILLWAY
CHANNEL
100' radius
160' radius
Slope for drainage
0.5%
Approx. location of future catch basin
Porous trench refill here
Future pipe line
temporary pole
22,000 volt transmission line
El 535.5
El 535.8
El 535.9
El 535.3

AD-A155 515 NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS 2/8
WINSOR DAM (MA 00588)..(U) CORPS OF ENGINEERS WALTHAM
MA NEW ENGLAND DIV SEP 78

UNCLASSIFIED F/G 13/13 NL




1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

CAMP DRESSER & MCKEE
Environmental Engineers
Boston, Mass.

CLIENT: [illegible] JOB NO. [illegible]
PROJECT: [illegible] SITE CHECKED: 9125.172
DETAIL: [illegible] CHECKED BY: Allied COMPUTED BY: [illegible]

[illegible]

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5340	0	0	0	15,200 ac	15,200 ac
5341	01	24	15.6 ac	15,500	15,565
5342	02	25	130.3	16,000	16,133
5343	03	25	244.0	16,500	16,744
5344	04	25	357.7	17,000	17,376
5345	05	25	546	17,500	18,046

CAMP DRESSER & McKEE
Environmental Engineers
Boston, Mass.

CLIENT [illegible] JOB NO. [illegible] PAGE [illegible]
PROJECT [illegible] DATE CHECKED 9/25/78 DATE [illegible]
DETAIL [illegible] CHECKED BY [illegible] COMPUTED BY [illegible]

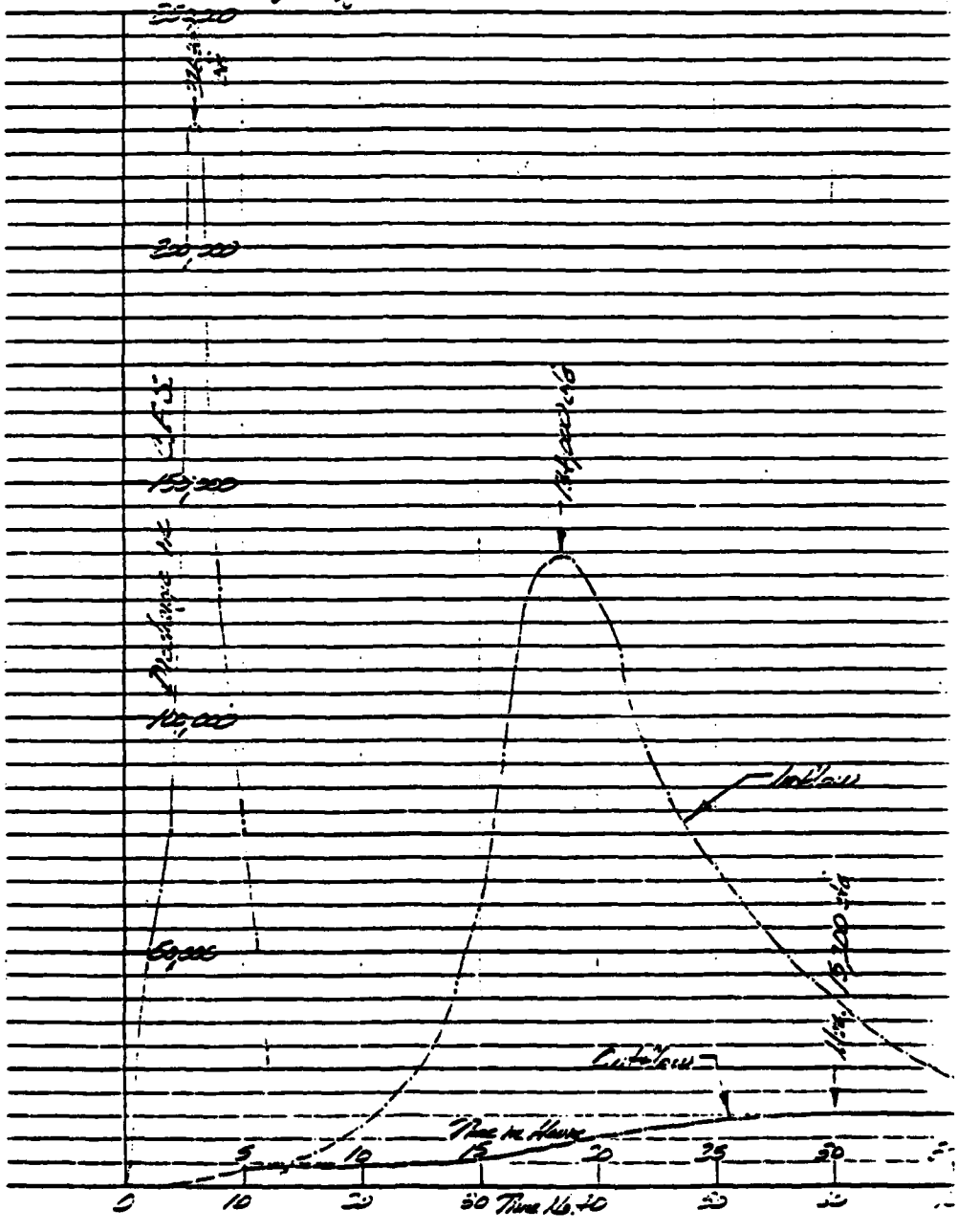
Calculation of Reservoir Outflow – Auxiliary Spillway Included

Time hr.	Inflow (cfs)	Average Inflow (cfs)	2S/Δt − O	2S/Δt + O	Head on Spillway (ft)	Outflow (cfs)
55	51,900	53,350	3,590,196	3,645,546	5.91	14,775
56	48,800	50,350	3,629,169	3,674,519	5.97	[illegible]
57	46,400	47,600	3,66[illegible]559	3,71[illegible] 189	6.02	[illegible]
58	44,000	45,200	3,68[illegible]	3,731,209	6.05	15,14[illegible]
59	[illegible],000	43,100	3,697,515	3,740,515	6.06	15,170
60	40,000	41,000	3,700,951	3,741,951	6.07	15,1[illegible]
61	37,750	38,875	[illegible]	3,740,[illegible]	6.06	15,192
62	35,500	36,625	3,700,[illegible]	3,737,5[illegible]9	6.06	15,170
63	33,500	34,500	3,69[illegible],763	3,734,263	6.05	15,14[illegible]
64	31,500	32,500	[illegible]61	3,729,761	6.05	15,1[illegible]
65	29,250	30,375	3,697,146	3,727,521	6.04	15,113
66	28,[illegible]00	28,725	3,695,906	37[illegible],921	6.04	)
67	26,850	27,525	3,694,741	3,722,266	6.04	15,115
68	25,500	26,175	3,693,[illegible]	3,719,3[illegible]	6.03	15,095
69	24,250	24,875	[illegible]	3,717,600	6.03	15,0[illegible]5
70	23,000	23,625	3,691,826	3,715,451	6.02	15,05[illegible]

CAMP DRESSER & MAKEE
Environmental Engineers
Boston, Mass.

CLIENT [illegible] JOB NO. [illegible]
PROJECT [illegible] DATE CHECKED [illegible]
DETAIL [illegible] CHECKED BY [illegible] COMPUTED BY [illegible]

PAGE [illegible]
DATE [illegible]



CAMP DRESSER & McKEE
Environmental Engineers
Boston, Mass.

CLIENT [illegible] JOB NO 261-9-RE PAGE 01
PROJECT [illegible] DAM DATE CHECKED 2/25/78 DATE 2-14-78
DETAIL [illegible] CHECKED BY [illegible] COMPUTED BY [illegible]

DAM FAILURE ANALYSIS

SPILLWAY CREST EL 530.0
EMERGENCY (OVERFLOW) SPILLWAY CREST EL. 536.0
TOP OF DAM EL 550.0

IT IS PHYSICALLY IMPOSSIBLE FOR THE RESERVOIR WATER SURFACE ELEV. TO REACH THE TOP OF DAM (EL. 550.0), AS THE EMERGENCY SPILLWAY WILL RELEASE OVERFLOWS AT EL. 536.0. ALSO THE ESTIMATED PMF SURCHARGE POOL LEVEL IS EL. 536.2

∴ ASSUME WATER LEVEL AT EL. 536.0 AT TIME OF FAILURE

STORAGE AT EL. 536.0 = 1,417,600 [illegible] or 462 billion gals.

WINSOR DAM

HEIGHT AT EL. 550.0 = 170'
" " " 536.0 = 156'

LENGTH = 2,340', ASSUME W_b = 20%.
∴ W_b = 2,340 x .2 = 468 ft.

$Q_{P_1} = 8/27 \times 468 \times (32.2)^{1/2} (156)^{3/2} = 1,833,000$ cfs

GOODNOUGH DIKE

HEIGHT AT EL. 550.0 = 135'
" " " 536.0 = 121'

LENGTH = 2,140', ASSUME W_b = 20%
∴ W_b = 2,140 x .2 = 428 ft.

$Q_{P_1} = 8/27 \times 428 \times (32.2)^{1/2} (121)^{3/2} = 936,000$ cfs

MAIN SPILLWAY

W.S. ELEV. ——— 536.0
M.N. ELEV. OF LEDGE EL. 530.0
6.0 ft

Let W_b = 40% of 370 ft. = 148 ft.

$Q_{P_1} = 8/27 (148)(32.2)^{1/2} (6)^{1.5} = 13,535$ cfs

Less than test flood

20

Haley & Aldrich - Dam Inspection Program for Corps of Engineers   June 29, 1978

Quabbin Reservoir - Field trip - H.P. Aldrich & Alan Holloway - H&A

Quabbin plans @ 20 Somerset St. - MDC Office   Roger Ward, C. Lovering; B.C.E. Fuller - CDM

Water Division - [illegible]

[illegible]

Today - WS El. ~~[illegible]~~ 529.73 BCB

{Note: 6.049 is corr. @ Quabbin for BCB to USGS - not 5.65 as usually stated "Red"

(worked on original construction) — Harold Willey

Harold Melvin, Supt.

- Public Document No. 147 - Quabbin Dam & Quabbin-Wachusett tunnel
  Goodnough Dike + Beaver Brook Dike

In 22 years that Harry Willey has been here, no modifications have been made to main dam, dike or spillway. Travelling screen was added to intake works in 1966 - plans by CDM - const. by R.H. White

CAMP DRESSER & McKEE
Environmental Engineers
Boston, Mass.

CLIENT [illegible] JOB NO. [illegible] PAGE [illegible]
PROJECT [illegible] DATE CHECKED DATE [illegible]
DETAIL [illegible] Inspection CHECKED BY COMPUTED BY [illegible]

Reconnaissance & Review of Plans - 8:30am to 10:00am

Overflow Spillway - 10:15 am to 11:45 am

Spillway length - 400 ft.

Crest Elev 530.0 (BCB) stone capped overflow

Elev 528.0 (BCB) 5 bay spillway with 2 ft. flashboards (3 bds @ 8")

Width - varies - see plans

Location - 4000' NE of [illegible] works

Number & type of gates - None

Note: weeds and organic overgrowth [illegible] settlement [illegible] of spillway [illegible] until spillage depth exceeds 6". Also [illegible] large & small branches just [illegible] of [illegible] 10 ft. of crest should be removed

Note: left (east) rock face of spillway discharge channel shows considerable weathering with rock deposited in channel about midway between spillway and stone arch bridge d/s. Covered by H.O.

Note: check out channel approach velocities at constriction about 100' u/s of spillway with flashboards. Channel narrows to 50'-60' from 80-90' width u/s.

CAMP DRESSER & McKEE Environmental Engineers Boston, Mass.	CLIENT Mohawk Albany – Dam Inspection PROJECT Contract for Corps of Engineers DETAIL [illegible]	JOB NO. 514-8-RP DATE CHECKED CHECKED BY
		PAGE 3 of 6 DATE June 29/1978 COMPUTED BY [illegible]

Intake Works – 12:30pm to 1:00pm

Inspection included structural (RJ Wool) and mechanical (C. Lawridge) of structure & equipment. Note – handling screens installed in 1966 by R.H. White with plans & specs. by CDM.

Emergency Spillway – 1pm to 1:30pm

Earth overflow section – slopes upward about 4' from shoulder which is 2' above W.S. ∴ spillway 6' above W.L. Good grass and sod cover – a few minor places where sod recently reseeded. Leads to sand drainage hurled above spillway before dropping to natural terrain.

Power House – 2pm to 3:30pm

Inspection included structural (R. Wool) and mechanical (C. Lawridge) of structure & equipment. We also observed 480 ft. of bypass tunnel from power station up to water level.

CAMP DRESSER & McKEE
Environmental Engineers
Boston, Mass.

CLIENT [illegible] JOB NO. [illegible]
PROJECT [illegible] DATE CHECKED
DETAIL [illegible] CHECKED BY

PAGE E3 of 6
DATE [illegible]
COMPUTED BY [illegible]

Culvert Adequacy Downstream of Goodnough Dike

Beaver Brook culvert beneath Rte. 9 in Ware

12' wide x 9' high corr. multi-plate arch - L = 70'±

QUABBIN RESERVOIR - Elevation - Capacity Data

Elev. (BCB)	Cap. (M.G.)	Elev. (BCB)	Cap. (M.G.)	
501.0	216,000	523.0	359,100	
502.0	219,700	524.0	366,600	
503.0	225,400	525.0	374,100	
504.0	231,200	526.0	381,600	
505.0	237,100	527.0	389,100	
506.0	243,100	528.0	396,100	
507.0	249,100	529.0	404,400	
508.0	255,100	530.0	412,240	Spillway Crest
509.0	261,300	530.2	413,929	
510.0	267,700	530.4	415,629	
511.0	274,100	530.6	417,340	
512.0	280,700	530.8	419,063	
513.0	287,800	531.0	420,800	
514.0	294,100	531.2	422,549	
515.0	300,900	531.4	424,310	
516.0	307,800	531.6	426,083	
517.0	314,900	531.8	427,868	
518.0	322,100	532.0	429,670	
519.0	329,400	532.2	431,488	
520.0	336,700	532.4	433,322	
521.0	344,100	532.6	435,172	
522.0	351,600	532.8	437,038	
		533.0	438,920	

CAMP DRESSER & McKEE
Environmental Engineers
Boston, Mass.

CLIENT [illegible] JOB NO. [illegible] PAGE [illegible]
PROJECT [illegible] DATE CHECKED DATE [illegible]
DETAIL [illegible] CHECKED BY COMPUTED BY [illegible]

QUABBIN RESERVOIR - Spillage to Swift River

1978	W.S. Elev.	Flow in cfs	1976	W.S. Elev.	Flow in cfs
April 16	530.01	2.0	April 2	530.02	6.0
17	.04	12.0	3	.08	21
18	.07	26.0	4	.13	63
19	.15	78.0	5	.14	70
20	.21	129.0	6	.13	63
21	.27	188.0	7	.11	49
22	.31	234.0	8	.10	43.2
23	.32	246.0	9	.08	31
24	.34	269.0	10	.06	12
25	.34	269.0	11	.03	9
26	.33	257.0	12	530.01 - 4hrs	@ 4
27	.33	257.0			
28	.31	234.0			
29	.29	210.0			
30	.27	188.0			
May 1	.26	178.0			
2	.21	129.0			
3	.15	78.0			
4	.11	49.0			
5	.09	37.0			
6	.05	16.3			
7	.05	10 hrs @ 6.0			
8	530.00	0			

Last previous spillage in 1961

Highest Elev. 531.03 Apr 18, 1953

Lowest Elev. 495.70 Nov 5, 1967

E 6 of 6

Nov 4, 1976 - 164.8 M.S. Label
Nov 1, 1976 253.0 cfs } same note
El. 529.89 163.5 mgd }
no keys - 5 keys open

Spillway discharged this year - first time since 1976 - no spillkeys
since 1961 till 1976

April 24, 1978 - El. 530.34 269.0 cfs - 173.8 mgd
all keys in place - no keys open

APPENDIX E
INFORMATION CONTAINED IN THE NATIONAL INVENTORY OF DAMS

INVENTORY OF DAMS IN THE UNITED STATES

STATE	IDENTITY NUMBER	DIVISION	STATE	COUNTY	CONGR. DIST.	STATE	COUNTY	CONGR. DIST.	NAME	LATITUDE (NORTH)	LONGITUDE (WEST)	REPORT DATE DAY	MO	YR
1A	588	NED	MA	015	01				QUABBIN-WINSOR DAM	4217.0	7220.0	06	SEP	78

POPULAR NAME	NAME OF IMPOUNDMENT
	QUABBIN RESERVOIR

REGION	BASIN	RIVER OR STREAM	NEAREST DOWNSTREAM CITY–TOWN–VILLAGE	DIST FROM DAM (MI.)	POPULATION
01	08	SWIFT RIVER	WARE	0	8679

TYPE OF DAM	YEAR COMPLETED	PURPOSES	STRUCTURAL HEIGHT (FT.)	HYDRAULIC HEIGHT (FT.)	IMPOUNDING CAPACITIES MAXIMUM (ACRE-FT.)	NORMAL (ACRE-FT.)	DIST	OWN	FED R	PRV/FED	SCS A	VER/DATE
RECTPG	1939	8	280	170	1810000	1265200	NED	N	N	N	N	28AUG78

REMARKS

U.S. MAP	SPILLWAY CREST LENGTH (FT.)	SPILLWAY TYPE	SPILLWAY WIDTH (FT.)	MAXIMUM DISCHARGE (CFS)	VOLUME OF DAM (CY)	POWER CAPACITY INSTALLED (MW)	POWER CAPACITY PROPOSED (MW)	NAVIGATION LOCKS NO.	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)
1	2640	C	405	15000	4000000									

OWNER	ENGINEERING BY	CONSTRUCTION BY
METROPOLITAN DIST, COMM	METROPOLITAN DIST, COMM	BENJAMIN FOSTER COMPANY

REGULATORY AGENCY			
DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
NONE	NONE	NONE	MA DPW

INSPECTION BY	INSPECTION DATE DAY	MO	YR	AUTHORITY FOR INSPECTION
HALEY & ALDRICH, INC.	29	JUN	78	PUBLIC LAW 92-367

REMARKS

INVENTORY OF DAMS IN THE UNITED STATES

(1) STATE	(2) NATIONAL INVENTORY NUMBER	(3) DIVISION	(4) BASIN	(5) COUNTY	(6) CONGRESS. DIST.	(7) STATE	(8) COUNTY	(9) CONGRESS. DIST.	(9) NAME	(10) LATITUDE (NORTH)	(11) LONGITUDE (WEST)	(12) REPORT DATE DAY | MO | YR
MA	589	NED	MA	015	01				QUABBIN SPILLWAY	4217.2	7220.5	08SEP78

(13) POPULAR NAME	(14) NAME OF IMPOUNDMENT
	QUABBIN RESERVOIR

(15) REGION	(16) BASIN	(17) RIVER OR STREAM	(18) NEAREST DOWNSTREAM CITY–TOWN–VILLAGE	(19) DIST FROM DAM (MI.)	(20) POPULATION
01	08	SWIFT RIVER	WARE	0	8079

(21) TYPE OF DAM	(22) YEAR COMPLETED	(23) PURPOSES	(24) STRUC. HEIGHT (FT.)	(25) HYDRAU. HEIGHT (FT.)	(26) IMPOUNDING CAPACITIES MAXIMUM (ACRE-FT.)	(26) NORMAL (ACRE-FT.)	(27) INSPECTION DIST	(28) UNDER CONSTRUCTION	(29) FEDERAL REGULATORY	(30) PRIVATE/FEDERAL	(31) SECURITY	(32) VIOLATION/DATE
GHPG	1938	8	10	10	1810000	1265200	NED	N	N	N	N	28AUG78

(33) REMARKS

(34) DAM	(35) SPILLWAY LENGTH (FT.)	(35) SPILLWAY TYPE	(35) SPILLWAY WIDTH (FT.)	(36) MAXIMUM DISCHARGE (CFS)	(37) VOLUME OF DAM (CY)	(38) POWER CAPACITY INSTALLED (MW)	(38) POWER CAPACITY PROPOSED (MW)	(39) NAVIGATION LOCKS NO	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)
3	405	C	55	15000												

(40) OWNER	(41) ENGINEERING BY	(42) CONSTRUCTION BY
METROPOLITAN DIST.COMM	METROPOLITAN DIST.COMM	

(43) REGULATORY AGENCY			
DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
NONE	NONE	NONE	MA DPW

(44) INSPECTION BY	(45) INSPECTION DATE DAY | MO | YR	(46) AUTHORITY FOR INSPECTION
HALEY & ALDRICH, INC.	29JUN78	PUBLIC LAW 92-367

(47) REMARKS

INVENTORY OF DAMS IN THE UNITED STATES

NAME	IDENTIFY NUMBER	DIVISION	STATE	COUNTY	CONGR DIST	STATE	COUNTY	CONGR DIST	NAME	LATITUDE (NORTH)	LONGITUDE (WEST)	REPORT DATE DAY | MO | YR
MA	590	NED	MA	015	01				QUABBIN GOODNOUGH DIKE	4217.9	7218.0	08SEP78

POPULAR NAME	NAME OF IMPOUNDMENT
	QUABBIN RESERVOIR

REGION	BASIN	RIVER OR STREAM	NEAREST DOWNSTREAM CITY–TOWN–VILLAGE	DIST FROM DAM (MI.)	POPULATION
01	08	BEAVER BROOK	HARE	0	8679

TYPE OF DAM	YEAR COMPLETED	PURPOSES	STRUCTURAL HEIGHT (FT.)	HYDRAULIC HEIGHT (FT.)	IMPOUNDING CAPACITIES MAXIMUM (ACRE-FT.)	IMPOUNDING CAPACITIES NORMAL (ACRE-FT.)
RECTPG	1938	8	200	135	1810000	1265200

DIST	OWN	FED H	PRV/FED	SCS A	VER/DATE
NED	N	N	N	N	28AUG78

REMARKS

D/S HAS	SPILLWAY CREST LENGTH (FT.)	SPILLWAY TYPE	SPILLWAY WIDTH (FT.)	MAXIMUM DISCHARGE (CFS)	VOLUME OF DAM (CY)	POWER CAPACITY INSTALLED	POWER CAPACITY PLANNED	NAVIGATION LOCKS NO	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)
1	2140	N			2700000											

OWNER	ENGINEERING BY	CONSTRUCTION BY
METROPOLITAN DIST,COMM	METROPOLITAN DIST,COMM	ARTHUR A. JOHNSON CORP.

REGULATORY AGENCY			
DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
NONE	NONE	NONE	MA DPW

INSPECTION BY	INSPECTION DATE DAY | MO | YR	AUTHORITY FOR INSPECTION
MALEY & ALDRICH, INC,	29JUN78	PUBLIC LAW 92-367

REMARKS
48-EMBANKMENT CONTRACT

INVENTORY OF DAMS IN THE UNITED STATES

(1) STATE	(2) IDENTITY NUMBER	(3) DIVISION	(4) STATE	(5) COUNTY	(6) CONGR. DIST.	(7) STATE	(8) COUNTY	(9) CONGR. DIST.	(10) NAME	(11) LATITUDE (DDMM.M)	(12) LONGITUDE (WEST)	(13) REPORT DATE DAY | MO | YR
MA	589	NED	MA	015	01				QUABBIN SPILLWAY	4217.2	7220.5	08SEP78

(14) POPULAR NAME	(15) NAME OF IMPOUNDMENT
	QUABBIN RESERVOIR

(16) REGION	(17) BASIN	(18) RIVER OR STREAM	(19) NEAREST DOWNSTREAM CITY–TOWN–VILLAGE	(20) DIST FROM DAM (MI.)	(21) POPULATION
01	08	SWIFT RIVER	WARE	0	8679

(22) TYPE OF DAM	(23) YEAR COMPLETED	(24) PURPOSES	(25) STRUCTURAL HEIGHT (FT.)	(26) HYDRAULIC HEIGHT (FT.)	(27) IMPOUNDING CAPACITIES MAXIMUM (ACRE–FT.)	(28) NORMAL (ACRE–FT.)	(29) DIST	(30) DAM	(31) FED N	(32) PRV/FED	(33) SCS A	(34) VEN/DATE
GRPG	1938	S	10	10	1610000	1265200	NED	N	N	N	N	28AUG78

(35) REMARKS

(36) D/S HAS	(37) SPILLWAY CREST (FT.)	(38) TYPE	(39) WIDTH (FT.)	(40) MAXIMUM DISCHARGE (CFS)	(41) VOLUME OF DAM (CY)	(42) POWER CAPACITY INSTALLED (MW)	(43) PROPOSED (MW)	(44) NO	(45) LENGTH (FT.)	(46) WIDTH (FT.)	(47) LENGTH (FT.)	(48) WIDTH (FT.)	(49) LENGTH (FT.)	(50) WIDTH (FT.)	(51) LENGTH (FT.)	(52) WIDTH (FT.)
Y	405	C	35	15000												

(53) OWNER	(54) ENGINEERING BY	(55) CONSTRUCTION BY
METROPOLITAN DIST.COMM	METROPOLITAN DIST.COMM	

(56) REGULATORY AGENCY			
DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
NONE	NONE	NONE	MA DPW

(57) INSPECTION BY	(58) INSPECTION DATE DAY | MO | YR	(59) AUTHORITY FOR INSPECTION
WALLEY & ALDRICH, INC.	29JU.78	PUBLIC LAW 92-367

(60) REMARKS

INVENTORY OF DAMS IN THE UNITED STATES

	IDENTITY NUMBER	AUTHORITY	STATE	COUNTY	CONGR DIST	STATE	COUNTY	CONGR DIST	NAME	LATITUDE (NORTH)	LONGITUDE (WEST)	REPORT DATE DAY / MO / YR
NA	590	NED	MA	015	01				QUABBIN GOODNOUGH DIKE	4217.9	7218.0	08SEP78

POPULAR NAME	NAME OF IMPOUNDMENT
	QUABBIN RESERVOIR

SECTION	BASIN	RIVER OR STREAM	NEAREST DOWNSTREAM CITY–TOWN–VILLAGE	DIST FROM DAM (MI.)	POPULATION
01	08	BEAVER BROOK	HARE	0	8679

TYPE OF DAM	YEAR COMPLETED	PURPOSES	STRUCTURAL HEIGHT (FT.)	HYDRAULIC HEIGHT (FT.)	IMPOUNDING CAPACITIES MAXIMUM (ACRE–FT.)	IMPOUNDING CAPACITIES NORMAL (ACRE–FT.)	DIST	DAM	FED R	PRV/FED	SCS A	YEAR/DATE
RECTPG	1938	8	200	135	1810000	1265200	NED	N	N	N	N	28AUG78

REMARKS

D/S HAZ	SPILLWAY CREST LENGTH (FT.)	SPILLWAY TYPE	SPILLWAY WIDTH (FT.)	MAXIMUM DISCHARGE (CFS)	VOLUME OF DAM (CY)	POWER CAPACITY INSTALLED (MW)	POWER CAPACITY PROJECTED (MW)	NAVIGATION LOCKS NO.	LOCK LENGTH (FT.)	LOCK WIDTH (FT.)	LOCK LENGTH (FT.)	LOCK WIDTH (FT.)	LOCK LENGTH (FT.)	LOCK WIDTH (FT.)	LOCK LENGTH (FT.)	LOCK WIDTH (FT.)
1	2140	N			2700000											

OWNER	ENGINEERING BY	CONSTRUCTION BY
METROPOLITAN DIST,COMM	METROPOLITAN DIST,COMM	ARTHUR A. JOHNSON CORP.

REGULATORY AGENCY			
DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
NONE	NONE	NONE	MA DPW

INSPECTION BY	INSPECTION DATE DAY / MO / YR	AUTHORITY FOR INSPECTION
HALEY & ALDRICH, INC.	29JUN78	PUBLIC LAW 92-367

REMARKS
48-EMBANKMENT CONTRACT

INVENTORY OF DAMS IN THE UNITED STATES

DAM	IDENTIFY NUMBER	NATIONAL	STATE	COUNTY	CONGRESS DIST.	OTHER	COUNTY	OTHER CONGR. DIST.	NAME	LATITUDE (NORTH)	LONGITUDE (WEST)	REPORT DATE DAY	MO	YR
MA	500	NED	MA	015	01				QUABBIN (WINSOR) DAM	4217.0	7220.0	08	SEP	78

POPULAR NAME	NAME OF IMPOUNDMENT
	QUABBIN RESERVOIR

CONGRESS DIST.	CODE	RIVER OR STREAM	NEAREST DOWNSTREAM CITY-TOWN-VILLAGE	DIST FROM DAM (MI.)	POPULATION
01	08	SWIFT RIVER	WARE	0	8679

TYPE OF DAM	YEAR COMPLETED	PURPOSES	STRUCTURAL HEIGHT (FT.)	HYDRAULIC HEIGHT (FT.)	IMPOUNDING CAPACITIES MAXIMUM (ACRE-FT.)	IMPOUNDING CAPACITIES NORMAL (ACRE-FT.)	DIST	UNN	FED R	PRV/FED	SCS A	VER/DATE
RECTMG	1939	8	280	170	1810000	1265200	NED	N	N	N	N	28AUG78

REMARKS

D/S HAS	SPILLWAY CREST LENGTH	SPILLWAY TYPE	SPILLWAY WIDTH (FT.)	MAXIMUM DISCHARGE (FT.)	VOLUME OF DAM (CY)	POWER CAPACITY INSTALLED (MWH)	POWER CAPACITY PROPOSED (MWH)	NAVIGATION LOCKS NO.	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)
1	2640	C	405	15000	4000000											

OWNER	ENGINEERING BY	CONSTRUCTION BY
METROPOLITAN DIST, COMM	METROPOLITAN DIST, COMM	BENJAMIN FOSTER COMPANY

REGULATORY AGENCY			
DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
NONE	NONE	NONE	MA DPW

INSPECTION BY	INSPECTION DATE DAY	MO	YR	AUTHORITY FOR INSPECTION
HALEY & ALDRICH, INC.	29	JUN	78	PUBLIC LAW 92-367

REMARKS

INVENTORY OF DAMS IN THE UNITED STATES

(1) STATE	(2) IDENTITY NUMBER	(3) DIVISION	(4) STATE	(5) COUNTY	(6) CONGR. DIST.	(7) STATE	(8) COUNTY	(9) CONGR. DIST.	(10) NAME	(11) LATITUDE (NORTH)	(12) LONGITUDE (WEST)	(13) REPORT DATE DAY | MO | YR
MA	509	NED	MA	015	01				QUABBIN SPILLWAY	4217.2	7220.5	08SEP78

(14) POPULAR NAME	(15) NAME OF IMPOUNDMENT
	QUABBIN RESERVOIR

(16) REGION	(17) BASIN	(18) RIVER OR STREAM	(19) NEAREST DOWNSTREAM CITY-TOWN-VILLAGE	(20) DIST FROM DAM (MI.)	(21) POPULATION
01	08	SWIFT RIVER	NAME	0	8079

(22) TYPE OF DAM	(23) YEAR COMPLETED	(24) PURPOSES	(25) STRUCTURAL HEIGHT (FT.)	(26) HYDRAULIC HEIGHT (FT.)	(27) IMPOUNDING CAPACITIES MAXIMUM (ACRE-FT.)	(28) NORMAL (ACRE-FT.)	(29) DIST	(30) DAM	(31) FED H	(32) PRV/FED	(33) SCS A	(34) YEAR/DATE
GRPG	1938	S	10	10	1810000	1265200	NED	N	N	N	N	28AUG78

(35) REMARKS

(36) DIS MAS	(37) SPILLWAY CREST ELEVATION (FT.)	(38) TYPE	(39) WIDTH (FT.)	(40) MAXIMUM DISCHARGE (FT.)	(41) VOLUME OF DAM (CY)	(42) POWER CAPACITY INSTALLED (MW)	(43) PROPOSED (MW)	(44) NO.	(45) NAVIGATION LOCKS LENGTH (FT.)	(46) WIDTH (FT.)	(47) LENGTH (FT.)	(48) WIDTH (FT.)	(49) LENGTH (FT.)	(50) WIDTH (FT.)	(51) LENGTH (FT.)	(52) WIDTH (FT.)
3	405	C	35	15000												

(53) OWNER	(54) ENGINEERING BY	(55) CONSTRUCTION BY
METROPOLITAN DIST.COMM	METROPOLITAN DIST.COMM	

(56) REGULATORY AGENCY DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
NONE	NONE	NONE	MA DPW

(57) INSPECTION BY	(58) INSPECTION DATE DAY | MO | YR	(59) AUTHORITY FOR INSPECTION
HALEY & ALDRICH, INC.	29JUN78	PUBLIC LAW 92-367

(60) REMARKS

DISPOSITION FORM

For use of this form, see AR 340-15, the proponent agency is TAGCEN.

REFERENCE OR OFFICE SYMBOL	SUBJECT
NEDED-E	Dam Inspection Final Report

TO Chief, Design Branch
Chief, F & M Branch
Chief, Water Control Branch

FROM Chairman,
Dam Safety Review Board

DATE 4 Oct. 78 CMT 1

1. Attached is a single copy of the final report for Winsor Dam, Quabbin Spillway & Goodnough Dike, Identity No. MA 00588, 00589 & 00590.

2. Please ascertain that the report is acceptable in accordance with your Branch comments or instructions given to the Architect-Engineer at the Review Board Meeting.

3. If acceptable, retain the copy for your files and be prepared to sign the (master) approval sheet on 18 Oct.

4. If the report requires further work or correction, notify the undersigned as soon as the determination is made.

5. The cost code for this review is ABA020700000000.

Tiersch
TIERSCH

Incl
as

DA FORM 1 FEB 62 2496 REPLACES DD FORM 96, WHICH IS OBSOLETE. GPO-1978-665-423/1093

DISPOSITION FORM

For use of this form, see AR 340-15, the proponent agency is TAGCEN.

REFERENCE OR OFFICE SYMBOL	SUBJECT
NEDED-E	Dam Inspection Final Report

TO: Chief, Design Branch
Chief, F & M Branch
Chief, Water Control Branch

FROM: Chairman,
Dam Safety Review Board

DATE: 4 oct. 78

CMT 1

1. Attached is a single copy of the final report for Winsor Dam, Quabbin Spillway & Dam, Identity No. MA00588, 00589 & 00590. Goodnough Dike

2. Please ascertain that the report is acceptable in accordance with your Branch comments or instructions given to the Architect-Engineer at the Review Board Meeting.

3. If acceptable, retain the copy for your files and be prepared to sign the (master) approval sheet on 9 oct.

4. If the report requires further work or correction, notify the undersigned as soon as the determination is made.

5. The cost code for this review is ABA0 20700000000.

Tiersch

Incl
as

TIERSCH

DA FORM 1 FEB 63 2496 REPLACES DD FORM 96, WHICH IS OBSOLETE.

This Phase I Inspection Report on Windsor Dam, Quabbin Spillway & Goodnough Dike has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

Charles G. Tiersch

CHARLES G. TIERSCH, Chairman
Chief, Foundation and Materials Branch
Engineering Division

Fred J. Ravens Jr.

FRED J. RAVENS, Jr., Member
Chief, Design Branch
Engineering Division

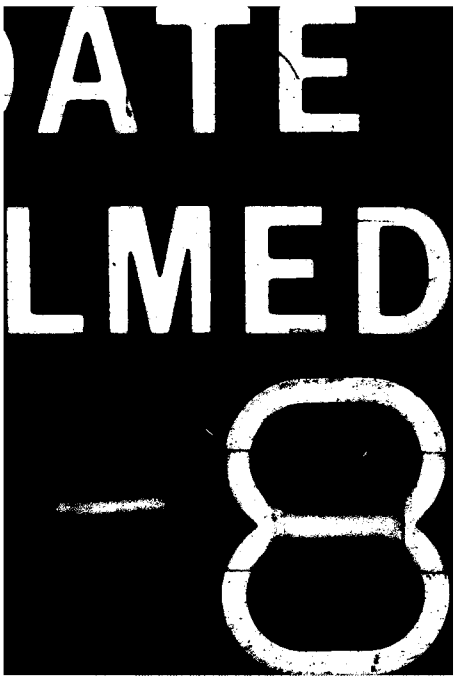
Saul Cooper

SAUL COOPER, Member
Chief, Water Control Branch
Engineering Division

APPROVAL RECOMMENDED:

Joe B. Fryar

JOE B. FRYAR
Chief, Engineering Division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